AN ESTIMATE OF JUVENILE FISH DENSITIES IN SKILAK AND KENAI LAKES, ALASKA THROUGH THE USE OF DUAL BEAM HYDROACOUSTIC TECHNIQUES IN 1987

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF APPENDICES

LIST OF APPENDICES (Continued)

LIST OF APPENDICES (Continued)

LIST OF APPENDICES (Continued)

INTRODUCTION

In 1986 the State of Alaska, Department of Fish and Game (ADF&G) begin developing new methodologies (Tarbox and King 1987) to assess the rearing success of sockeye salmon (*Oncorhynchus nerka*) in the glacial lake systems of the Kenai River, Upper Cook Inlet, Alaska (Figure 1). The Kenai River drainage consist of a number of sockeye rearing lakes (Figure 2) and is the single largest producer of sockeye salmon in Upper Cook Inlet. Recent sockeye salmon adult returns to the Kenai River have ranged between 5 and 9 million fish and have contributed over 75% to the total Upper Cook Inlet harvest. Unfortunately, because of the glacial nature and size of the Kenai River system, historical investigations which attempted to establish production models for rearing sockeye salmon have been ineffective. Typical capture mechanisms (tow netting) and survey techniques have failed to adequately estimate rearing fish populations. Therefore, the ADF&G began a new approach in 1986 which used hydroacoustic equipment to survey rearing fish populations and continued that approach into 1987. The report presented herein is a presentation of the results of the 1987 efforts. Formation of production models will be initiated after suitable counting techniques are achieved.

Specific objectives for the 1987 field investigation were: (1) to estimate the number and spatial distribution of sockeye salmon juveniles in Kenai and Skilak Lakes; and (2) to define the target strength distribution for fish targets in both lakes using dual beam hydroacoustic techniques.

METHODS

Hydroacoustic surveys of Skilak and Kenai Lakes were conducted on 12 and 17 October 1987, respectively. Consistent with past investigations the surveys were conducted at night to maximize targets available to the gear. Previous investigations on sockeye salmon in glacial lake systems on the Kenai Peninsula have documented strong surface orientation of juvenile sockeye salmon during daylight hours (Tarbox and King 1987, Thorne and Thomas 1981).

The survey design for the 1987 field season was a stratified random sample, which balanced the needs to disperse the sampling effort and provide an acceptable means of calculating sampling error (A. Gieger, Alaska Department of Fish and Game, Juneau, personal communication). Each lake was divided into subbasins and survey transects randomly selected in each basin. Within Kenai Lake a total of 19 transects were run within 5 subbasins (Figure 3). Because of the size of Skilak Lake only 10 transects were completed within the three subbasins (Figure 4). The total sample effort was limited by hours of darkness available for sampling. Each lake survey was completed in one night to minimize the potential for fish movement between basins.

The hydroacoustic equipment for survey data acquisition consisted of a Biosonics, Inc. Model 105 echo sounder with dual beam receivers, a 420 kHz, 6/15 degree dual beam transducer mounted in a towed body, a Model 171 tape recorder interface, a Sony model SL-HF400 video cassette recorder and

PCM-501ES digital audio processor, a Model 115 chart recorder, and a Model 315P oscilloscope. The selected pulse width was 0.4 milliseconds (ms) and the ping rate was 5 pings/second (additional acoustic parameters used during data collection and processing are presented in Appendix A.1). The system was calibrated at Biosonics, Inc. prior to and following the survey. The entire system was powered by batteries and the equipment was housed in a 6.7 m vessel powered by a 150 hp outboard motor. Transect speed was estimated at 2.7 meters/second (m/s) and beginning and end points of the transects were marked with flashing lights prior to darkness. The towed body was approximately 1 m below the surface during transecting.

During the survey it became evident the sounder was not operating correctly. Following a typical start up period (20 mins.) the sounder signal strength appeared to be reduced. Echoes from the bottom in 5 to 10 m of water were less than 100 mV. Air temperatures at the time were near 0 degrees Celsius. Interestingly, after using a heater to warm the vessel cabin the equipment appeared to function correctly and in situ ping pong ball experiments at 3 m below the transducer indicated that the system was within approximately 1 dB of the theoretical value of -40.5 dB.

A decision to continue the survey was dictated by the time period available (i.e prior to freezing of the lakes) and anticipated equipment repair time. Since the equipment was apparently functioning after an extended warm up period in a heated environment we decided to continue to collect data. The alternative of losing a seasons data was rejected as post season evaluations could be made on the usefulness of the data. Repair of the equipment indicated that a faulty integrated circuit that was part of the main frequency oscillator circuit was at fault (A. Wirtz, BioSonics, Inc, Seattle, personal communication).

In summary, our experience indicated that the system was capable of operating once the system was warm and the immediate surrounding environment was above freezing. In addition, verification of the calibration oscillator data indicated the system was apparently operating correctly. Also, data collected and presented in the following sections appears consistent with data collected in 1986. Therefore, we feel that the data should be presented. However, because of uncertainty with the equipment the data should be viewed accordingly.

Data reduction and analysis was facilitated by the use of microcomputers and associated software. Dual beam data were processed through a Biosonics, Inc. Model 181 dual beam processor. A returning pulse was accepted as a valid target if the amplitude of the pulse was below the bottom threshold of 5000 millivolt (mV; -36 decibels, dB) and above the counting threshold of 250 mV (-63dB, noise level was approximately 80mV, signal/noise ratio = 9.9 dB). Single targets were separated from multiple targets if the pulse width was within 20% of the transmitted pulse width at -6 dB and -18dB. The maximum half angle for processing was selected at 4 degrees.

Data stored by the dual beam processor were transferred to microcomputer data files for analysis using Biosonics, Inc. software program TS112 (revised). Computation of mean target strengths and backscattering cross sections were made from individual echoes and printed out by preselected 5 m depth intervals.

Estimates of fish density were made for each transect by echo integration using a Biosonics, Inc. Model 120 echo integrator (representative echograms for each lake are presented in Appendix B.1-B.5). Correction from the 40 log(R) setting used during data collection to 20 log(R) for data processing was accomplished by adjusting the B constant value for each depth strata (Appendix A.1). The TVG crossover for the system was 13.0 m. The depth strata selected for analysis were 5 m increments starting 2 m below the transducer (3 m below the water surface). Data were processed to 99 m below the transducer in Kenai and Skilak Lakes (visual examination of oscilloscope and chart recordings indicated no fish present below these depths).

Voltages from returning echoes were averaged in 1-minute sequences along each transect and the integrator outputs were transferred to diskettes for further reduction and analysis through use of Biosonics, Inc. software entitled Crunch. Prior to estimating fish density raw integrator outputs were edited to remove data associated with false bottoms echoes or bottom intrusions. Where this occurred, fish density estimates for the strata were imputed from adjacent sequences. Overall fish density was obtained by averaging the edited integrator output values across the transect by depth strata and multiplying by the integrator scaling factor (derived from mean backscattering cross section obtained with the dual beam processor). The mean backscattering cross section value was selected by depth strata from the transect of interest. In the case where the sample size for establishing the scaling factor was less than 150 echoes, the mean backscattering cross section for all Kenai or Skilak Lake transects combined for that depth strata was used.

Total fish abundance in each lake was calculated by dividing Kenai and Skilak Lakes into three and five areas, respectively (Figures 3 and 4) and summing the estimated abundance for each area. Transects located within these areas were treated as replicates for calculation of mean densities and associated variance. The total number of fish per transect was made from the direct hydroacoustic measurements and additions for fish unavailable to the hydroacoustic gear because of surface or bottom orientation. Corrections for bias associated with surface orientation of fish (i.e., within 3 m of the surface) were made from extrapolation of measured vertical distributions of fish density plotted from mean densities per stratum to the surface. Fish associated with the bottom and not available to the hydroacoustic system were estimated by multiplying the average fish densities measured just above the bottom times the volume of water not sampled (a bottom window of 2 m was selected during data processing).

The estimated number of fish for each area by individual transect was calculated from an estimate of water volume by depth strata multiplied by the absolute fish density for that depth strata. Water volume was estimated from analysis of the proportion of the transect sampled by hydroacoustic techniques for each depth strata and an estimate of surface area from planimeter measurements of each area from USGS maps.

In an effort to verify the echo integration procedure, selected transects in both lake systems were echo counted. Echo counts were made directly from chart recordings (BioSonics, Inc thermal chart recorder) using the procedures of BioSonics, Inc which are outlined in King and Tarbox (1988). Chart recording thresholds were the same as for data processing at 250mV. Fish

targets were counted by individual 5 m depth strata and an average density calculated. Water volumes for each depth strata used to estimate total fish abundance were the same as those estimated in the echo integration procedure.

In an effort to quantify species composition of measured fish targets, tow netting (utilizing a 2.7 m x 2.7 m Burgner tow net) was conducted on 13 October 1986 in Kenai Lake and on 15 and 17 October 1986 in Skilak Lake. A total of 300 and 540 minutes of surface tow netting were completed for Kenai and Skilak Lakes, respectively. Sample locations were in areas previously identified to have relatively high fish abundance. All fish captured were enumerated and identified, and preserved in 10% formalin. In the laboratory, specimens were measured to the nearest mm (fork length) and aged from analysis of scale patterns.

RESULTS

Compilation of data collected on individual echoes from Kenai and Skilak Lake indicated a mean target strength of -54.08 dB (n=4522) and -54.26 dB (n=16257) for each lake, respectively (Appendix A.2 and A.3). Consistent with the 1986 investigations, a decrease in target strength was observed with depth in both lake systems (Figures 5 and 6). Near surface measurements (7-12m) were recorded at -50.79 dB in Kenai Lake decreasing consistently to -56.3 dB at depths greater than 47 m (Appendix A.2). Within Skilak Lake surface (2-7 m) target strengths were -50.55 dB decreasing to -55.22 dB at 47 m. Because of the minimum threshold value selected for data processing it appears some small targets were eliminated from the analysis (see Figures 5 and 6 for graphic representation). This effect would also be exaggerated if there was a non-biological reason for the decrease in target strength with depth.

As previously noted, the total estimated fish in Skilak and Kenai Lakes was estimated from the actual estimates associated with the hydroacoustic equipment (Table 1), corrections for surface orientation (Table 2), and corrections for bottom orientation (Tables 3 and 4). Approximately 9 million fish were present in Skilak Lake and only slightly more than 1.1 million fish were in Kenai Lake (variance estimates and individual transect data are presented in Table 5).

The distribution of targets in both lakes was similar with most fish targets located between 25 and 35 m below the lake surface (Figures 7 to 14, Appendix A.4 to A.32). However, the maximum fish density measured was .01445 fish/m^3 along Skilak Lake Transect 0 between 5 and 10 m below the lake surface (Appendix A.23). This transect was in the relatively shallow water zone of the lake and water depths did not exceed 22 m. Maximum fish densities along other Skilak Lake transects did not exceed .0063 fish/m^3 (Appendix A.24 to A.32). In contrast, fish densities in Kenai Lake were still lower with a maximum recorded at .0043 fish/ m^3 at 25 to 30 m below the surface within Transect 3.4 (Appendix A.15). Typical maximum densities for other transects in Kenai Lake were less than .003 fish/ m^3 (Appendix A.4 to A.23).

The spatial distribution of fish within the lakes was consistent with the 1986 results. Within Skilak Lake 42.5% of the fish were estimated to inhabit Area 1 (the western end of the lake) which comprised only 22.6% of the lake volume (Table 6). In Kenai Lake 42% of the fish were found in Areas 1 and 2 which combined accounted for 28.3% of the lake volume.

Results of the echo counting procedure indicated no obvious undercounting from the echo integration procedures (Table 7). Within Kenai Lake single targets were well separated and easily counted (Appendix B.1 to B.3). Mean error from all three transects combined was less than 1%. However, individual transect error was as high as 31%. In Skilak Lake differences between the two methods ranged as high as 52% (Table 7). However, multiple targets within Skilak Lake transects (Appendix B.4 and B.5) made echo counting difficult and therefore the lower counts associated with echo counting may be related to this factor.

Tow netting results were less than satisfactory. A total of 300 and 540 mins of tow netting on Kenai and Skilak Lakes, respectively, captured only 11 fish (0 in Kenai Lake). These results were insufficient to estimate species composition with any precision. Of the 11 fish captured in Skilak Lake, 9 were sockeye salmon with a single chinook salmon (*O. tshawytscha*) and round whitefish (*Prosopium cylindraceum) taken. It should also be noted that use of trawl in the lake in late October captured 123 fish of which 104 were round whitefish* (primarily from one tow where the trawl was on bottom), 18 sockeye salmon, and 1 chinook salmon (D. Waltemyer, ADF&G, Soldotna, personal communication).

DISCUSSION

In a developmental project a number of technical project concerns tend to arise and must be solved prior to moving into an operational phase. Within the present investigation and specifically for 1987 a number of issues became apparent. First and foremost was whether the equipment and subsequent data should be considered usable. Factually, there is not definitive proof either way that data are suspect because of equipment malfunction. However, circumstantial evidence would suggest the data are usable. Target strength measurements in 1987 compared favorably to those collected in 1986 (this assumes similar sized fish for both years). In Skilak Lake mean target strength measurements were 1 dB greater in 1987 than 1986 at similar depths while in Kenai Lake target strengths were up to 2 dB greater. If signal loss had been substantial, target strength measurements should have been smaller not greater. Further support of this position is the results of the in situ ping pong ball target strength measurements. These measurements would suggest once the equipment was warm it functioned correctly. This was also our experience during the conduct of the survey. Constant observation of the oscilloscope indicated no decrease in bottom signal strength or obvious malfunctions after the initial warm up period. In addition, the results of echo counting, which is less sensitive to target strength measurements, indicated no consistent undercounting as a result of echo integration techniques which might be suspected if signal loss was significant. However, the issue of equipment stability obviously needs further investigations.

The pattern of decreasing target strengths with depth noticed in the 1986 survey results (Tarbox and King 1988) was also evident in the 1987 results. The cause of this pattern remains unknown and needs further evaluation. If signal attenuation is taking place because of glacial silt or some other factor, then the loss of small targets is a potential bias. Fortunately, the issue of signal attenuation will be addressed in the 1988 field season by ADF&G Chief Fisheries Scientist Office and results of this investigation can be used to modify historical data as appropriate (P. Skvorc, ADF&G, Juneau, personal communication).

Of major significance to the overall study is the inability to capture fish for target separation by species. While historical tow netting data suggest that sockeye salmon should be the predominant species the need to separate age classes and other species is paramount. The logical explanation for the 1987 results is that most targets were not available to the gear because of depth. Peak fish densities were significantly below the tow netting depths. The development of suitable capture techniques should be a major priority for future investigations.

The estimate of 9 million fish in Skilak Lake is significantly less than the 21.5 million fish estimated in 1986. A significant decrease in Kenai Lake was also noted (1.153 million vs 4.494 million). The estimates for 1987 may under-represent the actual number of the fish in the lake as the counting threshold used to process the dual beam data truncated the probable overall fish target strength distribution. Examination of the target strength distribution in 1986 vs 1987 indicated that up to a 1 dB difference in mean target strength could result from the counting threshold used. This would translate to a 33% undercounting error if consistent over the entire study area. However, echo counting results (Table 7), which, as noted, are less sensitive to mean target strength determinations, suggested that the error may not be consistent or of that magnitude. Within Kenai Lake, the mean error for three transects combined was less than 1%. Unfortunately, fish distribution and multiple targets made echo counting difficult for Skilak Lake transects. Only in transect 1 were fish sufficiently separated to count effectively. In this case the echo counts were 5% greater than the integrated estimate. For the other two transects the echo counts were substantially below the integrated estimate (presumably because of multiple target influence).

A number of project improvements are necessary if successful sockeye salmon rearing investigations in Kenai and Skilak Lakes are to be made. These are:

(1) species composition of the hydroacoustic targets must be accurate. New capture techniques should be explored and tested during the 1988 field season.

(2) investigations into attenuation of signal strength in glacial waters must be made to estimate the bias associated with eliminating small targets.

(3) false bottom echoes required significant editing of the data set for select transects. Examination of pulse repetition rate and sample power should be made to minimize this procedure.

(4) the purchase of a storage oscilloscope would allow echo counting techniques using the duration in beam method. This may eliminate or significantly reduce the need to echo integrate the data. Echo counting techniques, in general, are less sensitive to error associated with target strength determination.

(5) investigation into sampling design and concurrent sampling power may indicate the need for further modification of field procedures.

(6) the first two years of this project has been accomplished without formal funding. This has limited the options available for modifications and concurrent investigations. Modest funding of this project would increase program development.

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Table 1. Estimated number of fish available to the hydroacoustic equipment in Skilak and Kenai Lakes, Alaska in the fall of 1987.

Lake	Area	Transect	Estimated Number of Fish
Skilak	1	0	3.6805E+06
		1	1.9557E+06
		2	3.1704E+06
		3	3.0225E+06
	2	4	3.3411E+06
		5	3.5713E+06
		6	3.7626E+06
	3	7	1.8971E+06
		8	1.0782E+06
		9	1.2182E+06
Kenai	1	1	1.6128E+04
		2	1.5807E+05
		3	8.7068E+04
		4	1.6076E+05
	2	1	4.5996E+05
		2	2.6827E+05
		3	3.9863E+05
		4	2.9212E+05
	3	1	2.1698E+05
		2	1.3321E+05
		3	1.8389E+05
		4	4.9411E+05
	4	1	2.9868E+05
		2	1.5607E+05
		3	2.3959E+05
		4	2.1502E+05
	5	1	1.0026E+05
		2	1.8662E+05
		3	2.6483E+05

Table 2. Estimated number of fish not available to the hydroacoustic equipment because of surface orientation in Skilak and Kenai Lakes, Alaska during the fall of 1987.

Lake	Area	Transect	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
Skilak	1	0	1.4450E-02	1.2909E+08	1.8654E+06
		1	6.0000E-04	1.2909E+08	7.7454E+04
		2	6.0000E-04	1.2909E+08	7.7454E+04
		3	1.6110E-04	1.2909E+08	2.0796E+04
	2	4	6.6430E-06	1.0038E+08	6.6682E+02
		5	2.0550E-05	1.0038E+08	2.0628E+03
		6	0.0000E+00	1.0038E+08	0.0000E+00
	3	7	2.3750E-04	6.7500E+07	1.6031E+04
		8	1.6230E-04	6.7500E+07	1.0955E+04
		9	0.0000E+00	6.7500E+07	0.0000E+00
Kenai	1	1	0.0000E+00	2.3160E+07	0.0000E+00
		2	9.6040E-06	2.3160E+07	2.2243E+02
		3	0.0000E+00	2.3160E+07	0.0000E+00
		4	0.0000E+00	2.3160E+07	0.0000E+00
	2	1	0.0000E+00	3.5730E+07	0.0000E+00
		2	0.0000E+00	3.5730E+07	0.0000E+00
		3	5.0810E-06	3.5730E+07	1.8154E+02
		4	0.0000E+00	3.5730E+07	0.0000E+00
	3	1	0.0000E+00	3.1620E+07	0.0000E+00
		2	2.7670E-05	3.1620E+07	8.7493E+02
		3	5.6290E-05	3.1620E+07	1.7799E+03
		4	0.0000E+00	3.1620E+07	0.0000E+00
	4	1	0.0000E+00	4.3110E+07	0.0000E+00
		2	0.0000E+00	4.3110E+07	0.0000E+00
		3	0.0000E+00	4.3110E+07	0.0000E+00
		4	0.0000E+00	4.3110E+07	0.0000E+00
	5	1	6.1960E-05	3.2790E+07	2.0317E+03
		2	0.0000E+00	3.2790E+07	0.0000E+00
		3	2.3600E-05	3.2790E+07	7.7384E+02

Table 3 . Estimated number of fish not available to the hydroacoustic equipment because of bottom orientation in Skilak Lake,Alaska during the fall of 1987.

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	0	2-7	1.4450E-02	3.7417E+07	5.4068E+05
		7-12	3.4320E-03	3.7417E+07	1.2842E+05
		12-17	2.6050E-03	5.1449E+07	1.3402E+05
		17-22	0.0000E+00	2.3386E+07	0.0000E+00
		22-27	0.0000E+00	0.0000E+00	0.0000E+00
		27-32	0.0000E+00	0.0000E+00	0.0000E+00
		32-37	0.0000E+00	0.0000E+00	0.0000E+00
		37-42	0.0000E+00	0.0000E+00	0.0000E+00
		42-47	0.0000E+00	0.0000E+00	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			8.0312E+05
1	1	2-7	9.3500E-04	1.1128E+07	1.0405E+04
		7-12	1.5700E-03	2.2257E+07	3.4943E+04
		12-17	1.2870E-03	2.2257E+07	2.8645E+04
		17-22	1.9620E-03	1.1128E+07	2.1834E+04
		22-27	2.1930E-03	1.4838E+07	3.2540E+04
		27-32	4.0440E-03	1.8547E+07	7.5006E+04
		32-37	2.4530E-03	1.4838E+07	3.6397E+04
		37-42	5.7630E-04	1.8547E+07	1.0689E+04
		42-47	1.2910E-04	2.2257E+07	2.8734E+03
		47-52	3.8940E-05	1.8547E+07	7.2224E+02
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			2.5405E+05

- continued -

Table 3. (p 2 of 5)

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	2	2-7	1.0780E-03	3.0255E+07	3.2615E+04
		7-12	1.6310E-03	3.0255E+07	4.9347E+04
		12-17	1.1370E-03	1.3447E+07	1.5289E+04
		17-22	2.9040E-03	6.7234E+06	1.9525E+04
		22-27	4.0010E-03	6.7234E+06	2.6900E+04
		27-32	6.3010E-03	6.7234E+06	4.2364E+04
		32-37	4.1070E-03	6.7234E+06	2.7613E+04
		37-42	1.3520E-03	6.7234E+06	9.0901E+03
		42-47	4.8600E-04	6.7234E+06	3.2676E+03
		47-52	1.4670E-04	1.6809E+07	2.4658E+03
		52-57	2.0680E-04	1.0085E+07	2.0856E+03
		57-62	7.6480E-05	1.0085E+07	7.7131E+02
		62-67	5.3090E-05	1.0085E+07	5.3542E+02
		67-72	1.2190E-05	1.3447E+07	1.6392E+02
		72-77	5.6520E-06	2.0170E+07	1.1400E+02
		77-82	0.0000E+00	3.3617E+07	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			2.3215E+05
1	3	2-7	1.6110E-04	3.0255E+07	4.8742E+03
		7-12	3.5060E-04	2.0170E+07	7.0717E+03
		12-17	1.9780E-03	1.0085E+07	1.9948E+04
		17-22	4.0820E-03	6.7234E+06	2.7445E+04
		22-27	5.9800E-03	1.0085E+07	6.0309E+04
		27-32	4.4400E-03	6.7234E+06	2.9852E+04
		32-37	3.6620E-03	6.7234E+06	2.4621E+04
		37-42	1.2750E-03	6.7234E+06	8.5724E+03
		42-47	3.6240E-04	6.7234E+06	2.4366E+03
		47-52	1.4520E-04	1.0085E+07	1.4644E+03
		52-57	2.0270E-04	1.0085E+07	2.0443E+03
		57-62	6.5710E-05	1.6809E+07	1.1045E+03
		62-67	6.3950E-05	2.0170E+07	1.2899E+03
		67-72	9.3410E-06	1.3447E+07	1.2561E+02
		72-77	4.0950E-05	1.0085E+07	4.1299E+02
		77-82	0.0000E+00	2.6894E+07	0.0000E+00
		82-87	0.0000E+00	6.7234E+06	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			1.9157E+05
		MEAN OF TRANSECTS 0,1,2,& 3			3.7022E+05

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Table 3. (p 3 of 5)

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
2	4	2-7	6.6430E-06	1.8185E+06	1.2080E+01
		7-12	3.3160E-04	1.8185E+06	6.0301E+02
		12-17	1.4080E-03	1.8185E+06	2.5604E+03
		17-22	2.3710E-03	3.6370E+06	8.6232E+03
		22-27	3.5940E-03	5.4554E+06	1.9607E+04
		27-32	4.4220E-03	1.0911E+07	4.8248E+04
		32-37	5.2200E-03	7.2739E+06	3.7970E+04
		37-42	2.9510E-03	7.2739E+06	2.1465E+04
		42-47	1.0520E-03	1.0911E+07	1.1478E+04
		47-52	2.4430E-04	1.2729E+07	3.1098E+03
		52-57	9.2500E-05	9.0924E+06	8.4105E+02
		57-62	4.3780E-05	7.2739E+06	3.1845E+02
		62-67	5.6110E-05	9.0924E+06	5.1017E+02
		67-72	9.7400E-05	1.0911E+07	1.0627E+03
		72-77	2.7250E-05	9.0924E+06	2.4777E+02
		77-82	1.5600E-05	9.0924E+06	1.4184E+02
		82-87	1.5880E-05	1.6366E+07	2.5990E+02
		87-92	6.8590E-06	1.2729E+07	8.7311E+01
		92-97	1.7180E-05	1.8185E+07	3.1241E+02
		TOTAL			1.5746E+05
2	5	2-7	2.0550E-05	1.1153E+07	2.2920E+02
		7-12	2.8720E-03	1.1153E+07	3.2032E+04
		12-17	9.8090E-04	1.1153E+07	1.0940E+04
		17-22	2.0390E-03	5.5767E+06	1.1371E+04
		22-27	4.2920E-03	5.5767E+06	2.3935E+04
		27-32	4.5500E-03	5.5767E+06	2.5374E+04
		32-37	4.1160E-03	5.5767E+06	2.2954E+04
		37-42	3.2440E-03	5.5767E+06	1.8091E+04
		42-47	8.5270E-04	8.3650E+06	7.1328E+03
		47-52	3.2610E-04	8.3650E+06	2.7278E+03
		52-57	2.2870E-04	5.5767E+06	1.2754E+03
		57-62	3.0330E-04	5.5767E+06	1.6914E+03
		62-67	2.0300E-04	5.5767E+06	1.1321E+03
		67-72	9.5940E-05	1.1153E+07	1.0701E+03
		72-77	5.1970E-05	1.1153E+07	5.7964E+02
		77-82	5.5200E-05	1.1153E+07	6.1566E+02
		82-87	3.0880E-05	1.1153E+07	3.4441E+02
		87-92	5.7770E-06	1.1153E+07	6.4433E+01
		92-97	8.3890E-06	6.4132E+07	5.3800E+02
		TOTAL			1.6210E+05

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Table 3. (p. 4 of 5)

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
2	6	2-7	0.0000E+00	3.4854E+06	0.0000E+00
		7-12	1.8920E-05	3.4854E+06	6.5944E+01
		12-17	6.1250E-04	3.4854E+06	2.1348E+03
		17-22	1.7100E-03	3.4854E+06	5.9601E+03
		22-27	4.3480E-03	3.4854E+06	1.5155E+04
		27-32	6.5720E-03	3.4854E+06	2.2906E+04
		32-37	4.5830E-03	3.4854E+06	1.5974E+04
		37-42	2.1270E-03	3.4854E+06	7.4135E+03
		42-47	1.6160E-03	6.9708E+06	1.1265E+04
		47-52	5.2990E-04	1.0456E+07	5.5408E+03
		52-57	2.1030E-04	1.0456E+07	2.1989E+03
		57-62	1.9630E-04	6.9708E+06	1.3684E+03
		62-67	1.0050E-04	6.9708E+06	7.0057E+02
		67-72	1.9970E-04	6.9708E+06	1.3921E+03
		72-77	1.0950E-04	6.9708E+06	7.6331E+02
		77-82	4.1260E-05	6.9708E+06	2.8762E+02
		82-87	3.7020E-05	1.0456E+07	3.8709E+02
		87-92	8.5400E-06	1.3942E+07	1.1906E+02
		92-97	9.8510E-07	1.3942E+07	1.3734E+01
		TOTAL			9.3645E+04
		MEAN OF TRANSECTS 4,5,& 6			1.3773E+05
3	7	2-7	2.3750E-04	3.3088E+06	7.8585E+02
		7-12	1.4900E-04	3.3088E+06	4.9301E+02
		12-17	4.1550E-04	3.3088E+06	1.3748E+03
		17-22	3.2250E-03	9.9265E+06	3.2013E+04
		22-27	3.3440E-03	6.6176E+06	2.2129E+04
		27-32	5.2010E-03	6.6176E+06	3.4418E+04
		32-37	2.5120E-03	6.6176E+06	1.6624E+04
		37-42	1.2460E-03	6.6176E+06	8.2456E+03
		42-47	3.6680E-04	6.6176E+06	2.4274E+03
		47-52	9.9690E-05	6.6176E+06	6.5971E+02
		52-57	1.0600E-04	6.6176E+06	7.0147E+02
		57-62	6.4210E-05	6.6176E+06	4.2492E+02
		62-67	9.7380E-05	9.9265E+06	9.6664E+02
		67-72	9.5910E-05	1.3235E+07	1.2694E+03
		72-77	8.0340E-05	1.3235E+07	1.0633E+03
		77-82	2.4550E-05	9.9265E+06	2.4369E+02
		82-87	1.8800E-05	6.6176E+06	1.2441E+02
		87-92	2.1760E-06	6.6176E+06	1.4400E+01
		92-97	0.0000E+00	4.6324E+07	0.0000E+00
		TOTAL			1.2398E+05

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Table 3. (p. 5 of 5)

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
3	8	2-7	1.6230E-04	7.0313E+06	1.1412E+03
		7-12	2.7030E-04	7.0313E+06	1.9005E+03
		12-17	7.5670E-04	7.0313E+06	5.3205E+03
		17-22	1.6600E-03	1.0547E+07	1.7508E+04
		22-27	1.5990E-03	7.0313E+06	1.1243E+04
		27-32	2.1860E-03	7.0313E+06	1.5370E+04
		32-37	1.2570E-03	7.0313E+06	8.8383E+03
		37-42	5.4620E-04	1.4063E+07	7.6809E+03
		42-47	3.7210E-04	1.4063E+07	5.2327E+03
		47-52	2.7540E-04	1.0547E+07	2.9046E+03
		52-57	5.3270E-04	7.0313E+06	3.7455E+03
		57-62	2.4980E-04	7.0313E+06	1.7564E+03
		62-67	1.8480E-04	7.0313E+06	1.2994E+03
		67-72	1.5330E-04	7.0313E+06	1.0779E+03
		72-77	8.0000E-05	7.0313E+06	5.6250E+02
		77-82	9.0960E-05	1.0547E+07	9.5934E+02
		82-87	3.6400E-06	3.5156E+07	1.2797E+02
		87-92	0.0000E+00	1.0547E+07	0.0000E+00
		92-97	1.0230E-06	1.0547E+07	1.0789E+01
		TOTAL			8.6680E+04
3	9	2-7	0.0000E+00	3.7500E+06	0.0000E+00
		7-12	3.3060E-04	3.7500E+06	1.2398E+03
		12-17	6.7710E-04	3.7500E+06	2.5391E+03
		17-22	2.3340E-03	3.7500E+06	8.7525E+03
		22-27	2.3460E-03	3.7500E+06	8.7975E+03
		27-32	1.4500E-03	3.7500E+06	5.4375E+03
		32-37	1.2590E-03	3.7500E+06	4.7213E+03
		37-42	1.0270E-03	7.5000E+06	7.7025E+03
		42-47	6.8260E-04	7.5000E+06	5.1195E+03
		47-52	2.4330E-04	7.5000E+06	1.8248E+03
		52-57	1.8990E-04	7.5000E+06	1.4243E+03
		57-62	3.5140E-05	7.5000E+06	2.6355E+02
		62-67	7.1230E-05	7.5000E+06	5.3422E+02
		67-72	1.8960E-04	7.5000E+06	1.4220E+03
		72-77	7.0140E-05	7.5000E+06	5.2605E+02
		77-82	3.9120E-05	7.5000E+06	2.9340E+02
		82-87	3.0020E-05	7.5000E+06	2.2515E+02
		87-92	8.7290E-06	7.5000E+06	6.5468E+01
		92-97	5.3830E-07	7.5000E+06	4.0373E+00
		TOTAL			5.0893E+04
		MEAN OF TRANSECTS 7,8,& 9			8.7184E+04

Table 4. Estimated number of fish not available to the hydroacoustic equipment because of bottom orientation in Kenai Lake, Alaska during the fall of 1987.

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	1	2-7	0.0000E+00	0.0000E+00	0.0000E+00
		7-12	0.0000E+00	0.0000E+00	0.0000E+00
		12-17	5.6840E-06	1.9300E+06	1.0970E+01
		17-22	8.3600E-05	3.8600E+06	3.2270E+02
		22-27	1.7600E-04	3.8600E+06	6.7936E+02
		27-32	1.0830E-04	3.8600E+06	4.1804E+02
		32-37	2.1010E-04	9.6500E+06	2.0275E+03
		37-42	0.0000E+00	3.8600E+06	0.0000E+00
		42-47	0.0000E+00	0.0000E+00	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			3.4585E+03
1	2	2-7	9.6040E-06	6.4333E+06	6.1786E+01
		7-12	8.1520E-04	9.6500E+06	7.8667E+03
		12-17	7.2780E-04	6.4333E+06	4.6822E+03
		17-22	1.2590E-03	6.4333E+06	8.0996E+03
		22-27	1.8140E-03	9.6500E+06	1.7505E+04
		27-32	1.1910E-03	6.4333E+06	7.6621E+03
		32-37	1.2420E-03	9.6500E+06	1.1985E+04
		37-42	0.0000E+00	0.0000E+00	0.0000E+00
		42-47	0.0000E+00	0.0000E+00	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			5.7863E+04

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Table 4. (p. 2 of 2)

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	3	2-7	0.0000E+00	4.8250E+06	0.0000E+00
		7-12	1.1250E-04	4.8250E+06	5.4281E+02
		12-17	0.0000E+00	4.8250E+06	0.0000E+00
		17-22	4.4270E-04	4.8250E+06	2.1360E+03
		22-27	1.1500E-03	7.2375E+06	8.3231E+03
		27-32	6.5570E-04	4.8250E+06	3.1638E+03
		32-37	1.0380E-04	4.8250E+06	5.0084E+02
		37-42	1.2230E-04	4.8250E+06	5.9010E+02
		42-47	0.0000E+00	9.6500E+06	0.0000E+00
		47-52	0.0000E+00	1.4475E+07	0.0000E+00
		52-57	0.0000E+00	4.8250E+06	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			1.5257E+04
1	4	2-7	0.0000E+00	3.2167E+06	0.0000E+00
		7-12	2.5150E-04	4.8250E+06	1.2135E+03
		12-17	1.0080E-05	4.8250E+06	4.8636E+01
		17-22	8.1400E-04	3.2167E+06	2.6184E+03
		22-27	1.9610E-03	3.2167E+06	6.3079E+03
		27-32	1.0900E-03	3.2167E+06	3.5062E+03
		32-37	6.1630E-04	3.2167E+06	1.9824E+03
		37-42	4.6020E-04	1.6083E+06	7.4015E+02
		42-47	0.0000E+00	3.2167E+06	0.0000E+00
		47-52	9.1120E-05	3.2167E+06	2.9310E+02
		52-57	0.0000E+00	4.8250E+06	0.0000E+00
		57-62	0.0000E+00	3.2167E+06	0.0000E+00
		62-67	0.0000E+00	3.2167E+06	0.0000E+00
		67-72	0.0000E+00	3.2167E+06	0.0000E+00
		72-77	0.0000E+00	4.8250E+06	0.0000E+00
		77-82	0.0000E+00	8.0417E+06	0.0000E+00
		82-87	0.0000E+00	6.4333E+06	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			1.6710E+04
		MEAN OF TRANSECTS 1.1-1.4			2.3322E+04

Table 5 . Estimated number of fish available in Skilak and Kenai Lakes, Alaska in the fall of 1987.

Lake	Area	Transect	Estimated Number of Fish				Area Mean	Variance
			Surface	Midwater	Bottom	Total		
Skilak	1	0	1.8654E+06	3.6805E+06	8.0312E+05	6.3490E+06		
		1	7.7454E+04	1.9557E+06	2.5405E+05	2.2872E+06		
		2	7.7454E+04	3.1704E+06	2.3215E+05	3.4800E+06	3.8378E+06	3.0674E+12
		3	2.0796E+04	3.0225E+06	1.9157E+05	3.2349E+06		
	2	4	6.6682E+02	3.3411E+06	1.5746E+05	3.4992E+06		
		5	2.0628E+03	3.5713E+06	1.6210E+05	3.7355E+06	3.6970E+06	3.2976E+10
		6	0.0000E+00	3.7626E+06	9.3645E+04	3.8562E+06		
	3	7	1.6031E+04	1.8971E+06	1.2398E+05	2.0371E+06		
		8	1.0955E+04	1.0782E+06	8.6680E+04	1.1758E+06	1.4940E+06	2.2339E+11
		9	0.0000E+00	1.2182E+06	5.0893E+04	1.2691E+06		
	TOTAL						9.0288E+06	3.3237E+12
Kenai	1	1	0.0000E+00	1.6128E+04	3.4585E+03	1.9587E+04		
		2	2.2243E+02	1.5807E+05	5.7863E+04	2.1616E+05		
		3	0.0000E+00	8.7068E+04	1.5257E+04	1.0233E+05	1.2888E+05	7.5427E+09
		4	0.0000E+00	1.6076E+05	1.6710E+04	1.7747E+05		

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Table 5. (p. 2 of 2)

Lake	Area	Transect	Estimated Number of Fish: Surface	Midwater	Bottom	Total	Area Mean	Variance
	2	1	0.0000E+00	4.5996E+05	0.0000E+00	4.5996E+05		
		2	0.0000E+00	2.6827E+05	0.0000E+00	2.6827E+05		
		3	1.8154E+02	3.9863E+05	0.0000E+00	3.9881E+05	3.5479E+05	8.1373E+09
		4	0.0000E+00	2.9212E+05	0.0000E+00	2.9212E+05		
	3	1	0.0000E+00	2.1698E+05	0.0000E+00	2.1698E+05		
		2	8.7493E+02	1.3321E+05	0.0000E+00	1.3408E+05		
		3	1.7799E+03	1.8389E+05	0.0000E+00	1.8567E+05	2.5771E+05	2.6006E+10
		4	0.0000E+00	4.9411E+05	0.0000E+00	4.9411E+05		
	4	1	0.0000E+00	2.9868E+05	0.0000E+00	2.9868E+05		
		2	0.0000E+00	1.5607E+05	0.0000E+00	1.5607E+05		
		3	0.0000E+00	2.3959E+05	0.0000E+00	2.3959E+05	2.2734E+05	3.4902E+09
		4	0.0000E+00	2.1502E+05	0.0000E+00	2.1502E+05		
	5	1	2.0317E+03	1.0026E+05	0.0000E+00	1.0229E+05		
		2	0.0000E+00	1.8662E+05	0.0000E+00	1.8662E+05	1.8484E+05	6.6701E+09
		3	7.7384E+02	2.6483E+05	0.0000E+00	2.6560E+05		
	TOTAL						1.1536E+06	5.1846E+10
	TOTAL FOR BOTH LAKES						1.0182E+07	3.3756E+12

Table 6. Area (millions of square meters) and volumes (million of cubic meters) used for fish density estimates for Kenai and Skilak Lakes, Alaska 1987.

	Skilak Lake		
Area	Surface Area	Volume	Density of Fish(%)
1	43.03 (43.5%)	1331.76 (22.6%)	42.5
2	33.46 (33.8%)	2671.00 (45.3%)	41.0
3	22.50 (22.7%)	1889.70 (32.1%)	16.5
Total	98.99 (100.0%)	5892.46 (100.0%)	100.0

	Kenai Lake		
Area	Surface Area	Volume	Density of Fish(%)
1	7.72 (13.9%)	291.96 (7.2%)	11.2
2	11.91 (21.5%)	859.37 (21.1%)	30.8
3	10.54 (19.0%)	876.55 (21.5%)	22.3
4	14.37 (25.9%)	1254.40 (30.7%)	19.8
5	10.93 (19.7%)	800.66 (19.5%)	16.0
Total	98.99 (100.0%)	5892.46 (100.0%)	100.0

Table 7. Echo counting results for select transects in Kenai and Skilak Lake, Alaska during the fall of 1987.

Lake	Transect	Echo Count	Integration Count	Percent[1]
Kenai	1.3	81,445	87,076	94
	4.4	158,421	215,020	74
	5.1	131,530	100,260	131
Skilak	1	2,052,128	1,955,700	105
	6	1,813,781	3,762,600	48
	9	705,290	1,218,200	58

[1] Echo count divided by integration count times 100.

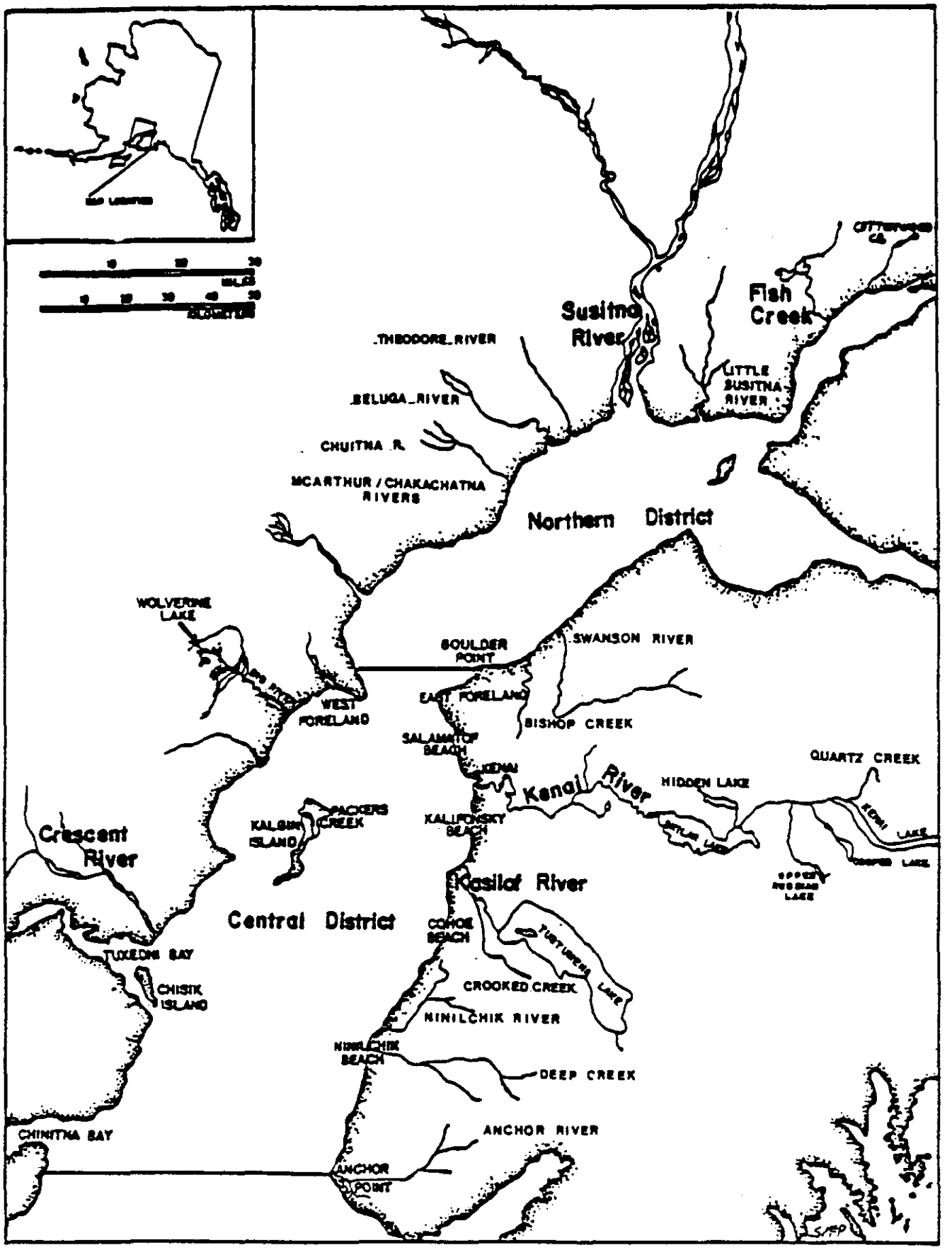


Figure 1. The Upper Cook Inlet area showing the location of the Northern and Central Districts and the major sockeye salmon spawning drainages .

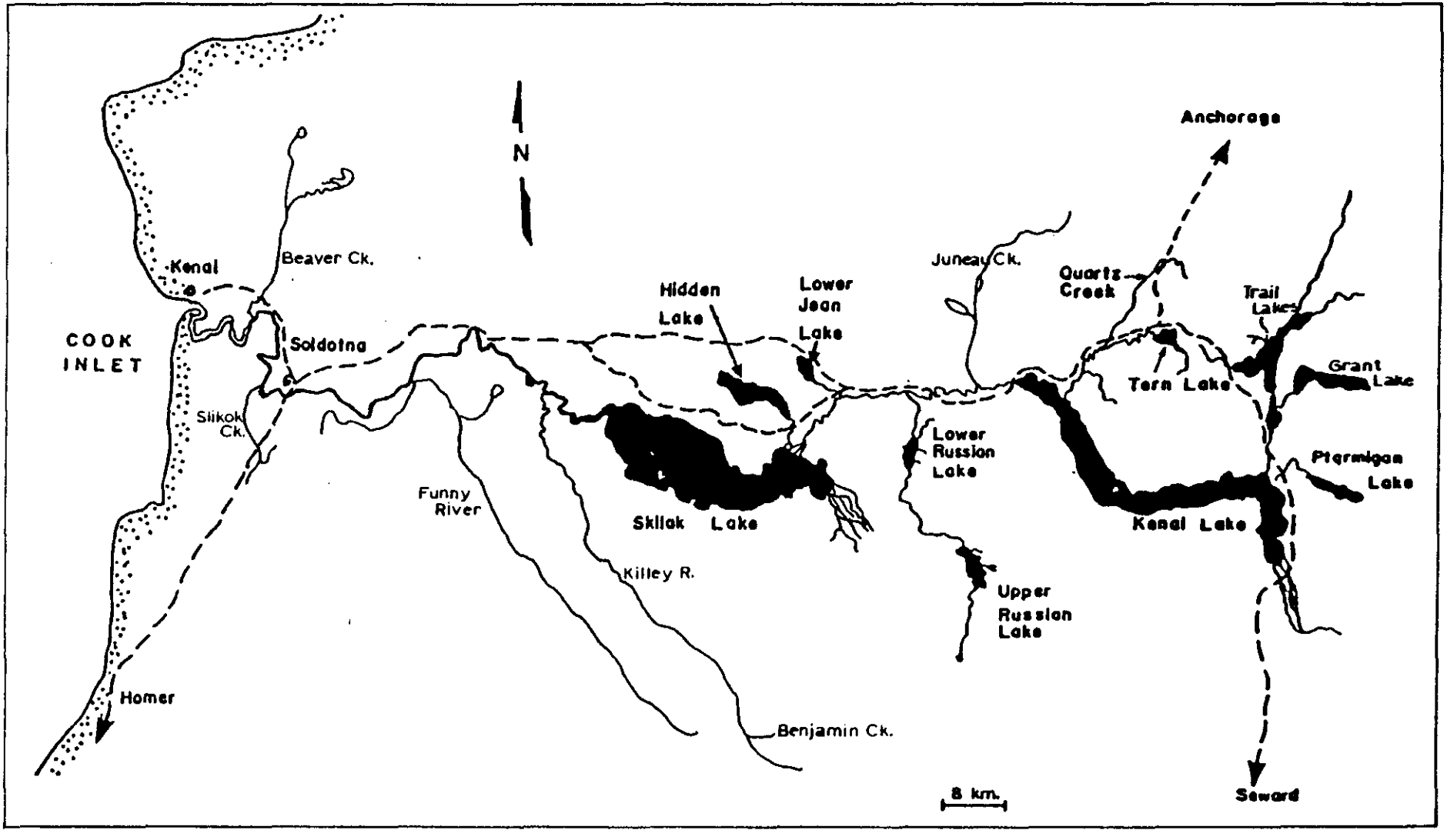


Figure 2. The Kenai River drainage, Alaska and the location of the major lake systems which are utilized by rearing sockeye salmon.

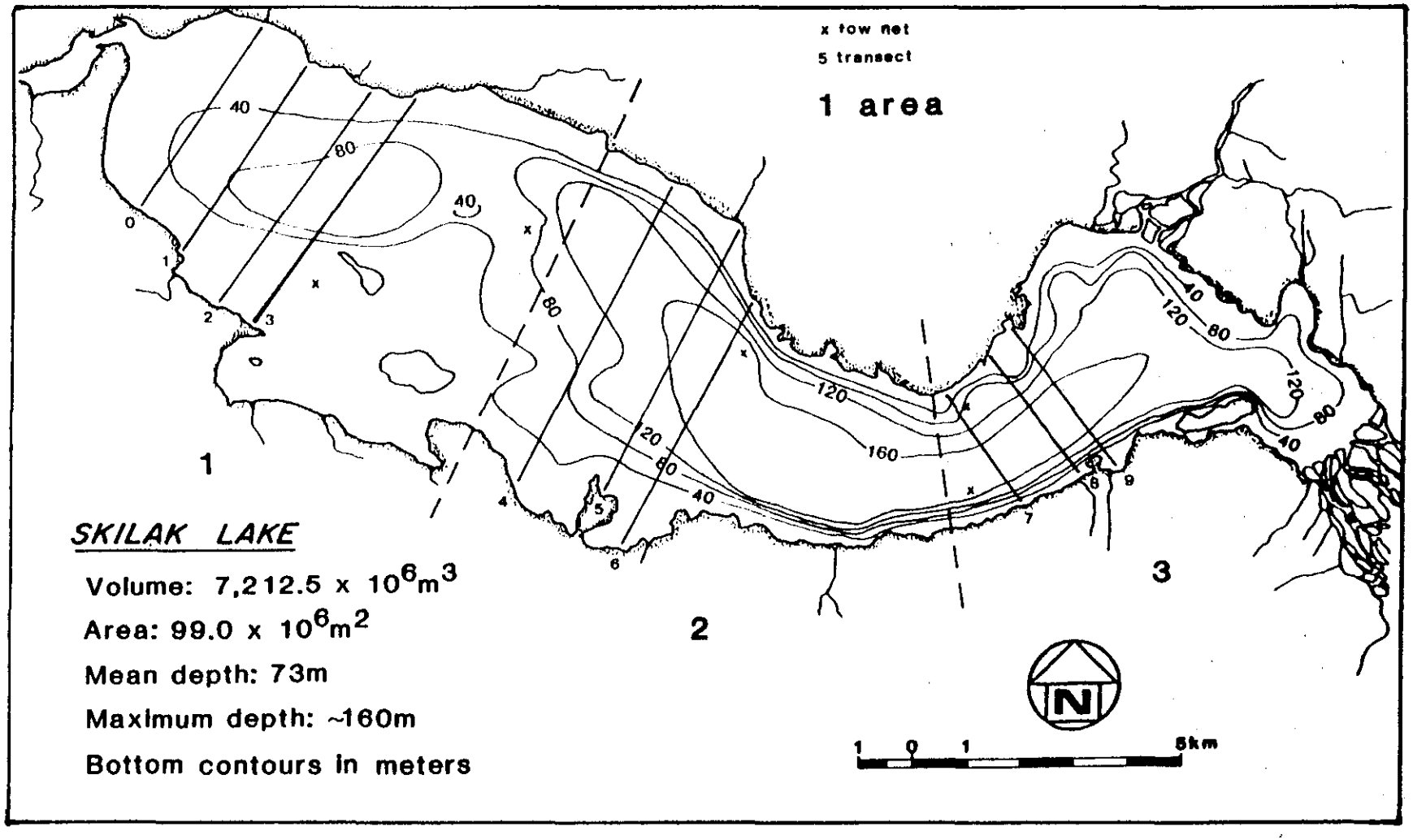


Figure 3. Skilak Lake, Alaska area designations, hydroacoustic transect locations, and tow netting stations, 1987.

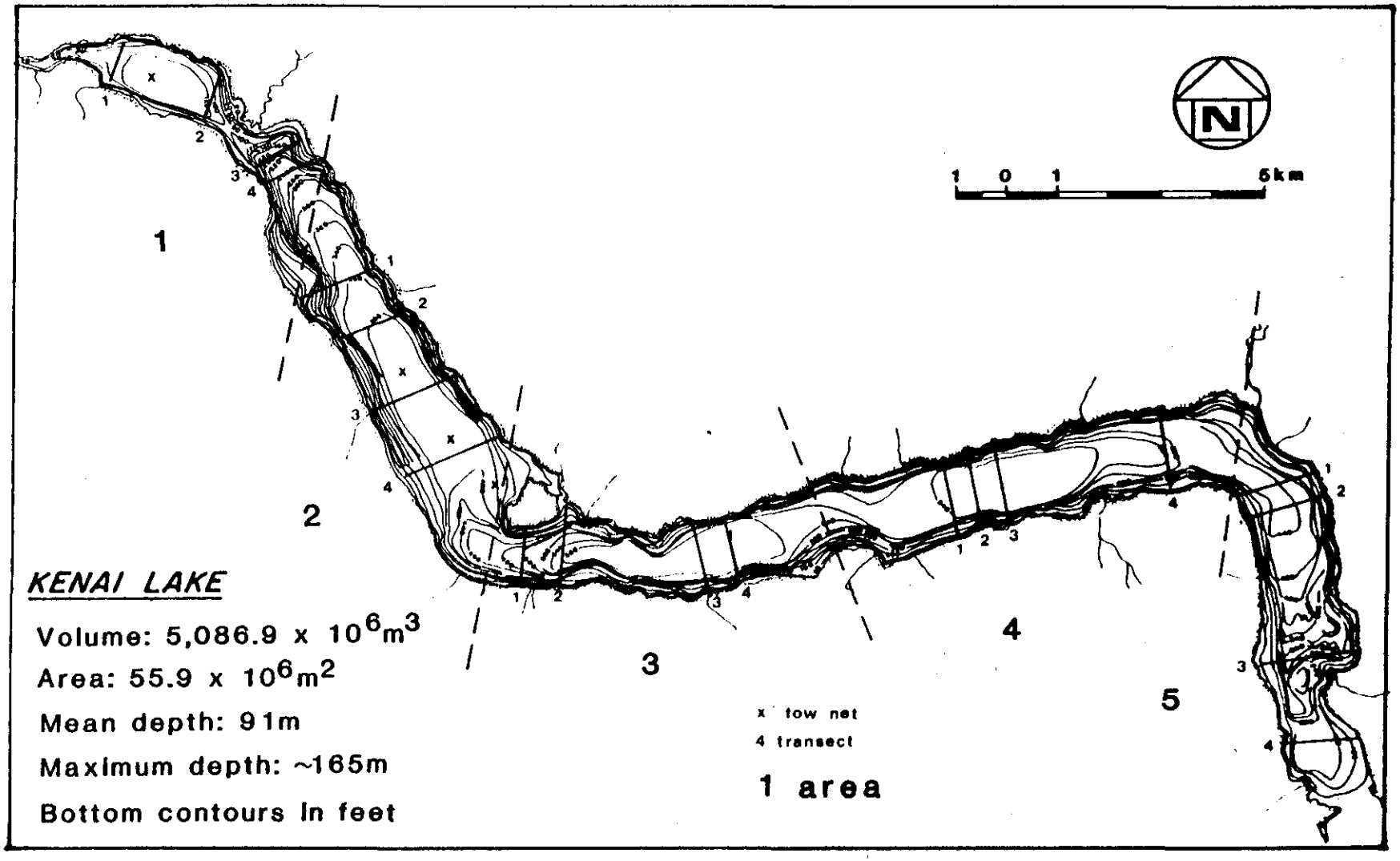


Figure 4. Kenai Lake, Alaska area designations, hydroacoustic transect locations, and tow netting stations, 1987.

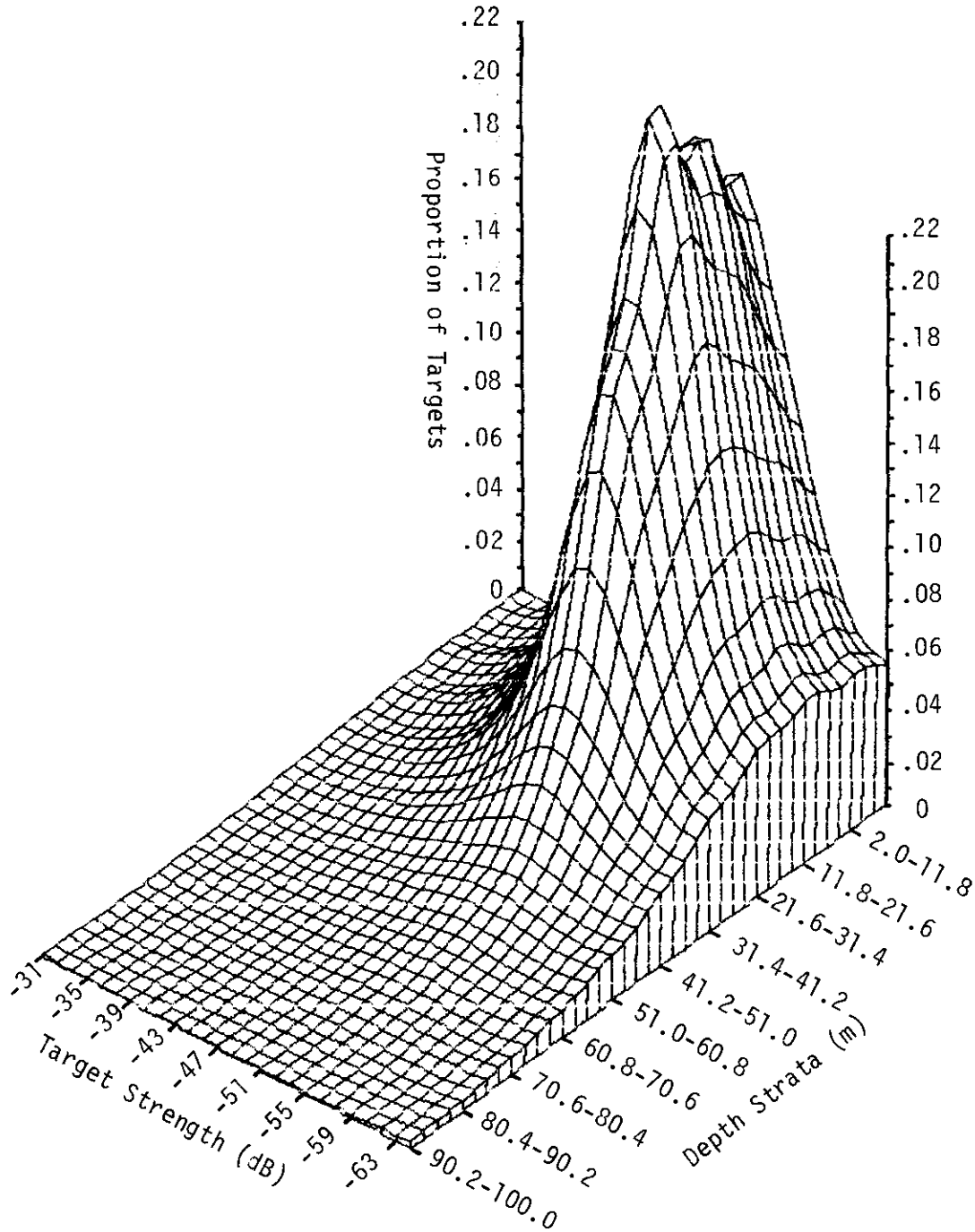


Figure 5. In situ target strength measurements and proportion by depth strata collected from Kenai Lake, Alaska, October 1987. (Note: the proportion of targets was scaled by $1/\text{range}^2$).

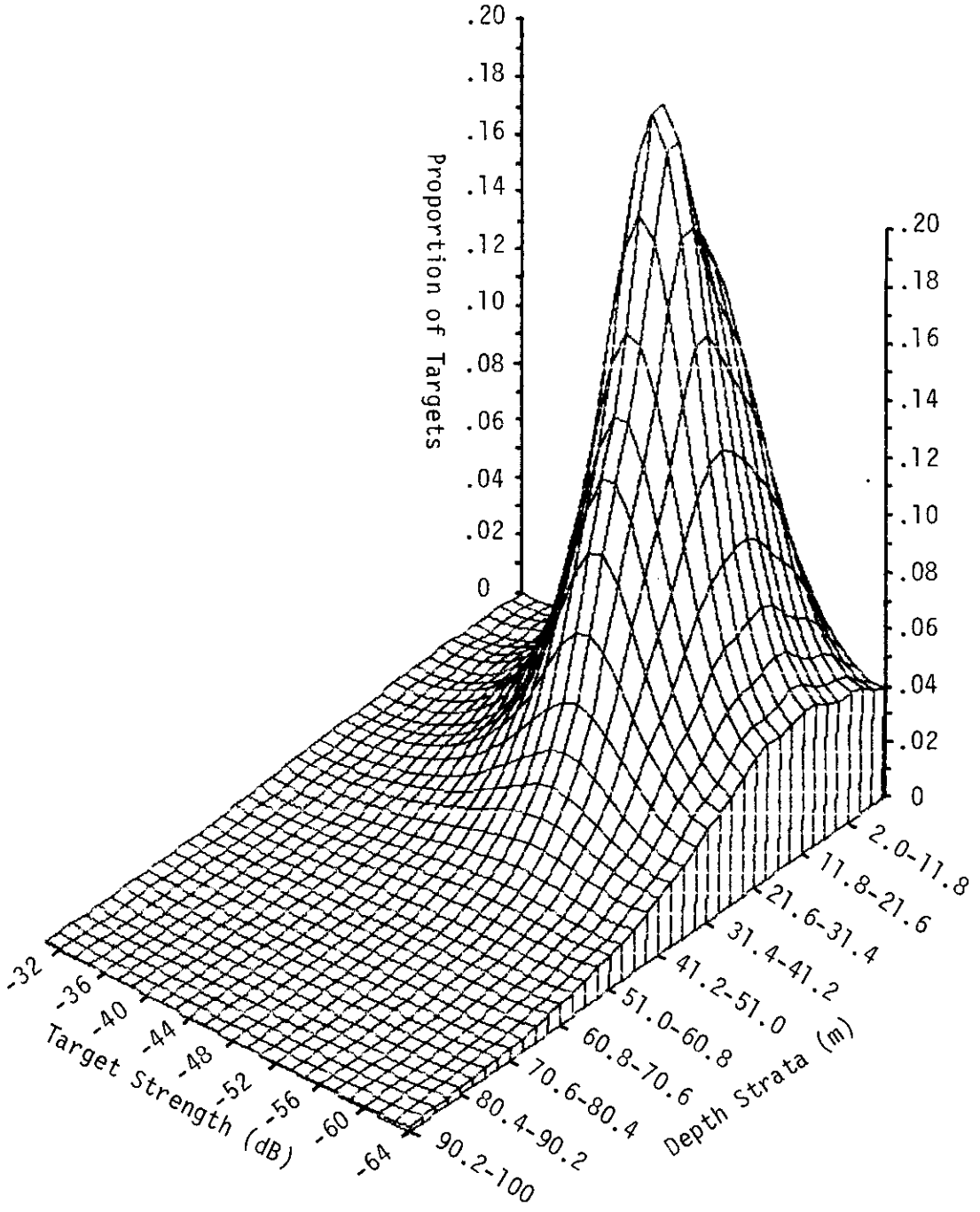


Figure 6. In situ target strength measurements and proportion by depth strata collected from Skilak Lake, Alaska, October 1987. (Note: the proportion of targets was scaled by $1/range^2$).

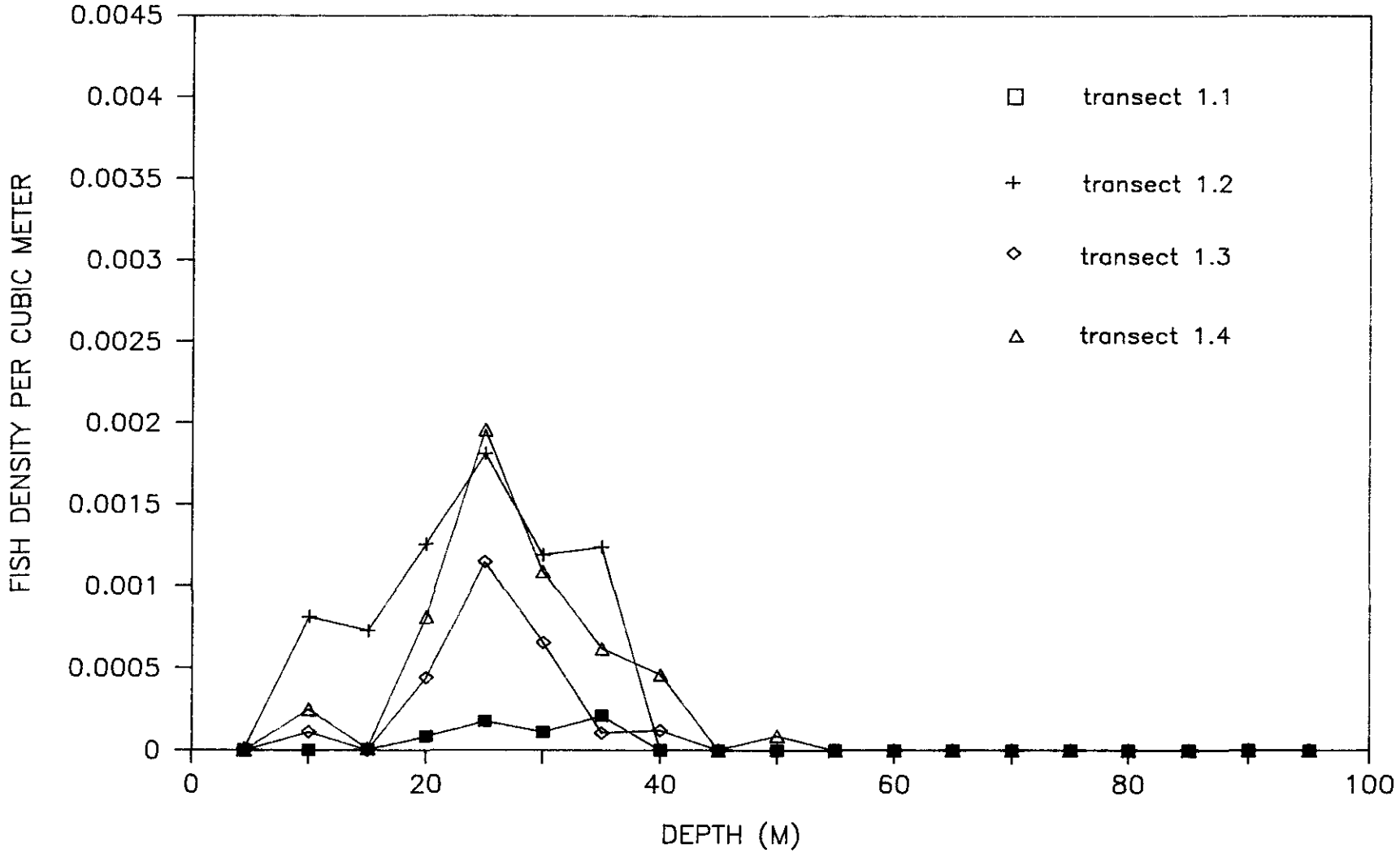


Figure 7. Vertical distribution of fish density measured during the hours of darkness in Kenai Lake, Alaska (Area 1: transects 1.1, 1.2, 1.3, 1.4) in October 1987.

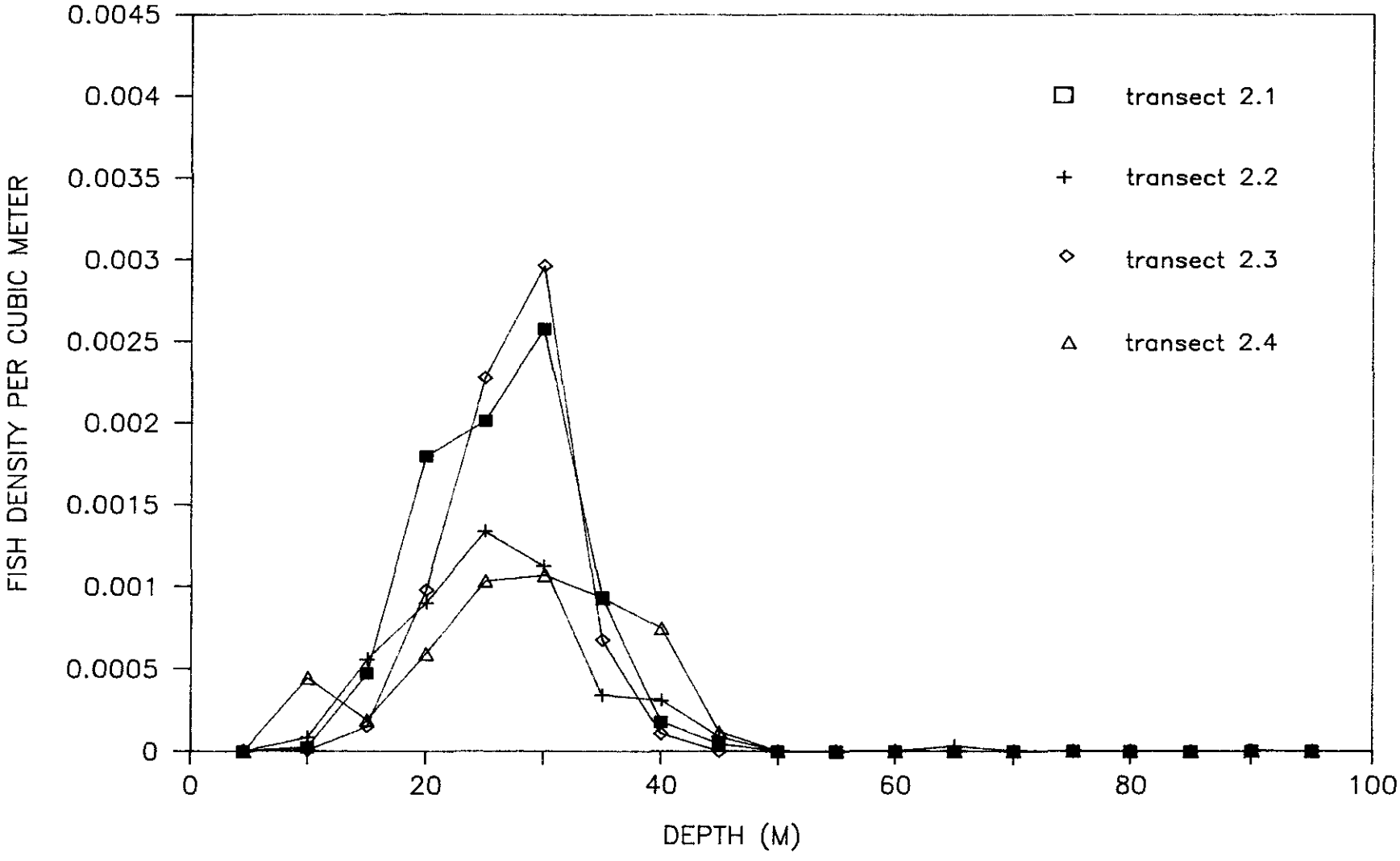


Figure 8. Vertical distribution of fish density measured during the hours of darkness in Kenai Lake, Alaska (Area 2: Transects 2.1, 2.2, 2.3, 2.4) in October 1987.

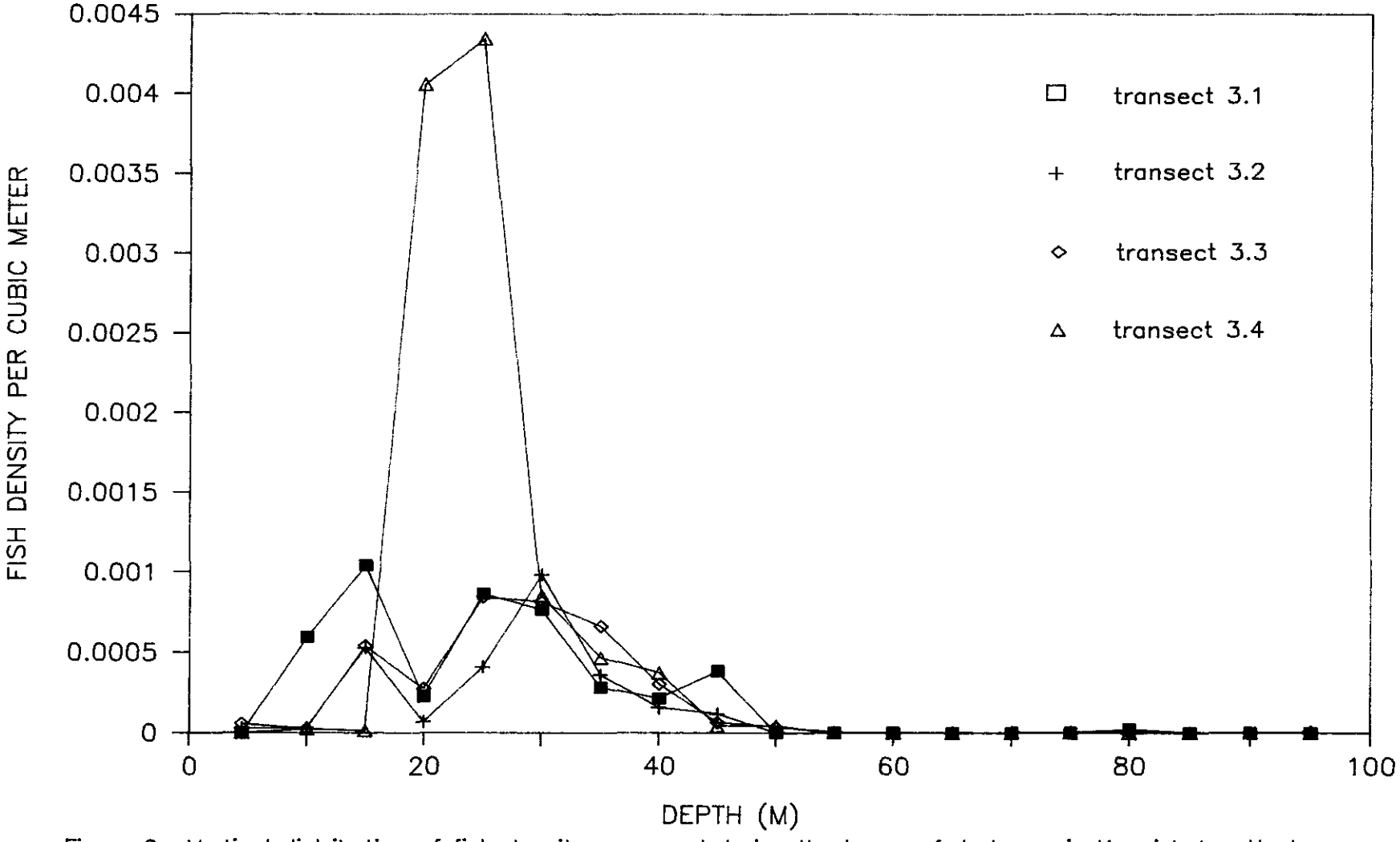


Figure 9. Vertical distribution of fish density measured during the hours of darkness in Kenai Lake, Alaska (Area 3: transects 3.1, 3.2, 3.3, 3.4) in October 1987.

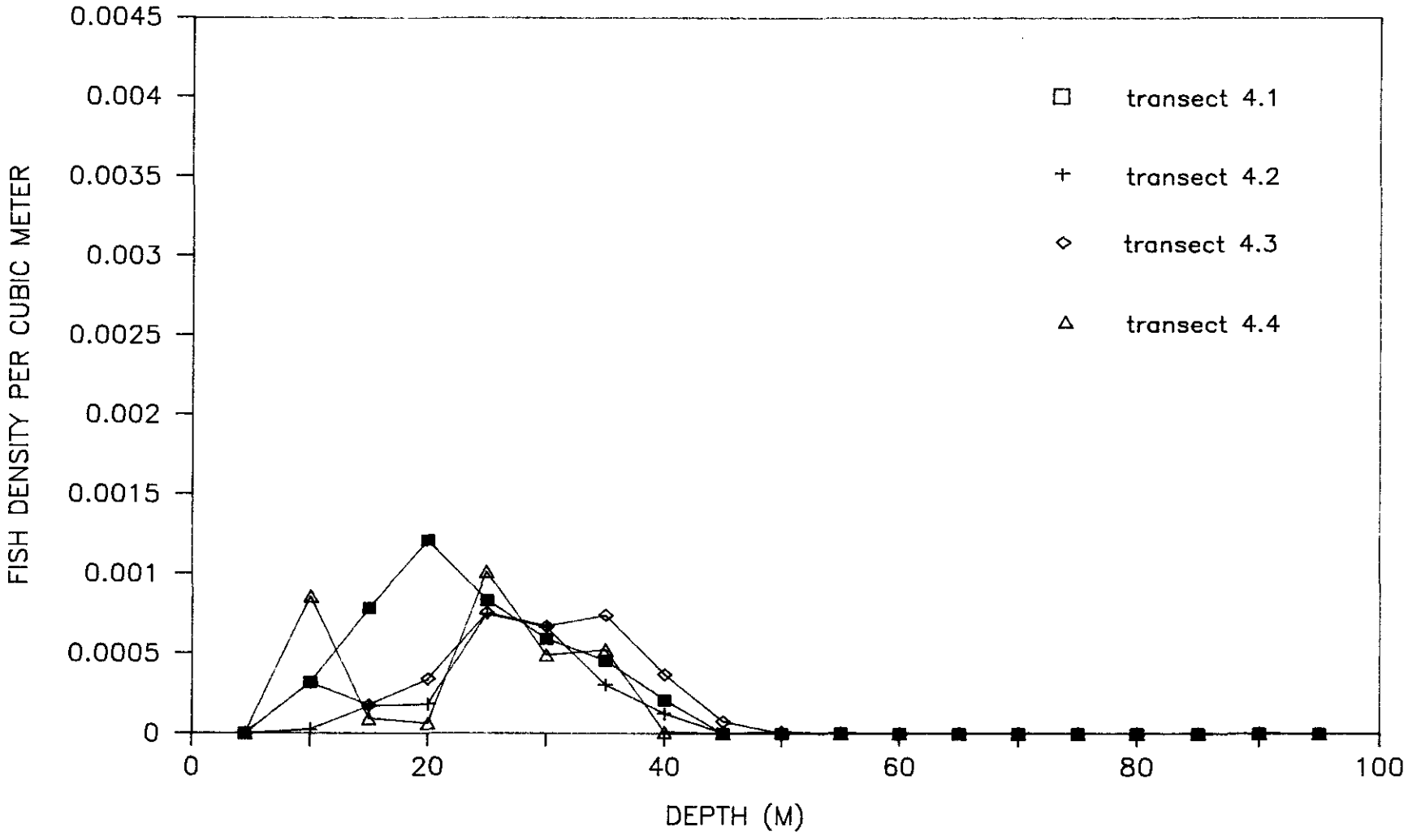


Figure 10. Vertical distribution of fish density measured during the hours of darkness in Kenai Lake, Alaska (Area 4: transects 4.1, 4.2, 4.3, 4.4) in October 1987.

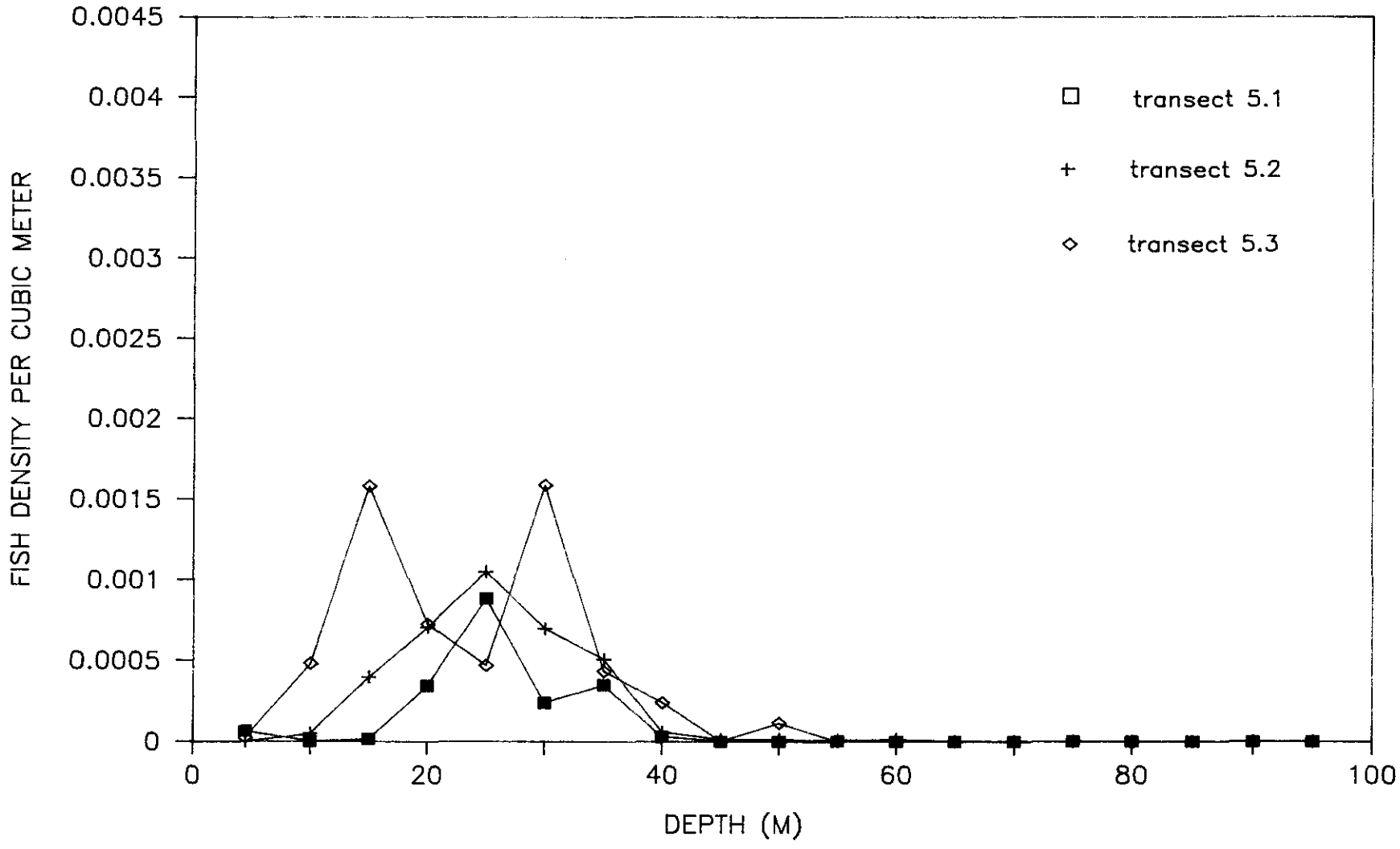


Figure 11. Vertical distribution of fish density measured during the hours of darkness in Kenai Lake, Alaska (Area 5: transects 5.1, 5.2, 5.3) in October 1987.

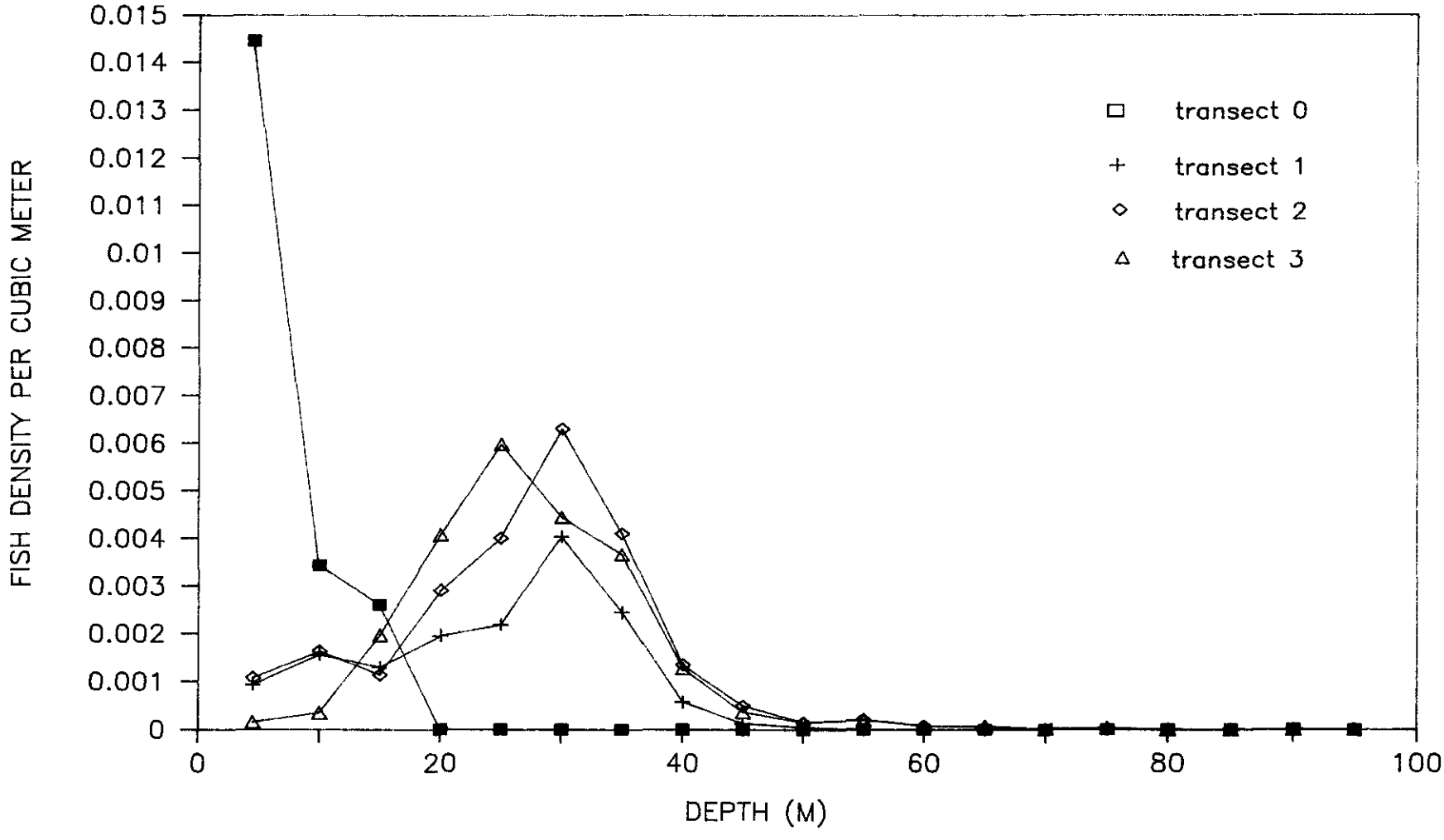


Figure 12. Vertical distribution of fish density during the hours of darkness in Skilak Lake, Alaska (Area 1: transects 0, 1, 2, 3) in October 1987.

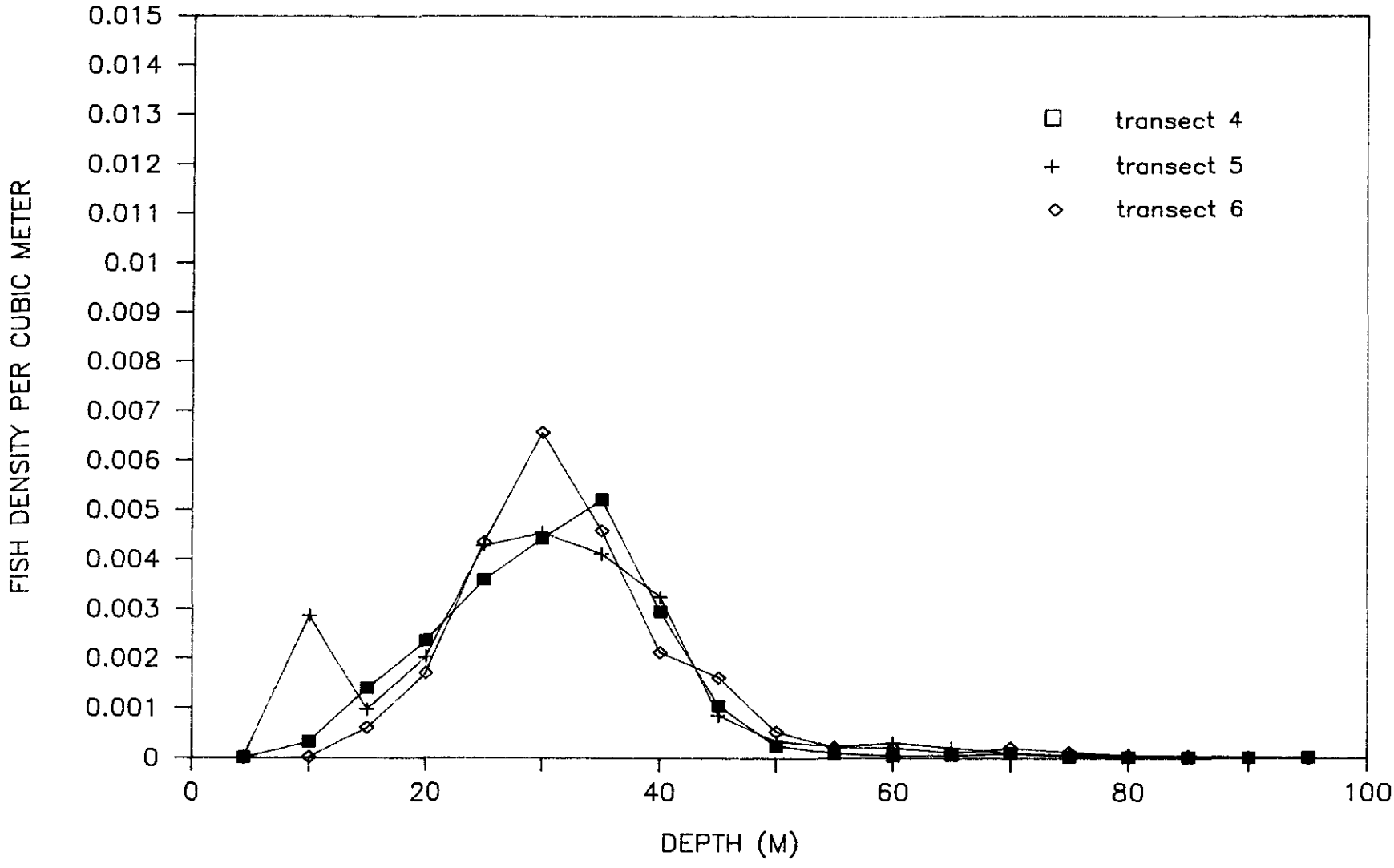


Figure 13. Vertical distribution of fish density measured during the hours of darkness in Skilak Lake, Alaska (Area 2: transects 4, 5, 6) in October 1987.

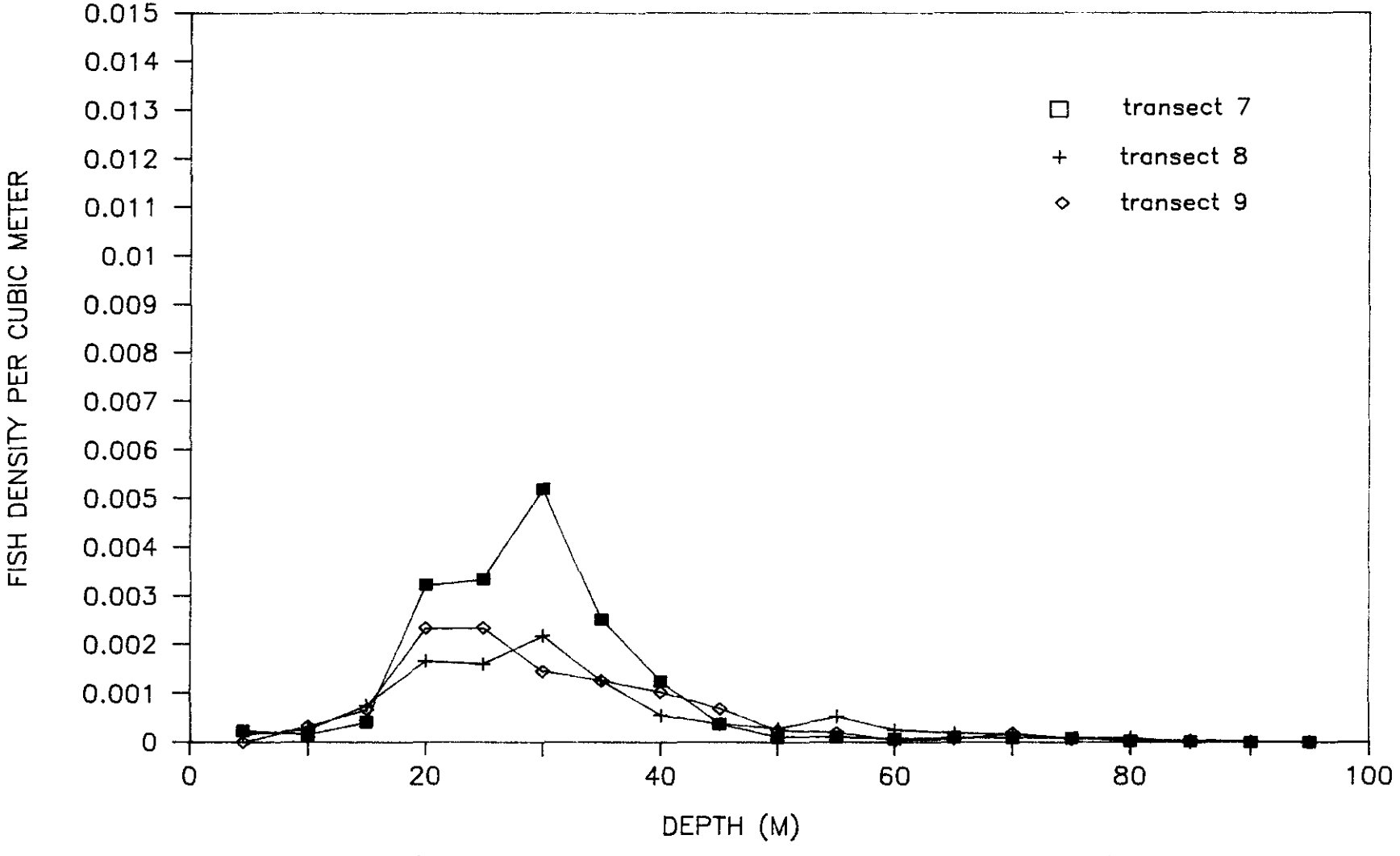


Figure 14. Vertical distribution of fish density measured during the hours of darkness in Skilak Lake, Alaska (Area 5: transects 7, 8, 9) in October 1987.

Appendix A1. Calibration and processing parameters used in collection and analysis of Kenai and Skilak Lakes, Alaska, 1987 hydroacoustic data.

Sounder	Receiving sensitivity (dB/uPa@1m)	Channel 1	40 log R =	-164.75 dB
			20 log R =	-143.12 dB
		Channel 2	40 log R =	-164.55 dB
			20 log R =	-142.33 dB
	Source level (dB/uPa@1m)			215.9 dB
	TVG Crossover			13.0 m
	Receiver gain			0 dB
Transducer	Beam width	Narrow		6 degree
		Wide		15 degree
	Wide beam dropoff	"A" coefficient		1.688 dB
		"B" coefficient		0.426 dB
	Beam pattern factor	Average squared value	Narrow	.00007513
Dual beam processor	Correction multiplier	Narrow beam		1.000 (0dB)
		Wide beam		0.977 (dB)
	Threshold	Narrow beam		250 mV (-63dB)
		Wide beam		250 mV (-63dB)
		Bottom		5000 mV (-36dB)
	Maximum half angle			4^{o}
	Pulse width criteria	-18 dB	Maximum	.7447 mS
		-6 dB	Minimum	.2668 mS
		-6 dB	Maximum	.5336 mS
	Bottom window			2.5 meters
	Start depth			2.0 meters
		Depth		

- Continued -

Appendix A.1. (p 2 of 2)

Echo integrator	B constant value	2.0 - 7.0 m	8.3
		7.0 - 12.0 m	1.9
		12.0 - 17.0 m	0.8
		17.0 - 22.0 m	0.44
		22.0 - 27.0 m	0.28
		27.0 - 32.0 m	0.19
		32.0 - 37.0 m	0.14
		37.0 - 42.0 m	0.11
		42.0 - 47.0 m	0.09
		47.0 - 52.0 m	0.07
		52.0 - 57.0 m	0.06
		57.0 - 62.0 m	0.05
		62.0 - 67.0 m	0.04
		67.0 - 72.0 m	0.04
		72.0 - 77.0 m	0.03
		77.0 - 82.0 m	0.03
		82.0 - 97.0 m	0.02

Appendix A.2. Average backscattering cross section (sigma) and target strength data by depth strata for all transects combined, Kenai Lake, Alaska, 1987.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[1] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	4	8.802E-05	1.502E-04	-46.82	9.11
7.0 - 12.0	31	1.083E-05	7.370E-06	-50.79	3.61
12.0 - 17.0	139	9.970E-06	1.815E-05	-52.77	5.08
17.0 - 22.0	450	7.842E-06	1.347E-05	-53.30	4.46
22.0 - 27.0	1016	6.297E-06	9.877E-06	-53.69	3.91
27.0 - 32.0	1325	5.922E-06	4.923E-06	-53.73	3.74
32.0 - 37.0	881	4.568E-06	3.392E-06	-54.60	3.41
37.0 - 42.0	498	3.798E-06	2.821E-06	-55.29	3.18
42.0 - 47.0	103	2.413E-06	1.540E-06	-57.01	2.76
47.0 - 97.0	75	2.961E-06	2.051E-06	-56.30	3.13
Total	4522	5.801E-06	9.162E-06	-54.08	3.86

[1] Target strength determined from dual beam data collected in situ.

Appendix A.3. Average backscattering cross section (sigma) and target strength data by depth strata for all transects combined, Skilak Lake, Alaska, 1987.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[1] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	21	1.385E-05	1.152E-05	-50.55	4.88
7.0 - 12.0	228	1.147E-05	9.038E-06	-51.12	4.42
12.0 - 17.0	584	9.291E-06	1.1179-05	-52.28	4.39
17.0 - 22.0	1298	7.246E-06	6.244E-06	-52.95	3.91
22.0 - 27.0	2239	5.969E-06	4.792E-06	-53.54	3.57
27.0 - 32.0	3398	5.275E-06	4.121E-06	-54.04	3.51
32.0 - 37.0	3486	4.410E-06	3.491E-06	-54.68	3.21
37.0 - 42.0	2275	4.064E-06	3.313E-06	-55.02	3.16
42.0 - 47.0	1094	3.665E-06	2.789E-06	-55.39	3.02
47.0 - 97.0	1634	4.076E-06	3.697E-06	-55.22	3.34
Total	16257	5.186E-06	4.941E-06	-54.26	3.56

[1] Target strength determined from dual beam data collected in situ.

Appendix A.4. Hydroacoustic estimate of fish inhabiting Area 1 , Kenai Lake, Alaska in 1987 based on Transect 1 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	3.8530E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	3.8520E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
12.0 - 17.0	3.8300E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	1.4660E-06	10	2.1510E-12	5.6840E-06	2.1773E+02	4.8540E+04	4.3180E+02
17.0 - 22.0	3.7340E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.6960E-05	10	9.6060E-11	8.3600E-05	3.1217E+03	3.3160E+06	3.5690E+03
22.0 - 27.0	3.5320E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	2.8680E-05	10	2.9090E-10	1.7600E-04	6.2162E+03	1.3760E+07	7.2700E+03
27.0 - 32.0	3.0550E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.6600E-05	9	2.5960E-10	1.0830E-04	3.3093E+03	1.0320E+07	6.2970E+03
32.0 - 37.0	1.5530E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	2.4830E-05	8	4.6700E-10	2.1010E-04	3.2635E+03	8.0710E+06	5.5680E+03
37.0 - 42.0	1.3630E+06	3.7980E-06	498	2.8210E-06	1.0180E+01	0.0000E+00	2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
42.0 - 47.0	0.0000E+00	2.4130E-06	103	1.5400E-06	1.6020E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	2.3545E+08									1.6128E+04	+ OR -	1.1680E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .772E+07.

Appendix A.5. Hydroacoustic estimate of fish inhabiting Area 1 , Kenai Lake, Alaska in 1987 based on Transect 2 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	3.7880E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	2.1870E-05	6	4.7850E-10	9.6040E-06	3.6380E+02	2.2870E+05	9.3730E+02
7.0 - 12.0	3.5160E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	2.2840E-04	6	1.9740E-08	8.1520E-04	2.8664E+04	3.2300E+08	3.5230E+04
12.0 - 17.0	3.1820E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	1.8780E-04	5	1.7540E-08	7.2780E-04	2.3159E+04	2.7960E+08	3.2780E+04
17.0 - 22.0	2.8140E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	2.5550E-04	5	3.6120E-08	1.2590E-03	3.5429E+04	7.0270E+08	5.1960E+04
22.0 - 27.0	2.2590E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	2.9550E-04	4	1.5930E-08	1.8140E-03	4.0971E+04	3.1020E+08	3.4520E+04
27.0 - 32.0	1.7470E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.8250E-04	3	3.3320E-08	1.1910E-03	2.0806E+04	4.3310E+08	4.0790E+04
32.0 - 37.0	6.9830E+06	4.5680E-06	881	3.3920E-06	8.4600E+00	1.4680E-04	3	2.1560E-08	1.2420E-03	8.6745E+03	7.5290E+07	1.7010E+04
37.0 - 42.0	0.0000E+00	3.7980E-06	498	2.8210E-06	1.0180E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
42.0 - 47.0	0.0000E+00	2.4130E-06	103	1.5400E-06	1.6020E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.8004E+08									1.5807E+05	+ OR -	9.0340E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .772E+07

Appendix A.6. Hydroacoustic estimate of fish inhabiting Area 1, Kenai Lake, Alaska in 1987 based on Transect 3 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	3.8040E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	3.7450E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	3.1510E-05	8	9.9310E-10	1.1250E-04	4.2110E+03	1.8000E+07	8.3150E+03
12.0 - 17.0	3.6500E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
17.0 - 22.0	3.5440E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	8.9820E-05	8	7.3790E-09	4.4270E-04	1.5687E+04	2.2670E+08	2.9510E+04
22.0 - 27.0	3.4090E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.8740E-04	8	2.0020E-08	1.1500E-03	3.9212E+04	8.8030E+08	5.8150E+04
27.0 - 32.0	3.2470E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.0050E-04	7	1.2660E-09	6.5570E-04	2.1289E+04	5.7060E+07	1.4810E+04
32.0 - 37.0	3.0300E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	1.2270E-05	7	8.1710E-11	1.0380E-04	3.1451E+03	5.3770E+06	4.5450E+03
37.0 - 42.0	2.8810E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	1.2020E-05	7	1.4450E-10	1.2230E-04	3.5240E+03	1.2430E+07	6.9110E+03
42.0 - 47.0	2.5650E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	1.1320E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	1.8530E+06	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	3.1192E+08									8.7068E+04	+ OR -	6.7890E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .772E+07

Appendix A.7. Hydroacoustic estimate of fish inhabiting Area 1 , Kenai Lake, Alaska in 1987 based on Transect 4 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	3.8180E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	12	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	3.6450E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	7.0490E-05	12	4.9680E-09	2.5150E-04	9.1683E+03	8.5310E+07	1.8100E+04
12.0 - 17.0	3.0960E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	2.6010E-06	10	3.6960E-12	1.0080E-05	3.1209E+02	5.5550E+04	4.6190E+02
17.0 - 22.0	3.1000E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.6520E-04	10	4.6350E-09	8.1400E-04	2.5231E+04	1.1230E+08	2.0770E+04
22.0 - 27.0	3.0490E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	3.1950E-04	10	1.4160E-08	1.9610E-03	5.9787E+04	5.0470E+08	4.4030E+04
27.0 - 32.0	3.0030E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.6700E-04	10	6.1580E-09	1.0900E-03	3.2735E+04	2.3710E+08	3.0180E+04
32.0 - 37.0	2.9510E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	7.2840E-05	10	7.4440E-10	6.1630E-04	1.8188E+04	4.6620E+07	1.3380E+04
37.0 - 42.0	2.8070E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	4.5230E-05	10	9.2410E-10	4.6020E-04	1.2919E+04	7.5580E+07	1.7040E+04
42.0 - 47.0	2.7230E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	2.6540E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	6.9820E-06	9	4.8740E-11	9.1120E-05	2.4188E+03	5.8880E+06	4.7560E+03
52.0 - 57.0	2.5290E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	2.4280E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	2.3430E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	2.2060E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	2.0220E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	1.4850E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	1.8300E+06	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	4.4042E+08									1.6076E+05	+ OR -	6.4040E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .772E+07

Appendix A.8. Hydroacoustic estimate of fish inhabiting Area 2 , Kenai Lake, Alaska in 1987 based on Transect 1 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.9390E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	5.9300E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	6.7300E-06	10	4.5290E-11	2.4010E-05	1.4242E+03	2.0590E+06	2.8120E+03
12.0 - 17.0	5.9000E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	1.2180E-04	10	3.0610E-09	4.7190E-04	2.7845E+04	1.7860E+08	2.6190E+04
17.0 - 22.0	5.8220E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	3.6500E-04	10	1.6860E-08	1.7990E-03	1.0473E+05	1.4600E+09	7.4880E+04
22.0 - 27.0	5.7510E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	3.2820E-04	10	1.4360E-08	2.0140E-03	1.1584E+05	1.8210E+09	8.3640E+04
27.0 - 32.0	5.6660E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	3.9490E-04	10	2.3800E-08	2.5770E-03	1.4601E+05	3.2650E+09	1.1200E+05
32.0 - 37.0	5.5690E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	1.1040E-04	10	2.0700E-09	9.3430E-04	5.2033E+04	4.6120E+08	4.2090E+04
37.0 - 42.0	5.5000E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	1.7270E-05	10	8.9320E-11	1.7580E-04	9.6667E+03	2.8080E+07	1.0390E+04
42.0 - 47.0	5.4130E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	2.7500E-06	10	6.1180E-12	4.4050E-05	2.3842E+03	4.6200E+06	4.2130E+03
47.0 - 52.0	5.3060E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	3.4600E-08	10	1.1970E-15	4.5160E-07	2.3962E+01	5.7780E+02	4.7110E+01
52.0 - 57.0	5.1470E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	4.9810E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	4.5340E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	4.3540E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	2.0300E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	1.5460E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	5	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	1.3930E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	5	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	1.1860E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	1.1010E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	8.3068E+08									4.5996E+05	+ OR -	1.6650E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .1191E+08

Appendix A.9. Hydroacoustic estimate of fish inhabiting Area 2 , Kenai Lake, Alaska in 1987 based on Transect 2 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.9060E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	5.8500E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	2.3260E-05	11	4.6460E-10	8.3000E-05	4.8554E+03	2.0600E+07	8.8950E+03
12.0 - 17.0	5.7930E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	1.4410E-04	11	6.6370E-09	5.5850E-04	3.2351E+04	3.5960E+08	3.7170E+04
17.0 - 22.0	5.7320E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.8290E-04	11	8.9850E-09	9.0150E-04	5.1673E+04	7.3450E+08	5.3120E+04
22.0 - 27.0	5.6450E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	2.1830E-04	11	6.4890E-09	1.3400E-03	7.5640E+04	7.9280E+08	5.5190E+04
27.0 - 32.0	5.5480E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.7230E-04	10	3.1310E-09	1.1240E-03	6.2381E+04	4.1250E+08	3.9810E+04
32.0 - 37.0	5.4450E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	4.0180E-05	10	5.8180E-10	3.4000E-04	1.8513E+04	1.2370E+08	2.1800E+04
37.0 - 42.0	5.3660E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	3.0330E-05	10	1.4190E-10	3.0860E-04	1.6561E+04	4.2610E+07	1.2790E+04
42.0 - 47.0	5.2620E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	5.3220E-06	10	1.0690E-11	8.5230E-05	4.4852E+03	7.6700E+06	5.4280E+03
47.0 - 52.0	5.1850E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	6.6710E-08	10	4.4500E-15	8.7070E-07	4.5143E+01	2.0510E+03	8.8760E+01
52.0 - 57.0	4.9260E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	9.0180E-08	10	8.1320E-15	1.1770E-06	5.7981E+01	3.3830E+03	1.1400E+02
57.0 - 62.0	4.7390E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.8250E-07	9	1.8000E-14	2.3820E-06	1.1285E+02	6.9680E+03	1.6360E+02
62.0 - 67.0	4.6670E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	2.5400E-06	9	6.4500E-12	3.3150E-05	1.5471E+03	2.4090E+06	3.0420E+03
67.0 - 72.0	4.5630E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	3.9850E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	9.3040E-08	9	8.6560E-15	1.2140E-06	4.8387E+01	2.3560E+03	9.5140E+01
77.0 - 82.0	1.8780E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	4.6600E+06	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	4.1510E+06	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	3.5060E+06	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	8.1722E+08									2.6827E+05	+ OR -	9.7930E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .1191E+08

Appendix A.10. Hydroacoustic estimate of fish inhabiting Area 2 , Kenai Lake, Alaska in 1987 based on Transect 3 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.8750E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	1.1570E-05	13	1.3390E-10	5.0810E-06	2.9852E+02	1.5400E+05	7.6910E+02
7.0 - 12.0	5.7930E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	1.3440E-06	13	1.8050E-12	4.7940E-06	2.7776E+02	7.8300E+04	5.4850E+02
12.0 - 17.0	5.7010E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	3.8220E-05	13	1.3250E-09	1.4820E-04	8.4475E+03	6.6400E+07	1.5970E+04
17.0 - 22.0	5.6410E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.9910E-04	13	5.3540E-09	9.8100E-04	5.5341E+04	4.3390E+08	4.0830E+04
22.0 - 27.0	5.5980E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	3.7110E-04	13	2.0470E-08	2.2770E-03	1.2750E+05	2.4560E+09	9.7130E+04
27.0 - 32.0	5.5400E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	4.5400E-04	13	1.5790E-08	2.9630E-03	1.6412E+05	2.0780E+09	8.9340E+04
32.0 - 37.0	5.4830E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	7.9870E-05	13	1.2270E-09	6.7570E-04	3.7050E+04	2.6500E+08	3.1900E+04
37.0 - 42.0	5.4200E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	1.0140E-05	13	5.8780E-11	1.0320E-04	5.5910E+03	1.7910E+07	8.2950E+03
42.0 - 47.0	5.3600E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	0.0000E+00	13	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	5.3000E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	13	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	5.2180E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	13	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	5.0790E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	12	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	4.7990E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	4.6030E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	4.1000E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	3.7700E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	3.4900E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	1.4950E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	8.0040E+06	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	8.9065E+08									3.9863E+05	+ OR -	1.4290E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .1191E+08

Appendix A.11. Hydroacoustic estimate of fish inhabiting Area 2 , Kenai Lake, Alaska in 1987 based on Transect 4 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.9420E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	15	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	5.9270E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	1.2490E-04	14	7.6420E-09	4.4580E-04	2.6426E+04	3.5230E+08	3.6790E+04
12.0 - 17.0	5.8740E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	4.8380E-05	14	1.6270E-09	1.8750E-04	1.1017E+04	8.7240E+07	1.8310E+04
17.0 - 22.0	5.8180E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.2050E-04	14	6.5750E-09	5.9380E-04	3.4546E+04	5.4840E+08	4.5900E+04
22.0 - 27.0	5.7540E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.6870E-04	14	4.5280E-09	1.0360E-03	5.9589E+04	5.7330E+08	4.6930E+04
27.0 - 32.0	5.7130E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.6440E-04	14	2.0460E-09	1.0730E-03	6.1277E+04	2.8630E+08	3.3170E+04
32.0 - 37.0	5.6150E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	1.0980E-04	14	1.1720E-09	9.2930E-04	5.2182E+04	2.6610E+08	3.1970E+04
37.0 - 42.0	5.4840E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	7.3280E-05	14	1.1930E-09	7.4570E-04	4.0898E+04	3.7330E+08	3.7870E+04
42.0 - 47.0	5.3060E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	7.2760E-06	13	1.6220E-11	1.1650E-04	6.1839E+03	1.1870E+07	6.7530E+03
47.0 - 52.0	5.1500E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	13	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	4.9180E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	13	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	4.6450E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	13	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	4.2410E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	13	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	4.1120E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	4.0130E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	3.8380E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	3.7150E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	2.6870E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	1.1420E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	8.9894E+08									2.9212E+05	+ OR -	9.7980E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .1191E+08

Appendix A.12. Hydroacoustic estimate of fish inhabiting Area 3 , Kenai Lake, Alaska in 1987 based on Transect 1 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.2530E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	5.2020E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	1.6650E-04	8	2.6090E-08	5.9410E-04	3.0904E+04	9.1340E+08	5.9240E+04
12.0 - 17.0	5.0810E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	2.6900E-04	8	1.8120E-08	1.0430E-03	5.2979E+04	7.6980E+08	5.4380E+04
17.0 - 22.0	5.0030E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	4.5590E-05	8	7.2690E-10	2.2470E-04	1.1242E+04	4.5020E+07	1.3150E+04
22.0 - 27.0	4.9260E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.4100E-04	8	3.7150E-09	8.6520E-04	4.2616E+04	3.4390E+08	3.6350E+04
27.0 - 32.0	4.8710E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.1760E-04	8	2.2720E-09	7.6720E-04	3.7369E+04	2.3030E+08	2.9740E+04
32.0 - 37.0	4.7790E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	3.3180E-05	8	1.6760E-10	2.8070E-04	1.3414E+04	2.7510E+07	1.0280E+04
37.0 - 42.0	4.6770E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	2.0870E-05	8	8.9680E-11	2.1240E-04	9.9319E+03	2.0420E+07	8.8570E+03
42.0 - 47.0	4.5770E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	2.3990E-05	8	1.6220E-10	3.8430E-04	1.7591E+04	8.8420E+07	1.8430E+04
47.0 - 52.0	4.3860E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	4.2930E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	4.2390E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.0540E-07	7	1.1120E-14	1.3760E-06	5.8333E+01	3.4250E+03	1.1470E+02
62.0 - 67.0	4.1930E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	4.1430E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	4.0650E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	2.1940E-08	7	4.8140E-16	2.8640E-07	1.1642E+01	1.3640E+02	2.2890E+01
77.0 - 82.0	3.9740E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.6650E-06	7	2.7730E-12	2.1740E-05	8.6378E+02	7.5090E+05	1.6980E+03
82.0 - 87.0	3.8780E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	3.7990E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	3.6590E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	8.4998E+08									2.1698E+05	+ OR -	9.6810E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .1054E+08

Appendix A.13. Hydroacoustic estimate of fish inhabiting Area 3 , Kenai Lake, Alaska in 1987 based on Transect 2 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.1870E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	6.3020E-05	9	3.9710E-09	2.7670E-05	1.4353E+03	3.5600E+06	3.6980E+03
7.0 - 12.0	5.1540E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	9.5010E-06	9	6.7800E-11	3.3900E-05	1.7472E+03	2.3390E+06	2.9970E+03
12.0 - 17.0	5.1190E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	1.3710E-04	9	7.6250E-09	5.3160E-04	2.7214E+04	3.1790E+08	3.4950E+04
17.0 - 22.0	5.0640E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.3180E-05	8	5.0560E-11	6.4950E-05	3.2889E+03	3.2200E+06	3.5170E+03
22.0 - 27.0	5.0090E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	6.6830E-05	8	1.3780E-09	4.1020E-04	2.0545E+04	1.3120E+08	2.2450E+04
27.0 - 32.0	4.9260E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.5110E-04	8	3.4390E-09	9.8640E-04	4.8588E+04	3.5660E+08	3.7010E+04
32.0 - 37.0	4.8600E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	4.2470E-05	8	4.4270E-10	3.5930E-04	1.7463E+04	7.5030E+07	1.6980E+04
37.0 - 42.0	4.7980E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	1.5150E-05	8	4.2870E-11	1.5420E-04	7.3971E+03	1.0280E+07	6.2840E+03
42.0 - 47.0	4.7340E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	7.2740E-06	8	5.2910E-11	1.1650E-04	5.5150E+03	3.0530E+07	1.0830E+04
47.0 - 52.0	4.6600E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	4.5830E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	4.4710E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	4.3550E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	4.2650E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	4.2050E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	4.1180E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	3.9760E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.4150E-08	8	2.0030E-16	1.8470E-07	7.3445E+00	5.4290E+01	1.4440E+01
87.0 - 92.0	3.8090E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.4770E-08	7	2.1820E-16	1.9280E-07	7.3445E+00	5.4290E+01	1.4440E+01
92.0 - 97.0	3.6840E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	8.6977E+08									1.3321E+05	+ OR -	5.9790E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was 1.0540E+07

Appendix A.14. Hydroacoustic estimate of fish inhabiting Area 3 , Kenai Lake, Alaska in 1987 based on Transect 3 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.2190E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	1.2820E-04	11	1.6440E-08	5.6290E-05	2.9380E+03	1.4920E+07	7.5700E+03
7.0 - 12.0	5.1840E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	6.3260E-06	11	3.0070E-11	2.2570E-05	1.1703E+03	1.0500E+06	2.0080E+03
12.0 - 17.0	5.1570E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	1.3970E-04	11	1.3050E-08	5.4150E-04	2.7925E+04	5.4020E+08	4.5550E+04
17.0 - 22.0	5.1300E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	5.5240E-05	11	3.5350E-10	2.7220E-04	1.3964E+04	2.3870E+07	9.5760E+03
22.0 - 27.0	5.1040E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.3740E-04	11	2.5640E-09	8.4350E-04	4.3057E+04	2.5610E+08	3.1370E+04
27.0 - 32.0	5.0770E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.2460E-04	11	3.0200E-09	8.1340E-04	4.1298E+04	3.3240E+08	3.5740E+04
32.0 - 37.0	5.0410E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	7.8420E-05	10	5.7910E-10	6.6350E-04	3.3444E+04	1.0600E+08	2.0180E+04
37.0 - 42.0	4.9760E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	2.9620E-05	10	1.1360E-10	3.0140E-04	1.4997E+04	2.9370E+07	1.0620E+04
42.0 - 47.0	4.9160E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	3.8980E-06	10	6.9030E-12	6.2430E-05	3.0693E+03	4.3170E+06	4.0730E+03
47.0 - 52.0	4.8190E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	2.6370E-06	10	5.2440E-12	3.4420E-05	1.6588E+03	2.0930E+05	2.8350E+03
52.0 - 57.0	4.7810E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	4.7280E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	4.6670E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.9190E-08	10	3.6810E-16	2.5040E-07	1.1685E+01	1.3740E+02	2.2980E+01
67.0 - 72.0	4.5910E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	4.5530E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	4.4920E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	4.4140E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	4.3020E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	4.1490E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	6.5920E-07	9	4.3450E-13	8.6030E-06	3.5697E+02	1.2820E+05	7.0190E+02
TOTAL	9.1300E+08									1.8389E+05	+ OR -	7.0950E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was 1.0540E+07

Appendix A.15. Hydroacoustic estimate of fish inhabiting Area 3 , Kenai Lake, Alaska in 1987 based on Transect 4 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.0130E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	4.9780E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	6.9670E-06	11	4.8530E-11	2.4860E-05	1.2375E+03	1.5540E+06	2.4440E+03
12.0 - 17.0	4.9430E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	3.3250E-06	10	6.8070E-12	1.2890E-05	6.3694E+02	2.5950E+05	9.9850E+02
17.0 - 22.0	4.8820E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	8.2340E-04	10	5.2120E-07	4.0580E-03	1.9812E+05	3.0430E+10	3.4190E+05
22.0 - 27.0	4.8230E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	7.0750E-04	10	2.7600E-07	4.3420E-03	2.0943E+05	2.4290E+10	3.0550E+05
27.0 - 32.0	4.8040E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.3050E-04	10	2.0520E-09	8.5150E-04	4.0900E+04	2.0250E+08	2.7890E+04
32.0 - 37.0	4.7820E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	5.5130E-05	10	5.2070E-10	4.6640E-04	2.2306E+04	8.5540E+07	1.8130E+04
37.0 - 42.0	4.7470E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	3.6430E-05	10	5.5030E-10	3.7070E-04	1.7596E+04	1.2880E+08	2.2240E+04
42.0 - 47.0	4.7120E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	2.4830E-06	10	2.9770E-12	3.9770E-05	1.8741E+03	1.7100E+06	2.5630E+03
47.0 - 52.0	4.6700E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	3.2830E-06	10	1.0780E-11	4.2850E-05	2.0014E+03	4.0310E+06	3.9350E+03
52.0 - 57.0	4.6430E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	4.6220E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	4.5860E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	4.5510E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	4.5070E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	4.4310E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	4.3310E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.0540E-08	10	1.1110E-16	1.3760E-07	5.9586E+00	3.5730E+01	1.1720E+01
87.0 - 92.0	4.2220E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	3.0970E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	8.7344E+08									4.9411E+05	+ OR -	4.6030E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was 1.0540E+07

Appendix A.16. Hydroacoustic estimate of fish inhabiting Area 4 , Kenai Lake, Alaska in 1987 based on Transect 1 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	7.1490E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	7.1200E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	8.9480E-05	11	1.8470E-09	3.1930E-04	2.2734E+04	1.2690E+08	2.2080E+04
12.0 - 17.0	6.0650E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	2.0180E-04	11	4.1290E-09	7.8210E-04	4.7436E+04	2.8190E+08	3.2910E+04
17.0 - 22.0	7.0250E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	2.4530E-04	11	6.9570E-09	1.2090E-03	8.4932E+04	8.8120E+08	5.8180E+04
22.0 - 27.0	6.9650E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.3560E-04	11	1.8870E-09	8.3200E-04	5.7949E+04	3.5290E+08	3.6820E+04
27.0 - 32.0	6.8990E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	9.0320E-05	11	1.0570E-09	5.8940E-04	4.0662E+04	2.1510E+08	2.8750E+04
32.0 - 37.0	6.8380E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	5.3460E-05	11	4.9320E-10	4.5230E-04	3.0927E+04	1.6570E+08	2.5230E+04
37.0 - 42.0	6.7640E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	2.0330E-05	11	1.6240E-10	2.0690E-04	1.3995E+04	7.7170E+07	1.7220E+04
42.0 - 47.0	6.6740E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	6.6270E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	6.5570E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	6.4870E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	6.4240E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	6.3700E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	3.6970E-08	11	1.3670E-15	4.8260E-07	3.0736E+01	9.5080E+02	6.0440E+01
72.0 - 77.0	6.2850E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.4040E-08	11	1.9720E-16	1.8330E-07	1.1521E+01	1.3360E+02	2.2650E+01
77.0 - 82.0	6.1670E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	6.0610E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	6.0110E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	5.8960E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.2438E+09									2.9868E+05	+ OR -	8.9840E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .1437E+08

Appendix A.17. Hydroacoustic estimate of fish inhabiting Area 4 , Kenai Lake, Alaska in 1987 based on Transect 2 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	7.1710E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	7.1660E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	7.1740E-06	11	5.1460E-11	2.5600E-05	1.8345E+03	3.4160E+06	3.6220E+03
12.0 - 17.0	7.1520E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	4.4380E-05	11	6.9890E-10	1.7200E-04	1.2304E+04	5.7320E+07	1.4840E+04
17.0 - 22.0	7.1320E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	3.6900E-05	11	4.5610E-10	1.8190E-04	1.2971E+04	5.7450E+07	1.4860E+04
22.0 - 27.0	7.0990E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.2200E-04	11	1.3670E-09	7.4870E-04	5.3144E+04	2.6620E+08	3.1980E+04
27.0 - 32.0	7.0350E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.0130E-04	11	1.3140E-09	6.6110E-04	4.6506E+04	2.7810E+08	3.2690E+04
32.0 - 37.0	6.9430E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	3.5510E-05	11	2.7950E-10	3.0040E-04	2.0857E+04	9.6710E+07	1.9270E+04
37.0 - 42.0	6.8450E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	1.1880E-05	11	2.5560E-11	1.2090E-04	8.2761E+03	1.2480E+07	6.9240E+03
42.0 - 47.0	6.7600E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	1.6000E-07	11	2.5610E-14	2.5630E-06	1.7327E+02	3.0140E+04	3.4030E+02
47.0 - 52.0	6.6560E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	6.5450E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	6.4440E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	6.3580E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	6.2940E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	6.2260E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	6.1430E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	6.0620E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	5.9990E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	5.9190E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.2595E+09									1.5607E+05	+ OR -	5.4450E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .1437E+08

Appendix A.18. Hydroacoustic estimate of fish inhabiting Area 4 , Kenai Lake, Alaska in 1987 based on Transect 3 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	7.1520E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	7.1350E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	8.8740E-05	11	5.6890E-09	3.1660E-04	2.2593E+04	3.7640E+08	3.8030E+04
12.0 - 17.0	7.0710E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	4.4960E-05	11	1.2890E-09	1.7430E-04	1.2324E+04	1.0040E+08	1.9640E+04
17.0 - 22.0	7.0360E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	6.8900E-05	11	5.8990E-10	3.3950E-04	2.3889E+04	7.4660E+07	1.6940E+04
22.0 - 27.0	7.0130E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.2270E-04	11	1.3940E-09	7.5320E-04	5.2829E+04	2.6500E+08	3.1910E+04
27.0 - 32.0	6.9760E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.0250E-04	11	8.6560E-10	6.6860E-04	4.6639E+04	1.8050E+08	2.6330E+04
32.0 - 37.0	6.9130E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	8.7270E-05	11	1.5620E-09	7.3830E-04	5.1045E+04	5.3580E+08	4.5370E+04
37.0 - 42.0	6.8530E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	3.6140E-05	11	1.4850E-10	3.6770E-04	2.5202E+04	7.2900E+07	1.6730E+04
42.0 - 47.0	6.8080E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	4.5570E-06	11	4.1220E-12	7.2980E-05	4.9686E+03	4.9980E+06	4.3820E+03
47.0 - 52.0	6.7140E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	6.6270E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	6.5440E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	4.4680E-08	11	1.9960E-15	5.8310E-07	3.8160E+01	1.4660E+03	7.5030E+01
62.0 - 67.0	6.4410E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	6.3440E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	7.3710E-08	11	5.4330E-15	9.6200E-07	6.1035E+01	3.7490E+03	1.2000E+02
72.0 - 77.0	6.2610E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	6.1600E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	6.0800E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	5.9950E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	5.3520E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.2547E+09									2.3959E+05	+ OR -	7.8660E+04

Appendix A.19. Hydroacoustic estimate of fish inhabiting Area 4 , Kenai Lake, Alaska in 1987 based on Transect 4 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	7.1740E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	12	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	7.1580E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	2.4090E-04	12	5.8060E-08	8.5980E-04	6.1548E+04	3.8450E+09	1.2150E+05
12.0 - 17.0	7.1000E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	2.3160E-05	12	2.4090E-10	8.9790E-05	6.3750E+03	1.9220E+07	8.5920E+03
17.0 - 22.0	7.0550E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.2480E-05	12	5.1460E-11	6.1500E-05	4.3390E+03	6.3440E+06	4.9370E+03
22.0 - 27.0	7.0220E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.6540E-04	12	1.9920E-09	1.0150E-03	7.1288E+04	3.8220E+08	3.8320E+04
27.0 - 32.0	6.9830E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	7.4800E-05	12	2.3730E-09	4.8820E-04	3.4087E+04	4.9340E+08	4.3540E+04
32.0 - 37.0	6.8720E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	6.1850E-05	11	1.0560E-09	5.2330E-04	3.5961E+04	3.5770E+08	3.7070E+04
37.0 - 42.0	6.8210E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	8.0670E-07	11	2.3990E-13	8.2090E-06	5.5989E+02	1.1590E+05	6.6730E+02
42.0 - 47.0	6.7460E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	7.4100E-08	11	5.4910E-15	1.1870E-06	8.0068E+01	6.4360E+03	1.5720E+02
47.0 - 52.0	6.6770E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	9.0310E-07	11	8.1560E-13	1.1790E-05	7.8703E+02	6.2340E+05	1.5480E+03
52.0 - 57.0	6.6330E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	6.5500E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	6.4780E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	6.4070E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	6.3240E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	6.2390E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	6.1520E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	6.0350E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	5.5450E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	11	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.2597E+09									2.1502E+05	+ OR -	1.4000E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .1437E+08

Appendix A.20. Hydroacoustic estimate of fish inhabiting Area 5 , Kenai Lake, Alaska in 1987 based on Transect 1 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.4550E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	1.4110E-04	10	1.9910E-08	6.1960E-05	3.3799E+03	1.9740E+07	8.7080E+03
7.0 - 12.0	5.4390E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
12.0 - 17.0	5.3940E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	4.0880E-06	10	4.4340E-12	1.5840E-05	8.5470E+02	2.1130E+05	9.0100E+02
17.0 - 22.0	5.3360E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	6.9930E-05	10	2.3930E-09	3.4460E-04	1.8389E+04	1.6770E+08	2.5380E+04
22.0 - 27.0	5.2510E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.4370E-04	10	5.3340E-09	8.8220E-04	4.6327E+04	5.5920E+08	4.6350E+04
27.0 - 32.0	5.1490E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	3.6350E-05	10	3.5530E-10	2.3720E-04	1.2214E+04	4.0190E+07	1.2420E+04
32.0 - 37.0	5.0960E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	4.1090E-05	10	5.8820E-10	3.4770E-04	1.7716E+04	1.0960E+08	2.0510E+04
37.0 - 42.0	5.0460E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	2.6780E-06	10	5.2210E-12	2.7250E-05	1.3752E+03	1.3790E+06	2.3010E+03
42.0 - 47.0	4.9670E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	4.8680E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	4.8010E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	4.7370E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	4.6580E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	4.5980E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	4.5300E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	4.4630E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	4.3750E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	3.2810E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	9.4720E+05	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	8.7539E+08									1.0026E+05	+ OR -	5.8730E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .1093E+08

Appendix A.21. Hydroacoustic estimate of fish inhabiting Area 5 , Kenai Lake, Alaska in 1987 based on Transect 2 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.4370E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	5.4140E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	1.3660E-05	9	1.8650E-10	4.8730E-05	2.6381E+03	7.0630E+06	5.2090E+03
12.0 - 17.0	5.3810E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	1.0230E-04	9	5.1910E-09	3.9670E-04	2.1345E+04	2.3670E+08	3.0160E+04
17.0 - 22.0	5.3730E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.4390E-04	9	6.0250E-09	7.0900E-04	3.8094E+04	4.3190E+08	4.0740E+04
22.0 - 27.0	5.3530E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	1.7080E-04	9	2.9560E-09	1.0480E-03	5.6115E+04	3.2670E+08	3.5430E+04
27.0 - 32.0	5.3060E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	1.0660E-04	9	1.6670E-09	6.9570E-04	3.6910E+04	2.0060E+08	2.7760E+04
32.0 - 37.0	5.2640E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	5.9680E-05	9	6.4070E-10	5.0490E-04	2.6578E+04	1.2750E+08	2.2130E+04
37.0 - 42.0	5.2280E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	5.4360E-06	9	2.9550E-11	5.5320E-05	2.8918E+03	8.3720E+06	5.6710E+03
42.0 - 47.0	5.1460E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	5.8320E-07	9	3.4010E-13	9.3410E-06	4.8063E+02	2.3190E+05	9.4390E+02
47.0 - 52.0	5.0490E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.0400E-06	9	7.7390E-13	1.3570E-05	6.8505E+02	3.3910E+05	1.1410E+03
52.0 - 57.0	4.9760E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	3.0160E-07	9	9.0960E-14	3.9360E-06	1.9588E+02	3.8620E+04	3.8520E+02
57.0 - 62.0	4.8960E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.0220E-06	9	9.2060E-13	1.3340E-05	6.5282E+02	3.7860E+05	1.2060E+03
62.0 - 67.0	4.7740E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	4.6570E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	4.5320E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	3.6790E-08	8	1.3540E-15	4.8020E-07	2.1764E+01	4.7670E+02	4.2790E+01
77.0 - 82.0	4.3960E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	1.8960E-08	8	3.5950E-16	2.4750E-07	1.0878E+01	1.1910E+02	2.1390E+01
82.0 - 87.0	4.2760E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	3.1830E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	1.4950E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	9.0146E+08									1.8662E+05	+ OR -	7.1740E+04

[1] Lake surface area (meters squared) used to calculate stratum volume was .1093E+08

Appendix A.22. Hydroacoustic estimate of fish inhabiting Area 5 , Kenai Lake, Alaska in 1987 based on Transect 3 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	5.0290E+07	8.8020E-05	4	1.5020E-04	4.3910E-01	5.3750E-05	6	2.8890E-09	2.3600E-05	1.1868E+03	2.4340E+06	3.0580E+03
7.0 - 12.0	4.9880E+07	1.0830E-05	31	7.3700E-06	3.5680E+00	1.3490E-04	6	7.8020E-09	4.8140E-04	2.4013E+04	2.5580E+08	3.1350E+04
12.0 - 17.0	4.9310E+07	9.9700E-06	139	1.8150E-05	3.8760E+00	4.0830E-04	6	1.3340E-07	1.5830E-03	7.8043E+04	5.0190E+09	1.3890E+05
17.0 - 22.0	4.7830E+07	7.8420E-06	450	1.3470E-05	4.9280E+00	1.4680E-04	6	3.9080E-09	7.2370E-04	3.4613E+04	2.2500E+08	2.9400E+04
22.0 - 27.0	4.6630E+07	6.2970E-06	1016	9.8770E-06	6.1370E+00	7.6040E-05	6	5.1740E-10	4.6670E-04	2.1762E+04	4.3520E+07	1.2930E+04
27.0 - 32.0	4.5350E+07	5.9220E-06	1325	4.9230E-06	6.5260E+00	2.4310E-04	6	4.0600E-09	1.5870E-03	7.1948E+04	3.5820E+08	3.7100E+04
32.0 - 37.0	4.3900E+07	4.5680E-06	881	3.3920E-06	8.4600E+00	5.1090E-05	6	7.4060E-10	4.3220E-04	1.8977E+04	1.0240E+08	1.9830E+04
37.0 - 42.0	4.2020E+07	3.7980E-06	498	2.8210E-06	1.0180E+01	2.3230E-05	6	8.0540E-11	2.3640E-04	9.9316E+03	1.4830E+07	7.5490E+03
42.0 - 47.0	4.0440E+07	2.4130E-06	103	1.5400E-06	1.6020E+01	0.0000E+00	6	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	3.8640E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	8.6300E-06	5	7.4480E-11	1.1260E-04	4.3521E+03	1.9060E+07	8.5570E+03
52.0 - 57.0	3.5620E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	5	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	3.4960E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	3.4590E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	3.3640E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	2.7680E+07	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	4.3620E+06	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	2.9610E-06	75	2.0510E-06	1.3050E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	6.2514E+08									2.6483E+05	+ OR -	1.5230E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .1093E+08

Appendix A.23. Hydroacoustic estimate of fish inhabiting Area 1 , Skilak Lake, Alaska in 1987 based on Transect 0 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	2.0250E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	5.1770E-03	23	2.0710E-05	1.4450E-02	2.9249E+06	6.8930E+12	5.1460E+06
7.0 - 12.0	1.4850E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	1.0190E-03	20	2.9420E-07	3.4320E-03	5.0963E+05	7.4340E+10	5.3440E+05
12.0 - 17.0	9.4420E+07	9.2910E-06	584	1.1790E-05	4.1600E+00	6.2630E-04	13	1.2800E-07	2.6050E-03	2.4598E+05	1.9910E+10	2.7660E+05
17.0 - 22.0	7.6070E+06	7.2460E-06	1298	6.2440E-06	5.3330E+00	0.0000E+00	5	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
22.0 - 27.0	0.0000E+00	5.9690E-06	2239	4.7920E-06	6.4750E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
27.0 - 32.0	0.0000E+00	5.2750E-06	3398	4.1210E-06	7.3260E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
32.0 - 37.0	0.0000E+00	4.4100E-06	3486	3.4910E-06	8.7630E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
37.0 - 42.0	0.0000E+00	4.0640E-06	2275	3.3130E-06	9.5090E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
42.0 - 47.0	0.0000E+00	3.6650E-06	1094	2.7890E-06	1.0540E+01	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.0 - 52.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.0 - 57.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	4.5303E+08									3.6805E+06	+ OR -	5.1810E+06

[1] Lake surface area (meters squared) used to calculate stratum volume was .4303E+08

Appendix A.24. Hydroacoustic estimate of fish inhabiting Area 1 , Skilak Lake, Alaska in 1987 based on Transect 1 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	2.0480E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	3.3510E-04	28	5.9370E-08	9.3500E-04	1.9152E+05	2.0600E+10	2.8130E+05
7.0 - 12.0	1.8720E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	4.6590E-04	29	4.7000E-08	1.5700E-03	2.9391E+05	1.8940E+10	2.6980E+05
12.0 - 17.0	1.6920E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	3.0930E-04	26	9.4660E-09	1.2870E-03	2.1767E+05	4.8190E+09	1.3610E+05
17.0 - 22.0	1.4090E+08	6.9940E-06	244	6.3720E-06	5.5260E+00	3.5510E-04	22	8.9150E-09	1.9620E-03	2.7650E+05	5.6660E+09	1.4750E+05
22.0 - 27.0	1.2570E+08	6.5280E-06	283	5.5830E-06	5.9200E+00	3.7040E-04	19	8.0770E-09	2.1930E-03	2.7571E+05	4.6720E+09	1.3400E+05
27.0 - 32.0	1.0650E+08	5.0470E-06	446	3.9190E-06	7.6570E+00	5.2820E-04	17	1.8630E-08	4.0440E-03	4.3075E+05	1.2640E+10	2.2030E+05
32.0 - 37.0	9.0910E+07	4.4100E-06	3486	3.4910E-06	8.7630E+00	2.7990E-04	14	4.7080E-09	2.4530E-03	2.2297E+05	2.9970E+09	1.0730E+05
37.0 - 42.0	6.9580E+07	4.0640E-06	2275	3.3130E-06	9.5090E+00	6.0610E-05	12	2.9640E-10	5.7630E-04	4.0098E+04	1.3020E+08	2.2370E+04
42.0 - 47.0	4.5330E+07	3.6650E-06	1094	2.7890E-06	1.0540E+01	1.2250E-05	9	5.4600E-11	1.2910E-04	5.8548E+03	1.2490E+07	6.9280E+03
47.0 - 52.0	1.9000E+07	4.0760E-06	1634	3.6970E-06	9.4810E+00	4.1070E-06	5	1.6860E-11	3.8940E-05	7.3984E+02	5.4760E+05	1.4500E+03
52.0 - 57.0	6.7670E+04	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.0 - 62.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.0 - 67.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.0 - 72.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.0 - 77.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
77.0 - 82.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.1592E+09									1.9557E+06	+ OR -	5.2030E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .4303E+08

Appendix A.25. Hydroacoustic estimate of fish inhabiting Area 1 , Skilak Lake, Alaska in 1987 based on Transect 2 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	1.9860E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	3.8620E-04	32	5.5880E-08	1.0780E-03	2.1397E+05	1.8660E+10	2.6770E+05
7.0 - 12.0	1.5810E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	4.8400E-04	28	6.4990E-08	1.6310E-03	2.5790E+05	1.8640E+10	2.6760E+05
12.0 - 17.0	1.3800E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	2.7340E-04	22	8.8100E-09	1.1370E-03	1.5689E+05	2.9690E+09	1.0680E+05
17.0 - 22.0	1.3280E+08	6.7630E-06	157	6.3550E-06	5.7140E+00	5.0810E-04	21	1.6910E-08	2.9040E-03	3.8546E+05	1.0570E+10	2.0150E+05
22.0 - 27.0	1.3090E+08	5.8890E-06	324	4.6220E-06	6.5620E+00	6.0970E-04	20	2.1370E-08	4.0010E-03	5.2395E+05	1.6300E+10	2.5020E+05
27.0 - 32.0	1.2950E+08	5.6990E-06	547	4.5370E-06	6.7810E+00	9.2910E-04	19	3.8910E-08	6.3010E-03	8.1605E+05	3.0780E+10	3.4390E+05
32.0 - 37.0	1.2870E+08	4.1880E-06	458	2.7340E-06	9.2280E+00	4.4500E-04	19	7.1690E-09	4.1070E-03	5.2871E+05	1.0380E+10	1.9970E+05
37.0 - 42.0	1.2800E+08	4.0750E-06	204	3.0330E-06	9.4840E+00	1.4260E-04	19	1.2020E-09	1.3520E-03	1.7310E+05	1.8530E+09	8.4380E+04
42.0 - 47.0	1.2690E+08	3.6650E-06	1094	2.7890E-06	1.0540E+01	4.6090E-05	19	2.0870E-10	4.8600E-04	6.1691E+04	3.7590E+08	3.8000E+04
47.0 - 52.0	1.1650E+08	4.0810E-06	160	3.9810E-06	9.4700E+00	1.5490E-05	19	1.1930E-10	1.4670E-04	1.7091E+04	1.4700E+08	2.3760E+04
52.0 - 57.0	1.0450E+08	4.0810E-06	160	3.9810E-06	9.4700E+00	2.1840E-05	17	8.6910E-11	2.0680E-04	2.1602E+04	8.7830E+07	1.8370E+04
57.0 - 62.0	9.9210E+07	4.0810E-06	160	3.9810E-06	9.4700E+00	8.0760E-06	16	2.9780E-11	7.6480E-05	7.5872E+03	2.6620E+07	1.0110E+04
62.0 - 67.0	9.4160E+07	4.0810E-06	160	3.9810E-06	9.4700E+00	5.6070E-06	15	6.3280E-12	5.3090E-05	4.9991E+03	5.1790E+06	4.4610E+03
67.0 - 72.0	8.3220E+07	4.0810E-06	160	3.9810E-06	9.4700E+00	1.2870E-06	14	1.6570E-12	1.2190E-05	1.0145E+03	1.0350E+06	1.9940E+03
72.0 - 77.0	6.6520E+07	4.0810E-06	160	3.9810E-06	9.4700E+00	5.9690E-07	12	2.1970E-13	5.6520E-06	3.7600E+02	8.8040E+04	5.8160E+02
77.0 - 82.0	2.0810E+07	4.0810E-06	160	3.9810E-06	9.4700E+00	0.0000E+00	10	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	0.0000E+00	4.0810E-06	160	3.9810E-06	9.4700E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	4.0810E-06	160	3.9810E-06	9.4700E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	4.0810E-06	160	3.9810E-06	9.4700E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.8564E+09									3.1704E+06	+ OR -	6.5240E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .4303E+08

Appendix A.26. Hydroacoustic estimate of fish inhabiting Area 1 , Skilak Lake, Alaska in 1987 based on Transect 3 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	1.8780E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	5.7720E-05	32	1.7010E-09	1.6110E-04	3.0251E+04	4.9740E+08	4.3710E+04
7.0 - 12.0	1.5470E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	1.0400E-04	26	2.4460E-09	3.5060E-04	5.4246E+04	6.7300E+08	5.0850E+04
12.0 - 17.0	1.4310E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	4.7560E-04	22	2.9420E-08	1.9780E-03	2.8303E+05	1.0640E+10	2.0220E+05
17.0 - 22.0	1.3170E+08	7.4140E-06	216	6.2310E-06	5.2130E+00	7.8300E-04	21	6.2990E-08	4.0820E-03	5.3772E+05	3.0650E+10	3.4310E+05
22.0 - 27.0	1.3250E+08	6.2470E-06	429	5.4100E-06	6.1860E+00	9.6660E-04	21	5.8590E-08	5.9800E-03	7.9247E+05	4.0490E+10	3.9440E+05
27.0 - 32.0	1.3130E+08	5.6010E-06	438	4.9180E-06	6.9000E+00	6.4350E-04	20	1.6880E-08	4.4400E-03	5.8282E+05	1.4440E+10	2.3550E+05
32.0 - 37.0	1.2970E+08	4.4170E-06	413	3.8670E-06	8.7490E+00	4.1860E-04	20	8.5880E-09	3.6620E-03	4.7500E+05	1.1480E+10	2.1000E+05
37.0 - 42.0	1.2820E+08	4.2450E-06	229	3.4530E-06	9.1040E+00	1.4010E-04	20	1.0740E-09	1.2750E-03	1.6345E+05	1.5390E+09	7.6900E+04
42.0 - 47.0	1.2720E+08	3.6650E-06	1094	2.7890E-06	1.0540E+01	3.4370E-05	20	2.5000E-10	3.6240E-04	4.6080E+04	4.5060E+08	4.1600E+04
47.0 - 52.0	1.2370E+08	4.0760E-06	1634	3.6970E-06	9.4810E+00	1.5320E-05	20	7.3620E-11	1.4520E-04	1.7959E+04	1.0140E+08	1.9740E+04
52.0 - 57.0	1.1800E+08	4.0760E-06	1634	3.6970E-06	9.4810E+00	2.1380E-05	19	7.0060E-11	2.0270E-04	2.3920E+04	8.8020E+07	1.8390E+04
57.0 - 62.0	1.0940E+08	4.0760E-06	1634	3.6970E-06	9.4810E+00	6.9300E-06	18	1.4010E-11	6.5710E-05	7.1894E+03	1.5100E+07	7.6170E+03
62.0 - 67.0	8.4590E+07	4.0760E-06	1634	3.6970E-06	9.4810E+00	6.7440E-06	16	1.4740E-11	6.3950E-05	5.4092E+03	9.4950E+06	6.0400E+03
67.0 - 72.0	6.9600E+07	4.0760E-06	1634	3.6970E-06	9.4810E+00	9.8510E-07	13	4.1590E-13	9.3410E-06	6.5014E+02	1.8140E+05	8.3470E+02
72.0 - 77.0	5.6460E+07	4.0760E-06	1634	3.6970E-06	9.4810E+00	4.3190E-06	11	1.2900E-11	4.0950E-05	2.3118E+03	3.7010E+06	3.7710E+03
77.0 - 82.0	2.8890E+07	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82.0 - 87.0	1.5980E+06	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
87.0 - 92.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	0.0000E+00	4.0760E-06	1634	3.6970E-06	9.4810E+00	0.0000E+00	0	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.8584E+09									3.0225E+06	+ OR -	6.5320E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .4303E+08

Appendix A.27. Hydroacoustic estimate of fish inhabiting Area 2 , Skilak Lake, Alaska in 1987 based on Transect 4 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	1.6660E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	2.3810E-06	46	5.6680E-12	6.6430E-06	1.1065E+03	1.2650E+06	2.2040E+03
7.0 - 12.0	1.6640E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	9.8420E-05	46	3.0160E-09	3.3160E-04	5.5182E+04	9.5660E+08	6.0620E+04
12.0 - 17.0	1.6610E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	3.3850E-04	46	1.2830E-08	1.4080E-03	2.3389E+05	6.2760E+09	1.5530E+05
17.0 - 22.0	1.6510E+08	7.0050E-06	231	5.2910E-06	5.5170E+00	4.2980E-04	46	1.5520E-08	2.3710E-03	3.9156E+05	1.3260E+10	2.2570E+05
22.0 - 27.0	1.6230E+08	5.7890E-06	468	4.6100E-06	6.6760E+00	5.3830E-04	46	1.1860E-08	3.5940E-03	5.8310E+05	1.4380E+10	2.3500E+05
27.0 - 32.0	1.5510E+08	5.2150E-06	934	3.8820E-06	7.4110E+00	5.9670E-04	45	5.3310E-09	4.4220E-03	6.8601E+05	7.3240E+09	1.6770E+05
32.0 - 37.0	1.4430E+08	4.5690E-06	1103	3.3250E-06	8.4580E+00	6.1710E-04	43	8.3850E-09	5.2200E-03	7.5303E+05	1.2760E+10	2.2140E+05
37.0 - 42.0	1.4180E+08	4.1070E-06	944	3.5100E-06	9.4100E+00	3.1360E-04	41	1.4340E-09	2.9510E-03	4.1841E+05	2.6890E+09	1.0160E+05
42.0 - 47.0	1.3840E+08	3.7900E-06	443	3.0500E-06	1.0200E+01	1.0320E-04	40	2.9340E-10	1.0520E-03	1.4568E+05	6.1560E+08	4.8630E+04
47.0 - 52.0	1.3220E+08	2.6790E-06	168	1.7950E-06	1.4430E+01	1.6940E-05	40	1.6920E-11	2.4430E-04	3.2293E+04	6.4280E+07	1.5710E+04
52.0 - 57.0	1.2480E+08	2.6790E-06	168	1.7950E-06	1.4430E+01	6.4120E-06	38	4.8390E-12	9.2500E-05	1.1540E+04	1.6030E+07	7.8470E+03
57.0 - 62.0	1.2030E+08	2.6790E-06	168	1.7950E-06	1.4430E+01	3.0350E-06	36	2.0010E-12	4.3780E-05	5.2677E+03	6.1040E+06	4.8420E+03
62.0 - 67.0	1.1330E+08	2.6790E-06	168	1.7950E-06	1.4430E+01	3.8900E-06	34	2.0250E-12	5.6110E-05	6.3563E+03	5.5140E+06	4.6020E+03
67.0 - 72.0	1.0730E+08	2.6790E-06	168	1.7950E-06	1.4430E+01	6.7520E-06	33	9.0780E-12	9.7400E-05	1.0452E+04	2.2050E+07	9.2030E+03
72.0 - 77.0	1.0240E+08	2.6790E-06	168	1.7950E-06	1.4430E+01	1.8990E-06	30	1.9190E-12	2.7250E-05	2.7898E+03	4.2080E+06	4.0210E+03
77.0 - 82.0	9.9390E+07	2.6790E-06	168	1.7950E-06	1.4430E+01	1.0820E-06	30	2.5040E-13	1.5600E-05	1.5588E+03	5.2640E+05	1.4220E+03
82.0 - 87.0	8.8050E+07	2.6790E-06	168	1.7950E-06	1.4430E+01	1.1010E-06	30	3.7120E-13	1.5880E-05	1.3982E+03	6.0410E+05	1.5230E+03
87.0 - 92.0	7.7790E+07	2.6790E-06	168	1.7950E-06	1.4430E+01	4.7550E-07	24	1.7800E-13	6.8590E-06	5.3360E+02	2.2490E+05	9.2950E+02
92.0 - 97.0	5.4050E+07	2.6790E-06	168	1.7950E-06	1.4430E+01	1.1910E-06	20	6.0570E-13	1.7180E-05	9.2854E+02	3.7050E+05	1.1930E+03
TOTAL	2.4262E+09									3.3411E+06	+ OR -	4.7360E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .3346E+08

Appendix A.28. Hydroacoustic estimate of fish inhabiting Area 2 , Skilak Lake, Alaska in 1987 based on Transect 5 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	1.6530E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	7.3660E-06	30	5.4260E-11	2.0550E-05	3.3968E+03	1.1920E+07	6.7670E+03
7.0 - 12.0	1.5930E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	8.5230E-04	30	4.3830E-07	2.8720E-03	4.5735E+05	1.2680E+11	6.9790E+05
12.0 - 17.0	1.5010E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	2.3580E-04	29	5.1970E-09	9.8090E-04	1.4724E+05	2.0860E+09	8.9510E+04
17.0 - 22.0	1.4880E+08	7.2460E-06	1298	6.2440E-06	5.3330E+00	3.8240E-04	27	1.6000E-08	2.0390E-03	3.0345E+05	1.0130E+10	1.9730E+05
22.0 - 27.0	1.4780E+08	5.6590E-06	296	4.3810E-06	6.8290E+00	6.2840E-04	27	1.0330E-08	4.2920E-03	6.3430E+05	1.1340E+10	2.0870E+05
27.0 - 32.0	1.4670E+08	5.1740E-06	448	3.7960E-06	7.4690E+00	6.0920E-04	27	1.0880E-08	4.5500E-03	6.6761E+05	1.3610E+10	2.2860E+05
32.0 - 37.0	1.4520E+08	4.2570E-06	456	3.4250E-06	9.0780E+00	4.5340E-04	27	1.6260E-08	4.1160E-03	5.9748E+05	2.8750E+10	3.3230E+05
37.0 - 42.0	1.4280E+08	3.7170E-06	373	2.7410E-06	1.0400E+01	3.1200E-04	27	1.0500E-08	3.2440E-03	4.6315E+05	2.3460E+10	3.0020E+05
42.0 - 47.0	1.4140E+08	3.2660E-06	192	2.5180E-06	1.1830E+01	7.2060E-05	27	1.9410E-10	8.5270E-04	1.2053E+05	5.8800E+08	4.7530E+04
47.0 - 52.0	1.3900E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	3.3920E-05	27	3.5910E-11	3.2610E-04	4.5327E+04	6.9210E+07	1.6310E+04
52.0 - 57.0	1.3650E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	2.3790E-05	26	2.2920E-11	2.2870E-04	3.1226E+04	4.1920E+07	1.2690E+04
57.0 - 62.0	1.3570E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	3.1550E-05	25	8.6740E-11	3.0330E-04	4.1167E+04	1.5180E+08	2.4150E+04
62.0 - 67.0	1.3480E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	2.1110E-05	25	2.6640E-11	2.0300E-04	2.7364E+04	4.6600E+07	1.3380E+04
67.0 - 72.0	1.3330E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	9.9800E-06	25	8.7040E-12	9.5940E-05	1.2792E+04	1.4710E+07	7.5160E+03
72.0 - 77.0	1.2870E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	5.4060E-06	24	2.6640E-12	5.1970E-05	6.6893E+03	4.1900E+06	4.0120E+03
77.0 - 82.0	1.2610E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	5.7420E-06	24	2.2810E-12	5.5200E-05	6.9614E+03	3.4730E+06	3.6530E+03
82.0 - 87.0	1.2270E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	3.2120E-06	24	4.3850E-12	3.0880E-05	3.7881E+03	6.1350E+06	4.8550E+03
87.0 - 92.0	1.1880E+08	4.0200E-06	293	3.4270E-06	9.6140E+00	6.0090E-07	24	1.7760E-13	5.7770E-06	6.8630E+02	2.3290E+05	9.4590E+02
92.0 - 97.0	9.5240E+07	4.0200E-06	293	3.4270E-06	9.6140E+00	8.7260E-07	24	3.8510E-13	8.3890E-06	7.9893E+02	3.2450E+05	1.1160E+03
TOTAL	2.6182E+09									3.5713E+06	+ OR -	9.1320E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .3346E+08

Appendix A.29. Hydroacoustic estimate of fish inhabiting Area 2 , Skilak Lake, Alaska in 1987 based on Transect 6 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	1.6700E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	0.0000E+00	24	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	1.6690E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	5.6170E-06	24	3.1550E-11	1.8920E-05	3.1588E+03	1.0010E+07	6.2000E+03
12.0 - 17.0	1.6680E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	1.4720E-04	24	5.2890E-09	6.1250E-04	1.0218E+05	2.5750E+09	9.9460E+04
17.0 - 22.0	1.6670E+08	7.2460E-06	1298	6.2440E-06	5.3330E+00	3.2070E-04	24	1.2520E-08	1.7100E-03	2.8515E+05	9.9440E+09	1.9540E+05
22.0 - 27.0	1.6670E+08	6.1660E-06	212	4.4450E-06	6.2680E+00	6.9380E-04	24	5.8120E-08	4.3480E-03	7.2470E+05	6.4710E+10	4.9860E+05
27.0 - 32.0	1.6220E+08	5.0680E-06	350	3.6910E-06	7.6260E+00	8.6190E-04	24	5.1290E-08	6.5720E-03	1.0660E+06	8.0190E+10	5.5500E+05
32.0 - 37.0	1.6600E+08	4.9710E-06	422	5.0030E-06	7.7740E+00	5.8950E-04	24	2.5940E-08	4.5830E-03	7.6086E+05	4.4600E+10	4.1390E+05
37.0 - 42.0	1.6170E+08	3.8680E-06	276	2.7790E-06	9.9910E+00	2.1290E-04	24	2.9830E-09	2.1270E-03	3.4396E+05	8.0070E+09	1.7540E+05
42.0 - 47.0	1.6010E+08	3.4340E-06	212	2.2160E-06	1.1250E+01	1.4360E-04	24	1.6440E-09	1.6160E-03	2.5882E+05	5.4710E+09	1.4500E+05
47.0 - 52.0	1.5460E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	5.1700E-05	24	1.3890E-10	5.2990E-04	8.1924E+04	3.6440E+08	3.7410E+04
52.0 - 57.0	1.5290E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	2.0510E-05	23	2.8110E-11	2.1030E-04	3.2138E+04	7.1430E+07	1.6560E+04
57.0 - 62.0	1.5090E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	1.9150E-05	22	3.5610E-11	1.9630E-04	2.9618E+04	8.7220E+07	1.8300E+04
62.0 - 67.0	1.5040E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	9.8080E-06	22	8.9790E-12	1.0050E-04	1.5124E+04	2.1890E+07	9.1690E+03
67.0 - 72.0	1.4950E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	1.9480E-05	22	3.5040E-11	1.9970E-04	2.9861E+04	8.4370E+07	1.8000E+04
72.0 - 77.0	1.4800E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	1.0680E-05	22	1.0010E-11	1.0950E-04	1.6202E+04	2.3660E+07	9.5330E+03
77.0 - 82.0	1.4740E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	4.0250E-06	22	1.8720E-12	4.1260E-05	6.0811E+03	4.3590E+06	4.0920E+03
82.0 - 87.0	1.4660E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	3.6110E-06	22	1.8880E-12	3.7020E-05	5.4269E+03	4.3330E+06	4.0800E+03
87.0 - 92.0	1.4300E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	8.3310E-07	22	1.4840E-13	8.5400E-06	1.2212E+03	3.2230E+05	1.1130E+03
92.0 - 97.0	1.4120E+08	3.7700E-06	306	3.1830E-06	1.0250E+01	9.6090E-08	22	3.9970E-15	9.8510E-07	1.3914E+02	8.4250E+03	1.7990E+02
TOTAL	2.9686E+09									3.7626E+06	+ OR -	9.1130E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .3346E+08

Appendix A.30. Hydroacoustic estimate of fish inhabiting Area 3 , Skilak Lake, Alaska in 1987 based on Transect 7 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	1.1240E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	8.5110E-05	17	4.0780E-09	2.3750E-04	2.6703E+04	4.2490E+08	4.0400E+04
7.0 - 12.0	1.1240E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	4.4230E-05	17	7.4080E-10	1.4900E-04	1.6747E+04	1.0690E+08	2.0270E+04
12.0 - 17.0	1.1230E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	9.9880E-05	17	9.0680E-10	4.1550E-04	4.6659E+04	2.0390E+08	2.7990E+04
17.0 - 22.0	1.1140E+08	7.2460E-06	1298	6.2440E-06	5.3330E+00	6.0470E-04	17	1.5420E-08	3.2250E-03	3.5911E+05	5.5140E+09	1.4550E+05
22.0 - 27.0	1.1030E+08	5.9690E-06	2239	4.7920E-06	6.4750E+00	5.1650E-04	16	3.8230E-08	3.3440E-03	3.6881E+05	1.9530E+10	2.7390E+05
27.0 - 32.0	1.0950E+08	4.6890E-06	172	3.4420E-06	8.2420E+00	6.3110E-04	16	1.6790E-07	5.2010E-03	5.6958E+05	1.3780E+11	7.2760E+05
32.0 - 37.0	1.0910E+08	4.1430E-06	244	2.6840E-06	9.3280E+00	2.6920E-04	16	1.2800E-08	2.5120E-03	2.7391E+05	1.3380E+10	2.2670E+05
37.0 - 42.0	1.0840E+08	4.0640E-06	2275	3.3130E-06	9.5090E+00	1.3100E-04	16	2.3540E-09	1.2460E-03	1.3511E+05	2.5080E+09	9.8170E+04
42.0 - 47.0	1.0760E+08	3.6650E-06	1094	2.7890E-06	1.0540E+01	3.4790E-05	16	6.6030E-11	3.6680E-04	3.9477E+04	8.5870E+07	1.8160E+04
47.0 - 52.0	1.0720E+08	5.3270E-06	192	4.5870E-06	7.2550E+00	1.3740E-05	16	1.3130E-11	9.9690E-05	1.0686E+04	8.3790E+06	5.6730E+03
52.0 - 57.0	1.0680E+08	5.3270E-06	192	4.5870E-06	7.2550E+00	1.4600E-05	16	4.8160E-11	1.0600E-04	1.1315E+04	2.9400E+07	1.0630E+04
57.0 - 62.0	1.0640E+08	5.3270E-06	192	4.5870E-06	7.2550E+00	8.8510E-06	16	1.1370E-11	6.4210E-05	6.8346E+03	6.9580E+06	5.1700E+03
62.0 - 67.0	1.0580E+08	5.3270E-06	192	4.5870E-06	7.2550E+00	1.3420E-05	16	3.1630E-11	9.7380E-05	1.0303E+04	1.9050E+07	8.5540E+03
67.0 - 72.0	1.0310E+08	5.3270E-06	192	4.5870E-06	7.2550E+00	1.3220E-05	16	1.8260E-11	9.5910E-05	9.8927E+03	1.0600E+07	6.3830E+03
72.0 - 77.0	9.8320E+07	5.3270E-06	192	4.5870E-06	7.2550E+00	1.1070E-05	16	2.0950E-11	8.0340E-05	7.8999E+03	1.0900E+07	6.4710E+03
77.0 - 82.0	9.1570E+07	5.3270E-06	192	4.5870E-06	7.2550E+00	3.3840E-06	15	5.7070E-12	2.4550E-05	2.2482E+03	2.5380E+06	3.1230E+03
82.0 - 87.0	8.8790E+07	5.3270E-06	192	4.5870E-06	7.2550E+00	2.5910E-06	14	8.9190E-13	1.8800E-05	1.6689E+03	3.8090E+05	1.2100E+03
87.0 - 92.0	8.7010E+07	5.3270E-06	192	4.5870E-06	7.2550E+00	3.0000E-07	14	8.9970E-14	2.1760E-06	1.8935E+02	3.5990E+04	3.7180E+02
92.0 - 97.0	4.7740E+06	5.3270E-06	192	4.5870E-06	7.2550E+00	0.0000E+00	14	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
TOTAL	1.8932E+09									1.8971E+06	+ OR -	8.3070E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .225E+08

Appendix A.31. Hydroacoustic estimate of fish inhabiting Area 3 , Skilak Lake, Alaska in 1987 based on Transect 8 integrator output.[1]

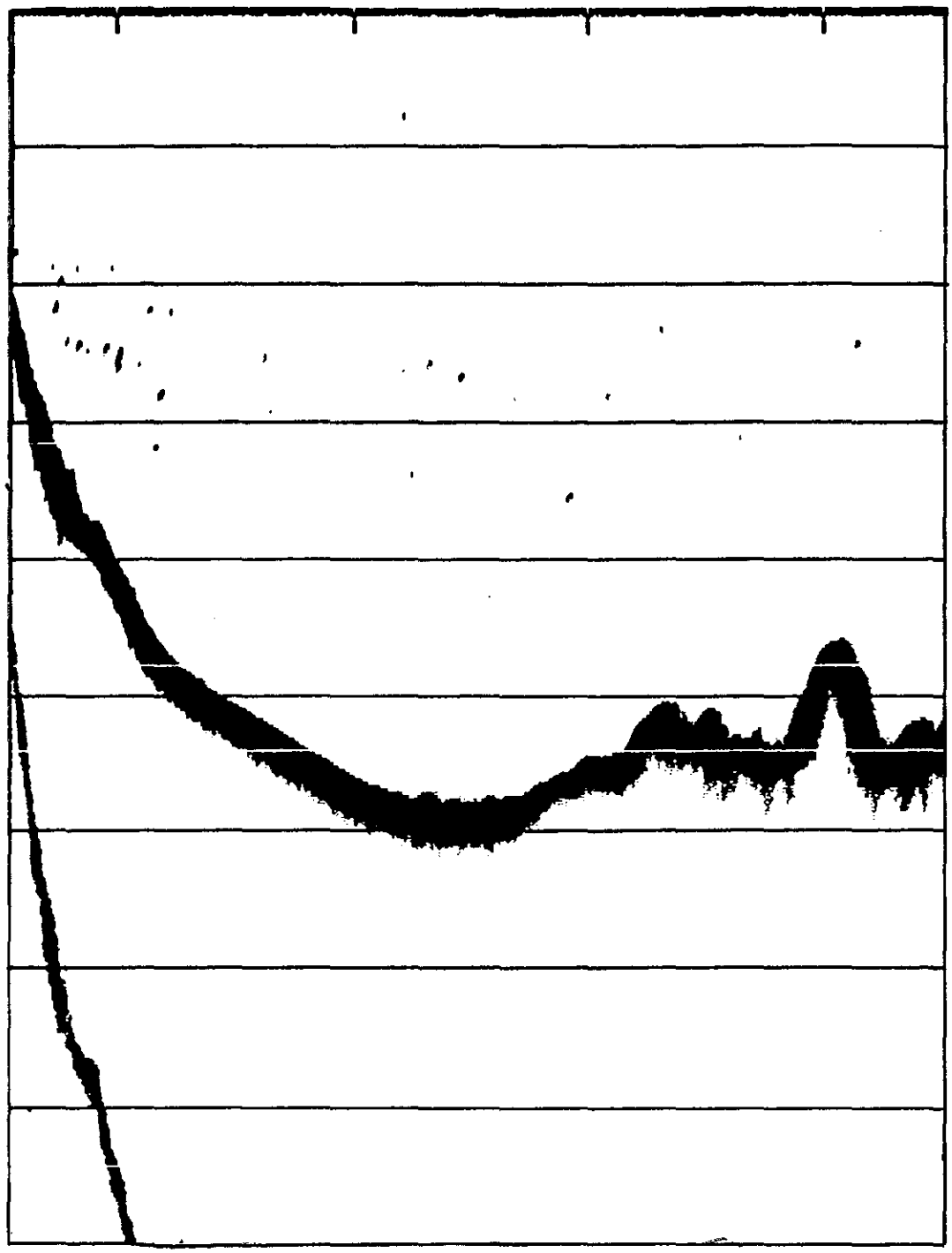
Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	1.1100E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	5.8150E-05	16	3.0930E-09	1.6230E-04	1.8006E+04	3.0730E+08	3.4360E+04
7.0 - 12.0	1.1060E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	8.0210E-05	16	4.3240E-09	2.7030E-04	2.9884E+04	6.0260E+08	4.8110E+04
12.0 - 17.0	1.1020E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	1.8190E-04	16	4.4300E-09	7.5670E-04	8.3372E+04	9.4950E+08	6.0400E+04
17.0 - 22.0	1.0840E+08	7.2460E-06	1298	6.2440E-06	5.3330E+00	3.1130E-04	16	4.8750E-09	1.6600E-03	1.8002E+05	1.6490E+09	7.9590E+04
22.0 - 27.0	1.0590E+08	5.9690E-06	2239	4.7920E-06	6.4750E+00	2.4700E-04	15	1.8230E-09	1.5990E-03	1.6932E+05	8.6480E+08	5.7640E+04
27.0 - 32.0	1.0560E+08	4.4260E-06	178	3.1590E-06	8.7320E+00	2.5030E-04	15	5.0250E-09	2.1860E-03	2.3087E+05	4.4270E+09	1.3040E+05
32.0 - 37.0	1.0550E+08	4.4100E-06	3486	3.4910E-06	8.7630E+00	1.4340E-04	15	1.2710E-09	1.2570E-03	1.3265E+05	1.0910E+09	6.4730E+04
37.0 - 42.0	1.0480E+08	4.0640E-06	2275	3.3130E-06	9.5090E+00	5.7440E-05	15	2.9220E-10	5.4620E-04	5.7234E+04	2.9110E+08	3.3440E+04
42.0 - 47.0	9.5370E+07	3.6650E-06	1094	2.7890E-06	1.0540E+01	3.5290E-05	15	8.3570E-11	3.7210E-04	3.5488E+04	8.5180E+07	1.8090E+04
47.0 - 52.0	9.1180E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	3.1870E-05	14	8.3910E-11	2.7540E-04	2.5115E+04	5.3440E+07	1.4330E+04
52.0 - 57.0	9.0770E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	6.1630E-05	13	9.4770E-10	5.3270E-04	4.8352E+04	5.8830E+08	4.7540E+04
57.0 - 62.0	9.0660E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	2.8900E-05	13	2.1080E-10	2.4980E-04	2.2648E+04	1.3050E+08	2.2390E+04
62.0 - 67.0	9.0350E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	2.1380E-05	13	6.8530E-11	1.8480E-04	1.6697E+04	4.2370E+07	1.2760E+04
67.0 - 72.0	8.8350E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	1.7740E-05	13	4.2380E-11	1.5330E-04	1.3548E+04	2.5100E+07	9.8190E+03
72.0 - 77.0	8.8090E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	9.2550E-06	13	1.2600E-11	8.0000E-05	7.0465E+03	7.4080E+06	5.3350E+03
77.0 - 82.0	8.4590E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	1.0520E-05	13	2.0630E-11	9.0960E-05	7.6939E+03	1.1150E+07	6.5450E+03
82.0 - 87.0	4.9240E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	4.2110E-07	12	5.3750E-14	3.6400E-06	1.7922E+02	9.8030E+03	1.9410E+02
87.0 - 92.0	3.3240E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	0.0000E+00	5	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
92.0 - 97.0	3.2860E+07	4.4710E-06	322	3.6600E-06	8.6440E+00	1.1840E-07	5	1.4010E-14	1.0230E-06	3.3616E+01	1.1320E+03	6.5960E+01
TOTAL	1.6967E+09									1.0782E+06	+ OR -	2.0670E+05

[1] Lake surface area (meters squared) used to calculate stratum volume was .225E+08

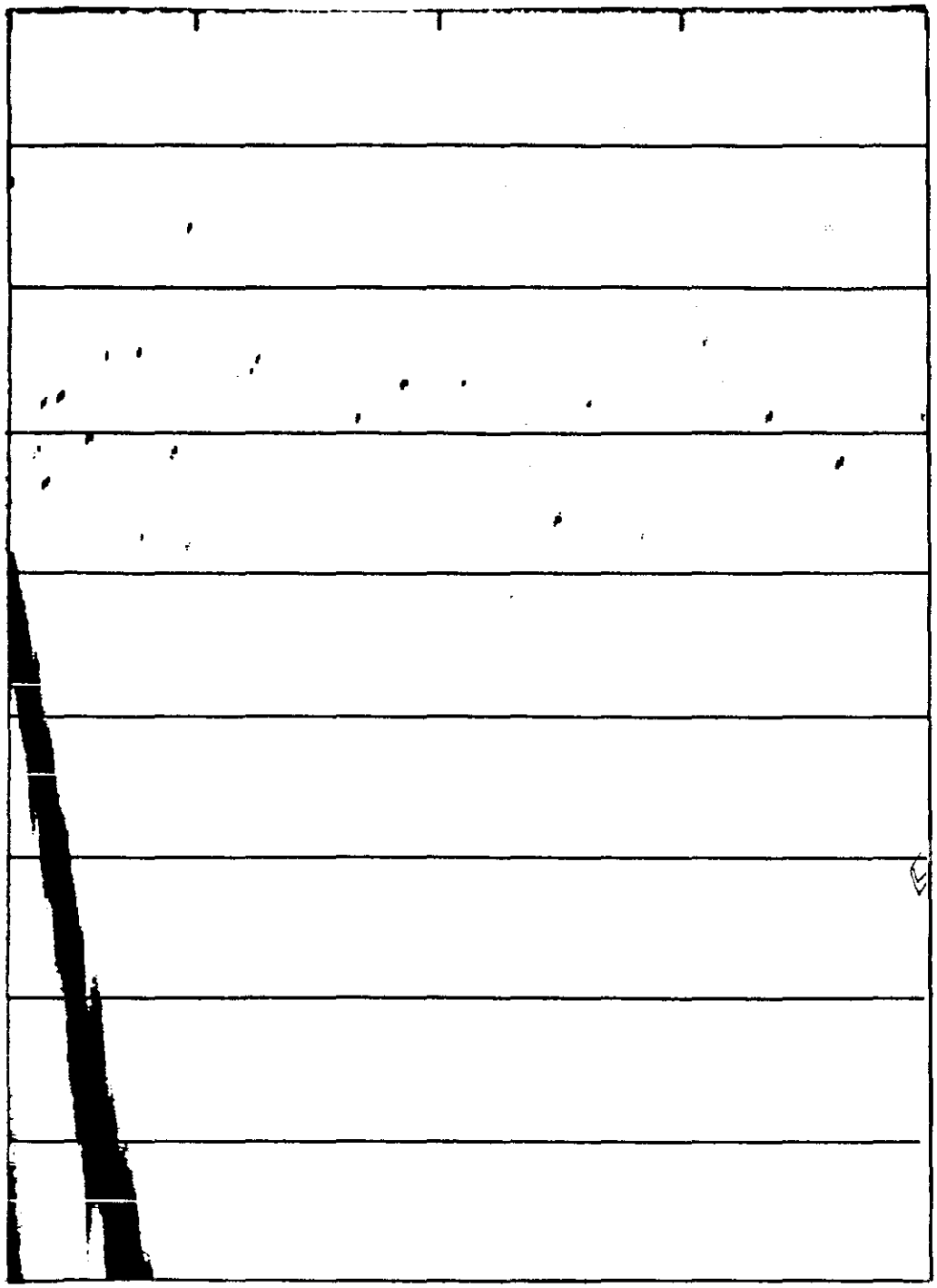
Appendix A.32. Hydroacoustic estimate of fish inhabiting Area 3 , Skilak Lake, Alaska in 1987 based on Transect 9 integrator output.[1]

Depth Stratum (m)	Stratum Volume (m^3)	Mean Sigma	Number Echoes Used	Standard Deviation Sigma	A Constant	Integrator Output	Number of Sequences	Mean Integrator Variance	Fish Density (no./m^3)	Estimated Number of Fish	Variance	Confidence Limits (95%)
2.0 - 7.0	1.1180E+08	1.3850E-05	21	1.1520E-05	2.7900E+00	0.0000E+00	15	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7.0 - 12.0	1.1180E+08	1.1470E-05	228	9.0380E-06	3.3690E+00	9.8130E-05	15	3.6440E-09	3.3060E-04	3.6948E+04	5.2030E+08	4.4710E+04
12.0 - 17.0	1.1170E+08	9.2910E-06	584	1.1790E-05	4.1600E+00	1.6280E-04	15	3.7740E-09	6.7710E-04	7.5655E+04	8.3100E+08	5.6500E+04
17.0 - 22.0	1.1170E+08	7.2460E-06	1298	6.2440E-06	5.3330E+00	4.3770E-04	15	5.8260E-09	2.3340E-03	2.6067E+05	2.1050E+09	8.9930E+04
22.0 - 27.0	1.1160E+08	5.9690E-06	2239	4.7920E-06	6.4750E+00	3.6230E-04	15	4.7300E-09	2.3460E-03	2.6175E+05	2.4890E+09	9.7780E+04
27.0 - 32.0	1.1150E+08	5.2750E-06	3398	4.1210E-06	7.3260E+00	1.9790E-04	15	2.1010E-09	1.4500E-03	1.6171E+05	1.4070E+09	7.3510E+04
32.0 - 37.0	1.1150E+08	4.4100E-06	3486	3.4910E-06	8.7630E+00	1.4370E-04	15	2.1430E-09	1.2590E-03	1.4040E+05	2.0490E+09	8.8720E+04
37.0 - 42.0	1.0910E+08	4.0640E-06	2275	3.3130E-06	9.5090E+00	1.0800E-04	15	7.0080E-10	1.0270E-03	1.1210E+05	7.5810E+08	5.3970E+04
42.0 - 47.0	1.0850E+08	3.6650E-06	1094	2.7890E-06	1.0540E+01	6.4730E-05	15	3.5120E-10	6.8260E-04	7.4085E+04	4.6290E+08	4.2170E+04
47.0 - 52.0	1.0840E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	2.4920E-05	15	7.5310E-11	2.4330E-04	2.6369E+04	8.6600E+07	1.8240E+04
52.0 - 57.0	1.0820E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	1.9450E-05	15	3.3190E-11	1.8990E-04	2.0541E+04	3.8420E+07	1.2150E+04
57.0 - 62.0	1.0820E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	3.5990E-06	15	4.4610E-12	3.5140E-05	3.8001E+03	5.0220E+06	4.3920E+03
62.0 - 67.0	1.0810E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	7.2950E-06	15	1.7510E-11	7.1230E-05	7.7008E+03	1.9710E+07	8.7020E+03
67.0 - 72.0	1.0800E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	1.9420E-05	15	5.5940E-11	1.8960E-04	2.0476E+04	6.3560E+07	1.5630E+04
72.0 - 77.0	1.0790E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	7.1830E-06	15	5.8630E-12	7.0140E-05	7.5694E+03	6.6980E+06	5.0730E+03
77.0 - 82.0	1.0790E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	4.0070E-06	15	2.2770E-12	3.9120E-05	4.2216E+03	2.5860E+06	3.1520E+03
82.0 - 87.0	1.0790E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	3.0740E-06	15	2.5530E-12	3.0020E-05	3.2382E+03	2.8670E+06	3.3190E+03
87.0 - 92.0	1.0770E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	8.9400E-07	15	3.8250E-13	8.7290E-06	9.4042E+02	4.2620E+05	1.2800E+03
92.0 - 97.0	1.0770E+08	3.9580E-06	178	3.0300E-06	9.7640E+00	5.5130E-08	15	3.0390E-15	5.3830E-07	5.7975E+01	3.3720E+03	1.1380E+02
TOTAL	2.0792E+09									1.2182E+06	+ OR -	2.0410E+05

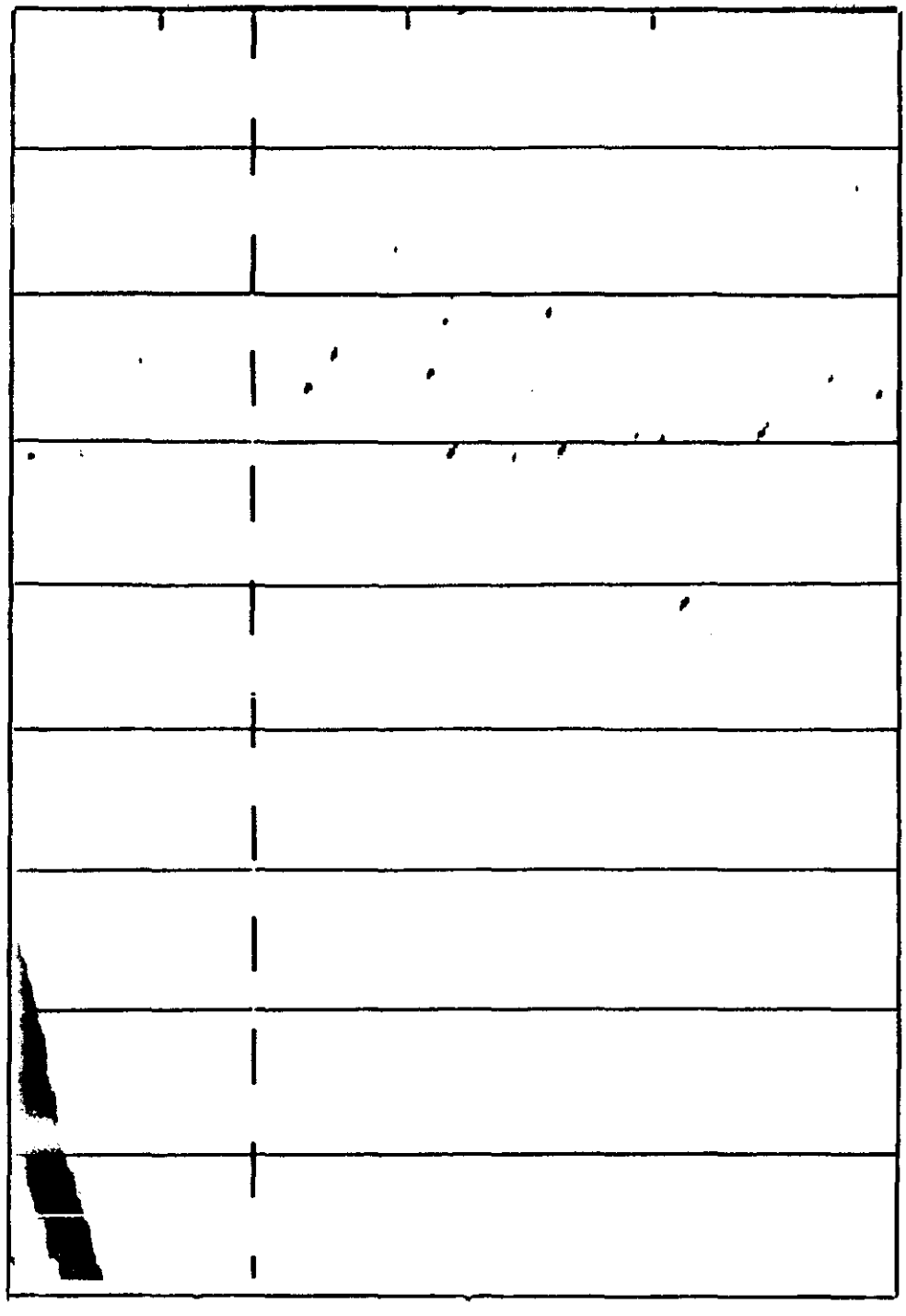
[1] Lake surface area (meters squared) used to calculate stratum volume was .225E+08



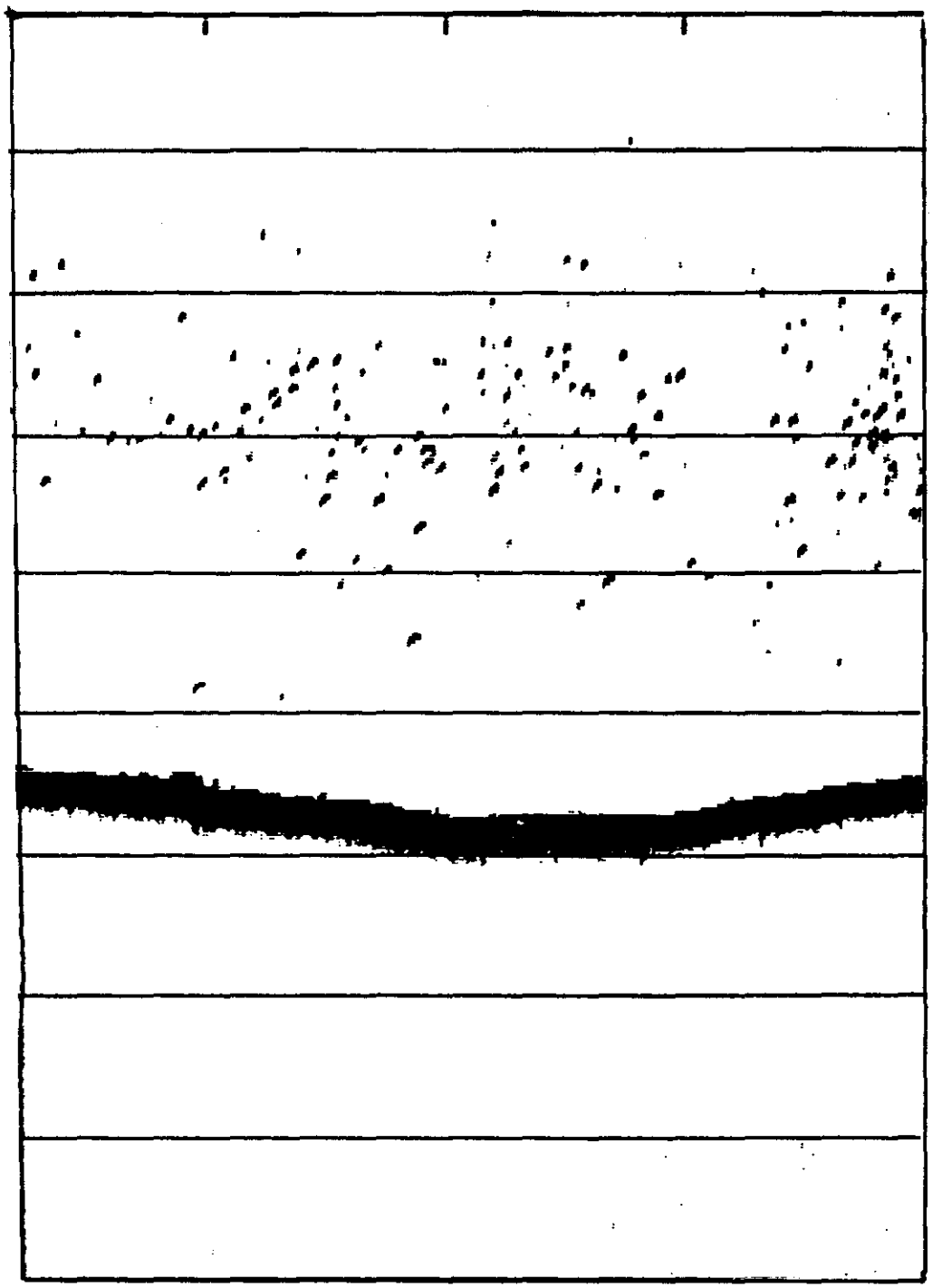
Appendix B.1. Representative echogram of Kenai Lake transect 1.3 taken in October of 1987.



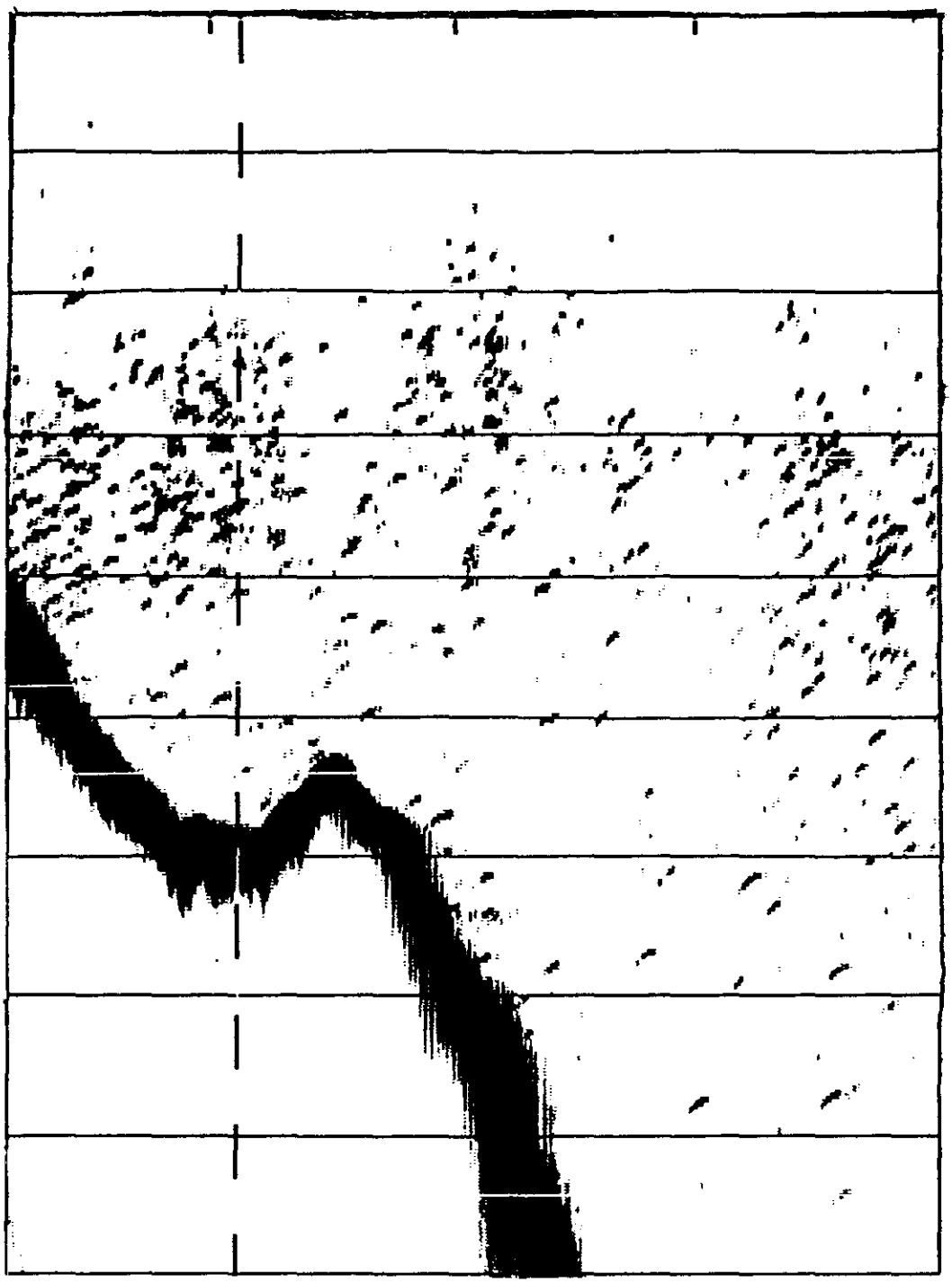
Appendix B.2. Representative echogram of Kenai Lake transect 4.4 taken in October of 1987.



Appendix B.3. Representative echogram of Kenai Lake transect 5.1 taken in October of 1987.



Appendix B.4. Representative echogram of Skilak Lake transect 1 taken in October of 1987.



Appendix B.5. Representative echogram of Skilak Lake transect 6 taken in October of 1987.