AN ESTIMATE OF JUVENILE FISH DENSITIES IN SKILAK AND KENAI LAKES, ALASKA, THROUGH THE USE OF DUAL-BEAM HYDROACOUSTIC TECHNIQUES IN 1995

By

Kenneth E. Tarbox

David Waltemyer

Stan R. Carlson

Regional Information Report[1] No. 2A96-35

Alaska Department of Fish and Game
Commercial Fisheries Management and Development Division
333 Raspberry Road
Anchorage, Alaska 99518

November 1996

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AUTHORS

Kenneth E. Tarbox is the Research Project Leader for the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Region II, Upper Cook Inlet, 34828 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669.

David Waltemyer is a Research Project Biologist for the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Region II, Upper Cook Inlet, 34828 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669.

Stan R. Carlson is a Biometrician for the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Limnology Unit, 34828 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669.

ACKNOWLEDGMENTS

The authors would like to thank Bruce King, Randall Davis, Morris Lambdin, Bill Glick, and J.R. Daily for assisting during the field operations. Special thanks go to Sandi Seagren for helping prepare the report. Finally, recognition is due to Steve Fried, and John Hilsinger for supporting the project through budget and scheduling decisions.

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ABSTRACT

The number and distribution of juvenile sockeye salmon *Onchorhynchus nerka* rearing in two glacial lakes of the Kenai River drainage was estimated in 1995 from hydroacoustic surveys. The number of age-1 sockeye salmon estimated in May 1995 in Skilak Lake (3,390,000), which typically represents 80-90% of the total abundance, indicated a 40.6% over-winter survival of age-0 sockeye salmon. In October 1994 the estimated number of age-0 juveniles in Kenai and Skilak Lakes was 11,159,400, of which 8,353,400 occurred in Skilak Lake. In September/October 1995 a total of 9,285,700 sockeye were estimated in the two lakes, with 7,845,600 counted in Skilak Lake. Age-0 sockeye salmon were estimated at 7,378,300 in Skilak Lake and 1,434,600 in Kenai Lake (total = 8,812,900). The age-1 component was estimated at 467,400 in Skilak Lake and 5,700 in Kenai Lake for a total of 473,100.

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

INTRODUCTION

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 (Tarbox and King 1988a, 1988b, Tarbox, King, and Brannian 1993, Tarbox et. al. 1995) . Program objectives for the 1995 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) estimate the age composition of sockeye salmon in each lake, and (4) document the condition of juvenile sockeye salmon using length and weight measurements.

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 1995, we also conducted hydroacoustic surveys in Skilak Lake during May 1995. The objective of this supplemental study was to assess survival of rearing sockeye salmon during the fall to winter transition period. In addition, we conducted an extensive tow netting program in 1995 to help improve age composition estimates. An assessment of potential bias from tow netting allocation will be 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. 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 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 9000 mV and above the counting threshold of 300 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°.

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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 an estimate of the number of fish detected 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

$$\hat{N}_{ij} = \hat{S}_{ij} + \hat{M}_{ij} + \hat{B}_{ij} .$$

The midwater component was estimated as

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

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 (5 m) 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 estimated 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

$$\hat{S}_{ij} = a_{is} m_{ij1} ,$$

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

The estimated number of fish near the bottom was

$$\hat{B}_{ij} = \sum_{k=1}^{K} b_{ijk} m_{ijk} ,$$

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

$$\hat{N}_i = J^{-1} \sum_{j=1}^{J} N_{ij} ,$$

and its variance was estimated as

$$v(\hat{N}_i) = \sum_{j=1}^{J} (\hat{N}_{ij} - \hat{N}_i)^2 (J-1)^{-1} J^{-1} .$$

Total abundance (N) for each lake was estimated as the sum of the area estimates and the variance of N was estimated as the sum of the area variance estimates.

The abundance of juvenile sockeye salmon in each lake (N_s) was estimated as

$$\hat{N}_s = \hat{N}\hat{P},$$

where $\hat{P}$ is the estimated proportion of juvenile sockeye salmon in the lake. Age-specific numbers of juvenile sockeye salmon (N_{sa}) were estimated as

$$\hat{N}_{sa} = \hat{N}\ \hat{p}_a,$$

where $\hat{P}_a$ is the estimated proportion of age-a sockeye salmon in the fish population. Variance estimates were calculated as

$$v(\hat{N}_s) = \hat{N}^2 v(\hat{P}) + \hat{P}^2 v(\hat{N}) - v(\hat{P})v(\hat{N})$$

and

$$v(\hat{N}_{sa}) = \hat{N}^2 v(\hat{P}_a) + \hat{P}_a^2 v(\hat{N}) - v(\hat{P}_a)v(\hat{N}).$$

We used a stratified random sampling design for night hydroacoustic surveys to distribute sampling effort and provide an appropriate 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 1994. Because of the configuration of Skilak Lake, a total of 14 transects perpendicular to shore were surveyed within three sub-basins (Figure 2). In Kenai Lake a total of 25 transects were surveyed within five sub-basins (Figure 3). The spring night survey of Skilak Lake was done on 1 May 1995. The fall Kenai Lake survey was conducted on 9 October 1995 and the Skilak Lake survey on 24 September 1995.

Mid-water trawling (tow netting) was conducted in both lakes to estimate species and age composition (proportions) of the targets. In Skilak Lake we used a stratified cluster sampling technique. Strata were defined by area and depth. Areas were the same as those used in the hydroacoustic sampling. Depth strata were developed to account for potential vertical variation in species and age composition. Three depth strata were defined: surface (0-10 m), mid-depth (15-25 m) and deep (30-40 m). Each tow was defined as a primary sampling unit and a minimum of 3 tows were conducted in each stratum. In Kenai Lake we used a stratified random sampling technique using area and depth strata. Three areas and two depth intervals were defined. Following the hydroacoustic sampling, Area 1 was used, Areas 2 and 3 were combined, and Areas 4 and 5 were combined (see Fig. 3). Two depth strata were defined: surface (0-10 m) and mid-depth (15-25 m). Details of the sampling and estimation methods will be provided in a separate report.

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 (wet) to the nearest 0.1 g, and an age determined from scale samples using criteria outlined by Mosher (1969). We calculated preliminary estimates of mean length and weight of age-0 and age-1 sockeye salmon; final estimates and details of the sampling methods will be provided in a separate report.

RESULTS

May 1995 Hydroacoustic and Tow Net Surveys

Twenty one thousand one hundred fifty one echoes were used to estimate target strength distributions in Skilak Lake on 1 May 1995. Mean target strength was -56.34 dB with a standard deviation of 5.7 dB. A total of 389 fish were captured to determine sockeye salmon and age-class proportions. The estimated fish population was 4,399,100 (Table 1) with a standard error (SE) of 505,100. An estimated 48% of the fish were located in area 1 (Table 2). The proportion of sockeye salmon in the fish population was estimated at 0.995 (SE = 3.38×10^{-3}). Thus, the estimated abundance of sockeye salmon in the lake was 4,377,500 (SE = 502,900). Age-1 sockeye salmon predominated with an estimated proportion of 0.771 (SE = 1.82×10^{-2}) and an abundance estimate of 3,390,000 (SE = 397,300). The age-2 component was next with an estimated proportion of 0.189 (SE = 1.72×10^{-2}) and an abundance of 830,900 (SE = 121,600). The remaining fish were age-0 sockeye salmon with an estimated proportion of 0.036 (SE = 1.14×10^{-2}) and an abundance of 156,500 (SE = 53,200).

September/October 1995 Night Hydroacoustic and Day Tow Net Surveys

A total of 11,605 echoes in Kenai Lake and 27,756 in Skilak Lake were used to estimate target strength distributions. As in past fall surveys, calculated mean target strengths decreased with depth (Figure 4). Mean target strength for Kenai Lake was -53.07 ± 5.41 dB. Near-surface measurements were -53.38 ± 6.46 dB in contrast to -56.09 ± 6.84 dB at a depth of 42-47 m. In Skilak Lake the mean target strength was -52.75 ± 5.41 dB. Mean target strength was fairly constant with depth (Figure 4).

The total estimated number of fish in both lakes was 9,469,700 (SE = 902,000) (Table 3). Approximately 15%, or 1,446,000 fish (SE = 126,500), were found in Kenai Lake and the remaining 8,023,700 fish (SE = 893,100) in Skilak Lake. An estimated 56% of the fish in Skilak Lake were located in Area 1, which comprised 43% of the lake volume (Table 4). Within Kenai Lake 51% of the fish were located in Areas 2&3 , which comprised 46% of the lake volume (Table 4).

The maximum fish density observed in Skilak Lake was .0084 fish/m^3 between 17-22 m along Transect 2 of Area 1. Maximum densities of fish were recorded in the 17-22 m depth range for 7 of the 13 transects. One transect had maximum densities deeper in the water column and five shallower.

The maximum density of fish observed in Kenai Lake was 0.0046 fish/m^3 between 17-22 m along Transect 5 of Area 3. Maximum densities of fish at 12 transects was between 17-22 m. Five transects had maximum densities at deeper strata and eight shallower.

Table 5 summarizes estimates of sockeye salmon contribution to the fish population in Skilak and Kenai Lakes. Juvenile sockeye salmon predominated the tow net catches, comprising 97.8% (SE = 0.71%) in Skilak Lake and 99.6% (SE = 2.7%) in Kenai Lake. After apportioning the tow net samples, corresponding abundance estimates were 7,845,600 (SE = 875,100) in Skilak Lake and 1,440,100 (SE = 131,700) in Kenai Lake. Age-0 sockeye salmon also predominated the tow net samples. In Skilak Lake the age-0 component comprised 92% (SE = 1.4%) of the catch resulting in an abundance estimate of 7,378,300 (SE = 829,000). In Kenai Lake age-0 sockeye salmon made up 99.2% (SE = 4.7%) of the catch and had an abundance estimate of 1,434,600 (SE = 142,700). The age-1 component comprised only 5.8% (SE = 1.3%) of the catch in Skilak Lake and 0.4% (SE = 4.0%) in Kenai Lake; abundance estimates of the age-1 component were, respectively, 467,400 (SE = 113,100) and 5,700 (SE = 57,800).

The number of juvenile sockeye salmon in both lakes was estimated at 9,285,700 (SE =884,900). Of this total, 8,812,900 (SE = 841,200) were age-0 sockeye salmon produced by the 1994 spawning population, and 473,100 (SE = 127,000) were age-1 sockeye salmon produced by the 1993 spawning population (Table 5).

Preliminary estimates of mean fork length and wet weight of sockeye salmon for the September/October samples are as follows. Mean length of age-0 fry in Skilak Lake (n = 760) was 53.3 mm (SE = 0.24) and mean weight was 1.76 g (SE = 0.022). Age-1 fry in Skilak Lake (n = 47) had a mean length of 79.2 mm and a mean weight of 5.71 g (SE = 0.132). In Kenai Lake age-0 fry (n = 677) had a mean length of 56.9 mm (SE = 0.31) and a mean weight of 2.33 g (SE = 0.039). Age-1 fry, of which only n = 3 were captured, had a mean length of 72.9 mm (SE = 2.87) and a mean weight of 5.25 g (SE = 0.60).

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 4).

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 5). The relative abundance of Skilak Lake fish in September/October, 1995 was 84.7%.

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 salmon into Skilak Lake took place between September 1994 and 1 May 1995 then the estimated overwinter survival of age-0 juvenile sockeye was 40.6%.

This investigation is part of a larger scientific look at factors limiting sockeye salmon juvenile production in the Kenai River system. Readers are referred to Schmidt et. al. (1993, 1996) for a complete evaluation of this data set.

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Table 1 . Estimated number of fish in Skilak Lake, Alaska on 1 May 1995. Counts are from a night hydroacoustic survey.

			Estimated Number of Fish					
Lake	Area	Transect	Surface	Midwater	Bottom	Total	Area Mean	Variance
Skilak	1	1	9.6818E+03	1.6970E+06	9.8417E+04	1.8051E+06		
		2	4.7905E+04	2.1328E+06	9.6831E+04	2.2775E+06		
		3	4.0986E+04	1.6441E+06	8.3971E+04	1.7691E+06	2.0926E+06	9.0030E+10
		4	3.4880E+04	2.9769E+06	1.1665E+05	3.1284E+06		
		5	2.6270E+04	2.3296E+06	2.1326E+05	2.5691E+06		
		6	1.8334E+03	6.8603E+05	3.1877E+05	1.0066E+06		
	2	1	4.6034E+04	8.8248E+05	7.5305E+03	9.3604E+05		
		2	2.2646E+04	6.2362E+05	1.9860E+04	6.6613E+05	1.1137E+06	9.9291E+10
		3	1.7938E+04	7.7008E+05	2.0123E+04	8.0814E+05		
		4	1.8400E+05	1.7825E+06	7.7919E+04	2.0444E+06		
	3	1	2.7844E+04	8.4568E+05	3.0228E+05	1.1758E+06		
		2	1.4594E+04	1.6704E+06	4.8737E+04	1.7337E+06	1.1928E+06	6.5890E+10
		3	8.0663E+04	1.2183E+06	5.6499E+04	1.3555E+06		
		4	6.4976E+04	4.1713E+05	2.4163E+04	5.0627E+05		
	TOTAL						4.3991E+06	2.5521E+11

Table 2. Areas, volumes, and estimated percent of fish in Skilak Lake, Alaska, night hydroacoustic survey, 1 May 1995.

Area	Surface Area ($m^2 \times 10^6$)	Volume ($m^3 \times 10^6$)	Percent of Fish
1	43.03 (43.5%)	2160 (34.4%)	47.6%
2	33.46 (33.8%)	2640 (42.0%)	25.3%
3	22.50 (22.7%)	1480 (23.6%)	27.1%
Total	98.99 (100%)	6270 (100%)	100%

Table 3. Estimated number of fish from night hydroacoustic surveys in Skilak and Kenai Lakes, Alaska in September/October 1995.

			Estimated Number of Fish					
Lake	Area	Transect	Surface	Midwater	Bottom	Total	Area Mean	Variance
Skilak	1	1	1.7505E+05	4.0550E+06	6.1606E+05	4.8461E+06		
		2	7.0328E+05	5.5426E+06	3.3121E+05	6.5771E+06		
		3	3.4144E+05	5.3952E+06	3.3928E+05	6.0759E+06	4.4913E+06	4.2604E+11
		4	1.0054E+05	2.7780E+06	1.5954E+05	3.0381E+06		
		5	1.9480E+05	2.3206E+06	2.5749E+05	2.7729E+06		
		6	1.8486E+05	3.0477E+06	4.0490E+05	3.6375E+06		
	2	1	6.4785E+04	8.3846E+05	2.1792E+04	9.2504E+05		
		2	3.4721E+04	2.9898E+06	3.3537E+04	3.0581E+06	2.4566E+06	2.6527E+11
		3	1.4726E+04	2.9821E+06	7.1829E+04	3.0687E+06		
		4	9.9557E+04	2.6135E+06	6.1603E+04	2.7747E+06		
	3	1	3.7213E+05	1.2389E+06	8.8740E+04	1.6998E+06		
		2	1.4614E+05	4.3180E+05	2.2449E+04	6.0039E+05	1.0758E+06	1.0624E+11
		3*						
		4	2.2241E+03	8.6231E+05	6.2660E+04	9.2719E+05		
	TOTAL						8.0236E+06	7.9755E+11
Kenai	1	1	2.4295E+03	1.6182E+05	1.1702E+04	1.7595E+05		
		2	0.0000E+00	1.3340E+05	1.4910E+04	1.4831E+05		
		3*					1.8805E+05	1.7722E+09
		4	0.0000E+00	1.3383E+05	2.0386E+04	1.5422E+05		
		5	3.3142E+04	3.0764E+05	1.0318E+04	3.5110E+05		
		6	0.0000E+00	1.0146E+05	9.1997E+03	1.1066E+05		
	2	1	3.2432E+03	4.1060E+05	0.0000E+00	4.1384E+05		
		2	2.2503E+04	5.6336E+05	0.0000E+00	5.8586E+05		
		3	1.8698E+04	3.0474E+05	0.0000E+00	3.2344E+05	4.4105E+05	5.9239E+09
		4*						
	3	1	1.3979E+04	1.5075E+05	0.0000E+00	1.6473E+05		
		2	9.0402E+03	2.7101E+05	0.0000E+00	2.8005E+05		
		3	4.1011E+02	2.9687E+05	0.0000E+00	2.9728E+05	2.9214E+05	5.6448E+09
		4	7.3738E+03	1.4284E+05	0.0000E+00	1.5021E+05		
		5	3.1117E+04	5.3733E+05	0.0000E+00	5.6845E+05		
	4	1	1.2661E+04	3.0800E+05	0.0000E+00	3.2066E+05		
		2	0.0000E+00	2.0716E+05	0.0000E+00	2.0716E+05		
		3	3.9920E+04	2.9465E+05	0.0000E+00	3.3457E+05	2.6517E+05	1.1306E+09
		4	8.1090E+02	1.6341E+05	0.0000E+00	1.6422E+05		
		5	6.3889E+03	2.9284E+05	0.0000E+00	2.9923E+05		
	5	1	7.9549E+02	4.1351E+05	0.0000E+00	4.1431E+05		
		2	3.9610E+04	2.1360E+05	0.0000E+00	2.5321E+05		
		3	4.7709E+04	2.5432E+05	0.0000E+00	3.0203E+05		
		4	2.1825E+03	1.1549E+05	0.0000E+00	1.1767E+05	2.5964E+05	1.5284E+09
		5	2.6488E+04	3.1647E+05	0.0000E+00	3.4296E+05		
		6	2.5094E+03	2.2741E+05	0.0000E+00	2.2992E+05		
		7	7.9549E+03	1.4944E+05	0.0000E+00	1.5739E+05		
	TOTAL						1.4460E+06	1.6000E+10
Both	TOTAL						9.4697E+06	8.1355E+11

* Not used in 1995.

Table 4. Areas, volumes, and estimated percent of fish in Skilak and Kenai Lakes Alaska, night hydroacoustic survey, September/October 1995.

Lake	Area	Surface Area ($m^2 \times 10^6$)	Volume ($m^3 \times 10^6$)	Percent of Fish
Skilak	1	43.03 (43.5%)	2160 (34.4%)	56.0%
	2	33.46 (33.8%)	2640 (42.0%)	30.6%
	3	22.50 (22.7%)	1480 (23.6%)	13.4%
	Total	98.99 (100%)	6270 (100%)	100%
Kenai	1	7.72 (13.9%)	315 (7.9%)	13.0%
	2	11.91 (21.5%)	957 (24.0%)	30.5%
	3	10.54 (19.0%)	868 (21.7%)	20.2%
	4	14.37 (25.9%)	1210 (30.4%)	18.3%
	5	10.93 (19.7%)	641 (16.0%)	18.0%
	Total	55.47 (100%)	4000 (100%)	100%

Table 5. Estimated contribution of juvenile sockeye salmon to the total fish population in Skilak and Kenai Lakes, Alaska, September/October 1995. Total Fish estimates are from night hydro-acoustic surveys. Fish composition data are from daytime tow net surveys.

		Estimated Abundance		
Lake	Total Fish	Sockeye Salmon[a]	Age-0[b]	Age-1[b]
Skilak[c]	8,023,600	7,845,600 (97.8%)	7,378,300 (92.0%)	467,400 (5.8%)
Kenai[c]	1,446,000	1,440,100 (99.6%)	1,434,600 (99.2%)	5,700 (0.4%)
Total[c]	9,469,700	9,285,700	8,812,900	473,100

[a] Species composition sample size for Skilak Lake = 1031, for Kenai Lake = 688.

[b] Age composition sample size for Skilak Lake = 807, for Kenai Lake = 682.

[c] Rounded to nearest 100 fish.

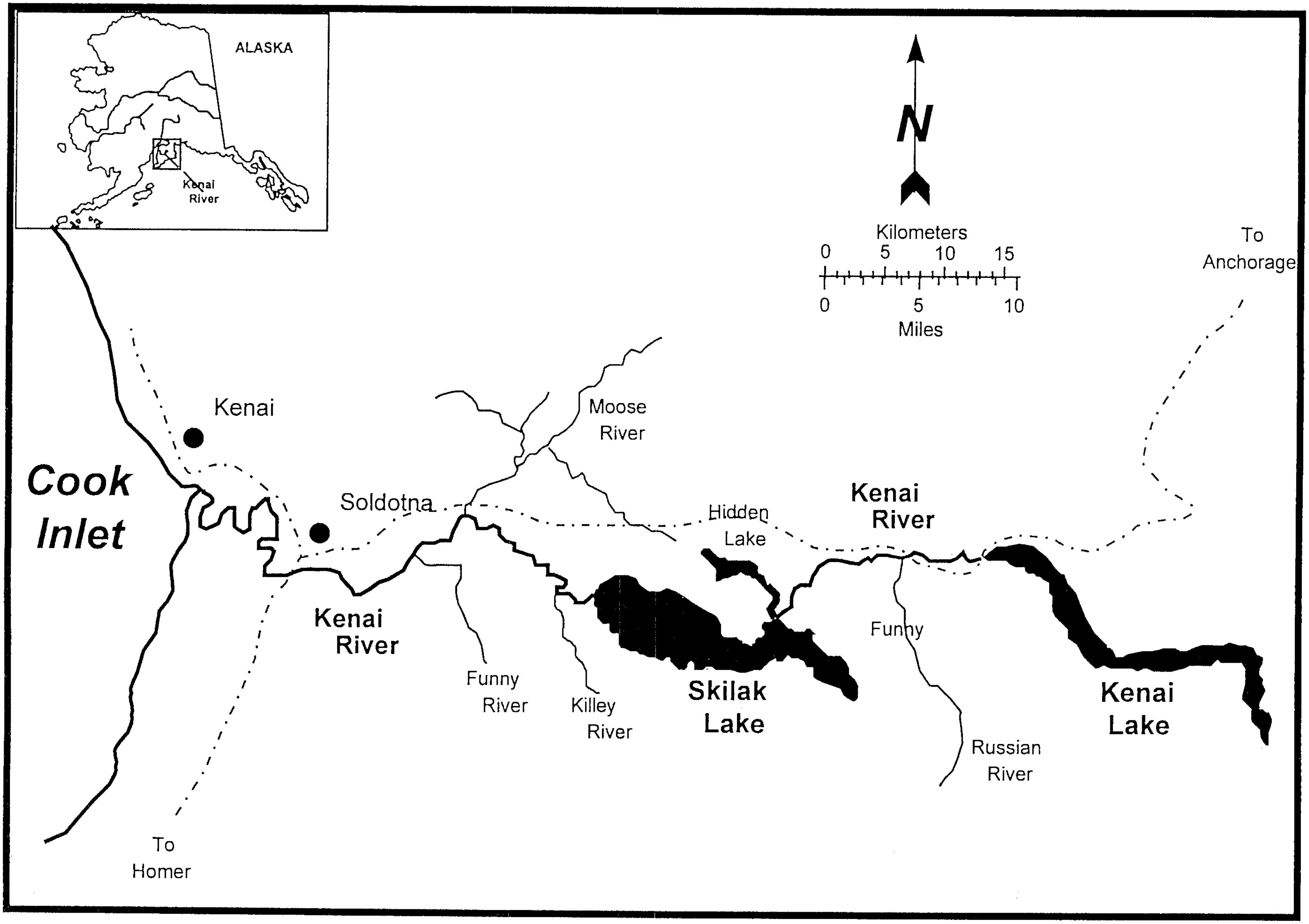

Figure 1. Map of the Kenai River drainage

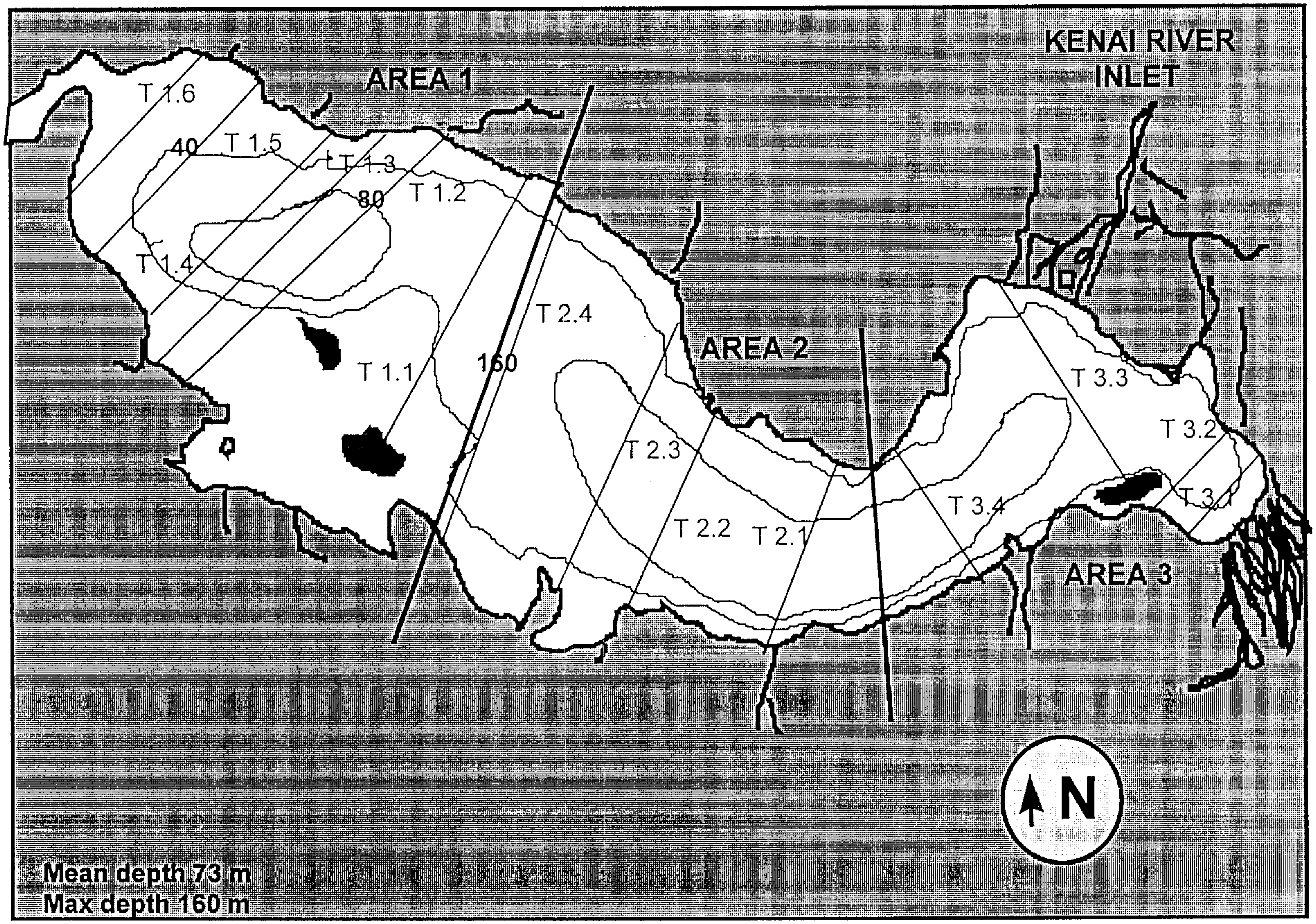

Figure 2. Hydroacoustic transects conducted in Skilak Lake, Alaska on 1 May 1995 and 24 September 1995.

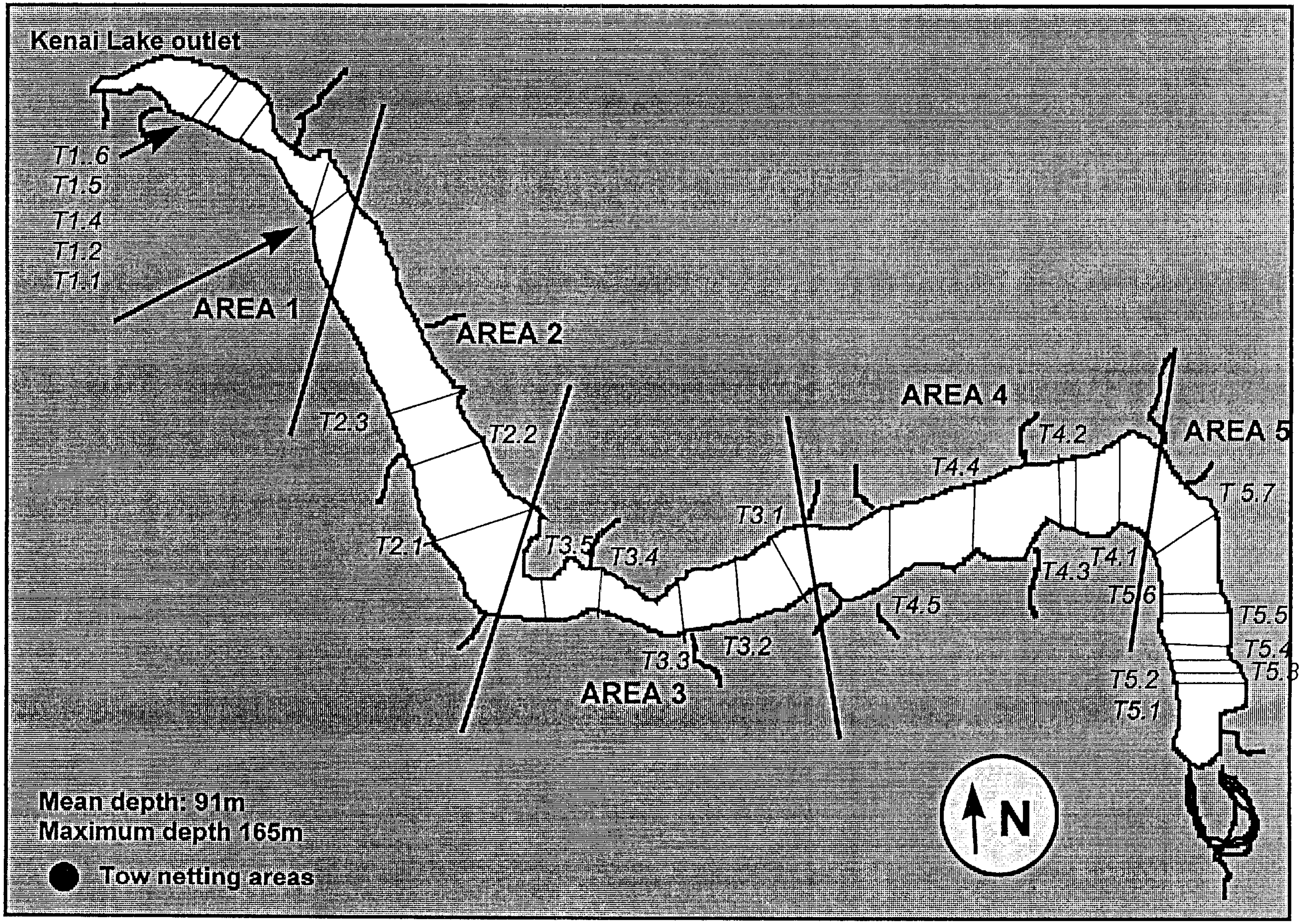

Figure 3. Hydroacoustic transects conducted in Kenai Lake, Alaska on 9 October 1995.

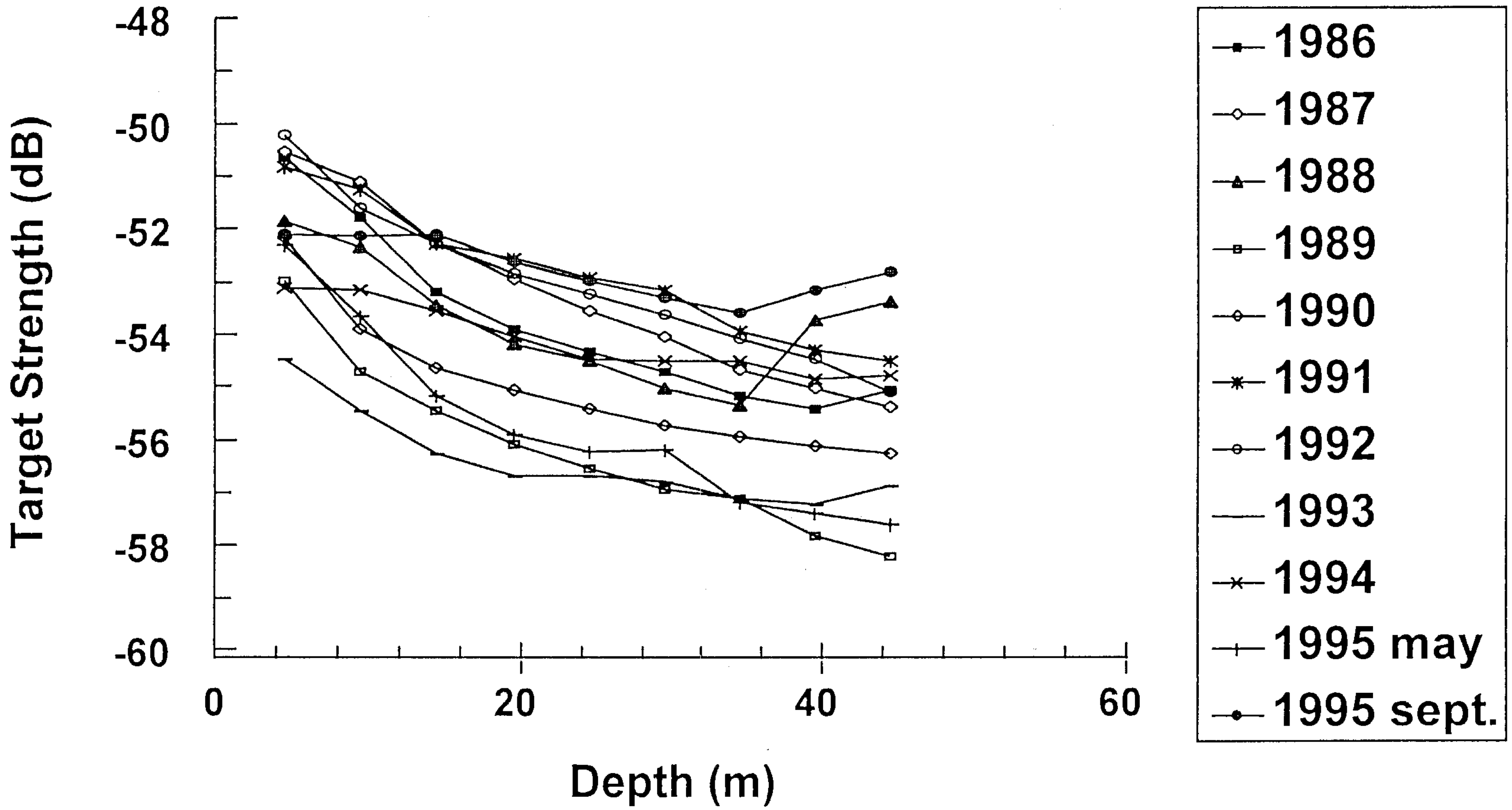

Figure 4. Fish target strength measured in Skilak Lake, Alaska in September, 1986-1995.

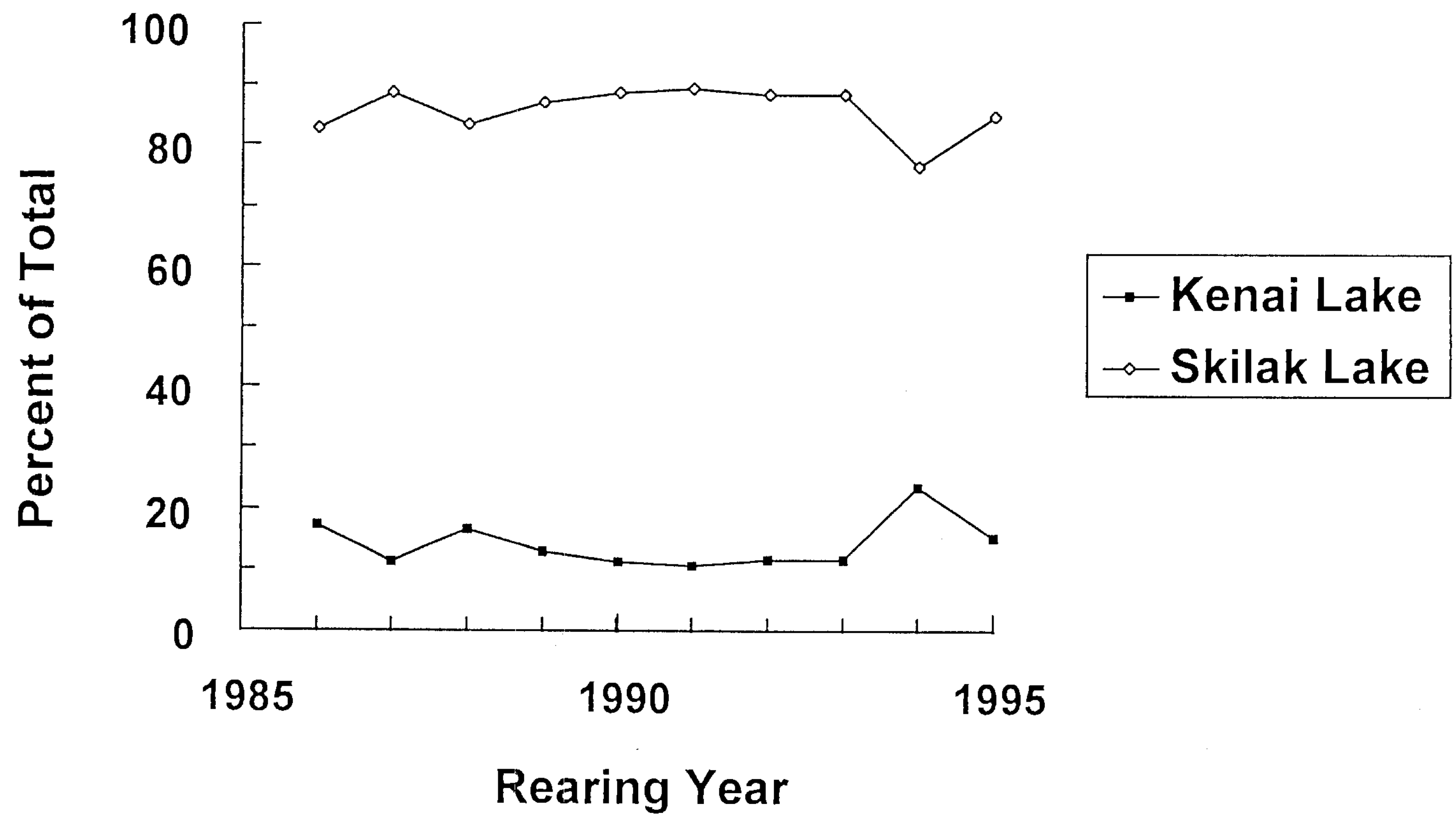

Figure 5. Relative distribution of juvenile sockeye in the Kenai River system, Alaska 1986-1995.