Exxon Valdez Oil Spill
Restoration Project Annual Report

Sockeye Salmon Overescapement

Restoration Project 94258
Annual Report

This annual report has been prepared for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have not been addressed in this annual report.

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Restoration Project 94258
Final Report

Study History: Restoration Project 94258 continues the study effort initiated in 1990 with Fish/Shellfish 27 (same title), which continued until 1992. In 1993, the effort continued with Restoration Project 93002.

Abstract: We provide a continuing examination of the effects of large escapements of sockeye salmon into the Kenai River system and into Red and Akalura lakes on Kodiak Island. Larger than anticipated adult returns to the Kenai River in 1994 suggest earlier reported smolt numbers were underestimated for at least the 1989 brood year. Fall fry from Skilak and Kenai lakes in 1993 were smaller and had less lipid content than Tustumena Lake fry, while spring fry samples indicated major decreases in fat content in Tustumena Lake fry while Skilak Lake fry showed little change. Mortality coupled with some early spring growth in Skilak Lake apparently explains these differences. Spawner abundances from the mainstem Kenai River are correlated with Skilak Lake fall fry size. This suggests a density dependent relationship with escapement into the Kenai River system. The effect of this density dependence on smolt production and subsequent adult returns requires data from returning adults in 1995 and 1996 due to uncertainty of Kenai River smolt esimates from the primary smolt age class migrating out of the system in 1992-93.

Key Words: Escapement, Kenai River, Kodiak Island, lake ecosystems, limnology, *Oncorhynchus nerka*, overescapement, overwinter survival, rearing, smolt production, sockeye salmon.

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REPORT NOTE: This is a report of studies that are in progress. All data and analyses provided are incomplete and preliminary. This report, as well as the data and analyses contained in the report, should not be cited without an express statement of the incomplete and preliminary nature of the information.

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EXECUTIVE SUMMARY

This status report is the fifth in a series describing progress on studies conducted of the effect of overescapement on the production of sockeye salmon from selected major rearing lakes impacted by the Exxon *Valdez* oil spill. Large escapements can result in the over abundance of juvenile salmon rearing in lakes. By exceeding the rearing capacity, prey resources are altered through changes in species, size composition, and biomass (Koenings and Burkett 1987; Kyle et al. 1988; Koenings and Kyle 1991). In some sockeye salmon systems, escapements of two to three times normal levels create major changes in nursery lakes which affect the abundance, size, and age structure of sockeye salmon smolts. These alterations to nursery lakes may be sustained and adversely affect productivity in succeeding years. We report an update on the results of studies of the 1989 overescapement event caused by the presence of oil on the fishing grounds.

Preliminary data are available on the 1994 smolt production, including size, age structure, and abundance. Adult returns in 1994 from predominantly the 1989 brood year were much higher than forecasts based on the smolt data. This suggests that the smolt numbers were underestimated in 1991. Projected returns from future smolt estimates will have a high degreee of uncertainty and the amount of damages incurred will await adult returns. The smolt estimates for 1994 were up significantly however, suggesting production in the future may be recovering. The pre-smolt however, indicated very low fat content and apparently significant mortality when compared with smolt produced from Tustumena Lake. The Red Lake system demonstrated low numbers of smolt outmigrating in 1994 although lake fry abudnance appeared to be significantly higher. .Akalura Lake also had low numbers of smolt and showed continuing poor production.

Further analysis of density related affects in Skilak Lake indicate that low return per spawner and fall weight and lipid content are related to escapements. Because of the uncertainty of the smolt numbers, the effect of these larges escapements on adult production is uncertain. Therefore, detailed studies recommended in the 1994 status report have been delayed for one year, pending the adult return for 1995.

INTRODUCTION

Following the Exxon *Valdez* oil spill (EVOS) in 1989, the presence of oil in the waters of traditional fishing areas in the Gulf of Alaska resulted in the closure of many commercial fisheries. This resulted in the escapement of large numbers of sockeye salmon (*Oncorhynchus nerka*) into some freshwater systems. EVOS-funded studies on the impact of large escapements on future sockeye salmon production were initiated in 1990. Specifically, these investigations assessed impacts to the production and ecology of major sockeye salmon rearing lakes on Kodiak Island and the Kenai Peninsula (Figures 1 and 2).

In the Kodiak Island area, 1989 Red Lake sockeye salmon escapement was 768,000, more than twice the management goal of 200,000 to 300,000. At Akalura Lake, the escapement was 116,000, about twice the 40,000 to 60,000 goal range. However, not all Kodiak systems received higher-than-average escapements. For example, nearby Upper Station Lake had a 286,000 escapement, which is reasonably close to the 200,000 to 275,000 goal.

The Kenai Peninsula in Southcentral Alaska contains several major glacial lakes that have produced large runs of sockeye salmon over the past decade. From 1987 to 1989, escapements of adults into the Kenai River system were approximately double those of previous years, and double the Alaska Department of Fish and Game's management goal of 550,000 adults.

High densities of planktivorous fish can exert top-down control over lower trophic levels, and measurable ecosystem changes within the affected lakes were expected to occur. For example, major forage items within the zooplankton community may be reduced or eliminated, prey item body-sizes may be reduced and preferred food items may be replaced by forms resistant to predation. Kyle et al. (1988) found that large sockeye escapements into Frazer Lake on Kodiak Island resulted in subsequent reductions in smolt size that was correlated to a depressed zooplankton community.

Density-dependent mechanisms may decrease production whereby predation exhausts or alters the availability of the food resources. This reduction in food resources may subsequently lead to decreased survival. Alternatively, climatic variation, such as extended winters could be a primary or an associated cause of poor survival.

Although measuring the magnitude of fish production is a high priority, the measurement of nutrients and the zooplankton community provides information to support potential rehabilitation programs required to restore lost productivity. Therefore, our investigations examined the availability of food resources to sockeye salmon fry in five glacial lake systems on the Kenai Peninsula and three clearwater lakes on Kodiak Island. Our studies attempt to link measurements of the food supply in these lakes with the fall condition and survival of juvenile sockeye salmon. These data also are essential to determine if production changes in fish are related to density rather than climatic or other non-density dependent factors.

This report provides interim observations as to changes that occurred in the biological, physical, and chemical properties during the course of these studies and relies on other investigations for comparative purposes. We also provide preliminary analyses of some of these data with the intent of determining if existing monitoring programs are adequate to measure the biological responses and provide evidence as to the cause of observed changes. Therefore, this report is not complete as sample analysis and data availability are time-dependent (for example adult returns lag 3-5 years from the time of juvenile measurements to estimate survival). It is not intended to be a comprehensive analysis but an overview of studies in progress. In addition, detailed methods and results for some portions of the study are presented in companion reports. These are referenced for further information. In addition, supporting data (e.g., adult run size estimates by river of origin) which are critical to these investigations are conducted and reported independently by ADF&G.

OBJECTIVES

The objectives of this study are to:

1. measure critical biological attributes (number, age, size) of juvenile sockeye salmon in the nursery lakes of the Kenai Peninsula and Kodiak Island;

2. estimate the biological effects on juvenile sockeye salmon production and subsequent adult returns for brood years with large spawning escapements; and

3. measure and prepare nutrient budgets, estimate plankton populations, and measure physical and chemical parameters in the nursery lakes.

Although not included in the original study plan, the collected data inherently provides an opportunity to examine the feasibility of alternative restoration methods.

METHODS

Adult Sockeye Salmon Assessment

Escapements of sockeye salmon were estimated by weirs at Red, Upper Station, and Akalura lakes. Escapement into the Kenai and Kasilof rivers was estimated by sonar counters using fish wheels for capturing fish samples for species apportionment, sex ratios, and size data (King and Tarbox 1991). Sockeye salmon spawners in the Kenai River were estimated from the sonar counts minus the estimated sport fishing harvests above the counting sites. Kenai River spawner estimates were further adjusted by removing escapement estimates from the Russian River and Hidden Lake (weir adults in the fisheries and spawning populations. Standard methods of scale sampling and aging were used.

Juvenile Sockeye Salmon Assessment

For each of the three lake studies on the Kenai Peninsula, the abundance, size and freshwater age of juveniles were estimated through hydroacoustic surveys combined with tow net sampling Detailed survey methods are documented for the Kenai River lakes in Tarbox and King (1992) and for Tustumena Lake in Kyle (1992). Since 1992, hydroacoustic surveys were conducted only on the Kenai Peninsula lakes.

Additional collections of hydroacoustic data and its analysis to determine the vertical distribution of sockeye salmon juveniles within Skilak, Kenai, and Tustumena lakes were initiated in 1992. One of the hydroacoustic transects used in the fall 1992 was surveyed again in May 1993 on Skilak Lake. Multiple recordings of hydroacoustic data from this same transect were obtained from twilight through darkness to determine diel changes in distribution of fry (Appendix A details the 1993 and 1994 Skilak and Kenai Lakes hydroacoustic methods and results).

A hydroacoustic survey of Upper Russian Lake was conducted on 14 September 1994. The survey consisted of 14 orthoganal transects and the data collected with the same equipment as in Skilak and Kenai Lakes. The data were analyzed by a combination of echo integration and echo counting. Counts were made in 8 depth strata. Detailed methods and results from this investigation are reported in Thorne (1994).

Freshwater growth and age of juvenile sockeye salmon from all study systems were determined from scale and otolith measurements made either by direct visual analysis of scales or from otoliths with an optical pattern recognition system. Sampling of fry using a closing net system designed by Biosonics Inc. was deployed in the summer and fall of 1994 in Skilak and Kenai Lake. This provided size and age data at different depth and area strata; stratified sampling methods were used to estimate fry age, weight, and length.

Lipid analyses for the 1994 sampling year are being conducted by the Palmer Laboratory of the University of Alaska using the methods described by Randall (1974). Because of contractual issues and delays which were beyond the control of the investigators these analyses have not been completed. Results will be reported in future reports.

Sockeye Salmon Smolt Enumeration

The total number of sockeye salmon smolt (with 95% confidence intervals) migrating from each of the lake systems in 1990-1994 was estimated by a mark-recapture technique (Rawson 1984). At regular intervals, a sample of sockeye salmon smolt was marked with Bismark Brown dye and released upstream. Recovery rates of the dyed fish were used to estimate trap efficiency. This efficiency rate was then applied to estimate the total smolt outmigration. Methods deviated slightly each year but specific details of sampling are available in Barrett et al. (1993a) for the Kodiak lakes, in King et al. (1991) for the Kenai River, and in Kyle (1992) for the Kasilof River. King et al. (1994; in Appendix A) described the procedures used to estimate smolt abundance in the mainstem Kenai River and Russian River.

Subsamples of smolts from Kodiak Island were stored frozen and sent to the University of Alaska Fairbanks to determine the relative levels of marine versus terrestrial nitrogen from selected Kodiak Island systems. These samples were taken to determine the effects of carcass nutrient additions in maintaining the productivity of Red Lake. These sample sets will be reported in the final report or in a later progress report.

Limnological Studies

Limnological sampling has been conducted in the Tustumena Lake at three stations since 1981. Two stations were sampled from Skilak and Kenai Lakes from 1986-1989, and beginning in 1990 three stations were used to collect limnological parameters. Zooplankton data were collected from Skilak Lake at five stations in 1990, 10 in 1991, and three in 1992, 1993, and 1994. Zooplankton samples from Kenai Lake were collected at three stations during 1990-1994.

Limnological data were collected from three stations in Red Lake, two stations in Akalura Lake, and two stations in Upper Station Lake. Samples were collected at about three-week intervals on each lake during May through October. Study site locations, sampling dates, physical, chemical and biological parameters, and data summaries are provided in Appendix A of Schmidt and Tarbox (1993).

Water nutrients and basic physical parameters, chlorophyll *a*, and zooplankton samples were analyzed at the State of Alaska's Limnology Laboratory located in Soldotna. Analytical procedures followed standardized laboratory and quality assurance methods (Koenings et al. 1987). In cases where prior years' data are available, limnological parameters during residence of juveniles from the 1987-89 escapements were compared to parameters during prior years.

To collect quantitative data representative of the vertical distribution of the zooplankton community, a closing zooplankton net was utilized. The net is constructed of 153-μ Nitex mesh with a 0.5-m stainless steel ring at the mouth and a 200-ml collection bucket. Essentially, this netting procedure is identical to the methods used for collecting water column zooplankton samples used for biomass estimates. The net is vertically lowered to the desired depth as measured with a tow line marked in 1-m increments. After vertically retrieving a 5- or 10-m tow, the line is sharply jerked triggering the release of a closure mechanism at the opening of the net. Triggering this mechanism causes the net to fold over on itself stopping any further collection of zooplankton.

After the collection bucket is thoroughly rinsed with distilled water, the release mechanism is reset and the net lowered to the depth at which collection had previously been halted.

RESULTS AND DISCUSSION

Kenai River System Investigations

Adults Returns and Escapement

Major departures from the established escapement goals in the Kenai River occurred during 1987-1989 (Figure 3). The 1989 event corresponded with closures associated with the *Exxon Valdez* oil spill. Escapements did not greatly exceed targeted values in the nearby Kasilof River/Tustumena Lake sockeye system during this same time period and was the primary reason this system has been studied has been used for comparison.

Since 1991 escapements into the Kenai River have exceeded the goal range (Figure 3). In contrast, the Kasilof River system has been managed to achieve the desired goal (Figure 4).

Smolt Production

Detailed study results are listed in King et al. (1991) and King et al.(1994, in Appendix A), for the Kenai River smolt investigations and in Kyle (1992) and Todd and Kyle (1992, 1994) for the Kasilof River smolt investigations. The abundance and population characteristics of smolts which migrated from the Kenai and Kasilof Rivers are presented in Tables 1-5, respectively. The adult returns in 1994 to the Kenai River suggested the Kenai mainstem smolt estimates were substantially below the number which actually migrated. An estimated 3.1 million smolt were produced by the 1989 brood year. However, adult returns for that brood year were estimated at 3.5 million sockeye salmon. Therefore, an estimate of smolt numbers was not produced from the 1994 trap data (individual trap data are presented in Appendix A). The mainstem smolt program has been discontinued in 1995.

Fry Production

The juvenile sockeye salmon production within Kenai and Skilak Lakes as reflected by fall fry abundance are reported in Tarbox and Brannian (1995; Appendix C). The fall fry abundance generally reflects escapement levels (Figure 5).

Fall fry length and weight data from Skilak, Kenai, and Tustumena Lakes are presented in Table 6. The Skilak and Kenai Lake fall fry are generally smaller than in Tustumena Lake. Figure 6 illustrates the relationship between estimated mainstem spawner abundance and fall fry weight in Skilak Lake.

During 1993 and 1994, preliminary side looking hydroacoustic data collected in July indicated near surface daylight schooling aggregations of sockeye salmon in Skilak Lake. These aggregations did not occur in Tustumena Lake. The schools dispersed at dusk and were generally not apparent from downward looking sonar (Appendix D has examples of the echo grams which show this pattern). Examination of sockeye salmon fry stomachs before dusk and after dark were inconclusive relative to this being a period of increased feeding (Appendix E presents limited food habit data analysed to date).

Contrary to earlier inferences from downward looking acoustic tranducer orientation (Schmidt and Tarbox 1993) DVM in juvenile sockeye in Skilak Lake may not occur. Dusk and night dispersions from near surface schools may provide the appearance of DVM when only down looking acoustic data are used (a full discussion of schooling behavior and results will be presented in future reports). This phenomena did not affect the September population estimates. Fish schools were deeper in the water column and dispersion makes them more available for acoustic enumeration.

In 1994, fall hydroacoustic estimate of Russian River sockeye salmon was 1,645,000 fish. This represents mid-water estimate only. No corrections were made for surface orientation.

Extensive tow netting in Skilak Lake in 1993 and 1994 indicated that there was evidence of differences among sampling areas and between depth increments in sockeye salmon fry age structure, size of age-0 fry, and species composition. The two types of gear tested (single boat vs. two boat) gave similar results. Results indicate that daytime tows by area and depth should be undertaken for use in allocation of hydroacoustic targets to species composition and age structure of sockeye salmon fry. Summary memos from Stan Carlson on the results of the 1993 and 1994 tow netting program is attached in Appendix F.

Limnological Studies

In the previous progress report (Schmidt and Tarbox 1993) we established that standing crop biomass of zooplankton in Skilak Lake had changed modestly and water quality parameters had only modest changes. For example, Figure 7 illustrates seasonal fluctuations of the turbidity values from Skilak Lake during the study. The relatively short period of this time series does not afford more detailed analysis relating to growth or survival of Skilak Lake sockeye salmon fry. Limnological data collected in 1994 are presented in Appendix G.

Figure 8 illustrates the trend in biomass of the two dominant copepod species through 1994 (specific station data are presented in Appendix G). *Cyclops* had an apparent increase in abundance in 1993,. However, both *Cyclops* and *Diaptomus* decreased in abundance in 1994.

Table 7 summarizes the relationship of zooplankton densities to fall juvenile sockeye salmon densities in Skilak and Tustumena Lakes. Only in 1993 and 1994 has the biomass of zooplankton per fall fry in Tustumena Lake exceeded that of Skilak Lake. Figure 9 illustrates the relationship of this relative measure of zooplankton density to fall fry weight in Skilak Lake from 1987-94 and in Tustumena Lake from 1986-94. We lack accurate measurements of fall weights prior to 1987 in Skilak Lake to extend this time series, while in Tutstumena Lake the stocking of approximately 18 million spring fed fry into this system invalidated any extension of this time series into early years.

Our hypothesis is that fish fall weights are determined by some other factor than the relative abundance of prey throughout the growing season. We suspect that DVM of the zooplankton

(Schmidt et al. 1994) contribute to the differences in apparent growth rates of juvenile sockeye salmon observed between these two lakes. Thus, the availablity of prey is the issue.

Kodiak Lake Investigations

Adult returns

Sockeye salmon escapements to Red Lake were 380,181 fish in 1994. This is approximately 100,000 greater than 1993 and 50% of the escapement realized in 1989 (Table 8). Akalura Lake escapement was 30,692 sockeye salmon which was one half the 1993 escapement and one fourth the 1989 escapement (Table 9). Frazer Lake sockeye salmon escapement was 206,071 fish in 1994 which was close to the historical range since 1989 (Table 10).

Smolt Abundance, Size, and Age

The following information was taken from Swanton et al. (1995), and condensed for this report.

Red Lake

In 1994, an estimated 562,690 ± 90,385 sockeye salmon smolt migrated from Red Lake, which was ~34% less than the 1990-94 average (Table 11). Age-2 smolt from the 1991 brood year were most abundant (92% of the total), followed by age-1 smolt (7%). The average length and weight of smolt in 1994 were within the range observed for the 1990-93 period (Tables 12 and 13). The total number of sockeye salmon smolt produced from the 768,000 escapement of 1989 is an estimated 1.6 million fish (Table 8). This respresents a 4-fold increase in smolt compared to the estimate for the 1988 brood year, and a 7-fold increase over the 1990 brood year.

Akalura Lake

The 1994 sockeye salmon smolt migration estimate for Akalura Lake was 170,172 ± 39,261, which was 0.1 million less than the average for 1990-93 (Table 14). Age-2 smolt were the most abundant comprising 53% of the estimate. In 1994, age-1 smolt averaged about 14 mm and 2.9 g greater than the average from 1990-93 migrations. The average sizes of both age-2 and age-3 smolts in 1994 were larger in length and weight than the average over 1990-93 (Tables 12 and 13). Brood years 1987 and 1988 both produced about twice the smolts than the 1989 brood year (Table 9). Also, the 1990 brood year produced fewer smolt (about 50% less) than the 1989 brood year. Presently, the causal mechanism for continued depressed smolt production is unknown, although several hypotheses have been forwarded (Edmundson et al. 1994).

Frazer Lake

The 1994 Frazer Lake sockeye salmon smolt outmigration was estimated at 5,902,863 ± 617,638 smolts which was 39% less than during 1993 but closely associated with the number of smolts outmigrating in 1991-92 (Table 15). This migration was dominated by age-2 (78.1%) and age-1 (12.3%) smolts with a substantial reduction in age-3 smolt numbers from 1993. That is, in 1991 age-1 smolt comprised 40% and age-2 smolt comprised 59% of the emigration, whereas in 1992 age-2 comprised 89% of the total population. In 1993, all age classes of smolt were similar in size compared to previous years (Tables 12 and 13). The 1989 brood year escapement produced an estimated 12.9 million smolt from an escapement of 360,000. The 1988 and 1990 brood year escapements produced less than half as many smolt from escapements that were only 22% and 28% less than the 1989 brood year escapement.

STATUS OF INJURY ASSESSMENT

The 1994 studies have provided some question as to the extent of reduction in smolt production in the Kenai River and from Red Lake on Kodiak Island. The Kenai River smolt production has decreased over time and major reductions in run returns from these smolt years are likely. The fall fry data coupled with limited sampling in the spring of 1992 provide support for the contention that overwintering mortality of fry in the lake is primarily responsible for the collapse. The 1993 fall data indicate high abundance and small size of juvenile sockeye salmon in Skilak Lake. In contrast, Tustumena Lake produced record sized fall fry in 1993 with increases in zooplankton densities, suggesting variations in the plankton community and in fish survival are most likely caused by density independent factors. Survival of these two populations would be expected to be different, given the pre-winter condition. As other factors may compound overwinter survival, such as length of winter, and availability spring zooplankton, forecasts of the 1994 smolt production from these systems would expect to have a high degree of uncertainty.

More detailed studies of zooplankton behavior, abundance, and distribution in Skilak Lake in 1993 suggests DVM may decline with increased abundance (and presumably increased competition for food), at least for the copepod Cyclops. The electivity of the feeding habits of fry from limited pre-overescapement gut samples is consistent with the hypothesis of reduced availability of copepods in Skilak Lake. DVM patterns in 1993 provided consistent correlation with spatial abundance and electivity indices of fry collected from the same times and areas. Because the current study approach provides only correlative data, we are recommending that in 1995, an enclosure investigation be initiated to determine the effect of altering sockeye salmon fry densities artificially, coupled with nutrient additions, on growth of juvenile sockeye salmon. These studies will provide the basis further restoration activities to facilitate recovery of Skilak Lake sockeye salmon. These investigations need to be coupled to the ongoing time series monitoring Skilak and Tustumena fry production and overwintering survival, in addition to the dynamics of the zooplankton communities.

Smolt production from Red Lake and Akalura Lake on Kodiak Island continue to be depressed. The decline in size of fry and zooplankton density from Akalura Lake suggests density based affects continue. The 1993 zooplankton abundance estimates for Akalura indicate an increase, which hopefully will be paralleled in increased growth and survival of juvenile sockeye salmon. Investigations of the nutrient status of Akalura Lake indicate sufficient nutrients to negate the value of any nutrient enrichment project. Red Lake appeared to have a recovered zooplankton community. Improved recruitment of juveniles to the lake pelagic system through maintaining adequate escapements should allow this system to restore naturally. Continued smolt monitoring until restoration is completed is recommended.

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Table 1. Kenai River smolt production by age class.

Brood Year	Spawning Escapement	Total Number of Smolt Produced Age-1.0	Age-2.0	Age-3.0	Brood year Total
1986	422,000	[a]	115,000[b]	16,000	
1987	1,408,000	24,416,000[b]	5,807,000[b]	1,000	30,224,000
1988	910,000	5,249,000[b]	431,000[b]	0	5,680,000
1989	1,379,000	2,776,000[b]	312,000[c]	0	3,088,000
1990	519,000	253,000[c]	33,000[c]	[d]	284,000
1991	431,000	735,000[c]	[d]		-
1992	807,000	d			
1993	697,000	d			
1994	857,000	d			

[a] No data collected.

[b] Includes Hidden Lake migration not thought to be captured by the km 31 inclined plane traps.

[c] Includes Hidden Lake and Moose River migration not thought to be captured by the km 31 inclined plane traps.

[d] 1994 migrating smolt numbers were not estimated.

Table 2. Kenai River smolt age composition summary.

	Smolt Age Composition (%)				
Smolt Year	Age-0	Age-1	Age-2	Age-3	n
1989	0	99.7	0.3	0	3567
1990	0	46.7	53.1	0.2	3422
1991	0	86.1	13.9	0	3741
1992	0	17.3	82.7	0	981
1993	8.5	88.5	3.0	0	1200
1994	0.7	95.7	3.6	0	2705

Table 3. Kasilof River escapement and smolt production summary by brood year.

	Spawner	Numbers of smolt with percent hatchery contribution				
	Escapement	Age-1*1000	% Hatchery	Age-2 *1000	% Hatchery	Total *1000
1981	256,625	6,817	40.7	2,869	20.6	9,686
1982	180,239	11,390	36.3	4,001	7.7	15,391
1983	210,270	12,580	27.8	2,223	11.1	14,803
1984	231,685	5,268	30.2	3,540	31.1	8,808
1985	505,049	1,074	59.2	2,549	17.0	3,623
1986	275,963	2,056	52.0	3,009	10.2	5,065
1987	249,246 [a]	3,109	30.3	3,521	3.0	6,630
1988	204,000	3,916	2.0	2,335	1.0	6,251
1989	158,206	2,400	7.0	2,012	1.3	4,412
1990	144,136	2,107	7.5	1,833	3.3	3,940
1991	238,269	7,189	6.3	1,763	1.1	8,952
1992	184,178	7,376	4.7			
1993	149,939					
1994	205,117					

[a] Because of sonar failure, escapement estimates were from stream surveys and spawning stream weir counts above Tustumena Lake. See Kyle (1992) for statistics of smolt abundance precision estimates.

Table 4. Kasilof River smolt age class summary.

Smolt	% Smolt Age Composition		
Year	n	Age-1	Age-2
1983	1163	84	16
1984	1192	80	20
1985	1263	76	24
1986	1348	70	30
1987	1635	23	77
1988	1275	45	55
1989	1125	51	49
1990	1150	53	47
1991	1018	51	49
1992	1150	56	44
1993	942	80	20
1994	737	81	19

Table 5. Kasilof River smolt fork length by outmigration year.[a]

	Age-1			Age-2		
Year	Mean	n	SD	Mean	n	SD
1983	70	712	3.8	83	451	5.4
1984	73	1005	3.5	85	187	4.4
19z`85	70	981	2.8	84	282	5.4
1986	69	983	3.9	84	365	5.1
1987	64	412	6.1	77	1223	4.8
1988	68	623	4.0	78	652	4.5
1989	66	609	4.4	81	516	4.5
1990	69	683	4.4	82	467	4.2
1991	68	529	3.5	80	489	3.2
1992	74	594	3.8	87	556	4.7
1993	69	755	3.5	82	187	4.2
1994	72	737	3.6	86	163	4.0

[a] Values are in mm; n = sample size; SD=1 standard deviation.

Table 6. Kenai Peninsula lakes fall fry data summary.

		Age-0						Age-1					
Location			Length			Weight			Length			Weight	
	Year	(n)	(mm)	SD	(n)	(g)	SD	(n)	(mm)	SD	(n)	(g)	SD
Skilak													
	1986	15	57	n/a				8	74				
	1988	109	50	5.3	109	0.9	0.4						
	1989	136	50	3.3	136	1.2	0.3	126	64	6.0	126	2.8	0.7
	1990	928	49	4.3	290	1.3	0.3	34	72.8	3.3	20	4.0	0.4
	1991	863	51	4.9	286	1.5	0.5	55	73.8	3.8	14	4.7	0.5
	1992	883	54	6.0	883	1.8	0.6	10	89	3.0	10	7.0	0.8
	1993	3652	49	5.0	3652	1.2	0.4	55	75	5.0	55	4.5	0.9
	1994	687	50	4	687	1.4	0.4	110	68.2	3.6	110	3.6	0.6
Kenai													
	1986	227	52	n/a	227			2	77				
	1989	38	48	4.5	38	1.0	0.2	56	64	4.6	56	2.5	0.6
	1990	1484	52	4.6	1484	1.5	0.4	62	69.4	4.2	22	3.6	0.6
	1991	1364	54	6.5	1364	2.0	0.6	40	75.9	4.8	15	5.5	1.0
	1992	1492	56	7.3	1492	2.0	0.8	12	78	10	12	5.6	1.7
	1993	2969	45	4.0	2969	1.0	0.2	4	68	1.0	4	3.3	0.5
	1994	861	54	4.6	861	1.9	0.5	39	76.8	3.7	39	5.2	0.7
Tustumena													
	1980	222	59	6.1	222	2.3	0.7	20	80	3.5	20	5.7	0.7
	1981	197	55	5.1	197	1.6	0.4	21	73	4.6	21	3.8	0.7
	1982	194	54	5.1	194	1.8	0.5	17	74	3.9	17	4.	0.9
	1983	562	60	6.1	562	2.5	0.7	55	80	5.0	55	5.8	1.1
	1984	388	61	4.6	388	2.5	0.6	186	79	3.7	186	5.3	0.8
	1985	173	56	5.6	173	2.1	0.6	52	78	5.0	52	5.6	1.2
	1986	156	50	6.4	156	1.3	0.5	92	73	4.5	92	4.1	0.7
	1987	143	53	5.9	143	1.8	0.6	50	71	3.8	50	4.2	0.6
	1988	303	55	5.3	303	1.8	0.5	89	75	3.6	89	4.5	0.6
	1989	47	52	5.7	47	1.9	0.6	18	74	4.6	18	5.1	0.9
	1990	200	57	5.5	200	1.5	0.4	50	75	2.9	50	3.4	0.5
	1991	202	57	5.4	202	2.0	0.5	47	78	6.5	47	5.1	1.2
	1992	323	59	4.4	323	2.0	0.4	21	79	4.1	21	4.52	0.7
	1993	417	63	6.7	417	2.9	0.8	46	81	3.0	46	6.18	0.7
	1994	318	64	5.0	318	2.6	0.6	76	83	3.0	76	5.5	0.5

Missing values indicate no data available. n = sample size; SD = 1 standard deviation.

Table 7. Comparison of copepod biomass and fall density of juvenile sockeye salmon in Tustumena and Skilak lakes, Kenai Peninsula, Alaska. Copepod biomass reflect the seasonal mean biomass m^{-2}. Fall fry densities estimated by hydroacoustics.

	Copepod biomass						Fall sockeye density \a		Copepod biomass/fall fry	
Rearing	mg m^{-2}						fry m^{-2}		mg fry^{-1}	
Year	Skilak	SE	n \c	Tustumena	SE	n \c	Skilak	Tustumena	Skilak	Tustumena
1986	514	46	2	115	13	3	0.22	0.056	2,370	2,062
1987	586	28	2	100	23	3	0.09	0.045	6,426	2,242
1988	565	6	2	75	10	3	0.31	0.051	1,805	1,472
1989	783	257	2	90	18	3	0.22	0.056	3,554	1,599
1990	417	55	5	74	5	5	0.23	0.062	1,833	1,186
1991	571	40	10	165	15	5	0.07	0.052	8,418	3,181
1992	637	191	3	110	9	5	0.09	0.051	7,428	2,136
1993	710	134	3	204	29	5	0.34	0.049	2,082	4,198
1994\b	432	44	5	209	31	5	0.13	0.041	3,323	5,070

\a Standard error (SE) of fall fry density estimates are <25% of the mean.

\b Preliminary data

\c n=number of stations

Table 8. Sockeye salmon smolt estimates by age by brood year escapement for Red Lake, 1986-94

		Number of Smolt (by Age)			
Brood Year	Escapement	1	2	3	Total
1986	318,135			6,427	6,427
1987	261,913		493,026	38,184	531,210
1988	291,774	240,500	119,849	25,792	386,143
1989	768,101	105,467	1,365,082	89,739	1,560,288
1990	371,282	29,482	201,307	1,895	232,684
1991	374,859	315,301	520,391		835,692
1992	344,184	40,404			
1993	286,170				
1994	380,181				

Missing data indicates not available.

Table 9. Sockeye salmon smolt estimates by brood year escapement for Akalura Lake, 1986-93.

		Number of Smolt (by Age)				
Brood Year	Escapement	1	2	3	4	Total
1986	9,800			0	0	
1987	6,116		408,330	1,251	0	409,581
1988	38,618	66,460	299,591	8,315	238	374,604
1989	116,029	9,086	182,963	12,315	0	204,364
1990	47,181	1,921	73,062	7,141		82,124
1991	44,189	3,259	90,467			93,726
1992	63,269	72,474				72,474
1993	30,692					
1994	13,381					

Missing data indicates not available.

Table 10. Frazer Lake smolt abundance data and escapements.

		Number of Smolt (by Age)				
Brood	Escapement	1	2	3	4	Total
1986	126,529			0		
1987	40,544			3,786	0	3,786
1988	246,704		3,777,426	557,584	612	4,335,622
1989	360,373	2,552,835	5,739,150	4,687,083		12,979,068
1990	226,960	108,489	5,077,866	566,824		5,753,179
1991	190,358	23,496	4,608,258			4,631,754
1992	185,825	727,781				
1993	178,391					
1994	206,071					

Missing data indicates not available.

Table 11. Sockeye salmon smolt estimates by age for each year for Red Lake, 1986-93.

			Ages			95 % CI	
Smolt Year		1	2	3	Total	Low	High
1990	#	240,500	493,026	6,427	739,954	402,905	1,077.004
	%	32.5	66.6	0.0	100.0		
1991	#	105,467	119,849	38,184	263,500	178,221	348.782
	%	40.0	45.5	14.5	100.0		
1992	#	29,482	1,365,082	25,792	1,420,356	1,117,748	1.722.965
	%	2.1	96.1	1.8	100.0		
1993	#	315,301	201,307	89,739	606,349	449,267	763.430
	%	52.0	33.2	14.8	100.0		
1994	#	40,404	520,391	1,895	562,690	474,305	647.655
	%	7.2	92.5	0.3	100.0		

Table 12. Mean lengths of sockeye salmon smolt by age and year for the Kodiak systems, 1990-94.

System	Smolt Year	Smolt Fork Length (mm)														
		Age-0			Age-1			Age-2			Age-3			Age-4		
		N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Red Lake																
	1990	0			342	106.5	0.2	1,052	111.8	0.3	20	117.9	1.9	0		
	1991	0			1,135	88.2	0.1	977	106.7	0.3	407	113.0	0.3	0		
	1992	0			85	99.5	0.9	1,667	110.2	0.2	63	119.7	1.4	0		
	1993	0			1,409	91.7	0.1	516	108.6	0.5	397	120.1	0.6	0		
	1994	0			225	86.2	0.5	1,718	98.7	0.2	7	104.9	2.3	0		
Akalura																
	1990	0			577	73.9	0.3	748	85.9	0.2	0			0		
	1991	0			41	77.2	2.0	1,382	77.5	0.2	22	97.3	4.0	0		
	1992	1	59.0		25	75.7	1.0	2,014	78.8	0.1	61	86.4	0.6	0		
	1993	0			74	61.8	1.2	992	85.8	0.2	94	90.8	0.7	2	101.5	2.5
	1994	2	73.0		721	87.5	0.2	763	93.1	0.2	146	95.8	0.6			
Frazer																
	1990	0			574	84.2	0.2	553	104.3	0.2	44	113.0	1.6	0		
	1991	0			746	89.7	0.2	1,344	89.5	0.2	4	120.8	9.1	0		
	1992	0			49	86.4	1.1	2,951	83.9	0.1	191	91.1	0.5	0		
	1993	0			8	89.9	0.5	682	100.3	0.1	913	104.2	0.2	3	121.3	9.4
	1994	0			713	86.3	0.2	1,456	102.6	0.1	302	112.8	0.3	0		

Table 13. Mean weights of sockeye salmon smolt by age and year for the Kodiak systems, 1990-94.

Smolt Weight (g)

System Smolt Year	Age-0 N	Age-0 Mean	Age-0 SE	Age-1 N	Age-1 Mean	Age-1 SE	Age-2 N	Age-2 Mean	Age-2 SE	Age-3 N	Age-3 Mean	Age-3 SE	Age-4 N	Age-4 Mean	Age-4 SE
Red Lake															
1990	0			341	10.0	>0.1	1,050	11.0	>0.1	20	13.0	0.1	0		
1991	0			1,135	5.0	0.0	977	9.5	0.1	407	11.3	0.1	0		
1992	0			85	8.8	0.3	1,666	11.8	0.1	63	15.2	0.6	0		
1993	0			1,409	7.3	>0.1	517	11.0	0.1	395	14.5	0.2	0		
1994	0			225	5.1	0.5	1,717	7.6	>0.1	7	9.0	0.6			
Akalura															
1990	0			577	3.6	<0.1	749	5.3	<0.1	0			0		
1991	0			41	4.3	0.5	1,382	4.0	0.0	22	8.9	1.2	0		
1992	1	1.5		25	3.7	0.3	2,007	3.9	0.0	61	4.9	0.1	0		
1993	0			74	2.2	0.1	992	5.7	0.0	94	6.8	0.2	2	10.10.5	
1994	2	3.4	0.3	721	6.1	>0.1	763	7.3	0.1	146	7.7	0.2	0		
1990	0			574	4.5	0.0	552	9.0	0.1	44	12.2	0.7	0		
1991	0			745	5.4	0.0	1,343	5.6	0.0	4	15.7	3.9	0		
1992	0			49	6.1	0.2	2,947	5.5	0.0	194	7.2	0.1	0		
1993	0			8	6.1	0.2	684	8.3	0.0	899	9.2	0.0	2	17.7	5.1
1994	0			713	5.2	>0.1	1,456	8.1	>0.1	302	10.7	0.1	0		

Table 14. Sockeye salmon smolt estimates by age for each year for Akalura Lake, 1986-93.

		Ages					95 % CI	
Smolt Year		1	2	3	4	Total	Low	High
1990	#	66,460	408,330	0	0	474,790	318,734	630,846
	%	14.0	86.0	0.0	0.0	100.0		
1991	#	9,086	299,591		0	309,928	237,981	381,875
	%	2.9	96.7	0.04	0.0	100.0		
1992	#	1,921	182,963	8,315	0	193,199	153,765	232,638
	%	2.9	96.7	4.3	0.0	100.0		
1993	#	3,259	73,062	12,315	238	88,873	35,943	141,802
	%	3.7	82.3	13.9	0.1	100.0		
1994	#	72,474	90,467	7,141	0	170,172	130,910	209,433
	%	42.6	53.2	4.2	0.0	100.00		

Table 15. Sockeye salmon smolt estimates by age for each year and by brood year escapement for Frazer Lake, 1986-93.

		Ages					95% CI	
Smolt a		1	2	3	4	Total	Low	High
1991	#	2,552,835	3,777,426	3,786	0	6,334,047	2,128,460	10,539,634
	%	40.3	59.6	0.1	0.0	100.0		
1992	#	108,489	5,739,150	557,584	0	6,405,222	2,649,678	10,160,766
	%	2.9	89.6	8.7	0.0	100.0		
1993	#	23,496	5,077,865	4,687,084	612	9,789,057	3,309,885	16,268,229
	%	0.2	51.9	47.9	0.0	100.0		
1994	#	727,781	4,608,258	566,824	0	5,902,863	5,285,225	6,520,501
	%	12.3	78.1	9.6	0.0	100.0		

Table 16. Tow net results from September, 1994 in Red and Frazer Lake, Kodiak

Lake	Age	No. Sampled	Length (mm) Mean	SD	Weight (g) Mean	SD
Red	0	44	49	6.9	0.9	0.4
	1	7	81	7.1	4.9	1
Frazer	0	22	65	5.6	1.5	0.4
	1	2	97	7	6.1	1.1

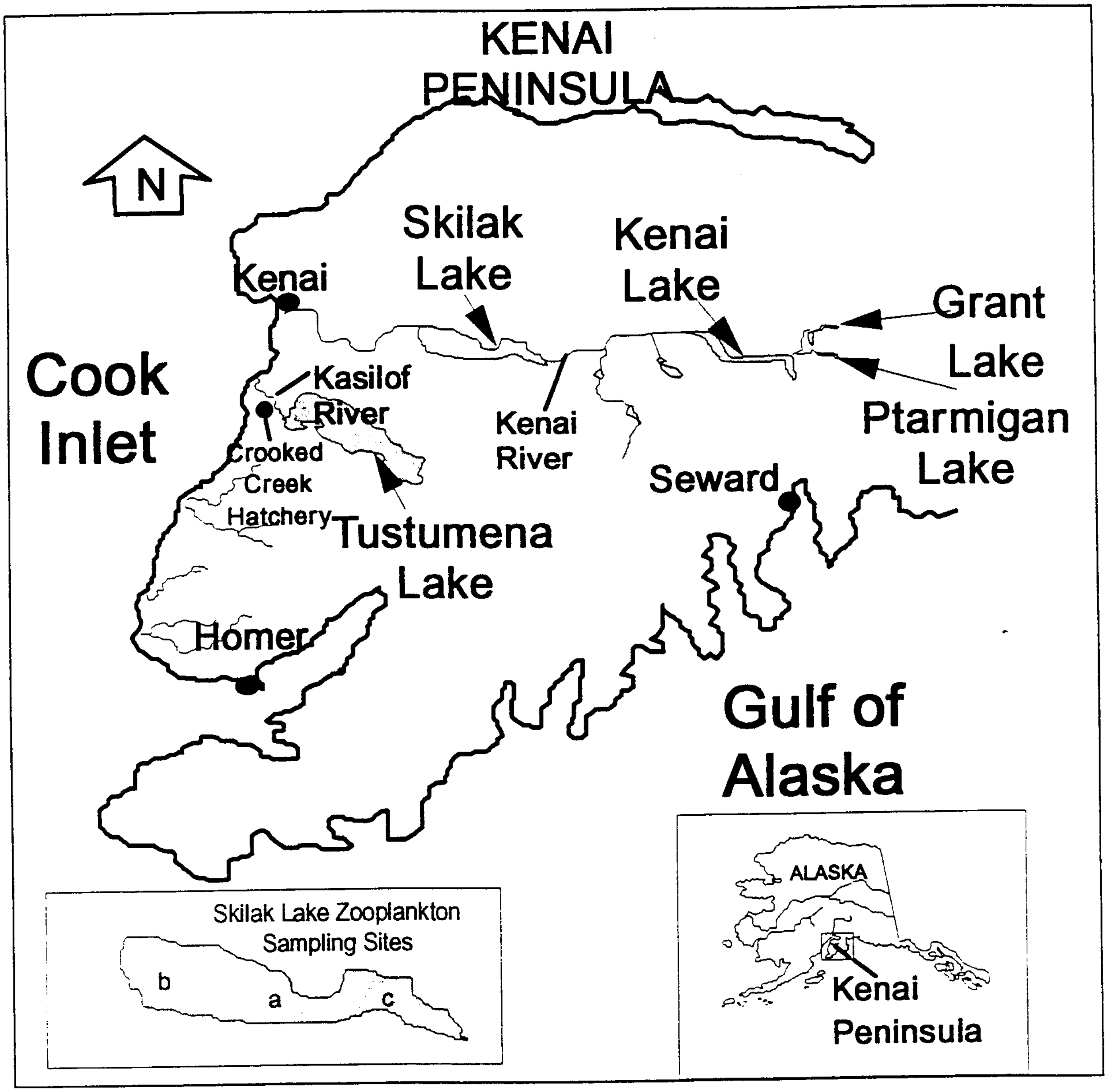


Figure 1. Location of the Kenai and Kasilof Rivers, Upper Cook Inlet, Alaska.

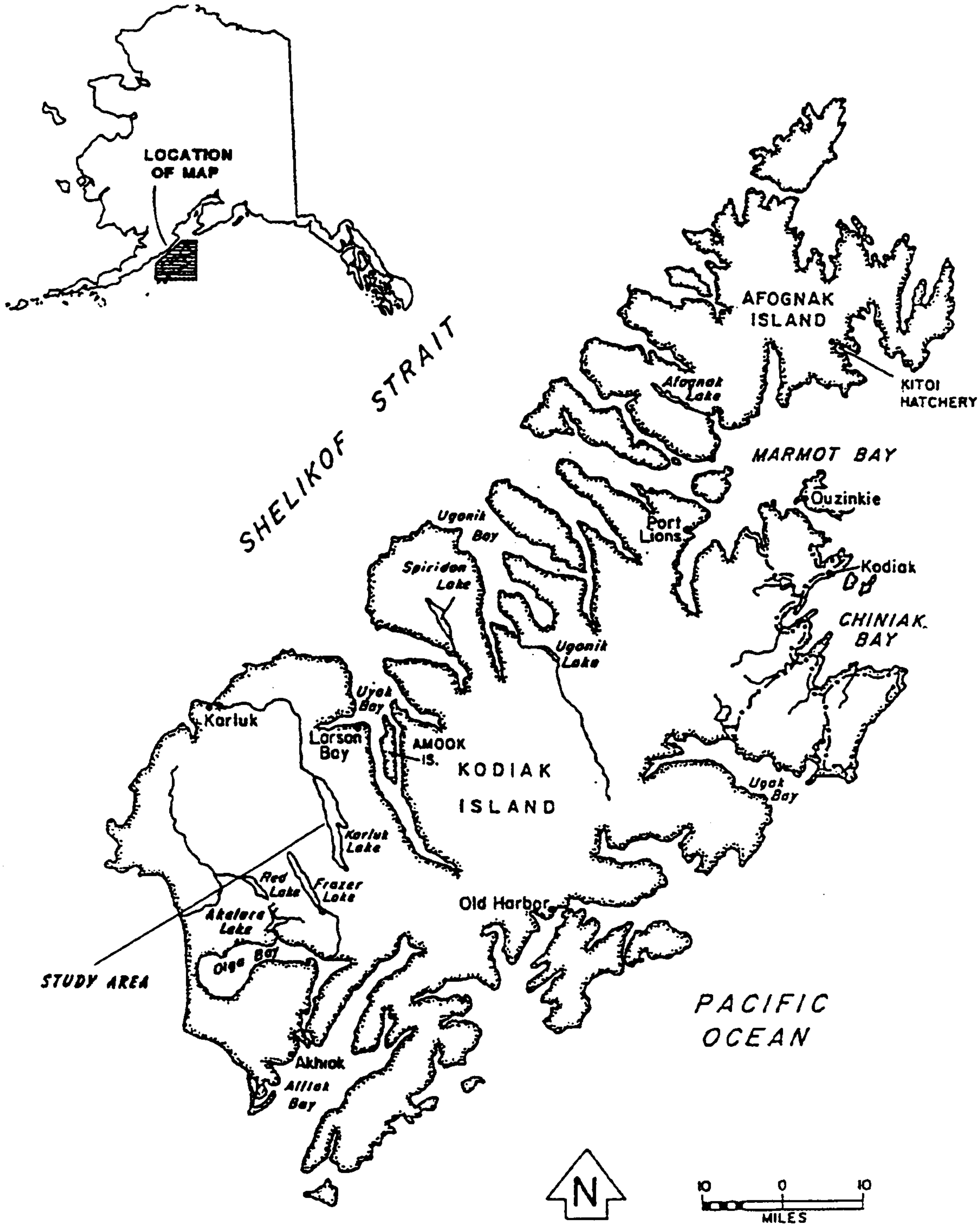


Figure 2. Kodiak study lakes, Alaska.

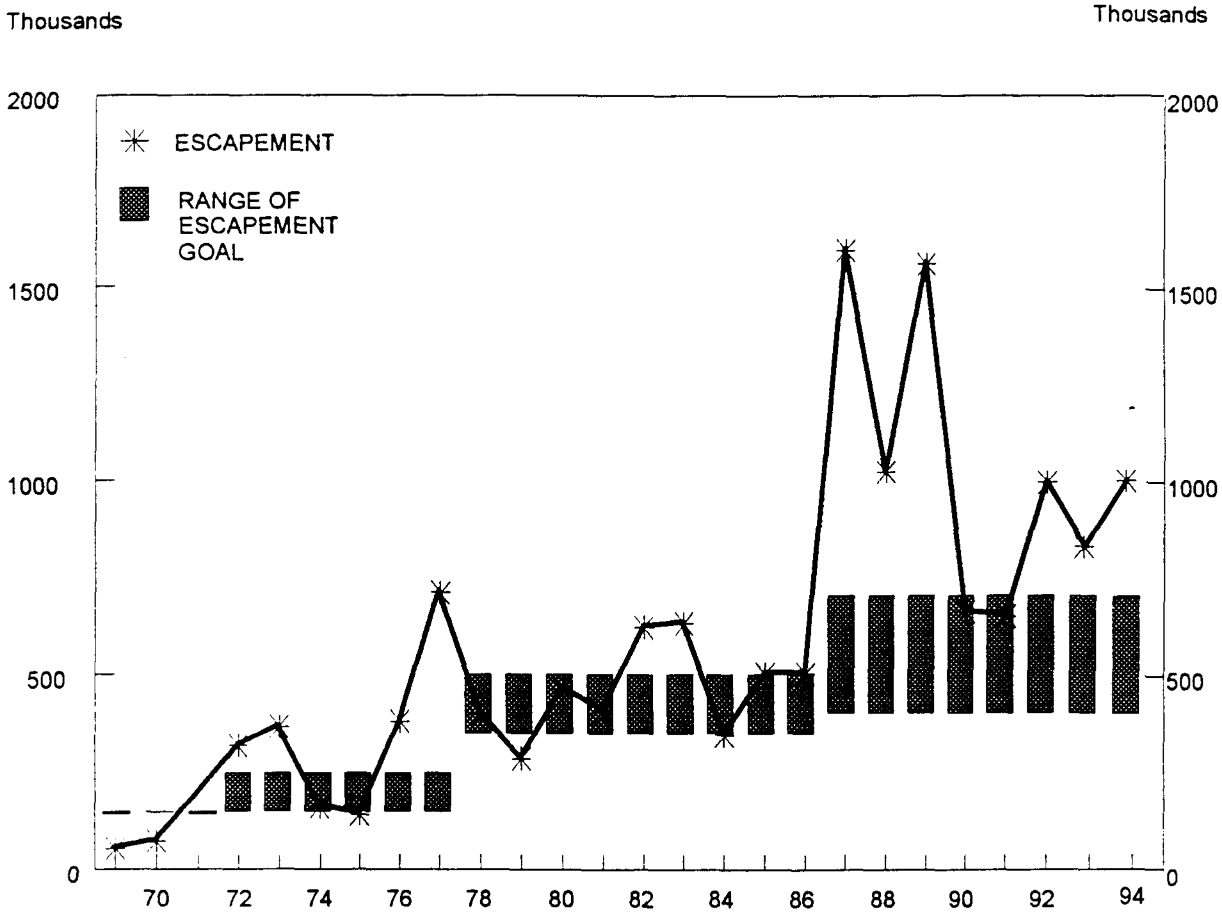
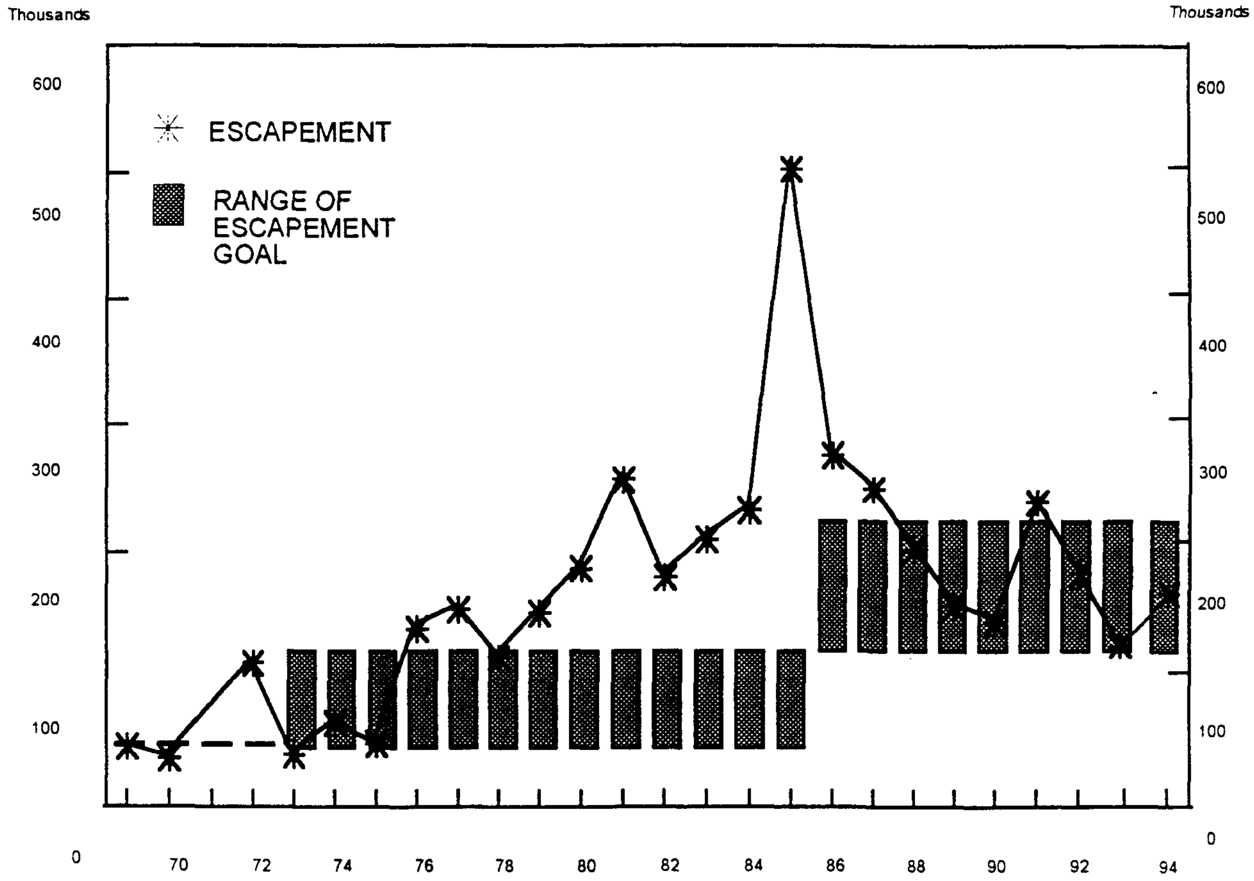


Figure 3. Summary of sonar count sockeye salmon escapements and historical escapement goal ranges for the Kenai River. Data represent total cumulative daily apportioned sonar counts at mile 19 of the Kenai River. Height of bars represents maximum escapement goal with the bottom of the gray bar representing the minimum escapement goal.



.Figure 4 Summary of sonar count sockeye salmon escapements and historical escapement goal ranges for the Kasilof River. Escapement data represent total cumulative daily apportioned sonar counts at mile 11 of the Kasilof River. Height of bars represents maximum escapement goal with the bottom of the gray bar representing the minimum escapement goal.

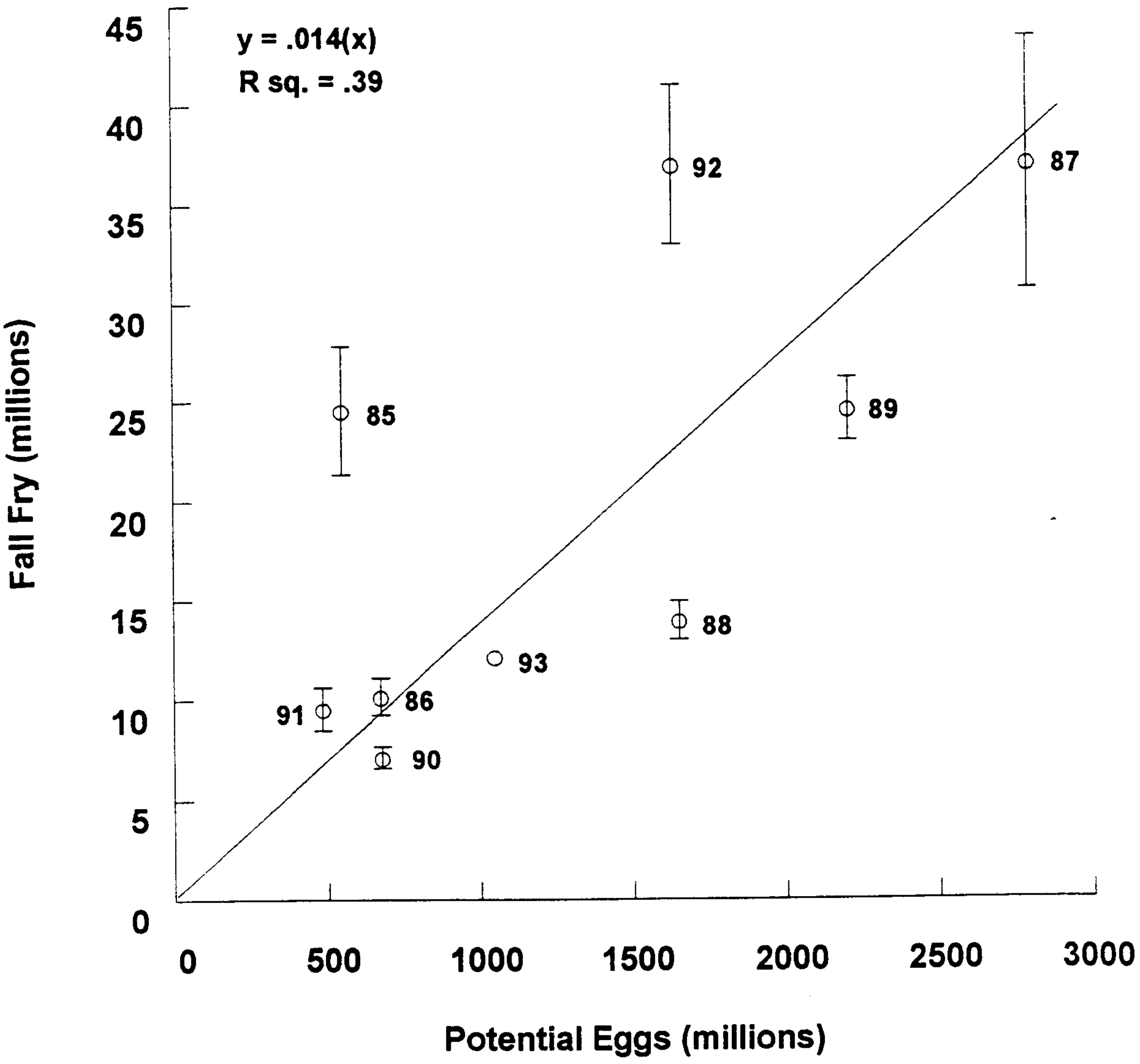


Figure 5. Relationship between the number of fall fry in Kenai and Skilak lakes and mainstem potential egg deposition. Vertical bars are standard errors of estimated fry abundance. Two models were used to assess the relationship: one with the constant term ($y = 7.32 + .010(x)$; R^2=.503; $P<.05$) and one without the constant ($y = .014(x)$; R^2=.390; $P<.05$). 1993 data point preliminary and not included in the regression.

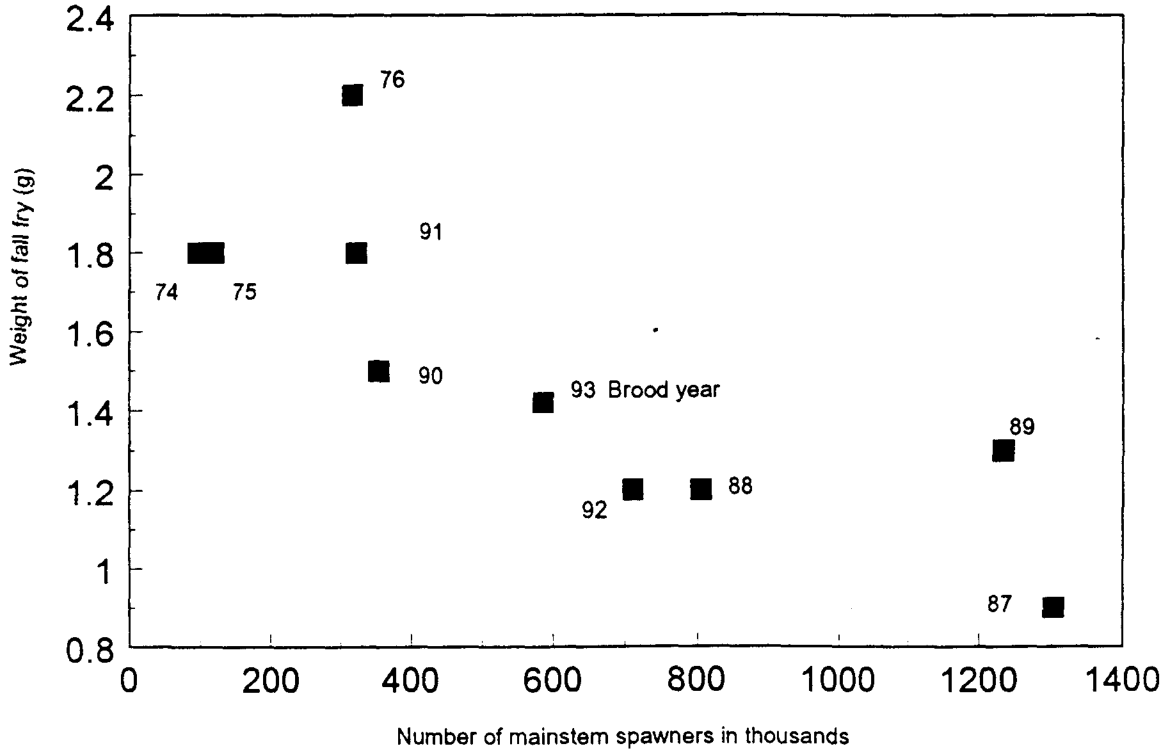


Figure 6. Relationship of Kenai River sockeye salmon spawning escapement to average weight of 0+ fall fry in Skilak Lake, Alaska. Brood year is indicated by data point label (1993 Brood Year indicates weight of fall fry in 1994.

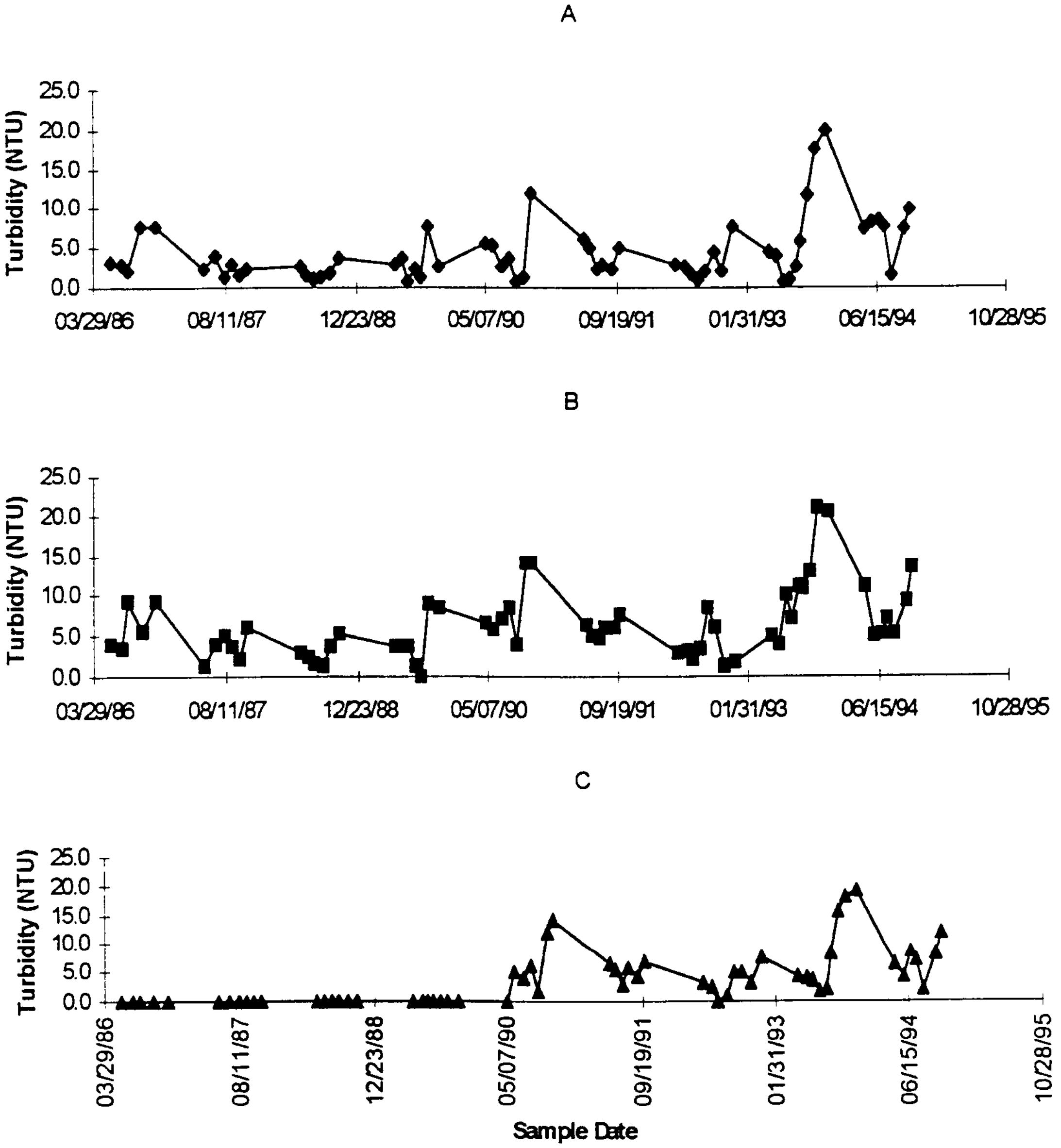


Figure 7. Seasonal turbidity fluctuations in Skilak Lake, Stations A , B and C. Station C was not sampled prior to 1990. Ordinates are in nephelometric turbidity units (NTU).

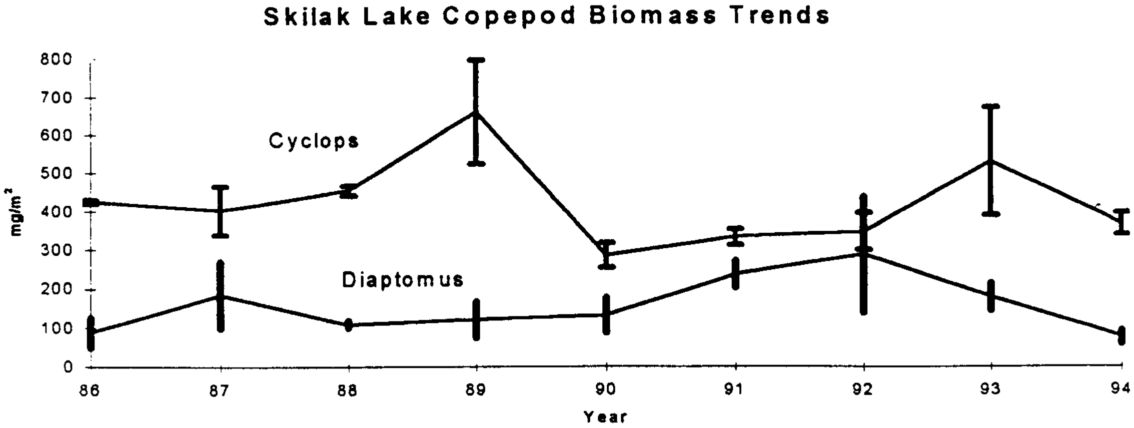


Figure 8. Inter-annual variation in Skilak Lake mean seasonal biomass. Error bars reflect one standard error of among sampling station variation.

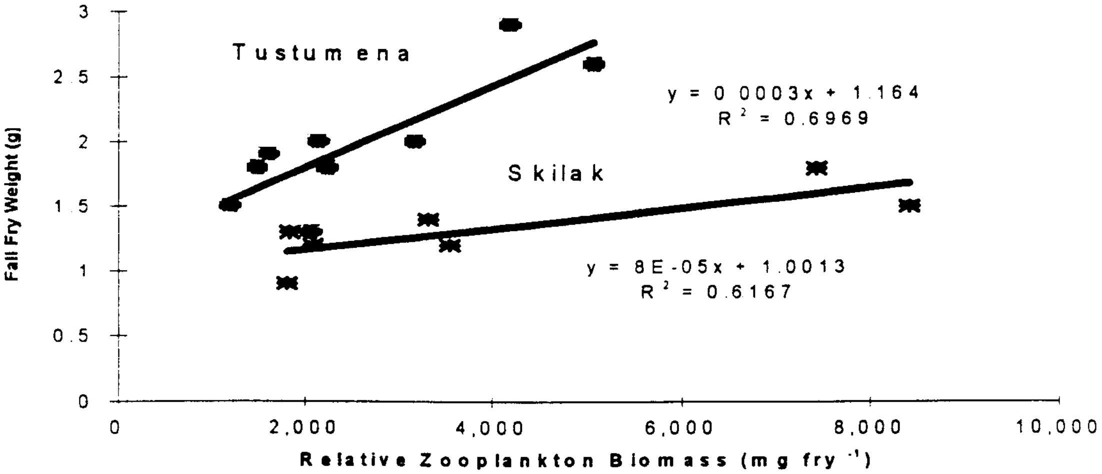


Figure 9. The relationship of fall fry mean wet weight versus relative zooplankton biomass are compared for Tustumena (1986-94) and Skilak (1987-94) lakes.

APPENDIX A:

Kenai River Sockeye Salmon Smolt Studies, 1993

by Bruce E. King, Linda K. Brannian, and Kenneth E. Tarbox

KENAI RIVER SOCKEYE SALMON SMOLT STUDIES, 1993

Bruce E. King

Linda K. Brannian

and

Kenneth E. Tarbox

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ABSTRACT

Inclined plane traps were placed in the Kenai River to capture seaward migrating sockeye salmon *Oncorhynchus nerka* smolt. Only 3,200 sockeye smolt were captured, continuing a trend of decreasing total annual catches since the first year of the study, 1989, when 161,000 smolt were captured. Historic trap efficiency data were used to calculate a 1993 seaward migration estimate of approximately 486,000 smolt. The minimum migration, including Moose River and Hidden Creek smolt which were not sampled by our traps, was 833,000 smolt. Approximately 88.5% of the population was age-1. smolt and the remainder smolt were age-2. (3.0%) and -0. (8.5%). Coho and sockeye salmon smolt length frequency data revealed decreased trap efficiency with increased smolt size. Age-0. smolt were not thought to be of Skilak Lake origin.

KEY WORDS: Sockeye salmon smolt, *Oncorhynchus nerka*, biological sampling, migratory timing, bismark brown dye, mark-recapture, population estimation, length frequency distribution

INTRODUCTION

The Kenai River (Figure 1) typically contributes more than 50% to annual Upper Cook Inlet (UCI) commercial harvests of sockeye salmon *Oncorhynchus nerka* (Ruesch and Fox 1993). Forecasting the return of this stock is important to the successful management of the fishery. Until 1993, forecasting was based on a combination of adult spawning escapements, age specific maturity schedules, and average numbers of returning adults per spawner. The 1993 forecast included adult sockeye salmon run estimates projected from the number and age composition of sockeye salmon smolt migrating out of the Kenai River.

The Kenai River smolt project has provided an estimate of the number and age composition of sockeye salmon smolt migrating out of the drainage since 1989 (King et al. 1990, 1991, 1994) This information has been used to evaluate sockeye salmon production in the Kenai River drainage in conjunction with estimates of spawners (Davis et al. 1993), juveniles rearing in Kenai and Skilak lakes (Tarbox and Brannian 1993), and adults passing weirs across Hidden Creek (Fandrei 1993) and Russian River (Marsh 1993a, 1993b) tributaries. Comparable production studies are being done in the Kasilof River drainage, the second largest producer of sockeye salmon in UCI (Kyle 1992).

Commercial fishing closures in UCI due to the 1989 Exxon Valdez oil spill resulted in an extremely large spawning escapement into the Kenai River. A suite of projects was designed to evaluate the effects of large spawning escapements on resulting progeny and lake rearing habitat. The Kenai River smolt project was a component of Natural Resource Damage Assessment Project No. 27, *"Sockeye Salmon Overescapement"*, from 1990 to 1992 (Schmidt and Tarbox 1991, 1992).

Objectives of the 1993 Kenai River smolt project were to:

1. estimate the number of sockeye salmon smolt migrating seaward during the peak migration period from 15 May through 30 June;
2. determine the age composition, mean weight, and mean length of sockeye salmon smolt;
3. describe daily and seasonal migration timing of sockeye salmon smolt;
4. determine the number of sockeye salmon smolt migrating adjacent to the right bank; and
5. assess the feasibility of using inclined plane traps to enumerate sockeye salmon smolt migrating from Russian River.

METHODS

Fishing Methods

All traps were similar in design to those used to estimate smolt migrations from the Crescent and Kasilof Rivers of UCI (Kyle 1983). Each trap was 2.1 m long, 1.5 m wide, and tapered in height from 1.05 m at the mouth to 0.1 m at the outlet or downstream end. Trap frames were constructed of angle aluminum and the bottom covered with perforated aluminum plate with 13 mm holes. The sides and top were covered with vexar plastic netting with 13 mm square mesh. The outlet end emptied into a 1.5 x 1.1 x 0.6 m live box which contained one vertical baffle. The mouth and outlet ends of the trap could be adjusted vertically to control fishing depth and the amount of water which entered the live box. Traps typically fished to approximately 1.0 m below the surface. All traps were fished continuously throughout the study. Traps were monitored continuously and emptied at least twice between 0001 h and 0500 h. Traps were checked only sporadically through the remainder of the day, and generally emptied once more between 2200 and 2300 h. All captured juvenile salmonids were counted and recorded by species and stage of development.

Kenai River

Six stationary floating inclined plane traps were placed in the Kenai River approximately 31 km upriver from the mouth (Figure 2). The river was 105 m wide with a maximum water depth of 2.5 m at the km 31 trap location (Figure 3). The thalweg occurred 25-30 m from the left bank and both current velocity and water depth generally decreased as one moved toward the right bank. Four of the six traps at km 31 were anchored from the left (south) bank with steel cable, and held at 9, 15, 21, and 24 m from shore with tubular aluminum booms. The inshore trap was designated trap 1. Traps on the left side of the river were placed in the area of highest surface water velocities and greatest flow volume, since we thought most smolt would travel downriver through this area (Hoar 1954, Foerster 1968, Bue et al. 1988). The remaining two traps, designated traps 5 and 6, were initially held 30 m offshore of the right bank using a similar cable and boom arrangement. On June 19 the right bank traps were moved closer to shore because increasing water velocity and debris load precluded continued deployment in the original location.

An additional two traps were placed in the river adjacent to the left bank at km 35. The two traps were anchored and held offshore 6 m and 12 m using cables and booms.

Russian River

A single smolt trap was placed in the Russian River 200 m above the confluence with the Kenai River. The front of the trap was anchored to the river bottom with steel stakes and cabled to shore. The rear of the trap was suspended between the legs of a quadrapod. The quadrapod was outfitted with a cable winch to raise and lower the outlet end of the trap. This controlled the flow of water entering the live box.

The trap was centered approximately 6 m from the right bank (Figure 4). Weir panels extended from the front of the trap, increasing the opening width to approximately 4 m. The near shore panel was 4 m long and ended 4 m from the left bank. The off shore panel was 8 m long and ended 9 m from the left bank.

The Russian River was 28 m wide at the front end of the trap weir panels (Figure 4). The maximum water depth of 0.54 m occurred 6 m from the right bank. Water depth decreased erratically to the left bank.

Estimating Smolt Abundance

Estimating Trap Efficiency

Methods used to estimate trap efficiency were similar at the Kenai River km 31 and Russian River sites. Sockeye salmon smolt were dyed and released each day until a minimum sample size was attained. No new releases of dyed smolt were made during the next 48 hours to allow those released to pass the counting site. This provided trap efficiency data within time strata. Sample size for each stratum was 2800 dyed sockeye salmon smolt for the Kenai River and 500 dyed sockeye salmon smolt for the Russian River.

The km 35 site was established as a dye site only. By dyeing 2800 sockeye salmon smolt at this site, we hoped to preclude dyeing at the km 31 site and allow the crew there to focus on examining fish for dye. We also suspected that we were subjecting fish to additional stress at the km 31 site by first examining them for dye and then using the same fish for dyeing.

At the km 35 site, sockeye salmon smolt were dyed in a solution of 5 g Bismark Brown in 190 l of water (approximately 1:36,000) for twenty minutes. Dyeing was done in the morning, using the previous night's catch. As sockeye salmon smolt were removed from the trap, they were counted and immediately placed into a live tank mounted in a boat. The water in this tank was constantly replaced by fresh river water using a battery operated pump. Smolt were dyed, held in the live tank for at least 12 hours, and released at approximately 2200-2300 h. After live smolt were released, dead smolt were counted to determine percent mortality from handling and dyeing. All smolt captured in the km 31 traps in the next 48 hours were examined for evidence of dye.

Russian River sockeye salmon smolt were dyed for 60 minutes in a 1:75,000 solution of neutral red. We used neutral red at this site to avoid including smolt dyed at the Russian River with dyed smolt recovered in the km 31 traps. Oxygen was pumped into the tank throughout the dyeing procedure. After 60 minutes in the dye, smolt were placed in perforated containers in the river and held until approximately 0500 h. Dyed smolt were then transported in buckets to a live box located approximately 0.8 km upstream of the trap for release the next evening at approximately 2200 h. Prior to release, we removed and counted any weak or dead smolt. We assumed that since dyed smolt were released in mid-stream at the onset of the nightly smolt migration, there would be adequate mixing of dyed smolt and other migrating sockeye salmon smolt prior to arrival at the trap. All smolt captured in the trap were examined for evidence of dye.

The number of smolt dyed and released (M_i) each marking period at the km 35 site was set at 2,800 to obtain an estimate of abundance (N_i) with a relative error of +/- 25% for trap efficiencies equal to or greater than 2%. Trap efficiency was defined as the number of recaptures (r_i) divided by the number of smolt dyed and released. Required M_i for a given trap efficiency varied only slightly with number of smolt caught ($\hat{C}_i$), but increased dramatically with decreasing trap efficiency. A 2% trap efficiency was twice that seen in previous years, but sample size requirements for lower efficiencies would require handling more smolt than we thought we could capture and process. We also assumed that dye marking events could be pooled since trap efficiencies of adjacent time strata were not significantly different in 1989 and 1990 (χ^2-test with $\alpha=0.05$ critical level). Pooling just two adjacent strata would result in a sample size of 5,600 smolt, which would provide estimates with the desired relative error for trap efficiencies as low as 1%.

At the Russian River site, we thought that the trap efficiency could reach 15%. We therefore selected a minimum sample size of 500 sockeye smolt for each stratum. This would give a relative error of +/- 25% for the estimate even if trap efficiency was as low as 10%.

Our estimator, like other mark-recapture estimates of population size, was biased when low numbers of dyed sockeye salmon smolt were recaptured (Seber 1982). To keep the level of bias below 10%, enough smolt had to be marked to ensure that at least 10 dyed smolt were recaptured within each time stratum. Fewer recaptures would result in a positive bias which would increase rapidly as recaptures fell below 10 smolt (King et al. 1994).

Analyses assumed: (1) all released dyed sockeye salmon smolt moved past the trap site within 48 hours so dyed smolt from one time period would not be caught in another; (2) the probability of capture among traps at km 31 was the same for marked and unmarked smolt; (3) the probability of capture for each individual smolt was independent of that of other smolt.

Estimating Sockeye Salmon Smolt Abundance

Sockeye salmon smolt abundance ($\hat{N}_i$) was estimated from trap data collected at km 31 (traps 1 through 4 only) using LaPlace's ratio estimate (Cochran 1978) as adapted by Rawson (1984):

$$\hat{N}_i = \hat{C}_i \frac{M_i}{r_i}[1+\frac{M_i-r_i}{M_i r_i}] \quad , \qquad (1)$$

where:

$\hat{N}_i$ = number of undyed sockeye salmon smolt migrating past traps in period i

$\hat{C}_i$ = number of sockeye salmon smolt caught in traps in period i

M_i = number of sockeye salmon smolt dyed and released upstream in period i

r_i = number of dyed sockeye salmon smolt recaptured in traps in period i.

The variance of $\hat{N}_i$ was estimated as:

$$V(\hat{N}_i) = \hat{C}_i(\hat{C}_i+r_i)M_i\frac{(M_i-r_i)}{r_i^3} \quad , \qquad (2)$$

and the (1-α) confidence interval as:

$$\hat{N}_i \pm z_\alpha\sqrt{V(\hat{N})} \quad , \qquad (3)$$

where z_α = the (1-α)/2 percentage point of the standard normal distribution.

Sockeye salmon smolt abundance in 1993 was also estimated with a resampling technique (Effron 1982) based on the number of smolt dyed and recovered each spring from 1989 through 1993. Data from each year were pooled when trap efficiencies were not significantly different (χ^2 test, p=0.05) between time strata. Data for the entire season were pooled for 1989, 1991, 1992 and 1993, but had to be split into two strata for 1990. These six pairs of M_i and r_i values were randomly chosen with replacement to produce estimates of 1993 smolt abundance using equation 1. The mean of five hundred bootstrap replications was used to estimate smolt abundance in 1993 (N_{93}):

$$N_{93} = \frac{\sum_{b=1}^{500} N_b}{500}, \qquad (4)$$

Variance of N_{93} was then calculated as:

$$V(N_{92}) = \frac{\sum_{b=1}^{500} (N_b - N_{92})^2}{500-1} \quad . \qquad (5)$$

A 95% confidence interval was approximated by ranking 500 estimates in ascending order and then using the 13th largest estimate (2.5 percentile) as the lower bound, and the 486th largest estimate (97.6 percentile) as the upper bound.

Run Timing

Migration timing was based on the proportion of the total catch made each day. We assumed that most smolt migrating from the Kenai River system passed the trap sites during the operational period. Therefore the mean date of the migration was the date when 50% of the total catch had occurred at the trap sites.

Age, Weight, and Length Sampling

Sockeye salmon smolt captured in km 31 and Russian River traps were sampled for age, weight, and length (AWL) information. A scale smear from the preferred area (INPFC 1963) of each smolt was placed on a standard laboratory slide for age determination, and each smolt was weighed to the nearest 0.1 g and measured (fork length) to the nearest mm.

Because of low catches at both the km 31 and Russian River sites, desired sample sizes were not obtained for the any of the 5 day time strata originally set for AWL sampling. However, nearly all smolt not used for the mark-recapture experiment were sampled for AWL information. Sample periods were initially redefined as the number of days needed to collect at least 300 smolt. This sample size provides a binomial (two age classes) simultaneous 90% confidence interval of +/- 0.05 when the proportion of the major age class in the population is at least 0.75. No samples were taken at the km 31 site from 1 to 9 June, the period when most of the smolt migrated from the system, since all available smolt were dyed for trap efficiency tests. We also could not use the next 300 smolt sample to estimate the age composition of the early June migration. This sample was not representative of the early portion of the migration since half of the sample was obtained later in June when age-0. smolt were most abundant. Consequently, we divided this 300 smolt sample into two periods and used only smolt captured during 10-12 June to represent the migration during 1-15 June.

AWL data were also collected from sockeye salmon smolt migrating from Moose River and Hidden Creek. We compared age composition, mean length and length frequencies for smolt from these tributaries to values from samples collected at the km 31 site to determine whether these substocks were represented in the km 31 trap catches. Age-specific mean lengths were compared among smolt samples from km 31, Moose River, Hidden Creek, and Russian River sites using one-way ANOVA to determine whether differences could be detected. Contrast statements were used to determine which sites were different. All tests were conducted at the nominal $P \leq .05$ level of significance. The same analyses were performed on mean lengths for age-0. smolt captured in the km 31 traps, 1992 age-0. fall fry captured in Skilak Lake, and 1993 age-0. summer fry captured in Skilak Lake.

We also examined length data from adipose fin clipped coho salmon smolt captured in the km 31 traps to provide another measure of trap efficiency. These marked coho salmon smolt were captured in the Moose River and marked by inserting a coded wire tag into the snout and removing the adipose fin (Carlon and Hasbrouck 1993). Nearly all coho salmon smolt passing the weir were tagged except a random sample preserved daily for collection of AWL passing the weir were tagged except a random sample preserved daily for collection of AWL data. We assumed that the length frequency distribution of the AWL sample (n=1,217) accurately represented the distribution for marked migrants. We were therefore able to apportion the total Moose River coho salmon smolt migration and the total km 31 catch of marked coho salmon smolt into 5 mm length interval strata. We then calculated a trap efficiency for each length stratum.

Climatological and Hydrological Sampling

Water velocity (m/sec) measurements were taken at the surface in front of each km 31 trap whenever river depth rose or fell 0.3 m. Water depth (m), temperature (°C), and turbidity (maximum depth in m a secchi disc was visible) were measured daily at this site. Kenai River daily discharge was calculated from stage height data gathered at river km 34 by the Alaska River Forecast Center (L. Rundquist, National Weather Service, NOAA, Anchorage, pers. comm.).

RESULTS

Km 31 site

Traps were fished from 17 May until 5 July 1993 at the km 31 site. Although we were prepared to subsample catches (King et al. 1991), the seaward migration was small enough to allow us to identify and count all fish captured.

A total of 105,229 fish were captured in traps 1-4 (Tables 1 through 5). Three percent (3,200) of the total fish caught were sockeye salmon smolt. Captures of fry of all salmonid species exceeded those recorded in previous years (Table 6). The historical trend of increased numbers of smolt and decreased numbers of fry with distance from shore of all species continued. Sockeye salmon smolt captures have decreased each year since the inception of the project in 1989 (Table 7).

Traps 5 and 6 caught a combined total of 14,357 fish of which 670, or 4.7% were sockeye salmon smolt (Tables 8-10). Most of the catch consisted of sockeye fry (36.7%), pink fry (20.9%), chinook fry (15.1%) and coho fry (10.8%). Catches of fry, except pink salmon, were proportionally higher than traps 1-4 combined, and the proportions of each group were most similar to traps 1 and 2. Sockeye salmon smolt catches from traps 5 and 6 represented 17% of the total catch of all traps, roughly half of that expected if smolt were uniformly distributed in the river. One dyed sockeye salmon smolt was captured in trap 6 on 5 June. Over 75% of trap 5 and 6 sockeye salmon smolt captures occurred prior to moving the traps closer to shore on June 19. Approximately the same percentage of the catch of sockeye salmon smolt in traps 1-4 also occurred prior to that date.

A total of 1,934 sockeye salmon smolt were dyed and released upstream. Survival during the holding period between dyeing and release ranged from 0.905 to 0.969 and averaged 0.926 (Table 11). The high survival rate reflected changes in procedures instituted in 1992 to reduce handling stress (King et al. 1994).

Six of the dyed sockeye salmon smolt released were recaptured in traps 1 through 4, resulting in a total trap efficiency of 0.003. This compares with trap efficiencies for the years 1989 through 1992 of 0.007 to 0.021 (Table 12). The ratio of dyed to undyed smolt was the same among traps 1 through 4 ($\chi^2=3.38$, $p=0.337$, 3 df). Using the 1993 M_i and r_i values resulted in an estimate of migration of 1,202,844 sockeye salmon smolt.

We chose to use the six pairs of M_i and r_i values from 1989-93 to generate 500 bootstrap estimates for 1993. The mean of 486,181 sockeye salmon smolt (Table 13) was used to estimate the 1993 smolt population. The 95% confidence bounds ranged from 163,998 to 1,202,844 smolt.

Sixty-three percent of the measured sockeye salmon smolt seaward migration occurred between 1 and 8 June, although within that time frame there were three distinct peaks in the daily passage rate (Figure 5). Only 1.0% of the migration occurred within the first 8 days of counting, and a relatively steady daily migration which constituted 20% of the total occurred during the last two weeks of the project. Age-2 sockeye smolt left the drainage earlier than age-1 smolt (Table 14).

An estimated 88.5% of the sockeye salmon smolt sampled at the km 31 site were age 1. (Table 15). There was a significant ($\chi^2=37.06$, $p=0.05$, 1 df) decrease in the proportion of age-2. smolt in period 2. In addition, there was a significant ($\chi^2=99.07$, $p=0.05$, 1df) decrease in age-1. and increase in age-0. migrants in period 3.

Age-0. sockeye salmon smolt, which comprised 8.5% of the estimated migration, have not been captured in the traps in previous years. These smolt were first captured on 19 June. The mean length for the first time stratum after their initial appearance was 51 mm (Table 16). Analysis of variance indicated that the mean length of the age-0. smolt captured at km 31 was smaller ($P<0.0001$) than that of the 1992 fall fry captured from Skilak Lake (Tarbox and Brannian 1993). Conversely, ANOVA revealed that the 1993 age-0. smolt were longer ($P<0.0001$) than 1993 age-0. fry sampled in July in Skilak Lake (mean = 41 mm; K. Tarbox, ADF&G, Soldotna, pers comm.).

As in 1992, mean lengths and weights of sockeye salmon smolt were greater than in any of the previous years (Table 16; Figures 6 and 7). In 1993 the mean length of age-1. sockeye salmon smolt from the km 31 (mainstem) traps and from samples collected in the Moose, Hidden, and Russian tributaries were, respectively, 77.9 mm, 114.2 mm, 130.1 mm, and 80.9 mm. The mean length of the km 31 age-1. smolt was significantly less than each of the substocks ($P<001$ in all cases). Mean length of age-2. sockeye smolt from the km 31 traps and from samples collected in Hidden, and Russian tributaries were, respectively, 98.2 mm, 187.4 mm, and 93.7 mm. The mean length of km 31 age-2. smolt was significantly different than Hidden Creek $p<0.001$), and Russian River ($p=0.008$) substocks.

In general, Hidden Creek sockeye salmon smolt appeared to be missing from the km 31 trap catches (Figure 8). There was some overlap in the length frequency distribution of km 31 and Moose River age-2. smolt, and the length frequency distributions of age-1. and -2. sockeye salmon smolt captured in the Russian River were very similar to that for the km 31 trap captures. Weighting the length frequency distributions by estimated smolt abundance from each of the tributaries and km 31 again showed that Hidden Creek age-1. smolt were not captured by the mainstem traps, and that Moose River age-2. sockeye smolt were partially available to the gear (Figure 9). Inclined plane traps at km 31 probably also missed most of the age-2. smolt exiting the Russian River. Conversely, the mainstem traps appeared to have captured a representative sample of the Russian River age-1. smolt.

Our analysis of length frequency data for Moose River marked coho salmon smolt (Carlon and Hasbrouck 1993) captured at km 31 indicated that trap efficiency decreased with increased length (Figure 10). Coho salmon smolt in the 100 to 114 mm length range had an equal probability ($\chi^2=0.101$, $p<0.05$, 2df) of capture (approximately 1.6 to 1.7%; Table 17). Significant differences ($p=0.05$) in trap efficiency were detected at 5 to 10 mm intervals in length frequency for other smolt size ranges. The lowest calculated trap efficiency, 0.17%, was for coho smolt from 155 to 159 mm long (based on only one recovery), and none of the estimated 415 tagged fish larger than 160 mm were captured at km 31.

Seasonal trends in hydrological parameters were similar to previous years. Water level increased daily until mid-June, while temperature fluctuated between 7 and 13° C at the km 31 site throughout the study (Table 18). Total discharge was the second highest on record for May (Figure 11). Changes in water clarity were significantly correlated ($r = 0.136$, $p = 0.01$, 48 df) with changes in discharge (Figure 12).

The 1993 adult sockeye salmon return provided the first opportunity to evaluate the accuracy of smolt estimates based on adult returns of all age classes. The 1987 parent year escapement of 1,408,000 adult spawners (Table 19), produced approximately 37,000,000 age-0. fry which reared in the two major lakes in the drainage (Tarbox and King 1989). This was a minimum estimate of fry production since Russian River, Hidden Lake, and Moose River were not included. However, these systems were thought to produce only a small portion of the production that year. The 1987 parent year spawning escapement produced 30,224,000 smolt. Most of these smolt (24,416,000) migrated to sea at age-1. Some (5,807,000) 1987 brood year juveniles remained in freshwater and left as age-2. smolt the next spring. The age-1. smolt brought back 7,793,000 age-1.2 and -1.3 adults giving an age-1. smolt to adult survival of 31.9%. The return of 2,017,000 age-2.2 and -2.3 adults in 1992 and 1993 gave an age-2. smolt-to-adult survival rate of 34.7%. The total smolt to adult survival rate for the 1987 brood year was 32.5%. Survival of Tustumena Lake (Kasilof River) 1987 brood year sockeye smolt from smolt to adult was approximately 15%.

The 1988 adult spawning escapement of 910,000 produced 5,249,000 age-1. smolt and 431,000 age-2. smolt for a total smolt production of 5,680,000. Survival of age-1. smolt from the 1988 brood year was similar to 1987 with relatively few (1.9%) returning as age-1.2

adults and more (22.8%) returning as age-1.3 adults for a total survival of 1 freshwater smolt to adult of 24.7%.

The 1989 parent year adult spawning escapement of 1,379,000 produced 2,776,000 age-1. smolt and 312,000 age-2. smolt. The 1990 adult spawning escapement of 519,000 produced only 253,000 age-1. and 36,000 age-2. smolt. The 1991 spawning escapement of 431,000 fish has to date produced 797,000 smolt (age-1. only). The age-2. component of the 1991 brood year will migrate to sea in 1994.

Russian River

The Russian River inclined plane trap collected 43,791 fish from 18 May through 15 July 1993 (Table 20). Sockeye salmon fry comprised 76.1% of the catch. A total of 8,425 sockeye salmon smolt, making up 19.2% of the total, were also captured.

Dyed sockeye salmon smolt were released on 20 nights. Recapture data for these dates were grouped into seven time strata, each with a minimum of 475 released dyed sockeye salmon smolt (Table 21). Trap efficiencies by stratum ranged from 0.011 to 0.152, and were not significantly different between strata 1 and 2 ($\chi^2=0.59$, $p=0.44$, 1df), and among strata 4,5 and 6 ($\chi^2=4.36$, $p=0.11$, 2df). By combining data from statistically similar strata, we established three periods with distinct trap efficiencies. Using these data we estimated 222,024 smolt with a 95% confidence interval of 119,485 to 324,562. However, this estimate was used only for comparison of weighted length frequency distributions of various Kenai River substocks because of uncertainties in the dye and recovery process.

There were two sockeye salmon smolt migration peaks during May and June. Approximately one-fourth of the trap captures occurred between 18 May and 6 June, followed by a period of 18 days in which our maximum daily catch was 46 smolt (Table 18). The latter period accounted for less than 5% of the total catch. On 25 June, 5 days before the project was scheduled to end, catches again increased, and between that date and 15 July we counted 69.2% of the catch total for the season. The catch on the last day of operation was 1.4% of the total.

Age-2. sockeye salmon smolt were numerically dominant in the catch from mid-May until early June (Table 22). After 2 June, age-1. sockeye smolt were the most abundant age class collected. There was a significant difference (($\chi^2=1021.14$, $p<0.001$, 15df) in age class composition of the smolt captured each period except for those sampled from 1 through 15 July. Mean length and weight of age-1. smolt was at least 10 mm and 2.0 grams smaller than age-2. smolt during each of the time strata sampled.

DISCUSSION

From the beginning of the season through the time period when most of the sockeye salmon smolt migration occurred in past years, the right and left bank traps were separated by approximately 25 m. The traps closest to the middle of the river, traps 4 and 5, were approximately equidistant from their respective banks. Catches from traps placed adjacent to the shallower right bank, traps 5 and 6, contained proportionally fewer sockeye salmon smolt than those on left bank. In addition, catches of other age classes and species, especially fry, were very similar to those of the left bank near shore traps 1 and 2. Nearshore distribution of fry was also observed by Clark and Smith (1972). This catch information suggests that traps 5 and 6 were placed in areas not preferred by sockeye salmon smolt, and that large numbers of smolt were not migrating past the right bank. These data, along with the high proportion of the total sockeye salmon smolt catch in trap 3, however did not provide sufficient evidence that few smolt migrate in the section of the river between the two sets of traps.

The high relative proportion of the sockeye salmon smolt catch (48.9%) from trap 3 was not observed in previous years. Historically, traps 3 and 4 have had approximately equal seasonal catch totals. The only other year when the proportion of the catch in trap 3 exceeded that of trap 4 was 1990 when the two traps captured 46% and 33% of the total sockeye salmon smolt, respectively. Both 1990 and 1993 also had greater daily and total discharge rates for May than other study years. Since surface velocities measured at the mouth of traps 3 and 4 were essentially the same, it did not appear that the relatively high proportion of sockeye salmon smolt catches in trap 3 was solely a function of flow regime.

We decided to exclude the data from traps 5 and 6 in this year's estimate so that it would be comparable with previous years. Traps 5 and 6 accounted for 17% of all sockeye salmon smolt and 14% of the dyed smolt caught, and the ratios of dyed to undyed smolt were not different among traps 1 through 6 (χ^2=w.74, p=0.59, 5 df). When these data were included in the bootstrap model, the estimate of migrants was 548,746 smolt, an increase of 12.9% over our chosen best estimate.

Numbers of sockeye salmon smolt continued a downward trend in catch from the 161,111 in 1989, the initial year of the study. In contrast, the numbers of smolt and fry of other species have either remained relatively constant or increased. Several questions, however, remain to be answered about our estimates of trap efficiency and smolt behavior before we feel comfortable with our smolt estimates.

An important assumption underlying the population estimate is that marked and unmarked smolt behave similarly. A violation of this assumption would be apparent if we obtained very different marked to unmarked ratios among traps. Since no differences were detected among traps 1-4, we had no evidence to suggest that marked and unmarked fish behaved differently. Differences were found in previous years, so our ability to detect differences this year may have been hampered by the small number of dyed smolt recovered in 1993.

As in 1992, the minimum sample size for a single dye event was not attained. The small sample size released on any given day also precluded examination of changes in trap efficiency over time. In addition, since fewer than 10 dyed smolt were recaptured, the mark-recapture estimate could be biased (Seber 1982). Finally, the minimum number of dyed smolt needed each period was based on the assumption that trap efficiency would either equal 2%, or be consistent over time if less than 2%. Sample sizes greater than 5,700 were needed to ensure a relative error of less than 25% for efficiencies equal to or less than 1%. Since we could not meet these requirements, our estimate had very wide confidence intervals. Although neither 1992 or 1993 dyed smolt sample sizes met the sampling objectives, we elected to include both in the bootstrap procedure because the range in trap efficiencies and subsequent confidence intervals reflected the uncertainty of our estimate.

The lack of sockeye smolt captures and increase in smolt size in 1992 and 1993 have led us to seriously question the validity of our population estimator. The bootstrap technique helped alleviate some sample concerns, but since smolt were larger in 1992 and 1993 than in previous years, it is possible that the mean bootstrap estimate is conservative because larger smolt may have been able to better avoid capture. Despite these potential problems, we think that the decrease in total smolt catch relative to 1989 supports our conclusion that the 1993 seaward migration was very low.

In 1992, we were concerned that larger smolt may have a different probability of capture in our traps than smaller smolt (King et al. 1994). Prior to 1992, age-2. sockeye smolt lengths from traps samples appeared to be normally distributed (King et al. 1991) which suggested that size selectivity did not occur. We assumed that length frequency distributions would be truncated at larger values or be skewed toward smaller sizes if larger smolt were better able to evade capture. Length frequency data for Russian River, Moose River, and Hidden Creek sockeye smolt, first collected in 1992, suggested that Hidden Creek (age-1.) and Moose River (age-2.) sockeye smolt were not represented in mainstem trap catches. Their length frequency distribution had little overlap with that measured for mainstem trap smolt samples, and the corresponding mean lengths were different. In contrast, there was sufficient overlap between the mainstem and Russian River age-2. length frequency distributions to infer that Russian River smolt were at least partially represented in mainstem catches. These results were duplicated in 1993. In addition, the length frequency distribution of Russian River age-1. sockeye salmon smolt very closely resembled that of the km 31 catch age-1.

Most surprising was the low abundance of age-1. sockeye salmon smolt in the 60-70 mm size range, the size of migrants we expected to leave Skilak Lake. It is unlikely that these juveniles grew from a mean length of 59 mm measured as age-0. fry in December 1992 to a mean length of 78 mm as age-1. smolt by May 1993, since fry only grew an average 5 mm in the 2.5 months prior to the December 1992 sampling period (Tarbox and Brannian 1993). Also, sockeye salmon fry in Skilak Lake in November 1993 were 97.7% age-0. (K. Tarbox, ADF&G, Soldotna, pers comm.), eliminating holdover as a possible reason for the apparent lack of age-1. migrants from Skilak Lake. Three explanations for their absence in the trap catches can be put forward. First, smolt may have migrated out of the system during a time frame, or in an area of the river not monitored by the project. Second, the estimated 9.5

million fry inhabiting Kenai and Skilak Lakes the previous fall may have survived at a very low rate. Third, trap avoidance may have been much greater than we suspected which would have violated the assumption that probability of capture was the same for marked and unmarked smolt.

The presence of age-0. sockeye salmon smolt in the migration was unusual since we have not captured this age group in previous years. These smolt first appeared in the traps after 80-90% of the total migration had occurred. The 51 mm mean length of this age class was nearly 10 mm smaller than the average for any smolt age group we have documented in any year of the study. In addition, age-0. fry captured in the traps were uniformly 25-35 mm in length.

We examined the possibility that the age-0. sockeye salmon smolt were of Skilak Lake origin. One hypothesis was that they were actually misaged age-1. smolt. If this were true, then the age-0. smolt would not have been smaller than the 1992 age-0. Skilak Lake fall fry, unless the spring smolt were all that remained of the smallest size of the Skilak Lake 1992 fall fry, implying that only the smallest fall fry survived until spring. A second hypothesis was that these age-0. sockeye salmon were identified as smolt, but were merely 1993 recruitment that had washed out of the lake as a result of the relatively high flow rates which occurred in May. This does not appear to be the case since 1993 age-0. smolt were larger than 1993 age-0. fry sampled in July in Skilak Lake. A third hypothesis, is that the age-0. migrants came from a lake in the drainage in which age-0. fry responded to higher than average spring temperatures by smolting. No sockeye juveniles of this description were observed in the Moose River in 1993, although the weir was dismantled three days prior to the first capture at km 31. Fandrei (1993) did not report atypically small fish leaving Hidden Creek in 1993.

A comparison of length frequency distributions for coho salmon captured in Moose River, Hidden Creek and the mainstem Kenai River suggested size selectivity in trap catches (Figure 10). Carlon and Hasbrouck (1993) found a significant ($p < 0.001$) difference in mean length between coho tagged in the Moose River and those recovered in the traps, and stated that traps could not be used to estimate the number of coho salmon migrating seaward from that drainage. We found that trap efficiency could be estimated for coho salmon smolt of various size ranges, and that smolt from 100-114 mm were caught at a rate of slightly less than 2%. Since we were unable to capture Moose River and Hidden Creek sockeye salmon smolt which had similar lengths to the coho salmon smolt captured at km 31, it appears that trap efficiency differed among species as well as within a species. Similar results were reported by Thedinga et al. (1993) for screw traps used on the Situk River in Southeastern Alaska.

Mean smolt length and weight have increased dramatically since 1989. However, fry to smolt survival experienced declines of a similar or greater level during the same time period. The relationship of increased smolt size with decreased numbers has been observed in other sockeye systems (Macdonald et al. 1987). The trend in fry to smolt survival seems counter intuitive; we would expect that larger smolt to have survived at a higher rate. That the opposite has been observed suggests two possible causes: there was less competition for food in the lake after most of the overwintering fry died which allowed the survivors to grow more rapidly; or, there was a change from earlier years of the project in the relative magnitude of the tributary populations being measured at the km 31 smolt enumeration site.

The sockeye salmon smolt estimate for 1993 was considerably less than that expected from fall fry estimates adjusted for average winter survival. Fall 1992 lake surveys produced estimates of 9,506,000 age-0. and 102,300 age-1. fry in Kenai and Skilak Lakes (Tarbox and Brannian 1993). If winter survival was average (75%), approximately 7,000,000 age-1. and 77,000 age-2. smolt should have migrated from Kenai and Skilak Lakes, in addition to smolt from Hidden Lake, Moose River, and Russian River.

If our estimates were reasonably accurate, our data suggest that sockeye salmon smolt production from the 1987-1991 parent years varied considerably despite record large escapements achieved in most of those years (Table 22). The numbers of smolt per spawner declined rapidly from over 20 to less than 1, even with the production from Moose River and Hidden Lake added to the smolt estimated at km 31.

We used the estimate of Russian River sockeye salmon smolt abundance in 1993 as an index of the order of magnitude of the migration. We encountered several problems which could affect the accuracy of the estimate, and decided to alter the program in 1994 prior to generating an estimate of migration. The primary area of concern was variation in trap efficiency through time. During the period 18 May through 29 June, the trap efficiency of 0.05 was much less than expected if trap catch was proportional to area of the river sampled. Large age-2. smolt made up at least 57.0% of the migrants prior to 2 June and were absent from the samples by 30 June. During the last three weeks of the project, the migration was nearly all age-1. smolt with a mean length 11 to 17 mm less than the age-2. smolt which migrated in May and June. The age-1. smolt were recaptured at a rate of 0.13. Only if the dyed age-2. smolt were able to avoid recapture completely during the last three weeks, could we have approached the trap efficiency recorded for the early period. During the middle period, 30 June through 3 July, only 8 of 760 dyed fish were recovered. Using that trap efficiency (0.01), and the numbers of smolt captured, resulted in half the total estimated migration occurring during that period. Clearly there were enough uncertainties in the recapture results to question migration estimates. In 1994 we intend to increase the number of traps to two and weir most of the river except for a small migratory channel for adults. We hope that this will increase trap efficiency, and provide us with a clearer understanding of trap avoidance.

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Table 1. Numbers of fish captured by trap 1 in the Kenai River, May 17 through July 5, 1993.

	Numbers of Fish [a]								
Date	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
17–May	0	9	0	24	0	2	21	1	57
18–May	0	4	0	11	0	0	44	0	59
19–May	0	10	8	24	1	9	9	4	65
20–May	0	20	2	31	0	0	30	2	85
21–May	0	0	10	0	0	0	72	8	90
22–May	0	11	3	22	1	6	79	2	124
23–May	0	10	8	37	0	3	194	9	261
24–May	0	0	17	37	4	2	146	6	212
25–May	0	21	6	17	2	31	56	2	135
26–May	2	1	16	10	3	4	151	6	193
27–May	5	21	18	20	0	2	46	5	117
28–May	1	8	5	12	1	1	123	5	156
29–May	0	25	2	12	0	4	544	0	587
30–May	0	7	1	5	1	2	158	5	179
31–May	1	5	6	6	2	1	140	4	165
01–Jun	4	55	2	16	1	2	135	6	221
02–Jun	3	128	17	13	1	2	119	8	291
03–Jun	4	328	4	15	1	12	128	7	499
04–Jun	5	274	1	1	0	1	152	3	437
05–Jun	2	215	0	4	0	0	135	5	361
06–Jun	1	99	0	2	0	2	128	5	237
07–Jun	11	48	2	2	3	1	213	4	284
08–Jun	2	70	1	3	7	4	155	5	247
09–Jun	2	1	1	1	1	0	125	3	134
10–Jun	1	43	3	1	0	0	41	1	90
11–Jun	0	18	3	0	0	1	85	4	111
12–Jun	1	10	0	0	2	5	80	3	101
13–Jun	1	7	1	1	5	3	50	1	69
14–Jun	0	8	0	13	0	1	120	2	144
15–Jun	0	33	3	3	0	0	50	0	89
16–Jun	0	20	4	4	0	0	25	2	55
17–Jun	0	3	8	4	1	8	60	2	86
18–Jun	0	1	5	6	0	4	40	0	56
19–Jun	0	8	1	28	1	11	50	2	101
20–Jun	0	33	2	35	1	4	140	4	219
21–Jun	1	24	2	13	1	3	80	1	125
22–Jun	0	0	2	32	0	0	90	2	126
23–Jun	0	44	5	15	0	8	30	0	102
24–Jun	2	45	0	26	1	12	20	3	109
25–Jun	1	40	10	21	1	14	20	0	107
26–Jun	1	0	6	32	1	1	20	1	62
27–Jun	1	30	18	15	0	3	30	1	98
28–Jun	1	35	3	6	0	4	20	2	71
29–Jun	2	18	7	32	1	5	3	0	68
30–Jun	5	25	5	6	3	27	5	0	76
01–Jul	3	71	15	43	0	3	10	1	146
02–Jul	4	70	20	70	1	25	1	4	195
03–Jul	7	27	43	34	0	26	6	4	147
04–Jul									
05–Jul	0	56	44	32	0	19	0	6	157
Total	74	2,039	340	797	48	278	4,179	151	7,906

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[a] No traps were fished on July 4.

Table 2. Numbers of fish captured by trap 2 in the Kenai River, May 17 through July 5, 1993.

	Numbers of Fish [a]								
Date	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
17-May	1	2	3	4	0	0	162	1	173
18-May	2	0	2	0	0	1	479	2	486
19-May	0	7	1	17	2	4	576	11	618
20-May	1	0	6	2	1	0	258	9	277
21-May	3	0	5	3	1	1	493	7	513
22-May	0	1	3	0	13	4	396	7	424
23-May	0	0	3	1	2	2	529	2	539
24-May	5	0	9	6	4	1	406	1	432
25-May	2	0	10	2	7	7	94	7	129
26-May	2	1	23	10	7	2	329	6	380
27-May	3	4	21	0	1	3	205	8	245
28-May	4	15	6	6	3	0	675	4	713
29-May	1	3	5	11	6	3	610	27	666
30-May	1	8	2	6	5	3	639	6	670
31-May	2	0	2	4	3	0	770	6	787
01-Jun	17	3	6	5	0	0	255	13	299
02-Jun	24	183	20	12	11	4	755	11	1,020
03-Jun	23	370	5	4	10	13	1032	10	1,467
04-Jun	38	196	2	0	2	0	750	7	995
05-Jun	11	175	4	3	9	2	1330	4	1,538
06-Jun	12	89	3	1	8	3	601	8	725
07-Jun	33	52	8	0	6	0	734	1	834
08-Jun	33	27	4	0	28	1	600	1	694
09-Jun	6	0	1	2	7	0	300	4	320
10-Jun	2	5	1	0	2	0	355	0	365
11-Jun	2	20	2	0	3	3	355	1	386
12-Jun	3	10	1	0	15	0	240	3	272
13-Jun	1	1	3	1	20	2	34	8	70
14-Jun	0	0	4	7	5	2	390	2	410
15-Jun	1	7	9	4	5	2	240	4	272
16-Jun	1	5	9	4	2	0	160	2	183
17-Jun	1	2	24	5	15	17	110	2	176
18-Jun	1	0	14	6	6	4	200	2	233
19-Jun	1	0	8	15	6	11	300	2	343
20-Jun	0	17	4	14	4	10	510	2	561
21-Jun	6	28	4	21	1	5	290	0	355
22-Jun	4	0	17	8	0	6	150	1	186
23-Jun	5	41	29	23	2	14	150	6	270
24-Jun	4	26	15	18	4	21	140	3	231
25-Jun	4	21	42	44	3	42	7	3	166
26-Jun	5	0	26	32	1	5	60	1	130
27-Jun	12	3	45	19	0	5	200	3	287
28-Jun	6	7	14	15	2	13	90	3	150
29-Jun	6	15	46	35	2	3	5	6	118
30-Jun	14	21	88	51	7	19	25	3	228
01-Jul	7	41	55	67	2	2	10	2	186
02-Jul	4	62	108	30	3	35	32	3	277
03-Jul	12	42	97	36	2	37	30	3	259
04-Jul									0
05-Jul	3	48	84	44	4	16	1	2	202
Total	329	1,558	903	598	252	328	17,062	230	21,260

[a] No traps were fished on July 4.

Table 3. Numbers of fish captured by trap 3 in the Kenai River, May 17 through July 5, 1993.

	Numbers of Fish [a]								
Date	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
17–May	0	1	0	1	0	0	376	5	383
18–May	1	0	2	0	0	0	501	6	510
19–May	2	1	2	6	1	0	364	7	383
20–May	2	1	0	0	2	2	1024	5	1,036
21–May	0	0	0	0	11	0	646	3	660
22–May	0	1	2	2	15	0	1089	2	1,111
23–May	3	2	2	1	9	3	1543	3	1,566
24–May	9	0	19	1	13	0	641	4	687
25–May	5	0	8	1	5	8	473	3	503
26–May	26	3	35	4	10	4	1425	5	1,512
27–May	47	20	20	19	7	0	1920	10	2,043
28–May	39	4	12	2	18	0	2140	9	2,224
29–May	5	6	3	8	11	0	1793	15	1,841
30–May	11	13	1	19	22	0	2720	5	2,791
31–May	39	7	4	6	16	0	1520	10	1,602
01–Jun	253	2	7	2	15	0	757	7	1,043
02–Jun	168	75	19	17	45	5	1680	11	2,020
03–Jun	77	321	16	11	41	5	2565	6	3,042
04–Jun	332	165	7	1	17	0	1280	4	1,806
05–Jun	59	130	3	4	13	2	2110	2	2,323
06–Jun	89	52	7	4	26	1	1685	5	1,869
07–Jun	251	7	11	4	36	4	2090	6	2,409
08–Jun	121	16	3	2	98	1	2385	7	2,633
09–Jun	52	0	1	0	20	0	915	2	990
10–Jun	12	2	0	0	8	0	1145	3	1,170
11–Jun	8	2	3	0	13	0	680	2	708
12–Jun	9	10	6	0	13	0	550	4	592
13–Jun	0	1	0	0	5	0	60	0	66
14–Jun	3	0	8	2	11	3	1245	3	1,275
15–Jun	2	4	7	3	7	1	450	0	474
16–Jun	3	0	25	1	15	0	360	3	407
17–Jun	5	0	29	5	64	8	250	2	363
18–Jun	7	0	25	10	27	8	670	4	751
19–Jun	14	0	22	23	16	16	580	1	672
20–Jun	1	9	11	7	3	6	790	0	827
21–Jun	7	50	4	3	7	1	1220	5	1,297
22–Jun	24	1	54	5	9	8	200	3	304
23–Jun	15	41	59	19	11	23	920	6	1,094
24–Jun	34	47	72	18	10	22	570	8	781
25–Jun	45	5	94	42	8	50	280	3	527
26–Jun	95	5	50	55	3	13	230	2	453
27–Jun	24	4	60	12	2	34	550	1	687
28–Jun	30	14	40	16	2	16	310	1	429
29–Jun	40	14	84	22	9	29	13	3	214
30–Jun	31	4	112	36	5	38	20	1	247
01–Jul	34	62	126	56	3	9	2	3	295
02–Jul	17	43	116	48	7	19	6	1	257
03–Jul	92	44	171	13	7	23	72	2	424
04–Jul									0
05–Jul	3	26	98	21	7	12	0	0	167
Total	2,146	1,215	1,460	532	723	374	44,815	203	51,468

[a] No traps were fished on July 4.

Table 4. Numbers of fish captured by trap 4 in the Kenai River, May 17 through July 3, 1993.

	Numbers of Fish [a]								
Date	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
17-May	0	1	0	1	0	0	296	5	298
18-May	1	0	3	0	4	0	370	5	378
19-May	0	0	0	0	2	0	237	4	239
20-May	0	2	2	2	5	0	550	7	561
21-May	0	0	1	1	4	1	560	15	567
22-May	0	1	0	3	28	0	817	4	849
23-May	3	0	2	0	7	0	781	6	793
24-May	0	0	8	0	15	1	339	10	363
25-May	4	0	3	0	9	0	88	3	104
26-May	8	0	26	2	9	0	276	8	321
27-May	19	6	22	7	10	0	290	8	354
28-May	4	1	3	2	10	0	440	9	460
29-May	4	1	3	7	30	0	510	10	555
30-May	6	0	2	8	13	0	710	13	739
31-May	20	0	3	4	15	0	750	7	792
01-Jun	96	9	12	0	8	0	312	10	437
02-Jun	60	21	13	6	32	27	971	11	1,130
03-Jun	34	141	8	0	25	5	755	5	968
04-Jun	98	108	6	2	7	0	838	3	1,059
05-Jun	15	50	2	7	20	2	1,110	3	1,206
06-Jun	24	10	4	3	23	1	830	11	895
07-Jun	81	62	2	0	38	0	1,065	5	1,248
08-Jun	22	13	2	1	52	16	1,360	4	1,466
09-Jun	6	0	3	0	16	2	576	3	603
10-Jun	6	10	0	1	3	0	808	1	828
11-Jun	4	0	2	0	17	3	460	4	486
12-Jun	2	10	1	0	23	2	400	1	438
13-Jun	0	0	3	1	46	1	185	5	236
14-Jun	1	0	4	0	16	3	630	3	654
15-Jun	1	0	13	2	17	0	220	1	253
16-Jun	0	0	21	3	16	1	180	2	221
17-Jun	2	0	33	6	59	9	120	1	229
18-Jun	3	1	28	11	30	6	230	4	309
19-Jun	2	0	17	0	11	8	440	0	478
20-Jun	2	2	9	5	5	4	700	4	727
21-Jun	6	10	11	8	4	1	420	1	460
22-Jun	16	10	27	9	5	6	120	3	193
23-Jun	8	0	45	29	5	18	50	3	155
24-Jun	8	8	54	18	1	29	120	1	238
25-Jun	9	22	80	26	5	52	220	3	414
26-Jun	24	10	26	43	1	1	30	1	135
27-Jun	8	0	46	16	0	18	350	1	438
28-Jun	7	10	32	31	2	16	150	4	248
29-Jun	8	2	86	12	3	7	6	4	124
30-Jun	4	7	75	14	10	28	20	4	158
01-Jul	5	22	88	53	3	10	10	1	191
02-Jul	6	15	63	36	3	33	5	1	161
03-Jul	14	20	113	16	2	19	29	1	213
Total	651	585	1,007	396	669	330	20,734	223	24.372

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[a] No traps were fished on July 4.

Table 5. Numbers of fish captured by smolt traps 1–4 at the Kenai River km 31 site, May 17 through July 5, 1993.

	Numbers of Fish [a]								
Date	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
17–May	1	13	3	30	0	2	855	12	916
18–May	4	4	7	11	4	1	1394	13	1,438
19–May	2	18	11	47	6	13	1186	26	1,309
20–May	3	23	10	35	8	2	1862	23	1,966
21–May	3	0	16	4	16	2	1771	33	1,845
22–May	0	14	8	27	57	10	2381	15	2,512
23–May	6	12	15	39	18	8	3047	20	3,165
24–May	14	0	53	44	36	4	1532	21	1,704
25–May	11	21	27	20	23	46	711	15	874
26–May	38	5	100	26	29	10	2181	25	2,414
27–May	74	51	81	46	18	5	2461	31	2,767
28–May	48	28	26	22	32	1	3378	27	3,562
29–May	10	35	13	38	47	7	3457	52	3,659
30–May	18	28	6	38	41	5	4227	29	4,392
31–May	62	12	15	20	36	1	3180	27	3,353
01–Jun	370	69	27	23	24	2	1459	36	2,010
02–Jun	255	407	69	48	89	38	3525	41	4,472
03–Jun	138	1160	33	30	77	35	4480	28	5,981
04–Jun	473	743	16	4	26	1	3020	17	4,300
05–Jun	87	570	9	18	42	6	4685	14	5,431
06–Jun	126	250	14	10	57	7	3244	29	3,737
07–Jun	376	169	23	6	83	5	4102	16	4,780
08–Jun	178	126	10	6	185	22	4500	17	5,044
09–Jun	66	1	6	3	44	2	1916	12	2,050
10–Jun	21	60	4	2	13	0	2349	5	2,454
11–Jun	14	40	10	0	33	7	1580	11	1,695
12–Jun	15	40	8	0	53	7	1270	11	1,404
13–Jun	2	9	7	3	76	6	329	14	446
14–Jun	4	8	16	22	32	9	2385	10	2,486
15–Jun	4	44	32	12	29	3	960	5	1,089
16–Jun	4	25	59	12	33	1	725	9	868
17–Jun	8	5	94	20	139	42	540	7	855
18–Jun	11	2	72	33	63	22	1140	10	1,353
19–Jun	17	8	48	66	34	46	1370	5	1,594
20–Jun	3	61	26	61	13	24	2140	10	2,338
21–Jun	20	112	21	45	13	10	2010	7	2,238
22–Jun	44	11	100	54	14	20	560	9	812
23–Jun	28	126	138	86	18	63	1150	15	1,624
24–Jun	48	126	141	80	16	84	850	15	1,360
25–Jun	59	88	226	133	17	158	527	9	1,217
26–Jun	125	15	108	162	6	20	340	5	781
27–Jun	45	37	169	62	2	60	1130	6	1,511
28–Jun	44	66	89	68	6	49	570	10	902
29–Jun	56	49	223	101	15	44	27	13	528
30–Jun	54	57	280	107	25	112	70	8	713
01–Jul	49	196	284	219	8	24	32	7	819
02–Jul	31	190	307	184	14	112	44	9	891
03–Jul	125	133	424	99	11	105	137	10	1,044
04–Jul									0
05–Jul	6	130	226	97	11	47	1	8	526
Total	3,200	5,397	3,710	2,323	1,692	1,310	86,790	807	105.229

[a] No traps were fished on July 4; on July 5 only traps 1–3 were fished.

Table 6. Numbers of juvenile fish caught with inclined plane traps 1–4 in the Kenai River, 1990–1993.

	Numbers of Fish								
Trap No.	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
1990									
1	8,708	481	861	300	[a]	87	23	148	10,608
2	18,132	180	1,168	239	[a]	69	17	134	19,939
3	59,528	631	2,776	232	[a]	106	100	184	63,557
4	43,499	43	3,114	68	[a]	58	44	272	47,098
Total	129,867	1,335	7,919	839		320	184	738	141,202
1991									
1	1,758	62	451	131	93	27	[a]	177	2,699
2	3,291	30	918	97	224	31	[a]	161	4,752
3	10,540	23	1,526	62	775	10	[a]	200	13,136
4	10,239	17	1,697	57	832	9	[a]	182	13,033
Total	25,828	132	4,592	347	1,924	77		720	33,620
1992									
1	47	1,594	500	944	141	117	23	183	3,549
2	189	306	598	274	338	44	23	159	1,931
3	1,205	223	1,198	229	1,021	46	32	179	4,133
4	1,725	82	1,544	136	1,968	45	17	269	5,786
Total	3,166	2,205	3,840	1,583	3,468	252	95	790	15,399
1993									
1	74	2,039	340	797	48	278	4,179	151	7,906
2	329	1,558	903	598	252	328	17,062	230	21,260
3	2,146	1,215	1,460	532	723	374	44,815	203	51,468
4	651	585	1,007	396	669	330	20,734	223	24,595
Total	3,200	5,397	3,710	2,323	1,692	1,310	86,790	807	105,229

[a] No counts conducted

Table 7. Numbers of sockeye salmon smolt captured daily in the Kenai River, 1989 – 1993.

	Year				
Date	1989[a]	1990	1991	1992	1993
15 – May		8			
16 – May	348	5	4	0	
17 – May	155	34	4	0	1
18 – May	204	376	1	1	4
19 – May	195	507	1	0	2
20 – May	454	3,159	8	0	3
21 – May	271	4,760	13	0	3
22 – May	716	2,690	36	0	0
23 – May	1,546	414	680	0	6
24 – May	1,184	282	389	0	14
25 – May	988	1,645	319	2	11
26 – May	785	16,411	622	1	38
27 – May	2,699	8,057	306	0	74
28 – May	2,056	1,903	151	1	48
29 – May	1,532	1,745	414	1	10
30 – May	2,268	9,578	502	2	18
31 – May	6,257	9,878	494	5	62
01 – Jun	8,221	3,305	284	1	370
02 – Jun	2,697	2,587	904	9	255
03 – Jun	4,350	8,037	459	9	138
04 – Jun	10,170	10,182	414	56	473
05 – Jun	17,579	14,143	440	35	87
06 – Jun	49,451	8,931	262	144	126
07 – Jun	16,276	8,337	579	69	376
08 – Jun	3,482	4,430	633	28	178
09 – Jun	3,271	6,336	492	94	66
10 – Jun	2,188	429	699	69	21
11 – Jun	988	261	525	250	14
12 – Jun	1,656	248	825	329	15
13 – Jun	1,044	93	1,296	300	2
14 – Jun	3,052	51	934	101	4
15 – Jun	763	131	654	1,123	4
16 – Jun	2,197	165	279	100	4
17 – Jun	1,369	123	182	99	8
18 – Jun	607	17	24	49	11
19 – Jun	972	36	658	57	17
20 – Jun	952	186	2,252	94	3
21 – Jun	1,036	168	1,971	16	20
22 – Jun	639	108	2,446	3	44
23 – Jun	2,835	37	923	14	28
24 – Jun	1,833	20	407	5	48
25 – Jun	660	56	377	2	59
26 – Jun	679		2,972	2	125
27 – Jun	486		263	6	45
28 – Jun			320	40	44
29 – Jun			213	18	56
30 – Jun			122	31	54
01 – Jul			517		49
02 – Jul			19		31
03 – Jul			239		125
04 – Jul			494		
05 – Jul			10		6
06 – Jul			32		
07 – Jul			30		
08 – Jul			40		
09 – Jul			33		
10 – Jul			6		
TOTAL	161,111	129.868	28,173	3,166	3,200

[a] Three traps were fished in 1989; four traps were fished in the remaining years.

Table 8. Comparison of catches in Kenai River traps 1–6, 1993.

	Numbers of Fish								
Trap No.	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
1	74	2039	340	797	48	278	4179	151	7755
2	329	1558	903	598	252	328	17062	230	21030
3	2146	1215	1460	532	723	374	44815	203	51265
4	651	585	1007	396	669	330	20734	223	24372
Total 1–4	3200	5397	3710	2323	1692	1310	86790	807	104422
5	322	2612	681	863	188	780	1739	169	7185
6	348	2650	397	1304	102	767	1267	168	6835
Total 5–6	670	5262	1078	2167	290	1547	3006	337	14020
Total	3,870	10,659	4,788	4,490	1,982	2,857	89,796	1,144	118,442
	Percent of Individual Trap Catch								
1	1.0	26.3	4.4	10.3	0.6	3.6	53.9	1.9	100.0
2	1.6	7.4	4.3	2.8	1.2	1.6	81.1	1.1	100.0
3	4.2	2.4	2.8	1.0	1.4	0.7	87.4	0.4	100.0
4	2.7	2.4	4.1	1.6	2.7	1.4	85.1	0.9	100.0
Total 1–4	3.1	5.2	3.6	2.2	1.6	1.3	83.1	0.8	100.0
5	4.5	36.4	9.5	12.0	2.6	10.9	24.2	2.4	100.0
6	5.1	38.8	5.8	19.1	1.5	11.2	18.5	2.5	100.0
Total 5–6	4.8	37.5	7.7	15.5	2.1	11.0	21.4	2.4	100.0
Total	3.3	9.0	4.0	3.8	1.7	2.4	75.8	1.0	100.0
	Percent of Total Catch								
1	0.1	1.7	0.3	0.7	0.0	0.2	3.5	0.1	6.5
2	0.3	1.3	0.8	0.5	0.2	0.3	14.4	0.2	17.8
3	1.8	1.0	1.2	0.4	0.6	0.3	37.8	0.2	43.3
4	0.5	0.5	0.9	0.3	0.6	0.3	17.5	0.2	20.6
Total 1–4	2.7	4.6	3.1	2.0	1.4	1.1	73.3	0.7	88.2
5	0.3	2.2	0.6	0.7	0.2	0.7	1.5	0.1	6.1
6	0.3	2.2	0.3	1.1	0.1	0.6	1.1	0.1	5.8
Total 5–6	0.6	4.4	0.9	1.8	0.2	1.3	2.5	0.3	11.8
Total	3.3	9.0	4.0	3.8	1.7	2.4	75.8	1.0	100.0

Table 9. Numbers of fish captured by trap 5 in the Kenai River, May 17 through July 2, 1993.

	Numbers of Fish								
Date	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
17–May	0	0	0	0	0	0	11	0	11
18–May	1	2	2	46	1	0	66	4	122
19–May	1	8	1	24	0	3	43	0	80
20–May	0	2	0	19	1	1	68	0	91
21–May	2	2	1	39	7	0	32	2	85
22–May	0	6	0	32	1	6	28	2	75
23–May	1	10	8	20	0	3	80	0	122
24–May	5	1	7	32	4	9	120	1	179
25–May	6	29	2	15	3	15	43	2	115
26–May	18	2	28	46	2	3	41	9	149
27–May	32	35	25	6	2	1	10	12	123
28–May	10	8	6	13	3	3	59	7	109
29–May	5	47	2	14	3	23	28	3	125
30–May	2	54	3	19	7	3	39	3	130
31–May	5	2	4	11	4	8	47	9	90
01–Jun	16	58	14	71	9	6	131	3	308
02–Jun	15	73	8	75	6	27	173	9	386
03–Jun	24	585	4	28	11	19	58	10	739
04–Jun	48	362	0	1	5	3	172	8	599
05–Jun	14	590	3	8	1	2	55	5	678
06–Jun	5	115	3	13	9	8	48	11	212
07–Jun	5	6	0	1	0	1	36	0	49
08–Jun	20	134	2	10	11	2	131	15	325
09–Jun	11	37	1	3	5	3	38	3	101
10–Jun	9	46	1	1	6	0	15	2	80
11–Jun	0	21	6	0	4	5	3	3	42
12–Jun	0	10	3	1	4	12	20	3	53
13–Jun	1	18	3	0	6	17	16	4	65
14–Jun	0	10	1	8	0	10	3	1	33
15–Jun	1	9	24	9	2	2	4	0	51
16–Jun	1	9	46	14	8	1	2	1	82
17–Jun	0	1	45	11	25	34	0	1	117
18–Jun	3	8	29	10	5	24	30	2	111
19–Jun	2	27	22	6	3	15	3	3	81
20–Jun	2	19	4	23	4	21	50	1	124
21–Jun	14	20	16	24	5	17	2	2	100
22–Jun	1	51	8	3	6	46	2	5	122
23–Jun	4	26	24	13	3	32	0	2	104
24–Jun	7	31	35	13	4	90	5	2	187
25–Jun	5	11	67	31	0	35	0	1	150
26–Jun	5	3	23	35	0	20	2	2	90
27–Jun	6	15	22	10	1	28	10	2	94
28–Jun	1	9	12	14	1	44	0	3	84
29–Jun	2	12	26	15	0	33	5	1	94
30–Jun	3	10	31	12	3	35	0	2	96
01–Jul	7	22	93	27	2	46	10	2	209
02–Jul	2	56	16	37	1	64	0	6	182
Total	322	2,612	681	863	188	780	1,739	169	7,354

Table 10. Numbers of fish captured by trap 6 in the Kenai River, May 17 through July 2, 1993.

	Numbers of Fish								
Date	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
17-May	0	0	0	0	0	0	4	0	4
18-May	0	0	0	23	0	0	26	0	49
19-May	0	3	0	13	4	2	15	3	37
20-May	0	6	1	12	0	0	22	0	41
21-May	0	1	0	31	1	0	16	2	49
22-May	0	22	0	42	0	5	13	4	82
23-May	1	10	1	27	0	0	18	2	57
24-May	3	0	1	24	1	1	30	2	60
25-May	2	19	0	15	0	9	3	1	48
26-May	12	3	2	53	0	0	45	4	115
27-May	39	39	3	12	1	7	11	4	112
28-May	7	13	8	34	2	0	58	12	122
29-May	3	49	3	21	1	7	34	5	118
30-May	2	27	0	9	4	5	1	2	48
31-May	1	0	1	15	0	4	31	3	52
01-Jun	7	39	1	53	2	2	120	4	224
02-Jun	12	92	4	42	2	5	140	17	297
03-Jun	11	596	7	442	6	25	34	9	1,121
04-Jun	53	272	1	0	1	10	148	4	485
05-Jun	8	270	2	11	1	1	50	1	343
06-Jun	5	176	2	14	0	8	48	6	253
07-Jun	50	148	5	1	5	11	45	8	265
08-Jun	22	100	9	14	3	4	105	7	257
09-Jun	7	60	2	0	2	1	50	3	122
10-Jun	5	103	0	3	2	0	13	0	126
11-Jun	1	25	2	0	8	2	11	3	49
12-Jun	3	13	1	1	7	7	23	1	55
13-Jun	0	17	2	0	3	9	12	4	43
14-Jun	0	30	0	3	5	17	1	2	56
15-Jun	1	8	14	3	4	1	0	4	31
16-Jun	3	16	38	8	0	4	0	2	69
17-Jun	3	23	33	10	12	27	30	1	138
18-Jun	2	6	18	14	4	14	30	4	88
19-Jun	3	39	13	4	5	8	5	4	77
20-Jun	2	31	1	32	2	11	30	4	109
21-Jun	19	13	0	29	1	14	11	2	87
22-Jun	2	55	9	7	1	38	3	4	115
23-Jun	11	46	11	24	2	59	5	6	158
24-Jun	4	25	39	22	4	98	0	4	192
25-Jun	7	16	54	34	1	53	10	3	175
26-Jun	7	14	12	50	0	2	0	0	85
27-Jun	10	49	22	30	0	10	0	3	121
28-Jun	4	14	10	19	0	25	5	1	77
29-Jun	4	25	7	25	1	49	0	2	111
30-Jun	6	31	14	14	0	80	1	2	146
01-Jul	3	42	31	34	3	62	10	5	185
02-Jul	3	64	13	30	1	70	0	4	181
Total	348	2,650	397	1,304	102	767	1,267	168	6,835

Table 11. Dyed Kenai River sockeye salmon smolt releases and recaptures by date, 1993.

Date	Number of Fish Dyed	Numbers of Dyed Fish Released	Capture to Release Survival[a]	Number of Dyed Fish Recovered	Trap Efficiency
02–Jun	313	291	0.930	0	
03–Jun	179	162	0.905	0	
04–Jun	678	632	0.932	4	
05–Jun	112	107	0.955	0	
06–Jun	137	124	0.905	0	
07–Jun	446	402	0.901	2	
08–Jun	223	216	0.969	0	
Total		1934	0.926	6	0.003

[a] Number of dyed fish released/Number of dyed fish.

Table 12. Results of sockeye salmon smolt dye tests conducted on the Kenai River, 1989–1993.

Date	Number of Fish Dyed	Number of Dyed Fish Recovered	Trap Efficiency
1989 total	12,599	86	0.007
1990 period 1	2,793	21	0.008
1990 period 2–4	8,409	109	0.013
1991 total	1,923	19	0.010
1992 total	926	19	0.021
1993 total	1,934	6	0.003

Table 13. Estimated daily sockeye salmon smolt seaward migration from the Kenai River, 1993.

Date	Daily Sockeye Smolt Trap Catch	Estimate of Sockeye Smolt Migration [a]				
		Daily	Cumulative	Age-0.	Age-1.	Age-2.
17-May	1	152	152	0	118	34
18-May	4	608	760	0	471	137
19-May	2	304	1,064	0	235	68
20-May	3	456	1,519	0	353	103
21-May	3	456	1,975	0	353	103
22-May	0	0	1,975	0	0	0
23-May	6	912	2,887	0	706	205
24-May	14	2,127	5,014	0	1,648	479
25-May	11	1,671	6,685	0	1,295	376
26-May	38	5,773	12,458	0	4,473	1,300
27-May	74	11,243	23,701	0	8,711	2,532
28-May	48	7,293	30,994	0	5,650	1,642
29-May	10	1,519	32,513	0	1,177	342
30-May	18	2,735	35,248	0	2,119	616
31-May	62	9,420	44,668	0	7,299	2,121
01-Jun	370	56,215	100,883	0	55,525	690
02-Jun	255	38,743	139,625	0	38,267	475
03-Jun	138	20,967	160,592	0	20,709	257
04-Jun	473	71,864	232,455	0	70,982	882
05-Jun	87	13,218	245,673	0	13,056	162
06-Jun	126	19,143	264,817	0	18,908	235
07-Jun	376	57,126	321,943	0	56,425	701
08-Jun	178	27,044	348,987	0	26,712	332
09-Jun	66	10,027	359,014	0	9,904	123
10-Jun	21	3,191	362,205	0	3,151	39
11-Jun	14	2,127	364,332	0	2,101	26
12-Jun	15	2,279	366,611	0	2,251	28
13-Jun	2	304	366,915	0	300	4
14-Jun	4	608	367,522	0	600	7
15-Jun	4	608	368,130	0	600	7
16-Jun	4	608	368,738	281	326	0
17-Jun	8	1,215	369,953	563	653	0
18-Jun	11	1,671	371,625	774	898	0
19-Jun	17	2,583	374,207	1,196	1,387	0
20-Jun	3	456	374,663	211	245	0
21-Jun	20	3,039	377,702	1,407	1,632	0
22-Jun	44	6,685	384,387	3,095	3,590	0
23-Jun	28	4,254	388,641	1,969	2,285	0
24-Jun	48	7,293	395,934	2,094	5,152	47
25-Jun	59	8,964	404,898	2,574	6,333	58
26-Jun	125	18,991	423,889	5,452	13,417	123
27-Jun	45	6,837	430,726	1,963	4,830	44
28-Jun	44	6,685	437,411	1,919	4,723	43
29-Jun	56	8,508	445,919	3,135	5,346	28
30-Jun	54	8,204	454,123	3,023	5,155	27
01-Jul	49	7,445	461,568	2,743	4,677	24
02-Jul	31	4,710	466,278	1,735	2,959	15
03-Jul	125	18,991	485,269	6,997	11,932	62
04-Jul	[b]					
05-Jul	6	912	486,181	336	573	3
Total	3,200	486,181		41,465	430,213	14,503

[a] Total migration- 486,181. Lower confidence interval- 163,998; Upper confidence interval- 1,202,844.

[b] No traps were fished on 4 July; only traps 1-3 were fished on 5 July.

Table 14. Cumulative proportion of sockeye salmon smolt seaward migration by day, 1989–1993.

	Age–1.					Age–2.				
Date	1989	1990	1991	1992	1993	1989	1990	1991	1992	1993
15–May		0.000					0.000			
16–May	0.002	0.000	0.000	0.000		0.002	0.000	0.001	0.000	
17–May	0.003	0.000	0.000	0.000	0.000	0.003	0.001	0.002	0.000	0.002
18–May	0.004	0.004	0.000	0.000	0.001	0.004	0.007	0.002	0.000	0.012
19–May	0.006	0.008	0.000	0.000	0.002	0.006	0.015	0.002	0.000	0.017
20–May	0.008	0.036	0.000	0.000	0.003	0.008	0.067	0.004	0.000	0.024
21–May	0.010	0.078	0.000	0.000	0.004	0.010	[a] 0.146	0.007	0.000	0.031
22–May	0.015	0.101	0.000	0.000	0.004	0.015	0.190	0.015	0.000	0.031
23–May	0.024	0.105	0.003	0.000	0.005	0.024	0.197	0.169	0.000	0.045
24–May	0.031	0.106	0.005	0.000	0.009	0.031	0.208	0.256	0.000	0.078
25–May	0.038	0.112	0.007	0.001	0.012	0.038	0.217	0.328	0.001	0.104
26–May	0.042	0.169	0.010	0.001	0.022	0.042	0.387	0.469	0.001	0.193
27–May	0.059	0.197	0.011	0.001	0.043	0.059	0.471	0.538	0.001	0.368
28–May	0.072	0.204	0.015	0.001	0.056	0.072	0.490	0.550	0.002	0.481
29–May	0.082	0.216	0.027	0.002	0.059	0.082	0.503	0.583	0.002	0.505
30–May	0.096	0.282	0.041	0.002	0.063	0.096	0.574	0.624	0.003	0.547
31–May	0.134	0.358	0.055	0.004	0.080	0.134	0.647	0.664	0.004	0.694
01–Jun	0.185	0.373	0.063	0.004	0.210	0.185	0.672	0.687	0.004	0.741
02–Jun	0.202	0.391	0.089	0.007	0.298	0.202	0.691	0.759	0.007	0.774
03–Jun	0.229	0.469	0.102	0.009	0.347	0.229	0.730	0.797	0.010	0.792
04–Jun	0.292	0.569	0.113	0.026	0.512	0.292	0.781	0.830	0.028	0.852
05–Jun	0.401	0.706	0.126	0.036	0.542	0.401	0.851	0.865	0.039	0.864
06–Jun	0.708	0.793	0.133	0.079	0.586	0.708	0.895	0.887	0.086	0.880
07–Jun	0.809	0.874	0.155	0.099	0.717	0.809	0.936	0.898	0.108	0.928
08–Jun	0.831	0.918	0.179	0.107	0.779	0.831	0.958	0.910	0.117	0.951
09–Jun	0.851	0.979	0.198	0.135	0.802	0.851	0.989	0.919	0.147	0.960
10–Jun	0.865	0.983	0.225	0.155	0.809	0.865	0.992	0.933	0.169	0.962
11–Jun	0.871	0.986	0.245	0.206	0.814	0.871	0.993	0.943	0.254	0.964
12–Jun	0.881	0.988	0.277	0.272	0.820	0.881	0.994	0.950	0.366	0.966
13–Jun	0.888	0.989	0.329	0.332	0.820	0.888	0.995	0.962	0.467	0.966
14–Jun	0.907	0.990	0.366	0.352	0.822	0.907	0.995	0.970	0.502	0.967
15–Jun	0.911	0.991	0.392	0.578	0.823	0.911	0.995	0.976	0.883	0.967
16–Jun	0.925	0.993	0.403	0.657	0.824	0.925	0.996	0.979	0.905	0.967
17–Jun	0.934	0.994	0.411	0.735	0.825	0.934	0.997	0.980	0.927	0.967
18–Jun	0.937	0.994	0.412	0.773	0.827	0.937	0.997	0.980	0.937	0.967
19–Jun	0.943	0.994	0.438	0.818	0.831	0.943	0.997	0.983	0.950	0.967
20–Jun	0.949	0.996	0.530	0.892	0.831	0.949	0.998	0.991	0.970	0.967
21–Jun	0.956	0.998	0.610	0.905	0.835	0.956	0.999	0.998	0.974	0.967
22–Jun	0.960	0.999	0.711	0.907	0.843	0.960	0.999	0.998	0.974	0.967
23–Jun	0.977	0.999	0.749	0.918	0.849	0.977	1.000	0.999	0.977	0.967
24–Jun	0.989	0.999	0.766	0.922	0.861	0.989	1.000	0.999	0.978	0.970
25–Jun	0.993	1.000	0.781	0.924	0.875	0.993	1.000	0.999	0.979	0.974
26–Jun	0.997		0.904	0.925	0.907	0.997		0.999	0.979	0.983
27–Jun	1.000		0.914	0.930	0.918	1.000		1.000	0.981	0.986
28–Jun			0.928	0.961	0.929			1.000	0.989	0.989
29–Jun			0.936	0.976	0.941			1.000	0.993	0.991
30–Jun			0.941	1.000	0.953			1.000	1.000	0.993
01–Jul			0.963		0.964			1.000		0.994
02–Jul			0.964		0.971			1.000		0.995
03–Jul			0.973		0.999			1.000		1.000
04–Jul			0.994		0.999			1.000		1.000
05–Jul			0.994		1.000			1.000		1.000
06–Jul			0.996					1.000		
07–Jul			0.997					1.000		
08–Jul			0.998					1.000		
09–Jul			1.000					1.000		
10–Jul			1.000					1.000		

[a] Shaded blocks highlight .1 proportion increments

Table 15. Summary of Kenai River sockeye salmon smolt age composition, 1989–1993. Data collected at river km 31.

Sample Period	Percent of Seaward Migration Age–0.	Age–1.	Age–2.	Age–3.	Sample Size
5/15–5/23/90	0.0	31.9	68.1	0.0	756
5/24–5/28/90	0.0	22.8	76.7	0.5	427
5/29–6/2/90	0.0	45.0	54.7	0.3	424
6/3–6/25/90	0.0	63.4	36.6	0.0	1,815
5/16–5/27/91	0.0	11.3	88.5	0.2	425
5/28–6/6/91	0.0	68.4	31.6	0.0	850
6/7–6/11/91	0.0	92.5	7.5	0.0	425
6/12–6/17/91	0.0	96.5	3.5	0.0	425
6/18–6/21/91	0.0	98.6	1.4	0.0	425
6/22–7/15/91	0.0	99.9	0.1	0.0	1,190
5/16–6/10/92	0.0	16.1	83.9	0.0	348
6/11–6/15/92	0.0	11.0	89.0	0.0	319
6/16–6/30/92	0.0	43.0	57.0	0.0	314
5/17–5/31/93	0.0	77.4	22.6	0.0	262
6/1–6/15/93	0.0	98.8	1.2	0.0	163
6/16–6/23/93	46.3	53.7	0.0	0.0	162
6/24–6/28/93	28.7	70.6	0.6	0.0	310
6/29–7/6/93	36.8	62.8	0.3	0.0	304
Season Summary					
1989	0.0	99.7	0.3	0.0	3,557
1990	0.0	46.7	53.1	0.2	3,422
1991	0.0	86.1	13.9	0.0	3,740
1992	0.0	17.3	82.7	0.0	981
1993	8.5	88.5	3.0	0.0	1,200

Table 16. Sockeye salmon smolt mean length and weight by age class and time strata, 1989-1993. Data collected at river km 31.

			Length						Weight					
Year	Time Period	Age	N	Mean	Min.	Max.	Var.	Stand. Dev.	N	Mean	Min.	Max.	Var.	Stand. Dev.
93	6/1-23	0.	75	51	44	78	25	5	75	1.4	0.9	4.2	0.2	0.5
93	6/24-28	0.	89	52	41	64	18	4	89	1.4	0.7	2.5	0.1	0.4
93	6/29-7/6	0.	112	54	43	74	27	5	112	1.7	0.9	3.9	0.2	0.5
89	5/16-20	1.	413	60	46	80	19	4	413	1.9	0.8	4.3	0.18	0.42
89	5/21-25	1.	338	61	60	72	22	5	338	2.1	1.2	3.3	0.13	0.38
89	5/26-30	1.	421	60	53	77	17	4	421	1.9	1.2	3.8	0.15	0.39
89	5/31-6/04	1.	424	59	49	70	13	4	424	1.8	1.0	3.4	0.13	0.36
89	6/06-09	1.	423	59	46	73	15	4	424	1.8	0.8	3.7	0.15	0.39
89	6/10-14	1.	425	58	49	74	14	4	425	1.8	1.1	3.5	0.12	0.35
89	6/15-6/19	1.	429	58	46	75	17	4	429	1.8	0.2	4.0	0.20	0.45
89	6/20-27	1.	679	60	19	85	19	4	679	2.1	1.0	5.4	0.26	0.51
90	5/15-23	1.	241	65	48	82	30	5	241	2.2	1.0	4.2	0.34	0.59
90	5/24-28	1.	97	63	52	78	25	5	97	2.0	1.0	3.8	0.27	0.52
90	5/29-6/02	1.	191	61	47	90	25	5	191	1.9	0.8	5.3	0.28	0.53
90	6/03-25	1.	1,150	70	52	138	53	7	1,150	3.1	1.0	23.8	2.17	1.47
91	5/23-27	1.	48	73	52	110	92	10	48	3.4	1.8	10.4	2.15	1.47
91	5/28-6/01	1.	292	65	52	89	41	6	292	2.3	1.1	5.5	0.55	0.74
91	6/02-06	1.	289	67	55	100	44	7	289	2.5	1.3	7.4	0.75	0.86
91	6/07-11	1.	393	64	50	79	16	4	393	2.4	1.2	4.8	0.22	0.46
91	6/13-17	1.	410	65	49	84	16	4	410	2.7	1.2	5.9	0.31	0.56
91	6/18-21	1.	419	65	50	79	21	5	419	2.8	1.3	5.6	0.40	0.63
91	6/22-25	1.	340	66	50	84	19	4	340	2.9	1.3	5.6	0.34	0.58
91	6/26-30	1.	424	65	50	75	11	3	424	2.7	1.2	4.3	0.21	0.46
91	7/01-05	1.	425	67	54	80	13	4	425	3.1	1.5	5.9	0.31	0.55
92	6/05-10	1.	56	74	60	90	54	7	28	3.9	2.5	6.3	1.21	1.10
92	6/11-15	1.	35	78	66	95	35	6	17	5.1	3.2	10.7	3.03	1.74
92	6/16-29	1.	135	78	58	130	86	9	97	4.7	1.9	22.0	5.33	2.31
93	5/17-31	1.	203	76	59	124	81	9	145	4.4	2.0	19.7	3.5	1.9
93	6/1-23	1.	248	77	60	93	45	7	248	4.2	1.8	7.4	1.4	1.2
93	6/24-28	1.	219	80	62	90	18	4	219	4.9	2.3	8.2	0.7	0.8
93	6/29-7/6	1.	191	79	65	90	17	4	191	5.0	2.9	6.6	0.4	0.7
90	5/15-23	2.	515	74	62	123	21	5	515	3.2	1.9	13.4	0.55	0.74
90	5/24-28	2.	326	74	61	115	35	6	326	3.2	1.8	8.8	0.68	0.82
90	5/29-6/02	2.	232	74	62	104	43	7	232	3.2	1.2	8.9	1.12	1.06
90	6/03-25	2.	665	75	60	102	28	5	665	3.7	1.8	7.8	0.71	0.84
91	5/23-27	2.	376	80	71	108	29	5	376	4.2	2.8	10.7	1.07	1.03
91	5/28-6/01	2.	133	79	70	101	32	6	133	4.1	3.0	8.9	1.01	1.01
91	6/02-06	2.	136	79	68	110	41	6	136	4.2	2.5	10.1	1.30	1.14
91	6/07-11	2.	32	78	70	91	25	5	32	4.1	2.4	6.3	0.85	0.92
91	6/13-17	2.	15	76	68	86	20	4	15	4.0	3.3	5.2	0.29	0.54
92	6/05-10	2.	292	97	71	117	62	8	151	7.7	3.3	11.2	2.73	1.65
92	6/11-15	2.	284	89	76	110	22	5	156	6.9	4.3	10.4	1.08	1.04
92	6/16-29	2.	179	89	69	111	20	4	134	6.5	3.2	12.0	1.16	1.08
93	5/17-31	2.	59	99	86	115	47	7	33	8.5	6.1	14.0	3.6	1.9

Table 17. Comparison of trap efficiency by length for Moose River coho salmon, 1993.

	Km 31 Enumeration Site Tagged Coho Smolt Recovered				Moose River Weir Coho Smolt [a]						
	Length Frequency Distribution				Length Frequency Distribution				Proportion of Total Tagged Smolt	Estimated Total Number of Tagged Smolt	Trap Efficiency [b]
	Age-1.	Age-2.	Age-3.	Total	Age-1.	Age-2.	Age-3.	Total			
90-94	0			0	1			1	0.001	82	0.0000
95-99	0	0		0	0	0		0	0.000	0	
100-104	3	5		8	3	3		6	0.005	491	0.0163
105-109	14	23		37	8	20		28	0.023	2292	0.0161
110-114	12	50	0	62	5	39		44	0.036	3602	0.0172
115-119	9	97	1	107	4	112	0	116	0.095	9496	0.0113
120-124	4	107	1	112	2	171	8	181	0.149	14818	0.0076
125-129	3	79	1	83	4	250	4	258	0.212	21121	0.0039
130-134	0	47	4	51	0	200	10	210	0.173	17192	0.0030
135-139		21	5	26	1	149	23	173	0.142	14163	0.0018
140-144		13	2	15	1	83	27	111	0.091	9087	0.0017
145-149		3	0	3	1	29	14	44	0.036	3602	0.0008
150-154		2	2	4	0	15	10	25	0.021	2047	0.0020
155-159		0	1	1		3	4	7	0.006	573	0.0017
160-164		1	2	3		4	3	7	0.006	573	0.0052
165-169		0	0	0		1	1	2	0.002	164	0.0000
170-174		0		0		0	2	2	0.002	164	0.0000
175-179		0		0			1	1	0.001	82	0.0000
Total	45	449	19	513	30	1079	108	1217			
Proportion	0.088	0.875	0.037	1	0.025	0.887	0.089	1			

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[a] We assumed that the length frequency distribution of coho smolt sampled at the weir were representative of all tagged smolt.

[b] Trap efficiency of the km 31 traps for moose river tagged coho smolt. Defined as the trap catch divided by the estimated total number of smolt tagged at the weir.

Table 18. River characteristics measured daily at the Kenai River km 31 smolt enumeration site, 1993.

	Level		Turbidity			Velocity (fps)					
Date	Reading (cm)	Change (cm)	Reading (cm)	Change (cm)	Temp. (°c)	Trap 1	Trap 2	Trap 3	Trap 4	Trap 5	Trap 6
17-May	3	•	76		7						
18-May	6	3	76	0	8						
19-May	9	1	81	5	8	3.1	3.4	3.4	3.5	3.3	3.8
20-May	10	5	84	3	8						
21-May	15	9	81	-3	8						
22-May	24	2	71	-10	10						
23-May	26	4	66	-5	8	3.8	3.8	3.9	3.8	3.7	3.8
24-May	30	3	61	-5	8						
25-May	34	6	61	0	10						
26-May	40	0	56	-5	8	3.2	3.8	3.8	4.0	4.2	3.0
27-May	40	3	61	5	7						
28-May	43	0	99	38	8						
29-May	43	6	135	36	10						
30-May	49	1	102	-33	10						
31-May	49	5	107	5	11						
01-Jun	55	6	94	-13	7						
02-Jun	61	6	64	-30	9						
03-Jun	67	12	81	18	10						
04-Jun	79	12	66	-15	12	3.8	4.1	4.0	3.9	3.8	3.8
05-Jun	91	12	89	23	9						
06-Jun	104	-21	84	-5	13						
07-Jun	82	0	86	3	9						
08-Jun	82	-3	107	20	8						
09-Jun	79	-3	119	13	9						
10-Jun	76	3	132	13	9						
11-Jun	79	-3	130	-3	8						
12-Jun	76	3	137	8	8						
13-Jun	79	-3	135	-3	9						
14-Jun	76	0	140	5	9						
15-Jun	76	-3	137	-3	8						
16-Jun	73	-3	137	0	8						
17-Jun	70	3	140	3	8						
18-Jun	73	0	152	13	9						
19-Jun	73	0	157	5	11						
20-Jun	73	3	157	0	13						
21-Jun	76	-3	135	-23	12						
22-Jun	73	6	135	0	13						
23-Jun	79	3	147	13	11						
24-Jun	82	-3	91	-56	10						
25-Jun	79	0	102	10	12						
26-Jun	79	0	112	10	13						
27-Jun	79	0	112	0	13						
28-Jun	79	3	91	-20	13						
29-Jun	82	3	107	15	12						
30-Jun	85	0	122	15	12						
01-Jul	85	0	107	-15	12						
02-Jul	85	1	107	0	12						
03-Jul	86	1	91	-15	12						
04-Jul	87	2	91	0	10						
05-Jul	88	2	81	-10	10						
06-Jul	90	2	99	18	13						

Table 19. Sockeye salmon adult escapement and smolt production in the Kenai River, 1986–1993.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				Smolt per Spawner
		Age–1.	Age–2.	Age–3.	Total	
1986	422,000	[a]	115,000[b]	16,000		
1987	1,408,000	24,416,000[b]	5,807,000[b]	1,000	30,224,000	21.5
1988	910,000	5,249,000[b]	431,000[b]	0	5,680,000	6.2
1989	1,379,000	2,776,000[b]	312,000[c]	0	3,088,000	2.2
1990	519,000	253,000[c]	36,000[c]	[d]	289,000	0.6
1991	431,000	797,000[c]	[d]			
1992	807,000					
1993	697,000					

[a] No data collected.

[b] Includes Hidden Lake migration not thought to be captured by the km 31 inclined plane traps.

[c] Includes Hidden Lake (Fandrei 1993) and Moose River migration not thought to be captured by the km 31 inclined plane traps.

[d] Migrate as smolt in 1994.

Table 21. Results of sockeye salmon smolt dye experiments in the Russian River, 1993.

Period(s)	Date(s)	Number of Fish Dyed	Number of Dyed Fish Recovered	Trap Efficiency	Calculated Chi Square Value	Table Chi Square Value	Reject Hypothesis?[a]
	5/26	89	1				
	5/28	100	10				
	5/29	100	0				
	6/1	95	1				
	6/2	111	10				
	6/3	110	6				
	6/5	61	5				
	6/6	189	5				
	6/8	44	1				
	6/10	31	2				
	6/27	201	16				
	7/1	363	1				
	7/3	397	7				
	7/4	225	44				
	7/7	250	24				
	7/8	250	31				
	7/10	275	24				
	7/11	258	32				
	7/14	112	23				
	7/15	123	20				
1	5/18–6/2	495	22	0.044			
2	6/3–6/29	636	35	0.055			
3	6/30–7/3	760	8	0.011			
4	7/4–7/7	475	68	0.143			
5	7/8–7/10	525	55	0.105			
6	7/11–7/15	493	75	0.152			
1–6	5/18–7/15				112.29	11.07	yes
1–2	5/18–6/29				0.59	3.84	no
1–3	5/18–7/3				21.33	5.99	yes
3–4	6/30–7/3				76.78	3.84	yes
4–6	7/4–7/15				4.36	5.99	no
1–2	5/18–6/29	1131	57	0.050			
3	6/30–7/3	760	8	0.011			
4–6	7/4–7/15	1493	198	0.133			

[a] Hypothesis: Trap efficiency was independant of dye date; reject at alpha = 0.05.

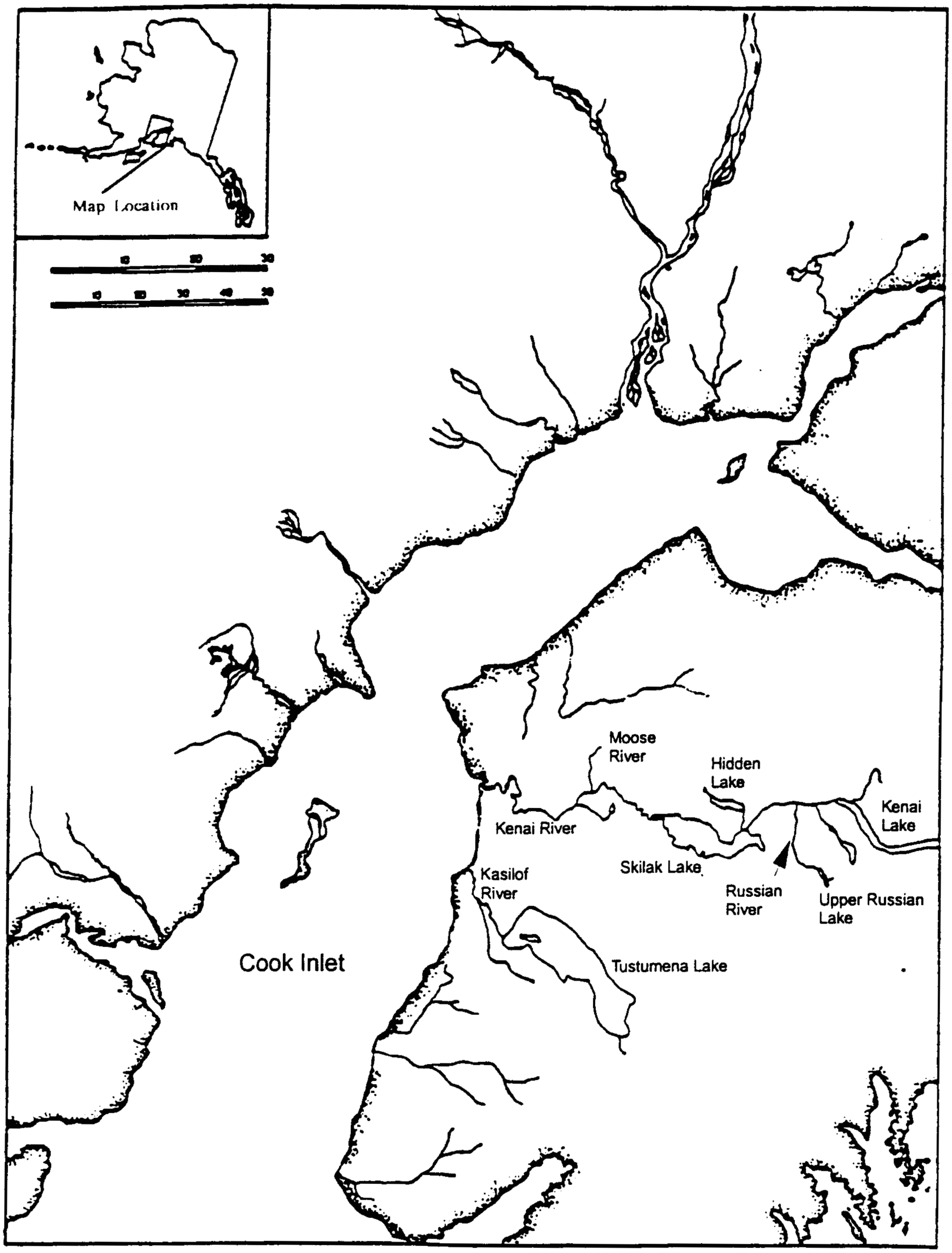

Figure 1. Location of the Kenai River and other noted rivers and lakes in Upper Cook Inlet, Alaska.

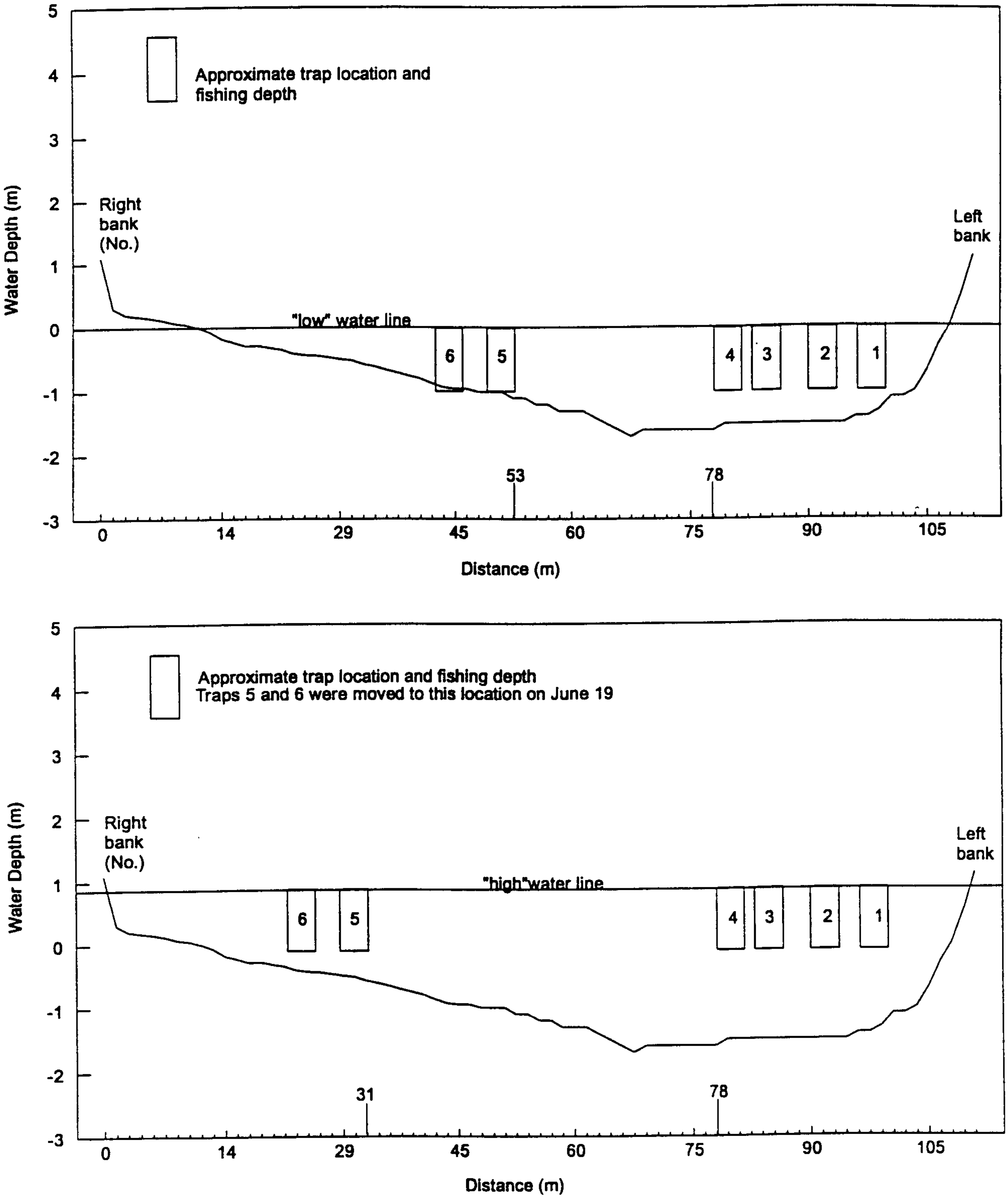

Figure 3. Cross section, Kenai River km 31 sockeye salmon smolt enumeration project site.

APPENDIX B

Table . Sockeye salmon smolt mean length and weight by age class and time strata, 1989-1994. Data collected at river km 31.

			Length						Weight					
Year	Time Period	Age	N	Mean	Min.	Max.	Var.	Stand. Dev.	N	Mean	Min.	Max.	Var.	Stand. Dev.
93	6/16-23	0	75	51	44	78	25	5	75	1.4	0.9	4.2	0.2	0.5
93	6/24-28	0	89	52	41	64	19	4	89	1.4	0.7	2.5	0.1	0.4
93	6/29-7/6	0	112	54	43	74	27	5	112	1.7	0.9	3.9	0.2	0.5
94	5/17-21	0	6	45	43	48	3	2	1					
94	5/27-31	0	9	49	44	59	18	4	5	1.0	0.9	1.3	0.0	0.1
89	5/16-20	1	413	60	46	80	19	4	413	1.9	0.8	4.3	0.18	0.42
89	5/21-25	1	338	61	60	72	22	5	338	2.1	1.2	3.3	0.13	0.38
89	5/26-30	1	421	60	53	77	17	4	421	1.9	1.2	3.8	0.15	0.39
89	5/31-04	1	424	59	49	70	13	4	424	1.8	1.0	3.4	0.13	0.36
89	6/06-09	1	423	59	46	73	15	4	424	1.8	0.8	3.7	0.15	0.39
89	6/10-14	1	425	58	49	74	14	4	425	1.8	1.1	3.5	0.12	0.35
89	6/15-19	1	429	58	46	75	17	4	429	1.8	0.2	4.0	0.20	0.45
89	6/20-27	1	679	60	19	85	19	4	679	2.1	1.0	5.4	0.26	0.51
90	5/15-23	1	241	65	48	82	30	5	241	2.2	1.0	4.2	0.34	0.59
90	5/24-28	1	97	63	52	78	25	5	97	2.0	1.0	3.8	0.27	0.52
90	5/29-6/02	1	191	61	47	90	25	5	191	1.9	0.8	5.3	0.28	0.53
90	6/03-25	1	1150	70	52	138	53	7	1150	3.1	1.0	23.8	2.17	1.47
91	5/23-27	1	48	73	52	110	92	10	48	3.4	1.8	10.4	2.15	1.47
91	5/28-6/01	1	292	65	52	89	41	6	292	2.3	1.1	5.5	0.55	0.74
91	6/02-06	1	289	67	55	100	44	7	289	2.5	1.3	7.4	0.75	0.86
91	6/07-11	1	393	64	50	79	16	4	393	2.4	1.2	4.8	0.22	0.46
91	6/13-17	1	410	65	49	84	16	4	410	2.7	1.2	5.9	0.31	0.56
91	6/18-21	1	419	65	50	79	21	5	419	2.8	1.3	5.6	0.40	0.63
91	6/22-25	1	340	66	50	84	19	4	340	2.9	1.3	5.6	0.34	0.58
91	6/26-30	1	424	65	50	75	11	3	424	2.7	1.2	4.3	0.21	0.46
91	7/01-05	1	425	67	54	80	13	4	425	3.1	1.5	5.9	0.31	0.55
92	6/05-10	1	56	74	60	90	54	7	28	3.9	2.5	6.3	1.21	1.10
92	6/11-15	1	35	78	66	95	35	6	17	5.1	3.2	10.7	3.03	1.74
92	6/16-29	1	135	78	58	130	86	9	97	4.7	1.9	22.0	5.33	2.31
93	5/17-31	1	203	76	59	124	81	9	145	4.4	2.0	19.7	3.5	1.9
93	6/01-15	1	161	76	60	93	46	7	161	4.1	1.8	7.1	1.4	1.2
93	6/16-23	1	87	79	65	91	38	6	87	4.5	2.2	7.4	1.2	1.1
93	6/24-28	1	219	80	62	90	18	4	219	4.9	2.3	8.2	0.7	0.8
93	6/29-7/06	1	191	79	65	90	17	4	191	5.0	2.9	6.6	0.4	0.7
94	5/17-21	1	261	63	45	81	36	6	104	2.2	0.7	3.5	0.3	0.5
94	5/22-26	1	292	61	50	75	15	4	144	1.9	1.1	3.0	0.1	0.3
94	5/27-31	1	258	61	48	77	23	5	79	2.1	0.8	5.1	0.4	0.6
94	6/01-05	1	280	64	53	96	21	5	96	2.3	1.5	7.3	0.4	0.6
94	6/06-10	1	292	64	50	76	17	4	93	2.3	1.4	3.4	0.2	0.4
94	6/11-15	1	300	65	55	76	12	3	100	2.6	1.8	3.2	0.1	0.4
94	6/16-20	1	297	65	50	126	47	7	99	2.7	1.4	19.3	2.9	1.7
94	6/21-25	1	296	66	52	76	12	3	99	2.7	1.6	4.1	0.2	0.5
94	6/26-30	1	275	67	54	79	8	3	100	2.8	1.4	3.7	0.1	0.3
90	5/15-23	2	515	74	62	123	21	5	515	3.2	1.9	13.4	0.55	0.74
90	5/24-28	2	326	74	61	115	35	6	326	3.2	1.8	8.8	0.68	0.82
90	5/29-6/02	2	232	74	62	104	43	7	232	3.2	1.2	8.9	1.12	1.06
90	6/03-25	2	665	75	60	102	28	5	665	3.7	1.8	7.8	0.71	0.84
91	5/23-27	2	376	80	71	108	29	5	376	4.2	2.8	10.7	1.07	1.03
91	5/28-6/01	2	133	79	70	101	32	6	133	4.1	3.0	8.9	1.01	1.01
91	6/02-06	2	136	79	68	110	41	6	136	4.2	2.5	10.1	1.30	1.14
91	6/07-11	2	32	78	70	91	25	5	32	4.1	2.4	6.3	0.85	0.92
91	6/13-17	2	15	76	68	86	20	4	15	4.0	3.3	5.2	0.29	0.54
92	6/05-10	2	292	97	71	117	62	8	151	7.7	3.3	11.2	2.73	1.65
92	6/11-15	2	284	89	76	110	22	5	156	6.9	4.3	10.4	1.08	1.04
92	6/16-29	2	179	89	69	111	20	4	134	6.5	3.2	12.0	1.16	1.08
93	5/17-31	2	59	99	86	115	47	7	33	8.5	6.1	14.0	3.60	1.90
94	5/17-21	2	56	81	67	90	20	4	24	4.4	2.7	5.6	0.5	0.7
94	5/22-26	2	17	79	65	87	31	6	7	3.8	2.1	5.5	1.1	1.0
94	5/27-31	2	33	78	67	84	14	4	17	4.0	2.7	5.1	0.3	0.6
94	6/01-05	2	20	80	71	99	46	7	4					

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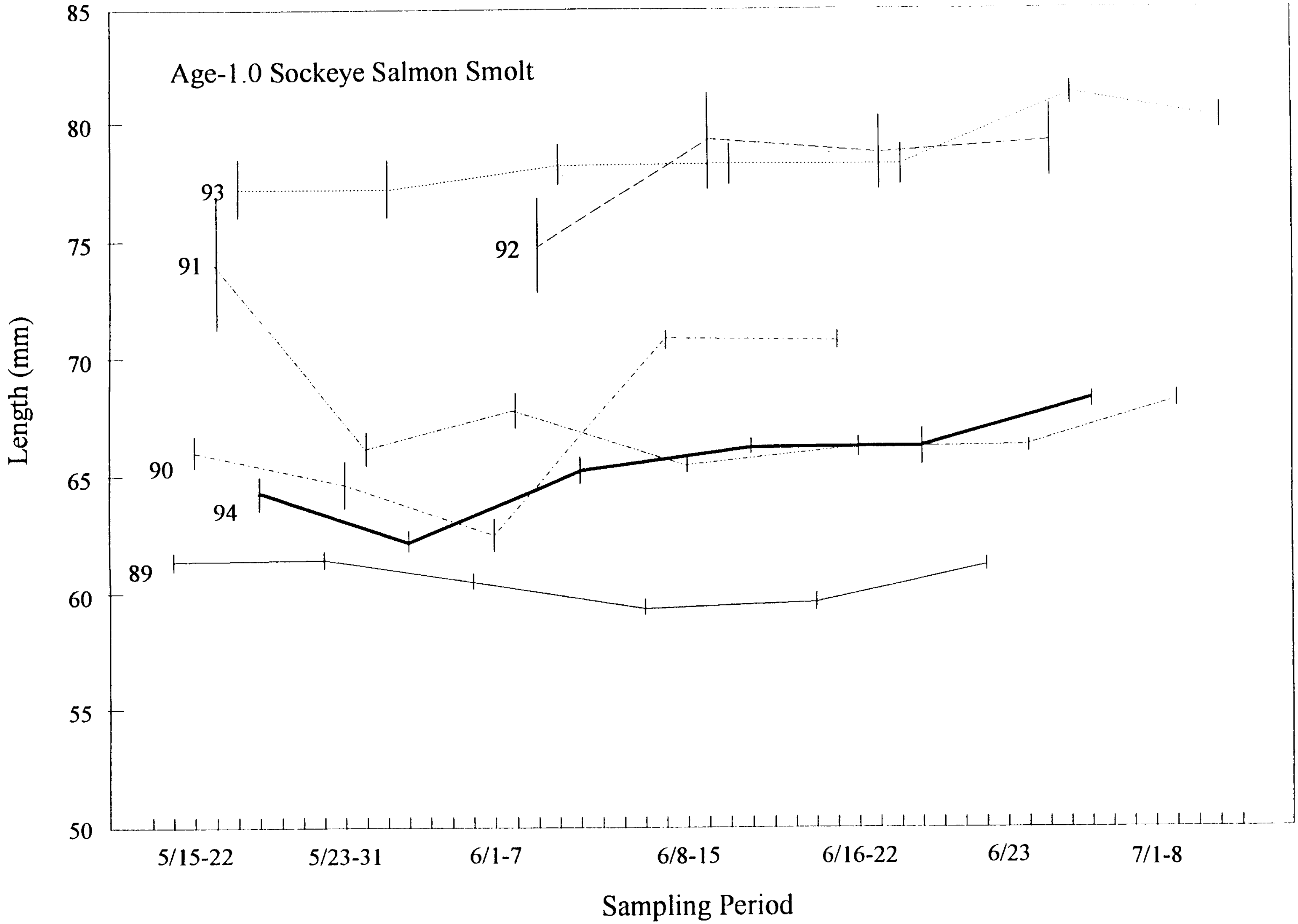


Figure . Mean lengths and 95% confidence bounds for age-1. sockeye salmon smolt sampled at the Kenai River km 31 smolt enumeration site, 1989-1994.

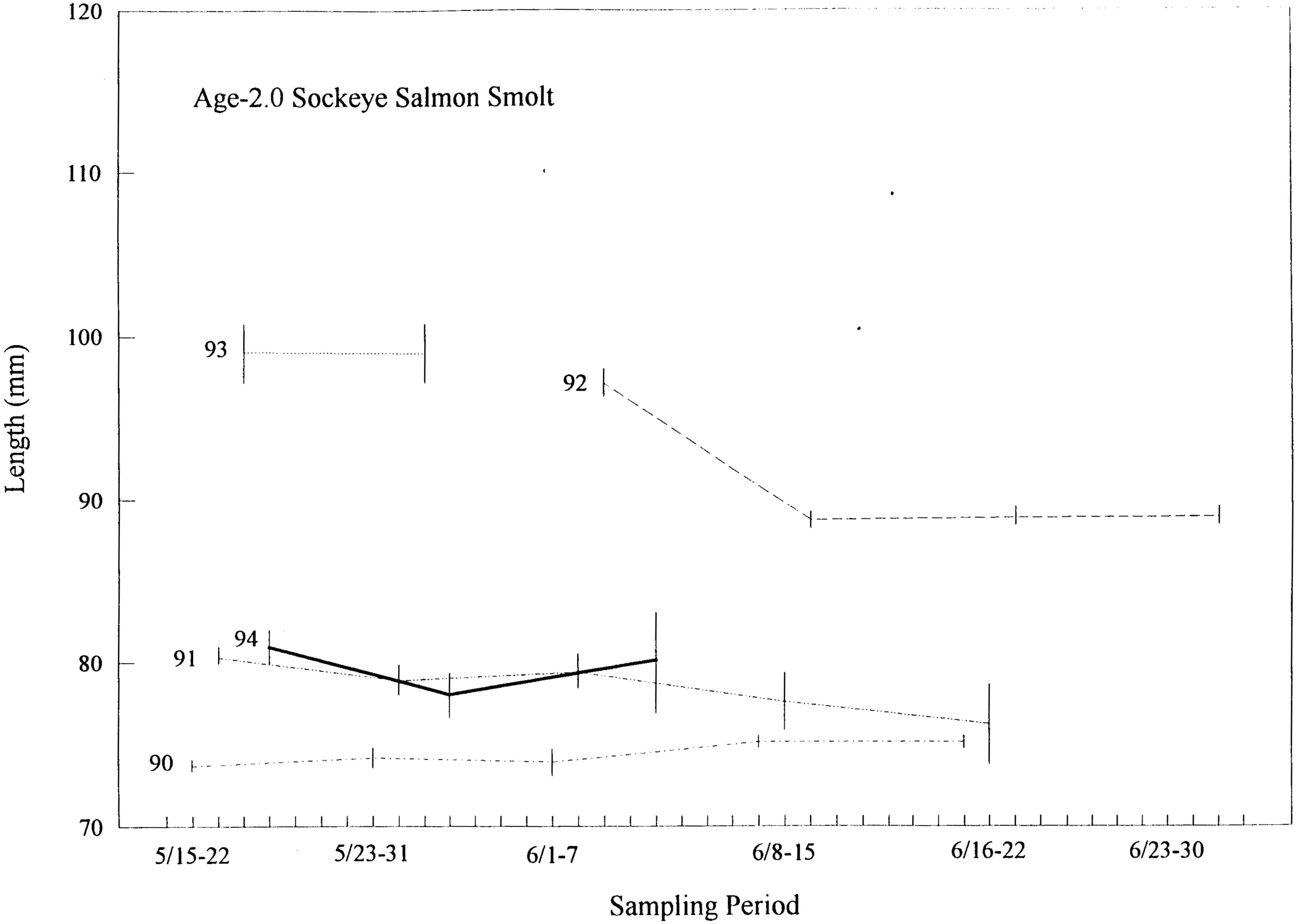
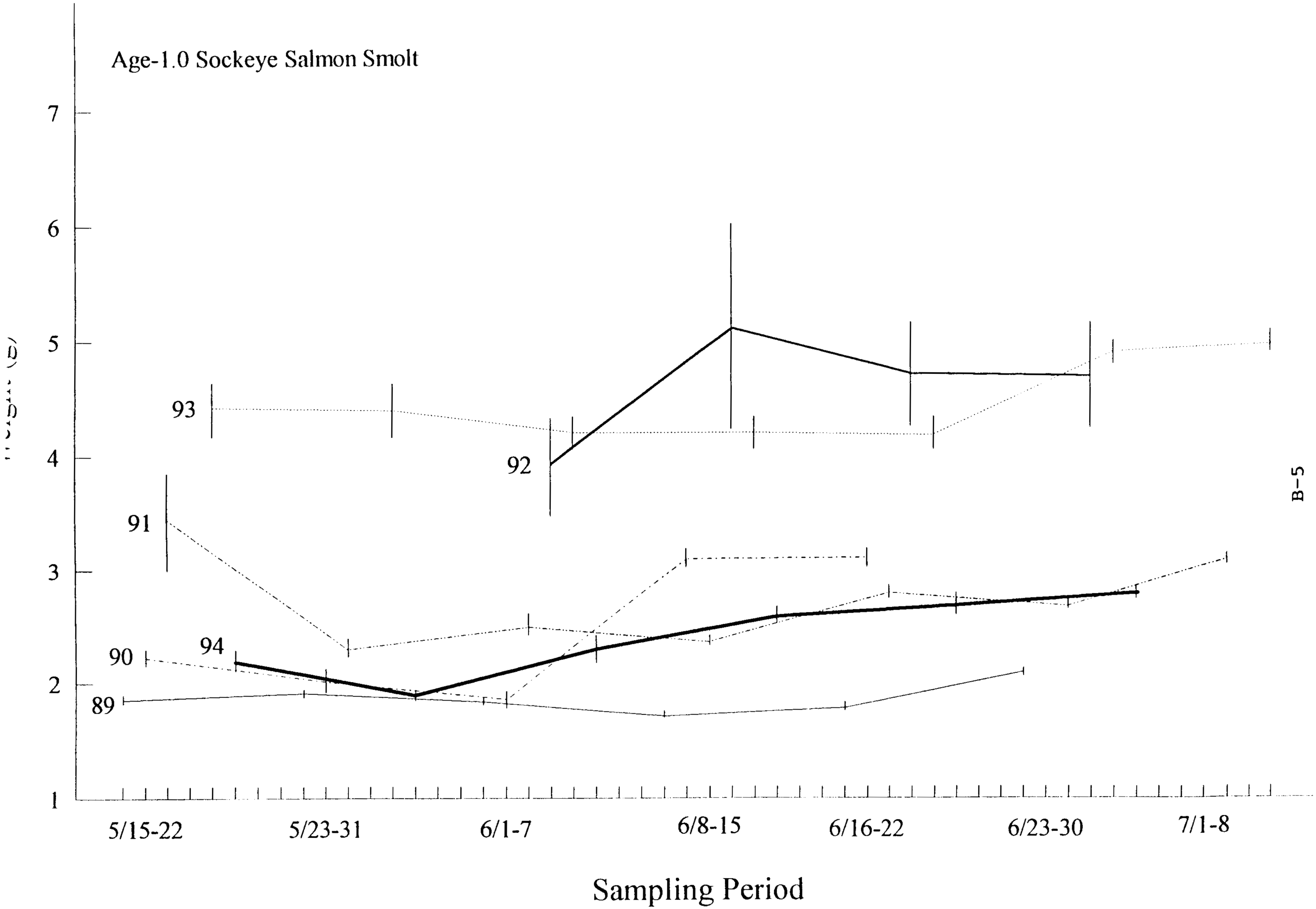


Figure . Mean lengths and 95% confidence bounds for age-2. sockeye salmon smolt sampled at the Kenai River km 31 smolt enumeration site, 1989-1994.



'igure . Mean weights and 95% confidence bounds for age-1. sockeye salmon smolt sampled at the Kenai River km 31 smolt enumeration site, 1989-1994.

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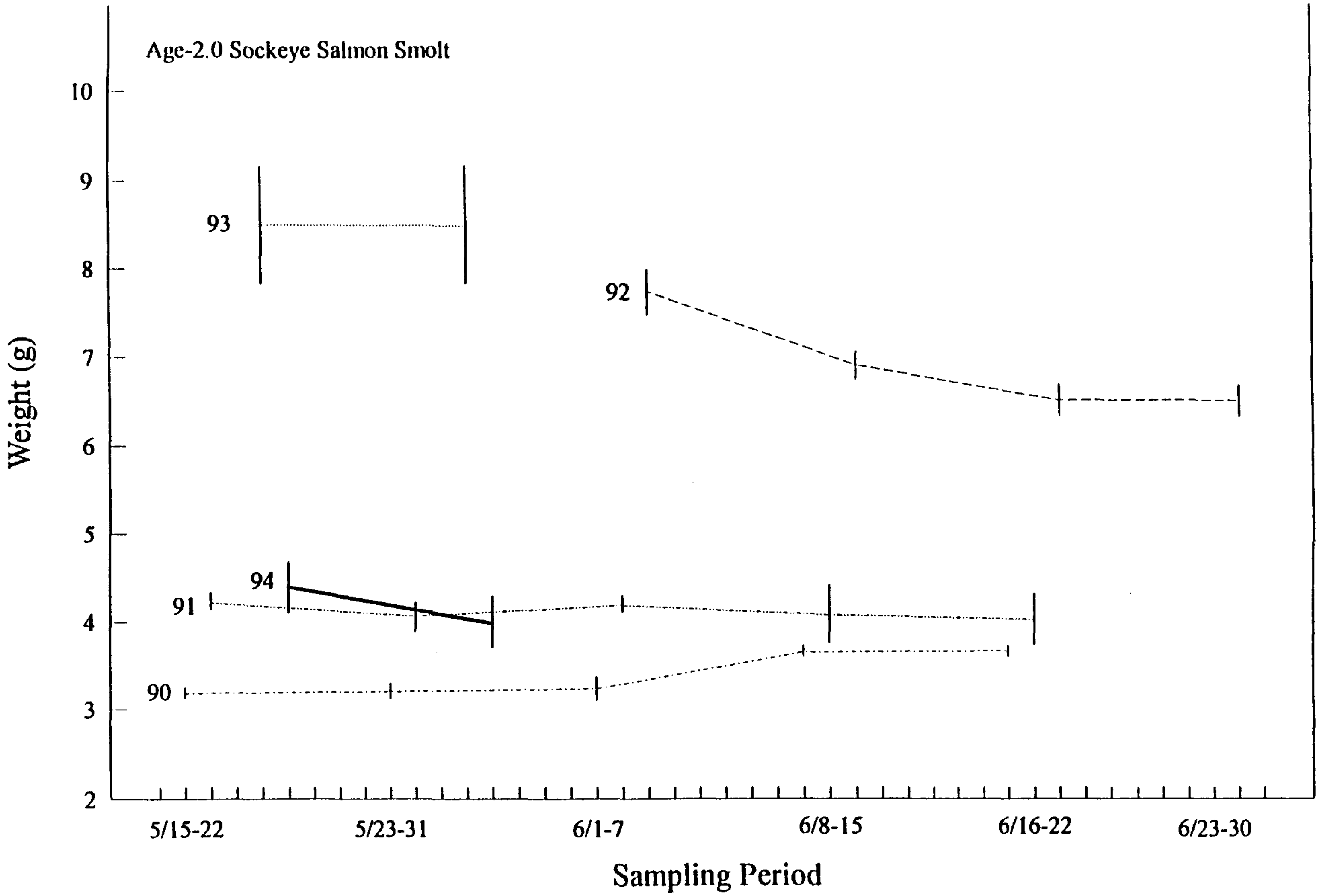

Figure . Mean weights and 95% confidence bounds for age-2. sockeye salmon smolt sampled at the Kenai River km 31 smolt enumeration site, 1990-1994.

Table . Sockeye salmon smolt mean length and weight by age class and time strata, 1994. Data collected at river km 31.

					Length						Weight			
Year	Time Period	Age	N	Mean	Min.	Max.	Var.	Stand. Dev.	N	Mean	Min.	Max.	Var.	Stand. Dev.
94	5/17–21	1	261	63	45	81	36	6	104	2.2	0.7	3.5	0.3	0.5
94	5/22–26	1	292	61	50	75	15	4	144	1.9	1.1	3.0	0.1	0.3
94	5/27–31	1	258	61	48	77	23	5	79	2.1	0.8	5.1	0.4	0.6
94	6/01–05	1	280	64	53	96	21	5	96	2.3	1.5	7.3	0.4	0.6
94	6/06–10	1	292	64	50	76	17	4	93	2.3	1.4	3.4	0.2	0.4
94	6/11–15	1	300	65	55	76	12	3	100	2.6	1.8	3.2	0.1	0.4
94	6/16–20	1	297	65	50	126	47	7	99	2.7	1.4	19.3	2.9	1.7
94	6/21–25	1	296	66	52	76	12	3	99	2.7	1.6	4.1	0.2	0.5
94	6/26–30	1	275	67	54	79	8	3	100	2.8	1.4	3.7	0.1	0.3
94	5/17–21	2	56	81	67	90	20	4	24	4.4	2.7	5.6	0.5	0.7
94	5/22–26	2	17	79	65	87	31	6	7	3.8	2.1	5.5	1.1	1.0
94	5/27–31	2	33	78	67	84	14	4	17	4.0	2.7	5.1	0.3	0.6
94	6/01–05	2	20	80	71	99	46	7	4					

Table . Numbers of fish captured by smolt traps at the Kenai River km 31 site, May 12 through June 30, 1994.

	Numbers of Fish ^{a}								
Date	Sockeye Smolt	Sockeye Fry	Chinook Smolt	Chinook Fry	Coho Smolt	Coho Fry	Pink Fry	Other	Total
12-May	32	71	29	101	0	5	0	14	252
13-May	115	140	19	97	1	5	0	6	383
14-May	22	109	13	59	0	8	0	9	220
15-May	18	26	35	108	0	0	0	4	191
16-May	26	203	16	59	1	2	0	9	316
17-May	33	192	17	72	1	1	0	4	320
18-May	86	84	55	35	0	6	0	6	272
19-May	45	493	77	261	2	2	0	17	897
20-May	752	420	97	118	1	6	0	13	1407
21-May	3521	226	130	169	3	28	1	14	4092
22-May	3147	216	93	121	1	10	0	24	3612
23-May	1951	204	79	109	2	2	3	16	2366
24-May	3279	114	97	48	3	9	0	10	3560
25-May	3024	93	37	51	1	10	0	13	3229
26-May	2975	191	56	86	4	12	0	14	3338
27-May	1848	62	71	70	4	8	0	19	2082
28-May	727	85	55	70	2	2	0	19	960
29-May	775	130	50	92	6	5	0	21	1079
30-May	2050	164	27	92	14	2	5	14	2368
31-May	3228	278	38	104	20	1	0	27	3696
01-Jun	3127	643	23	99	18	1	3	23	3937
02-Jun	1848	600	38	73	59	1	0	26	2645
03-Jun	4223	687	29	74	14	0	0	8	5035
04-Jun	4593	681	42	109	8	5	0	32	5470
05-Jun	2701	645	40	113	35	8	0	27	3569
06-Jun	1011	636	36	87	21	5	0	38	1834
07-Jun	6642	448	74	142	44	5	0	40	7395
08-Jun	6192	704	91	65	40	7	0	38	7137
09-Jun	3603	383	92	58	51	3	0	41	4231
10-Jun	2662	499	35	35	27	2	6	45	3311
11-Jun	4544	969	50	31	23	2	0	29	5648
12-Jun	1688	1249	85	130	43	6	0	32	3233
13-Jun	2007	531	100	57	49	9	0	19	2772
14-Jun	5578	376	47	33	35	2	0	20	6091
15-Jun	5978	331	78	25	57	2	0	28	6499
16-Jun	8366	608	293	36	73	4	0	36	9416
17-Jun	6891	895	668	64	72	27	1	21	8639
18-Jun	4195	774	491	44	53	17	1	12	5587
19-Jun	1624	156	93	8	32	9	0	13	1935
20-Jun	2104	110	137	14	220	16	0	13	2614
21-Jun	453	53	492	40	13	13	0	22	1086
22-Jun	292	29	839	36	14	14	0	15	1239
23-Jun	869	40	476	66	587	16	1	11	2066
24-Jun	99	36	600	34	6	4	0	22	801
25-Jun	70	15	206	27	8	1	0	9	336
26-Jun	1685	7	274	44	16	0	0	13	2039
27-Jun	442	4	92	8	9	0	0	26	581
28-Jun	44	3	255	16	23	2	0	26	369
29-Jun	170	6	243	23	10	4	0	29	485
30-Jun	292	5	198	24	5	3	0	27	554
									0
Total	111,647	15,624	7,308	3,537	1,731	312	21	1,014	141194

May 12 - trap 6 too shallow to fish.
May 13 - trap 3 lost fish when funnel cable failed.
May 25 - trap 4 lost fish when livebox flooded.
June 24 - trap 6 did not fish due to breakdown.
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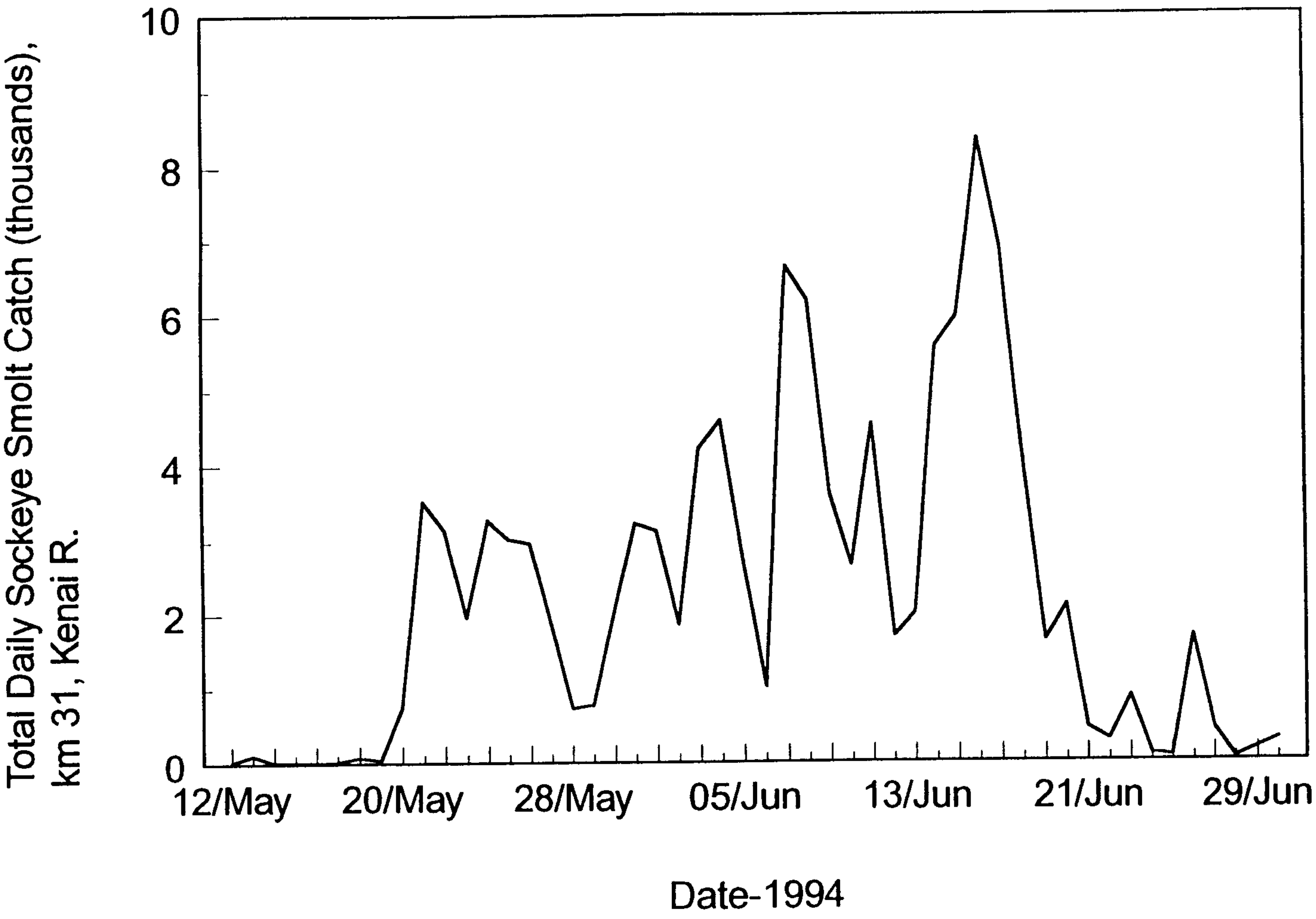
Total Daily Sockeye Smolt Catch (thousands),
km 31, Kenai R.
10
8
6
4
2
0
12/May
20/May
28/May
05/Jun
13/Jun
21/Jun
29/Jun
Date-1994

Table . Estimated Russian River sockeye salmon smolt seaward migration, 1994.

Date	Estimated Sockeye Salmon Smolt Trap Catch	Estimated Sockeye Salmon Smolt Migration						
		Daily	Cumulative	Age-0.0	Age-1.0	Age-2.0	Age-3.0	
6-May	0	0	0	0	0	0	0	
7-May	0	0	0	0	0	0	0	
8-May	20	53	53	0	0	50	2	
9-May	41	109	161	0	0	103	5	
10-May	290	768	929	0	3	729	36	
11-May	400	1,059	1,988	0	4	1,006	49	
12-May	1,226	3,245	5,233	0	11	3,083	151	
13-May	2,651	7,017	12,251	0	23	6,666	327	
14-May	13,553	35,876	48,126	0	120	34,082	1,674	
15-May	2,348	6,215	54,342	0	21	5,905	290	
16-May	2,167	5,736	60,078	0	19	5,449	268	
17-May	20,037	53,039	113,117	0	530	52,509	0	
18-May	27,980	74,063	187,180	0	741	73,323	0	
19-May	22,161	58,661	245,841	0	587	58,074	0	
20-May	14,636	38,742	284,583	0	387	38,355	0	
21-May	44,940	118,957	403,541	0	1,190	117,768	0	
22-May	10,775	48,084	451,625	0	484	47,600	0	
23-May	58,227	259,850	711,474	0	2,616	257,234	0	
24-May	65,371	291,731	1,003,206	0	2,937	288,795	0	
25-May	18,157	81,028	1,084,234	0	816	80,212	0	
26-May	24,029	107,236	1,191,470	0	1,080	106,157	0	
27-May	20,013	89,311	1,280,781	0	899	88,412	0	
28-May	2,479	11,064	1,291,845	0	111	10,953	0	
29-May	3,436	15,334	1,307,179	51	615	14,616	51	
30-May	5,770	17,187	1,324,366	57	690	16,382	57	
31-May	3,599	10,721	1,335,087	36	430	10,219	36	
1-Jun	3,846	11,456	1,346,543	0	1,115	10,265	77	
2-Jun	3,489	10,393	1,356,936	0	1,011	9,312	70	
3-Jun	1,681	5,007	1,361,944	0	487	4,486	34	
4-Jun	2,574	9,922	1,371,866	0	966	8,890	67	
5-Jun	2,235	8,617	1,380,483	0	699	7,918	0	
6-Jun	1,583	6,103	1,386,586	0	495	5,608	0	
7-Jun	1,146	4,418	1,391,004	0	358	4,060	0	
8-Jun	1,019	3,929	1,394,933	0	367	3,523	39	
9-Jun	602	2,321	1,397,254	0	217	2,081	23	
10-Jun	606	2,336	1,399,590	0	218	2,095	23	
11-Jun	689	2,656	1,402,246	0	248	2,382	27	
12-Jun	455	1,754	1,404,001	0	164	1,573	18	
13-Jun	435	1,677	1,405,678	0	157	1,504	17	
14-Jun	267	1,029	1,406,707	0	96	923	10	
15-Jun	560	2,159	1,408,866	0	580	1,579	0	
16-Jun	636	2,452	1,411,318	0	658	1,794	0	
17-Jun	756	2,915	1,414,233	0	782	2,132	0	
18-Jun	598	2,306	1,416,538	0	619	1,687	0	
19-Jun	514	1,982	1,418,520	0	532	1,450	0	
20-Jun	635	2,448	1,420,968	0	657	1,791	0	
21-Jun	455	1,754	1,422,723	0	471	1,283	0	
22-Jun	585	2,255	1,424,978	0	605	1,650	0	
23-Jun	601	2,317	1,427,295	0	1,420	897	0	
24-Jun	1,047	4,037	1,431,332	0	2,474	1,563	0	
25-Jun	1,140	4,395	1,435,727	0	2,693	1,702	0	
26-Jun	742	2,861	1,438,588	0	1,753	1,108	0	
27-Jun	565	2,178	1,440,766	0	1,335	843	0	
28-Jun	1,114	4,295	1,445,061	0	2,632	1,663	0	
29-Jun	1,518	5,853	1,450,913	0	5,123	729	0	
30-Jun	2,221	8,563	1,459,476	0	7,496	1,067	0	
1-Jul	2,634	10,155	1,469,632	0	8,890	1,265	0	
2-Jul	2,974	11,466	1,481,098	0	10,038	1,428	0	
3-Jul	1,928	7,433	1,488,531	0	6,507	926	0	
4-Jul	3,209	12,372	1,500,903	0	10,831	1,541	0	
5-Jul	1,429	5,509	1,506,412	0	4,823	686	0	
6-Jul	1,621	6,250	1,512,662	0	5,471	779	0	
7-Jul	2,281	8,794	1,521,456	0	7,699	1,096	0	
8-Jul	2,444	9,423	1,530,879	0	8,249	1,174	0	
9-Jul	2,887	11,131	1,542,009	0	9,744	1,387	0	
10-Jul	1,308	5,043	1,547,052	0	4,415	628	0	
11-Jul	1,225	4,723	1,551,775	0	4,135	588	0	
12-Jul	996	3,840	1,555,615	0	3,362	478	0	
13-Jul	816	3,146	1,558,761	0	2,754	392	0	
14-Jul	289	1,114	1,559,875	0	975	139	0	
Total	424,660	1,559,875		145	138,632	1,417,747	3,352	1,559,875

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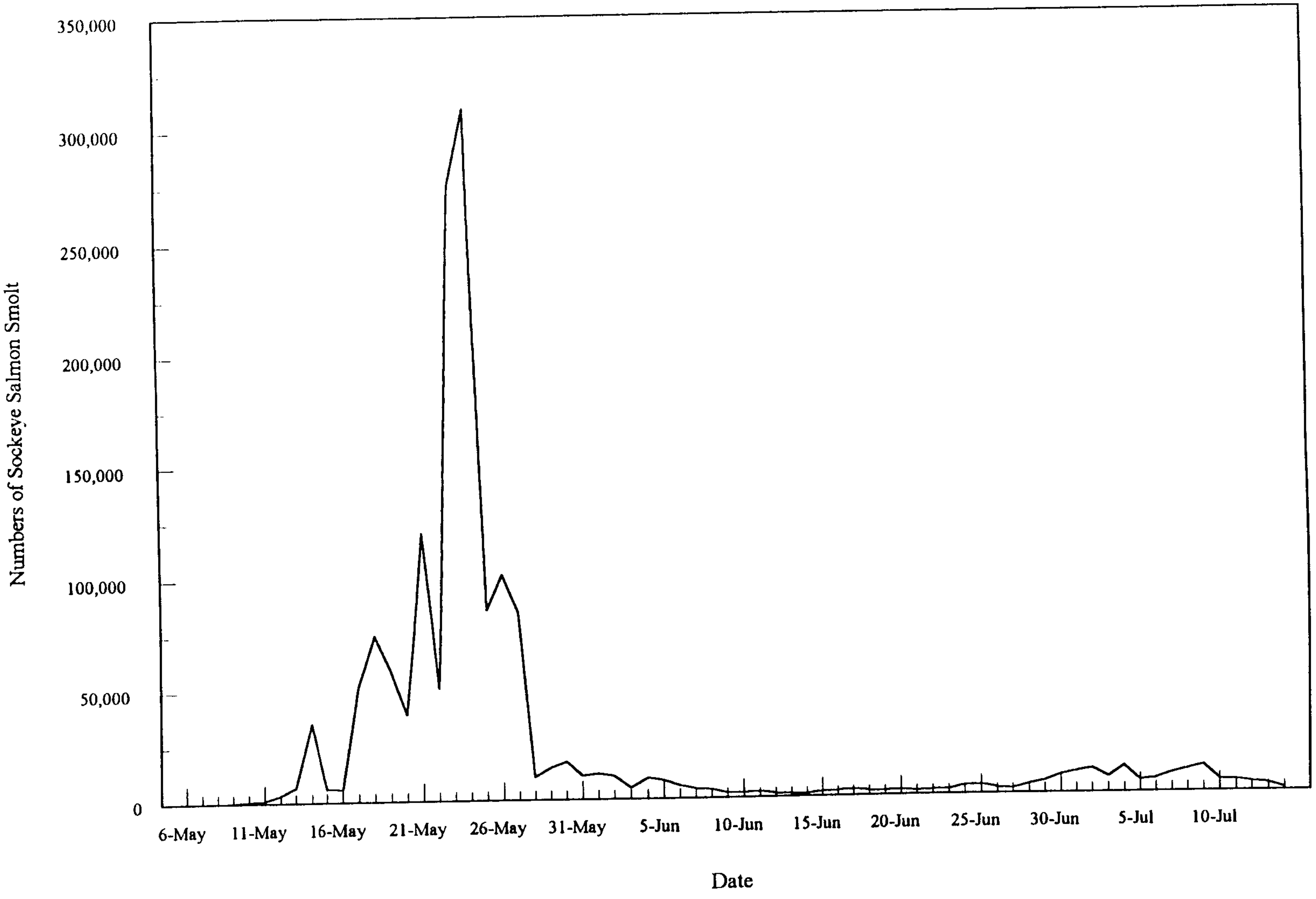


Figure . Estimated daily sockeye salmon smolt migration from the Russian river, 1994.

dayest.pre

Table . Sockeye salmon smolt mean length and weight by age class and time strata for the Russian River, 1993-1995.

			Length						Weight					
Year	Time Period	Age	N	Mean	Min.	Max.	Var.	Stand. Dev.	N	Mean	Min.	Max.	Var.	Stand. Dev.
1993	May 18-27	1	122	83	57	92	29	5	84	4.7	2.0	6.7	0.7	0.8
1993	May 28-Jun 2	1	157	81	62	95	39	6	133	4.5	2.3	6.8	0.7	0.8
1993	Jun 3-23	1	197	84	65	99	31	6	189	5.5	2.2	8.7	0.9	0.9
1993	June 24-30	1	458	80	65	98	15	4	294	5.8	3.1	10.4	0.7	0.8
1993	Jul 1-15	1	871	80	69	100	14	4	711	5.8	3.8	10.7	0.8	0.8
1994	May 11-13	1	1						1					
1994	May 18	1	3						3					
1994	May 22 & 28	1	3						3					
1994	May 28 & 29	1	12	82	74	97	40	6	12	4.6	3.2	6.9	1.0	1.0
1994	June 2-3	1	29	78	67	92	59	8	29	4.4	2.5	7.4	1.6	1.3
1994	June 5-6	1	24	82	69	98	47	7	24	4.7	2.7	5.9	0.8	0.9
1994	June 9, 10 ,12	1	28	89	75	97	21	5	28	6.1	3.8	8.1	0.8	0.9
1994	June 18-19	1	80	86	72	98	23	5	80	6.3	3.9	8.4	0.8	0.9
1994	June 25, 26, 28	1	182	85	74	100	16	4	182	6.2	3.9	9.4	0.6	0.8
1994	July 2-3	1	260	85	73	122	18	4	260	6.1	3.5	13.7	0.7	0.9
1995														
1995														
1993	May 18-27	2	253	97	75	117	67	8	193	7.6	3.1	12.9	3.0	1.7
1993	May 28-Jun 2	2	208	91	78	108	36	6	192	6.4	4.2	11.0	1.4	1.2
1993	Jun 3-23	2	132	93	80	130	48	7	123	7.1	3.6	20.1	3.2	1.8
1993	June 24-30	2	14											
1993	Jul 1-15	2	6											
1994	May 11-13	2	285	111	90	125	34	6	285	11.6	6.2	17.0	3.1	1.8
1994	May 18	2	297	103	80	117	47	7	297	9.2	4.5	14.1	3.1	1.7
1994	May 22 & 28	2	295	100	75	115	55	7	295	8.4	3.8	13.4	3.3	1.8
1994	May 28 & 29	2	285	96	71	115	64	8	285	7.5	3.8	12.5	2.8	1.7
1994	June 2-3	2	267	90	71	114	62	8	267	6.6	2.9	12.4	2.4	1.6
1994	June 5-6	2	272	93	77	115	50	7	272	6.9	3.9	12.6	2.5	1.6
1994	June 9, 10 ,12	2	269	96	79	118	34	6	269	7.4	4.3	14.1	1.7	1.3
1994	June 18-19	2	218	90	79	101	18	4	218	7.1	5.0	10.3	0.8	0.9
1994	June 25, 26, 28	2	115	91	80	102	20	4	115	7.5	5.0	10.7	1.0	1.0
1994	July 2-3	2	37	89	80	97	15	4	37	6.9	5.4	9.3	0.8	0.9
1995														
1995														

Table . Morphological information collected from sockeye salmon smolt captured in the Russian River, 1994.

Period		1	2	3	4	5	6	7	8	9	10
Date		May 11-13	May 18	May 22 & 28	May 28 & 29	June 2 & 3	June 5 & 6	June 9 10 12	June 18-19	June 25 26 28	July 2 & 3
AGE 0	N=	0	0	0	1	0	0	0	0	0	0
	Percent	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
AGE 1	N=	1	3	3	12	29	24	28	80	182	260
	Percent	0.003	0.010	0.010	0.040	0.097	0.081	0.093	0.268	0.613	0.875
AGE 2	N=	285	297	295	285	267	272	269	218	115	37
	Percent	0.950	0.990	0.990	0.953	0.896	0.919	0.897	0.732	0.387	0.125
AGE 3	N=	14	0	0	1	2	0	3	0	0	0
	Percent	0.047	0.000	0.000	0.003	0.007	0.000	0.010	0.000	0.000	0.000
		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
total		300	300	298	299	298	296	300	298	297	297

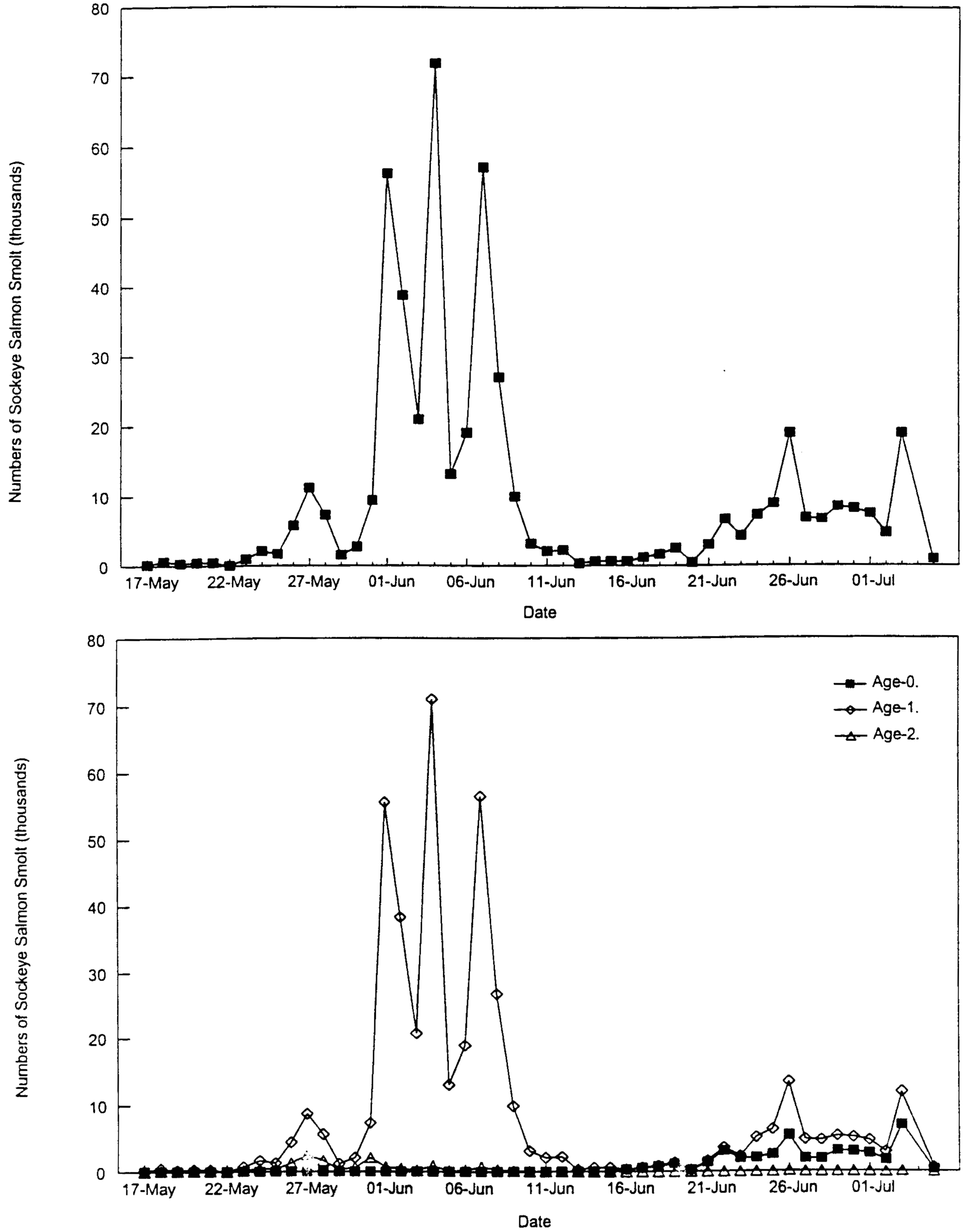


Figure 5. Daily numbers of sockeye salmon smolt, all ages (top) and by age class (bottom), migrating seaward from the Kenai River, 1993.

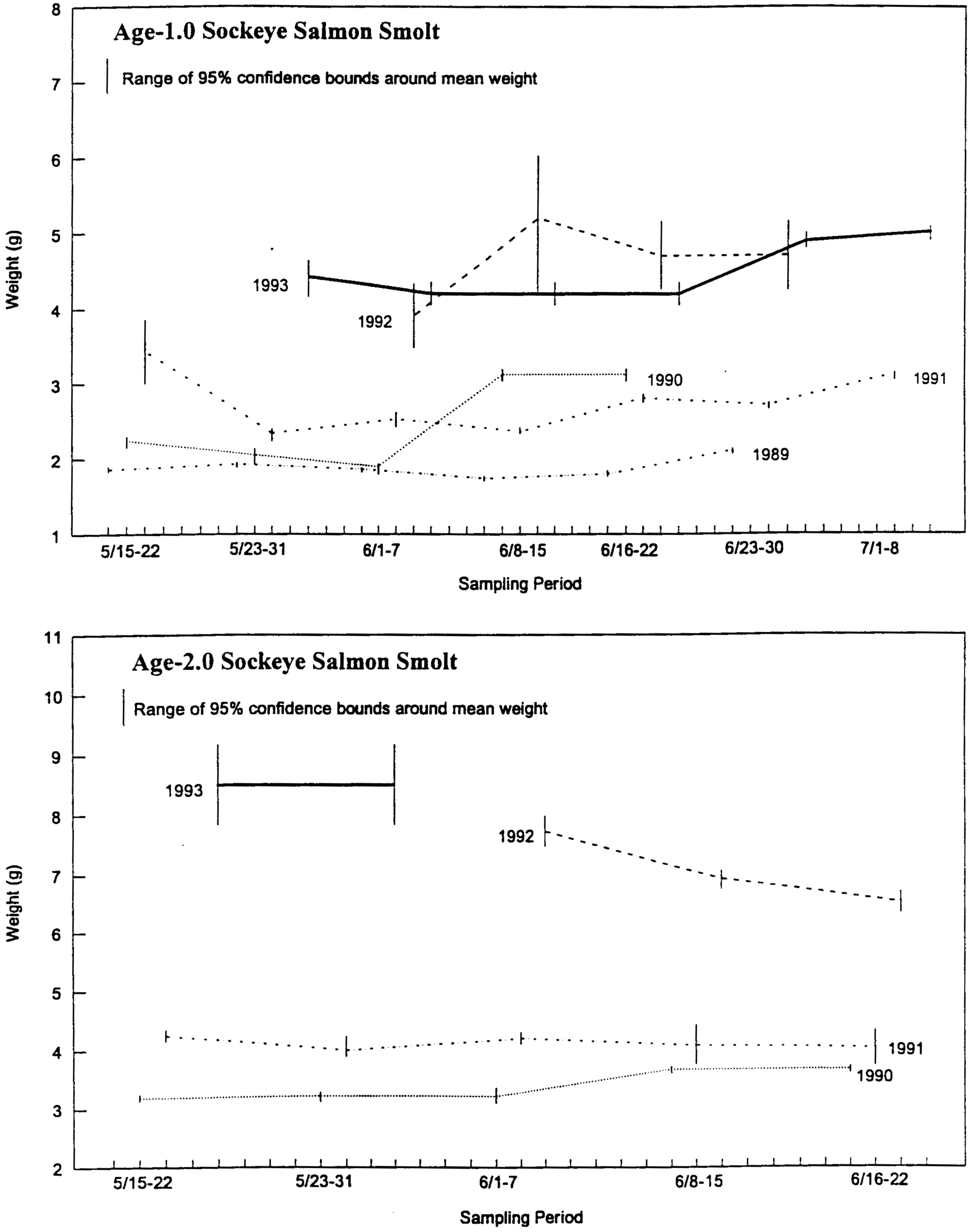
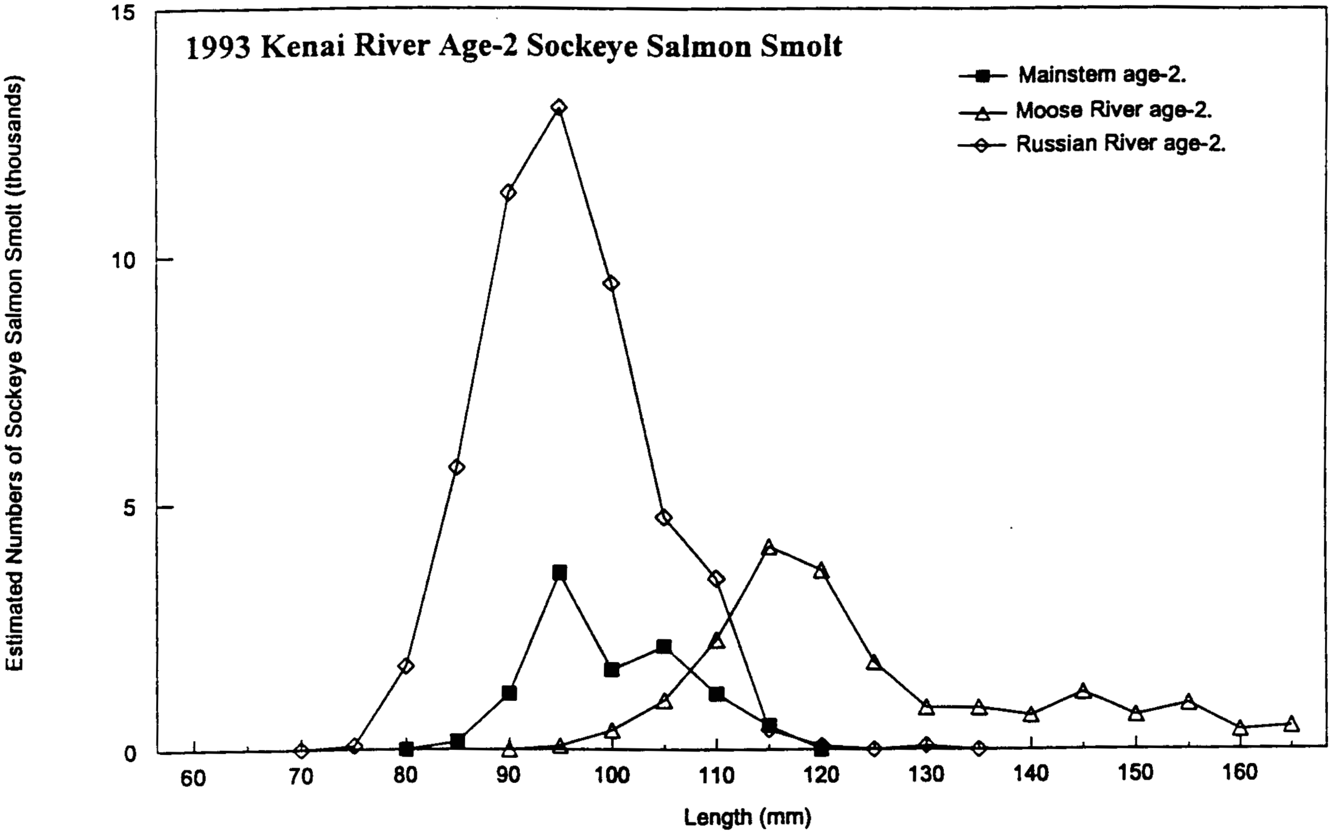


Figure 7. Mean weights and 95% confidence bounds for age-1. and -2. sockeye salmon sampled at the Kenai River km 31 smolt enumeration site, 1989-1993.



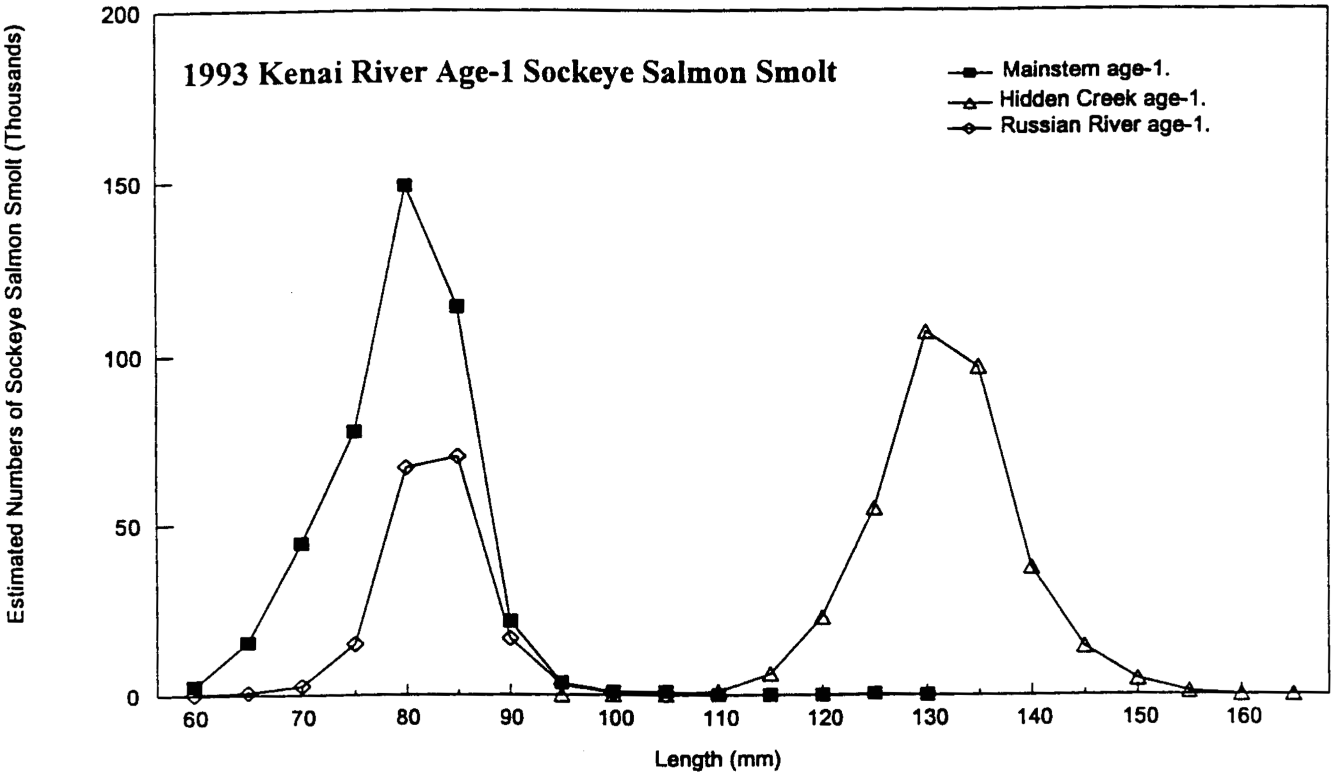


Figure 9. Length frequency distribution of age-1 (bottom) and -2 (top) sockeye salmon smolt from theKenai River drainage, 1993. Estimated numbers of smolt from weirs (Hidden Creek and Moose River), and dye studies (km 31and Russian River).

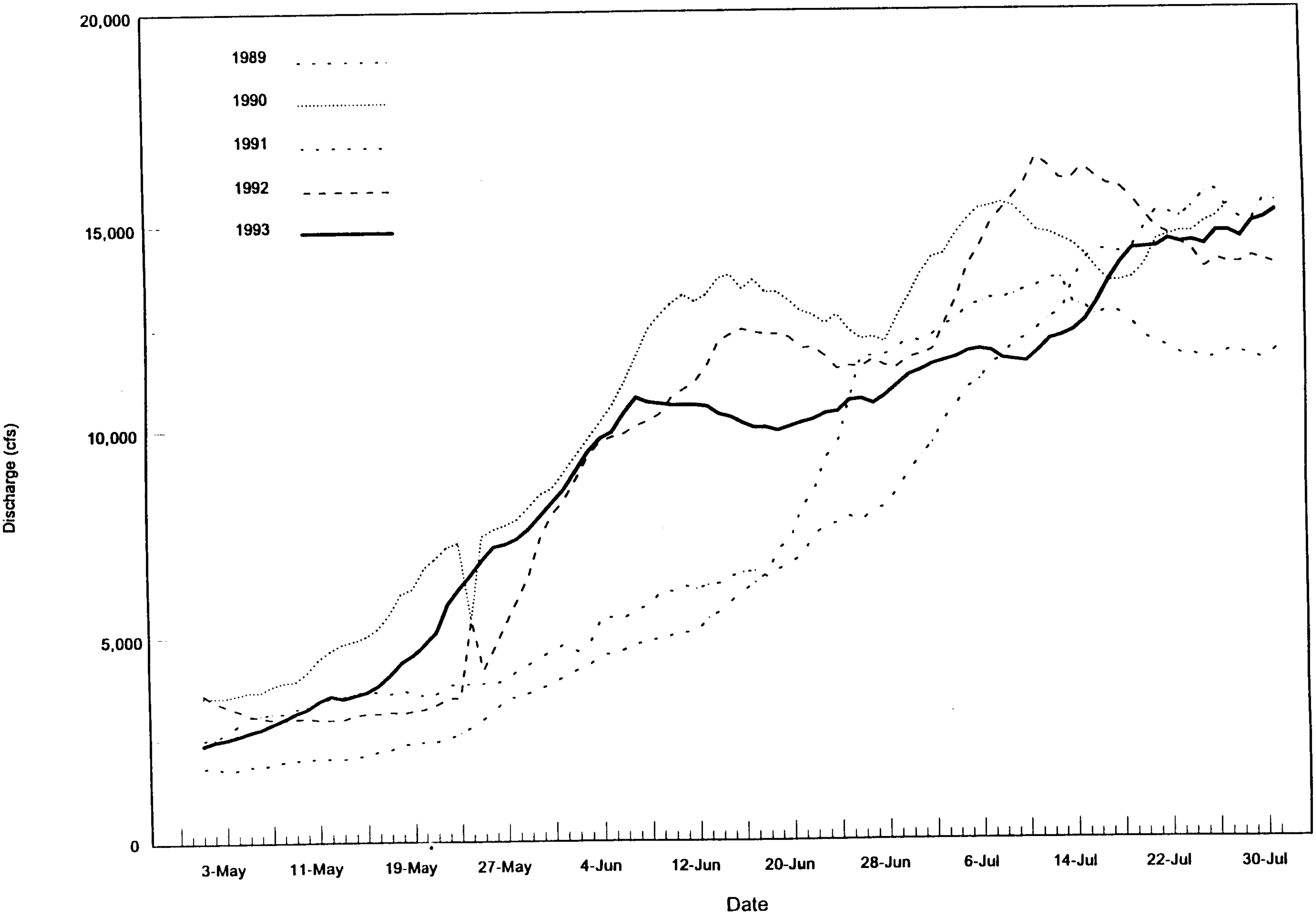


Figure 11. Daily Kenai River discharge, 1989-1993.

length frequency distributions- kenai river stocks, 1994																		
		age 1			age2		Mile 19	Mile 19	RR	RR	Hidden	Hidden	Mile 19	Mile 19	Moose	Moose	RR	RR
Length (mm)	Km 31	RR	Hid. Lk.	Km 31	RR	Hid. Lk.	Age 1	Age 1	Age 1	Age 1	Age 1	Age 1	Age 2	Age 2	Age 2	Age 2	Age 2	Age 2
							#	pop	#	pop	#	pop	#	pop	#	pop	#	pop
41-45	0.000	0.000	0.000	0.000	0.000	0.000	1	5482	0	0	0	0	0	0	0	0	0	0
46-50	0.005	0.000	0.000	0.000	0.000	0.000	14	76742	0	0	0	0	0	0	0	0	0	0
51-55	0.045	0.000	0.000	0.000	0.000	0.000	116	635865	0	0	0	0	0	0	0	0	0	0
56-60	0.165	0.000	0.000	0.000	0.000	0.000	422	2313234	0	0	0	0	0	0	0	0	0	0
61-65	0.435	0.000	0.000	0.008	0.000	0.000	1111	6090055	0	0	0	0	1	3788	0	0	0	0
66-70	0.307	0.010	0.000	0.023	0.000	0.000	785	4303054	6	1445	0	0	3	11364	0	0	0	0
71-75	0.033	0.026	0.000	0.174	0.003	0.000	85	465936	16	3852	0	0	23	87121	0	0	7	4489
76-80	0.004	0.119	0.000	0.371	0.025	0.000	10	54816	74	17817	0	0	49	185606	0	0	59	37837
81-85	0.001	0.404	0.000	0.311	0.072	0.000	2	10963	252	60674	0	0	41	155303	0	0	169	108380
86-90	0.000	0.352	0.000	0.091	0.171	0.000	0	0	219	52729	0	0	12	45455	0	0	399	255879
91-95	0.000	0.064	0.001	0.008	0.199	0.000	1	5482	40	9631	1	304	1	3788	0	0	466	298846
96-100	0.000	0.021	0.001	0.015	0.191	0.000	1	5482	13	3130	1	304	2	7576	0	0	446	286020
101-105	0.000	0.003	0.001	0.000	0.148	0.046	0	0	2	482	1	304	0	0	12	2308	347	222531
106-110	0.001	0.000	0.009	0.000	0.095	0.031	3	16445	0	0	12	3647	0	0	8	1538	223	143010
111-115	0.000	0.000	0.019	0.000	0.068	0.108	0	0	0	0	25	7599	0	0	28	5385	158	101325
116-120	0.000	0.000	0.074	0.000	0.024	0.323	1	5482	0	0	97	29483	0	0	84	16154	56	35913
121-125	0.000	0.002	0.185	0.000	0.004	0.235	1	5482	1	241	244	74164	0	0	61	11731	9	5772
126-130	0.000	0.000	0.260	0.000	0.000	0.115	1	5482	0	0	342	103951	0	0	30	5769	0	0
131-135	0.000	0.000	0.277	0.000	0.000	0.038	0	0	0	0	365	110942	0	0	10	1923	0	0
136-140	0.000	0.000	0.131	0.000	0.000	0.027	0	0	0	0	172	52280	0	0	7	1346	0	0
141-145	0.000	0.000	0.040	0.000	0.000	0.015	0	0	0	0	52	15805	0	0	4	769	0	0
146-150			0.002			0.019					3	912			5	962		
151-155			0.001			0.023					1	304			6	1154		
156-160			0.000			0.008					0	0			2	385		
161-165						0.012									3	577		
166-170						0.000									0	0		

APPENDIX C

An Estimate of Juvenile Fish Desitites in Skilak and Kenai Lakes, Alaska through the Use of Dual-Beam Hydroacoustic Techniques in 1993-1994

by Kenneth E. Tarbox and Linda K. Brannian

AN ESTIMATE OF JUVENILE FISH DENSITIES IN SKILAK AND KENAI LAKES, ALASKA, THROUGH THE USE OF DUAL-BEAM HYDROACOUSTIC TECHNIQUES IN 1993-1994

By

Kenneth E. Tarbox

and

Linda K. Brannian

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ABSTRACT

The number and distribution of sockeye salmon *Onchorhynchus nerka* rearing in two glacial lakes of the Kenai River drainage was estimated in 1993 and 1994 from hydroacoustic surveys. Using dual-beam acoustic techniques, mean *in situ* target strength ranged from -54.1 dB to -58.4 dB. Densities of fish estimated in May 1993 suggested a significant over-winter mortality of age-0 sockeye salmon. Surviving fish were concentrated at 20-40 m in May and showed indications of moving toward the surface with increasing darkness. In October 1993 the number of age-0 sockeye salmon in Kenai and Skilak Lakes was estimated at 35,687,400. In November 1993, the number of age-0 sockeye salmon in Skilak Lake was estimated at 27,608,400. By April 1994 a minimum of 15,375,800 age-0 sockeye salmon had survived the winter in Skilak Lake. In September/October 1994 a total of 12,441,900 sockeye were estimated in Kenai/Skilak Lakes. Age-0 sockeye salmon numbered 11,159,500 and age-1 were estimated at 1,282,500 fish. Age-0 sockeye salmon mean length and weight were measured for all sample periods. A linear relationship between potential egg deposition and fall fry numbers remained during this period though the residual for the 1992 brood year was one of the largest.

KEY WORDS: hydroacoustic survey, sockeye salmon, target strength, glacial lake, Alaska, *Onchorhynchus nerka*

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) began investigations in 1972 to assess juvenile sockeye salmon *Onchorhynchus nerka* populations rearing in the major lakes of the Kenai River drainage (Figure 1; Davis et al. 1973). As part of these investigations, juvenile sockeye salmon were collected from Skilak and Kenai Lakes using tow nets to estimate relative abundance, age structure, and growth (Davis et al. 1974; Namtvedt and Friese 1976). However, the inefficiency of tow netting restricted the usefulness of these data for abundance estimates (Waltemyer 1981). Therefore, in 1986 ADF&G began developing new methods to enumerate fry using hydroacoustic equipment (Tarbox and King 1988a, 1988b).

Annual fall hydroacoustic surveys have been conducted in Kenai and Skilak Lakes since 1986 to develop a time series of juvenile sockeye salmon population estimates. Program objectives for the 1993-94 field investigation were to (1) estimate the number and spatial distribution of sockeye salmon juveniles, (2) determine the target strength distributions using dual-beam hydroacoustic techniques, (3) document the condition of juvenile sockeye salmon using length and weight measurements, and (4) estimate the age composition of sockeye salmon in each lake.

Since the initiation of the project in 1986 the standard procedure for estimating juvenile sockeye salmon abundance in Kenai and Skilak Lakes has been to conduct night-time hydroacoustic surveys during September or October. While this procedure was followed in 1993-94, we also conducted hydroacoustic work in Skilak Lake during May and November 1993 and April 1994. The objective of these supplemental studies was to define the depth distribution of rearing sockeye salmon in spring and fall and to assess survival of rearing sockeye salmon during the fall to winter transition period. In addition, we conducted an extensive tow netting program in 1993-94 to assess potential bias in the age composition allocation. This information is reported in a separate document.

METHODS

The equipment used for data acquisition consisted of a Biosonics Inc. Model 105[1] echo sounder with dual-beam receivers, a 420 kHz 6°/15° dual beam transducer mounted in a V-fin for towing, a Model 171 tape recorder interface, a Sony[1] digital audio tape (DAT) player, a chart recorder, and an oscilloscope. The selected pulse width was 0.4 ms and the pulse repetition rate was 5 pulses/s. Additional acoustic parameters used during data collection and processing are presented in Appendix A.1. Biosonics, Inc. calibrated the system before and following the surveys. The entire system was powered by 12-V batteries and carried in a 7.2-m vessel powered by outboard motors. Vessel speed along each transect was estimated at 2.0 to 2.5 m/s. The transducer was

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[1] Use of a company name does not constitute endorsement by ADF&G.

towed approximately 1 m below the water surface during surveys. Equipment procedures were outlined in King and Tarbox (1988).

Dual-beam data recorded on DAT were processed through a Biosonics, Inc. Model 281 Echo Signal Processor[1] (ESP). A returning pulse was accepted as a valid target if the amplitude was below the bottom threshold of 7000 mV and above the counting threshold of 200 mV. Single targets were separated from multiple targets if the pulse width was within 20% of the transmitted pulse width at -6 dB and -18 dB. The maximum half-angle selected for data processing was 4°. Data were stratified in 5-m increments for analysis starting 2 m below the transducer, or 3 m below the water surface. Only data collected at range less than 97 m were accepted for processing. Examination of oscilloscope traces and echograms indicated that few fish were present below this depth.

Data generated by the dual beam processor were transferred to computer data files for analysis using the Biosonics, Inc. software "Target Strength Post Processing Program ESPTS." Computations of mean target strength and backscattering cross section were made from individual echoes, and a hard copy of the results was printed for each 5-m depth interval.

Estimates of fish density were made for each transect by echo integration using a Biosonics, Inc. ESP Model 221[1] echo integrator. Correction from the 40 log(R) setting used during data collection to the 20 log(R) used for data processing was accomplished by adjusting the B constant value for each depth stratum.

The echo integrator compiled data in 1-min sequences along each transect and sent outputs to computer files for further reduction and analysis using the Biosonics, Inc. software "Echo Integration Post Processing Program ESPCRNCH." Raw integrator outputs were edited to remove data that resulted from false bottom echoes. Where this occurred, fish densities were usually estimated using the average densities of adjacent sequences at the same depth. Overall fish density was obtained by calculating the average edited integrator output value across the transect for each depth stratum. These averages were multiplied by the integrator scaling factor derived from the mean backscattering cross-section value obtained from the ESPTS program. Mean backscattering cross section values were calculated for each depth stratum using data from those transects where false bottom did not occur or did not influence the target strength data.

The total number of fish (N_{ij}) for area stratum i based on transect j was estimated across depth stratum k. It consisted of the number of fish estimated by hydroacoustic gear in the midwater section (M_{ij}) plus an estimate of fish unavailable to the hydroacoustic gear because of their location near the surface (S_{ij}) or bottom (B_{ij}), or

$$N_{ij} = S_{ij} + M_{ij} + B_{ij} .$$

The midwater component was estimated as

$$M_{ij} = \sum_{k=1}^{K} a_i w_{ijk} m_{ijk} \ ,$$

where a_i represented the surface area (m^2) of area stratum i which was estimated using a planimeter and USGS maps of Skilak and Kenai Lakes, and w_{ijk} was the average depth (5m) of depth stratum k measured along transect j in area i. This depth would be less than the maximum 5 m if the bottom was detected within depth stratum k anytime along the transect. The mean fish density in area i depth k across transect j was m_{ijk} in number per m^3.

The estimated number of fish near the surface (0-3 m) in area i was

$$S_{ij} = a_{is} m_{ij1} \ ,$$

where a_{is} was the estimated volume (m^3) of the surface area stratum (0-3 m), and m_{ij1} was the mean fish density for the first ensonified depth strata (2-7 m below transducer) of transect j.

The estimated number of fish near the bottom was

$$B_{ij} = \sum_{k=1}^{K} b_{ijk} m_{ijk} \ ,$$

where b_{ijk} was the estimated volume (m^3) in area i of depth k that could not be ensonified due to the proximity of the bottom along transect j, and m_{ijk} was the estimated fish density (number per m^3) along transect j in area i depth k that was ensonified. In cases where all of depth stratum k was along the bottom, the mean density m_{ijk-1} from the next shallower depth strata (k-1) was used.

The abundance in area i (N_i) became the mean abundance estimated by each transect j, or

$$N_i = J^{-1} \sum_{j=1}^{J} N_{ij} \ ,$$

and its variance was estimated as

$$V(N_i) = \sum_{j=1}^{J} (N_{ij}-N_i)^2(J-1)^{-1}J^{-1} \quad .$$

Total abundance for each lake became the sum of its area estimates. Its variance became the sum of the area variances.

Age-specific estimates of the numbers of juvenile sockeye salmon (N_{ayi}) were estimated

$$N_{ayi} = N_{yi}\, p_{ayi},$$

where p_{ayi} was the proportion of fish caught in area i (n_{yi}) and year y of age a (n_{ayi}). Samples were pooled across areas not found to have significantly different age compositions (chi-square test). The pooled proportion for age a was then substituted for p_{ayi} for the appropriate areas.

The variance for N_{ayi} was estimated as the product of two random variables, p_{ayi} and N_{yi}, as

$$V(N_{ayi}) = N_{yi}^2 V(p_{ayi}) + p_{ayi}^2 V(N_{yi}) - V(p_{ayi}) V(N_{yi}).$$

The total estimate for the Kenai and Skilak Lakes system became

$$N_{ay} = \sum_{all\ i} N_{ayi},$$

and its variance was estimated as

$$V(N_{ay}) = \sum_{all\ i} V(N_{ayi}) \quad .$$

We conducted a hydroacoustic survey during the day on 5 May 1993 to define fish abundance and depth distribution, in Skilak Lake (Figure 2). A second survey was conducted on 8-9 May to define diel vertical behavior of juvenile sockeye salmon. A single transect in Area 1 of Skilak Lake was replicated sixteen times in a 7-h period (1842 to 0203 hours; Figure 3). Because of low densities of fish in the study area, mean target strength data by depth were calculated by pooling results from the two surveys.

We used a stratified random sampling design for 1993 fall night surveys to distribute sampling effort and provide an acceptable way of calculating sampling error. We divided each lake into areas or sub-basins and randomly established survey transects within each of these areas. The number of transects was chosen to reduce the relative error to 0.25 for Skilak Lake and 0.3 for Kenai Lake. Our sample size was based on the average coefficient of variation observed from 1986 to 1989. Because of the configuration of Skilak Lake, a total of 13 transects perpendicular to shore were surveyed within three sub-basins (Figure 4). In Kenai Lake a total of 27 transects were surveyed within five sub-basins (Figure 5). The Kenai Lake survey was conducted on 4 October 1993 and the Skilak Lake survey on 26 September 1993.

Following the regular night hydroacoustic survey of Skilak Lake on 26 September, we returned to Skilak Lake on the nights of 16 and 18 November 1993 to ascertain fish abundance in the late fall/early winter. A total of thirteen transects was completed (Figure 6).

To evaluate overwinter survival we conducted a day survey of Skilak Lake on 25 April 1994. However, during that survey we suspected that we may have missed fish because of nearsurface orientation. Therefore we returned to Skilak Lake on 29 April 1994 to conduct a night survey (the same transects used in November 1993 were resurveyed in April).

We returned in September/October 1994 to survey both Kenai and Skilak Lakes as part of our normal operational plan (Figures 7 and 8). The survey design proceedure was the same as for the 1993 fall survey. However, rough water kept us from completing Area 5 in Kenai Lake. We, therefore, expanded Area 4 surface area to include Area 5 in the density estimate.

To estimate species composition of the targets mid water trawling was conducted in both lakes. The sampling program was designed to collect a minimum of 300 fish from each area of each lake. All captured fish were enumerated, identified, and preserved in 10% formalin. In the laboratory juvenile sockeye salmon were measured to the nearest millimeter (fork length), weighed to the nearest 0.1 g, and an age determined from scale samples using criteria outlined by Mosher (1969). Differences in age and species composition between areas were tested with chi-square analysis. Detailed methods and results of this effort are reported in a separate document (Carlson et. al, in press).

RESULTS

May 1993 Hydroacoustic and Tow Net Surveys

Sixteen thousand five hundred and ninety three echoes were used to estimate target strength distributions in Skilak Lake on 5 May 1993. Mean target strength was -55.04 dB with a standard deviation of 4.76 dB (Appendix A.2). The estimated fish population was only 859,240 (Table 1). No apparent concentration of fish was observed as fish distribution was similar to the relative volume estimates for each area (Table 2). No species apportionment was made since tow netting resulted in insufficient catches. The depth distribution of targets indicated no obvious surface orientation as peak densities were typically in the 20-40 m range (Figures 9 and 10).

On 8 May 1993 population estimates for Area 1, Skilak Lake, ranged from 476,020 to 4,646,700 fish depending on when the transect was conducted. Early evening estimates (1842 to 2004 hrs) typically were the lowest with peak estimates made between 2200 and 2334 hrs (Table 3). Density estimates by depth indicated that fish were distributed at deeper depths during the early evening with higher densities recorded near surface as night advanced (Figures 11 and 12). Target strength measurements were essentially the same as the 5 May 1993 survey (mean value -54.09 dB, Appendix A.3).

September/October 1993 Night Hydroacoustic and Day Tow Net Surveys

A total of 44,813 echoes in Kenai Lake and 138,697 in Skilak Lake were used to estimate target strength distributions. As in past fall surveys, calculated mean target strengths decreased with depth (Figure 13). Mean target strength for Kenai Lake was -57.6 dB (Appendix A.4). Near-surface measurements were -55.52 dB in contrast to -59.19 dB at a depth of 52-57 m. In Skilak Lake the mean target strength was -56.68 dB. Mean target strength decreased from a near surface value of -54.47 dB to -57.21 dB at 37 m (Appendix A.5).

The total estimated number of fish in both lakes was 38,108,400 (Table 4). Approximately 11%, or 4,355,300 fish, were found in Kenai Lake and the remaining 33,753,100 fish in Skilak Lake. An estimated 55.2% of the fish in Skilak Lake were located in Area 1, which comprised 28.9% of the lake volume . Within Kenai Lake 31.5% of the fish were located in Area 4, which composed 29.3% of the lake volume (Table 5).

The maximum fish density observed in Skilak Lake was 0.089 fish/m^3 between 22-27 m along Transect 6 of Area 1. Maximum densities of fish were recorded in the 17-22 m depth range for 6 of the 13 transects. Two transects had maximum densities deeper in the water column and five shallower.

The maximum density of fish observed in Kenai Lake was 0.011 fish/m^3 between 17-22 m along Transect 1 of Area 2. Maximum densities of fish at 12 transects was between 22-27 m. Six transects had maximum densities at deeper strata and nine shallower.

Sockeye salmon were the predominant species in catches from both lakes, representing nearly 100% of the total catch for both lakes (Table 6). Age-1 sockeye salmon made up 0.1% and age-0 composed 99.9% of the Kenai Lake juvenile sockeye estimate (*N* = 2.973; Table 6). Within Skilak Lake, age-0 sockeye salmon comprised 94.8% of the estimate (*N* = 2,879; Table 6).

After adjusting the total number of targets using species and age composition data from tow net samples, the number of juvenile sockeye salmon in both lakes was estimated at 37,420,000. Of this total, 35,687,400 were age-0 sockeye salmon produced by the 1992 spawning population, and 1,732,700 were age-1 sockeye salmon produced by the 1991 spawning population (Table 6).

Mean length of age-0 sockeye salmon in Skilak Lake was 49 mm and mean weight was 1.2 g. Age-1 sockeye salmon in Skilak Lake had a mean length of 75 mm and weight of 4.5 g. Mean size and weight of age-0 sockeye salmon in Kenai Lake was 45 mm and 1.0 g. They were smaller (N.S.C.) in size than those collected in Skilak Lake (Table 7).

November 1993 Night Hydroacoustic and Day Tow Net Survey

As expected, Skilak Lake mean fish target strength measurements in November 1993 were within 0.14 dB of the September values (mean -56.54 dB). However, in contrast to the September survey no obvious trend of decreasing target strength measurements with depth were observed in the data set (Appendix A.6).

A total of 29,091,000 fish were estimated in Skilak Lake (Table 8). The majority of fish targets (48.6%) were observed in Area 3 which comprised only 23.1% of the lake volume (Table 9). Tow netting indicated that 98.1% of the fish were sockeye salmon. Age-0 sockeye salmon numbered 27,608,400 while age-1 sockeye salmon comprised 1.9% of the sockeye population (527,000 fish; Table 10).

Comparing the mean size of age-0 and age-1 sockeye salmon indicated that no increase in length or weight took place between September and November (N.S.C.). Age-0 sockeye salmon were 48 mm (S.D. = 5mm, N= 1856) and 1.0 g (S.D.= 0.3, N = 1856) in November. Age-1 sockeye salmon were 75 mm (S.D. = 5, N = 43) and 4.1 g (S.D. = 0.8, N = 43).

April 1994 Hydroacoustic and Tow Net Surveys

A daylight survey on 25 April 1994 estimated 7,339,800 fish present in Skilak Lake (Table 11). Fish were concentrated in Area 1, with 80.9% of the population occupying 38.1% of the lake volume (Table 12). Mean target strength was approximately 2 dB lower (mean -58.41 dB) than the previous November estimate (Appendix A.7).

In contrast, the night survey of Area 1, Skilak Lake, on 29 April 1994 produced an estimate of 18,178,000 fish (Table 13), which was three times the daylight estimate. Mean target strength was -56.63 dB (Appendix A.8), which was within 0.09 dB of the November estimate and 1.78 dB of the April daylight estimate. Based on extensive tow netting, sockeye salmon comprised 98.1% of the fish population. Age-1 sockeye salmon contributed 86.2% (15,375,800 fish) of the total sockeye estimate (Table 14).

Mean size of sockeye salmon were as follows: 1) Age-0 were 28.7 mm (S.D. = 1.0 mm, N = 10) in length and weighted 0.215 g (S.D. = 0.4, N = 10); 2) Age-1 were 53.3 mm (S.D. = 5.7 mm, N = 574) and 1.7 g (S.D. = 0.5 g, N = 574); and 3) Age-2 were 76.9 mm (S.D. = 4.6 mm, N = 65) and 4.5 g (S.D. = 4.6 g, N = 65).

September/October 1994 Night Hydroacoustic and Day Tow Net Survey

Mean fish target strength estimates for Skilak and Kenai Lakes were -54.14 and -54.44 dB, respectively (Appendix A.9 and A.10). Decreasing fish target strengths with depth during the fall surveys was again observed in 1994. However, the magnitude of the decrease was less than previous years (Figure 13). Within Skilak Lake near surface fish target strength was measured at -53.12 dB and decreased to -54.83 dB at 37-42 m. However, below this depth fish target strength increased slightly for a majority of the remaining depth strata (Appendix A.9). In Kenai Lake, except for the 2-7 m depth strata, target strength decreased from -53.71 dB at 7-12 m to -56.76 dB at 57-62 m (Appendix A.10).

The total number of fish in both Skilak and Kenai Lake was 12,514,000 (Table 15). Skilak Lake contributed 76.4% to the total population estimate (9,567,400 fish) which was the lowest on record (Figure 14). Distribution of fish in Skilak Lake was fairly evenly spread with Area 1 having 43.3% of the fish and 33.8% of the lake volume. Area 3 had slightly lower numbers (Table 16).

Sockeye salmon were the predominant species (99.3%) captured in tow nets. Age-0 sockeye salmon were 87.8% of the Skilak Lake sockeye estimate (8,353,900 fish) while in Kenai Lake they contributed 95.7% (2,805,600 fish, Table 17).

Mean size of Skilak Lake sockeye salmon juveniles were similar to the 1993 measurements (Table 7). However, age-0 fish were 0.2 g heavier that the 1993 fish. In contrast, Kenai Lake fish were almost twice as heavy than the 1993 cohort (Table 7).

DISCUSSION

This is the eighth year of hydroacoustic work on Skilak Lake, and during that time several trends have become evident in the data set. Fish-target strength estimates by depth in 1993 and 1994 were within historical bounds (Figure 13), and the trend of decreasing target strength with depth continued. This phenomenon appears related to the use of 420 kHz in this glacial lake system. Tarbox et al. (1993) found no decrease in target strength with depth using a 120 kHz system in Skilak Lake.

Schmidt et al. (1993) noted a relationship between potential egg deposition (a function of the number of spawners) and fall fry numbers in Skilak and Kenai Lakes over the available time series (Figure 15). The 1992 brood year production was the second highest measured. Schmidt (ADF&G, Soldotna, personal communication) has indicated that zooplankton abundance and behavior was abnormal and optimum for the 1993 rearing year in Skilak Lake. In contrast, the 1993 brood year production was 8 million fish below the regression model prediction.

The distribution of fish between Skilak and Kenai Lakes has also been very consistent: Skilak Lake generally produces between 80% and 90% of the counts (Figure 14). The relative abundance of fish in Skilak Lake in 1994 was the lowest on record and probably reflects reduced survival in Skilak Lake as opposed to increased production in Kenai Lake.

Overwinter survival of juvenile sockeye salmon in Skilak Lake is difficult to estimate since a number of variables are still unknown about juvenile sockeye salmon behavior in the Kenai River drainage. However, if one assumes that no immigration of juvenile sockeye into Skilak Lake took place between September 1993 and April 29, 1994 then the overwinter survival of age-0 juvenile sockeye was 49%. Because only Area 1 was surveyed at night in April the estimate is a minimum. If we assume that the distribution of fish between Areas on April 29th was the same as the day survey on April 25th an adjusted population estimate would increase overwinter survival to 61%.

Age analysis of the tow net data indicated that age specific depth differences in juvenile salmon abundance can significantly influenced the estimates of the number of age-1 or age-2 sockeye salmon (Carlson, ADF&G, Soldotna, personal communication). For example, in September and November 1993 the estimate of age-1 sockeye salmon in Skilak Lake was estimated at 1,726,000 and 527,000 fish respectively. In contrast, the age-2 estimate in April, 1994 was 2,456,600 fish or almost 4.7 times the November estimate. In September 1993 we collected data on age structure of the fish populations at various depths in Skilak Lake to evaluate this potential bias. Previous Skilak Lake investigations were limited to surface tows. In November 1993 we had not completed the analysis of the September data and were limited by time, weather, and gear to surface tows. By April 1994 we had completed the analysis of catch data and designed a program to collect age composition data at all depths as our hypothesis of depth age composition differences was not rejected (Carlson, ADF&G, Soldotna, personal communication). Therefore, the estimates for September 1993 and 1994 and April 1994 are probably more reflective of the true age composition of the juvenile salmon population than the November estimate.

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Table 1. Estimated number of fish in Skilak Lake, Alaska, on 5 May 1993.

			Estimated Number of Fish					
Lake	Area	Transect	Surface	Midwater	Bottom	Total	Area Mean	Variance
Skilak	1	1	1.9570E+03	2.4694E+05	3.1609E+04	2.8051E+05		
		2	8.4735E+03	2.8523E+05	1.5436E+04	3.0914E+05		
		3	1.9454E+04	2.3779E+05	2.4274E+04	2.8152E+05	2.7675E+05	7.0858E+08
		4	3.0749E+03	3.0480E+05	2.6689E+04	3.3456E+05		
		5	1.2974E+03	1.2890E+05	4.7845E+04	1.7804E+05		
	2	1	0.0000E+00	1.7673E+05	1.3561E+04	1.9029E+05		
		2	6.5056E+03	3.6209E+05	2.2847E+04	3.9144E+05	3.5233E+05	7.1496E+09
		3	0.0000E+00	4.5222E+05	2.3037E+04	4.7526E+05		
	3	1	6.3281E+03	4.2285E+05	4.3468E+04	4.7265E+05		
		2	0.0000E+00	2.0449E+05	3.0577E+04	2.3507E+05	2.3015E+05	7.5193E+09
		3	0.0000E+00	1.1389E+05	1.2535E+04	1.2643E+05		
		4	0.0000E+00	8.0906E+04	5.5644E+03	8.6470E+04		
	TOTAL						8.5924E+05	1.5377E+10

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Table 2. Areas, volume and fish estimates (%) in Skilak Lake, Alaska, day survey, 5 May 1993.

Area	Skilak Lake		
	Surface Area ($m^2 \times 10^6$)	Volume ($m^3 \times 10^6$)	Number of Fish (%)
1	43.03 (43.5%)	1734.0 (27.8%)	26.8
2	33.46 (33.8%)	2782.0 (44.6%)	41.0
3	22.50 (22.7%)	1725.0 (27.6%)	32.2
Total	98.99 (100.0%)	6241.0 (100.0%)	100.0

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Table 3. Estimated number of fish available to the hydroacoustic techniques in Skilak Lake, Alaska, 8 May 1993.

Date	Area	Transect	Beginning Time	Estimated Number of Fish
May 8, 1993	1	1	1842	476,020
		2	1908	972,920
		3	1935	684,610
		4	2004	581,980
		5	2033	1,220,300
		6	2119	1,075,500
		7	2143	1,145,600
		8	2207	4,646,700
		9	2232	2,548,200
		10	2311	2,679,400
		11	2334	1,579,800
May 9, 1993	1	12	0005	1,195,100
		13	0035	1,108,200
		14	0105	1,396,300
		15	0136	1,529,300
		16	0203	2,220,200

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Table 4. Estimated number of fish in Skilak and Kenai Lakes, Alaska in September and October 1993.

			Estimated Number of Fish					
Lake	Area	Transect	Surface	Midwater	Bottom	Area Total	Mean	Variance
Skilak	1	1	1.9286E+06	1.5736E+07	3.6244E+06	2.1289E+07		
		2	2.7109E+06	2.4576E+07	2.6964E+06	2.9983E+07		
		3	7.6266E+05	1.5910E+07	1.2624E+06	1.7935E+07	1.8637E+07	8.9830E+12
		4	1.7298E+06	1.7345E+07	1.8244E+06	2.0899E+07		
		5	2.6993E+06	4.8310E+06	1.4507E+06	8.9810E+06		
		6	2.1816E+06	6.4490E+06	4.1013E+06	1.2732E+07		
	2	1	6.4042E+04	5.9890E+06	6.2774E+03	6.0593E+06		
		2	1.6543E+05	7.2300E+06	1.4472E+05	7.5402E+06	7.4378E+06	3.9326E+11
		3	7.3227E+04	8.1650E+06	4.7577E+05	8.7140E+06		
	3	1	4.3268E+05	1.3678E+07	9.3483E+05	1.5046E+07		
		2	4.5779E+05	7.7010E+06	2.9387E+05	8.4527E+06	7.6783E+06	7.3499E+12
		3	1.4101E+05	3.0790E+06	8.6931E+04	3.3069E+06		
		4	8.6670E+04	3.7730E+06	4.8478E+04	3.9081E+06		
	TOTAL						3.3753E+07	1.6726E+13
Kenai	1	1	1.3593E+02	2.2680E+05	7.4360E+03	2.3437E+05		
		2	3.4694E+02	4.5853E+05	5.8538E+04	5.1741E+05		
		3	3.5805E+03	2.9075E+05	7.3466E+04	3.6780E+05	3.7444E+05	2.6827E+09
		4	0.0000E+00	2.4403E+05	2.5795E+04	2.6983E+05		
		5	0.0000E+00	2.9858E+05	2.1498E+04	3.2008E+05		
		6	6.2995E+02	4.6830E+05	6.8223E+04	5.3715E+05		
	2	1	7.3318E+02	1.9670E+06	0.0000E+00	1.9677E+06		
		2	0.0000E+00	9.6065E+05	0.0000E+00	9.6065E+05		
		3	9.1290E+03	7.0240E+05	0.0000E+00	7.1153E+05	1.1073E+06	8.4964E+10
		4	3.8910E+02	7.8897E+05	0.0000E+00	7.8936E+05		
	3	1	5.5683E+03	4.9268E+05	0.0000E+00	4.9825E+05		
		2	0.0000E+00	2.8979E+05	0.0000E+00	2.8979E+05		
		3	0.0000E+00	4.9482E+05	0.0000E+00	4.9482E+05	3.8204E+05	2.6829E+09
		4	0.0000E+00	2.4448E+05	0.0000E+00	2.4448E+05		
		5	3.8798E+03	3.7900E+05	0.0000E+00	3.8288E+05		
	4	1	1.1691E+05	9.7567E+05	0.0000E+00	1.0926E+06		
		2	5.8630E+04	1.9775E+06	0.0000E+00	2.0361E+06		
		3	3.9950E+04	1.5705E+06	0.0000E+00	1.6105E+06	1.3704E+06	4.9284E+10
		4	1.8882E+04	1.3618E+06	0.0000E+00	1.3807E+06		
		5	1.4425E+04	7.1756E+05	0.0000E+00	7.3199E+05		
	5	1	5.1579E+04	3.2285E+05	0.0000E+00	3.7443E+05		
		2	1.1440E+05	5.3571E+05	0.0000E+00	6.5011E+05	1.1212E+06	4.1647E+10
		3	2.5111E+05	1.4519E+06	0.0000E+00	1.7030E+06		
		4	1.0149E+05	1.0844E+06	0.0000E+00	1.1859E+06		
		5	7.1941E+04	7.1263E+05	0.0000E+00	7.8457E+05		
		6	5.7546E+04	1.2922E+06	0.0000E+00	1.3497E+06		
		7	1.3421E+05	1.6662E+06	0.0000E+00	1.8004E+06		
	TOTAL						4.3553E+06	1.8126E+11
	TOTAL FOR BOTH LAKES						3.8108E+07	1.6907E+13

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Table 5. Areas, volume and fish estimates (%) in Kenai and Skilak Lakes, Alaska, night survey, September/October 1993.

	Skilak Lake		
Area	Surface Area ($m^2 \times 10^6$)	Volume ($m^3 \times 10^6$)	Number of Fish (%)
1	43.03 (43.5%)	1808.0 (28.9%)	55.2
2	33.46 (33.8%)	2674.0 (42.8%)	22.0
3	22.50 (22.7%)	1768.0 (28.3%)	22.8
Total	98.99 (100.0%)	6250.0 (100.0%)	100.0

	Kenai Lake		
Area	Surface Area ($m^2 \times 10^6$)	Volume ($m^3 \times 10^6$)	Number of Fish (%)
1	7.72 (13.9%)	331.1 (8.0%)	8.6
2	11.91 (21.5%)	968.0 (23.5%)	25.4
3	10.54 (19.0%)	944.7 (23.0%)	8.8
4	14.37 (25.9%)	1205.0 (29.3%)	31.5
5	10.93 (19.7%)	666.0 (16.2%)	25.7
Total	55.47 (100.0%)	4114.8 (100.0%)	100.0

File: 5tab94.w51

Table 6. Estimated contribution of age-0 and age-1 sockeye salmon to the total fish population in Kenai and Skilak Lakes, Alaska, night survey, September/October 1993.

Location	Total Fish	Estimated Sockeye Salmon	Percent Age-0[a]	Total Age-0	Percent Age-1[a]	Total Age-1
Skilak Lake	33,753,100	33,073,500	94.8	31,346,700	5.2	1,726,800
Kenai Lake	4,355,300	4,346,500	99.87	4,340,700	0.13	5,900
Total[b]	38,108,400	37,420,000		35,687,400		1,732,700
Variance	1.6907E+13	1.6369E+13		1.4952E+13		2.7397E+11

[a] Age composition sample size for Skilak Lake = 2,879, for Kenai Lake = 2,979.
[b] Rounded to nearest 100 fish. File: 6tab94.w51

Table 7. Kenai Peninsula lakes' fall fry sockeye mean fork length and weight data.

Location		Age-0						Age-1					
		Length			Weight			Length			Weight		
	Year	(n)	(mm)	S.D.	(n)	(g)	S.D.	(n)	(mm)	S.D.	(n)	(g)	S.D.
Skilak													
	1986	15	57	n/a				8	74				
	1988	109	50	5.3	109	0.9	0.4						
	1989	136	50	3.3	136	1.2	0.3	126	64	6.0	126	2.8	0.7
	1990	928	49	4.3	290	1.3	0.3	34	72.8	3.3	20	4.0	0.4
	1991	863	51	4.9	286	1.5	0.5	55	73.8	3.8	14	4.7	0.5
	1992	883	54	6.0	883	1.8	0.6	10		3.6	10	7.0	0.8
	1993	3652	49	5.0	3652	1.2	0.4	55	75	5.0	55	4.5	0.9
	1994	687	50	3.9	687	1.4	0.4	110	68.3	3.7	110	3.6	0.6
Kenai													
	1986	227	52	n/a	227			2	77				
	1989	38	48	4.5	38	1.0	0.2	56	64	4.6	56	2.5	0.6
	1990	1484	52	4.6	1484	1.5	0.4	62	69.4	4.2	22	3.6	0.6
	1991	1364	53.5	6.5	1364	2.0	0.6	40	75.9	4.8	15	5.5	1.0
	1992	1492	56	7.3	1492	2.0	0.8	12	78	10.0	12	5.6	1.7
	1993	2969	45	4.0	2969	1.0	0.2	4	68	1.0	4	3.3	0.5
	1994	861	53.7	4.6	861	1.9	0.5	39	76.8	3.7	39	5.2	0.7
Tustumena													
	1980	222	59	6.1	222	2.3	0.7	20	80	3.5	20	5.7	0.7
	1981	197	55	5.1	197	1.6	0.4	21	73	4.6	21	3.8	0.7
	1982	194	54	5.1	194	1.8	0.5	17	74	3.9	17	4.0	0.9
	1983	562	60	6.1	562	2.5	0.7	55	80	5.0	55	5.8	1.1
	1984	388	61	4.6	388	2.5	0.6	186	79	3.7	186	5.3	0.8
	1985	173	56	5.6	173	2.1	0.6	52	78	5.0	52	5.6	1.2
	1986	156	50	6.4	156	1.3	0.5	92	73	4.5	92	4.1	0.7
	1987	143	53	5.9	143	1.8	0.6	50	71	3.8	50	4.2	0.6
	1988	303	55	5.3	303	1.8	0.5	89	75	3.6	89	4.5	0.6
	1989	47	52	5.7	47	1.9	0.6	18	74	4.6	18	5.1	0.9
	1990	200	57	5.5	200	1.5	0.4	50	75	2.9	50	3.4	0.5
	1991	202	57	5.4	202	2.0	0.5	47	78	6.5	47	5.1	1.2
	1992	323	59	4.4	323	2.0	0.4	21	79	4.1	21	4.52	0.7
	1993	417	63	6.7	417	2.9	0.8	46	81	3.0	46	6.18	0.7
	1994	318	64	5.0	318	2.6	0.6	76	82.7	3.0	76	5.5	0.5

Missing values indicate no data available. n = sample size; S. D. = 1 standard deviation. File: 7tab94.w51

Table 8. Estimated number of fish in Skilak Lake, Alaska, on 16 November 1993.

			Estimated Number of Fish					
Lake	Area	Transect	Surface	Midwater	Bottom	Area Total	Mean	Variance
Skilak	1	1	1.2320E+06	9.5400E+06	2.1745E+06	1.2947E+07		
		2	2.0409E+06	1.3407E+07	1.5619E+06	1.7010E+07		
		3	2.1635E+05	6.4590E+06	4.3184E+05	7.1072E+06	1.0211E+07	3.4067E+12
		4	4.0444E+05	1.0831E+07	8.9100E+05	1.2126E+07		
		5	3.8792E+05	4.6720E+06	5.4768E+05	5.6076E+06		
		1A	4.7983E+05	5.6140E+06	3.7533E+05	6.4692E+06		
	2	1	7.9611E+03	4.2100E+06	9.7858E+04	4.3158E+06		
		2	1.5077E+05	5.8360E+06	2.7847E+05	6.2652E+06	4.7344E+06	6.2598E+11
		3	1.6191E+05	3.2800E+06	1.8019E+05	3.6221E+06		
	3	1	9.9630E+05	1.5270E+07	3.4416E+06	1.9708E+07		
		2	2.3450E+05	1.8578E+07	1.7191E+06	2.0532E+07	1.4145E+07	1.4707E+13
		3	1.1900E+05	3.7400E+06	2.2750E+05	4.0865E+06		
		4	9.3690E+05	1.0632E+07	6.8514E+05	1.2254E+07		
	TOTAL						2.9091E+07	1.8740E+13

File: 8tab94.w51

Table 9. Areas, volume and fish estimates (%) in Skilak Lake, Alaska, night survey, November 1993.

Area	Skilak Lake		
	Surface Area (m^2 x 10^6)	Volume (m^3 x 10^6)	Number of Fish (%)
1	43.03 (43.5%)	2217.0 (34.8%)	35.1
2	33.46 (33.8%)	2678.0 (42.1%)	16.3
3	22.50 (22.7%)	1470.0 (23.1%)	48.6
Total	98.99 (100.0%)	6365.0 (100.0%)	100.0

File: 9tab94.w51

Table 10. Estimated contribution of age-0 and age-1 sockeye salmon to the total fish population in Skilak Lake, Alaska, night survey, November 1993.

Location	Total Fish	Estimated Sockeye Salmon	Percent Age-0[a]	Total Age-0	Percent Age-1[a]	Total Age-1
Skilak Lake	29,091,000	28,135,400	98.1	27,608,400	1.9	527,000
Variance	1.8740E+13	1.7582E+13		1.6967E+13		4.360E+10

[a] Age composition sample size for Skilak Lake = 1,808; species composition sample size = 3,035

[b] Rounded to nearest 100 fish, file 10tab94.w51

Table 11. Estimated number of fish in Skilak Lake, Alaska, day survey, 25 April 1994.

			Estimated Number of Fish					
Lake	Area	Transect	Surface	Midwater	Bottom	Total	Area Mean	Variance
Skilak	1	1	5.2436E+05	2.5149E+06	0.0000E+00	3.0393E+06	5.9415E+06	5.5646E+11
		2	7.7196E+05	7.0149E+06	0.0000E+00	7.7869E+06		
		3	1.9092E+05	5.6623E+06	0.0000E+00	5.8532E+06		
		4	3.1046E+05	4.5780E+06	0.0000E+00	4.8885E+06		
		5	1.4419E+06	6.4150E+06	0.0000E+00	7.8569E+06		
		1A	8.2863E+04	6.1415E+06	0.0000E+00	6.2244E+06		
	2	1	2.5768E+04	4.6104E+05	0.0000E+00	4.8681E+05	6.5871E+05	3.5987E+10
		2	1.6814E+04	4.3493E+05	0.0000E+00	4.5174E+05		
		3	4.9106E+04	9.8847E+05	0.0000E+00	1.0376E+06		
	3	1	3.7253E+04	6.0719E+05	0.0000E+00	6.4444E+05	7.3955E+05	7.9936E+09
		2	1.9359E+04	7.8655E+05	0.0000E+00	8.0591E+05		
		3	4.4665E+04	9.1181E+05	0.0000E+00	9.5648E+05		
		4	9.4703E+04	4.5665E+05	0.0000E+00	5.5135E+05		
	TOTAL						7.3398E+06	6.0044E+11

No bottom estimate was made; file: 11tab94.w51

Table 12. Areas, volume and fish estimates (%) in Skilak Lake, Alaska, day survey, 25 April 1994.

Area	Skilak Lake		
	Surface Area ($m^2 \times 10^6$)	Volume ($m^3 \times 10^6$)	Number of Fish (%)
1	43.03 (43.5%)	2631.0 (38.1%)	80.9
2	33.46 (33.8%)	2712.0 (39.3%)	9.0
3	22.50 (22.7%)	1564.0 (22.6%)	10.1
Total	98.99 (100.0%)	6365.0 (100.0%)	100.0

File: 12tab94.w51

Table 13. Estimated number of fish in Skilak Lake, Area 1, Alaska, on 29 April 1994.

			Estimated Number of Fish					
Lake	Area	Transect	Surface	Midwater	Bottom[a]	Total	Area Mean	Variance
Skilak	1	1a	1.1228E+06	9.6880E+06	0.0000E+00	1.0811E+07	1.8178E+07	7.0595E+12
		2	2.4566E+06	1.0733E+07	0.0000E+00	1.3190E+07		
		3	2.7741E+06	1.7090E+07	0.0000E+00	1.9864E+07		
		4	2.6967E+06	1.9756E+07	0.0000E+00	2.2453E+07		
		5	2.4475E+06	2.2127E+07	0.0000E+00	2.4575E+07		

[a] No estimate was made for fish near the bottom; file: 13tab94.w51

Table 14. Estimated contribution of age-1 and age-2 sockeye salmon to the total fish population in Skilak Lake, Area 1, Alaska, night survey, 29 April, 1994.

Location	Total Fish	Estimated Sockeye Salmon	Percent Age-1[a]	Total Age-1	Percent Age-2[a]	Total Age-2
Skilak Lake	18,178,000	17,832,400	86.2	15,375,800	13.8	2,456,600
Variance	7.0596E+12	6.7966E+12		5.1752E+12		2.5123E+11

[a] Age composition sample size for Skilak Lake = 306; species composition sample size = 1,736

[b] Rounded to nearest 100 fish, file 14tab94.w51

Table 15. Estimated number of fish in Skilak and Kenai Lakes, Alaska, September 1994.

			Estimated Number of Fish					
Lake	Area	Transect	Surface	Midwater	Bottom	Total	Area Mean	Variance
Skilak	1	1	3.1885E+05	5.4550E+06	4.7069E+05	6.2445E+06	4.1387E+06	2.9813E+11
		2	9.8354E+04	2.8210E+06	1.3733E+05	3.0567E+06		
		3	7.2536E+04	3.3389E+06	1.8145E+05	3.5929E+06		
		4	1.8602E+05	2.6739E+06	1.7032E+05	3.0302E+06		
		5	3.0194E+05	2.9170E+06	3.3674E+05	3.5557E+06		
		6	6.5604E+05	4.2440E+06	4.5197E+05	5.3520E+06		
	2	1	5.5430E+04	1.2753E+06	1.8853E+04	1.3496E+06	3.8348E+06	3.5614E+12
		2	1.2517E+05	2.1545E+06	1.0430E+04	2.2901E+06		
		3	4.4237E+04	2.1655E+06	3.0680E+04	2.2404E+06		
		4	1.1694E+05	8.8981E+06	4.4405E+05	9.4591E+06		
	3	1	3.1334E+05	7.1764E+05	8.2635E+04	1.1136E+06	1.5939E+06	2.1068E+11
		2	5.0659E+05	2.4572E+06	5.5101E+03	2.9693E+06		
		3	1.1414E+05	1.0592E+06	2.3922E+04	1.1973E+06		
		4	4.1776E+04	1.0023E+06	5.1406E+04	1.0955E+06		
	TOTAL						9.5674E+06	4.0702E+12
Kenai	1	1	4.5440E+02	6.8480E+05	5.1831E+04	7.3709E+05	9.6855E+05	6.8088E+10
		2	0.0000E+00	5.7118E+05	8.7262E+04	6.5844E+05		
		3	1.9554E+03	5.7934E+05	6.1039E+04	6.4233E+05		
		4	3.1173E+05	1.6255E+06	2.9041E+05	2.2276E+06		
		5	0.0000E+00	4.6916E+05	5.4113E+04	5.2327E+05		
		6	1.8602E+03	9.3909E+05	8.1590E+04	1.0225E+06		
	2	1	3.5873E+03	2.2141E+05	0.0000E+00	2.2500E+05	7.7715E+05	6.2868E+10
		2	7.9642E+03	5.5516E+05	0.0000E+00	5.6312E+05		
		3	0.0000E+00	1.3950E+06	0.0000E+00	1.3950E+06		
		4	0.0000E+00	9.2546E+05	0.0000E+00	9.2546E+05		
	3	1	2.0151E+04	5.1343E+05	0.0000E+00	5.3358E+05	5.5970E+05	7.4753E+09
		2	4.3667E+02	6.3860E+05	0.0000E+00	6.3904E+05		
		3	1.5718E+04	7.8709E+05	0.0000E+00	8.0281E+05		
		4	0.0000E+00	5.5212E+05	0.0000E+00	5.5212E+05		
		5	1.4090E+04	2.5687E+05	0.0000E+00	2.7096E+05		
	4	1	6.4158E+02	6.3374E+05	0.0000E+00	6.3438E+05	6.4088E+05	1.4365E+09
		2	9.2598E+01	5.2835E+05	0.0000E+00	5.2844E+05		
		3	4.7005E+04	6.7096E+05	0.0000E+00	7.1797E+05		
		4	0.0000E+00	5.9387E+05	0.0000E+00	5.9387E+05		
		5	6.6306E+03	7.2310E+05	0.0000E+00	7.2973E+05		
	TOTAL						2.9463E+06	1.3987E+11
	TOTAL FOR BOTH LAKES						1.2514E+07	4.2101E+12

File 15tab94.w51

Table 16. Areas, volume and fish estimates (%) in Kenai and Skilak Lakes, Alaska, night survey, September/October 1994.

	Skilak Lake		
Area	Surface Area (m^2 x 10^6)	Volume (m^3 x 10^6)	Number of Fish (%)
1	43.03 (43.5%)	2120.0 (33.8%)	43.3
2	33.46 (33.8%)	2666.0 (42.5%)	40.1
3	22.50 (22.7%)	1491.0 (23.7%)	16.6
Total	98.99 (100.0%)	6277.0 (100.0%)	100.0

	Kenai Lake		
Area	Surface Area (m^2 x 10^6)	Volume (m^3 x 10^6)	Number of Fish (%)
1	7.72 (13.9%)	316.0 (7.3%)	32.9
2	11.91 (21.5%)	951.0 (22.1%)	26.4
3	10.54 (19.0%)	888.0 (20.6%)	19.0
4	25.30 (25.9%)	2150.0 (50.0%)	21.7
Total	55.47 (100.0%)	4305.0 (100.0%)	100.0

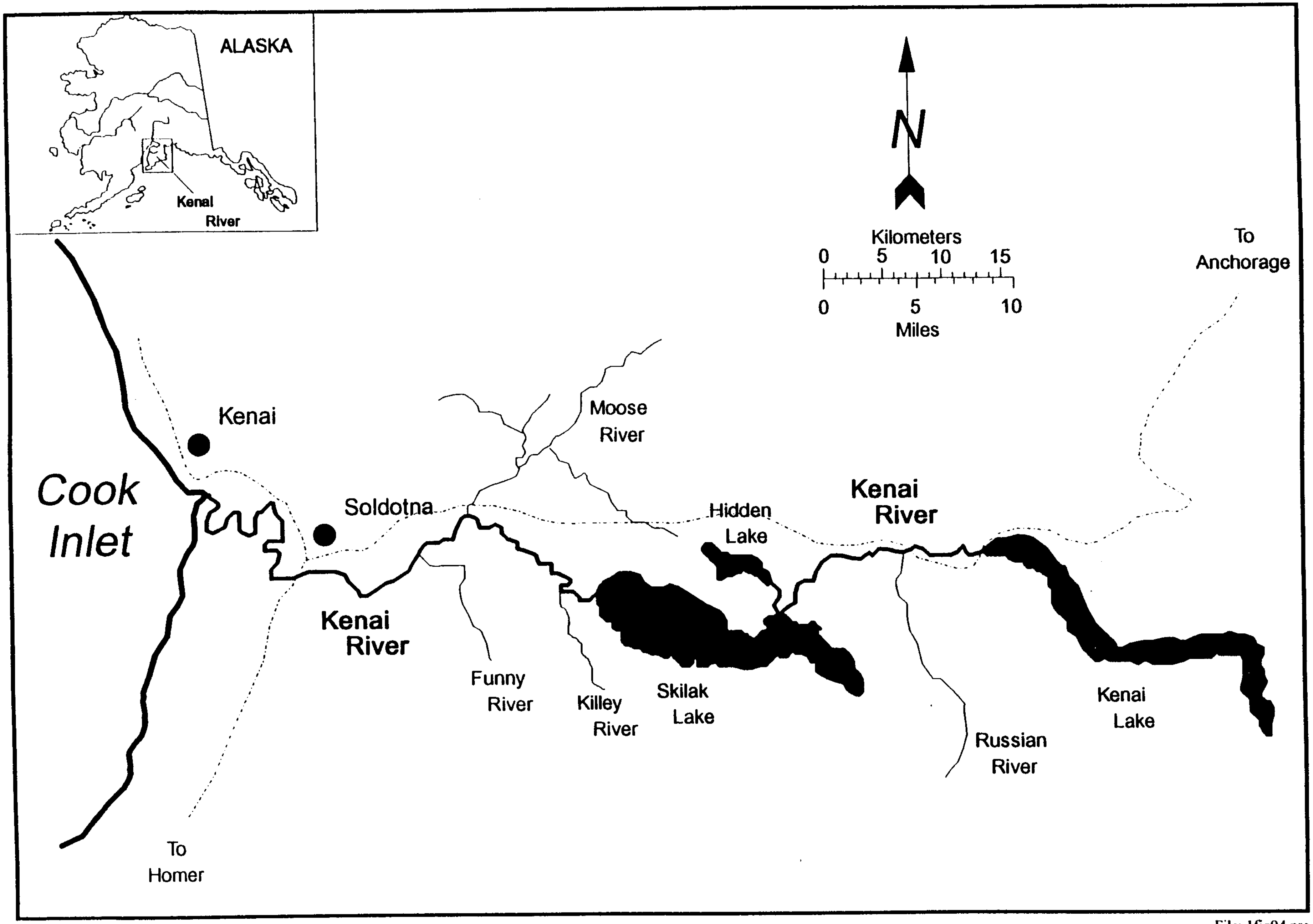
File: 16tab94.w51

Table 17. Estimated contribution of age-0 and age-1 sockeye salmon to the total fish population in Kenai and Skilak Lakes, Alaska, night survey, September/October 1994.

Location	Total Fish	Estimated Sockeye Salmon	Percent Age-0[a]	Total Age-0	Percent Age-1[a]	Total Age-1
Skilak Lake	9,567,400	9,510,300	87.8	8,353,900	12.2	1,156,500
Kenai Lake	2,946,300	2,931,600	95.7	2,805,600	4.3	126,000
Total[b]	12,513,700	12,441,900	89.7	11,159,500	10.3	1,282,500
Variance	4.2101E+12	4.1604E+12		3.2452E+12		7.4078E+10

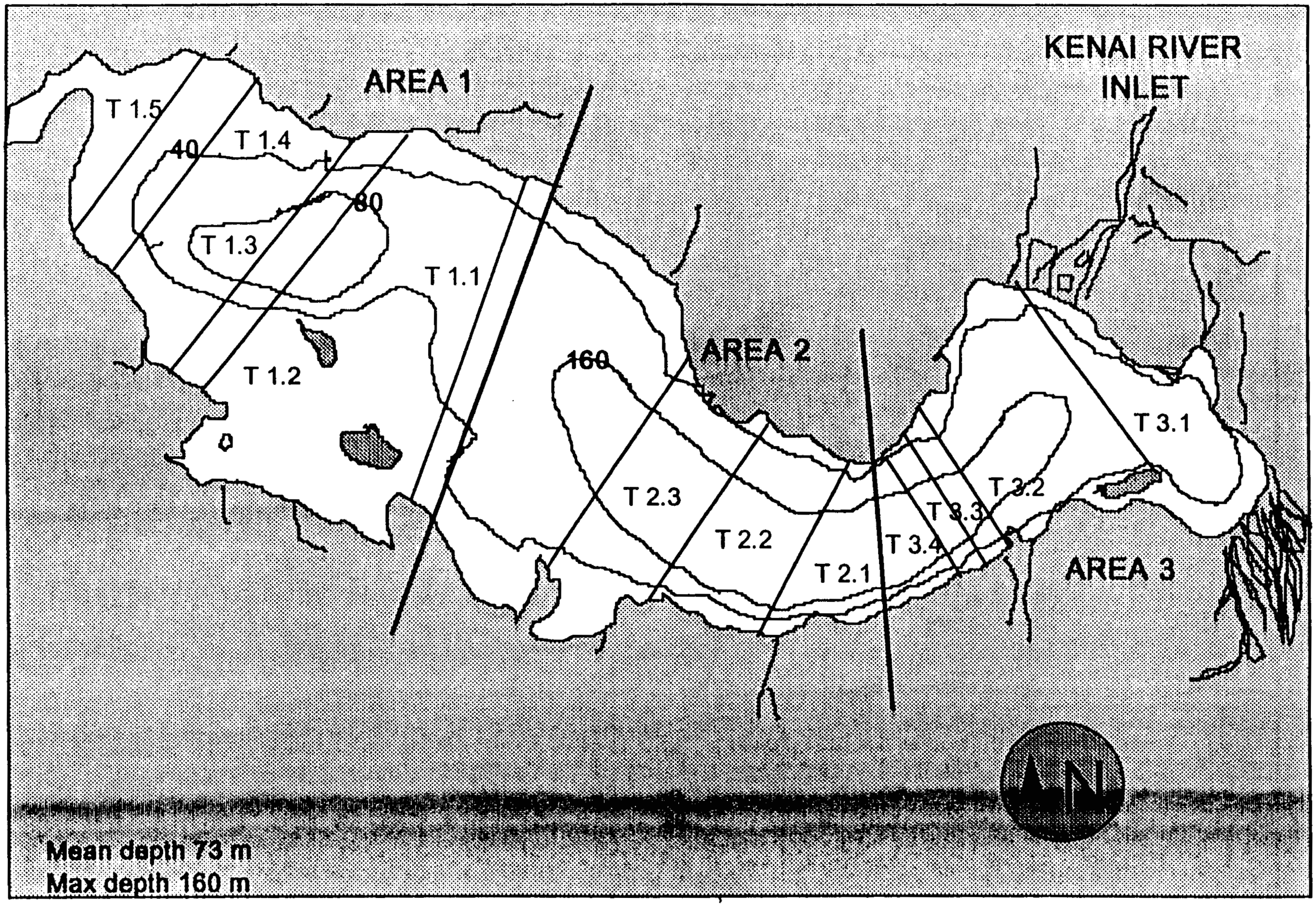
[a] Age composition sample size for Skilak Lake = 797;for Kenai Lake = 900. Species composition sample size for Skilak Lake = 2020

[b] Rounded to nearest 100 fish. File 17tab94.w51



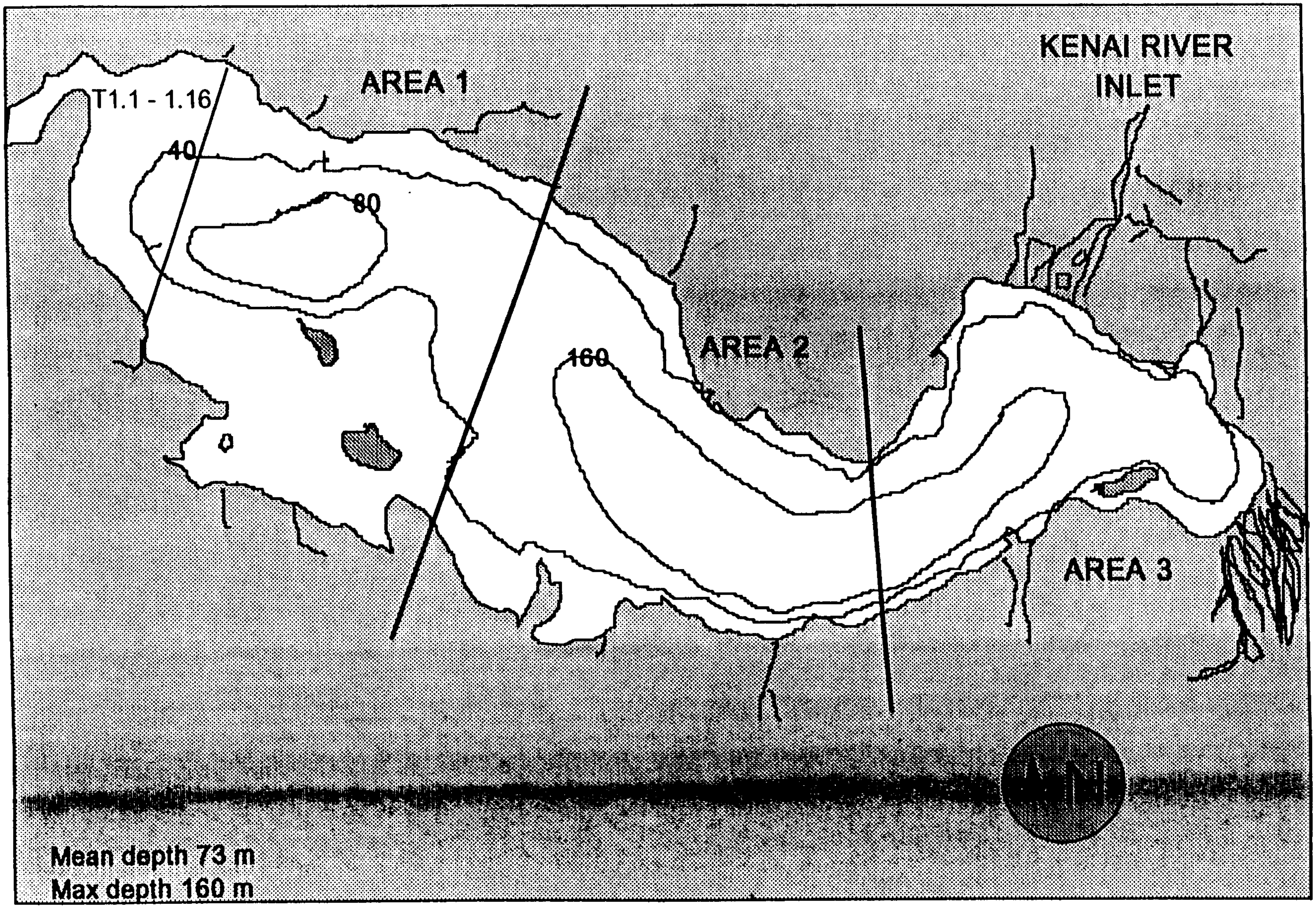
File: 1fig94.prc

Figure 1. Map of the Kenai River drainage



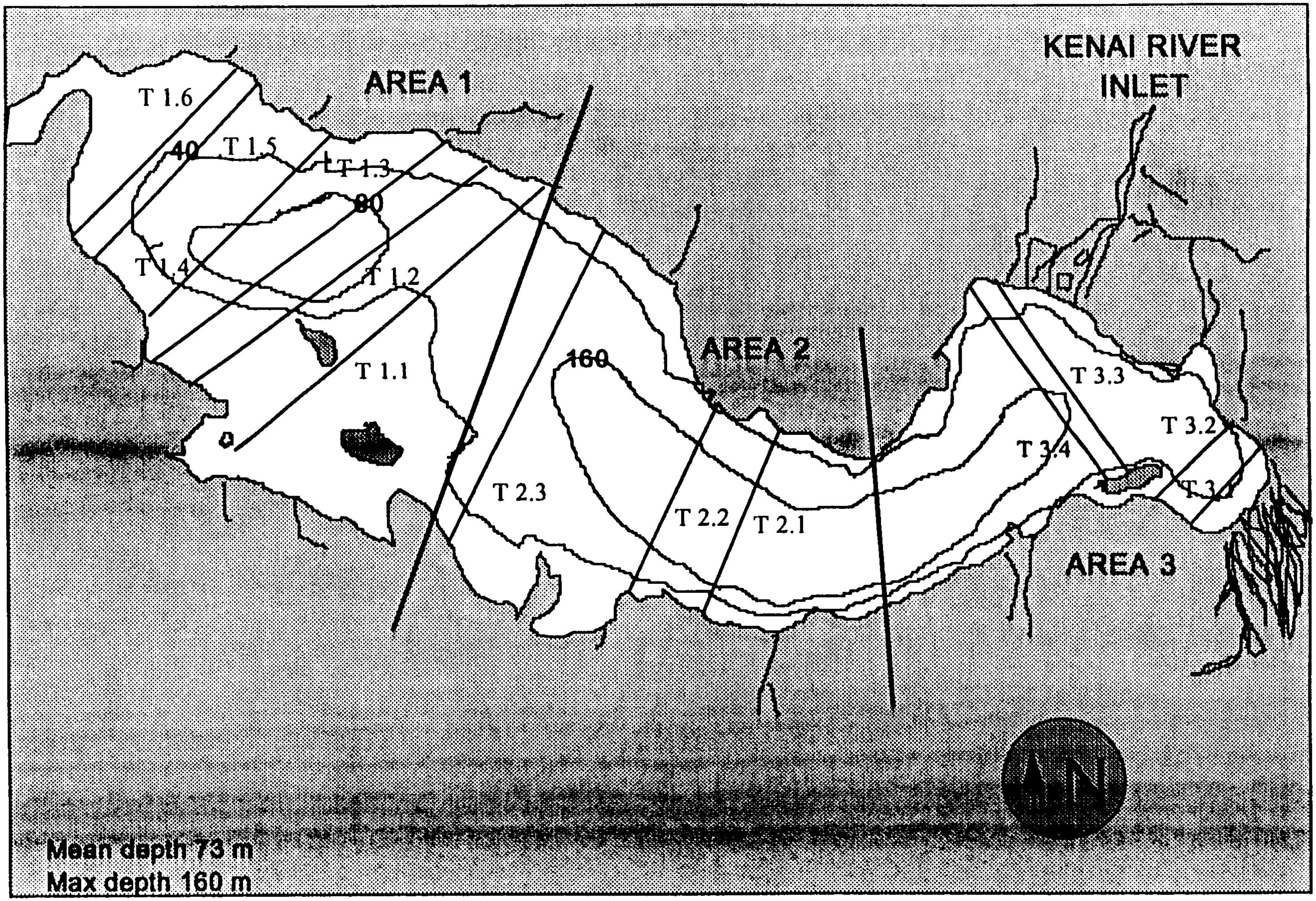
File: 2fig94.pre

Figure 2 . Hydroacoustic transects conducted in Skilak Lake, Alaska on 5 May 1993.



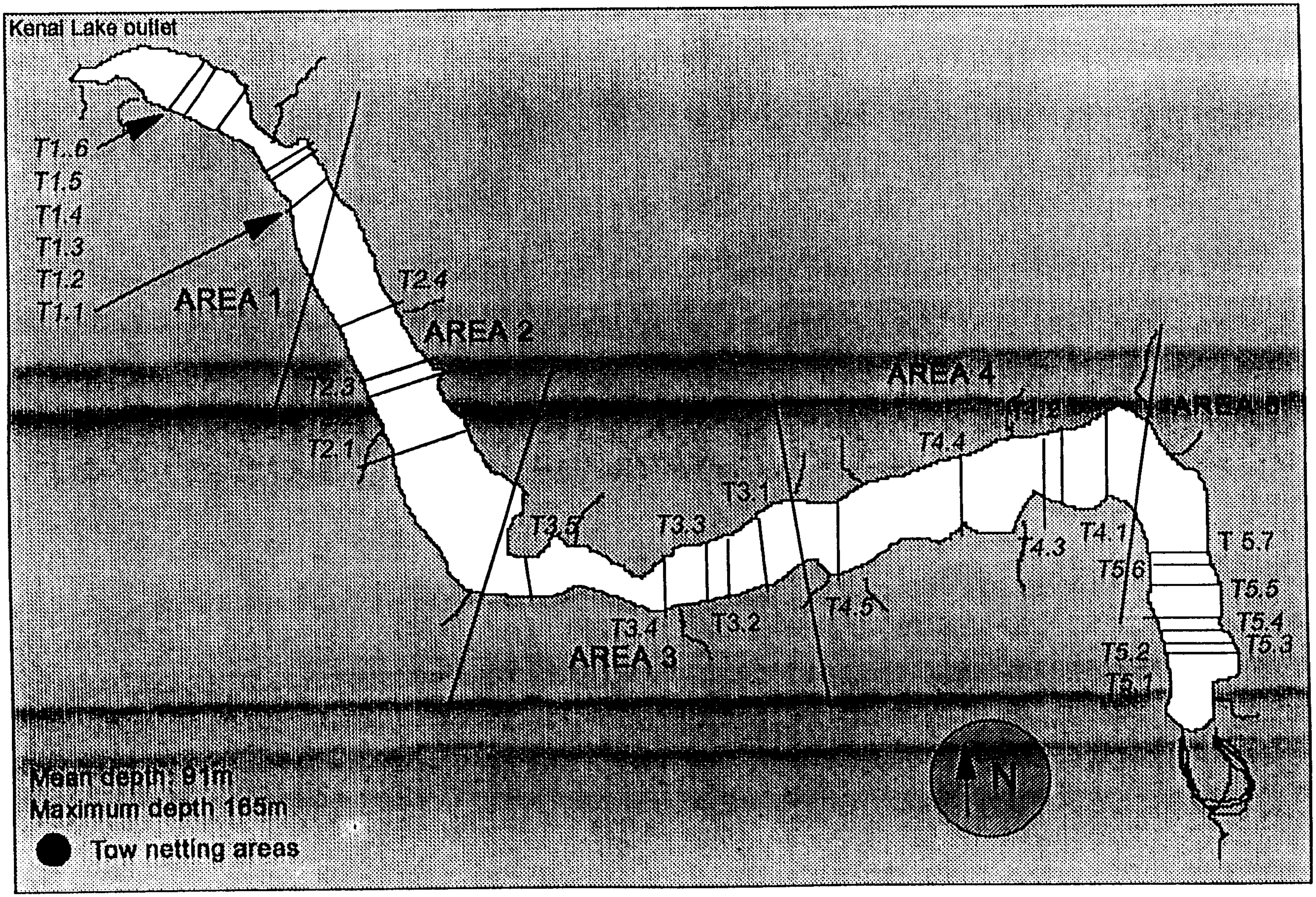
File: 3fig94.pre

Figure 3. Hydroacoustic transects conducted in Skilak Lake, Alaska on 8 May 1993.
(Note : a single transect was repeated 16 times)



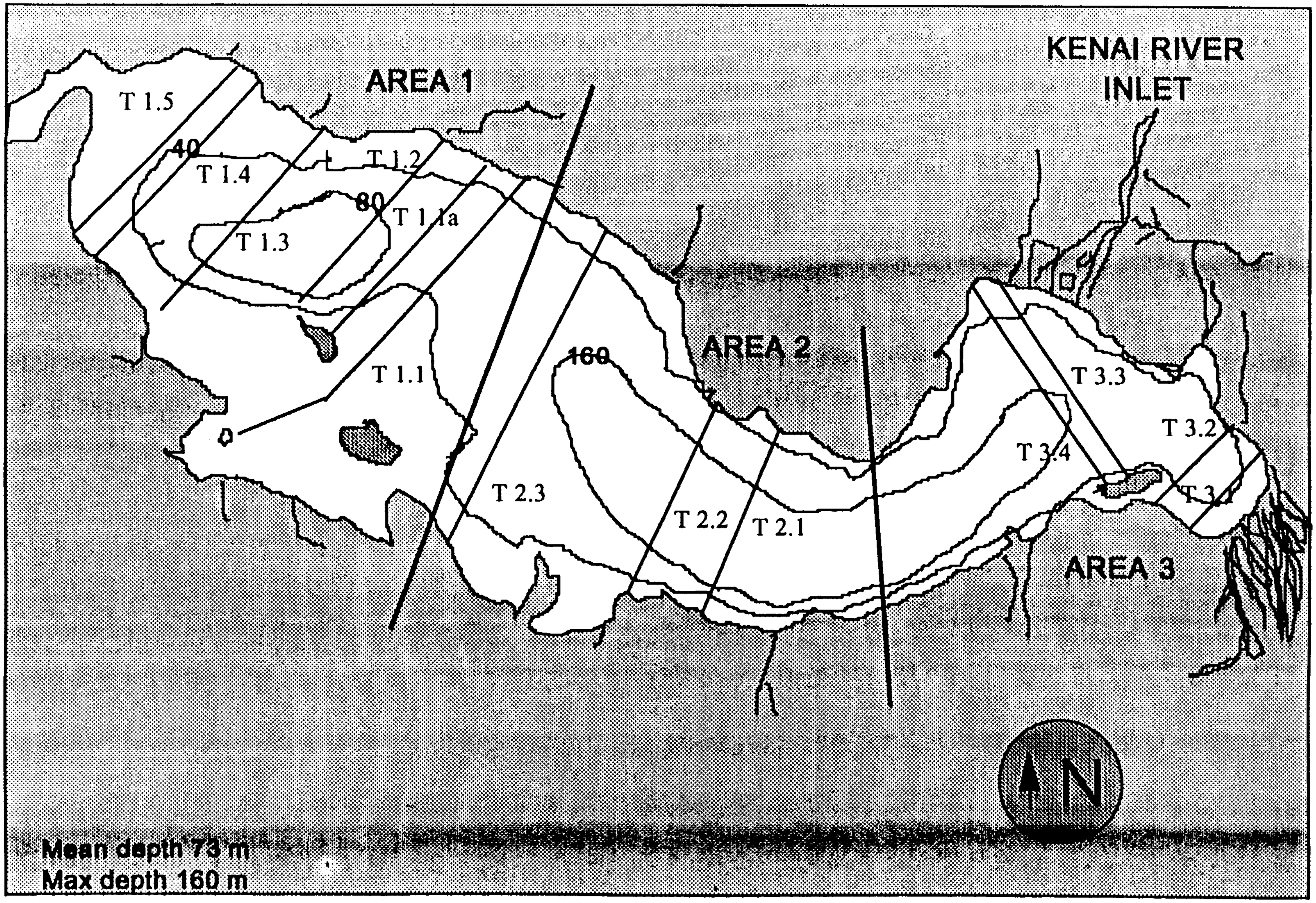
File: 4fig94.pre

Figure 4. Hydroacoustic transects conducted in Skilak Lake, Alaska on 26 September 1993.



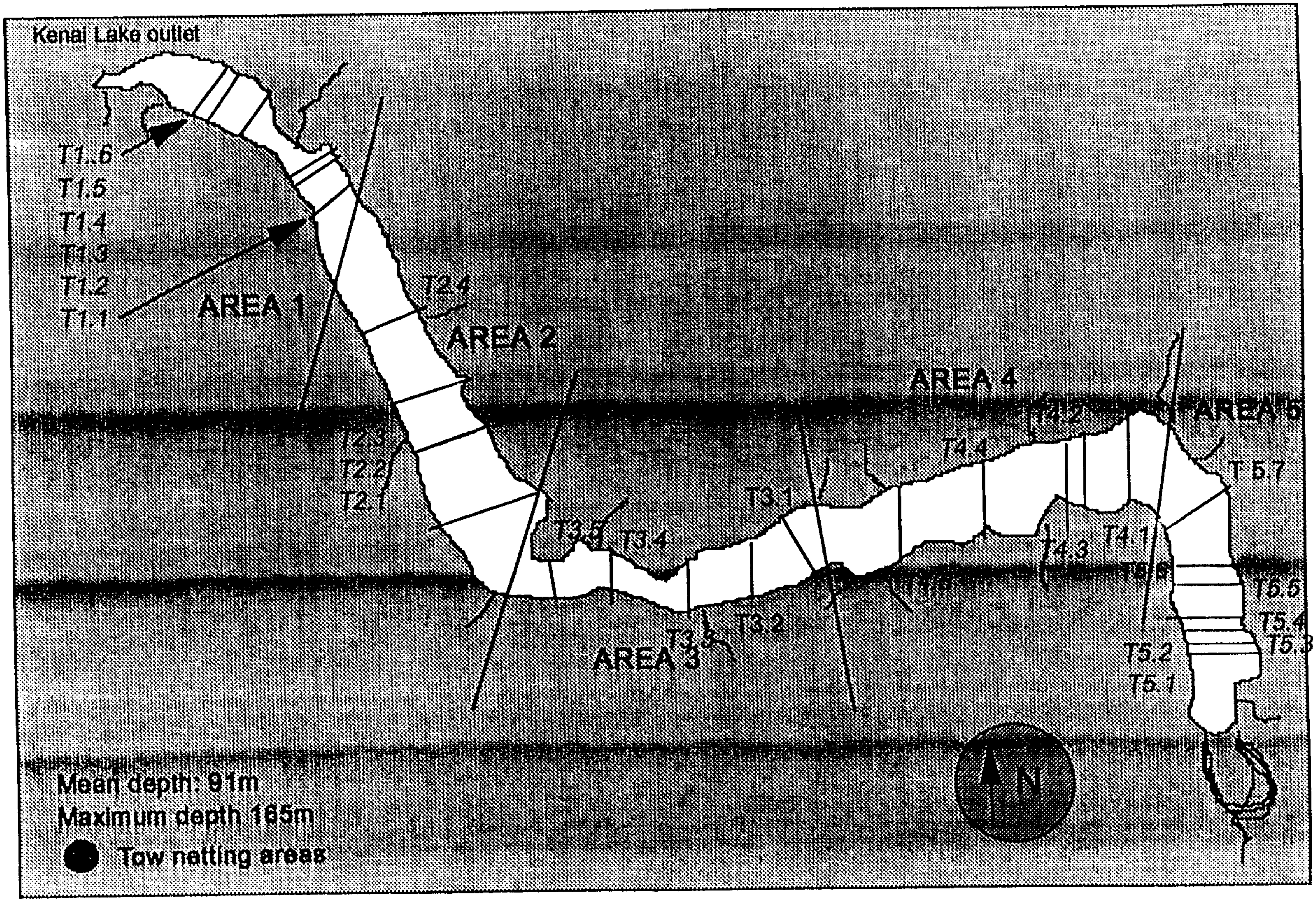
File: 5fig94.pre

Figure 5. Hydroacoustic transects conducted in Kenai Lake, Alaska on 4 October 1993.



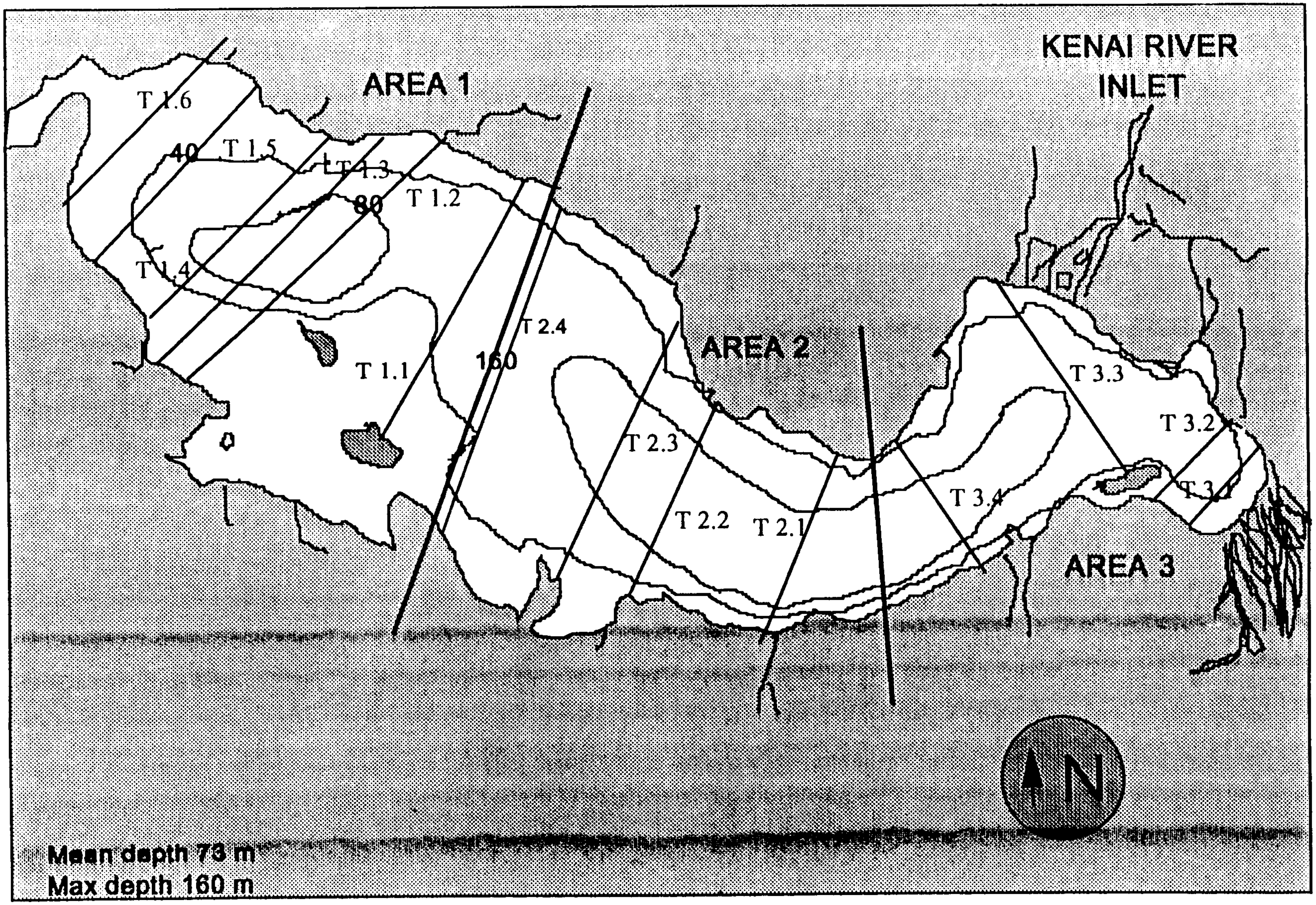
File: 6fig94.pre

Figure 6. Hydroacoustic transects conducted in Skilak Lake, Alaska on 16 & 18 November 1993.



File: 7fig94.pre

Figure 7. Hydroacoustic transects conducted in Kenai Lake, Alaska on 7 October 1994.



File: 8fig94.pre

Figure 8. Hydroacoustic transects conducted in Skilak Lake, Alaska on 27 September 1994.

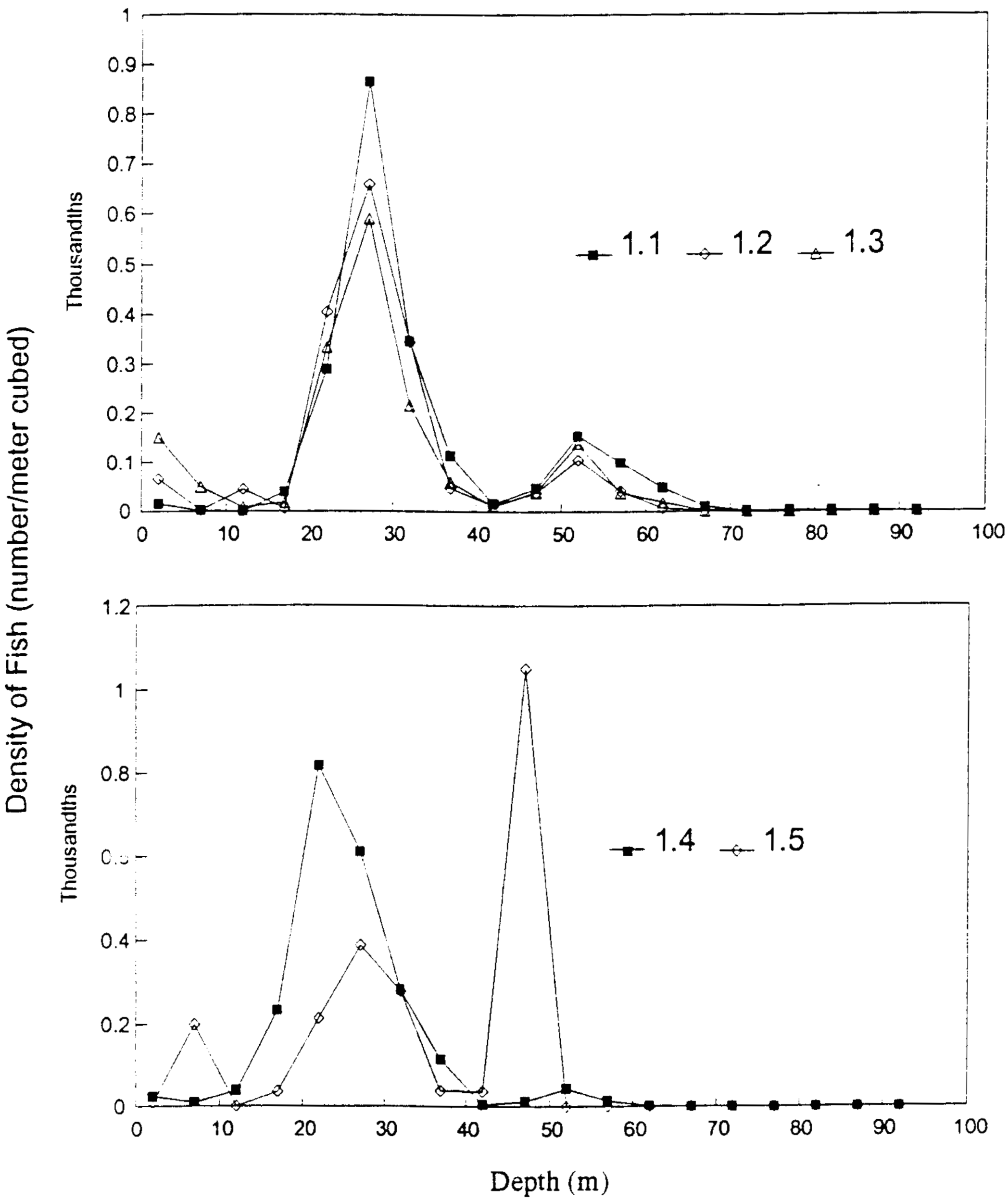


Figure 9. Density of fish in Skilak Lake, Area 1 during a day survey on 5 May 1993.

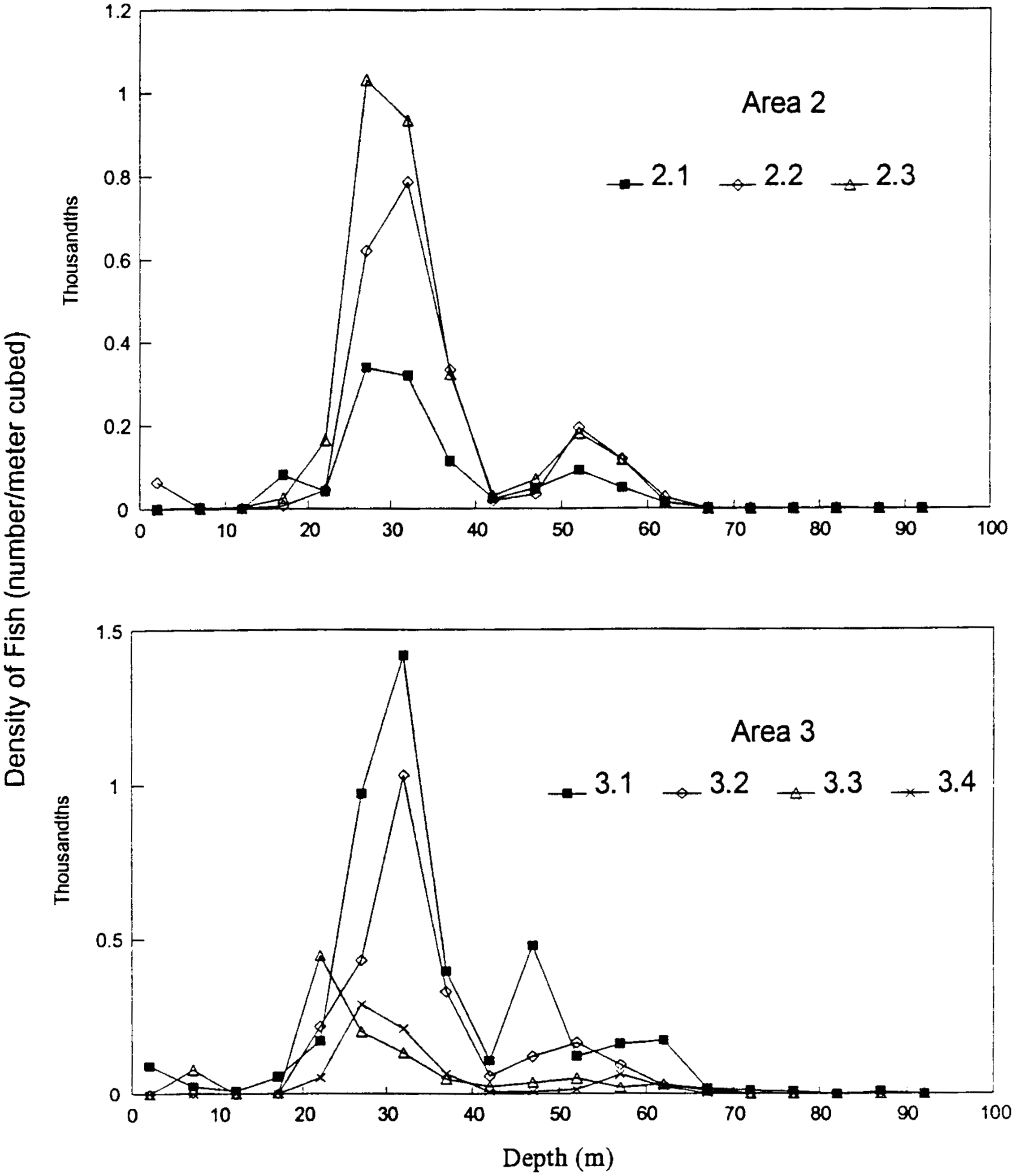


Figure 10. Density of fish in Skilak Lake, Areas 2 and 3, during a day survey on 5 May 1993.

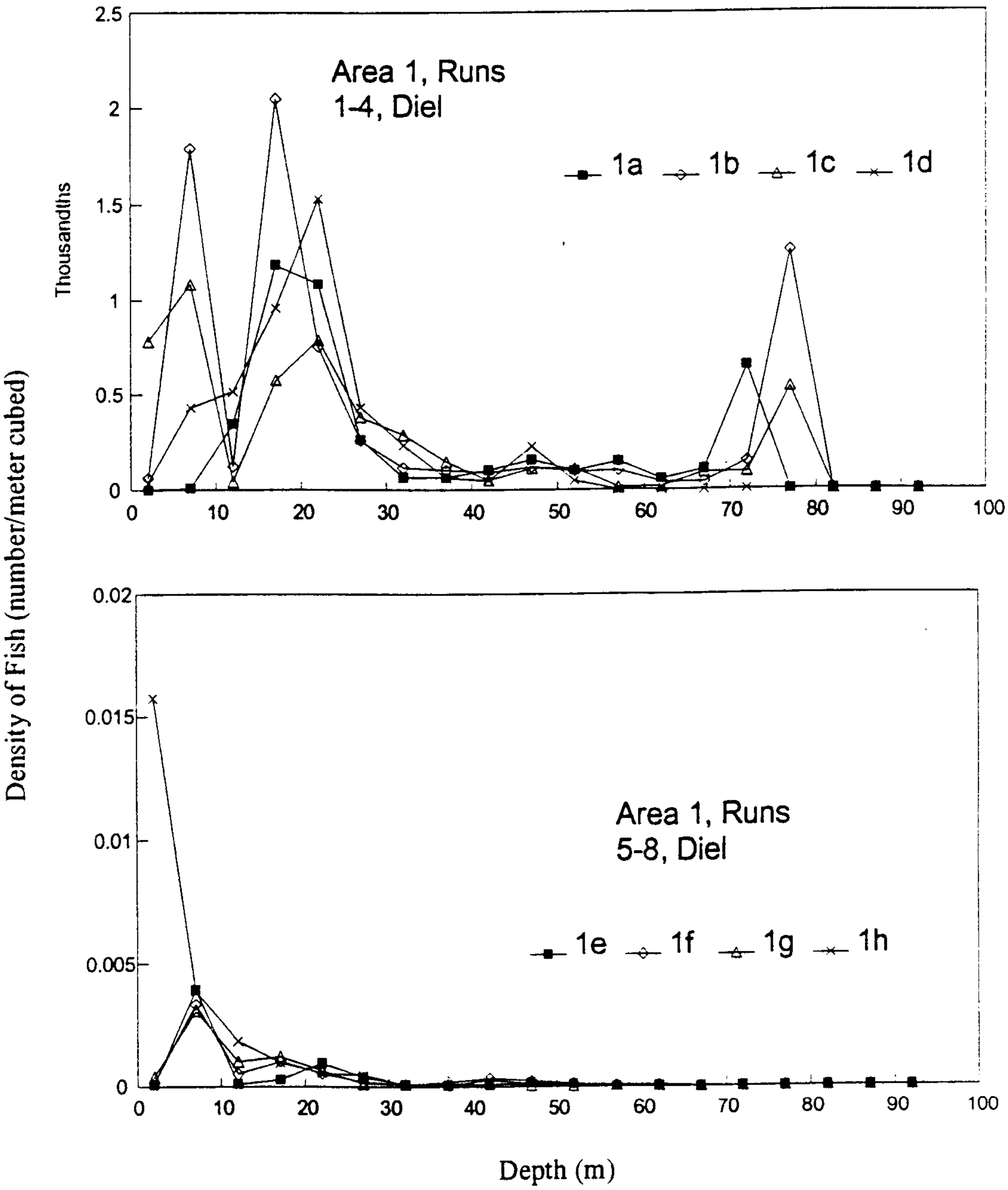


Figure 11. Density of fish in Skilak Lake, Area 1, runs 1 - 8, during diel studies conducted on 8 May 1993.

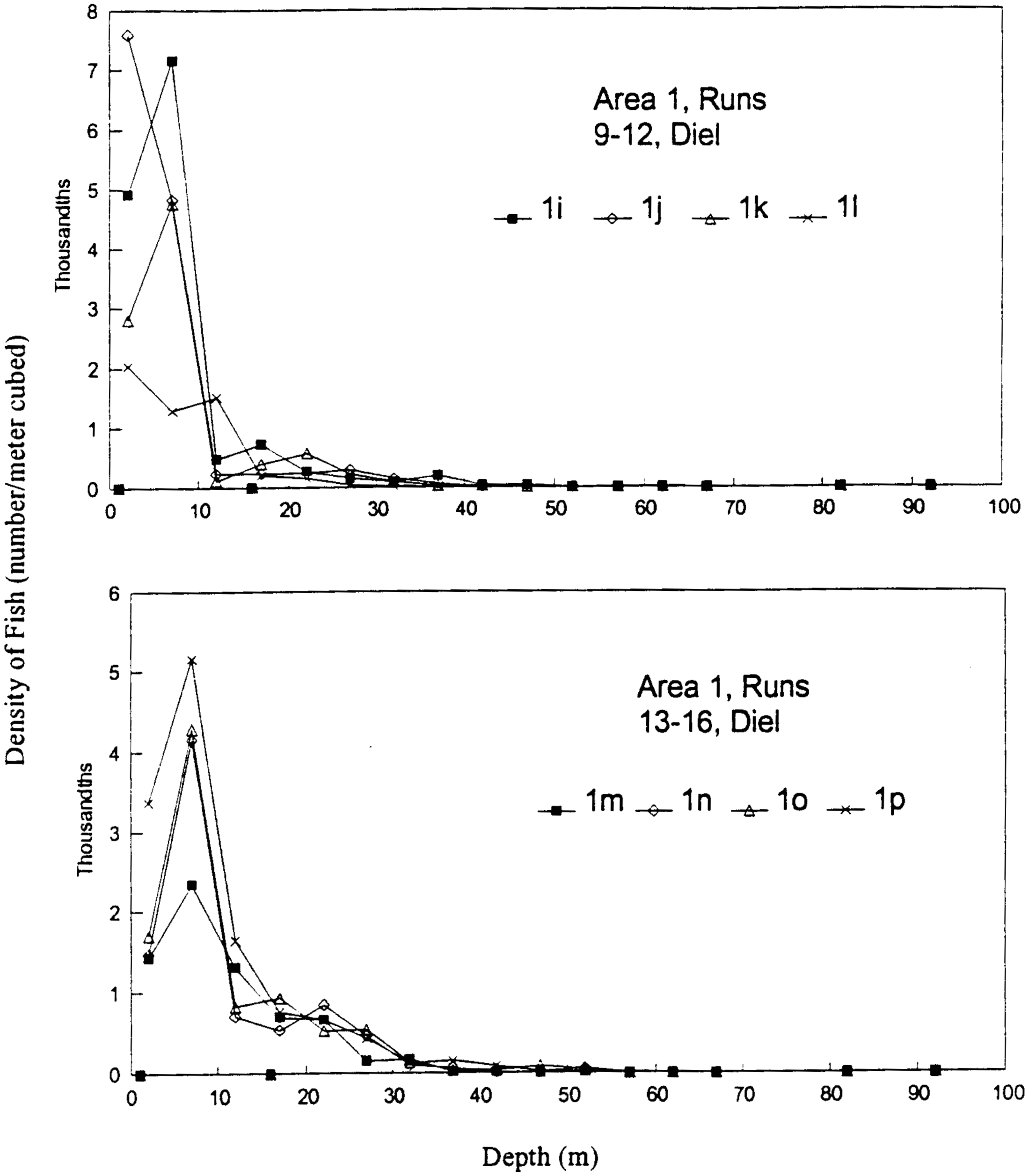


Figure 12. Density of fish in Skilak Lake, Area 1, runs 9-16, during diel studies conducted on 8 May 1993.

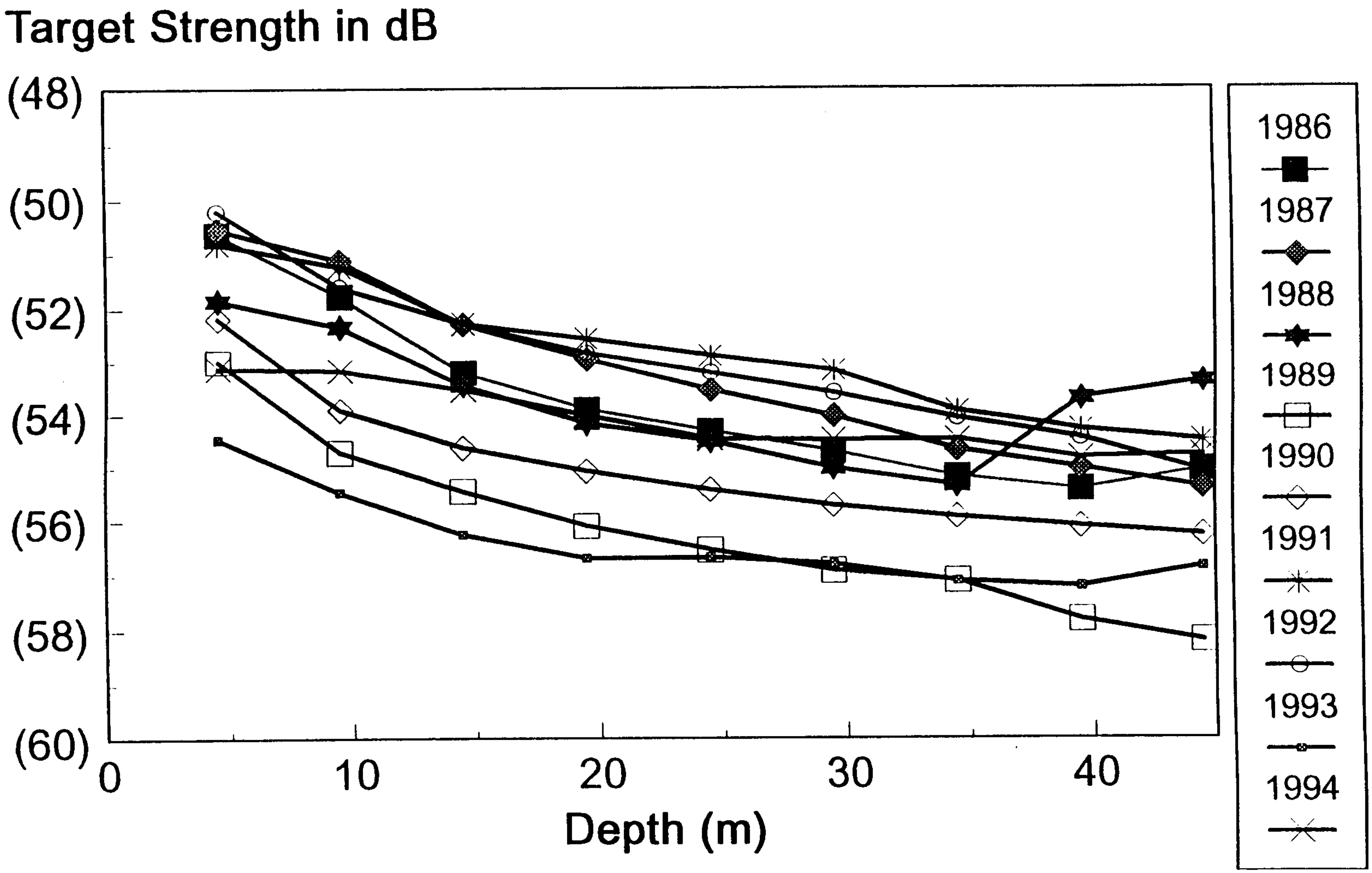


Figure 13. Fish target strength measured in Skilak Lake, Alaska in September, 1986-1994.

File: 13fog94 pre

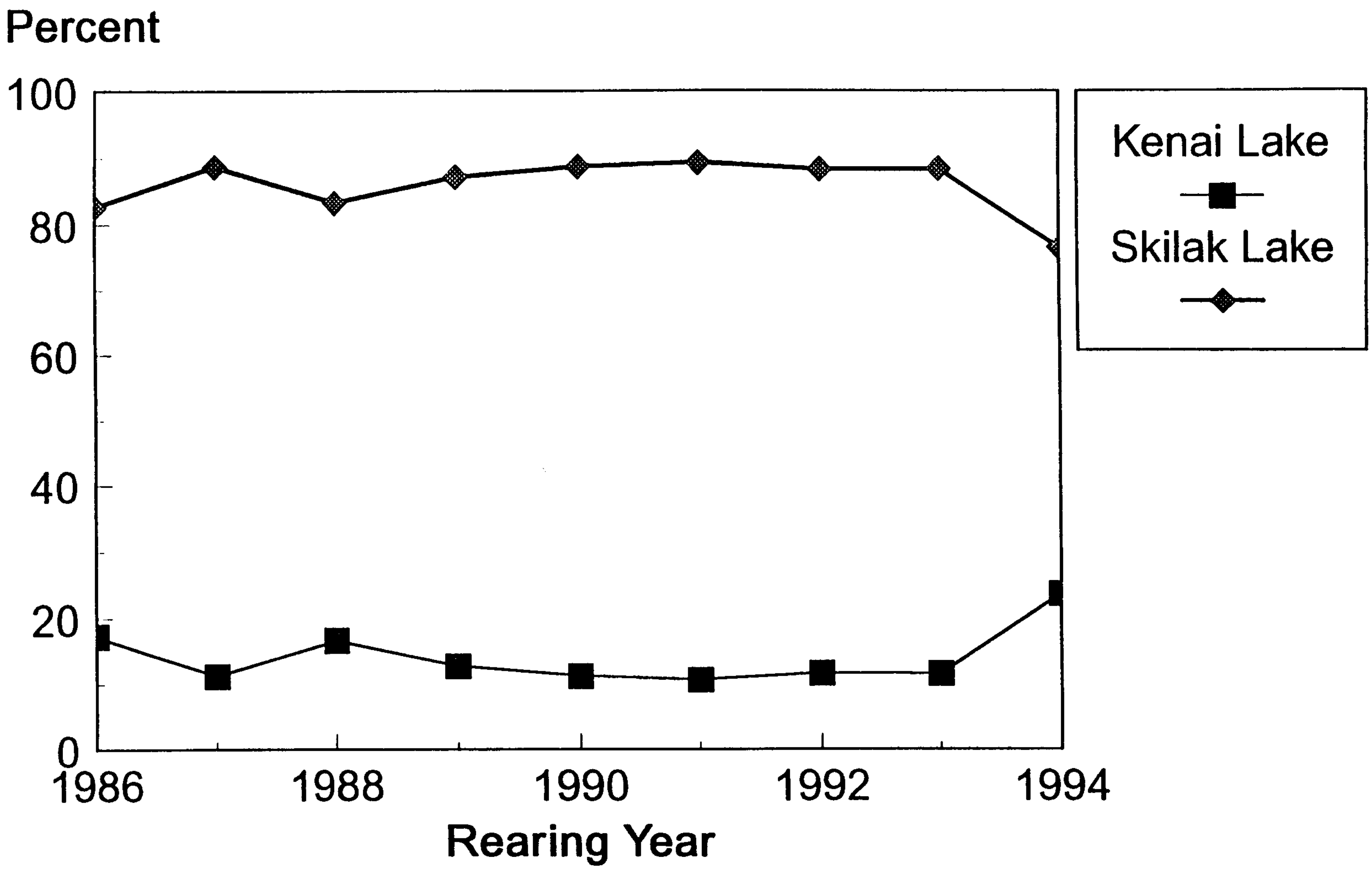


Figure 14. Relative distribution of juvenile sockeye in the Kenai River system, Alaska 1986-1994.

File: 14fig94

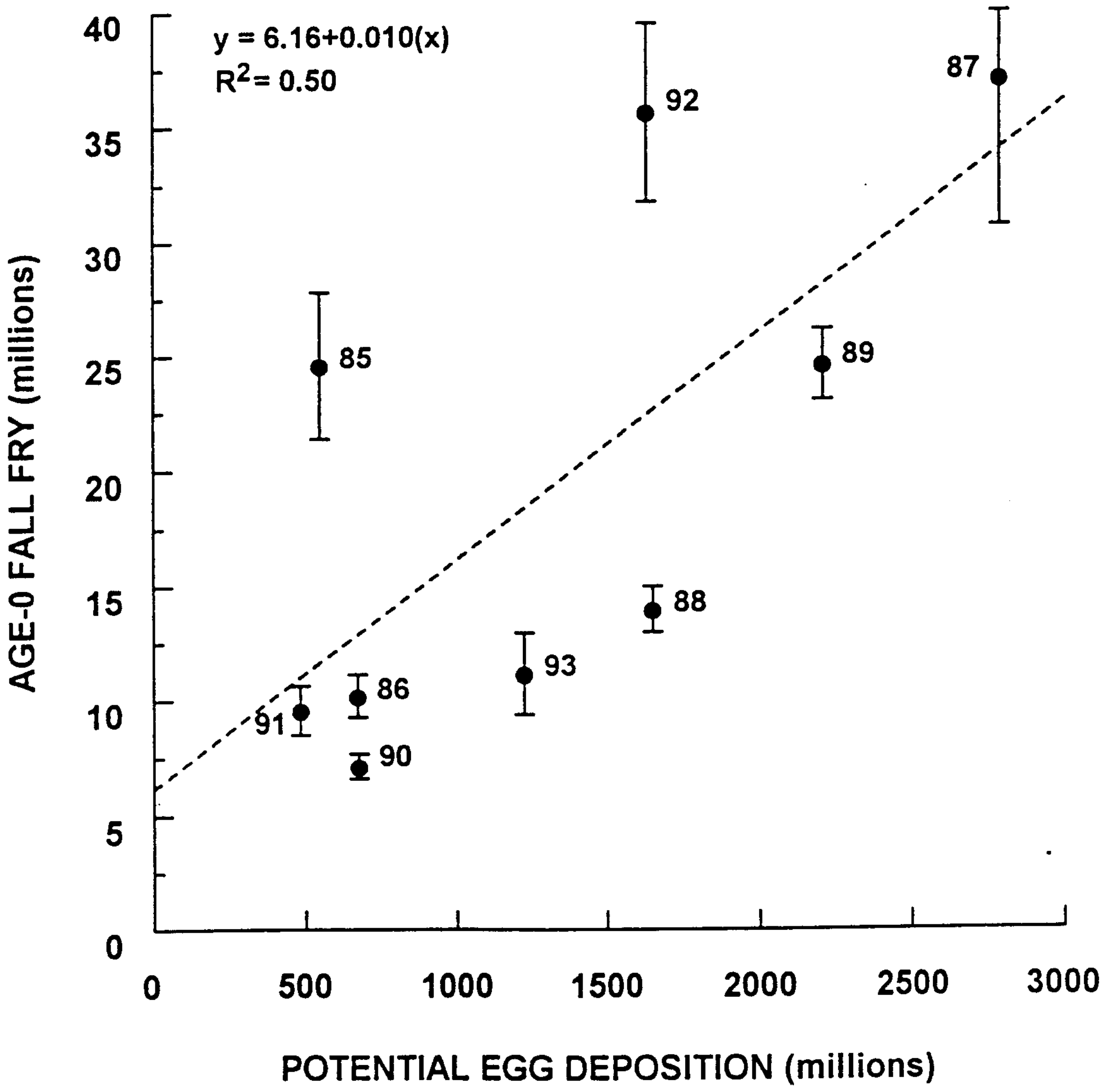


Figure 15. Relationship between the number of age-0 sockeye salmon fall fry in Kenai and Skilak Lakes and potential egg deposition by mainstem spawners. Values listed indicate brood year of the eggs and fry. Vertical bars are standard errors of estimated fry abundances.

APPENDIX

Appendix A.1. Calibration and processing parameters used in collection and analysis of Kenai and Skilak Lake, Alaska hydroacoustic data, 1993-1994.

Date	Source Level (dB)	Receiving Sensitivity 1 (dB)	Receiving Sensitivity 2 (dB)	Gain (dB)	Threshold (mv)	Wide Beam Dropoff (dB)	Narrow Beam Pattern Factor	A Coefficient	B Coefficient	Bottom Threshold (mv)
May 1993	217.66	-165.77	-165.67	0	200	1.346	.1052e-02	1.289	.610	9000
Sept 1993- Nov. 1993	216.74	-165.75	-165.39	6	200	1.310	.1093e-02	1.883	.467	9000
April 1994	216.74	-165.75	-165.39	6	200	1.310	.1093e-02	1.883	.467	7000
Sept. 1994	21.7	-166.86	-167.12	6	300	1.180	.1010e-02	1.919	.424	9000

File: 1aptab94.w51

Appendix A.2. Average backscattering cross section (sigma) and target strength data by depth strata for Skilak Lake, Alaska, 5 May 1993.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	8	.1672E-03	.1928E-03	-42.69	8.90
7.0 - 12.0	26	.1331E-03	.3469E-03	-48.92	10.21
12.0 - 17.0	21	.1317E-03	.3027E-03	-48.23	10.36
17.0 - 22.0	89	.5326E-04	.1248E-03	-48.96	7.82
22.0 - 27.0	379	.2058E-04	.5907E-04	-51.90	6.27
27.0 - 32.0	2500	.1249E-04	.8160E-04	-53.65	5.29
32.0 - 37.0	3475	.6944E-05	.2007E-04	-54.55	4.71
37.0 - 42.0	2389	.7069E-05	.6088E-04	-55.26	4.36
42.0 - 47.0	1298	.1546E-04	.1241E-03	-55.21	4.86
47.0 - 52.0	1261	.4741E-05	.2143E-04	-56.17	3.93
52.0 - 57.0	2120	.3206E-05	.3563E-05	-56.60	3.72
57.0 - 62.0	1849	.3569E-05	.4285E-05	-56.37	3.98
62.0 - 67.0	893	.5643E-05	.6651E-05	-54.64	4.40
67.0 - 72.0	197	.7019E-05	.8129E-05	-53.83	4.57
72.0 - 77.0	42	.5159E-05	.4050E-05	-54.30	3.89
77.0 - 82.0	41	.5239E-05	.5331E-05	-55.08	4.88
82.0 - 87.0	2	.1197E-05	.8813E-05	-59.90	3.54
87.0 - 92.0	3	.2477E-05	.1283E-05	-56.42	2.09
92.0 - 97.0	0	.0000E-00	.0000E-00	-00.00	0.00
Total	16593	.8556E-05	.5848E-04	-55.04	4.76

[a] Target strength determined from dual-beam data collected *in situ*. File: 2aptab94.w51

Appendix A.3. Average backscattering cross section (sigma) and target strength data by depth strata for Skilak Lake, Alaska, 8 May 1993.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	301	.2332E-04	.3785E-04	-49.45	5.75
7.0 - 12.0	1183	.1868E-04	.5008E-04	-50.71	5.33
12.0 - 17.0	845	.2067E-04	.9690E-04	-52.13	5.70
17.0 - 22.0	1480	.1060E-04	.3701E-04	-53.38	5.17
22.0 - 27.0	2263	.6761E-05	.1002E-04	-54.19	4.81
27.0 - 32.0	1528	.5628E-05	.8322E-05	-54.98	4.65
32.0 - 37.0	703	.4614E-05	.5427E-05	-55.30	4.25
37.0 - 42.0	645	.4540E-05	.4617E-05	-55.36	4.31
42.0 - 47.0	712	.3925E-05	.6865E-05	-56.32	4.24
47.0 - 52.0	1088	.3367E-05	.2986E-05	-56.18	3.66
52.0 - 57.0	600	.4214E-05	.4396E-05	-55.69	4.19
57.0 - 62.0	161	.6920E-05	.7092E-05	-53.96	4.79
62.0 - 67.0	81	.5323E-05	.4973E-05	-54.35	4.01
67.0 - 72.0	33	.4046E-05	.2856E-05	-55.14	3.56
72.0 - 77.0	10	.4626E-05	.2205E-05	-53.91	2.47
77.0 - 82.0	2	.2660E-05	.2585E-05	-57.14	5.18
82.0 - 87.0	0	.0000E-00	.0000E-00	-00.00	0.00
87.0 - 92.0	0	.0000E-00	.0000E-00	-00.00	0.00
92.0 - 97.0	0	.0000E-00	.0000E-00	-00.00	0.00
Total	11635	.8858E-05	.3493E-04	-54.09	5.09

[a] Target strength determined from dual-beam data collected *in situ*. File: 3aptab94.w51

Appendix A.4. Average backscattering cross section (sigma) and target strength data by depth strata for Kenai Lake, Alaska, 4 October 1993.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	198	.1122E-04	.4837E-04	-55.52	7.32
7.0 - 12.0	541	.7691E-05	.1892E-04	-56.54	7.24
12.0 - 17.0	2233	.5728E-05	.1919E-04	-57.16	6.48
17.0 - 22.0	5501	.4197E-05	.6045E-05	-57.13	5.93
22.0 - 27.0	9171	.3710E-05	.4349E-05	-57.32	5.61
27.0 - 32.0	9963	.3404E-05	.3610E-05	-57.40	5.38
32.0 - 37.0	7885	.2917E-05	.3935E-05	-57.92	5.08
37.0 - 42.0	4362	.2631E-05	.2526E-05	-57.96	4.78
42.0 - 47.0	2104	.2518E-05	.2551E-05	-58.09	4.65
47.0 - 52.0	1184	.2163E-05	.1927E-05	-58.44	4.28
52.0 - 57.0	707	.1798E-05	.1532E-05	-59.19	4.26
57.0 - 62.0	465	.1778E-05	.1822E-05	-59.39	4.28
62.0 - 67.0	250	.1790E-05	.1565E-05	-59.07	4.00
67.0 - 72.0	137	.1511E-05	.1226E-05	-59.45	3.45
72.0 - 77.0	56	.1666E-05	.1151E-05	-59.22	4.02
77.0 - 82.0	28	.1598E-05	.1191E-05	-59.23	3.56
82.0 - 87.0	21	.1414E-05	.1971E-05	-60.45	3.75
87.0 - 92.0	5	.6158E-04	.9034E-04	-52.55	13.29
92.0 - 97.0	2	.1831E-05	.8386E-06	-57.61	2.06
Total	44813	.3476E-05	.7090E-05	-57.60	5.41

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[a] Target strength determined from dual-beam data collected *in situ*. File: 4aptab94.w51

Appendix A.5. Average backscattering cross section (sigma) and target strength data by depth strata for Skilak Lake, Alaska, 26 September 1993.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	1438	.9673E-05	.2355E-04	-54.47	6.67
7.0 - 12.0	5619	.7465E-05	.1159E-04	-55.46	6.61
12.0 - 17.0	13195	.5427E-05	.8170E-05	-56.25	6.14
17.0 - 22.0	25486	.4469E-05	.5374E-05	-56.69	5.83
22.0 - 27.0	30573	.4168E-05	.5255E-05	-56.68	5.54
27.0 - 32.0	26860	.3846E-05	.4472E-05	-56.80	5.29
32.0 - 37.0	17410	.3428E-05	.4083E-05	-57.11	5.07
37.0 - 42.0	8279	.3301E-05	.4583E-05	-57.21	4.95
42.0 - 47.0	3645	.3993E-05	.1239E-04	-56.85	5.09
47.0 - 52.0	2817	.3735E-05	.5015E-05	-56.89	5.04
52.0 - 57.0	1523	.3992E-05	.5051E-05	-56.47	4.91
57.0 - 62.0	774	.3914E-05	.4392E-05	-56.27	4.69
62.0 - 67.0	464	.4057E-05	.4542E-05	-56.49	5.06
67.0 - 72.0	290	.4547E-05	.4753E-05	-55.63	4.72
72.0 - 77.0	134	.3985E-05	.3621E-05	-55.59	3.99
77.0 - 82.0	77	.4141E-05	.4688E-05	-56.11	4.77
82.0 - 87.0	59	.2517E-05	.2263E-05	-57.74	4.33
87.0 - 92.0	39	.3679E-05	.4112E-05	-56.65	5.01
92.0 - 97.0	5	.8688E-06	.5658E-06	-62.14	5.11
Total	138697	.4309E-05	.6501E-05	-56.68	5.56

[a] Target strength determined from dual-beam data collected *in situ*. File: 5aptab94.w51

Appendix A.6. Average backscattering cross section (sigma) and target strength data by depth strata for Skilak Lake, Alaska, 16 November 1993.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	547	.7928E-05	.1173E-04	-55.29	6.44
7.0 - 12.0	2870	.6346E-05	.9945E-05	-56.28	6.49
12.0 - 17.0	5770	.5229E-05	.7589E-05	-57.01	6.32
17.0 - 22.0	12136	.4474E-05	.5433E-05	-56.87	5.97
22.0 - 27.0	14149	.4441E-05	.5270E-05	-56.57	5.74
27.0 - 32.0	13272	.4247E-05	.4717E-05	-56.41	5.40
32.0 - 37.0	11717	.4063E-05	.4345E-05	-56.41	5.19
37.0 - 42.0	8548	.3810E-05	.3842E-05	-56.41	4.88
42.0 - 47.0	4430	.3606E-05	.3536E-05	-56.49	4.70
47.0 - 52.0	2946	.3738E-05	.6482E-05	-56.48	4.60
52.0 - 57.0	1687	.3751E-05	.5372E-05	-56.45	4.53
57.0 - 62.0	1080	.3647E-05	.3590E-05	-56.38	4.53
62.0 - 67.0	718	.3483E-05	.3601E-05	-56.47	4.25
67.0 - 72.0	396	.3841E-05	.3739E-05	-56.04	4.36
72.0 - 77.0	289	.4015E-05	.3760E-05	-55.73	4.22
77.0 - 82.0	130	.5121E-05	.4613E-05	-54.75	4.40
82.0 - 87.0	35	.2782E-05	.2499E-05	-57.16	3.60
87.0 - 92.0	28	.2038E-05	.1617E-05	-58.44	4.09
92.0 - 97.0	0	.0000E-00	.0000E-00	-00.00	0.00
Total	80748	.4316E-05	.5428E-05	-56.54	5.48

[a] Target strength determined from dual-beam data collected *in situ*. File: 6aptab94.w51

Appendix A.7. Average backscattering cross section (sigma) and target strength data by depth strata for Skilak Lake, Alaska, 25 April 1994.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	91	.2145e-04	.4911E-04	-53.26	8.13
7.0 - 12.0	502	.1290E-04	.2616E-04	-54.41	7.36
12.0 - 17.0	2575	.7448E-05	.1779E-04	-55.94	6.41
17.0 - 22.0	4177	.4823E-05	.1448E-04	-57.04	5.80
22.0 - 27.0	6136	.2475E-05	.3310E-05	-59.20	5.40
27.0 - 32.0	5995	.2165E-05	.3267E-05	-59.69	5.36
32.0 - 37.0	2195	.2128E-05	.3102E-05	-60.15	5.56
37.0 - 42.0	1151	.2804E-05	.4221E-05	-59.19	5.83
42.0 - 47.0	865	.2754E-05	.4043E-05	-58.87	5.65
47.0 - 52.0	665	.3142E-05	.4100E-05	-58.44	5.82
52.0 - 57.0	853	.4075E-05	.4344E-05	-56.60	5.37
57.0 - 62.0	418	.3615E-05	.3935E-05	-56.92	4.98
62.0 - 67.0	287	.3795E-05	.4148E-05	-56.46	4.71
67.0 - 72.0	117	.4817E-05	.5866E-05	-56.03	5.33
72.0 - 77.0	59	.3571E-05	.2516E-05	-55.68	3.69
77.0 - 82.0	21	.2364E-05	.1804E-05	-57.78	4.03
82.0 - 87.0	6	.8569E-06	.5824E-06	-61.82	3.89
87.0 - 92.0	2	.6369E-06	.4249E-06	-62.51	3.15
92.0 - 97.0	2	.6685E-06	.5678E-06	-62.72	4.26
Total	26117	.3645E-05	.1002E-04	-58.41	5.85

[a] Target strength determined from dual-beam data collected *in situ*. File 7aptab94.w51

Appendix A.8. Average backscattering cross section (sigma) and target strength data by depth strata for Skilak Lake, Alaska, 29 April 1994.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	876	.1075E-04	.1487E-04	-53.85	6.76
7.0 - 12.0	4799	.8236E-05	.1757E-04	-54.83	6.22
12.0 - 17.0	9188	.5776E-05	.8783E-05	-55.81	5.93
17.0 - 22.0	9488	.4493E-05	.8667E-05	-56.78	5.82
22.0 - 27.0	7011	.3677E-05	.6489E-05	-57.56	5.63
27.0 - 32.0	3142	.2787E-05	.3299E-05	-58.61	5.54
32.0 - 37.0	945	.2495E-05	.2819E-05	-58.94	5.41
37.0 - 42.0	319	.1986E-05	.2521E-05	-60.18	5.44
42.0 - 47.0	175	.2132E-05	.2686E-05	-59.80	5.38
47.0 - 52.0	151	.2053E-05	.2315E-05	-59.41	4.89
52.0 - 57.0	66	.2238E-05	.2188E-05	-58.74	4.90
57.0 - 62.0	48	.2801E-05	.2164E-05	-57.28	4.51
62.0 - 67.0	36	.7845E-05	.7229E-05	-53.89	5.83
67.0 - 72.0	34	.2268E-05	.1511E-05	-57.71	3.72
72.0 - 77.0	23	.2692E-05	.2291E-05	-57.88	5.23
77.0 - 82.0	2	.5672E-05	.5891E-05	-54.15	5.76
82.0 - 87.0	0	.0000E-00	.0000E-00	-00.00	0.00
87.0 - 92.0	7	.2156E-05	.1249E-05	-57.49	3.14
92.0 - 97.0	0	.0000E-00	.0000E-00	-00.00	0.00
Total	36310	.5056E-05	.9911E-05	-56.63	5.98

[a] Target strength determined from dual-beam data collected *in situ*. File 8aptab94.w51

Appendix A.9. Average backscattering cross section (sigma) and target strength data by depth strata for Skilak Lake, Alaska, 27 September 1994.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	423	.1543E-04	.4321E-04	-53.12	6.98
7.0 - 12.0	3096	.1216E-04	.1979E-04	-53.16	6.61
12.0 - 17.0	8346	.9831E-05	.1262E-04	-53.53	6.21
17.0 - 22.0	13057	.8209E-05	.1005E-04	-54.02	5.98
22.0 - 27.0	13804	.6953E-05	.1122E-04	-54.47	5.62
27.0 - 32.0	10873	.6303E-05	.6162E-05	-54.50	5.31
32.0 - 37.0	5256	.5938E-05	.5980E-05	-54.48	5.01
37.0 - 42.0	1701	.5764E-05	.1885E-04	-54.83	4.91
42.0 - 47.0	445	.5643E-05	.6458E-05	-54.78	4.94
47.0 - 52.0	397	.8674E-05	.3072E-05	-53.99	5.39
52.0 - 57.0	449	.8343E-05	.1067E-04	-53.72	5.60
57.0 - 62.0	481	.8123E-05	.7896E-05	-53.17	5.11
62.0 - 67.0	317	.6886E-05	.5823E-05	-53.31	4.31
67.0 - 72.0	190	.6776E-05	.5952E-05	-53.25	4.11
72.0 - 77.0	160	.7359E-05	.5085E-05	-52.79	4.35
77.0 - 82.0	83	.7352E-05	.5286E-05	-53.39	5.69
82.0 - 87.0	30	.5997E-05	.6670E-05	-56.42	7.41
87.0 - 92.0	29	.7060E-05	.4295E-05	-52.61	3.98
92.0 - 97.0	12	.2928E-05	.4147E-05	-60.55	7.70
Total	59149	.7747E-05	.1183E-04	-54.14	5.73

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[a] Target strength determined from dual-beam data collected *in situ*. File 9aptab94.w51

Appendix A.10. Average backscattering cross section (sigma) and target strength data by depth strata for Kenai Lake, Alaska, 7 October 1994.

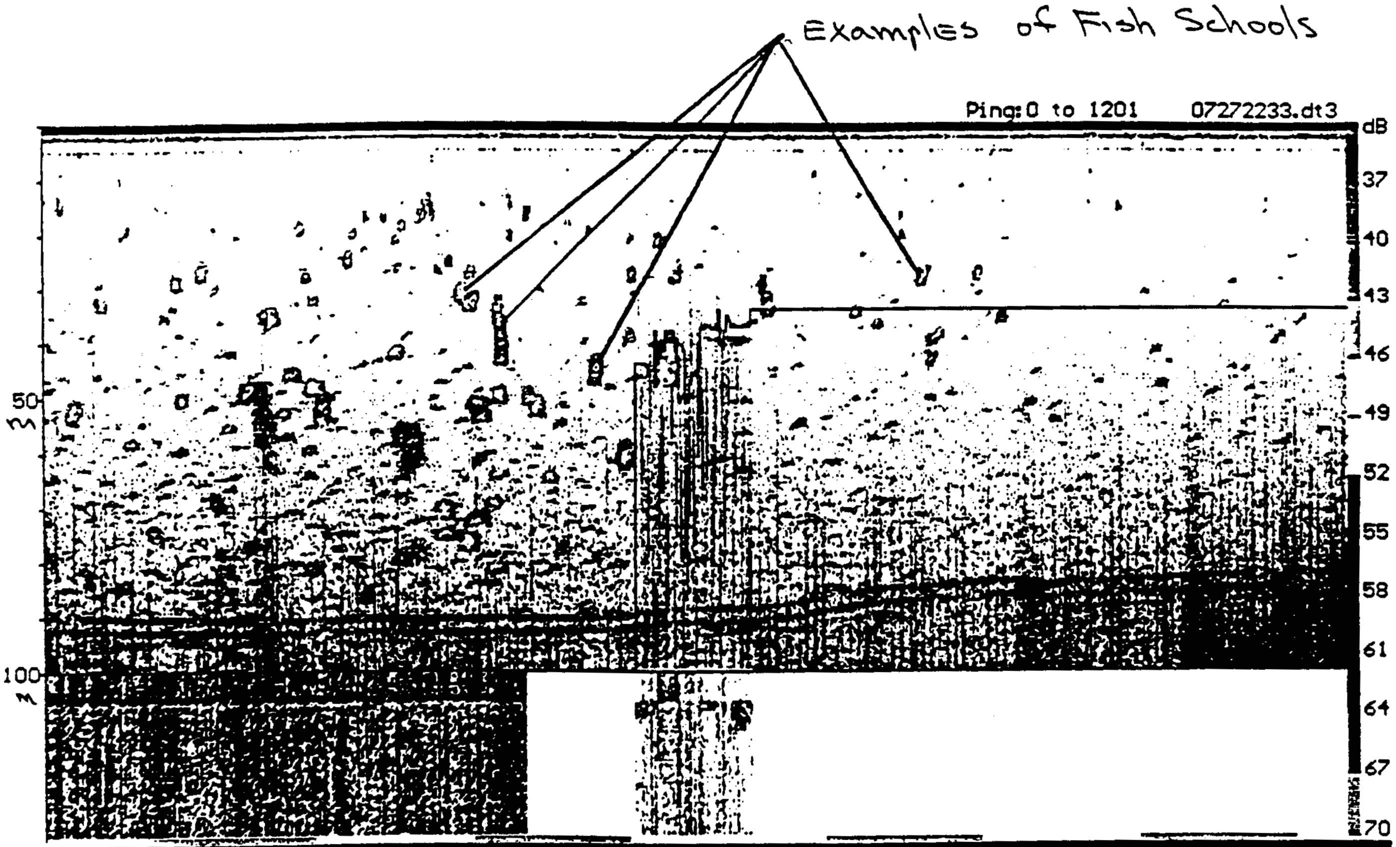
Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	40	.9215E-05	.2490E-04	-58.70	8.32
7.0 - 12.0	312	.1235E-04	.1707E-04	-53.71	7.39
12.0 - 17.0	1570	.1033E-04	.1418E-04	-53.97	6.82
17.0 - 22.0	4462	.8254E-05	.9306E-05	-54.25	6.27
22.0 - 27.0	6734	.7578E-05	.8410E-05	-54.15	5.78
27.0 - 32.0	6729	.6439E-05	.6675E-05	-54.66	5.54
32.0 - 37.0	3818	.5857E-05	.6062E-05	-54.75	5.24
37.0 - 42.0	998	.5339E-05	.5200E-05	-55.14	5.18
42.0 - 47.0	140	.5274E-05	.4891E-05	-55.04	5.01
47.0 - 52.0	65	.4433E-05	.5466E-05	-55.82	4.69
52.0 - 57.0	24	.3200E-05	.3155E-05	-56.75	4.07
57.0 - 62.0	4	.2422E-05	.1173E-05	-56.76	2.96
62.0 - 67.0	1	.5676E-05	.0000E-00	-52.46	0.00
67.0 - 72.0	3	.1723E-05	.1880E-05	-59.40	4.70
72.0 - 77.0	3	.5876E-06	.5324E-06	-63.42	3.66
77.0 - 82.0	0	.0000E-00	.0000E-00	-00.00	0.00
82.0 - 87.0	0	.0000E-00	.0000E-00	-00.00	0.00
87.0 - 92.0	2	.8069E-06	.7969E-06	-62.38	5.31
92.0 - 97.0	2	.1918E-06	.1481E-06	-67.94	3.76
Total	24907	.7245E-05	.8527E-05	-54.44	5.81

[a] Target strength determined from dual-beam data collected *in situ*. File 10apt94.w51

APPENDIX D

E SIMRAD EPS-500

HP PaintJet print utility (Lda)



File parameters for A:\07272233.dt3

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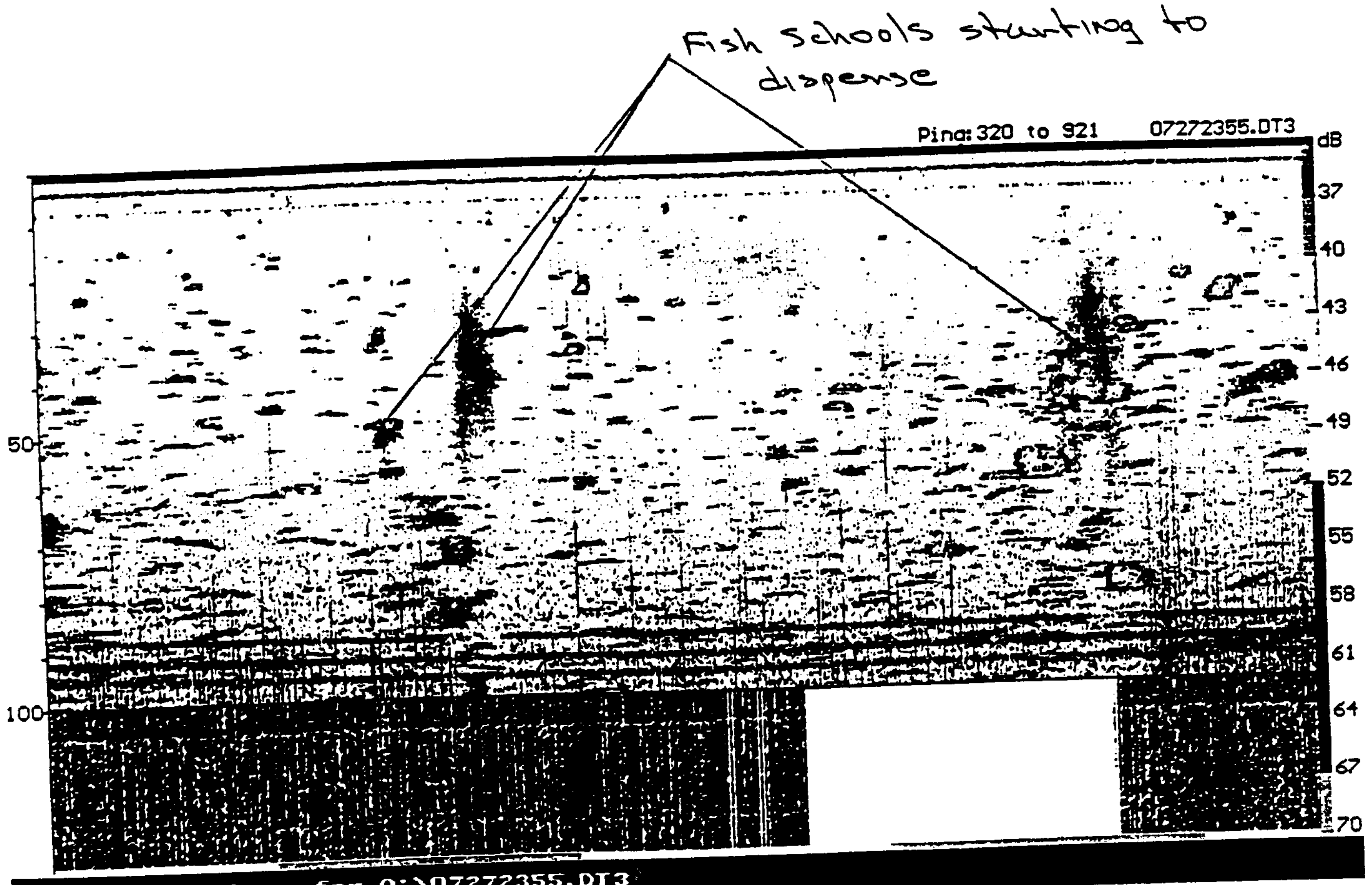
Time : 22:33:21 to 22:42:24
MinTS: -65 dB
Pings: 1369
Size : 409078 bytes
☐ Store under bottom data
☒ Store bottom expansion data

Survey area : SKILAK LAKE
Transect : HORIZ LOOK
Trs file name: ES120 (Split) Angle=4.5 deg
Sv threshold : -70 dB (-100 to 0 dB)
TS threshold : -65 dB (-100 to 0 dB)
Sv color min : -70 dB (-100 to 0 dB)

Figure 2. Prior to dusk

E SIMRAD EPS-500
HP PaintJet print utility (Lda)



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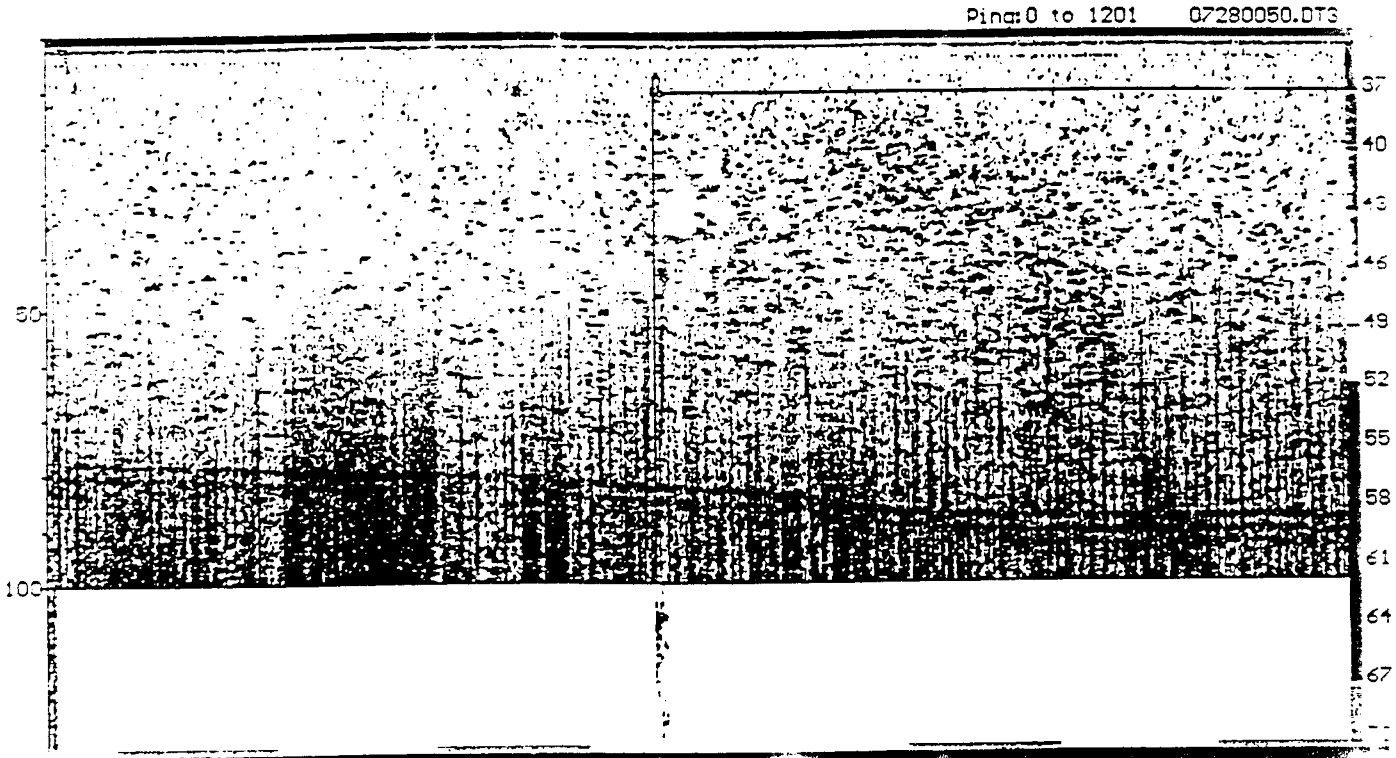
File parameters for A:\07272355.DT3

Date : 27/07/93                          Survey area   :  SKILAK LAKE
Time : 23:45:13 to 23:47:34              Transect      :  HORIZ TEST
MinTS: -65 dB                            Trs file name:  ES120     (Split) Angle=4.5 deg
Pings: 357                               Sv threshold :  -70  dB  (-100 to 0 dB)
Size : 409445 bytes                      TS threshold :  -65  dB  (-100 to 0 dB)
Telegrams used: Q1 - E1 - D1 - A1 - H1 - LL   Sv color min :  -70  dB  (-100 to 0 dB)
```

Figure 3. At dusk

Total Dispersion of Fish Schools



```
File parameters for C:\EY500\07280050.DT3
Date : 28 07/93                                Survey area   : SKILAK LAKE
Time : 00:50:54 to 00:59:52                    Transect      : HORIZ TEST
MinTS: -65 dB                                  Trs file name: TS120      (Split) Angle=4.5 deg
Pings: 1305                                    Sv threshold : -70  dB  (-100 to 0 dB)
Size : 467269 bytes                            TS threshold : -65  dB  (-100 to 0 dB)
Telegrams used: Q1 - E1 - D1 - A1 - H1 - LL    Sv color min : -70  dB  (-100 to 0 dB)
```

Figure 4. After dark.

APPENDIX E

SKILAK LAKE FEED STUDY

Date	Time	Daylight Factor	Age	Fish Length (mm)	Fish Weight (g)	Dried Gut Wt (mg)	Sample Size
8-Aug	18:14 - 18:44	Daylight	0	46.3	1.0	1.26280	43
3-Aug	21:40 - 22:10	Dusk	0	43.7	0.9	2.47364	23
	22:25 - 22:55	Dusk	0	43.7	0.8	1.64215	41
4-Aug	20:54 - 21:24	Dusk	0	47.6	1.1	2.40000	7
	21:38 - 22:08	Dusk	0	47.7	1.1	2.68333	6
	22:21 - 22:51	Dusk	0	43.1	0.8	1.18248	38
4-Aug	00:20 - 00:50	Dark	0	43.2	0.8	2.06742	139
	01:09 - 01:39	Dark	0	42.3	0.8	1.70036	66
	01:56 - 02:26	Dark	0	43.1	0.8	2.00546	84
	02:47 - 03:17	Dark	0	44.7	1.0	2.01810	30
5-Aug	00:16 - 00:46	Dark	0	44.8	0.9	1.67580	60
	01:01 - 01:31	Dark	0	43.7	0.8	1.42157	51
	01:47 - 02:17	Dark	0	44.9	0.9	1.69808	52
	02:29 - 02:59	Dark	0	43.7	0.8	1.30417	48
30-Aug	09:50 - 10:20	Daylight	0	47.8	1.1	1.26320	38
31-Aug	19:38 - 20:08	Dusk	0	50.5	1.3	2.61014	148
	20:24 - 20:54	Dusk	0	49.2	1.3	2.85723	159
31-Aug	22:45 - 23:15	Dark	0	48.8	1.2	3.08942	189
	23:29 - 23:59	Dark	0	48.5	1.2	3.24000	45

APPENDIX F

MEMORANDUM
Limnology Section
Soldotna

STATE OF ALASKA
Department of Fish & Game
CFMAD Division

TO: Ken Tarbox
Area Biologist

Bruce King
Research Biologist

DATE: 3/8/94

FROM: Stan Carlson SC
Biometrician

file: SKTOW93.MEM

SUBJECT: 1993 Skilak Lake Townet Analyses

This memo is a brief summary of results of statistical analyses that I conducted to evaluate sockeye salmon fry sampling techniques in Skilak Lake. The overall goal was to develop recommendations that would help improve the sampling design of the fry townetting program. Throughout the 1993 field season a variety of towing methods were undertaken. These included tows at various depths (surface tows, 10 m, etc.), by area (strata), at different times (day versus night), and using two types of gear (2-boat versus boom-boat). We identified the following objectives: (1) compare sockeye age composition between the different towing methods; (2) compare length and weight of age-0 and (where possible) age-1 fry between methods; (3) compare the proportion of sockeye fry captured between methods; and (4) summarize catch rates (CPUE) for each sampling period and towing method.

Sockeye age composition, species composition, size data (length and weight), and catch rates were obtained for each of the following sets of tows. Note that some depths are rounded and/or pooled together and date is the start date.

File	Date	Area	Depths (m)	Time	Gear
SK200	July 19	1-3	surface	day	2-boat
SK228	Aug. 16	1	0, 10, 20	day	boom
		1	0, 10, 15	night	boom
		2	0, 15, 25, 35	day	boom
		3	0, 15	day	boom
SK257	Sept. 13	1-3	surface	day	both
SK265	Sept. 22	1	10, 20, 30	day	boom
		2	10, 15	day	boom
		3	10, 20	day	boom
SK319	Nov. 15	1	0, 12, 20	day	boom
		2	0, 20	day	boom
		3	0, 20	day	boom

Additionally, all species composition and CPUE information was stored in the file SK93SPP.

Statistical analyses were generally conducted by date, except for September data which was combined in one analysis. In the case of the discrete data (age classes and species composition), I took the approach of analyzing sets of contingency tables, stratified by area or depth where appropriate. Species composition data were simplified to sockeye and 'other' since non-sockeye species were very rare. Three test statistics were calculated: the standard Chi-Square, G^2 (likelihood ratio chi-square), and Fisher's Exact Test (after relaxing the assumption of fixed marginal totals). I used the three

NOTE: Backup data available on request.

statistics in conjunction since there is some controversy over appropriate testing for sparse tables with small expected values (the case here since age-0 sockeye dominate the samples). Disparate results were obtained in only 1 out of 52 tests (when the nominal P=.05 level of significance was applied). In the case of the continuous data (length and weight), I used standard ANOVA procedures for completely random designs followed by pair-wise contrasts of significant factors. Tests were conducted at the P≤.05 significance level and observed P-values are given in appendices. The critical assumption in all of the analyses is that each group of fry collected provide a random and representative sample.

RESULTS

Differences in age and species composition and fry size (by age) were detected among depths and areas, although this depended somewhat on the time period sampled. Detail is given below for each set of analyses. Contingency tables are provided in appendix A. Summary tables are provided for significant (P<.05) ANOVA results in appendix B. Appendix C is the CPUE summary. All or part of the output from the statistical analyses is available upon request.

July (SK200)

Data collected in July were used to make areal (among strata) comparisons of daytime surface tows using the 2-boat method. No differences in sockeye age composition were detected and age-0 fry exceeded 99% in all three areas (A.1). Similarly, no difference among areas in species composition was detected and only two non-sockeye species were netted, both in area 2 (A.2). However, mean length and weight of age-0 fry differed significantly and substantially among the areas, with the largest fry occurring in area 1 and the smallest in area 3 (B.1). The sample size of age-1 fry was too small to be analyzed (n=5).

August (SK228)

Data collected in August consisted of a complex set of boom-boat tows that included day and night tows of two matching depths conducted in area 1 and various depth tows in all sampling areas conducted during the day. Sockeye age and species composition and size of age-0 fry collected in area 1 were compared between day and night tows stratified by depths of 0 and 10 m. Age composition did not depend on timing as only two age-1 fry were obtained in these tows (A.3-4). However, there is some evidence that the proportion of sockeye differed between day and night tows at the 10 m depth (0% versus 28.6%; A.6) but not at the surface (A.5). It is worth pointing out, however, that only a few fish were obtained in the surface-day tows (n=38) and 10 m-night tows (n=14); further studies may be needed to fully address the timing issue. Mean length and weight of age-0 fry did not differ between day and night tows sampled at 10 m. However, age-0 fry collected at the surface during the day were significantly larger than fry obtained in night-surface and day-10 m tows (B.2).

Areal comparisons were made for the surface (all areas) and 15 m (areas 2 & 3) depth tows conducted during the day. No differences among areas in age composition were detected in the surface tows (A.7). However, the proportion of age-1 fry netted at 15 m was significantly higher in area 3 than in area 2 (15% and .5%, respectively; A.8). There is some indication that age composition differs among areas at the surface but sample sizes were small in areas 1 & 2 (38 and 10, respectively; A.9) and only two non-sockeye species were captured. In the 10 m tows, a significantly higher proportion of non-sockeye species were captured in area 3 than in area 2 (16.2% and 1.4%, respectively; A.10). Age-0 fry collected in surface tows were significantly larger in area 1 than in areas 2 or 3 (B.3). No differences in fry size were detected between areas 2 & 3 at 15 m.

Comparisons among depth increments were made for each area and for night tows in area 1. For the daytime tows, age composition differed significantly among depths in all three areas (A.11-13). Higher proportions of age-1 fry occurred in the 15-25 m depths (e.g., in area 3, 14.6% at 15 m versus .3% at 0 m). Note, however, that very small samples were obtained in some of these tows. Species composition also depended upon depth in areas 2 and 3 with generally higher occurrence rates of non-sockeye species in the deeper zones (A.14-16; e.g., in area 3, 16.1% at 15 m versus 0% at 0 m). Size of age-0 fry also differed among depths (B.4). In area 1 significantly larger fry were netted near the surface. On the other hand, the larger fry in area 2 were collected at 25 m (B.5). In area 3 slightly heavier fry were collected at 15 m compared to the surface (B.6).

For the night tows, a significantly higher proportion of age-1 fry were netted at 15 m (9%) than at the surface (.4%) or at 10 m (0%) (A.17); however, note that only 11 sockeye were captured at 10 m. Species composition also varied significantly between depths with the highest proportion of non-sockeye species occurring at 10 m (29%), compared to 3.1% at the surface and 1.6% at 15 m (A.18). Again, this result is based on a sample size of only 14 fish at 10 m. Age-0 fry captured at 10 m were also significantly larger than those captured at the surface or at 15 m (B.7).

September (SK257-265)

Data from tows conducted on Sept. 13-15 (SK257) were used to compare gear types (2-boat versus boom-boat). These surface tows were conducted during the day in each of the three areas. No difference in fry age composition between gear types was detected (A.19-21). Also, no differences in species composition were detected in areas 1 and 2 (A.22-23). However, in area 3 the 2-boat method captured a significantly higher proportion of non-sockeye species than the boom-boat (2.3% versus .1%; A.24). Note that this data was comprised entirely of stickleback (n=26) captured in a single tow. Overall, gear type did not have a significant effect on the size (length or weight) of fry captured (age-0 or age-1).

Differences in age composition among areas were not detected for the 2-boat method (A.25). However, the boom-boat captured a significantly lower proportion of age-1 fry in area 1 than in areas 2 and 3 (.3%, 1.8%, and 2.3%, respectively; A.26). Similarly, no differences in species composition were detected among areas for the 2-boat method and about 1-2% non-sockeye species were netted (A.27). Boom-boat tows, however, captured a significantly higher proportion of non-sockeye species in areas 1 and 2 compared to area 3 (1.3%, 1.0%, and .1%, respectively; A.28). Areal differences in the size of age-0 fry were detected, with significantly and slightly smaller fry captured in area 3 (B.8). Size of age-1 fry did not differ significantly among areas.

The boom-boat was used to conduct daytime tows on Sept. 22-24 (SK265). These data were used to make comparisons among areas (10 m data) and depths; surface tows were not conducted. Age composition of sockeye fry collected at 10 m differed significantly among the areas with the highest proportion of age-1 fry occurring in area 3 (10.6%), followed by area 2 (6.7%), then area 1 (1.2%) (A.29). Species composition in 10 m tows also differed significantly among the areas, with the highest incidence of 'other' species occurring in area 1 (5.5%), followed by area 3 (2.5%), then area 2 (.8%) (A.30). Size of age-0 and age-1 fry sampled at 10 m did not differ significantly among the areas.

A significant difference in age composition among depths ≥ 10 m was detected in area 1, with the highest proportion of age-1 fry obtained at 30 m (8.8% versus 0-2% at 10-20 m; A.31). No depth differences in age composition were found in areas 2 and 3 and the proportion of age-1 fry ranged from about 5-12% (A.32-33). Similarly, no differences in species composition among depths were detected in any of the areas (A.34-36). However, a significant size difference in age-0 fry was detected among depths in area 1, with the largest fry occurring at 30 m (B.9). In area 2, age-1 fry were significantly larger at 15 m than at 10 m (B.10). No other size differences among depths were detected.

All boom-boat data collected in September were combined so that surface tows could be included in the depth analyses. In all 3 areas, a significantly higher proportion of age-1 fry occurred at depths of 10-30 m (8-12%)m compared to surface tows (<3%; A.37-39). Similarly, non-sockeye species occurred at higher rates in the 10-30 m tows compared to surface tows (e.g., in area 1, 5-13% versus 1.3% at the surface; A.40-42). Size of age-0 fry differed among depths with the largest fry occurring in surface tows and at 20-30 m (B.11-13); the smaller fry occurred at 10-15 m. Size of age-1 fry differed significantly among depths in area 2 only, where larger fry were collected at 15 m (B.14); area 3 showed a similar, but non-significant trend.

November (SK319)

In November the boom-boat was used to make depth and areal comparisons of daytime tows. Age composition differed significantly among depths in all 3 areas with higher proportions of age-1 fry (about 5%) occurring at depths of 20 m compared to the surface (<1%; A.43-45). Species composition also differed significantly among depths with the highest proportions of non-sockeye species occurring in the 13-20 m tows (7-11% versus <.4% at the surface; A.46-48). Larger age-0 fry were collected at 20 m than at the surface or at 12 m (B.15 & B.17). No differences among depths in the size of age-1 fry were detected.

Fry age composition and species composition did not differ significantly among areas at the surface or at 20 m (A.49-52). A significant difference in the size of age-0 fry was detected among areas, with area 2 fry being slightly larger than fry collected in areas 1 and 3 (B.15-16). No differences in the size of age-1 fry were detected.

CPUE

Catch rates were calculated for sockeye, non-sockeye, and all species by defining 30 minutes of towing as one unit of effort. Data for each set of tows was pooled (by date, area, depth, time, and gear) and then total counts converted to CPUE (C.1-3). As expected, variability in CPUE among (comparable) tows was high, which may indicate a generally clumped dispersion pattern of fish.

RECOMMENDATIONS

There is substantial evidence of differences among sampling areas and between depth increments in sockeye fry age structure, size of age-0 fry, and species composition. In cases of relatively small sample sizes, however, the representativeness of the tow(s) may be questionable (especially considering that the fish are probably patchily dispersed). The two types of gear used gave reasonably similar results, although there is some indication that the boom-boat captures a lower proportion of age-1 fry than the 2-boat method. More studies are needed to fully address differences between day and night towing.

Results of the statistical analyses indicate that, for estimation purposes, stratification of daytime tows by area and depth should be undertaken. The desired number of depth strata is still in question, but 2 or 3 (including surface tows) should be adequate. The major problem lies in apportioning depth strata (within areas) to the hydroacoustic estimates (Ken has indicated that this would be very difficult). One possible way around this problem would be to sample in proportion to fish abundance within each depth increment. The data could then be pooled and treated as a random sample of the area. If certain assumptions are met, equivalent length (time) tows at each depth may accomplish this. One critical assumption is that CPUE be linearly or proportionally related to fish abundance or density, which may not be the case. Capture efficiency studies could be undertaken in the upcoming field season to address this problem.

appendices

cc: Dana Schmidt
Linda Brannian

SKILAK LAKE TOWNET EFFORT 1984 84EFFORT.WK

AREA/STATION/DEPTH/DATE
AREA 1

STATION A
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	11	0	30	0.37
143	744	1	60	12.40
164	306	1	30	10.20
193	35	0	30	1.17
220	3	0	30	0.10
234	0	0	30	0.00
262	190	1	30	6.33
293	13	0	30	0.43
TOTAL	1302	3	270	4.82

STATION A
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	58	0	30	1.93
143	36	2	60	0.60
164	73	0	30	2.43
193	104	0	30	3.47
220	5	0	30	0.17
234	0	0	30	0.00
262	39	0	30	1.30
293	85	0	30	2.83
TOTAL	400	2	270	1.48

STATION A
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	24	4	30	0.80
143	136	3	60	2.27
164	2	3	30	0.07
193	12	0	30	0.40
220	3	1	30	0.10
234	8	0	30	0.27
262	20	0	30	0.67
293	133	1	30	4.43
TOTAL	338	12	270	1.25

AREA/STATION/ALL DEPTH/DATE

STATION A
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	93	4	90	1.03
143	916	6	180	5.09
164	381	4	90	4.23
193	151	0	90	1.68
220	11	1	90	0.12
234	8	0	90	0.09
262	249	1	90	2.77
293	231	1	90	2.57
TOTAL	2040	17	810	2.52

AREA 1

STATION B
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	753	0	30	25.10
143	264	0	60	4.40
164	166	0	30	5.53
193	5	1	30	0.17
220	4	0	30	0.13
234	14	0	30	0.47
262	256	1	30	8.53
293	23	0	30	0.77
TOTAL	1485	2	270	5.50

STATION B
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	69	2	30	2.30
143	58	2	60	0.97
164	52	0	30	1.73
193	17	0	30	0.57
220	10	0	30	0.33
234	5	0	30	0.17
262	543	0	30	18.10
293	1	0	30	0.03
TOTAL	755	4	270	2.80

STATION B
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	6	4	30	0.20
143	132	3	60	2.20
164	18	1	30	0.60
193	0	3	30	0.00
220	1	0	30	0.03
234	1	1	30	0.03
262	5	0	30	0.17
293	54	0	30	1.80
TOTAL	217	12	270	0.80

STATION B
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	828	6	90	9.20
143	454	5	180	2.52
164	236	1	90	2.62
193	22	4	90	0.24
220	15	0	90	0.17
234	20	1	90	0.22
262	804	1	90	8.93
293	78	0	90	0.87
TOTAL	2457	18	810	3.03

AREA 1

STATION C
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	19	0	30	0.63
143	N/A		0	
164	29	0	30	0.97
193	4	1	30	0.13
220	N/A		0	
234	45	0	30	1.50
262	N/A		0	
293	N/A		0	
TOTAL	97	1	120	0.81

STATION C
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	60	0	30	2.00
143	N/A		0	
164	29	0	30	0.97
193	0	0	30	0.00
220	N/A		0	
234	5	0	30	0.17
262	N/A		0	
293	N/A		0	
TOTAL	94	0	120	0.78

STATION C
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	29	0	30	0.97
143	N/A		0	
164	1	0	30	0.03
193	2	0	30	0.07
220	N/A		0	
234	0	1	30	0.00
262	N/A		0	
293	N/A		0	
TOTAL	32	1	120	0.27

STATION C
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	108	0	90	1.20
143	N/A			
164	58	0	90	0.62
193	6	1	90	0.07
220	N/A			
234	50	1	90	0.56
262	N/A			
293	N/A			
TOTAL	220	10	300	0.81

AREA 1

STATION D
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	100	0	30	3.33
143	169	0	60	2.82
164	336	0	30	11.20
193	0	0	30	0.00
220	156	0	30	5.20
234	13	0	30	0.43
262	233	1	30	7.77
293	41	0	30	1.37
TOTAL	1048	1	270	3.88

STATION D
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	6	1	30	0.20
143	50	5	60	0.83
164	147	0	30	4.90
193	47	0	30	1.57
220	6	0	30	0.20
234	5	0	30	0.17
262	16	0	30	0.53
293	30	0	30	1.00
TOTAL	307	6	270	1.14

STATION D
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	37	1	30	1.23
143	1	3	60	0.02
164	126	4	30	4.20
193	2	1	30	0.07
220	0	2	30	0.00
234	1	1	30	0.03
262	7	2	30	0.23
293	40	1	30	1.33
TOTAL	214	15	270	0.79

STATION D
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	143	2	90	1.59
143	220	8	180	1.22
164	609	4	90	6.77
193	49	1	90	0.54
220	162	2	90	1.80
234	19	1	90	0.21
262	256	3	90	2.84
293	111	1	90	1.23
TOTAL	1569	22	810	1.94

AREA 1

STATION E
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	485	0	30	16.17
143	N/A		0	
164	4	0	30	0.13
193	5	0	30	0.17
220	N/A		0	
234	101	0	30	3.37
262	N/A		0	
293	N/A		0	
TOTAL	595	0	150	3.97

STATION E
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	37	0	30	1.23
143	N/A		0	
164	3	0	30	0.10
193	N/A		0	
220	N/A		0	
234	9	0	30	0.30
262	N/A		0	
293	N/A		0	
TOTAL	49	0	120	0.41

STATION E
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	9	13	30	0.30
143	N/A		0	
164	3	6	30	0.10
193	N/A		0	
220	N/A		0	
234	90	0	30	3.00
262	N/A		0	
293	N/A		0	
TOTAL	102	19	120	0.85

STATION E
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	531	13	90	5.90
143	N/A			
164	10	6	90	0.11
193	5	0	30	0.17
220	N/A			
234	200	0	90	2.22
262	N/A			
293	N/A			
TOTAL	746	19	300	2.49

AREA/ALL STATION/DEPTH/DATE

AREA 1
STATION ALL
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	1368	0	150	9.12

AREA 1
STATION ALL
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	230	3	150	1.53

AREA 1
STATION ALL
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	105	30	150	0.70

AREA/ALL STATION/ALL DEPTH/DATE
AREA 1

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	1703	33	450	3.78
143	1590	19	540	2.94
164	1202	15	450	2.67
193	233	6	300	0.78
220	188	3	270	0.70
234	297	3	450	0.66
262	1309	5	270	4.85
293	420	2	270	1.56
TOTALS	7032	86	3000	2.70

AREA 2

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	267	3	150	1.78
143	2244	13	540	4.16
164	813	14	360	2.26
193	364	8	270	1.35
220	215	6	270	0.80
234	398	13	450	0.88
262	501	3	270	1.86
293	212	2	270	0.79
TOTALS	5014	61	2580	1.94

AREA 3

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	# FIS/MIN
115	88	6	210	0.41
143	1531	22	540	2.84
164	800	30	360	2.75
193	181	6	360	0.50
220	170	10	270	0.63
234	367	13	360	1.02
262	197	5	360	0.55
293	241	5	270	0.89
TOTALS	3582	87	2730	1.31

WHOLE LAKE/ALL STAT
AREA ALL

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER
115	2058	42
143	5365	54
164	2815	59
193	778	20
220	573	19
234	1062	29
262	2007	13
293	873	9
TOTALS	15610	244

DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN	#SOCK	#OTHER	TOW DUR	$ FIS/MIN	#SOCK	#OTHER	TOW DUR	$ FIS/MIN	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
164	N/A		0		N/A		0		N/A		0		N/A			
193	N/A		0		N/A		0		N/A		0		N/A			
220	N/A		0		N/A		0		N/A		0		N/A			
234	N/A		0		N/A		0		N/A		0		N/A			
262	N/A		0		N/A		0		N/A		0		N/A			
293	N/A		0		N/A		0		N/A		0		N/A			
TOTAL1	2	0	30	0.07	0	0	30	0.00	0	1	30	0.00	2	1	90	0.02

AREA/ALL STATION/DEPTH/DATE

	AREA 3 STATION ALL DEPTH 0-10				AREA 3 STATION ALL DEPTH 10-30				AREA 3 STATION ALL DEPTH >30			
DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN	#SOCK	#OTHER	TOW DUR	$ FIS/MIN	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
115	86	2	90	0.96	0	0	60	0.00	0	4	60	0.00
143	785	0	180	4.36	674	7	180	3.74	72	15	180	0.40
164	112	4	120	0.93	440	7	120	3.67	257	19	120	2.14
193	4	2	120	0.03	133	0	120	1.11	44	4	120	0.37
220	160	2	90	1.78	8	4	90	0.09	2	4	90	0.02
234	338	8	120	2.82	28	3	120	0.23	1	4	120	0.01
262	134	3	120	1.12	45	1	120	0.38	18	1	120	0.15
293	53	2	90	0.59	131	2	90	1.46	57	1	90	0.63
TOTAL1	1672	21	930	1.80	1459	24	900	1.62	451	52	900	0.50

SOCKEYE PERCENTAGE

AREA/STATION/ALL DEPTH/DATE

AREA 1

	STATION A DEPTH 0-10				STATION A DEPTH 10-30				STATION A DEPTH >30				STATION A DEPTH ALL			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	11	0	30	100.0%	58	0	30	100.0%	24	4	30	85.7%	93	4	90	95.9%
143	744	1	60	99.9%	36	2	60	94.7%	136	3	60	97.8%	916	6	180	99.3%
164	308	1	30	99.7%	73	0	30	100.0%	2	3	30	40.0%	383	4	90	99.0%
193	35	0	30	100.0%	104	0	30	100.0%	12	0	30	100.0%	151	0	90	100.0%
220	3	0	30	100.0%	6	0	30	100.0%	3	1	30	75.0%	11	1	90	91.7%
234	0	0	30	0.0%	0	0	30	0.0%	8	0	30	100.0%	8	0	90	100.0%
262	190	1	30	99.5%	39	0	30	100.0%	20	0	30	100.0%	249	1	90	99.6%
293	13	0	30	100.0%	85	0	30	100.0%	133	1	30	99.3%	231	1	90	99.6%
TOTAL1	1302	3	270	99.8%	400	2	270	99.5%	338	12	270	96.6%	2040	17	810	99.2%

AREA 1

	STATION B DEPTH 0-10				STATION B DEPTH 10-30				STATION B DEPTH >30				STATION B DEPTH ALL			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	753	0	30	100.0%	60	2	30	97.2%	6	4	30	60.0%	819	6	90	99.3%
143	264	0	60	100.0%	58	2	60	96.7%	132	3	60	97.8%	454	5	180	98.9%
164	168	0	30	100.0%	62	0	30	100.0%	18	1	30	94.7%	248	1	90	99.6%
193	5	1	30	83.3%	17	0	30	100.0%	0	3	30	0.0%	22	4	90	84.6%
220	4	0	30	100.0%	10	0	30	100.0%	1	0	30	100.0%	15	0	90	100.0%
234	14	0	30	100.0%	5	0	30	100.0%	1	1	30	50.0%	20	1	90	95.2%
262	258	1	30	99.6%	643	0	30	100.0%	6	0	30	100.0%	904	1	90	99.9%
293	23	0	30	100.0%	1	0	30	100.0%	54	0	30	100.0%	78	0	90	100.0%
TOTAL1	1489	2	270	99.9%	755	4	270	99.5%	217	12	270	94.8%	2457	18	810	99.3%

AREA 1

	STATION C DEPTH 0-10				STATION C DEPTH 10-30				STATION C DEPTH >30				STATION C DEPTH ALL			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	19	0	30	100.0%	60	0	30	100.0%	29	8	30	78.4%	108	8	90	93.1%
143	N/A		0		N/A		0		N/A		0		N/A			
164	29	0	30	100.0%	26	0	30	100.0%	1	0	30	100.0%	56	0	90	100.0%
193	4	1	30	80.0%	0	0	30	0.0%	2	0	30	100.0%	6	1	90	85.7%
220	N/A		0		N/A		0		N/A		0		N/A			
234	45	0	30	100.0%	5	0	30	100.0%	0	1	30	0.0%	50	1	90	98.0%
262	N/A		0		N/A		0		N/A		0		N/A			
293	N/A		0		N/A		0		N/A		0		N/A			
TOTAL1	97	1	120	99.0%	91	0	120	100.0%	32	9	120	78.0%	220	10	360	95.7%

AREA 1

	STATION D DEPTH 0-10				STATION D DEPTH 10-30				STATION D DEPTH >30				STATION D DEPTH ALL			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	100	0	30	100.0%	6	1	30	85.7%	37	1	30	97.4%	143	2	90	98.6%
143	169	0	60	100.0%	50	5	60	90.9%	1	3	60	25.0%	220	8	180	96.5%
164	338	0	30	100.0%	147	0	30	100.0%	126	4	30	96.9%	609	4	90	99.3%

AREA 1

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	1703	33	450	98.1%
143	1500	18	540	98.8%
164	1202	15	450	98.8%
193	233	6	300	97.5%
220	188	3	270	98.4%
234	297	3	450	99.0%
262	1300	5	270	99.6%
293	420	2	270	99.5%
TOTALS	7032	86	3000	98.8%

AREA 2

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	267	3	150	98.9%
143	2244	13	540	99.4%
164	813	14	360	98.3%
193	364	8	270	97.8%
220	215	5	270	97.7%
234	388	13	450	96.8%
262	501	3	270	99.4%
293	212	2	270	99.1%
TOTALS	5004	61	2580	98.8%

AREA 3

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	86	6	210	93.5%
143	1531	22	540	98.6%
164	809	30	360	96.4%
193	181	6	360	96.8%
220	170	10	270	94.4%
234	367	13	360	96.6%
262	197	5	360	97.5%
293	241	5	270	98.0%
TOTALS	3582	97	2730	97.4%

AREA ALL

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER
115	2054	42
143	5366	54
164	2914	58
193	778	20
220	673	18
234	1062	28
262	2007	13
293	873	9
TOTALS	15818	244

193	0	0	30	0.0%	47	0	30	100.0%	2	1	30	66.7%	49	1	90	98.0%
220	156	0	30	100.0%	6	0	30	100.0%	0	.	30	0.0%	162	2	90	98.8%
234	13	0	30	100.0%	5	0	30	100.0%	1	1	30	50.0%	19	1	90	95.0%
262	233	1	30	99.6%	18	0	30	100.0%	7	2	30	77.8%	258	3	90	98.8%
293	41	0	30	100.0%	30	0	30	100.0%	40	1	30	97.6%	111	1	90	99.1%
TOTAL	1048	1	270	99.9%	307	6	270	98.1%	214	15	270	93.4%	1569	22	810	98.6%

AREA 1

	STATION E DEPTH 0-10				STATION E DEPTH 10-30				STATION E DEPTH >30				STATION E DEPTH ALL			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	485	0	30	100.0%	37	0	30	100.0%	9	13	30	40.9%	531	13	90	97.6%
143	N/A		0		N/A		0		N/A		0		N/A			
164	4	0	30	100.0%	3	0	30	100.0%	3	6	30	33.3%	10	6	90	62.5%
193	5	0	30	100.0%	N/A		0		N/A		0		5	0	30	100.0%
220	N/A		0		N/A		0		N/A		0		N/A			
234	101	0	30	100.0%	9	0	30	100.0%	90	0	30	100.0%	200	0	90	100.0%
262	N/A		0		N/A		0		N/A		0		N/A			
293	N/A		0		N/A		0		N/A		0		N/A			
TOTAL	595	0	150	100.0%	49	0	120	100.0%	102	19	120	84.3%	746	19	300	97.5%

AREA/ALL STATION/DEPTH/DATE

	AREA 1 STATION ALL DEPTH 0-10				AREA 1 STATION ALL DEPTH 10-30				AREA 1 STATION ALL DEPTH >30			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	1368	0	150	100.0%	230	3	150	98.7%	105	30	150	77.8%
143	1177	1	180	99.9%	144	9	180	94.1%	269	9	180	96.8%
164	841	1	150	99.9%	301	0	150	100.0%	150	14	150	91.5%
193	49	2	150	96.1%	168	0	120	100.0%	16	4	120	80.0%
220	103	0	90	100.0%	21	0	90	100.0%	4	3	90	57.1%
234	173	0	150	100.0%	24	0	150	100.0%	100	3	150	97.1%
262	619	3	90	99.5%	596	0	90	100.0%	32	2	90	94.1%
293	77	0	90	100.0%	118	0	90	100.0%	227	2	90	99.1%
TOTAL	4527	7	1050	99.8%	1602	12	1020	99.3%	903	67	1020	93.1%

AREA 2

AREA/STATION/ALL DEPTH/DATE

	STATION A DEPTH 0-10				STATION A DEPTH 10-30				STATION A DEPTH >30				STATION A DEPTH ALL			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0		N/A		0		N/A		0		N/A			
143	N/A		0		N/A		0		N/A		0		N/A			
164	4	1	30	80.0%	43	0	30	100.0%	30	1	30	96.8%	77	2	90	97.5%
193	N/A		0		N/A		0		N/A		0		N/A			
220	N/A		0		N/A		0		N/A		0		N/A			
234	57	0	30	100.0%	0	1	30	0.0%	0	1	30	0.0%	57	2	90	96.6%
262	N/A		0		N/A		0		N/A		0		N/A			
293	N/A		0		N/A		0		N/A		0		N/A			
TOTAL	61	1	60	98.4%	43	1	60	97.7%	30	2	60	93.8%	134	4	180	97.1%

AREA 2

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	267	3	150	1.78
143	2244	13	540	4.16
164	813	14	360	2.26
193	364	8	270	1.35
220	215	5	270	0.80
234	388	13	450	0.86
262	601	3	270	1.86
293	212	2	270	0.79
TOTALS	6004	61	2580	1.94

AREA 2

	STATION B DEPTH 0-10				STATION B DEPTH 10-30				STATION B DEPTH >30				STATION B DEPTH ALL			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	205	0	30	100.0%	29	1	30	96.7%	0	1	30	0.0%	234	2	90	99.2%
143	421	0	60	100.0%	88	0	60	100.0%	44	9	60	83.0%	653	9	180	98.4%
164	13	0	30	100.0%	50	0	30	100.0%	13	1	30	92.9%	76	1	90	98.7%
193	80	0	30	100.0%	11	0	30	100.0%	2	2	30	50.0%	93	2	90	97.9%
220	10	0	30	100.0%	14	0	30	100.0%	1	3	30	25.0%	25	3	90	89.3%
234	5	0	30	100.0%	18	2	30	90.0%	0	1	30	0.0%	23	3	90	88.5%
262	19	0	30	100.0%	10	0	30	100.0%	4	0	30	100.0%	33	0	90	100.0%
293	23	0	30	100.0%	22	0	30	100.0%	47	0	30	100.0%	92	0	90	100.0%
TOTAL	776	0	270	100.0%	242	3	270	98.8%	111	17	270	86.7%	1129	20	810	98.3%

AREA 2

	STATION C DEPTH 0-10				STATION C DEPTH 10-30				STATION C DEPTH >30				STATION C DEPTH ALL			
DATE	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK	#SOCK	#OTHER	TOW DUR	%SOCK
115	33	0	30	100.0%	N/A		0		0	1	30	0.0%	33	1	60	97.1%
143	N/A		0		N/A		0		N/A		0		N/A			
164	N/A		0		N/A		0		N/A		0		N/A			
193	N/A		0		N/A		0		N/A		0		N/A			
220	N/A		0		N/A		0		N/A		0		N/A			
234	182	0	30	100.0%	4	1	30	80.0%	0	1	30	0.0%	186	2	90	98.9%
262	N/A		0		N/A		0		N/A		0		N/A			
293	N/A		0		N/A		0		N/A		0		N/A			
TOTAL	215	0	60	100.0%	4	1	30	80.0%	0	2	60	0.0%	219	3	150	98.6%

AREA 2

AREA/ALL STATION/DEPTH/DATE
AREA 2
STATION ALL
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
115	238	0	60	3.97
143	1980	0	180	11.00
164	460	5	120	3.83
193	250	1	90	2.78
220	125	0	90	1.39
234	344	0	150	2.29
262	416	2	90	4.62
293	40	0	90	0.44
TOTALS	3853	8	870	4.43

AREA 2
STATION ALL
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
29	1	30	0.97
125	2	180	0.69
266	3	120	2.22
96	2	90	1.07
83	1	90	0.92
41	5	150	0.27
52	0	90	0.58
72	0	90	0.80
764	14	840	0.91

AREA 2
STATION ALL
DEPTH >30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
0	2	60	0.00
139	11	180	0.77
87	6	120	0.73
18	5	90	0.20
7	4	90	0.08
3	8	150	0.02
33	1	90	0.37
100	2	90	1.11
387	39	870	0.44

AREA 3
STATION A
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
115	N/A		0	
143	19	0	60	0.32
164	27	0	30	0.90
193	0	1	30	0.00
220	18	1	30	0.60
234	8	0	30	0.27
262	39	2	30	1.30
293	18	1	30	0.60
TOTALS	129	5	240	0.54

STATION A
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
N/A		0	
232	1	60	3.87
97	0	30	3.23
46	0	30	1.53
3	3	30	0.10
1	1	30	0.03
5	0	30	0.17
55	1	30	1.83
439	6	240	1.83

STATION A
DEPTH >30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
N/A		0	
27	4	60	0.45
101	10	30	3.37
9	2	30	0.30
1	2	30	0.03
1	0	30	0.03
3	0	30	0.10
11	0	30	0.37
153	18	240	0.64

AREA/STATION/ALL DEPTH/DATE
STATION A
DEPTH ALL

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
N/A			
278	5	180	1.54
225	10	90	2.50
55	3	90	0.61
22	6	90	0.24
10	1	90	0.11
47	2	90	0.52
84	2	90	0.93
721	29	720	1.00

AREA 3

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
115	86	8	210	0.41
143	1531	22	540	2.84
164	809	30	360	2.25
193	181	8	360	0.50
220	170	10	270	0.63
234	367	13	360	1.02
262	197	6	360	0.55
293	241	5	270	0.89
TOTALS	3582	97	2730	1.31

AREA 3
STATION B
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
116	77	1	30	2.57
143	N/A		0	
164	35	1	30	1.17
193	2	0	30	0.07
220	N/A		0	
234	137	1	30	4.57
262	39	0	30	1.30
293	N/A		0	
TOTALS	290	3	150	1.93

STATION B
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
N/A		0	
N/A		0	
73	0	30	2.43
21	0	30	0.70
N/A		0	
8	1	30	0.27
13	0	30	0.43
N/A		0	
115	1	120	0.96

STATION B
DEPTH >30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
N/A		0	
N/A		0	
37	0	30	1.23
3	0	30	0.10
N/A		0	
0	2	30	0.00
5	0	30	0.17
N/A		0	
45	2	120	0.38

STATION B
DEPTH ALL

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
77	1	30	2.57
N/A			
145	1	90	1.61
26	0	90	0.29
N/A			
145	4	90	1.61
57	0	90	0.63
N/A			
450	6	390	1.15

AREA 3
STATION C
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
115	N/A		0	
143	55	0	60	0.92
164	30	1	30	1.00
193	2	0	30	0.07
220	58	1	30	1.93
234	125	4	30	4.17
262	16	0	30	0.53
293	12	1	30	0.40
TOTALS	298	7	240	1.24

STATION C
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
N/A		0	
204	5	60	3.40
195	4	30	6.50
34	0	30	1.13
3	0	30	0.10
15	0	30	0.50
7	0	30	0.23
32	0	30	1.07
490	9	240	2.04

STATION C
DEPTH >30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
N/A		0	
26	8	60	0.43
16	1	30	0.53
3	1	30	0.10
0	0	30	0.00
0	1	30	0.00
4	0	30	0.13
22	1	30	0.73
71	12	240	0.30

STATION C
DEPTH ALL

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
N/A			
285	13	180	1.58
241	6	90	2.68
39	1	90	0.43
61	1	90	0.68
140	5	90	1.56
27	0	90	0.30
66	2	90	0.73
859	28	720	1.19

AREA 3
STATION D
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
115	7	1	30	0.23
143	711	0	60	11.85
164	20	2	30	0.67
193	0	1	30	0.00
220	84	0	30	2.80
234	68	1	30	2.27
262	40	1	30	1.33
293	23	0	30	0.77
TOTALS	953	6	270	3.53

STATION D
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
0	0	30	0.00
238	1	60	3.97
75	3	30	2.50
32	0	30	1.07
2	1	30	0.07
4	1	30	0.13
20	1	30	0.67
44	1	30	1.47
415	8	270	1.54

STATION D
DEPTH >30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
0	3	30	0.00
19	3	60	0.32
103	8	30	3.43
29	1	30	0.97
1	2	30	0.03
0	1	30	0.00
6	1	30	0.20
24	0	30	0.80
182	19	270	0.67

STATION D
DEPTH ALL

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
7	4	90	0.08
968	4	180	5.38
198	13	90	2.20
61	2	90	0.68
87	3	90	0.97
72	3	90	0.80
66	3	90	0.73
91	1	90	1.01
1550	33	810	1.91

AREA 3
STATION E
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	$ FIS/MIN
115	2	0	30	0.07
143	N/A		0	

STATION E
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
0	0	30	0.00
N/A		0	

STATION E
DEPTH >30

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
0	1	30	0.00
N/A		0	

STATION E
DEPTH ALL

#SOCK	#OTHER	TOW DUR	$ FIS/MIN
2	1	90	0.02
N/A			

143	1177	1	180	6.54	144	8	180	0.80	269	9	180	1.49
164	841	1	150	5.61	301	0	150	2.01	150	14	150	1.00
193	49	2	150	0.33	168	0	120	1.40	16	4	120	0.13
220	163	0	90	1.81	21	0	90	0.23	4	3	90	0.04
234	173	0	150	1.15	24	0	150	0.16	100	3	150	0.67
262	679	3	90	7.54	608	0	90	6.64	32	2	90	0.36
293	77	0	90	0.86	118	0	90	1.29	227	2	90	2.52
TOTAL	4527	7	1050	4.31	1602	12	1020	1.57	903	67	1020	0.89

AREA 2

AREA/STATION/ALL DEPTH/DATE

DATE	STATION A DEPTH 0-10				STATION A DEPTH 10-30				STATION A DEPTH >30				STATION A DEPTH ALL			
	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN
115	N/A		0		N/A		0		N/A		0		N/A			
143	N/A		0		N/A		0		N/A		0		N/A			
164	4	1	30	0.13	43	0	30	1.43	30	1	30	1.00	77	2	90	0.86
193	N/A		0		N/A		0		N/A		0		N/A			
220	N/A		0		N/A		0		N/A		0		N/A			
234	57	0	30	1.90	0	1	30	0.00	0	1	30	0.00	57	2	90	0.63
262	N/A		0		N/A		0		N/A		0		N/A			
293	N/A		0		N/A		0		N/A		0		N/A			
TOTAL	61	1	60	1.02	43	1	60	0.716667	30	2	60	0.50	134	4	180	0.74

AREA 2

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	S FIS/MIN
115	267	3	150	1.78
143	2244	13	540	4.16
164	813	14	360	2.26
193	364	8	270	1.35
220	215	5	270	0.80
234	388	13	450	0.86
262	501	3	270	1.86
293	212	2	270	0.79
TOTALS	5004	61	2580	1.94

AREA 2

DATE	STATION B DEPTH 0-10				STATION B DEPTH 10-30				STATION B DEPTH >30				STATION B DEPTH ALL			
	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN
115	205	0	30	6.83	29	1	30	0.97	0	1	30	0.00	234	2	90	2.60
143	421	0	60	7.02	88	0	60	1.47	44	8	60	0.73	553	8	180	3.07
164	13	0	30	0.43	50	0	30	1.67	13	1	30	0.43	76	1	90	0.84
193	80	0	30	2.67	11	0	30	0.37	2	2	30	0.07	93	2	90	1.03
220	10	0	30	0.33	14	0	30	0.47	1	3	30	0.03	25	3	90	0.28
234	5	0	30	0.17	18	2	30	0.60	0	1	30	0.00	23	3	90	0.26
262	19	0	30	0.63	10	0	30	0.33	4	0	30	0.13	33	0	90	0.37
293	23	0	30	0.77	22	0	30	0.73	47	0	30	1.57	92	0	90	1.02
TOTAL	776	0	270	2.87	242	3	270	0.90	111	17	270	0.41	1129	20	810	1.39

AREA 2

DATE	STATION C DEPTH 0-10				STATION C DEPTH 10-30				STATION C DEPTH >30				STATION C DEPTH ALL			
	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN
115	33	0	30	1.10	N/A		0		0	1	30	0.00	33	1	60	0.55
143	N/A		0		N/A		0		N/A		0		N/A			
164	N/A		0		N/A		0		N/A		0		N/A			
193	N/A		0		N/A		0		N/A		0		N/A			
220	N/A		0		N/A		0		N/A		0		N/A			
234	182	0	30	6.07	4	1	30	0.13	0	1	30	0.00	186	2	90	2.07
262	N/A		0		N/A		0		N/A		0		N/A			
293	N/A		0		N/A		0		N/A		0		N/A			
TOTAL	215	0	60	3.58	4	1	30	0.13	0	2	60	0.00	219	3	150	1.46

AREA 2

DATE	STATION D DEPTH 0-10				STATION D DEPTH 10-30				STATION D DEPTH >30				STATION D DEPTH ALL			
	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN
115	N/A		0		N/A		0		N/A		0		N/A			
143	1212	0	60	20.20	15	1	60	0.25	4	1	60	0.07	1231	2	180	6.84
164	407	1	30	13.57	127	0	30	4.23	9	2	30	0.30	543	3	90	6.03
193	168	0	30	5.60	36	0	30	1.20	3	1	30	0.10	207	1	90	2.30
220	37	0	30	1.23	52	0	30	1.73	2	0	30	0.07	91	0	90	1.01
234	93	0	30	3.10	8	0	30	0.27	2	1	30	0.07	103	1	90	1.14
262	250	1	30	8.33	21	0	30	0.70	20	0	30	0.67	291	1	90	3.23
293	15	0	30	0.50	17	0	30	0.57	19	2	30	0.63	51	2	90	0.57
TOTAL	2182	2	240	9.09	276	1	240	1.15	59	7	240	0.25	2517	10	720	3.50

AREA 2

DATE	STATION E DEPTH 0-10				STATION E DEPTH 10 30				STATION E DEPTH >30				STATION E DEPTH ALL			
	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN	#SOCK	#OTHER	TOW DUR	S FIS/MIN
115	N/A		0		N/A		0		N/A		0		N/A			
143	347	0	60	5.78	22	1	60	0.37	91	1	60	1.52	460	2	180	2.56
164	36	3	30	1.20	46	3	30	1.53	35	2	30	1.17	117	8	90	1.30
193	2	1	30	0.07	49	2	30	1.63	13	2	30	0.43	64	5	90	0.71
220	78	0	30	2.60	17	1	30	0.57	4	1	30	0.13	99	2	90	1.10
234	7	0	30	0.23	11	1	30	0.37	1	4	30	0.03	19	5	90	0.21
262	147	1	30	4.90	21	0	30	0.70	9	1	30	0.30	177	2	90	1.97
293	2	0	30	0.07	33	0	30	1.10	34	0	30	1.13	69	0	90	0.77
TOTAL	619	5	240	2.58	199	8	240	0.83	187	11	240	0.78	1005	24	720	1.40

STATION D
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	1212	0	60	100.0%
164	407	1	30	99.8%
193	168	0	30	100.0%
220	37	0	30	100.0%
234	93	0	30	100.0%
262	250	1	30	99.6%
293	15	0	30	100.0%
TOTAL:	2182	2	240	99.9%

STATION D
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	15	1	60	93.8%
164	127	0	30	100.0%
193	36	0	30	100.0%
220	52	0	30	100.0%
234	8	0	30	100.0%
262	21	0	30	100.0%
293	17	0	30	100.0%
TOTAL:	276	1	240	99.6%

STATION D
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	4	1	60	80.0%
164	9	2	30	81.8%
193	3	1	30	75.0%
220	2	0	30	100.0%
234	2	1	30	66.7%
262	20	0	30	100.0%
293	19	2	30	90.5%
TOTAL:	59	7	240	89.4%

STATION D
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A			
143	1231	2	180	99.8%
164	543	3	90	99.5%
193	207	1	90	99.5%
220	91	0	90	100.0%
234	103	1	90	99.0%
262	291	1	90	99.7%
293	51	2	90	96.2%
TOTAL:	2517	10	720	99.6%

AREA 2

STATION E
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	347	0	60	100.0%
164	36	3	30	92.3%
193	2	1	30	66.7%
220	78	0	30	100.0%
234	7	0	30	100.0%
262	147	1	30	99.3%
293	2	0	30	100.0%
TOTAL	619	6	240	99.2%

STATION E
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	22	1	60	95.7%
164	46	3	30	93.9%
193	49	2	30	96.1%
220	17	1	30	94.4%
234	11	1	30	91.7%
262	21	0	30	100.0%
293	33	0	30	100.0%
TOTAL	199	8	240	96.1%

STATION E
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	91	1	60	98.9%
164	35	2	30	94.6%
193	13	2	30	86.7%
220	4	1	30	80.0%
234	1	4	30	20.0%
262	9	1	30	90.0%
293	34	0	30	100.0%
TOTAL	187	11	240	94.4%

STATION E
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A			
143	460	2	180	99.6%
164	117	8	90	93.6%
193	64	5	90	92.8%
220	99	2	90	98.0%
234	19	5	90	79.2%
262	177	2	90	98.9%
293	69	0	90	100.0%
TOTAL	1005	24	720	97.7%

AREA/ALL STATION/DEPTH/DATE

AREA 2
STATION ALL
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	238	0	60	100.0%
143	1000	0	180	100.0%
164	480	5	120	99.0%
193	250	1	90	99.6%
220	125	0	90	100.0%
234	344	0	150	100.0%
262	418	2	90	99.5%
293	40	0	90	100.0%
TOTAL:	3853	8	870	99.8%

AREA 2
STATION ALL
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	79	1	30	98.7%
143	125	2	180	98.4%
164	264	3	120	98.9%
193	96	2	90	98.0%
220	83	1	90	98.8%
234	41	5	150	89.1%
262	62	0	90	100.0%
293	72	0	90	100.0%
TOTAL:	764	14	840	98.2%

AREA 2
STATION ALL
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	0	2	60	0.0%
143	139	11	180	92.7%
164	87	6	120	90.6%
193	18	5	90	78.3%
220	7	4	90	63.6%
234	3	8	150	27.3%
262	33	1	90	97.1%
293	100	2	90	98.0%
TOTAL:	387	39	870	90.8%

AREA 3

STATION A
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	19	0	60	100.0%
164	27	0	30	100.0%
193	0	1	30	0.0%
220	18	1	30	94.7%
234	8	0	30	100.0%
262	39	2	30	95.1%
293	18	1	30	94.7%
TOTAL:	129	5	240	96.3%

STATION A
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	232	1	60	99.6%
164	97	0	30	100.0%
193	46	0	30	100.0%
220	3	3	30	50.0%
234	1	1	30	50.0%
262	5	0	30	100.0%
293	55	1	30	98.2%
TOTAL:	439	6	240	98.7%

STATION A
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	27	4	60	87.1%
164	101	10	30	91.0%
193	9	2	30	81.8%
220	1	2	30	33.3%
234	1	0	30	100.0%
262	3	0	30	100.0%
293	11	0	30	100.0%
TOTAL:	153	18	240	89.5%

AREA/STATION/ALL DEPTH/DATE

STATION A
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A			
143	278	5	180	98.2%
164	225	10	90	95.7%
193	55	3	90	94.8%
220	22	6	90	78.6%
234	10	1	90	90.9%
262	47	2	90	95.9%
293	84	2	90	97.7%
TOTAL:	721	29	720	96.1%

AREA 3

STATION ALL
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	86	6	210	0.41
143	1531	22	540	2.84
164	809	30	360	2.25
193	181	6	360	0.50
220	170	10	270	0.63
234	367	13	360	1.02
262	197	5	360	0.55
293	241	5	270	0.89
TOTALS	3582	97	2730	1.31

AREA 3

STATION B
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	77	1	30	98.7%
143	N/A		0	
164	35	1	30	97.2%
193	2	0	30	100.0%
220	N/A		0	
234	137	1	30	99.3%
262	39	0	30	100.0%
293	N/A		0	
TOTAL:	290	3	150	99.0%

STATION B
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	N/A		0	
164	73	0	30	100.0%
193	21	0	30	100.0%
220	N/A		0	
234	8	1	30	88.9%
262	13	0	30	100.0%
293	N/A		0	
TOTAL:	115	1	120	99.1%

STATION B
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	N/A		0	
164	37	0	30	100.0%
193	3	0	30	100.0%
220	N/A		0	
234	0	2	30	0.0%
262	5	0	30	100.0%
293	N/A		0	
TOTAL:	45	2	120	95.7%

STATION B
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	77	1	30	98.7%
143	N/A			
164	145	1	90	99.3%
193	26	0	90	100.0%
220	N/A			
234	145	4	90	97.3%
262	57	0	90	100.0%
293	N/A			
TOTAL:	450	6	390	98.7%

AREA 3

STATION C
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	55	0	60	100.0%
164	30	1	30	96.8%
193	2	0	30	100.0%
220	58	1	30	98.3%

STATION C
DEPTH 10-30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	204	5	60	97.6%
164	195	4	30	98.0%
193	34	0	30	100.0%
220	3	0	30	100.0%

STATION C
DEPTH >30

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A		0	
143	26	8	60	76.5%
164	16	1	30	94.1%
193	3	1	30	75.0%
220	0	0	30	0.0%

STATION C
DEPTH ALL

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	N/A			
143	285	13	180	95.6%
164	241	6	90	97.6%
193	39	1	90	97.5%
220	61	1	90	98.4%

234	125	4	30	96.9%	15	0	30	100.0%	0	1	30	0.0%	140	5	90	96.6%
262	18	0	30	100.0%	7	0	30	100.0%	4	0	30	100.0%	27	0	90	100.0%
293	12	1	30	92.3%	32	0	30	100.0%	22	1	30	95.7%	66	2	90	97.1%
TOTAL:	298	7	240	97.7%	490	9	240	98.2%	71	12	240	85.5%	859	28	720	96.8%

AREA 3

STATION D
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	7	1	30	87.5%
143	711	0	60	100.0%
164	20	2	30	90.9%
193	0	1	30	0.0%
220	84	0	30	100.0%
234	68	1	30	98.6%
262	40	1	30	97.6%
293	23	0	30	100.0%
TOTAL:	953	6	270	99.4%

STATION D
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	%SOCK
0	0	30	0.0%
238	1	60	99.6%
75	3	30	96.2%
32	0	30	100.0%
2	1	30	66.7%
4	1	30	80.0%
20	1	30	95.2%
44	1	30	97.8%
415	8	270	98.1%

STATION D
DEPTH >30

#SOCK	#OTHER	TOW DUR	%SOCK
0	3	30	0.0%
19	3	60	86.4%
103	8	30	92.8%
29	1	30	96.7%
1	2	30	33.3%
0	1	30	0.0%
6	1	30	85.7%
24	0	30	100.0%
182	19	270	90.5%

STATION D
DEPTH ALL

#SOCK	#OTHER	TOW DUR	%SOCK
7	4	90	63.6%
968	4	180	99.6%
198	13	90	93.8%
61	2	90	96.8%
87	3	90	96.7%
72	3	90	96.0%
66	3	90	95.7%
91	1	90	98.9%
1550	33	810	97.9%

AREA 3

STATION E
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	2	0	30	100.0%
143	N/A		0	
164	N/A		0	
193	N/A		0	
220	N/A		0	
234	N/A		0	
262	N/A		0	
293	N/A		0	
TOTAL:	2	0	30	100.0%

STATION E
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	%SOCK
0	0	30	0.0%
N/A		0	
N/A		0	
N/A		0	
N/A		0	
N/A		0	
N/A		0	
N/A		0	
0	0	30	0.0%

STATION E
DEPTH >30

#SOCK	#OTHER	TOW DUR	# FIS/MIN
0	1	30	0.0%
N/A		0	
N/A		0	
N/A		0	
N/A		0	
N/A		0	
N/A		0	
N/A		0	
0	1	30	0.0%

STATION E
DEPTH ALL

#SOCK	#OTHER	TOW DUR	%SOCK
2	1	90	66.7%
N/A			
N/A			
N/A			
N/A			
N/A			
N/A			
N/A			
2	1	90	66.7%

AREA/ALL STATION/DEPTH/DATE

AREA 3
STATION ALL
DEPTH 0-10

DATE	#SOCK	#OTHER	TOW DUR	%SOCK
115	84	2	90	97.7%
143	785	0	180	100.0%
164	112	4	120	96.6%
193	4	2	120	66.7%
220	180	2	90	98.9%
234	338	6	120	98.3%
262	134	3	120	97.8%
293	63	2	90	96.9%
TOTAL:	1672	21	930	98.8%

AREA 3
STATION ALL
DEPTH 10-30

#SOCK	#OTHER	TOW DUR	%SOCK
0	0	90	0.0%
674	7	180	99.0%
440	7	120	98.4%
133	0	120	100.0%
8	4	90	66.7%
28	3	120	90.3%
45	1	120	97.8%
131	2	90	98.5%
1459	24	900	98.4%

AREA 3
STATION ALL
DEPTH >30

#SOCK	#OTHER	TOW DUR	%SOCK
0	4	90	0.0%
72	15	180	82.8%
257	19	120	93.1%
44	4	120	91.7%
2	4	90	33.3%
1	4	120	20.0%
18	1	120	94.7%
57	1	90	98.3%
451	52	900	89.7%

APPENDIX G

SKILAK

11/03/95

WATER QUALITY SUMMARY
General Tests and Metals

LAKE	DATE	STA	DEPTH (M)	Sp. Cond. (umhos/cm)	Ph (Units)	Alkalinity (mg/l)	Turbidity (NTU)	Color (Pt)	Calcium (mg/l)	Magnesium (mg/l)	Iron (ug/l)
SKILAK	04/25/94	A	1	61	6.7	18.0	7.4	3	10.0	<0.3	413
SKILAK	04/25/94	A	2	NA	NA	NA	NA	NA	NA	NA	NA
SKILAK	04/25/94	A	50	61	6.6	19.0	8.5	4	10.0	<0.3	406
SKILAK	04/25/94	B	1	62	6.6	20.0	11.2	5	11.0	<0.3	588
SKILAK	04/25/94	C	1	61	6.6	21.0	6.5	5	10.0	0.7	391
SKILAK	05/25/94	A	1	59	6.9	21.0	8.3	4	9.5	<0.3	462
SKILAK	05/25/94	A	50	60	6.8	21.0	10.3	5	9.5	0.8	485
SKILAK	05/25/94	B	1	60	6.7	19.0	5.0	5	9.5	0.8	426
SKILAK	05/25/94	B	50	61	6.6	18.5	3.9	6	9.5	0.8	302
SKILAK	05/25/94	C	1	61	6.6	18.5	4.2	4	9.5	0.8	330
SKILAK	05/25/94	C	50	61	6.6	19.0	8.8	3	9.5	0.8	456
SKILAK	06/23/94	A	1	64	7.3	21.0	8.6	6	10.4	<0.3	383
SKILAK	06/23/94	A	2	NA	NA	NA	NA	NA	NA	NA	NA
SKILAK	06/23/94	A	70	63	7.2	21.0	10.0	4	10.4	0.7	432
SKILAK	06/23/94	B	1	63	7.3	20.0	5.3	9	10.4	0.7	205
SKILAK	06/23/94	B	2	NA	NA	NA	NA	NA	NA	NA	NA
SKILAK	06/23/94	B	50	63	7.3	20.0	12.4	4	10.4	0.7	578
SKILAK	06/23/94	C	1	64	7.3	21.0	8.7	3	9.6	0.7	410
SKILAK	06/23/94	C	2	NA	NA	NA	NA	NA	NA	NA	NA
SKILAK	06/23/94	C	50	65	7.2	21.0	10.2	4	9.6	0.7	408
SKILAK	07/13/94	A	1	69	7.0	23.0	7.8	4	10.0	<0.3	292
SKILAK	07/13/94	A	50	68	6.7	23.0	7.5	4	10.0	0.5	310
SKILAK	07/13/94	B	1	69	6.8	24.0	7.2	4	10.0	0.5	366
SKILAK	07/13/94	B	50	68	6.8	24.0	9.0	12	10.0	<0.3	156
SKILAK	07/13/94	C	1	69	6.8	24.0	7.2	5	10.0	<0.3	318
SKILAK	07/13/94	C	50	68	7.0	23.0	12.9	5	10.0	0.7	566
SKILAK	08/10/94	A	1	68	6.8	21.0	1.7	5	9.5	0.6	104
SKILAK	08/10/94	A	50	67	6.8	25.0	7.7	8	9.5	0.6	319
SKILAK	08/10/94	B	1	73	6.9	21.0	5.4	9	9.5	<0.3	529
SKILAK	08/10/94	B	50	64	6.8	22.0	21.0	12	9.5	0.6	791
SKILAK	08/10/94	C	1	71	6.8	25.0	2.2	12	9.5	0.6	183
SKILAK	08/10/94	C	50	66	6.9	27.0	13.2	10	9.5	0.6	602
SKILAK	09/27/94	A	1	66	7.5	22.5	7.4	6	9.9	0.6	388
SKILAK	09/27/94	A	50	65	7.4	22.0	12.2	5	9.9	0.6	528
SKILAK	09/27/94	B	1	68	7.4	22.5	9.2	6	9.9	0.6	442
SKILAK	09/27/94	B	50	62	7.4	20.5	25.2	6	9.9	0.6	1584
SKILAK	09/27/94	C	1	65	7.4	21.5	8.4	9	9.9	0.6	393
SKILAK	09/27/94	C	50	64	7.4	21.5	11.1	10	9.9	0.6	842
SKILAK	10/19/94	A	1	64	6.7	20.0	9.8	8	10.0	0.6	360
SKILAK	10/19/94	A	50	64	6.8	20.0	10.9	9	10.0	0.6	516
SKILAK	10/19/94	B	1	64	6.8	20.5	13.6	9	10.0	0.6	672
SKILAK	10/19/94	B	50	64	6.8	20.0	13.8	6	10.0	0.6	658
SKILAK	10/19/94	C	1	64	6.8	20.5	12.0	8	10.0	0.6	590
SKILAK	10/19/94	C	50	64	6.8	20.5	10.7	5	10.0	0.6	288

SKILAK

WATER QUALITY SUMMARY
Nutrients and Primary Production

LAKE	DATE	STA	DEPTH (M)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH3+NH4 (ug/l)	NO3+NO2 (ug/l)	RSi (ug/l)	Carbon (ug/l)	TPP (ug/l)	Chl a (ug/l)	Phaeo a (ug/l)
SKILAK	04/25/94	A	1	5.5	2.7	1.0	34.7	<1.7	202.7	1511	61	NA	0.24	0.16
SKILAK	04/25/94	A	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.23	0.20
SKILAK	04/25/94	A	50	9.1	2.7	1.5	33.1	<1.7	208.5	1463	38	NA	0.18	0.06
SKILAK	04/25/94	B	1	11.7	2.5	1.9	24.2	<1.7	220.9	1475	30	NA	0.32	0.28
SKILAK	04/25/94	C	1	16.7	2.7	2.2	40.3	<1.7	221.8	1457	38	NA	0.32	0.26
SKILAK	05/25/94	A	1	5.9	1.5	1.3	23.4	<1.7	217.6	1336	55	NA	0.29	0.11
SKILAK	05/25/94	A	50	4.5	2.0	1.7	28.2	<1.7	217.6	1336	33	NA	0.19	0.11
SKILAK	05/25/94	B	1	3.9	1.5	1.3	27.4	<1.7	240.0	1360	30	NA	0.12	0.12
SKILAK	05/25/94	B	50	4.8	4.6	4.0	27.4	<1.7	235.8	1383	33	NA	0.08	0.07
SKILAK	05/25/94	C	1	5.5	1.0	1.2	25.0	<1.7	224.2	1360	33	NA	0.18	0.16
SKILAK	05/25/94	C	50	6.3	0.9	1.4	26.6	2.1	211.8	1360	33	NA	0.13	0.07
SKILAK	06/23/94	A	1	10.6	2.2	2.3	44.1	2.7	198.5	1420	94	NA	0.43	0.25
SKILAK	06/23/94	A	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.56	0.27
SKILAK	06/23/94	A	70	8.4	0.9	1.1	24.6	<1.7	216.8	1369	41	NA	0.12	0.10
SKILAK	06/23/94	B	1	7.4	3.2	4.1	31.4	<1.7	207.6	1375	74	NA	0.47	0.21
SKILAK	06/23/94	B	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.40	0.25
SKILAK	06/23/94	B	50	9.8	0.9	1.2	26.9	<1.7	223.4	1429	52	NA	0.09	0.09
SKILAK	06/23/94	C	1	4.0	1.1	0.9	32.1	2.1	215.1	1405	80	NA	0.58	0.20
SKILAK	06/23/94	C	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.47	0.18
SKILAK	06/23/94	C	50	10.3	0.8	1.1	29.1	2.1	223.4	1429	33	NA	0.09	0.08
SKILAK	07/13/94	A	1	5.3	0.7	0.9	30.6	2.1	206.0	1298	66	NA	0.22	0.11
SKILAK	07/13/94	A	50	7.6	0.8	1.4	28.4	2.1	223.4	1298	55	NA	0.10	0.08
SKILAK	07/13/94	B	1	8.8	0.8	1.4	32.1	2.1	214.3	1298	61	NA	0.17	0.20
SKILAK	07/13/94	B	50	10.8	4.4	5.4	26.9	3.2	222.6	1499	41	NA	0.11	0.10
SKILAK	07/13/94	C	1	9.6	1.7	1.8	37.5	2.7	210.1	1384	77	NA	0.39	0.20
SKILAK	07/13/94	C	50	13.4	1.2	1.4	33.6	3.2	219.2	1327	61	NA	0.10	0.10
SKILAK	08/10/94	A	1	6.0	1.8	1.4	59.5	3.2	177.8	1488	110	NA	0.46	0.22
SKILAK	08/10/94	A	50	8.6	3.7	3.0	30.6	2.1	222.6	1508	33	NA	0.07	0.07
SKILAK	08/10/94	B	1	9.8	1.5	1.4	39.8	2.1	202.6	1570	93	NA	0.33	0.32
SKILAK	08/10/94	B	50	24.6	3.7	4.9	42.0	2.1	203.5	1502	193	NA	0.06	0.07
SKILAK	08/10/94	C	1	10.5	4.0	2.8	60.0	2.1	196.0	1529	117	NA	0.44	0.31
SKILAK	08/10/94	C	50	20.5	2.7	2.7	35.1	2.1	212.6	1502	69	NA	0.04	0.09
SKILAK	09/27/94	A	1	9.5	1.8	1.4	34.4	3.2	199.3	1384	94	NA	0.56	0.12
SKILAK	09/27/94	A	50	13.8	1.3	1.3	32.1	<1.7	206.0	1371	41	NA	0.03	0.08
SKILAK	09/27/94	B	1	8.1	1.9	1.7	38.2	4.3	226.7	1371	69	NA	0.38	0.17
SKILAK	09/27/94	B	50	28.8	3.1	2.6	44.3	<1.7	198.5	1328	96	NA	0.07	0.07
SKILAK	09/27/94	C	1	7.0	2.6	2.2	34.4	3.2	220.1	1346	45	NA	0.31	0.18
SKILAK	09/27/94	C	50	19.9	2.5	2.1	37.5	3.2	225.1	1359	71	NA	0.02	0.08
SKILAK	10/19/94	A	1	7.5	1.8	1.7	30.6	3.2	227.6	1406	30	NA	0.18	0.19
SKILAK	10/19/94	A	50	10.2	2.1	2.1	32.1	3.2	210.1	1386	36	NA	0.26	0.07
SKILAK	10/19/94	B	1	11.3	1.9	1.6	32.9	3.2	232.5	1386	44	NA	0.09	0.19
SKILAK	10/19/94	B	50	14.8	2.4	1.9	36.0	3.2	200.2	1348	36	NA	0.09	0.17
SKILAK	10/19/94	C	1	9.6	2.6	2.3	37.5	3.2	235.9	1336	50	NA	0.14	0.17
SKILAK	10/19/94	C	50	11.8	1.9	1.9	39.0	3.2	211.8	1323	55	NA	0.12	0.16

KENAI

WATER QUALITY SUMMARY
General Tests and Metals

LAKE	DATE	STA	DEPTH (M)	Sp. Cond. (umhos/cm)	Ph (Units)	Alkalinity (mg/l)	Turbidity (NTU)	Color (Pt)	Calcium (mg/l)	Magnesium (mg/l)	Iron (ug/l)
KENAI	05/06/94	B	1	69	6.3	22.0	6.7	11	13.0	<0.3	270
KENAI	05/06/94	B	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	05/06/94	B	50	70	6.5	22.5	6.7	5	12.0	<0.3	291
KENAI	05/06/94	C	1	69	6.4	22.0	6.8	4	15.0	<0.3	282
KENAI	05/06/94	C	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	05/06/94	C	50	69	6.6	22.0	6.3	5	12.0	0.7	273
KENAI	05/06/94	D	1	69	6.6	22.0	6.1	4	12.0	<0.3	238
KENAI	05/06/94	D	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	05/06/94	D	50	69	6.5	22.0	6.7	5	12.0	0.7	268
KENAI	06/08/94	B	1	72	6.9	22.0	6.0	10	11.6	<0.3	223
KENAI	06/08/94	B	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/08/94	B	50	73	6.9	22.0	4.0	2	10.6	<0.3	199
KENAI	06/08/94	C	1	61	6.9	22.0	1.7	2	11.6	<0.3	95
KENAI	06/08/94	C	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/08/94	C	50	69	6.9	21.0	5.0	2	11.6	<0.3	130
KENAI	06/08/94	D	1	72	6.8	22.0	4.1	2	11.6	<0.3	116
KENAI	06/08/94	D	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/08/94	D	50	72	6.8	22.0	5.3	3	11.6	<0.3	140
KENAI	06/30/94	B	1	78	7.0	23.5	3.9	2	11.8	0.7	145
KENAI	06/30/94	B	2A	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/30/94	B	2B	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/30/94	B	50	78	6.8	23.0	4.8	2	11.8	0.7	154
KENAI	06/30/94	C	1	77	7.0	23.5	6.0	2	11.8	0.7	218
KENAI	06/30/94	C	2A	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/30/94	C	2B	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/30/94	C	50	78	6.9	23.0	8.1	2	11.8	<0.3	334
KENAI	06/30/94	D	1	77	7.0	23.0	4.3	2	11.8	0.7	125
KENAI	06/30/94	D	2A	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/30/94	D	2B	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	06/30/94	D	50	76	6.8	23.0	4.8	2	11.8	0.7	78
KENAI	07/29/94	B	1	74	7.0	24.0	4.0	2	11.7	0.9	172
KENAI	07/29/94	B	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	07/29/94	B	50	74	7.0	24.0	4.2	4	11.7	0.9	172
KENAI	07/29/94	C	1	71	7.0	24.0	4.2	3	11.7	0.9	128
KENAI	07/29/94	C	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	07/29/94	C	50	73	7.2	24.0	5.7	2	11.7	0.9	260
KENAI	07/29/94	D	1	74	7.2	24.0	4.8	4	11.7	0.9	208
KENAI	07/29/94	D	2	NA	NA	NA	NA	NA	NA	NA	NA
KENAI	07/29/94	D	50	69	7.1	22.0	25.2	2	11.7	<0.3	1190
KENAI	08/16/94	B	1	71	6.9	24.0	5.5	18	10.5	0.6	178
KENAI	08/16/94	B	50	72	6.9	24.0	1.1	2	10.5	1.3	40
KENAI	08/16/94	C	1	69	7.0	22.0	13.3	4	10.5	0.6	596
KENAI	08/16/94	C	50	68	6.9	22.0	7.2	4	10.5	0.6	294
KENAI	08/16/94	D	1	70	7.0	23.0	10.7	2	10.5	0.6	418
KENAI	08/16/94	D	50	71	6.9	23.0	3.9	2	10.5	0.6	195
KENAI	09/28/94	B	1	71	7.0	21.0	3.6	2	10.9	0.6	152
KENAI	09/28/94	B	50	72	6.9	21.5	2.9	2	11.9	<0.3	173
KENAI	09/28/94	C	1	71	6.9	21.0	12.1	2	10.9	0.6	636
KENAI	09/28/94	C	50	71	6.9	21.0	7.3	2	10.9	0.6	658

KENAI

WATER QUALITY SUMMARY
Nutrients and Primary Production

LAKE	DATE	STA	DEPTH (M)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH3+NH4 (ug/l)	NO3+NO2 (ug/l)	RSi (ug/l)	Carbon (ug/l)	TPP (ug/l)	Chl a (ug/l)	Phaeo a (ug/l)
KENAI	05/06/94	B	1	6.7	8.6	7.2	32.1	<1.7	212.5	1555	36	NA	0.12	0.14
KENAI	05/06/94	B	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.28	0.10
KENAI	05/06/94	B	50	7.7	2.5	2.0	42.0	<1.7	214.4	1543	25	NA	0.28	0.07
KENAI	05/06/94	C	1	7.3	2.1	1.6	36.0	<1.7	214.4	1561	17	NA	0.10	0.13
KENAI	05/06/94	C	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.13	0.10
KENAI	05/06/94	C	50	7.5	2.5	1.9	32.9	<1.7	216.3	1561	<8	NA	0.14	0.05
KENAI	05/06/94	D	1	7.2	2.3	1.9	29.9	<1.7	214.4	1531	9	NA	0.13	0.14
KENAI	05/06/94	D	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.15	0.14
KENAI	05/06/94	D	50	7.3	2.4	1.9	30.6	<1.7	214.4	1513	9	NA	0.10	0.18
KENAI	06/08/94	B	1	6.0	6.7	6.7	32.9	2.2	205.2	1513	52	NA	0.22	0.16
KENAI	06/08/94	B	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.23	0.16
KENAI	06/08/94	B	50	7.8	1.7	1.7	46.7	2.8	242.8	1502	46	NA	0.16	0.19
KENAI	06/08/94	C	1	6.7	1.9	1.8	42.0	2.2	238.1	1572	33	NA	0.24	0.16
KENAI	06/08/94	C	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.22	0.18
KENAI	06/08/94	C	50	8.0	1.9	1.7	37.5	3.3	219.3	1513	20	NA	0.20	0.19
KENAI	06/08/94	D	1	6.9	2.6	2.2	37.5	4.9	216.2	1466	30	NA	0.26	0.20
KENAI	06/08/94	D	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.15	0.12
KENAI	06/08/94	D	50	6.5	2.4	2.2	47.4	2.8	216.2	1484	36	NA	0.24	0.19
KENAI	06/30/94	B	1	6.0	1.1	1.1	44.3	2.8	222.4	1599	30	NA	0.17	0.14
KENAI	06/30/94	B	2A	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.26	0.17
KENAI	06/30/94	B	2B	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.23	0.18
KENAI	06/30/94	B	50	9.1	2.7	1.7	58.8	2.8	228.7	1587	20	NA	0.13	0.19
KENAI	06/30/94	C	1	9.2	1.7	1.7	46.6	4.9	230.2	1732	44	NA	0.11	0.13
KENAI	06/30/94	C	2A	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.23	0.14
KENAI	06/30/94	C	2B	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.19	0.14
KENAI	06/30/94	C	50	12.0	2.8	1.4	42.8	4.9	220.9	1660	57	NA	0.18	0.20
KENAI	06/30/94	D	1	5.9	1.3	0.9	27.5	4.9	227.2	1574	30	NA	0.14	0.13
KENAI	06/30/94	D	2A	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.10	0.16
KENAI	06/30/94	D	2B	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.12	0.14
KENAI	06/30/94	D	50	7.0	1.0	0.9	30.6	3.9	228.7	1587	17	NA	0.16	0.19
KENAI	07/29/94	B	1	3.9	1.0	0.8	34.4	<1.7	213.0	1640	67	NA	0.16	0.16
KENAI	07/29/94	B	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.29	0.18
KENAI	07/29/94	B	50	4.8	5.2	2.8	29.8	<1.7	234.9	1616	20	NA	0.07	0.22
KENAI	07/29/94	C	1	5.0	3.7	1.9	39.1	<1.7	219.3	1598	33	NA	0.22	0.15
KENAI	07/29/94	C	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.30	0.16
KENAI	07/29/94	C	50	7.3	2.4	1.5	28.2	<1.7	230.2	1592	22	NA	0.04	0.26
KENAI	07/29/94	D	1	5.5	3.5	2.2	29.8	<1.7	219.3	1592	28	NA	0.13	0.14
KENAI	07/29/94	D	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.40	0.16
KENAI	07/29/94	D	50	25.4	1.2	1.4	36.0	<1.7	195.8	1507	83	NA	0.07	0.14
KENAI	08/16/94	B	1	6.8	11.8	11.1	39.9	2.8	234.9	1708	52	NA	0.21	0.17
KENAI	08/16/94	B	50	2.4	1.3	1.3	32.1	<1.7	231.8	1770	17	NA	0.05	0.11
KENAI	08/16/94	C	1	12.4	3.3	3.3	44.5	<1.7	177.0	1577	71	NA	0.32	0.38
KENAI	08/16/94	C	50	15.3	3.1	3.2	29.1	<1.7	220.9	1632	44	NA	0.05	0.10
KENAI	08/16/94	D	1	7.7	1.7	1.2	36.2	<1.7	194.2	1564	83	NA	0.34	0.21
KENAI	08/16/94	D	50	11.8	2.3	1.7	29.1	<1.7	222.4	1653	89	NA	0.04	0.10
KENAI	09/28/94	B	1	4.3	1.2	1.2	22.1	<1.7	188.0	1432	54	NA	0.21	0.16
KENAI	09/28/94	B	50	5.7	1.0	1.0	18.2	<1.7	217.8	1506	12	NA	0.05	0.08
KENAI	09/28/94	C	1	10.8	0.9	1.0	25.2	<1.7	184.8	1414	49	NA	0.16	0.16
KENAI	09/28/94	C	50	26.1	1.0	1.4	29.8	<1.7	203.6	1518	110	NA	0.03	0.07

WATER QUALITY SUMMARY

General Tests and Metals

LAKE	DATE	STA	DEPTH (M)	Sp. Cond. (umhos/cm)	Ph (Units)	Alkalinity (mg/l)	Turbidity (NTU)	Color (Pt)	Calcium (mg/l)	Magnesium (mg/l)	Iron (ug/l)
KENAI	09/28/94	D	1	70	7.1	21.0	2.1	4	10.9	0.6	142
KENAI	09/28/94	D	50	71	7.0	21.0	8.8	2	11.9	0.6	342
KENAI	10/25/94	B	1	70	6.4	24.0	6.7	2	13.0	<0.3	326
KENAI	10/25/94	B	50	70	6.4	24.0	1.9	2	12.0	<0.3	108
KENAI	10/25/94	C	1	69	6.5	23.0	3.7	2	12.0	<0.3	184
KENAI	10/25/94	C	50	70	6.6	22.0	1.7	2	12.0	<0.3	120
KENAI	10/25/94	D	1	70	6.4	22.0	7.1	2	12.0	0.7	413
KENAI	10/25/94	D	50	70	6.4	23.0	2.4	2	12.0	0.7	132

11/03/95

TUSTUMENA

WATER QUALITY SUMMARY

General Tests and Metals

LAKE	DATE	STA	DEPTH (M)	Sp. Cond. (umhos/cm)	Ph (Units)	Alkalinity (mg/l)	Turbidity (NTU)	Color (Pt)	Calcium (mg/l)	Magnesium (mg/l)	Iron (ug/l)
TUSTUMENA	04/26/94	A	1	42	6.5	14.0	44.5	9	5.0	0.7	2503
TUSTUMENA	04/26/94	A	30	40	6.4	13.0	43.6	8	5.0	0.7	2663
TUSTUMENA	04/26/94	B	1	40	6.4	14.0	44.3	4	5.0	0.7	2365
TUSTUMENA	04/26/94	B	50	40	6.4	15.0	44.0	6	5.0	0.7	2409
TUSTUMENA	04/26/94	C	1	40	6.5	14.0	40.0	8	5.0	0.7	2532
TUSTUMENA	04/26/94	C	50	40	6.6	14.0	43.9	6	5.0	0.7	2596
TUSTUMENA	05/24/94	A	1	40	7.4	12.5	33.1	4	4.8	1.6	2702
TUSTUMENA	05/24/94	A	25	40	7.2	12.5	43.0	5	4.8	1.6	2617
TUSTUMENA	05/24/94	B	1	40	7.1	12.0	47.6	6	4.8	1.6	2642
TUSTUMENA	05/24/94	B	50	40	7.0	11.0	30.8	6	4.8	0.8	2622
TUSTUMENA	05/24/94	C	1	40	6.8	11.0	28.3	8	4.8	0.8	2592
TUSTUMENA	05/24/94	C	50	40	6.7	10.0	31.3	4	4.8	0.8	2311
TUSTUMENA	06/17/94	A	1	43	6.7	13.5	45.0	9	5.0	1.4	2562
TUSTUMENA	06/17/94	A	25	43	6.6	13.0	48.1	13	5.0	1.4	2342
TUSTUMENA	06/17/94	B	1	43	6.8	13.0	48.6	5	5.0	0.7	2704
TUSTUMENA	06/17/94	B	50	43	6.7	13.0	49.8	5	5.0	0.7	2773
TUSTUMENA	06/17/94	C	1	43	6.8	12.5	49.0	6	5.0	0.7	2754
TUSTUMENA	06/17/94	C	50	42	6.7	12.5	50.3	8	5.0	0.7	2862
TUSTUMENA	07/06/94	A	1	42	6.8	12.0	43.4	6	5.0	1.4	1440
TUSTUMENA	07/06/94	A	25	42	6.8	12.0	47.0	9	5.0	1.4	1520
TUSTUMENA	07/06/94	B	1	42	6.8	12.0	46.0	8	5.0	1.4	1398
TUSTUMENA	07/06/94	B	50	41	6.7	12.0	48.0	8	5.0	1.4	1496
TUSTUMENA	07/06/94	C	1	42	6.7	12.0	50.3	5	5.0	1.4	1828
TUSTUMENA	07/06/94	C	50	42	6.7	12.0	50.3	4	5.0	1.4	1766
TUSTUMENA	07/28/94	A	1	42	7.1	15.0	39.9	5	4.9	1.3	2414
TUSTUMENA	07/28/94	A	30	41	7.0	15.0	47.1	6	4.9	1.5	2754
TUSTUMENA	07/28/94	B	1	39	7.0	14.0	40.6	4	4.9	0.9	2492
TUSTUMENA	07/28/94	B	50	41	7.0	15.0	44.1	5	4.9	1.5	2777
TUSTUMENA	07/28/94	C	1	40	7.0	15.0	41.4	5	4.9	0.9	2584
TUSTUMENA	07/28/94	C	50	40	7.0	15.0	46.5	4	4.9	1.5	2827
TUSTUMENA	08/18/94	A	1	42	6.7	13.0	35.5	4	5.0	0.7	2074
TUSTUMENA	08/18/94	A	30	42	6.5	13.0	30.1	4	5.0	1.7	1881
TUSTUMENA	08/18/94	B	1	40	6.7	13.0	29.0	5	5.0	0.7	1840
TUSTUMENA	08/18/94	B	50	40	6.5	13.0	32.2	8	6.0	0.7	2108
TUSTUMENA	08/18/94	C	1	39	6.7	13.0	30.0	4	5.0	0.7	1857
TUSTUMENA	08/18/94	C	50	40	6.7	13.0	31.1	5	5.0	0.7	1860
TUSTUMENA	09/12/94	A	1	43	6.9	13.0	39.0	5	4.9	1.4	2248
TUSTUMENA	09/12/94	A	25	43	6.8	13.0	48.0	6	4.9	0.6	2940
TUSTUMENA	09/12/94	B	1	43	6.8	13.0	39.0	5	4.9	1.4	2392
TUSTUMENA	09/12/94	B	50	44	6.8	13.0	49.0	4	4.9	1.4	2868
TUSTUMENA	09/12/94	C	1	43	6.8	13.0	41.0	5	4.9	1.4	2564
TUSTUMENA	09/12/94	C	50	43	6.8	13.0	50.0	4	4.9	0.6	3140
TUSTUMENA	10/12/94	A	1	41	6.6	11.5	41.0	4	5.0	1.3	2304
TUSTUMENA	10/12/94	A	30	41	6.6	12.0	41.9	4	5.0	1.3	2360
TUSTUMENA	10/12/94	B	1	41	6.6	11.5	45.9	4	5.0	1.3	2639
TUSTUMENA	10/12/94	B	50	41	6.6	11.5	51.2	5	5.0	1.3	2886
TUSTUMENA	10/12/94	C	1	42	6.6	11.5	43.5	4	5.0	1.3	2418
TUSTUMENA	10/12/94	C	50	41	6.6	11.5	49.0	3	5.0	1.3	2754

WATER QUALITY SUMMARY
Nutrients and Primary Production

LAKE	DATE	STA	DEPTH (M)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH3+NH4 (ug/l)	NO3+NO2 (ug/l)	RSi (ug/l)	Carbon (ug/l)	TPP (ug/l)	Chl a (ug/l)	Phaeo a (ug/l)
KENAI	09/28/94	D	1	4.3	2.4	2.6	21.3	<1.7	188.0	1420	33	NA	0.17	0.17
KENAI	09/28/94	D	50	12.5	2.3	1.2	24.4	<1.7	203.6	1488	99	NA	0.03	0.07
KENAI	10/25/94	B	1	8.9	0.8	1.2	23.6	<1.7	202.1	1647	33	NA	0.12	0.14
KENAI	10/25/94	B	50	8.7	0.9	1.2	24.4	<1.7	200.5	1586	27	NA	0.11	0.11
KENAI	10/25/94	C	1	10.9	1.6	1.2	23.6	<1.7	192.7	1568	44	NA	0.09	0.20
KENAI	10/25/94	C	50	10.5	2.5	1.2	23.6	<1.7	194.2	1623	38	NA	0.10	0.08
KENAI	10/25/94	D	1	7.2	2.6	1.3	19.8	<1.7	197.4	1598	38	NA	0.08	0.18
KENAI	10/25/94	D	50	10.4	2.6	1.2	24.4	<1.7	199.0	1604	30	NA	0.09	0.08

TUSTUMENA

WATER QUALITY SUMMARY

Nutrients and Primary Production

LAKE	DATE	STA	DEPTH (M)	TP (ug/l)	TFP (ug/l)	FRP (ug/l)	TKN (ug/l)	NH3+NH4 (ug/l)	NO3+NO2 (ug/l)	RSi (ug/l)	Carbon (ug/l)	TPP (ug/l)	Chl a (ug/l)	Phaeo a (ug/l)
TUSTUMENA	04/26/94	A	1	38.6	5.9	6.7	47.6	<1.7	80.6	2314	127	NA	0.05	0.13
TUSTUMENA	04/26/94	A	30	40.8	4.7	5.3	46.0	<1.7	91.8	2278	116	NA	0.03	0.12
TUSTUMENA	04/26/94	B	1	39.0	5.1	4.7	46.0	2.6	97.8	2218	66	NA	<0.01	0.14
TUSTUMENA	04/26/94	B	50	43.0	6.2	6.1	45.2	<1.7	98.5	2206	104	NA	<0.01	0.09
TUSTUMENA	04/26/94	C	1	39.1	7.2	7.1	46.8	2.6	97.0	2218	161	NA	0.02	0.15
TUSTUMENA	04/26/94	C	50	44.5	5.2	5.2	52.2	2.0	103.8	2206	125	NA	<0.01	0.07
TUSTUMENA	05/24/94	A	1	25.2	5.2	4.3	66.2	2.6	91.8	2206	156	NA	0.07	0.14
TUSTUMENA	05/24/94	A	25	32.1	5.1	4.3	60.5	<1.7	97.0	2182	156	NA	0.05	0.13
TUSTUMENA	05/24/94	B	1	34.8	4.9	3.8	71.2	3.6	91.8	2182	166	NA	0.03	0.14
TUSTUMENA	05/24/94	B	50	25.9	7.2	5.3	64.6	<1.7	93.2	2148	161	NA	0.03	0.09
TUSTUMENA	05/24/94	C	1	38.0	6.9	5.6	80.2	<1.7	93.2	2112	187	NA	0.02	0.14
TUSTUMENA	05/24/94	C	50	36.7	5.0	3.7	64.6	<1.7	103.8	2159	177	NA	<0.01	0.07
TUSTUMENA	06/17/94	A	1	42.6	5.7	4.9	77.7	<1.7	88.0	2760	332	NA	0.94	0.72
TUSTUMENA	06/17/94	A	25	43.0	9.0	8.3	58.4	<1.7	106.0	2737	203	NA	0.02	0.09
TUSTUMENA	06/17/94	B	1	41.8	4.7	4.6	57.6	<1.7	103.0	2138	172	NA	0.19	0.15
TUSTUMENA	06/17/94	B	50	44.5	5.2	4.7	53.8	<1.7	105.2	2126	135	NA	0.02	0.07
TUSTUMENA	06/17/94	C	1	46.1	5.8	5.0	52.2	<1.7	109.0	2126	140	NA	0.08	0.09
TUSTUMENA	06/17/94	C	50	47.1	5.2	3.5	53.8	<1.7	100.0	2114	151	NA	0.02	0.06
TUSTUMENA	07/06/94	A	1	35.7	3.4	3.0	71.5	<1.7	84.3	2024	259	NA	1.00	0.46
TUSTUMENA	07/06/94	A	25	42.2	5.2	5.3	55.3	<1.7	91.0	2024	161	NA	0.10	0.12
TUSTUMENA	07/06/94	B	1	32.1	3.5	3.4	51.4	<1.7	95.5	1909	151	NA	0.51	0.24
TUSTUMENA	07/06/94	B	50	41.0	5.5	5.4	66.1	<1.7	102.2	1966	270	NA	0.02	0.10
TUSTUMENA	07/06/94	C	1	37.5	5.3	5.2	53.8	<1.7	100.8	1909	259	NA	1.60	2.14
TUSTUMENA	07/06/94	C	50	46.4	5.0	5.3	53.0	<1.7	100.8	1938	244	NA	<0.01	0.08
TUSTUMENA	07/28/94	A	1	34.1	3.0	3.5	107.0	<1.7	84.3	2186	291	NA	0.55	0.38
TUSTUMENA	07/28/94	A	30	30.1	4.8	5.2	51.4	<1.7	100.8	2204	177	NA	NA	NA
TUSTUMENA	07/28/94	B	1	34.4	3.3	3.3	74.6	<1.7	91.8	2180	156	NA	0.41	0.48
TUSTUMENA	07/28/94	B	50	42.1	4.8	4.8	58.4	<1.7	103.0	2168	234	NA	0.02	0.15
TUSTUMENA	07/28/94	C	1	35.9	4.2	4.0	52.2	2.6	97.0	2180	368	NA	0.43	0.40
TUSTUMENA	07/28/94	C	50	42.0	4.0	3.9	46.0	<1.7	98.5	2186	228	NA	0.02	0.10
TUSTUMENA	08/18/94	A	1	25.1	2.9	2.8	56.1	<1.7	61.2	2304	441	NA	1.52	0.33
TUSTUMENA	08/18/94	A	30	44.0	4.5	5.1	46.8	<1.7	101.5	2414	223	NA	<0.01	0.27
TUSTUMENA	08/18/94	B	1	28.7	4.0	3.9	68.5	<1.7	58.2	2400	316	NA	1.82	0.20
TUSTUMENA	08/18/94	B	50	46.4	4.3	4.9	53.0	<1.7	102.2	2386	187	NA	0.02	0.12
TUSTUMENA	08/18/94	C	1	32.0	2.9	3.0	55.3	<1.7	63.3	2386	218	NA	1.08	0.38
TUSTUMENA	08/18/94	C	50	49.1	5.1	5.6	48.3	<1.7	103.0	2413	151	NA	NA	0.14
TUSTUMENA	09/12/94	A	1	27.8	3.8	3.7	41.4	<1.7	86.5	2090	280	NA	0.48	0.59
TUSTUMENA	09/12/94	A	25	39.1	6.9	7.0	51.5	<1.7	102.2	2102	182	NA	<0.01	0.26
TUSTUMENA	09/12/94	B	1	33.3	4.1	4.7	46.0	<1.7	91.8	2090	182	NA	0.31	0.44
TUSTUMENA	09/12/94	B	50	42.6	4.8	5.8	48.4	<1.7	107.5	2126	151	NA	0.03	0.11
TUSTUMENA	09/12/94	C	1	33.8	4.2	4.0	49.1	<1.7	91.8	2066	156	NA	0.30	0.44
TUSTUMENA	09/12/94	C	50	50.1	4.5	5.4	60.7	<1.7	100.8	2102	161	NA	<0.01	0.19
TUSTUMENA	10/12/94	A	1	32.6	4.0	4.8	45.2	<1.7	99.2	2468	265	NA	0.13	0.29
TUSTUMENA	10/12/94	A	30	38.2	3.7	4.6	50.6	<1.7	100.0	2316	311	NA	0.12	0.31
TUSTUMENA	10/12/94	B	1	35.5	4.3	4.2	45.2	<1.7	100.6	2188	156	NA	0.10	0.17
TUSTUMENA	10/12/94	B	50	42.9	4.8	5.7	51.5	<1.7	104.5	2138	130	NA	0.02	0.14
TUSTUMENA	10/12/94	C	1	35.5	4.5	4.8	48.3	<1.7	100.0	2049	130	NA	0.07	0.21
TUSTUMENA	10/12/94	C	50	44.0	3.5	4.7	53.0	<1.7	100.8	2074	130	NA	0.03	0.19

Lake: *SKILAK*
Station: A
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	25-Apr	25-May	22-Jun	13-Jul	10-Aug	27-Sep	19-Oct	Seasonal Mean (No/m2)
Ergasilus								0
Epischura								0
Diaptomus	14,646	5,094	13,585	3,821	5,094	2,972	1,528	6,677
Cyclops	220,963	81,081	58,160	180,425	242,397	125,233	60,112	138,339
Ovig Cyc					6,368	10,613	1,528	2,644
Ovig Diap					1,274	3,821	340	776
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0
							Total:	148,436

Body Size
(mm)

	25-Apr	25-May	22-Jun	13-Jul	10-Aug	27-Sep	19-Oct	SEASONAL MEANS Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus											
Epischura											
Diaptomus	0.68	0.70	0.89	1.29	1.30	1.30	1.28	1.06	0.92	34	23
Cyclops	0.77	0.75	0.91	0.59	0.78	0.68	0.74	0.75	0.73	266	256
Ovig Cyclops					0.78	1.07	1.06	0.97	0.97	9	9
Ovig Diaptomus					1.30	1.30	1.28	1.29	1.30	7	7
Daphnia g											
Holopedium											
Chydorinae											
Polyphemus											
								TOTAL:		316	294

Lake: *SKILAK*
Station: B
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	25-Apr	25-May	22-Jun	13-Jul	10-Aug	27-Sep	19-Oct	Seasonal Mean (No/m2)
Ergasilus								0
Epischura								0
Diaptomus	5,909	9,238	33,876	28,867	18,848	4,755	16,302	16,828
Cyclops	68,671	123,758	166,330	201,396	243,500	89,317	96,959	141,419
Ovig Cyc				1,698	27,509	6,283	2,717	5,458
Ovig Diap				3,396		1,189	679	752
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0
							Total:	164,457

Body Size
(mm)

SEASONAL MEANS

								Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus											
Epischura											
Diaptomus	0.67	0.86	1.12	1.28	1.28	1.28	1.26	1.11	1.17	96	112
Cyclops	0.80	0.84	0.93	1.03	0.80	0.87	0.91	0.88	0.89	390	397
Ovig Cyclops				1.18	1.07	1.08	1.08	1.10	1.08	24	23
Ovig Diaptomus				1.32		1.28	1.25	1.28	1.30	7	7
Daphnia g											
Holopedium											
Chydorinae											
Polyphemus											
								TOTAL:		517	539

Lake: *SKILAK*
Station: C
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	25-Apr	25-May	22-Jun	13-Jul	10-Aug	27-Sep	19-Oct	Seasonal Mean (No/m2)
Ergasilus								0
Epischura								0
Diaptomus	3,057	9,849	11,293	7,641	10,613	9,806	3,863	8,017
	1	1	1	1	1	1	1	
Cyclops	106,643	162,333	83,800	216,085	203,349	91,824	121,243	140,754
Ovig Cyc					20,377	9,806	2,377	4,651
Ovig Diap				1,274	424	1,486		455
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0
							Total:	153,878

Body Size
(mm)

SEASONAL MEANS

								Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus											
Epischura											
Diaptomus	0.62	0.81	1.05	1.19	1.24	1.29	1.24	1.06	1.09	41	44
Cyclops	0.79	0.82	0.83	0.83	0.78	0.65	0.71	0.77	0.78	292	300
Ovig Cyclops				1.28	1.07	1.11	1.09	1.14	1.08	22	20
Ovig Diaptomus				1.33	1.29	1.33		1.32	1.32	4	4
Daphnia g											
Holopedium											
Chydorinae											
Polyphemus											
								TOTAL:		359	368

Lake: *SKILAK*
Station: D
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	25-Apr	25-May	22-Jun	13-Jul	10-Aug	27-Sep	19-Oct	Seasonal Mean (No/m2)
Ergasilus								0
Epischura								0
Diaptomus	10,613	4,245	26,321	3,821	15,622	7,132	8,490	10,892
Cyclops	176,605	261,500	165,563	117,168	457,117	206,821	104,941	212,816
Ovig Cyc					38,716	28,528	4,755	10,286
Ovig Diap						4,075	1,358	776
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0
							Total:	234,770

Body Size
(mm)

SEASONAL MEANS

								Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus											
Epischura											
Diaptomus	0.73	0.74	1.12	1.26	1.28	1.32	1.29	1.11	1.12	62	65
Cyclops	0.79	0.79	0.81	0.48	0.60	0.68	0.82	0.71	0.70	368	353
Ovig Cyclops					1.12	1.10	1.07	1.10	1.11	45	46
Ovig Diaptomus						1.31	1.27	1.29	1.30	7	7
Daphnia g											
Holopedium											
Chydorinae											
Polyphemus											
								TOTAL:		482	471

Lake: *SKILAK*
Station: E
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	25-Apr	25-May	22-Jun	13-Jul	10-Aug	27-Sep	19-Oct	Seasonal Mean (No/m2)
Ergasilus								0
Epischura								0
Diaptomus	1,681	11,717	12,566	14,009	30,141	9,679	4,755	12,078
Cyclops	29,954	88,299	111,564	150,023	214,812	145,438	102,562	120,379
Ovig Cyc			170	1,019	41,603	16,301	5,434	9,218
Ovig Diap				0	0	509	340	121
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0
							Total:	141,797

Body Size
(mm)

SEASONAL MEANS

								Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus											
Epischura											
Diaptomus	0.74	0.86	1.16	1.27	1.30	1.27	1.22	1.12	1.19	71	86
Cyclops	0.87	0.85	1.00	1.06	0.82	0.93	0.87	0.91	0.92	358	360
Ovig Cyclops			0.96	1.15	1.11	1.09	1.07	1.08	1.10	39	41
Ovig Diaptomus				1.32	1.31	1.29	1.27	1.30	1.28	1	1
Daphnia g											
Holopedium											
Chydorinae											
Polyphemus											
								TOTAL:		469	487

Lake: *KENAI*
Station: B
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	6-May	8-Jun	30-Jun	29-Jul	16-Aug	28-Sep	25-Oct	Seasonal Mean (No/m2)
OCyc		1,223	1,494	4,755	4,245	1,698		1,916
ODiap				0	1,698	5,094	1,019	1,116
Diaptomus	4,890	23,688	13,721	10,868	27,594	25,810	6,283	16,122
Cyclops	54,883	59,144	53,661	126,001	278,490	87,282	46,527	100,855
Bosmina				present				0
Daphnia l.								0
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0
							Total:	120,010

Body Size
(mm)

	6-May	8-Jun	30-Jun	29-Jul	16-Aug	28-Sep	25-Oct
OCyc		1.23	1.22	1.17	1.16	1.16	
ODiap				1.10	1.31	1.30	1.27
Diaptomus	0.57	0.77	0.92	1.10	1.22	1.25	1.26
Cyclops	0.78	0.61	0.65	0.58	0.66	0.61	0.65
Bosmina				0.24			
Daphnia l.							
Daphnia g							
Holopedium							
Chydorinae							
Polyphemus							

SEASONAL MEANS

	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
OCyc	1.19	1.18	10	10
ODiap	1.25	1.30	9	10
Diaptomus	1.01	1.06	72	81
Cyclops	0.65	0.64	144	141
Bosmina	0.24	0.24		
Daphnia l.				
Daphnia g				
Holopedium				
Chydorinae				
Polyphemus				
TOTAL:			234	242

Lake: *KENAI*
Station: C
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	6-May	8-Jun	30-Jun	29-Jul	16-Aug	28-Sep	25-Oct	Seasonal Mean (No/m2)
OCyc	85	509	2,377	15,452	1,868	1,528	136	3,136
ODiap			340	297	1,019	5,943	1,087	1,241
Diaptomus	4,500	22,414	57,395	13,967	9,509	9,170	1,630	16,941
Cyclops	24,198	76,666	94,073	97,467	71,319	80,148	88,978	76,121
Heterocope			present					0
Cyclops cappilatus				present				0
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0

Total: 97,439

Body Size
(mm)

SEASONAL MEANS

								Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
OCyc	1.04	1.25	1.25	1.17	1.20	1.11	1.02	1.15	1.18	15	16
ODiap			1.24	1.34	1.34	1.30	1.26	1.30	1.30	11	11
Diaptomus	0.58	0.80	1.12	1.17	1.25	1.29	1.21	1.06	1.07	86	88
Cyclops	0.90	1.07	0.91	0.90	0.80	0.83	0.73	0.88	0.87	207	205
Heterocope			2.48					2.48	2.48		
Cyclops cappilatus				2.24				2.24	2.24		
Daphnia g											
Holopedium											
Chydorinae											
Polyphemus											
								TOTAL:		319	321

Lake: *KENAI*
Station: D
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	6-May	8-Jun	30-Jun	29-Jul	16-Aug	28-Sep	25-Oct	Seasonal Mean (No/m2)
OCyc			170	3,566	8,915	1,358		2,001
ODiap			85	1,019	4,840	10,528	849	2,474
Diaptomus	6,962	15,283	20,037	25,471	23,688	9,509	849	14,543
Cyclops	28,528	29,208	27,848	71,488	167,346	66,057	76,582	66,722
Bosmina					present			0
Daphnia l.								0
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0
							Total:	85,741

Body Size
(mm)

SEASONAL MEANS

								Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
OCyc			1.21	1.17	1.21	1.18		1.19	1.20	11	11
ODiap			1.02	1.35	1.30	1.29	1.24	1.24	1.29	20	22
Diaptomus	0.56	0.73	1.02	1.29	1.20	1.28	1.24	1.05	1.08	71	78
Cyclops	0.78	0.84	0.93	0.64	0.80	0.79	0.67	0.78	0.76	141	134
Bosmina					0.34			0.34	0.34		
Daphnia l.											
Daphnia g											
Holopedium											
Chydorinae											
Polyphemus											
								TOTAL:		242	245

Lake: *KENAI*
Station: E
Depth: 50m
Year: 1994

Macrozooplankton Density

(no./m^2)

Date:	6-May	8-Jun	30-Jun	29-Jul	16-Aug	28-Sep	25-Oct	Seasonal Mean (No/m2)
OCyc		255	2,377	11,887	3,566	170		2,608
ODiap				340	3,269	4,755	425	1,256
Diaptomus	5,094	15,198	35,999	34,980	21,396	4,415	1,486	16,938
Cyclops	23,518	24,707	89,998	210,565	103,119	118,186	119,715	98,544
Bosmina						170		24
Heterocope					present			0
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0

Total: 119,370

Body Size

(mm)

	6-May	8-Jun	30-Jun	29-Jul	16-Aug	28-Sep	25-Oct
OCyc		1.22	1.21	1.18	1.13	1.10	
ODiap				1.33	1.31	1.33	1.26
Diaptomus	0.59	0.82	1.02	1.12	1.26	1.28	1.25
Cyclops	0.90	1.01	0.97	0.91	0.90	0.81	0.88
Bosmina						0.26	
Heterocope					2.84		
Daphnia g							
Holopedium							
Chydorinae							
Polyphemus							

SEASONAL MEANS

Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
1.17	1.17	13	13
1.31	1.32	11	12
1.05	1.06	83	86
0.91	0.90	291	281
0.26	0.26	0.01	0.01
2.84	2.84		
TOTAL:		386	379

Lake: *KENAI*
Station: F
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	6-May	8-Jun	30-Jun	29-Jul	16-Aug	28-Sep	25-Oct	Seasonal Mean (No/m2)
OCyc		127	1,274	679	4,585	509		1,025
ODiap				679	2,887	45,593	2,207	7,338
Diaptomus	1,953	23,688	22,287	15,113	19,188	58,583	1,358	20,310
Cyclops	21,396	41,772	93,180	75,904	67,244	112,073	97,978	72,792
Bosmina								0
Daphnia l.								0
Daphnia g.								0
Holopedium								0
Chydorinae								0
Polyphemus								0
							Total:	101,465

Body Size
(mm)

SEASONAL MEANS

								Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
OCyc		0.80	1.23	1.18	1.16	0.66		1.01	1.13	4	5
ODiap				1.35	1.30	1.29	1.24	1.30	1.29	65	65
Diaptomus	0.55	0.69	1.03	1.04	1.26	1.16	1.24	1.00	1.05	86	101
Cyclops	0.80	0.80	0.79	0.71	0.59	0.66	0.70	0.72	0.71	130	125
Bosmina											
Daphnia l.											
Daphnia g											
Holopedium											
Chydorinae											
Polyphemus											
								TOTAL:		286	296

Lake: *TUSTUMENA*
Station: A
Depth: 35-40m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	26-Apr	24-May	17-Jun	6-Jul	28-Jul	18-Aug	12-Sep	12-Oct	Seasonal Mean (No/m2)
Ovig Cyc		153		2,038	891	170	102	68	428
Ovig Diap					1,189	1,528	5,502		1,027
Diaptomus			1,868	16,301	141,747	12,141	27,916	23,908	27,985
Cyclops	25,132	28,171	57,224	23,841	35,957	34,131	24,452	9,713	29,828
Bosmina									0
Daphnia l.									0
Daphnia g.									0
Holopedium									0
Chydorinae									0
Polyphemus									0

Total: 59,268

Body Size
(mm)

SEASONAL MEANS

									Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ovig Cyc	1.28		1.24	1.20	1.20	1.17	1.18	1.22	1.21	1.20	2	2
Ovig Diap					1.15	1.02	1.02		1.06	1.04	5	5
Diaptomus	1.30		0.59	0.78	0.97	1.03	1.04	1.02	0.96	0.97	108	111
Cyclops	0.94	0.97	0.99	0.97	0.79	0.74	0.86	0.78	0.88	0.89	82	84
Bosmina												
Daphnia l.												
Daphnia g												
Holopedium												
Chydorinae												
Polyphemus												
									TOTAL:		197	202

Lake: *TUSTUMENA*
Station: B
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	26-Apr	24-May	17-Jun	6-Jul	28-Jul	18-Aug	12-Sep	12-Oct	Seasonal Mean (No/m2)
Ovig Cyc				408	815	543	153		240
Ovig Diap	170				204	2,717	1,630	1,596	790
Diaptomus	679	1,494	32,739	18,034	36,679	4,024	3,872		12,190
Cyclops	40,925	21,939	31,721	41,842	41,875	31,788	21,446	16,335	30,984
Bosmina									0
Daphnia l.									0
Daphnia g.									0
Holopedium									0
Chydorinae									0
Polyphemus									0

Total: 44,204

Body Size
(mm)

Ovig Cyc			1.26	1.17	1.14	1.17	1.20	0.98
Ovig Diap	0.98				0.80	1.04	1.04	1.02
Diaptomus	0.98	0.57	0.81	0.80	1.05	1.06	1.00	1.22
Cyclops	0.89	0.85	0.80	0.89	0.85	0.81	0.79	0.81
Bosmina								
Daphnia l.								
Daphnia g								
Holopedium								
Chydorinae								
Polyphemus								

SEASONAL MEANS

	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ovig Cyc	1.15	1.16	1	1
Ovig Diap	0.98	1.03	3	4
Diaptomus	0.94	0.91	44	41
Cyclops	0.84	0.84	76	78
Bosmina				
Daphnia l.				
Daphnia g				
Holopedium				
Chydorinae				
Polyphemus				
TOTAL:			124	123

Lake: *TUSTUMENA*
Station: C
Depth: 50m
Year: 1994

Macrozooplankton Density

(no./m^2)

Date:	26-Apr	29-May	17-Jun	6-Jul	28-Jul	18-Aug	12-Sep	12-Oct	Seasonal Mean (No/m2)
Ovig Cyc					1,698	1,274		170	393
Ovig Diap	68				2,123		2,445	509	643
Diaptomus	34			10,121	179,152	68,263	2,853	1,596	32,752
Cyclops	13,653	13,381	22,992	36,679	29,292	50,943	23,570	16,268	25,847
Bosmina									0
Daphnia l.									0
Daphnia g.									0
Holopedium									0
Chydorinae									0
Polyphemus									0

Total: **59,636**

Body Size

(mm)

SEASONAL MEANS

									Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ovig Cyc					1.17	1.14	1.17	1.15	1.16	1.16	2	2
Ovig Diap	0.98			0.65	1.08		1.00	1.00	0.94	1.03	2	3
Diaptomus	0.98			0.65	0.89	1.01	1.01	1.01	0.93	0.91	113	109
Cyclops	0.79	0.91	0.80	0.86	0.83	0.83	0.86	0.96	0.86	0.85	67	65
Bosmina												
Daphnia l.												
Daphnia g.												
Holopedium												
Chydorinae												
Polyphemus												
									TOTAL:		184	180

Lake: *TUSTUMENA*
Station: D
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	26-Apr	29-May	17-Jun	6-Jul	28-Jul	18-Aug	12-Sep	12-Oct	Seasonal Mean (No/m2)
Ovig Cyc		34	255	1,189	1,528		272		410
Ovig Diap					340	2,343	2,921	1,562	896
Diaptomus	374			242,486	46,697	21,498	5,026	5,026	40,138
Cyclops	33,759	12,294	106,979	157,496	57,565	22,720	44,151	23,637	57,325
Bosmina									0
Daphnia l.									0
Daphnia g.									0
Holopedium									0
Chydorinae									0
Polyphemus									0
								Total:	98,769

Body Size
(mm)

SEASONAL MEANS

									Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ovig Cyc		1.14	1.21	1.18	1.16	1.17	1.16	1.10	1.16	1.17	2	2
Ovig Diap					1.11	1.02	1.01	1.03	1.04	1.02	4	4
Diaptomus	0.97			0.82	0.95	1.01	1.02	1.03	0.97	0.86	157	112
Cyclops	0.86	0.94	0.96	0.96	0.82	0.73	0.92	0.92	0.89	0.92	160	172
Bosmina												
Daphnia l.												
Daphnia g.												
Holopedium												
Chydorinae												
Polyphemus												
									TOTAL:		324	290

Lake: *TUSTUMENA*
Station: E
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	26-Apr	24-May	17-Jun	6-Jul	28-Jul	18-Aug	12-Sep	12-Oct	Seasonal Mean (No/m2)
Ovig Cyc			170	509	2,547	340	306	51	490
Ovig Diap		34			679	1,698	3,260	968	830
Diaptomus		136	136	13,754	37,188	24,962	11,819	2,853	11,356
Cyclops	40,075	17,150	17,287	52,387	64,697	46,867	44,115	20,071	37,831
Bosmina									0
Daphnia l.									0
Daphnia g.									0
Holopedium									0
Chydorinae									0
Polyphemus									0
								Total:	50,507

Body Size
(mm)

									SEASONAL MEANS			
									Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ovig Cyc			1.19	1.20	1.20	1.16	1.21	1.16	1.19	1.20	3	3
Ovig Diap		1.02			1.14	1.01	1.03	1.00	1.04	1.03	4	4
Diaptomus		1.02	0.57	0.83	0.99	1.03	1.03	1.02	0.93	0.98	39	46
Cyclops	0.86	0.87	0.90	0.99	0.96	0.82	0.88	0.90	0.90	0.91	108	110
Bosmina												
Daphnia l.												
Daphnia g												
Holopedium												
Chydorinae												
Polyphemus												
									TOTAL:		154	163

APPENDIX H

Appendix D. Kodiak Island limnological data for 1994

LAKE	Date	Sta	Depth (m)	Specific conductance (umhos/cm)	pH (Units)	Alkalinity (mg/L)	Turbidity (NTU)	Color (Pt units)	Calcium (mg/L)	Magnesium (mg/L)	Iron (ug/L)	Total-P (ug/L P)	Total filterable-P (ug/L P)
AFOGNAK	05/05/94	1	1	48	6.2	9.0	4.0	15	4.0	0.7	242	4.8	2.8
AFOGNAK	05/05/94	1	2										
AFOGNAK	05/05/94	1	17	48	6.2	8.5	1.2	13	4.0	0.7	145	7.4	2.7
AFOGNAK	05/05/94	2	1	48	6.4	8.5	1.4	13	3.0	1.4	144	5.1	3.3
AFOGNAK	05/05/94	2	2										
AFOGNAK	05/05/94	2	9	48	6.3	9.0	4.5	13	3.0	0.7	474	6.6	3.0
AFOGNAK	06/09/94	1	1	48	6.6	8.0	1.0	11	3.0	0.7	49	5.0	2.1
AFOGNAK	06/09/94	1	2										
AFOGNAK	06/09/94	1	18	48	6.5	8.0	0.7	11	3.0	0.7	60	4.0	2.3
AFOGNAK	06/09/94	2	1	54	6.6	9.0	1.0	11	3.0	0.7	72	5.3	2.4
AFOGNAK	06/09/94	2	2										
AFOGNAK	06/09/94	2	11	47	6.6	9.0	3.0	13	3.0	0.7	217	5.4	3.1
AFOGNAK	06/30/94	1	1	52	6.4	9.0	1.5	10	3.0	1.4	48	10.2	2.4
AFOGNAK	06/30/94	1	2										
AFOGNAK	06/30/94	1	18	51	6.4	9.0	1.4	11	3.0	1.4	64	4.0	2.9
AFOGNAK	06/30/94	2	1	50	6.6	10.0	1.3	11	3.0	1.4	46	15.3	7.3
AFOGNAK	06/30/94	2	2										
AFOGNAK	06/30/94	2	11	51	6.4	9.0	1.1	11	3.0	1.4	38	4.5	3.1
AFOGNAK	07/20/94	1	1	49	6.6	10.0	1.3	11	2.9	1.3	97	8.1	2.7
AFOGNAK	07/20/94	1	2										
AFOGNAK	07/20/94	1	17	51	6.6	10.0	1.3	10	2.9	1.3	70	10.1	1.8
AFOGNAK	07/20/94	2	1	50	6.6	10.0	1.1	12	3.9	0.7	52	9.6	1.9
AFOGNAK	07/20/94	2	2										
AFOGNAK	07/20/94	2	11	50	6.5	10.0	1.1	15	3.9	1.3	110	7.9	4.2
AFOGNAK	08/12/94	1	1	50	6.7	10.0	0.9	19	2.7	1.3	68	10.0	9.8
AFOGNAK	08/12/94	1	2										
AFOGNAK	08/12/94	1	15	51	6.4	11.0	0.9	12	3.7	1.3	84	7.8	3.8
AFOGNAK	08/12/94	2	1	49	6.7	10.0	0.9	13	3.7	0.6	79	11.1	7.5
AFOGNAK	08/12/94	2	2										
AFOGNAK	08/12/94	2	12	53	6.4	11.0	1.8	11	3.7	1.3	138	7.9	3.4
AFOGNAK	08/31/94	1	1	53	6.5	11.0	1.5	8	3.9	1.3	64	7.2	2.6
AFOGNAK	08/31/94	1	2										
AFOGNAK	08/31/94	1	15	53	6.5	11.0	1.3	8	3.9	1.3	77	8.4	2.9
AFOGNAK	08/31/94	2	1	52	6.6	11.0	1.5	5	3.9	1.3	69	36.4	2.3
AFOGNAK	08/31/94	2	2										
AFOGNAK	08/31/94	2	10	52	6.5	11.0	1.5	9	3.9	1.3	72	8.5	3.1
AFOGNAK	09/22/94	1	1	51	6.5	9.5	0.6	12	4.0	1.2	64	8.1	36.8
AFOGNAK	09/22/94	1	2										

AFOGNAK	09/22/94	1	16	52	6.5	10.0	1.1	8	3.0	1.2	64	6.4	4.8
AFOGNAK	09/22/94	2	1	51	6.6	10.0	0.8	9	4.0	1.2	60	7.8	24.2
AFOGNAK	09/22/94	2	2										
AFOGNAK	09/22/94	2	11	52	6.6	10.0	1.1	10	4.0	1.2	122	6.5	4.0
AFOGNAK	10/14/94	1	1	54	6.5	9.0	1.3	9	4.0	1.3	79	7.2	2.7
AFOGNAK	10/14/94	1	2										
AFOGNAK	10/14/94	1	16	54	6.4	9.0	1.0	9	4.0	1.3	79	7.7	2.2
AFOGNAK	10/14/94	2	1	50	6.5	9.0	1.3	10	4.0	1.3	82	6.0	2.1
AFOGNAK	10/14/94	2	2										
AFOGNAK	10/14/94	2	10	52	6.5	9.0	1.0	10	4.0	1.3	90	6.9	6.1
AKALURA	05/16/94	1	1	58	6.9	13.0	2.1	9	5.0	1.4	56	12.5	6.3
AKALURA	05/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	05/16/94	1	17	58	7.2	14.0	3.0	8	5.0	1.4	128	16.7	3.1
AKALURA	05/16/94	2	1	58	7.0	13.5	2.4	4	4.0	1.4	56	12.7	3.4
AKALURA	05/16/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	05/16/94	2	14	58	7.1	14.0	3.0	5	5.0	1.4	64	11.7	3.4
AKALURA	06/14/94	1	1	58	6.8	14.0	2.3	6	5.0	0.7	66	9.5	2.8
AKALURA	06/14/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	06/14/94	1	16	59	6.6	14.0	3.0	5	5.0	0.7	244	12.1	2.6
AKALURA	06/14/94	2	1	58	6.8	14.0	3.0	4	5.0	0.7	84	10.1	3.0
AKALURA	06/14/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	06/14/94	2	14	58	6.6	13.0	3.0	8	5.0	0.7	308	16.9	3.8
AKALURA	07/18/94	1	1	58	6.9	14.0	3.2	4	4.9	1.5	76	9.6	2.7
AKALURA	07/18/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	07/18/94	1	16	61	6.6	15.0	2.0	10	4.9	1.5	679	18.6	7.5
AKALURA	07/18/94	2	1	58	7.0	14.0	3.3	4	4.9	1.5	70	10.4	3.2
AKALURA	07/18/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	07/18/94	2	13	58	6.6	15.0	2.4	5	4.9	1.5	192	11.7	3.1
AKALURA	08/18/94	1	1	57	6.7	14.0	7.5	6	5.0	1.7	66	19.8	3.5
AKALURA	08/18/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	08/18/94	1	17	63	6.4	16.0	2.1	12	5.0	1.7	1186	50.9	13.6
AKALURA	08/18/94	2	1	59	7.2	15.0	13.0	9	5.0	1.7	228	10.6	14.1
AKALURA	08/18/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	08/18/94	2	14	61	6.3	15.0	1.7	9	5.0	1.7	434	19.9	6.5
AKALURA	09/26/94	1	1	64	7.0	15.0	0.8	6	4.9	1.3	98	22.9	6.7
AKALURA	09/26/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	09/26/94	1	16	64	7.0	15.0	1.1	3	4.9	1.3	112	22.5	5.6
AKALURA	09/26/94	2	1	64	7.0	15.0	1.0	4	4.9	1.3	107	18.5	6.4
AKALURA	09/26/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
AKALURA	09/26/94	2	14	63	7.0	15.0	1.0	6	4.9	1.3	129	20.1	6.8
BIG KITOI	05/26/94	1	1	66	6.8	19.0	1.0	20	7.6	1.6	64	5.6	5.3

BIG KITOI	05/26/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
BIG KITOI	05/26/94	1	32	68	6.7	20.0	0.4	13	7.6	1.6	38	2.6	1.4
BIG KITOI	07/27/94	1	1	91	7.4	23.0	1.0	18	8.1	1.5	88	6.0	5.3
BIG KITOI	07/27/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
BIG KITOI	07/27/94	1	31	84	7.0	21.0	0.6	14	9.0	1.5	75	2.5	2.0
BIG KITOI	09/08/94	1	1	86	7.5	23.0	0.6	17	7.9	2.2	64	4.2	2.0
BIG KITOI	09/08/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
BIG KITOI	09/08/94	1	31	88	7.0	21.0	0.4	15	7.9	1.4	42	3.8	1.9
BIG KITOI	10/27/94	1	1	77	6.8	24.0	0.3	13	9.0	1.4	10	4.6	1.3
BIG KITOI	10/27/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
BIG KITOI	10/27/94	1	30	86	6.5	24.0	0.2	14	10.0	0.7	3	3.2	1.4
CRESCEN	06/01/94	1	1	36	6.9	5.0	1.8	6	2.0	0.2	134	5.9	3.7
CRESCEN	06/01/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
CRESCEN	06/01/94	1	26	35	6.7	5.0	0.7	4	3.1	0.2	142	6.5	3.2
CRESCEN	06/30/94	1	1	52	6.4	5.0	0.5	4	1.0	0.7	76	4.9	1.8
CRESCEN	06/30/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
CRESCEN	06/30/94	1	26	36	6.1	5.0	1.0	4	2.0	0.7	139	4.4	4.0
CRESCEN	07/28/94	1	1	39	6.5	10.0	2.3	3	3.9	0.7	204	6.9	6.2
CRESCEN	07/28/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
CRESCEN	07/28/94	1	26	35	6.0	5.0	0.4	4	1.9	0.7	165	4.1	4.0
CRESCEN	08/25/94	1	1	36	6.8	7.0	0.5	3	2.0	0.6	141	5.6	2.1
CRESCEN	08/25/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
CRESCEN	08/25/94	1	26	37	6.6	8.0	0.5	3	2.0	0.6	178	6.0	2.5
CRESCEN	09/22/94	1	1	35	6.4	5.0	0.7	11	2.0	0.5	118	5.4	10.4
CRESCEN	09/22/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
CRESCEN	09/22/94	1	25	37	5.9	5.0	0.8	15	2.0	0.5	372	6.1	12.6
CRESCEN	10/19/94	1	1	36	6.4	10.0	0.7	3	2.0	0.6	171	5.2	2.6
CRESCEN	10/19/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
CRESCEN	10/19/94	1	25	36	6.4	11.0	1.0	3	2.0	0.6	187	4.4	2.2
FRAZER	06/02/94	1	1	55	7.3	15.0	1.3	6	4.8	1.1	9	6.9	2.0
FRAZER	06/02/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
FRAZER	06/02/94	1	23	56	7.2	14.0	0.5	8	4.8	0.2	8	3.7	2.6
FRAZER	06/02/94	3	1	55	7.1	14.0	0.8	8	4.8	1.1	12	11.0	3.5
FRAZER	06/02/94	3	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
FRAZER	06/02/94	3	50	54	7.0	13.0	0.5	4	4.8	1.1	3	3.2	2.1
FRAZER	07/19/94	1	1	56	6.5	13.0	0.4	5	4.9	1.3	13	9.8	1.8
FRAZER	07/19/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
FRAZER	07/19/94	1	23	55	6.6	14.0	0.5	5	4.9	1.3	14	3.3	1.9
FRAZER	07/19/94	3	1	55	6.6	13.0	0.9	4	4.9	1.3	36	3.9	1.8
FRAZER	07/19/94	3	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
FRAZER	07/19/94	3	50	54	6.5	13.0	0.4	4	4.9	1.3	10	5.2	2.2

FRAZER	08/25/94	1	1	54	7.3	15.0	0.4	6	4.7	1.4	32	3.6	1.7
FRAZER	08/25/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
FRAZER	08/25/94	1	24	52	7.0	14.0	0.3	4	4.7	1.4	30	3.6	1.7
FRAZER	08/30/94	3	1	54	6.8	13.0	0.4	6	4.8	1.3	30	5.8	2.5
FRAZER	08/30/94	3	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
FRAZER	08/30/94	3	50	54	6.5	12.5	0.4	4	4.8	1.3	36	3.4	1.2
FRAZER	10/11/94	1	1	57	6.7	13.0	0.3	4	5.0	1.3	10	4.8	1.6
FRAZER	10/11/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
FRAZER	10/11/94	1	23	56	6.6	12.0	0.4	3	5.0	1.3	11	4.7	1.8
FRAZER	10/11/94	3	1	56	6.7	12.5	0.4	4	5.0	1.3	11	4.9	1.6
FRAZER	10/11/94	3	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
FRAZER	10/11/94	3	43	55	6.6	12.0	0.4	3	5.0	1.3	12	13.5	1.5
HIDDEN K	05/16/94	1	1	47	6.7	7.0	0.7	13	3.0	0.7	66	3.0	1.2
HIDDEN K	05/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
HIDDEN K	05/16/94	1	40	47	6.7	7.0	1.0	13	3.0	0.7	53	2.6	0.9
HIDDEN K	06/16/94	1	1	53	6.7	6.5	1.3	12	3.0	0.7	0	5.9	1.1
HIDDEN K	06/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
HIDDEN K	06/16/94	1	38	47	6.5	6.5	0.2	13	3.0	0.7	0	4.2	1.2
HIDDEN K	07/05/94	1	1	45	6.4	7.0	0.7	11	3.0	0.5	30	5.2	1.5
HIDDEN K	07/05/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
HIDDEN K	07/05/94	1	42	45	6.4	7.0	0.8	14	3.0	0.5	36	3.3	1.6
HIDDEN K	07/29/94	1	1	45	6.6	7.0	0.4	14	2.9	1.3	74	4.4	2.5
HIDDEN K	07/29/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
HIDDEN K	07/29/94	1	43	46	6.2	6.0	0.4	13	2.9	0.7	65	4.6	1.2
HIDDEN K	08/19/94	1	1	48	6.4	8.0	0.9	10	3.9	1.2	87	4.8	1.8
HIDDEN K	08/19/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
HIDDEN K	08/19/94	1	41	46	6.0	8.0	0.3	12	2.9	1.2	68	3.3	1.4
HIDDEN K	09/16/94	1	1	50	6.6	8.0	0.4	10	4.0	1.2	38	7.0	1.9
HIDDEN K	09/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
HIDDEN K	09/16/94	1	39	49	6.2	8.0	0.4	12	3.0	1.2	30	9.2	2.5
HIDDEN K	10/07/94	1	1	47	6.2	7.0	0.5	11	2.9	1.3	42	2.1	1.9
HIDDEN K	10/07/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
HIDDEN K	10/07/94	1	39	46	6.0	7.0	0.3	11	2.9	1.3	29	2.7	1.4
JENNIFER	06/01/94	1	1	133	7.0	17.0	0.4	15	5.8	2.1	26	3.9	1.9
JENNIFER	06/01/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
JENNIFER	06/01/94	1	21	136	6.7	17.0	0.5	17	5.8	2.1	30	4.4	3.5
JENNIFER	07/21/94	1	1	130	6.6	19.0	0.6	30	5.9	1.9	71	5.4	10.8
JENNIFER	07/21/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
JENNIFER	07/21/94	1	20	134	6.4	19.0	1.0	17	5.9	1.9	75	4.4	2.9
JENNIFER	08/18/94	1	1	130	6.5	18.0	0.6	13	5.8	3.6	84	5.4	3.1
JENNIFER	08/18/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0

JENNIFER	08/18/94	1	20	136	6.2	17.0	0.4	15	6.7	3.6	70	4.9	2.8
JENNIFER	10/24/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
JENNIFER	10/24/94	1	19	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
JENNIFER	10/24/94	2	1	128	6.5	18.0	0.4	20	7.0	2.1	26	5.0	3.2
JENNIFER	10/24/94	2	19	127	6.5	18.0	0.5	22	6.0	2.8	47	45.5	4.0
JENNIFER	06/01/94	1	1	133	7.1	16.5	0.5	9	4.8	4.2	12	6.2	1.7
JENNIFER	06/01/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
JENNIFER	06/01/94	1	21	133	6.8	16.5	0.6	10	4.8	3.2	10	2.6	1.8
JENNIFER	07/21/94	1	1	128	6.5	16.0	0.6	13	5.9	1.9	48	3.9	4.0
JENNIFER	07/21/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
JENNIFER	07/21/94	1	21	133	6.4	18.0	2.0	9	5.9	1.9	102	3.4	3.3
JENNIFER	08/18/94	1	1	127	6.6	17.0	0.3	8	5.8	3.6	50	6.0	2.1
JENNIFER	08/18/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
JENNIFER	08/18/94	1	21	132	6.3	18.0	0.4	8	6.7	3.6	48	6.0	2.1
JENNIFER	10/24/94	1	1	129	6.5	17.0	0.3	9	6.0	2.1	3	4.3	2.5
JENNIFER	10/24/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
JENNIFER	10/24/94	1	20	133	6.5	18.5	0.2	12	7.0	2.8	3	3.3	2.3
KARLUK	06/02/94	3	1	70	7.3	20.0	0.6	8	7.7	1.1	3	4.3	4.5
KARLUK	06/02/94	3	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
KARLUK	06/02/94	3	50	69	7.1	20.0	0.7	9	7.7	1.1	3	5.5	5.0
KARLUK	07/19/94	3	1	71	7.0	22.0	1.6	8	6.9	1.3	70	4.1	2.3
KARLUK	07/19/94	3	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
KARLUK	07/19/94	3	50	72	6.8	22.0	4.5	9	7.9	1.3	326	5.0	2.1
KARLUK	08/30/94	3	1	71	7.1	22.0	0.4	10	7.7	1.3	27	7.6	2.5
KARLUK	08/30/94	3	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
KARLUK	08/30/94	3	50	72	6.5	22.0	1.5	9	7.7	1.3	344	68.6	19.2
KARLUK	10/11/94	3	1	73	6.9	20.5	0.4	10	7.0	2.0	7	5.9	2.2
KARLUK	10/11/94	3	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
KARLUK	10/11/94	3	43	72	6.8	20.5	0.4	11	8.0	2.0	30	9.2	2.7
LAURA	05/16/94	1	1	67	6.8	9.0	1.5	18	3.9	1.1	94	4.4	1.8
LAURA	05/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LAURA	05/16/94	1	38	67	6.7	9.5	1.2	17	4.0	1.4	97	3.8	1.8
LAURA	06/15/94	1	1	66	6.6	9.0	0.5	19	4.0	0.2	40	6.2	2.2
LAURA	06/15/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LAURA	06/15/94	1	32	67	6.5	9.0	0.9	15	4.0	0.2	52	3.2	3.5
LAURA	07/06/94	1	1	64	6.6	9.0	1.8	11	4.0	0.5	66	16.9	4.4
LAURA	07/06/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LAURA	07/06/94	1	35	73	6.7	14.0	1.2	14	6.0	1.9	102	5.2	2.4
LAURA	07/29/94	1	1	64	6.6	15.0	0.5	11	3.9	1.3	62	11.5	2.2
LAURA	07/29/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0

LAURA	07/29/94	1	37	68	6.3	11.0	1.0	13	3.9	1.3	95	5.7	2.3
LAURA	08/19/94	1	1	66	6.4	10.0	0.7	13	3.9	1.2	64	11.6	2.9
LAURA	08/19/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LAURA	08/19/94	1	34	69	6.2	10.0	0.7	14	3.9	2.4	83	4.3	1.9
LAURA	09/16/94	1	1	69	6.6	10.0	0.7	11	4.9	1.2	17	11.6	2.6
LAURA	09/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LAURA	09/16/94	1	37	81	6.5	10.0	0.6	12	4.0	1.9	40	4.6	2.1
LAURA	10/07/94	1	1	66	6.2	10.0	0.6	12	3.8	1.3	60	7.5	3.5
LAURA	10/07/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LAURA	10/07/94	1	37	65	6.0	10.0	0.7	14	3.8	2.0	58	4.8	1.8
LITTLE KIT	05/26/94	1	1	97	6.8	24.0	0.6	19	9.5	2.4	51	3.8	2.5
LITTLE KIT	05/26/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LITTLE KIT	05/26/94	1	18	126	6.5	26.0	1.0	20	9.5	2.4	57	4.3	2.3
LITTLE KIT	05/26/94	2	1	95	6.6	24.0	1.0	22	8.6	2.4	42	4.2	2.5
LITTLE KIT	05/26/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LITTLE KIT	05/26/94	2	14	120	6.5	30.0	5.7	18	11.4	2.4	92	4.2	2.6
LITTLE KIT	07/24/94	1	1	106	7.2	29.0	1.0	19	9.7	1.5	48	4.9	3.2
LITTLE KIT	07/24/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LITTLE KIT	07/24/94	1	18	381	7.0	32.0	0.8	20	11.7	7.8	42	4.4	4.4
LITTLE KIT	07/24/94	2	1	107	7.3	32.0	1.3	19	9.7	1.5	68	4.8	3.9
LITTLE KIT	07/24/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LITTLE KIT	07/24/94	2	15	141	6.9	34.0	0.8	19	12.6	2.2	30	3.7	4.1
LITTLE KIT	09/09/94	1	1	113	6.9	27.0	0.8	19	9.8	2.2	44	4.6	3.8
LITTLE KIT	09/09/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LITTLE KIT	09/09/94	1	11	190	6.7	27.0	0.8	14	10.8	3.7	45	4.5	3.0
LITTLE KIT	09/09/94	2	1	128	7.5	33.0	0.7	15	11.8	2.2	46	7.4	3.7
LITTLE KIT	09/09/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LITTLE KIT	09/09/94	2	15	156	6.6	32.0	1.0	18	11.8	2.2	57	4.5	3.5
LITTLE KIT	10/27/94	1	1	132	6.6	26.0	0.3	20	12.0	2.1	6	5.6	2.8
LITTLE KIT	10/27/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LITTLE KIT	10/27/94	1	20	5990	7.6	160.0	0.7	97	88.0	140.0	202	62.3	64.7
LITTLE KIT	10/27/94	2	1	224	6.6	31.0	0.3	26	13.0	0.7	24	6.0	4.3
LITTLE KIT	10/27/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
LITTLE KIT	10/27/94	2	15	129	6.6	30.0	0.4	21	11.0	2.1	10	6.6	3.2
MALINA L	05/05/94	1	1	71	6.7	20.0	1.0	8	7.0	1.4	74	7.9	2.7
MALINA L	05/05/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA L	05/05/94	1	10	71	6.5	19.0	1.0	6	7.0	1.4	60	6.1	2.7
MALINA L	06/09/94	1	1	72	6.8	20.0	0.9	29	8.0	1.4	22	5.3	12.5
MALINA L	06/09/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA L	06/09/94	1	9	72	6.8	20.0	0.8	5	7.0	1.4	18	3.7	2.5
MALINA L	06/30/94	1	1	75	7.0	20.0	0.7	10	7.0	2.1	38	6.6	4.5

MALINA L	06/30/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA L	06/30/94	1	9	88	6.9	20.0	0.7	6	7.0	2.1	32	5.1	4.1
MALINA L	07/20/94	1	1	76	6.8	22.0	0.7	44	6.9	1.9	29	5.3	40.9
MALINA L	07/20/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA L	07/20/94	1	9	77	6.9	21.0	0.7	14	6.9	1.3	30	4.2	5.5
MALINA L	08/12/94	1	1	76	7.0	22.0	0.4	9	12.4	1.3	55	7.3	5.7
MALINA L	08/12/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA L	08/12/94	1	10	74	6.9	22.0	0.5	21	12.4	1.3	57	6.2	7.4
MALINA L	08/31/94	1	1	79	6.9	22.0	0.6	4	6.7	2.0	54	5.2	2.7
MALINA L	08/31/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA L	08/31/94	1	8	79	7.0	22.0	0.6	5	7.7	1.3	49	5.1	2.7
MALINA L	09/22/94	1	1	76	7.1	21.0	0.5	18	7.8	1.2	23	4.4	9.3
MALINA L	09/22/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA L	09/22/94	1	9	76	7.1	22.0	1.3	14	6.8	1.2	55	6.8	7.2
MALINA L	10/14/94	1	1	77	7.0	21.5	0.4	4	8.0	2.0	26	5.8	3.1
MALINA L	10/14/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA L	10/14/94	1	9	77	6.9	21.5	0.5	4	8.0	2.0	26	4.9	3.9
MALINA U	05/05/94	2	1	68	6.5	18.5	1.2	8	7.0	1.4	109	4.6	2.1
MALINA U	05/05/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA U	05/05/94	2	27	68	6.5	18.0	1.0	8	7.0	1.4	102	7.6	2.6
MALINA U	06/09/94	2	1	69	6.8	18.0	1.0	8	7.0	1.4	28	5.0	1.9
MALINA U	06/09/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA U	06/09/94	2	27	71	6.8	18.0	0.8	9	7.0	1.4	46	4.4	2.8
MALINA U	06/30/94	2	1	72	7.0	18.0	1.0	6	6.0	1.4	42	10.7	2.7
MALINA U	06/30/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA U	06/30/94	2	27	72	6.7	18.0	0.8	6	7.0	1.4	43	5.9	2.5
MALINA U	07/20/94	2	1	71	6.9	19.0	1.0	9	6.9	1.3	36	8.0	2.8
MALINA U	07/20/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA U	07/20/94	2	27	73	6.6	19.0	1.9	13	6.9	1.3	85	6.9	6.3
MALINA U	08/12/94	2	1	70	7.0	20.0	0.6	8	6.6	1.3	82	11.0	3.8
MALINA U	08/12/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA U	08/12/94	2	27	73	6.6	20.0	0.6	6	6.6	1.3	63	6.5	3.8
MALINA U	08/31/94	2	1	73	7.0	21.0	0.8	6	6.7	1.3	42	5.5	2.6
MALINA U	08/31/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA U	08/31/94	2	21	74	6.5	20.0	0.6	18	6.7	1.3	50	7.6	5.3
MALINA U	09/22/94	2	1	72	6.9	19.0	1.3	5	6.8	1.9	39	6.0	2.9
MALINA U	09/22/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA U	09/22/94	2	26	72	6.8	19.0	1.3	5	6.8	1.9	55	7.2	4.5
MALINA U	10/14/94	2	1	74	7.0	19.0	1.0	5	7.0	1.3	43	4.6	3.9
MALINA U	10/14/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
MALINA U	10/14/94	2	26	74	6.9	19.0	1.0	6	7.0	2.0	40	4.7	3.5

PORTAGE	05/16/94	1	1	47	6.8	8.5	2.6	22	4.0	0.7	214	5.0	2.4
PORTAGE	05/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
PORTAGE	05/16/94	1	14	48	6.8	8.5	3.5	21	4.0	0.7	332	5.9	2.3
PORTAGE	06/16/94	1	1	47	6.8	10.0	2.0	20	4.0	0.7	109	9.1	2.1
PORTAGE	06/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
PORTAGE	06/16/94	1	17	83	6.7	9.0	1.4	23	4.0	0.7	120	5.8	3.5
PORTAGE	07/06/94	1	1	47	6.5	9.0	0.9	21	4.0	0.5	106	13.9	3.9
PORTAGE	07/06/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
PORTAGE	07/06/94	1	17	46	6.1	9.0	0.8	22	4.0	0.5	126	4.6	2.4
PORTAGE	07/29/94	1	1	45	6.5	11.0	1.4	28	3.9	1.3	230	20.0	5.0
PORTAGE	07/29/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
PORTAGE	07/29/94	1	15	48	6.3	11.0	0.7	20	4.1	0.8	170	5.3	2.6
PORTAGE	08/19/94	1	1	48	6.5	11.0	1.2	23	3.9	1.2	182	10.6	3.9
PORTAGE	08/19/94	1	18	49	6.0	10.0	1.0	21	3.9	1.2	182	5.4	2.8
PORTAGE	09/16/94	1	1	46	6.6	10.0	1.0	19	4.0	1.2	100	7.2	3.5
PORTAGE	09/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
PORTAGE	09/16/94	1	17	55	6.2	10.0	1.6	20	4.0	1.2	123	6.8	2.6
PORTAGE	10/07/94	1	1	51	6.2	10.0	1.4	24	3.8	1.3	268	7.9	3.0
PORTAGE	10/07/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
PORTAGE	10/07/94	1	17	51	6.2	10.0	2.0	28	4.0	1.3	276	8.6	3.0
RED	05/16/94	1	1	59	7.3	15.0	1.0	12	5.0	1.4	28	13.7	9.4
RED	05/16/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	05/16/94	1	38	62	7.1	15.0	1.0	5	5.0	1.4	36	13.2	4.6
RED	05/16/94	2	1	63	7.1	15.0	1.0	3	5.0	1.4	34	10.6	4.2
RED	05/16/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	05/16/94	2	38	63	7.1	15.0	1.5	2	5.0	1.4	46	14.1	4.7
RED	06/14/94	1	1	61	7.2	16.0	1.0	2	5.0	0.7	12	9.0	4.0
RED	06/14/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	06/14/94	1	38	62	6.9	16.0	1.9	3	5.0	0.7	212	42.0	13.4
RED	06/14/94	2	1	61	7.1	16.0	2.0	3	5.0	0.7	14	9.2	3.8
RED	06/14/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	06/14/94	2	38	75	7.4	20.0	2.0	2	5.0	0.7	197	32.1	9.9
RED	07/18/94	1	1	62	6.7	16.0	0.4	3	4.9	1.5	55	11.4	4.6
RED	07/18/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	07/18/94	1	38	63	6.6	16.0	1.8	4	4.9	1.5	546	76.2	22.6
RED	07/18/94	4	1	62	6.8	16.0	0.5	4	4.9	1.5	59	11.7	5.1
RED	07/18/94	4	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	07/18/94	4	37	64	6.7	16.0	1.8	4	4.9	1.5	519	70.7	26.4
RED	08/18/94	1	1	64	6.7	16.0	0.5	4	5.8	1.2	38	20.6	6.3
RED	08/18/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	08/18/94	1	38	65	6.2	15.0	2.7	9	4.8	2.4	916	125.3	63.1
RED	08/18/94	2	1	63	6.7	16.0	0.5	3	5.8	1.2	43	10.5	6.9

RED	08/18/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	08/18/94	2	37	70	6.3	16.0	3.4	5	4.8	2.4	1334	130.4	45.8
RED	09/22/94	1	1	65	6.8	15.0	0.8	4	5.9	1.2	22	17.2	9.5
RED	09/22/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	09/22/94	1	37	65	6.4	15.0	1.8	5	4.9	1.9	529	111.2	40.0
RED	09/22/94	2	1	63	6.9	15.0	0.8	4	4.9	1.2	34	17.9	10.7
RED	09/22/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	09/22/94	2	37	65	6.3	14.5	2.0	4	5.9	1.2	648	147.9	44.8
RED	10/22/94	1	1	62	6.9	12.0	1.1	5	5.0	0.7	74	34.8	16.8
RED	10/22/94	1	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	10/22/94	1	37	61	6.3	17.0	1.0	6	6.0	1.4	91	33.6	23.4
RED	10/22/94	2	1	62	6.4	17.0	1.1	6	6.0	1.4	77	34.2	18.1
RED	10/22/94	2	2	0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
RED	10/22/94	2	37	62	6.4	19.0	1.5	5	6.0	1.4	144	39.4	17.7

Appendix D. Kodiak Island limnological data for 1994

LAKE	Date	Sta	Depth (m)	Filterable reactive-P (ug/L P)	Total Kjel-dahl nitrogen (ug/L N)	Ammonia (ug/L N)	Nitrate+ nitrite (ug/L N)	Reactive silicon (ug/L Si)	Organic carbon (ug/L)	Chloro-phyll a (ug/L)	Phaeo-phytin a (ug/L)
AFOGNAK	05/05/94	1	1	2.5	129.5	1.7	150.4	2942	201	2.33	0.01
AFOGNAK	05/05/94	1	2							1.88	0.44
AFOGNAK	05/05/94	1	17	3.0	139.6	1.5	155.3	2882	190	2.00	0.57
AFOGNAK	05/05/94	2	1	3.5	137.2	1.5	154.3	2894	165	2.06	0.39
AFOGNAK	05/05/94	2	2							2.17	0.53
AFOGNAK	05/05/94	2	9	2.7	161.2	1.5	154.3	2894	182	2.30	0.43
AFOGNAK	06/09/94	1	1	2.2	145.0	1.5	98.0	2820	209	1.93	0.71
AFOGNAK	06/09/94	1	2							1.80	0.59
AFOGNAK	06/09/94	1	18	2.4	137.2	2.1	103.9	2878	146	1.14	0.45
AFOGNAK	06/09/94	2	1	2.6	131.8	3.2	98.0	2690	154	1.30	0.30
AFOGNAK	06/09/94	2	2							1.04	0.39
AFOGNAK	06/09/94	2	11	2.9	131.8	3.7	98.0	2714	168	1.11	0.32
AFOGNAK	06/30/94	1	1	2.2	187.7	12.6	62.4	2310	278	2.22	1.21
AFOGNAK	06/30/94	1	2							2.11	1.37
AFOGNAK	06/30/94	1	18	2.2	136.5	20.3	99.0	2740	113	0.71	0.41
AFOGNAK	06/30/94	2	1	4.7	231.0	22.5	64.0	2310	289	2.43	1.22
AFOGNAK	06/30/94	2	2							2.07	1.47
AFOGNAK	06/30/94	2	11	2.5	138.8	23.6	90.3	2597	127	0.63	0.67
AFOGNAK	07/20/94	1	1	2.4	195.4	2.6	30.1	2225	292	3.88	1.20
AFOGNAK	07/20/94	1	2							4.38	1.11
AFOGNAK	07/20/94	1	17	1.9	199.2	14.8	38.8	2310	294	2.70	1.54
AFOGNAK	07/20/94	2	1	2.0	196.9	3.7	32.0	2164	432	4.16	1.25
AFOGNAK	07/20/94	2	2							4.12	1.45
AFOGNAK	07/20/94	2	11	3.8	183.8	12.6	41.7	2480	474	2.64	1.57
AFOGNAK	08/12/94	1	1	9.4	202.4	13.7	14.6	2180	379	1.62	0.62
AFOGNAK	08/12/94	1	2							1.82	0.55
AFOGNAK	08/12/94	1	15	3.2	225.6	57.8	38.9	2633	131	1.06	1.08
AFOGNAK	08/12/94	2	1	6.7	207.8	14.8	18.4	2125	234	2.11	0.53
AFOGNAK	08/12/94	2	2							1.80	0.59
AFOGNAK	08/12/94	2	12	2.5	224.8	70.0	35.9	2620	192	1.52	1.45
AFOGNAK	08/31/94	1	1	1.4	214.8	25.8	16.5	1742	271	2.26	0.63
AFOGNAK	08/31/94	1	2							2.00	0.86
AFOGNAK	08/31/94	1	15	1.6	244.2	31.3	23.3	1858	274	1.50	0.74
AFOGNAK	08/31/94	2	1	1.0	217.1	22.5	14.6	1730	313	1.99	0.68
AFOGNAK	08/31/94	2	2							2.46	0.56
AFOGNAK	08/31/94	2	10	1.8	211.7	25.8	16.5	1717	278	1.47	0.68
AFOGNAK	09/22/94	1	1	27.2	179.1	29.1	37.9	1580	161	1.72	0.30
AFOGNAK	09/22/94	1	2							1.84	0.29

AFOGNAK	09/22/94	1	16	2.5	179.1	28.6	48.6	1697	174	1.09	0.49
AFOGNAK	09/22/94	2	1	19.9	214.1	26.9	34.0	1592	210	1.97	0.59
AFOGNAK	09/22/94	2	2							2.64	0.24
AFOGNAK	09/22/94	2	11	2.6	182.2	29.1	45.6	1801	174	1.26	0.42
AFOGNAK	10/14/94	1	1	1.7	215.6	17.6	70.9	2021	189	1.70	0.35
AFOGNAK	10/14/94	1	2							1.71	0.33
AFOGNAK	10/14/94	1	16	1.6	175.2	19.2	35.9	2123	152	1.20	0.40
AFOGNAK	10/14/94	2	1	1.8	187.6	26.9	70.9	2052	176	1.83	0.32
AFOGNAK	10/14/94	2	2							1.79	0.39
AFOGNAK	10/14/94	2	10	3.9	177.6	14.8	72.8	2148	152	1.29	0.43
AKALURA	05/16/94	1	1	3.9	204.7	1.8	23.4	752	487	5.75	0.12
AKALURA	05/16/94	1	2	0.0	0.0	0.0	0.0	0	0	4.74	1.05
AKALURA	05/16/94	1	17	2.0	241.6	6.2	34.2	776	565	7.23	1.69
AKALURA	05/16/94	2	1	2.2	193.8	3.4	27.9	724	490	5.73	0.36
AKALURA	05/16/94	2	2	0.0	0.0	0.0	0.0	0	0	5.65	1.13
AKALURA	05/16/94	2	14	2.5	193.0	3.4	27.9	724	524	6.16	0.63
AKALURA	06/14/94	1	1	1.7	171.8	3.4	0.8	705	348	2.58	0.60
AKALURA	06/14/94	1	2	0.0	0.0	0.0	0.0	0	0	2.35	0.42
AKALURA	06/14/94	1	16	1.7	133.3	50.7	8.2	922	224	2.36	0.87
AKALURA	06/14/94	2	1	1.7	133.3	3.4	7.0	664	280	2.25	0.52
AKALURA	06/14/94	2	2	0.0	0.0	0.0	0.0	0	0	2.33	0.42
AKALURA	06/14/94	2	14	2.5	224.3	59.6	7.6	940	318	2.78	1.63
AKALURA	07/18/94	1	1	2.2	240.8	6.8	0.8	596	509	5.45	0.77
AKALURA	07/18/94	1	2	0.0	0.0	0.0	0.0	0	0	5.31	0.71
AKALURA	07/18/94	1	16	4.9	317.6	149.7	18.9	1358	239	0.73	0.81
AKALURA	07/18/94	2	1	2.7	240.8	7.9	4.0	609	609	5.29	0.93
AKALURA	07/18/94	2	2	0.0	0.0	0.0	0.0	0	0	5.84	0.57
AKALURA	07/18/94	2	13	2.7	272.1	45.1	5.9	797	427	4.09	0.44
AKALURA	08/18/94	1	1	3.0	460.7	1.7	4.0	935	1227	14.67	0.01
AKALURA	08/18/94	1	2	0.0	0.0	0.0	0.0	0	0	13.79	0.01
AKALURA	08/18/94	1	17	8.6	433.3	176.7	78.8	1717	524	0.39	0.87
AKALURA	08/18/94	2	1	8.9	378.7	1.7	0.8	959	1038	13.70	0.15
AKALURA	08/18/94	2	2	0.0	0.0	0.0	0.0	0	0	12.11	0.01
AKALURA	08/18/94	2	14	4.8	218.2	75.4	125.1	1546	138	0.65	0.73
AKALURA	09/26/94	1	1	4.8	301.7	91.2	47.1	1408	319	2.10	1.06
AKALURA	09/26/94	1	2	0.0	0.0	0.0	0.0	0	0	2.39	0.64
AKALURA	09/26/94	1	16	4.0	303.2	92.3	46.0	1396	399	3.01	0.51
AKALURA	09/26/94	2	1	4.7	280.4	90.1	44.9	1420	312	1.93	0.59
AKALURA	09/26/94	2	2	0.0	0.0	0.0	0.0	0	0	1.75	0.75
AKALURA	09/26/94	2	14	4.8	285.0	93.4	47.1	1420	269	1.77	0.98
BIG KITOI	05/26/94	1	1	2.1	103.8	4.3	169.5	2450	103	0.34	0.19

BIG KITOI	05/26/94	1	2	0.0	0.0	0.0	0.0	0	0	0.43	0.17
BIG KITOI	05/26/94	1	32	1.0	81.1	5.4	139.6	2520	36	0.22	0.11
BIG KITOI	07/27/94	1	1	3.4	229.2	25.2	79.0	2599	480	0.27	0.20
BIG KITOI	07/27/94	1	2	0.0	0.0	0.0	0.0	0	0	0.16	0.21
BIG KITOI	07/27/94	1	31	1.2	101.4	18.6	167.0	2768	61	0.08	0.12
BIG KITOI	09/08/94	1	1	1.4	130.5	7.6	55.0	2174	86	0.80	0.19
BIG KITOI	09/08/94	1	2	0.0	0.0	0.0	0.0	0	0	0.79	0.23
BIG KITOI	09/08/94	1	31	1.2	110.1	12.0	173.7	2531	91	0.10	0.17
BIG KITOI	10/27/94	1	1	0.7	96.7	1.0	132.2	2707	60	0.40	0.24
BIG KITOI	10/27/94	1	2	0.0	0.0	0.0	0.0	0	0	0.32	0.18
BIG KITOI	10/27/94	1	30	0.7	91.2	1.0	131.3	2732	52	0.39	0.21
CRESCEN	06/01/94	1	1	3.6	195.0	0.7	71.0	2968	66	0.94	0.30
CRESCEN	06/01/94	1	2	0.0	0.0	0.0	0.0	0	0	0.99	0.37
CRESCEN	06/01/94	1	26	3.2	191.2	1.2	75.9	2956	216	0.71	0.33
CRESCEN	06/30/94	1	1	1.5	161.4	1.8	40.1	2740	96	0.21	0.16
CRESCEN	06/30/94	1	2	0.0	0.0	0.0	0.0	0	0	0.14	0.23
CRESCEN	06/30/94	1	26	3.3	149.2	12.6	85.7	2970	140	0.21	0.39
CRESCEN	07/28/94	1	1	5.6	121.0	0.7	59.6	2651	108	0.41	0.34
CRESCEN	07/28/94	1	2	0.0	0.0	0.0	0.0	0	0	0.62	0.45
CRESCEN	07/28/94	1	26	3.9	141.6	18.0	82.4	3392	55	0.18	0.15
CRESCEN	08/25/94	1	1	1.8	159.1	4.0	17.3	2924	143	0.45	0.36
CRESCEN	08/25/94	1	2	0.0	0.0	0.0	0.0	0	0	0.19	0.44
CRESCEN	08/25/94	1	26	2.3	150.8	21.6	92.2	3476	122	0.19	0.26
CRESCEN	09/22/94	1	1	6.9	154.6	5.1	23.8	2865	158	0.76	0.20
CRESCEN	09/22/94	1	2	0.0	0.0	0.0	0.0	0	0	0.86	0.23
CRESCEN	09/22/94	1	25	10.6	162.9	28.8	82.4	3430	110	0.44	0.18
CRESCEN	10/19/94	1	1	1.9	167.6	5.1	27.0	2912	115	0.56	0.29
CRESCEN	10/19/94	1	2	0.0	0.0	0.0	0.0	0	0	0.57	0.31
CRESCEN	10/19/94	1	25	1.7	166.8	8.3	27.0	2836	126	0.44	0.30
FRAZER	06/02/94	1	1	1.7	99.7	2.2	75.0	1841	149	0.58	0.13
FRAZER	06/02/94	1	2	0.0	0.0	0.0	0.0	0	0	0.73	0.16
FRAZER	06/02/94	1	23	1.9	92.0	4.4	85.0	1900	124	0.96	0.08
FRAZER	06/02/94	3	1	2.4	138.6	4.4	79.2	1876	190	0.66	0.20
FRAZER	06/02/94	3	2	0.0	0.0	0.0	0.0	0	0	0.69	0.19
FRAZER	06/02/94	3	50	1.6	86.7	9.8	90.7	1923	116	0.75	0.17
FRAZER	07/19/94	1	1	1.5	102.7	8.6	53.6	1901	165	0.52	0.16
FRAZER	07/19/94	1	2	0.0	0.0	0.0	0.0	0	0	0.47	0.20
FRAZER	07/19/94	1	23	1.3	89.8	5.5	56.4	1913	171	0.52	0.21
FRAZER	07/19/94	3	1	1.2	95.1	3.3	47.9	1931	124	0.61	0.17
FRAZER	07/19/94	3	2	0.0	0.0	0.0	0.0	0	0	0.58	0.20
FRAZER	07/19/94	3	50	1.8	97.4	16.4	75.0	2004	80	0.36	0.24

FRAZER	08/25/94	1	1	1.2	91.3	7.7	42.1	1924	127	0.79	0.17
FRAZER	08/25/94	1	2	0.0	0.0	0.0	0.0	0	0	0.65	0.17
FRAZER	08/25/94	1	24	1.2	101.2	22.9	67.8	2015	138	0.42	0.14
FRAZER	08/30/94	3	1	1.9	111.9	5.5	30.7	1963	132	0.76	0.17
FRAZER	08/30/94	3	2	0.0	0.0	0.0	0.0	0	0	0.74	0.16
FRAZER	08/30/94	3	50	1.0	101.2	33.8	80.7	2143	36	0.18	0.09
FRAZER	10/11/94	1	1	1.0	86.0	1.1	73.5	1932	102	0.71	0.08
FRAZER	10/11/94	1	2	0.0	0.0	0.0	0.0	0	0	0.79	0.11
FRAZER	10/11/94	1	23	1.2	84.4	1.1	76.4	2014	134	0.62	0.10
FRAZER	10/11/94	3	1	1.0	89.0	1.1	70.7	2059	102	0.78	0.13
FRAZER	10/11/94	3	2	0.0	0.0	0.0	0.0	0	0	0.75	0.13
FRAZER	10/11/94	3	43	1.0	105.8	4.4	70.7	1983	70	0.56	0.13
HIDDEN K	05/16/94	1	1	1.3	76.8	1.1	56.4	1733	86	0.49	0.10
HIDDEN K	05/16/94	1	2	0.0	0.0	0.0	0.0	0	0	0.44	0.13
HIDDEN K	05/16/94	1	40	0.9	75.2	1.1	56.4	1768	66	0.28	0.11
HIDDEN K	06/16/94	1	1	1.0	94.3	1.1	32.1	1744	195	0.18	0.17
HIDDEN K	06/16/94	1	2	0.0	0.0	0.0	0.0	0	0	0.31	0.17
HIDDEN K	06/16/94	1	38	1.1	80.6	3.3	50.7	1862	170	0.04	0.12
HIDDEN K	07/05/94	1	1	0.9	149.2	5.5	10.8	1499	220	0.73	0.09
HIDDEN K	07/05/94	1	2	0.0	0.0	0.0	0.0	0	0	0.62	0.14
HIDDEN K	07/05/94	1	42	1.5	127.1	6.6	52.2	1671	38	0.04	0.16
HIDDEN K	07/29/94	1	1	2.4	138.6	3.3	2.2	1644	273	4.43	0.01
HIDDEN K	07/29/94	1	2	0.0	0.0	0.0	0.0	0	0	2.89	0.12
HIDDEN K	07/29/94	1	43	1.2	88.2	9.8	52.2	1858	44	0.04	0.12
HIDDEN K	08/19/94	1	1	0.9	169.8	3.3	2.2	1558	295	1.10	0.01
HIDDEN K	08/19/94	1	2	0.0	0.0	0.0	0.0	0	0	1.02	0.04
HIDDEN K	08/19/94	1	41	1.1	86.7	8.8	55.0	1790	55	0.06	0.11
HIDDEN K	09/16/94	1	1	1.1	113.4	5.5	2.9	1616	69	0.57	0.32
HIDDEN K	09/16/94	1	2	0.0	0.0	0.0	0.0	0	0	0.61	0.35
HIDDEN K	09/16/94	1	39	1.9	79.9	9.8	57.9	1930	56	0.06	0.21
HIDDEN K	10/07/94	1	1	0.9	99.7	8.8	26.4	1767	110	0.25	0.20
HIDDEN K	10/07/94	1	2	0.0	0.0	0.0	0.0	0	0	0.19	0.24
HIDDEN K	10/07/94	1	39	0.7	79.9	12.0	60.0	1818	33	0.04	0.12
JENNIFER	06/01/94	1	1	1.6	163.2	7.7	230.5	1917	80	0.20	0.10
JENNIFER	06/01/94	1	2	0.0	0.0	0.0	0.0	0	0	0.17	0.16
JENNIFER	06/01/94	1	21	2.6	165.5	17.5	301.8	2230	7	0.20	0.22
JENNIFER	07/21/94	1	1	9.1	177.2	22.9	173.4	1852	234	0.62	0.28
JENNIFER	07/21/94	1	2	0.0	0.0	0.0	0.0	0	0	0.00	0.00
JENNIFER	07/21/94	1	20	1.9	192.9	33.8	252.7	2431	131	0.13	0.18
JENNIFER	08/18/94	1	1	1.2	185.9	9.8	72.1	1570	192	0.64	0.17
JENNIFER	08/18/94	1	2	0.0	0.0	0.0	0.0	0	0	0.57	0.24

JENNIFER	08/18/94	1	20	1.3	174.9	28.9	261.2	2725	55	0.12	0.20
JENNIFER	10/24/94	1	2	0.0	0.0	0.0	0.0	0	0	0.20	0.09
JENNIFER	10/24/94	1	19	0.0	0.0	0.0	0.0	0	105	0.13	0.18
JENNIFER	10/24/94	2	1	1.7	189.1	25.1	263.2	2204	102	0.04	0.25
JENNIFER	10/24/94	2	19	3.0	243.9	25.1	260.4	2364	105	0.00	0.00
JENNIFER	06/01/94	1	1	1.1	158.5	9.8	32.1	1338	198	0.12	0.14
JENNIFER	06/01/94	1	2	0.0	0.0	0.0	0.0	0	0	0.20	0.23
JENNIFER	06/01/94	1	21	1.0	127.9	12.0	69.2	1490	100	0.20	0.26
JENNIFER	07/21/94	1	1	3.3	146.7	9.8	16.5	1076	97	0.84	0.15
JENNIFER	07/21/94	1	2	0.0	0.0	0.0	0.0	0	0	0.46	0.18
JENNIFER	07/21/94	1	21	1.6	146.7	25.1	85.0	1604	52	0.12	0.12
JENNIFER	08/18/94	1	1	1.0	179.6	5.5	2.2	1008	66	0.28	0.14
JENNIFER	08/18/94	1	2	0.0	0.0	0.0	0.0	0	0	0.20	0.14
JENNIFER	08/18/94	1	21	1.1	157.7	27.2	102.1	1632	60	0.12	0.09
JENNIFER	10/24/84	1	1	1.0	153.8	12.0	42.1	1353	107	0.30	0.09
JENNIFER	10/24/94	1	2	0.0	0.0	0.0	0.0	0	0	0.17	0.17
JENNIFER	10/24/94	1	20	1.0	145.1	25.1	80.7	1629	67	0.08	0.21
KARLUK	06/02/94	3	1	0.9	110.1	2.9	136.2	61	293	0.53	0.12
KARLUK	06/02/94	3	2	0.0	0.0	0.0	0.0	0	0	0.49	0.13
KARLUK	06/02/94	3	50	1.0	96.2	10.0	147.5	44	346	1.13	0.20
KARLUK	07/19/94	3	1	1.3	107.8	4.0	59.6	112	246	0.91	0.24
KARLUK	07/19/94	3	2	0.0	0.0	0.0	0.0	0	0	0.86	0.14
KARLUK	07/19/94	3	50	1.1	100.0	19.1	126.4	94	222	1.31	0.27
KARLUK	08/30/94	3	1	1.0	136.5	4.0	30.3	126	502	1.21	0.15
KARLUK	08/30/94	3	2	0.0	0.0	0.0	0.0	0	0	1.14	0.23
KARLUK	08/30/94	3	50	17.0	184.5	53.7	124.7	512	376	0.65	0.42
KARLUK	10/11/94	3	1	0.4	103.2	1.7	92.2	257	121	1.22	0.27
KARLUK	10/11/94	3	2	0.0	0.0	0.0	0.0	0	0	1.18	0.41
KARLUK	10/11/94	3	43	1.6	87.7	1.7	154.0	225	126	0.61	0.20
LAURA	05/16/94	1	1	1.4	114.1	4.4	17.6	1686	146	1.07	0.18
LAURA	05/16/94	1	2	0.0	0.0	0.0	0.0	0	0	1.09	0.31
LAURA	05/16/94	1	38	0.9	110.2	4.4	20.9	1710	118	0.49	0.26
LAURA	06/15/94	1	1	1.4	146.5	5.4	4.0	1544	69	1.04	0.36
LAURA	06/15/94	1	2	0.0	0.0	0.0	0.0	0	0	1.22	0.30
LAURA	06/15/94	1	32	2.2	113.4	9.7	17.6	1791	88	0.55	0.27
LAURA	07/06/94	1	1	2.0	238.8	4.4	4.4	109	60	5.21	1.02
LAURA	07/06/94	1	2	0.0	0.0	0.0	0.0	0	0	5.50	0.94
LAURA	07/06/94	1	35	1.5	130.2	14.0	14.3	1656	102	0.48	0.30
LAURA	07/29/94	1	1	1.6	230.4	28.9	12.7	630	265	2.62	0.21
LAURA	07/29/94	1	2	0.0	0.0	0.0	0.0	0	0	2.79	0.35

LAURA	07/29/94	1	37	1.3	194.2	68.4	22.6	1832	74	0.35	0.25
LAURA	08/19/94	1	1	1.4	218.1	10.8	4.0	690	248	1.43	0.80
LAURA	08/19/94	1	2	0.0	0.0	0.0	0.0	0	0	1.71	0.78
LAURA	08/19/94	1	34	1.4	200.3	96.1	24.2	1766	69	0.18	0.22
LAURA	09/16/94	1	1	1.4	187.3	5.5	4.0	871	210	4.36	0.33
LAURA	09/16/94	1	2	0.0	0.0	0.0	0.0	0	0	3.63	0.89
LAURA	09/16/94	1	37	1.7	171.9	63.0	11.0	1930	58	0.21	0.20
LAURA	10/07/94	1	1	1.5	152.6	6.5	91.9	1145	166	2.38	0.86
LAURA	10/07/94	1	2	0.0	0.0	0.0	0.0	0	0	2.75	0.60
LAURA	10/07/94	1	37	1.4	143.4	39.6	92.2	1805	126	0.45	0.25

LITTLE KIT	05/26/94	1	1	1.6	153.2	2.9	210.9	2649	119	1.05	0.36
LITTLE KIT	05/26/94	1	2	0.0	0.0	0.0	0.0	0	0	0.81	0.49
LITTLE KIT	05/26/94	1	18	1.6	149.8	6.3	223.7	3150	117	0.33	0.37
LITTLE KIT	05/26/94	2	1	1.7	175.9	6.3	214.1	2556	164	0.87	0.34
LITTLE KIT	05/26/94	2	2	0.0	0.0	0.0	0.0	0	0	0.88	0.55
LITTLE KIT	05/26/94	2	14	1.8	141.3	13.1	244.6	3210	83	0.29	0.29
LITTLE KIT	07/24/94	1	1	1.6	143.0	5.2	130.8	2262	131	0.96	0.53
LITTLE KIT	07/24/94	1	2	0.0	0.0	0.0	0.0	0	0	1.24	0.47
LITTLE KIT	07/24/94	1	18	2.8	151.3	70.1	287.3	3110	47	0.25	0.18
LITTLE KIT	07/24/94	2	1	2.0	143.0	5.2	128.7	2250	172	1.38	0.45
LITTLE KIT	07/24/94	2	2	0.0	0.0	0.0	0.0	0	0	1.41	0.49
LITTLE KIT	07/24/94	2	15	2.8	105.2	6.3	259.6	3135	50	0.47	0.29
LITTLE KIT	09/09/94	1	1	2.2	198.6	10.9	86.0	2007	228	0.67	0.34
LITTLE KIT	09/09/94	1	2	0.0	0.0	0.0	0.0	0	0	0.77	0.34
LITTLE KIT	09/09/94	1	11	1.6	162.1	14.2	270.2	2852	50	0.40	0.14
LITTLE KIT	09/09/94	2	1	1.6	208.0	13.1	90.3	2090	209	0.85	0.30
LITTLE KIT	09/09/94	2	2	0.0	0.0	0.0	0.0	0	0	0.78	0.31
LITTLE KIT	09/09/94	2	15	2.4	116.7	4.0	251.0	3102	75	0.47	0.32
LITTLE KIT	10/27/94	1	1	1.3	143.0	20.0	215.2	2780	78	0.88	0.48
LITTLE KIT	10/27/94	1	2	0.0	0.0	0.0	0.0	0	0	0.76	0.35
LITTLE KIT	10/27/94	1	20	61.2	3282.5	2223.0	108.4	6931	619	0.17	0.36
LITTLE KIT	10/27/94	2	1	2.5	160.2	21.1	214.1	2915	78	0.00	0.00
LITTLE KIT	10/27/94	2	2	0.0	0.0	0.0	0.0	0	0	0.77	0.29
LITTLE KIT	10/27/94	2	15	0.8	212.1	21.1	222.6	2866	30	0.61	0.31

MALINA L	05/05/94	1	1	0.7	140.3	2.2	207.3	2811	218	1.39	0.20
MALINA L	05/05/94	1	2	0.0	0.0	0.0	0.0	0	0	1.33	0.24
MALINA L	05/05/94	1	10	1.0	129.5	3.3	207.3	2811	201	1.41	0.25
MALINA L	06/09/94	1	1	11.1	165.7	5.5	156.2	2620	331	1.81	0.28
MALINA L	06/09/94	1	2	0.0	0.0	0.0	0.0	0	0	1.81	0.27
MALINA L	06/09/94	1	9	3.1	125.7	4.4	151.2	2714	262	1.46	0.31
MALINA L	06/30/94	1	1	4.7	145.7	6.5	116.6	2339	201	1.22	0.33

MALINA L	06/30/94	1	2	0.0	0.0	0.0	0.0	0	0	1.40	0.31
MALINA L	06/30/94	1	9	4.4	128.0	8.6	119.9	2482	162	0.72	0.32
MALINA L	07/20/94	1	1	35.8	168.0	15.0	93.5	2489	146	1.26	0.32
MALINA L	07/20/94	1	2	0.0	0.0	0.0	0.0	0	0	1.06	0.42
MALINA L	07/20/94	1	9	5.8	154.2	15.0	95.2	2513	140	0.67	0.36
MALINA L	08/12/94	1	1	5.0	161.1	4.4	86.9	2566	140	1.44	0.43
MALINA L	08/12/94	1	2	0.0	0.0	0.0	0.0	0	0	1.23	0.47
MALINA L	08/12/94	1	10	6.2	146.5	19.3	93.5	2628	152	0.72	0.28
MALINA L	08/31/94	1	1	3.2	153.4	4.4	70.4	2516	146	0.99	0.29
MALINA L	08/31/94	1	2	0.0	0.0	0.0	0.0	0	0	0.97	0.26
MALINA L	08/31/94	1	8	3.1	145.7	6.5	70.4	2464	131	0.84	0.34
MALINA L	09/22/94	1	1	7.1	144.2	10.8	67.1	2471	123	1.05	0.41
MALINA L	09/22/94	1	2	0.0	0.0	0.0	0.0	0	0	1.00	0.27
MALINA L	09/22/94	1	9	4.8	143.3	12.9	63.8	2324	120	0.69	0.31
MALINA L	10/14/94	1	1	3.3	151.1	12.9	93.5	2519	105	0.61	0.18
MALINA L	10/14/94	1	2	0.0	0.0	0.0	0.0	0	0	0.62	0.27
MALINA L	10/14/94	1	9	3.8	143.3	15.0	96.8	2532	81	0.50	0.21
MALINA U	05/05/94	2	1	2.5	120.2	4.4	225.5	2942	209	1.19	0.33
MALINA U	05/05/94	2	2	0.0	0.0	0.0	0.0	0	0	1.78	0.03
MALINA U	05/05/94	2	27	1.0	134.1	4.4	181.0	2930	201	1.51	0.17
MALINA U	06/09/94	2	1	1.9	137.2	6.5	191.7	2808	251	1.14	0.24
MALINA U	06/09/94	2	2	0.0	0.0	0.0	0.0	0	0	1.16	0.21
MALINA U	06/09/94	2	27	3.9	127.2	9.7	138.1	2901	207	1.02	0.16
MALINA U	06/30/94	2	1	2.9	176.5	11.8	195.8	2310	336	2.62	0.89
MALINA U	06/30/94	2	2	0.0	0.0	0.0	0.0	0	0	3.07	0.63
MALINA U	06/30/94	2	27	3.2	130.2	21.4	17.6	2769	146	0.55	0.31
MALINA U	07/20/94	2	1	3.0	181.1	2.2	108.4	2528	333	3.36	0.85
MALINA U	07/20/94	2	2	0.0	0.0	0.0	0.0	0	0	3.25	0.85
MALINA U	07/20/94	2	27	6.2	147.2	21.4	187.6	3050	116	0.43	0.43
MALINA U	08/12/94	2	1	4.0	192.7	7.5	57.2	2742	99	3.25	1.05
MALINA U	08/12/94	2	2	0.0	0.0	0.0	0.0	0	0	3.38	0.86
MALINA U	08/12/94	2	27	1.7	144.1	42.8	184.2	3374	87	0.28	0.34
MALINA U	08/31/94	2	1	2.9	171.9	8.6	62.1	2513	282	2.56	0.19
MALINA U	08/31/94	2	2	0.0	0.0	0.0	0.0	0	0	1.80	0.33
MALINA U	08/31/94	2	21	6.4	142.6	34.2	184.2	3078	90	0.40	0.32
MALINA U	09/22/94	2	1	3.2	159.6	4.4	75.4	2520	323	2.71	0.46
MALINA U	09/22/94	2	2	0.0	0.0	0.0	0.0	0	0	2.54	0.63
MALINA U	09/22/94	2	26	4.0	154.9	9.7	97.7	2644	193	1.89	0.29
MALINA U	10/14/94	2	1	3.7	154.2	6.5	90.2	2696	181	2.06	0.13
MALINA U	10/14/94	2	2	0.0	0.0	0.0	0.0	0	0	2.06	0.05
MALINA U	10/14/94	2	26	3.6	143.3	8.6	90.2	2658	179	1.72	0.28

PORTAGE	05/16/94	1	1	2.2	104.7	1.7	19.0	2100	149	0.42	0.22
PORTAGE	05/16/94	1	2	0.0	0.0	0.0	0.0	0	0	0.38	0.23
PORTAGE	05/16/94	1	14	1.8	105.5	1.7	25.5	2083	202	0.17	0.31
PORTAGE	06/16/94	1	1	1.8	112.5	1.7	9.2	2267	164	0.56	0.29
PORTAGE	06/16/94	1	2	0.0	0.0	0.0	0.0	0	0	0.41	0.28
PORTAGE	06/16/94	1	17	3.1	137.2	1.7	19.0	2314	128	0.09	0.21
PORTAGE	07/06/94	1	1	2.7	124.8	1.7	4.0	1585	720	3.78	0.87
PORTAGE	07/06/94	1	2	0.0	0.0	0.0	0.0	0	0	2.01	0.99
PORTAGE	07/06/94	1	17	2.1	210.9	2.2	27.1	1986	84	0.04	0.15
PORTAGE	07/29/94	1	1	2.9	295.4	11.0	23.9	1592	202	2.89	0.67
PORTAGE	07/29/94	1	2	0.0	0.0	0.0	0.0	0	0	2.82	0.67
PORTAGE	07/29/94	1	15	2.2	138.0	12.1	35.2	2215	119	0.36	0.35
PORTAGE	08/19/94	1	1	2.0	219.4	1.7	4.0	0	355	2.87	0.76
PORTAGE	08/19/94	1	18	1.9	168.2	29.7	40.1	2138	90	0.18	0.70
PORTAGE	09/16/94	1	1	1.6	186.8	4.4	9.2	791	183	1.82	1.02
PORTAGE	09/16/94	1	2	0.0	0.0	0.0	0.0	0	0	1.92	0.82
PORTAGE	09/16/94	1	17	1.8	200.8	56.1	40.1	2334	45	0.20	0.28
PORTAGE	10/07/94	1	1	1.8	193.8	5.4	28.7	1837	160	0.94	0.32
PORTAGE	10/07/94	1	2	0.0	0.0	0.0	0.0	0	0	0.91	0.30
PORTAGE	10/07/94	1	17	2.7	193.1	3.6	27.1	1935	150	0.67	0.36
RED	05/16/94	1	1	5.2	142.8	1.2	23.9	53	432	4.94	0.01
RED	05/16/94	1	2	0.0	0.0	0.0	0.0	0	0	4.40	0.01
RED	05/16/94	1	38	2.0	154.5	2.9	25.6	53	533	5.83	0.01
RED	05/16/94	2	1	1.2	128.7	1.7	23.4	41	368	5.05	0.01
RED	05/16/94	2	2	0.0	0.0	0.0	0.0	0	0	3.11	0.32
RED	05/16/94	2	38	1.7	186.7	2.3	24.5	47	435	5.08	0.01
RED	06/14/94	1	1	1.0	120.1	1.8	4.0	235	167	1.00	0.15
RED	06/14/94	1	2	0.0	0.0	0.0	0.0	0	0	1.22	0.17
RED	06/14/94	1	38	10.5	225.9	27.1	5.3	241	449	5.71	0.44
RED	06/14/94	2	1	0.7	127.9	1.7	4.0	188	220	1.09	0.27
RED	06/14/94	2	2	0.0	0.0	0.0	0.0	0	0	1.13	0.42
RED	06/14/94	2	38	7.6	194.5	21.4	6.4	205	471	4.70	0.62
RED	07/18/94	1	1	1.3	139.6	1.7	4.0	128	191	1.22	0.66
RED	07/18/94	1	2	0.0	0.0	0.0	0.0	0	0	1.17	0.60
RED	07/18/94	1	38	20 2	356.1	97.9	7.0	436	228	0.40	0.56
RED	07/18/94	4	1	1.6	146.7	3.4	4.0	142	209	0.96	0.82
RED	07/18/94	4	2	0.0	0.0	0.0	0.0	0	0	1.06	0.58
RED	07/18/94	4	37	24.1	307.8	109.2	6.4	436	230	0.34	0.84
RED	08/18/94	1	1	2.5	246.2	5.7	4.0	299	399	5.84	0.69
RED	08/18/94	1	2	0.0	0.0	0.0	0.0	0	0	4.12	1.37
RED	08/18/94	1	38	60.0	329.5	131.7	112.7	800	233	0.19	0.69
RED	08/18/94	2	1	2.2	213.3	3.4	4.0	299	282	4.37	0.37

RED	08/18/94	2	2	0.0	0.0	0.0	0.0	0	0	4.31	0.69
RED	08/18/94	2	37	44.7	334.1	154.2	88.9	764	441	0.27	1.19
RED	09/22/94	1	1	4.6	200.8	10.2	8.7	129	231	3.52	1.22
RED	09/22/94	1	2	0.0	0.0	0.0	0.0	0	0	3.98	1.16
RED	09/22/94	1	37	38.1	121.6	7.4	182.7	762	183	0.52	0.66
RED	09/22/94	2	1	5.5	167.8	10.2	13.2	117	242	3.86	1.30
RED	09/22/94	2	2	0.0	0.0	0.0	0.0	0	0	4.12	1.30
RED	09/22/94	2	37	44.8	176.4	19.2	189.5	886	318	0.60	1.03
RED	10/22/94	1	1	13.8	154.2	16.4	49.9	62	258	4.04	0.44
RED	10/22/94	1	2	0.0	0.0	0.0	0.0	0	0	9.33	0.17
RED	10/22/94	1	37	15.6	157.3	14.5	50.7	74	288	0.00	0.00
RED	10/22/94	2	1	14.6	158.8	18.2	53.1	68	280	8.33	0.86
RED	10/22/94	2	2	0.0	0.0	0.0	0.0	0	0	8.25	0.76
RED	10/22/94	2	37	14.9	171.3	16.4	51.5	56	293	8.75	0.84

Lake: AKALURA
Station: 1
Depth: 16-17m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	16-May	14-Jun	18-Jul	17-Aug	26-Sep	Seasonal Mean (No/m^2)
Ergasilus					1,062	212
Epischura	1,911	21,019	29,725	30,255	6,369	17,856
Eurytemora	955	34,077	32,377	40,446	19,639	25,499
Ovig Eurytemora		318			2,123	488
Cyclops	637	11,465	3,185	5,732	14,862	7,176
Bosmina	1,274	6,688	92,357	42,356	186,831	65,901
Ovig Bosmina	318	3,503	28,132	28,344	33,970	18,853
Daphnia l.			318			64
Daphnia g.						
Holopedium						
Chydorinae						
Polyphemus						

Total: 136,050

Body Size
(mm)

	16-May	14-Jun	18-Jul	17-Aug	26-Sep
Ergasilus					0.42
Epischura	0.53	0.96	0.94	1.11	0.70
Eurytemora	0.89	0.94	0.98	0.88	0.88
Ovig Eurytemora		1.08	1.01		1.10
Cyclops	0.53	0.54	0.71	0.55	0.46
Bosmina	0.36	0.28	0.27	0.27	0.29
Ovig Bosmina	0.41	0.37	0.31	0.29	0.31
Daphnia l.					
Daphnia g.					
Holopedium					
Chydorinae					
Polyphemus					

SEASONAL MEANS

Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
0.42	0.42	0.1	0.1
0.85	0.98	50	75
0.91	0.92	128	130
1.06	1.10	3	3
0.56	0.52	7	6
0.29	0.28	51	46
0.34	0.31	19	16
TOTAL:		259	277

Lake: AKALURA
Station: 2
Depth: 13-14m
Year: 1994

Macrozooplankton Density
(no./m²)

Date:	16-May	14-Jun	18-Jul	17-Aug	26-Sep	Seasonal Mean (No/m²)
Ergasilus					present	
Epischura		9,236	29,724	35,881	5,414	16,051
Eurytemora	4,777	17,197	24,204	20,382	13,376	15,987
Ovig Eurytemora					955	191
Cyclops	318	5,732	4,671	1,486	22,293	6,900
Bosmina	1,911	12,739	91,296	49,469	96,182	50,319
Ovig Bosmina		3,822	28,875	25,053	19,746	15,499
Daphnia l.						
Ovig Daphnia		955				191
Daphnia g.						
Holopedium						
Chydorinae						
Polyphemus						

Total: 105,139

Body Size
(mm)

SEASONAL MEANS

						Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus					0.58	0.58	0.58		
Epischura		0.85	0.96	1.18	0.78	0.94	1.03	61	79
Eurytemora	1.00	0.93	0.85	0.90	1.01	0.94	0.92	84	80
Ovig Eurytemora	1.24	1.10	1.03		1.13	1.13	1.13	1	1
Cyclops	0.52	0.59	0.71	0.57	0.53	0.58	0.57	8	7
Bosmina	0.35	0.30	0.30	0.27	0.30	0.30	0.29	42	39
Ovig Bosmina		0.35	0.31	0.29	0.30	0.31	0.30	14	13
Daphnia l.									
Ovig Daphnia		0.94				0.94	0.94	0.8	0.8
Daphnia g.									
Holopedium									
Chydorinae									
Polyphemus									
						TOTAL:		210	221

Lake: AKALURA
Station: 3
Depth: 20m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	16-May	14-Jun	18-Jul	17-Aug	26-Sep	Seasonal Mean (No/m^2)
Ergasilus					present	
Epischura	849	10,616	30,997	32,484	6,369	16,263
Eurytemora	4,034	35,669	42,038	41,401	14,862	27,601
Ovig Eurytemora				212	425	127
Cyclops	425	5,945	2,548	1,274	19,958	6,030
Bosmina	637	3,397	142,255	36,094	118,047	60,086
Ovig Bosmina	212	1,274	39,490	24,204	22,080	17,452
Daphnia l.						
Ovig Daphnia						
Daphnia g.						
Holopedium						
Chydorinae						
Polyphemus						

Total: 127,559

Body Size
(mm)

	16-May	14-Jun	18-Jul	17-Aug	26-Sep
Ergasilus					0.58
Epischura	0.80	1.01	0.85	1.14	0.95
Eurytemora	0.90	0.99	0.90	0.93	0.87
Ovig Eurytemora		1.13	1.06	1.02	1.14
Cyclops	0.62	0.51	0.63	0.47	0.48
Bosmina	0.31	0.29	0.27	0.27	0.30
Ovig Bosmina	0.36	0.37	0.31	0.31	0.31
Daphnia l.					
Ovig Daphnia					
Daphnia g.					
Holopedium					
Chydorinae					
Polyphemus					

SEASONAL MEANS

	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus	0.58	0.58		
Epischura	0.95	0.9	63	72
Eurytemora	0.92	0.93	140	142
Ovig Eurytemora	1.09	1.10	0.8	0.9
Cyclops	0.54	0.50	6	5
Bosmina	0.29	0.28	44	42
Ovig Bosmina	0.33	0.31	17	15
Daphnia l.				
Ovig Daphnia				
Daphnia g.				
Holopedium				
Chydorinae				
Polyphemus				
TOTAL:			271	278

Lake: *FRAZER*
Station: 1
Depth: 23-24m
Year: 1994

Macrozooplankton Density

(no./m^2)

Date:	2-Jun	19-Jul	25-Aug	11-Oct	Seasonal Mean (No/m^2)
Ergasilus			1,062	637	425
Epischura					
Diaptomus	425				106
Ovig Diaptomus		318			80
Cyclops	47,559	7,643	9,023	4,883	17,277
Ovig Cyclops		present	present		
Bosmina	2,760	45,542	99,788	45,648	48,435
Ovig Bosmina	0	7,325	30,255	14,438	13,005
Daphnia l.	637	7,006	37,686	13,588	14,729
Ovig Daphnia		637	19,639	425	5,175
Daphnia g.					
Holopedium					
Chydorinae					
Polyphemus					

Total: 99,231

Body Size

(mm)

SEASONAL MEANS

	2-Jun	19-Jul	25-Aug	11-Oct	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus		0.45	0.52	0.51	0.49	0.52	0.3	0.4
Epischura								
Diaptomus	1.08	1.04			1.06	1.08	1	1
Ovig Diaptomus		1.00			1.00	1.00	0.3	0.3
Cyclops	0.65	0.86	0.98	0.62	0.78	0.71	36	30
Ovig Cyclops		1.10	0.90		1.00	1.00		
Bosmina	0.39	0.33	0.35	0.37	0.36	0.35	57	54
Ovig Bosmina	0.54	0.39	0.36	0.45	0.44	0.39	23	18
Daphnia l.	0.83	0.57	0.66	0.53	0.65	0.62	26	24
Ovig Daphnia		0.73	0.70	0.65	0.69	0.70	11	11
Daphnia g.								
Holopedium								
Chydorinae								
Polyphemus								
TOTAL:							155	139

Lake: *FRAZER*
Station: 2
Depth: 50m
Year: 1994

Macrozooplankton Density

(no./m^2)

Date:	2-Jun	19-Jul	5-Aug	11-Oct	Seasonal Mean (No/m^2)
Ergasilus		1,274	3,185	2,229	1,672
Epischura					
Diaptomus		1,274			319
Ovig Diaptomus					
Cyclops	296,815	159,236	39,277	10,510	126,460
Ovig Cyclops		1,274		318	398
Bosmina	10,191	38,854	311,041	76,115	109,050
Ovig Bosmina	849	10,828	81,742	17,197	27,654
Daphnia l.	849	4,459	30,786	55,096	22,798
Ovig Daphnia		1,274	5,308	955	1,884
Daphnia g.					
Holopedium					
Chydorinae					
Polyphemus					

Total: 290,234

Body Size

(mm)

SEASONAL MEANS

	2-Jun	19-Jul	5-Aug	11-Oct	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus		0.47	0.53	0.54	0.51	0.52	1.4	1.5
Epischura								
Diaptomus	0.70	0.68			0.69	0.68	0.5	0.5
Ovig Diaptomus								
Cyclops	0.73	0.88	0.85	0.81	0.82	0.79	296	274
Ovig Cyclops		1.22	1.13	0.81	1.05	1.14	2	2
Bosmina	0.38	0.45	0.38	0.42	0.41	0.39	167	155
Ovig Bosmina	0.50	0.44	0.38	0.45	0.44	0.40	50	40
Daphnia l.	0.65	0.74	0.57	0.56	0.63	0.57	38	31
Ovig Daphnia	0.74	0.76	0.65	0.57	0.68	0.66	4	4
Daphnia g.								
Holopedium								
Chydorinae								
Polyphemus								
					TOTAL:		559	508

Lake: *FRAZER*
Station: 3
Depth: 50m
Year: 1994

Macrozooplankton Density

(no./m^2)

Date:	2-Jun	19-Jul	30-Aug	11-Oct	Seasonal Mean (No/m^2)
Ergasilus		637	1,274	637	637
Epischura					
Diaptomus		*present*			
Cyclops	128,981	140,765	42,675	15,924	82,086
Ovig Cyclops	318		637		239
Bosmina	6,369	51,592	217,834	251,599	131,849
Ovig Bosmina	1,274	20,383	83,440	36,942	35,510
Daphnia l.	955	1,911	47,771	75,797	31,609
Ovig Daphnia		1,911	15,287	1,911	4,777
Daphnia g.					
Holopedium					
Chydorinae				*present*	
Polyphemus					

Total: 286,706

Body Size

(mm)

SEASONAL MEANS

	2-Jun	19-Jul	30-Aug	11-Oct	Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus			0.49	0.52	0.51	0.50	1	1
Epischura								
Diaptomus		1.30			1.30	1.30		
Cyclops	0.64	0.80	0.82	0.87	0.78	0.74	175	157
Ovig Cyclops	0.64	1.12	1.32	1.18	1.07	1.09	1	1
Bosmina	0.41	0.37	0.37	0.41	0.39	0.39	184	184
Ovig Bosmina	0.49	0.42	0.40	0.44	0.44	0.41	63	56
Daphnia l.	0.55	0.67	0.57	0.59	0.60	0.58	47	45
Ovig Daphnia	0.69	0.78	0.66	0.61	0.69	0.67	10	9
Daphnia g.								
Holopedium								
Chydorinae				0.73	0.73	0.73		
Polyphemus								
TOTAL:							481	453

Lake: *FRAZER*
Station: 4
Depth: 50m
Year: 1994

Macrozooplankton Density
(no./m²)

Date:	2-Jun	19-Jul	30-Aug	11-Oct	Seasonal Mean (No/m²)
Ergasilus			3,185		796
Epischura					
Diaptomus	2,123				531
Cyclops	172,395	299,369	66.879	15,711	138.589
Ovig Cyclops	1,274	637	1,274	849	1.009
Bosmina	29.724	8.280	189.172	160.089	96.816
Ovig Bosmina	19,532	1,911	85,351	11,040	29.459
Daphnia l.	2.972	0	39,491	75,583	29.512
Ovig Daphnia	849		15,924		4.193
Daphnia g.					
Holopedium					
Chydorinae					
Polyphemus					

Total: 300,904

Body Size
(mm)

SEASONAL MEANS

					Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus	0.58		0.50	0.50	0.53	0.50	0.7	0.7
Epischura								
Diaptomus	1.13				1.13	1.13	3	3
Cyclops	0.81	0.63	0.87	0.89	0.80	0.72	309	249
Ovig Cyclops	1.15	1.00	1.17	1.25	1.14	1.15	5	5
Bosmina	0.36	0.45	0.40	0.39	0.40	0.39	143	138
Ovig Bosmina	0.42	0.51	0.39	0.43	0.44	0.40	53	44
Daphnia l.	0.72	0.69	0.66	0.59	0.67	0.62	56	48
Ovig Daphnia	0.82		0.70	0.73	0.75	0.71	10	9
Daphnia g.								
Holopedium								
Chydorinae								
Polyphemus								
					TOTAL:		580	496

Lake: RED - (Kodiak)
Station: 1
Depth: 37-38m
Year: 1994

Macrozooplankton Density

(no./m^2)

Date:	16-May	14-Jun	18-Jul	17-Aug	22-Sep	22-Oct	Seasonal Mean (No/m2)
Ergasilus					1,061		177
Immature Calanoids	15,924	7,431	8,493	27,601	6,369	531	11,058
Diaptomus	14,331	38,747	108,280	93,417	14,862	16,986	47,771
Ovig Diaptomus		531				1,062	266
Cyclops	250,525	288,217	222,930	192,143	80,678	95,011	188,251
Ovig Cyclops		11,677	48,831	70,064	4,246		22,470
Bosmina	4,777	5,839	96,602	145,436	26,539	5,839	47,505
Ovig Bosmina	1,062	1,592	8,493	24,416	1,061		6,104
Daphnia l.				18,047	9,554	16,454	7,343
Ovig Daphnia			2,123	6,369	4,246	9,023	3,627
Daphnia g.							
Holopedium							
Chydorinae			1,061	8,493	1,061		1,769
Ovig Chydorinae			1,061				177
Polyphemus							

Total: 336,516

Body Size

(mm)

SEASONAL MEANS

							Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus					0.32		0.32	0.32	0.1	0.1
Immature Calanoids	0.54	0.58	0.54	0.49	0.45		0.52	0.51	8	8
Diaptomus	0.86	1.06	1.13	1.00	0.89	1.00	0.99	1.04	200	232
Ovig Diaptomus		1.16					1.16	1.16	1.7	1.7
Cyclops	0.71	0.80	0.96	0.65	0.66	0.52	0.72	0.75	332	369
Ovig Cyclops		1.09	1.14	1.16	1.21	1.27	1.17	1.15	114	109
Bosmina	0.46	0.48	0.43	0.41	0.38	0.47	0.44	0.42	85	77
Ovig Bosmina	0.50	0.50	0.49	0.36	0.36	0.54	0.46	0.40	12	9
Daphnia l.	0.67	0.74	0.70	0.59	0.55	0.65	0.65	0.60	13	11
Ovig Daphnia			0.86	0.76	0.68	0.77	0.77	0.76	9	9
Daphnia g.										
Holopedium										
Chydorinae	0.36		0.36	0.36	0.29		0.34	0.35	1.9	2.0
Ovig Chydorinae			0.35	0.35			0.35	0.35	0.2	0.2
Polyphemus										
							TOTAL:		777	828

Lake: RED - (Kodiak)
Station: 2
Depth: 37 - 38m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	16-May	14-Jun	18-Jul	17-Aug	22-Sep	22-Oct	Seasonal Mean (No/m2)
Immature Calanoids	4,246	3,185	5,308	7,962	3,981		4.114
Diaptomus	35.032	18.046	41.932	40,605	58.918	35,562	38.349
Ovig Diaptomus					present		
Cyclops	239.920	160.828	140.658	167.197	93.153	123.142	154.150
Ovig Cyclops		3,715	43.524	26.274	8,758	1,592	13.977
Bosmina	3,715	3,715	54,670	156,050	21,497	2,654	40.384
Ovig Bosmina	2,123			33,439	3,185	531	6.546
Daphnia l.			7,431	31,051	14,331	10,616	10.572
Ovig Daphnia			4,246	8,758	3,981	1,062	3.008
Chydorinae	1,592	531	1,062	5,573	796		1.592
Ovig Chydorinae	present		present				

Total: 272,691

Body Size
(mm)

SEASONAL MEANS

							Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Ergasilus										
Immature Calanoids	0.54	0.54	0.57	0.48	0.53		0.53	0.53	3	3
Diaptomus	0.93	1.13	0.95	0.97	0.88	1.07	0.99	0.97	160	149
Ovig Diaptomus					1.20		1.20	1.20		
Cyclops	0.67	0.86	0.81	0.75	0.57	0.64	0.72	0.72	272	279
Ovig Cyclops		1.13	1.13	1.18	1.20	1.25	1.18	1.16	71	69
Bosmina	0.50	0.45	0.38	0.30	0.39	0.41	0.41	0.33	61	40
Ovig Bosmina	0.52	0.54		0.32	0.39	0.52	0.46	0.34	13	7
Daphnia l.		0.66	0.66	0.51	0.59	0.58	0.60	0.56	16	14
Ovig Daphnia		0.90	0.76	0.59	0.67	0.72	0.73	0.66	7	6
Chydorinae	0.31	0.25	0.34	0.28	0.27		0.29	0.29	1	1
Ovig Chydorinae	0.36		0.32				0.34	0.34		
							TOTAL:		604	567

Lake: *RED - KODIAK*

Station: 3

Depth: 32 - 38m

Year: 1994

Macrozooplankton Density

(no./m^2)

Date:	16-May	14-Jun	18-Jul	17-Aug	22-Sep	22-Oct	Seasonal Mean (No/m2)
Ergasilus							
Epischura							
Diaptomus	62.634	43.525	71,124	73,567	135,349	50,957	72.859
Ovig Diaptomus		4.246		2,972			1.203
Cyclops	329.076	398.089	185.774	168.684	218,154	171,975	245.292
Ovig Cyclops		6.369	78.557	15,605	1,592	3,185	17.551
Bosmina	2.123	4.246	101.911	167,940	38,217	17,516	55.326
Ovig Bosmina	1,061	2.123	7,431	40,127	1,592		8.722
Daphnia l.		1,061		2,972	28,662	23.885	9.430
Ovig Daphnia				1,486	15,923	7,962	4.229
Daphnia g.							
Holopedium							
Chydorinae				5,202			867
Ovig Chydorinae				743			124
Polyphemus							

Total: 415,603

Body Size

(mm)

SEASONAL MEANS

							Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Diaptomus	0.99	1.03	1.23	0.99	0.97	0.97	1.03	1.02	341	335
Ovig Diaptomus		1.03		0.99			1.01	1.01	5	5
Cyclops	0.82	0.81	0.73	0.79	0.65	0.58	0.73	0.75	450	476
Ovig Cyclops	1.09	1.12	1.12	1.19	1.18		1.14	1.13	84	82
Bosmina	0.45	0.47	0.33	0.33	0.39	0.35	0.39	0.34	76	58
Ovig Bosmina	0.53	0.53	0.41	0.34	0.42		0.45	0.36	16	11
Daphnia l.	0.82	0.49	0.48	0.61	0.51	0.59	0.58	0.55	13	12
Ovig Daphnia		0.91	0.80	0.70	0.71	0.68	0.76	0.70	11	9
Chydorinae	0.35	0.39		0.29			0.34	0.29	0.9	0.6
Ovig Chydorinae	0.47	0.39		0.35			0.40	0.35	0.2	0.1
							TOTAL:		997	989

Lake: *RED - KODIAK*
Station: 4
Depth: 32 - 37m
Year: 1994

Macrozooplankton Density
(no./m^2)

Date:	16-May	14-Jun	18-Jul	17-Aug	22-Sep	22-Oct	Seasonal Mean (No/m2)
Diaptomus	60.511	54.140	14,331	37,154	132,167	92,357	65,110
Ovig Diaptomus		2,123	3,981		1,592	1,061	1,460
Cyclops	498.392	254,777	78,026	72,718	152,866	300,424	226,201
Ovig Cyclops		7,431	9,554	7,431	4,777		4,866
Bosmina	1,592	3,185	13,535	90,764	44,586	31,847	30,918
Ovig Bosmina		1,061	7,962	61,572			11,766
Daphnia l.		2,123	6,370	13,800	38,217	45,646	17,693
Ovig Daphnia			1,592	5,839	6,369	18,047	5,308
Chydorinae				531			89
Ovig Chydorinae			present	present			
						Total:	363,409

Body Size
(mm)

SEASONAL MEANS

							Mean Length (mm)	Weighted Length (mm)	Biomass (mg/m^2)	Weighted Biomass (mg/m^2)
Diaptomus	1.03	0.96	0.91	0.73	0.82	0.88	0.89	0.88	200	196
Ovig Diaptomus		0.96	1.40	1.26	1.16	0.88	1.13	1.19	9	10
Cyclops	0.71	1.00	0.78	0.66	0.73	0.62	0.75	0.75	440	438
Ovig Cyclops		1.11	1.16	1.13	1.19	1.12	1.14	1.14	23	23
Bosmina	0.50	0.46	0.34	0.32	0.35	0.41	0.40	0.35	45	34
Ovig Bosmina	0.53	0.52	0.48	0.35	0.38	0.47	0.46	0.37	23	14
Daphnia l.	0.82	0.67	0.63	0.51	0.57	0.63	0.64	0.59	31	26
Ovig Daphnia	0.84	0.67	0.83	0.63	0.64	0.75	0.73	0.71	12	12
Chydorinae		0.24	0.30	0.31	0.38		0.31	0.31	0.1	0.1
Ovig Chydorinae			0.36	0.36			0.36	0.36		
							TOTAL:		783	753