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ACOUSTIC STOCK ESTIMATION IN LAKE NUNAVAUGALUK IN THE
NUSHAGAK DISTRICT OF BRISTOL BAY, ALASKA

by

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INFORMATIONAL REPORT

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INTRODUCTION

In response to the present public demand for positive action in rebuilding the Bristol Bay sockeye salmon runs the Alaska Department of Fish and Game is currently constructing a gravel incubation system in the Snake River watershed in the Nushagak District. The principal purpose of this enhancement program is to test the technique and to evaluate its efficiency for possible use in other districts in Bristol Bay.

The output of fry from the gravel incubation system can easily be measured. But the subsequent survival to the smolt stage is a function of the physical aspects of the system, the rearing potential of the nursery area, Lake Nunavaugaluk, and the populations of predators and food competitors present there.

In an effort to estimate the latter ones an acoustic estimate was made of the population of fishes in the limnetic zone in the late summer of 1973. Because of very small adult sockeye returns in recent years, the pelagic fish targets can be assumed to represent resident fishes without introducing any substantial errors.

METHODS AND MATERIALS

The field work was completed during the nights of September 10 and 13, 1973, from an open 16-ft outboard powered boat. Inclement weather prevented finishing the survey in one night. A series of eight transects spaced approximately 2 miles apart were run orthogonal to the long axis of the lake (Fig. 1). Transects 1 and 2 were completed during the first night of sounding, and the remainder during the second night. The transect speed was determined by a Gurley current meter.

A technical description and operational procedure of the acoustic data collection system used during the survey are given in Thorne, Nunnallee, and Green (1972) and Nunnallee (1973). Briefly, the system consists of a modified 105 kHz Ross 200A echosounder, an interface amplifier, and a Sony 560D stereo tape recorder (Fig. 2). The interface amplifier enables acoustic data to be recorded on magnetic tape. The transducer, which produces about an 8 degree circular beam to the 3dB points, is mounted on a towing vehicle, and during the survey was suspended alongside the boat about one meter below the surface. A Hewlett-Packard 1205A oscilloscope was used to monitor the system during operation. Power for the data collection system was supplied by a storage battery through a direct current to a frequency controlled alternating current inverter manufactured by the Terado Company.

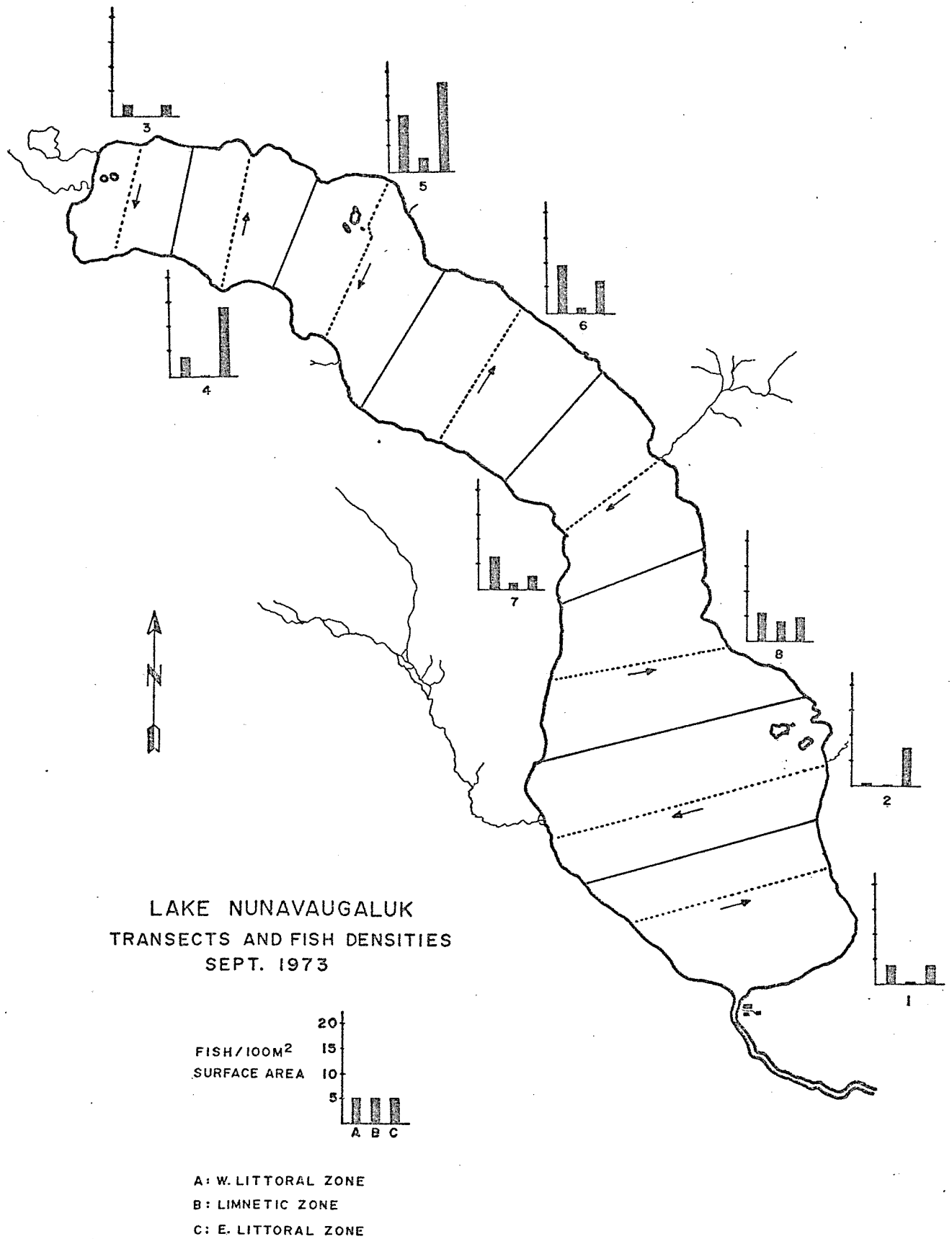


Fig. 1. Location of transects and density/unit area for littoral and limnetic zones during the September 1973 acoustic survey of Lake Nunavaugluk. Echosounding transects indicated by dashed lines.

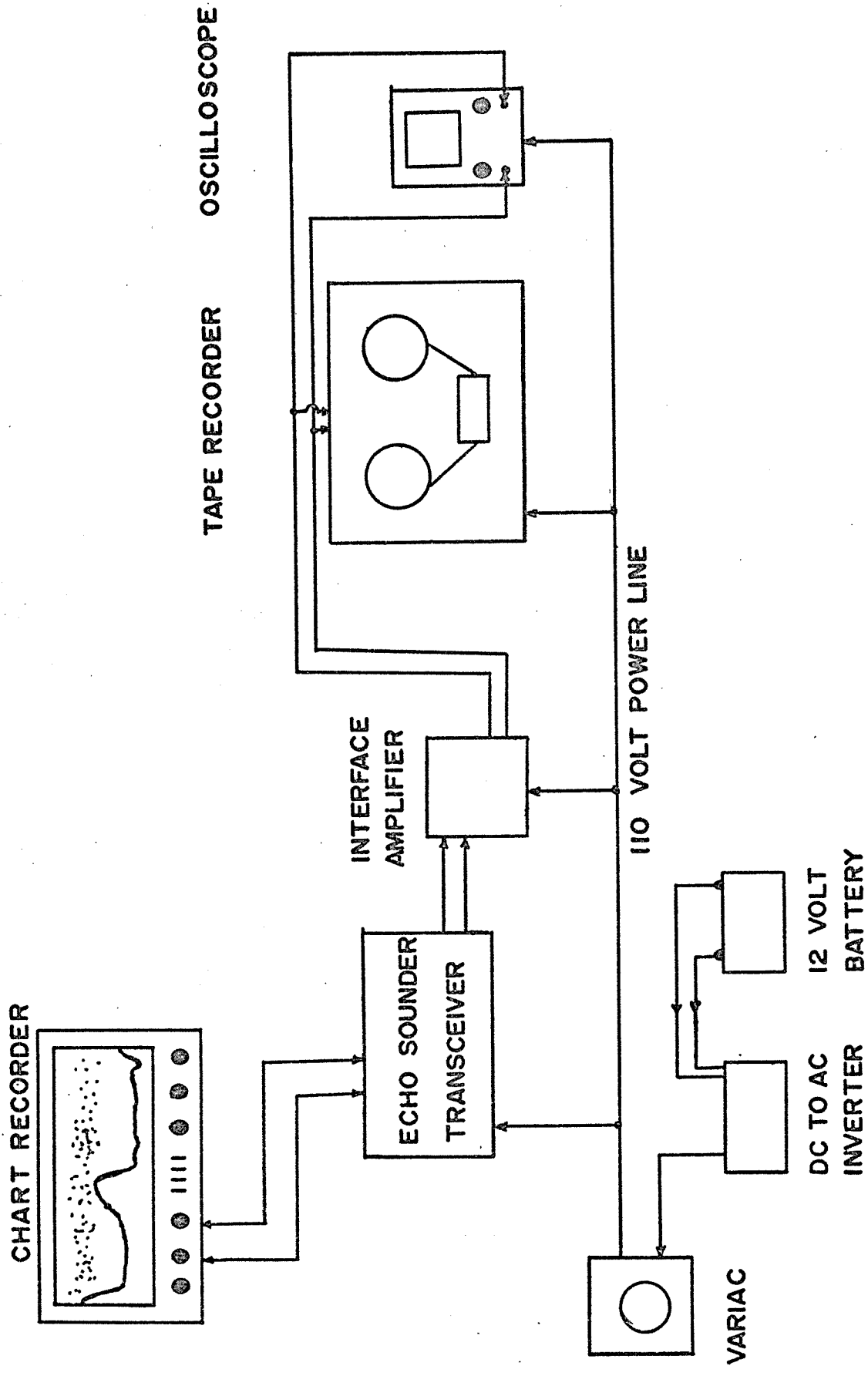


Fig. 2. The acoustic data collection system (from Dawson, 1972).

DATA ANALYSIS

The analysis techniques applied to the acoustic data collected from Nunavaugaluk Lake included sample volume estimation, fish target counting and target strength analysis.

Effective Sample Volume Determination

Acoustic fish abundance is usually expressed as the number of fish per unit volume. To convert the number of fish detected per echosounder pulse to a density expression it is necessary to determine the sample volume per pulse. The method utilized has been described by Thorne (1972) and Nunnallee (1973). Briefly, it involves calculating the radius of the sounder cone at depths which correspond to the upper and lower limits of the depth intervals being analyzed. The radii can be directly determined by calculating the number of pulses that fish targets, within the depth planes of interest, remain within the sounder cone as the transducer passes over the fish at a known speed. The effective sample volume per pulse can then be determined by assuming each depth stratum represents a frustum of a right circular cone, the volume of which easily can be calculated. The pulse volumes for the Nunavaugaluk survey were calculated from transect number five and are given in Table 1.

Target Counts

Fish target counting is done by observing specific depth intervals on an oscilloscope while the tape recording of a transect is played back. A thorough description of the procedure is given by Croker (1972) and Nunnallee (1973). Initial processing of the data indicated the majority of the fish targets were above 45 m. Six depth intervals of 7.3 m each extending from 3.7 to 47.5 m were established for target counting. System noise and pulse length eliminated counts above 3.7 m. In considering horizontal as well as vertical distribution, the target counts for all depth intervals along each transect were made in 2 min segments. Care was taken to insure proper vertical alignment of corresponding 2 min time-depth cells within each transect. All counting commenced and ended at about the 5 m depth contour.

Estimation of Fish Population

After the target detection counts were completed, estimates of fish density/unit volume for the time-depth cells along each transect were computed and later converted to numbers of fish/unit of lake surface area. The methods used are described elsewhere (Nunnallee, 1973). Population estimates can be made by expanding values of density/unit area over larger surface areas.

Table 1. Estimated effective beam dimensions and volume per pulse for depths indicated

Depth (m)	Radius of cone (m)	Depth interval (m)	Volume/pulse (m ³)
3.7	.34	3.7 - 11.0	9.7
11.0	.91	11.0 - 18.3	31.5
18.3	1.41	18.3 - 25.6	65.9
25.6	1.96	25.6 - 32.9	127.7
32.9	2.73	32.9 - 40.2	215.9
40.2	3.39	40.2 - 47.5	288.6
47.5	3.70		

Rather than calculating a mean density value for the entire lake and expanding it over the total surface area to obtain a fish population estimate, Nunavaugaluk Lake was divided into sections corresponding to the transects (Fig. 1). The 5 m depth contour along the shoreline and boundaries placed approximately midway between adjoining transects defined the area of each section.

Because of a very noticeable density gradient from shallow to deep water, the sections were further subdivided into littoral and limnetic zones. The littoral zone was defined as the surface area associated with the water mass between the 5 and 40 m depth contours, and the limnetic zone as the surface area of the water mass deeper than 40 m. A planimeter was used to calculate the surface area of the zones within each section of the lake, referenced to a total lake surface area of 86 km² (Gadau, 1966).

The first and last time interval of each transect was considered part of the limnetic zone as well as those 2 min segments where bottom interference was encountered in the fifth depth interval (33-40 m) for 90 sec or more. The limnetic and littoral zone categorization of time intervals along each transect is given in Table 2. Sections 2 and 4-8 contained both a western and an eastern littoral zone and section 3 had no limnetic zone.

Target Strength Analysis

Target voltage measurements were made on approximately 300 randomly selected fish targets within transect number five. The techniques used have been described by Nunnallee, Lemberg, and Mathisen (1973). The target strength data were used to examine the relative fish frequency distribution (Craig and Forbes, 1969).

RESULTS AND DISCUSSION

The mean density values calculated for each group of time intervals within a zone are given in Table 2. The zones are shown graphically on a map of the area (Fig. 1). Population estimates were made by multiplying the product of the surface area and the mean density (Table 2) and produced a total population estimate of 2.45 million fish.

The size distribution derived from the target strength analysis shows a large group of targets (-72 to -58 dB) comparable to the size of age 0 and age 1 stickleback (*Gasterosteus* spp.) (Fig. 3). However, the equations used to convert target strength to fish length have been calculated for larger fish and are not strictly applicable to smaller species. Consequently the size distribution should be considered in relative terms.

Table 2. Mean fish densities, population estimates and pertinent littoral and limnetic zone data for Lake Nunavaugaluk

Transect or section	Zone	Time int. w/in zone	Tot. surface area (km ²)	Mean density/100 m ²	Population estimate(x 10 ³)
1	Littoral ¹	1A-1C,1F,1N	5.919	3.81	225.5
	Limnetic	1D,1E,1G-1M	4.287	.33	14.1
2	W.Littoral	2L-2O,2Q,2R	3.537	.67	23.7
	Limnetic	2F-2K,2P	7.260	.35	25.4
	E.Littoral	2A-2E	2.664	7.45	198.5
3	Littoral ²	3A-3H	2.911	2.17	63.2
4	W.Littoral	4A,4B	.794	3.75	29.8
	Limnetic	4C-4F	3.617	.26	9.4
	E.Littoral	4G-4I	1.570	14.15	222.2
5	W.Littoral	5K,5L,5N	1.209	10.96	132.5
	Limnetic	5F-5J,5M	5.425	2.24	121.5
	E.Littoral	5A-5E	2.241	17.80	398.8
6	W.Littoral	6A-6C	1.120	9.64	108.0
	Limnetic	6D-6K	8.892	3.90	80.0
	E.Littoral	6L	1.447	6.17	89.3
7	W.Littoral	7I	.670	6.85	45.9
	Limnetic	7B-7H	7.957	1.24	98.7
	E.Littoral	7A	1.367	2.45	33.5
8	W.Littoral	8A,8E	1.394	5.92	82.5
	Limnetic	8B-8D,8F-8K	9.457	4.09	386.8
	E.Littoral	8L	1.244	5.12	63.7

¹Littoral zone includes eastern and western sectors.

²Littoral zone includes eastern and western sectors, no limnetic zone because of shallow depth.

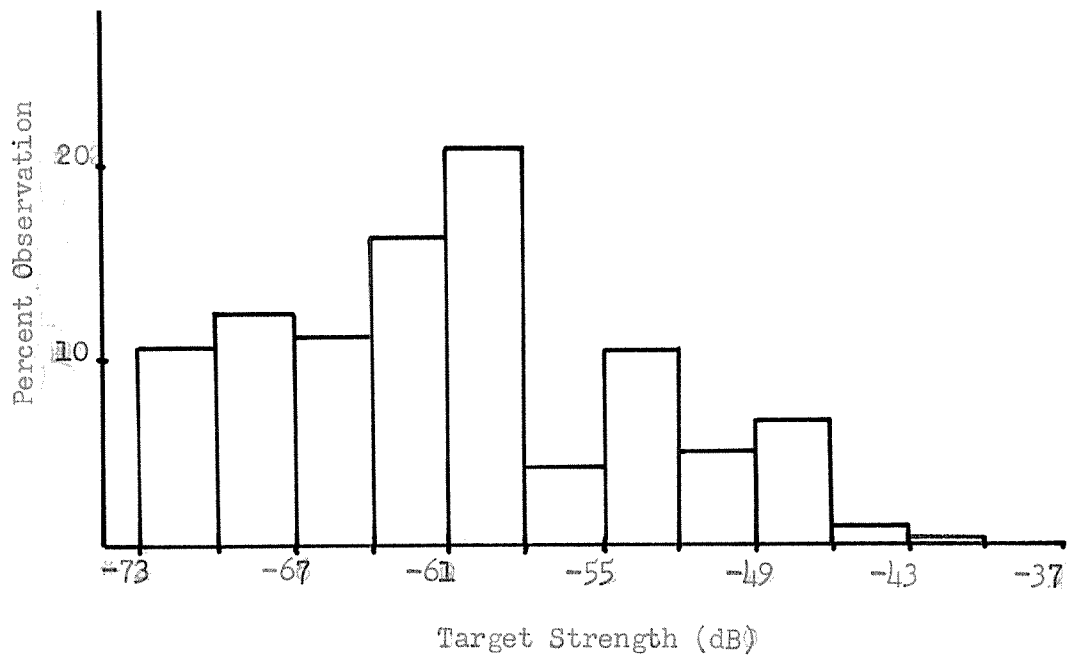


Figure 3. Target strength distribution observed during September, 1973, survey of Lake Nunavaugaluk.

The littoral zones comprised 37.5% of the total surveyed surface area and contributed 70% of the population estimate. It is apparent that fish concentrations were generally much greater along the shoreline and shelf areas, although considerable variation existed among sections. A similar variation was noted in the 1973 beach seine catches among stations on the lake.¹ Stickleback accounted for about 70% of the total catch. Although the acoustically designated littoral zones were considerably deeper than the beach seine sites, the survey was conducted relatively late in the season, after the offshore movement of juvenile sockeye salmon and stickleback usually takes place. It is probable that the high density of fish acoustically assessed in the upper depth strata of the littoral zone were primarily stickleback. The presence of large populations of stickleback in Lake Nunavaugaluk has been reported previously (Reeves, 1969).

The larger fish targets, although occurring relatively infrequently, were observed predominantly in the mid-lake region, transects 4-8. They were usually in proximity to the steeply sloping bottom areas between 10 and 30 m. Reeves (1969) has reported moderate catches of Arctic char (*Salvelinus alpinus*) with submerged horizontal gill nets in similar bottom contour and depth regions of Lake Nunavaugaluk. He found the char population index to rank intermediate in comparison to other lake systems in the district. If the larger fish targets observed were Arctic char, their distribution at the time of the acoustic surveys was largely confined to the inshore areas.

The acoustic survey generally showed low fish densities in the pelagic area of the lake. Acoustic surveys of other sockeye salmon nursery areas in Alaska, British Columbia, and Washington have rarely indicated such low numbers of fish, which must be considered in an evaluation of the efficiency of fry releases. Reeves (1969) ranks this lake lowest in salmon production in the Nushagak District, although the rearing capacity has never been assessed.

If a finer estimate is required, one needs to determine the magnitude of errors associated with hydroacoustic sampling such as the possibility of fish being inaccessible to detection. Relatively high fish densities were observed in the upper depth interval at the beginning and end of several mid-lake transects. It is conceivable that fish were located above the effective sampling range which must be tested by tow netting. Also, the weather conditions were somewhat marginal during transects 1 and 2. The surface noise from the waves and considerable pitch and roll movement of the towing vehicle definitely eliminated some fish targets. Error in the analysis procedure is generally related to the subjective process of counting target signals, and is directly proportional to fish density, which was relatively low throughout the survey.

¹Rogers, D. Alaska salmon studies: The study of red salmon in the Nushagak District. Univ. Washington, Fish. Res. Inst. Periodic Report No. 1 to Nat. Mar. Fish. Serv., January 25, 1974.

ACKNOWLEDGMENTS

The field work was accomplished through a cooperative effort among agencies. The acoustic survey was conducted by members of the Fisheries Research Institute. Necessary air transportation to and from the area was arranged by Dr. M. L. Dahlberg of the National Marine Fisheries Service. The Alaska Department of Fish and Game provided living facilities and supplies and was represented by Mr. R. E. Johnson who rendered valuable assistance in all aspects of the field work.

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APPENDIX

Appendix Table 1. Estimated fish densities within time-depth cells of echosounding transects made during the September, 1973, acoustic survey of Lake Nunavaugaluk. Shaded areas indicate total bottom interference.

NUNAVAUGALUK SURVEY TRANS/TIME INT: 1/A 1/B 1/C 1/D 1/E 1/F 1/G

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	1/A	1/B	1/C	1/D	1/E	1/F	1/G
4 - 11	1.56707	.62780	.31390	0.00000	0.00000	3.45290	.31390
11 - 18	.09636	0.00000	.96360	.09490	.09490	4.53330	.57670
18 - 26	.13961	0.00000	.41610	0.00000	.18250	.45990	.13870
26 - 33	0.00000	0.00000	.14454	.07300	0.00000	0.00000	0.00000
33 - 40	0.00000	0.00000	0.00000	.07300	0.00000	0.00000	.12532
40 - 48	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.03200
TOTAL	1.80304	.62780	1.83814	.24090	.27740	8.44610	1.18662

NUNAVAUGALUK SURVEY TRANS/TIME INT: 1/H 1/I 1/J 1/K 1/L 1/M 1/N

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	1/H	1/I	1/J	1/K	1/L	1/M	1/N
4 - 11	0.00000	0.00000	0.00000	.30100	.30100	0.00000	4.20980
11 - 18	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.57176
18 - 26	.18250	0.00000	.10400	0.00000	0.00000	0.00000	.45783
26 - 33	0.00000	0.00000	0.00000	0.00000	.04900	0.00000	.04462
33 - 40	0.00000	0.00000	0.00000	0.00000	0.00000	.04200	0.00000
40 - 48	0.00000	0.00000	.09600	0.00000	0.00000	.16000	.07000
TOTAL	.18250	0.00000	.20000	.30100	.35000	.20200	6.35402

Appendix Table 1. Estimated fish densities within time-depth cells of echosounding transects made during the September, 1973, acoustic survey of Lake Nunavaugaluk. Shaded areas indicate total bottom interference - continued

NUINAUGALUK SURVEY TRANS/TIME INT: 2/A 2/B 2/C 2/D 2/E 2/F 2/G 2/H 2/I

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	2/A	2/B	2/C	2/D	2/E	2/F	2/G	2/H	2/I
4 - 11	6.90958	9.03000	12.04000	3.91300	3.31100	.30100	0.00000	0.00000	0.00000
11 - 18	.92581	0.00000	.55450	.28000	.27708	.46200	0.00000	.18200	0.00000
18 - 26	0.00000	0.00000	0.00000	0.00000	0.00000	.15200	0.00000	.10400	0.00000
26 - 33	0.00000	0.00000	0.00000	0.00000	0.00000	.09100	0.00000	.11200	0.00000
33 - 40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.08400	0.00000	0.00000
40 - 48	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.05600	0.00000
TOTAL	7.83539	9.03000	12.59650	4.19300	3.58808	1.00600	.08400	.45400	0.00000

NUINAUGALUK SURVEY TRANS/TIME INT 2/J 2/K 2/L 2/M 2/N 2/O 2/P 2/Q 2/R

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	2/J	2/K	2/L	2/M	2/N	2/O	2/P	2/Q	2/R
4 - 11	0.00000	0.00000	0.00000	0.00000	0.00000	.90300	0.00000	.30100	.98828
11 - 18	.14200	.14200	.15200	.30400	.09100	0.00000	.18200	.18200	.46107
18 - 26	0.00000	0.00000	.15200	.30400	0.00000	0.00000	.15200	0.00000	.15300
26 - 33	0.00000	.07000	0.00000	.04900	0.00000	.14000	.04900	.04900	0.00000
33 - 40	0.00000	0.00000	0.00000	0.00000	.06866	0.00000	0.00000	0.00000	0.00000
40 - 48	0.00000	.03167	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL	.18200	.28367	.33400	.35300	.15966	1.04300	.38300	.53200	1.60235

Appendix Table 1. Estimated fish densities within time-depth cells of echosounding transects made during the September, 1973, acoustic survey of Lake Nunavaugaluk. Shaded areas indicate total bottom interference. - continued

NUNAVAUGALUK SURVEY TRANS/TIME INT: 3/A 3/B 3/C 3/D 3/E 3/F 3/G 3/H

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	3/A	3/B	3/C	3/D	3/E	3/F	3/G	3/H
4 - 11	.30144	.90300	.90300	2.40800	6.62200	.90475	0.00000	0.00000
11 - 18	.46200	.18200	.37071	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL	.76344	1.08500	1.27371	2.40800	6.62200	.90475	0.00000	0.00000

NUNAVAUGALUK SURVEY TRANS/TIME INT: 4/A 4/B 4/C 4/D 4/E 4/F 4/G 4/H 4/I

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	4/A	4/B	4/C	4/D	4/E	4/F	4/G	4/H	4/I
4 - 11	.90300	1.20400	0.00000	0.00000	0.00000	.30100	.30100	11.43800	22.54087
11 - 18	1.29360	1.84800	.09100	0.00000	0.00000	.37100	2.12800	2.21812	2.40625
18 - 26	0.00000	1.76800	0.00000	0.00000	0.00000	.10400	1.06000	0.00000	0.00000
26 - 33	0.00000	.43143	0.00000	0.00000	0.00000	.09100	.36680	0.00000	0.00000
33 - 40	0.00000	.05375	0.00000	0.00000	0.00000	.05133	0.00000	0.00000	0.00000
40 - 48	0.00000	0.00000	0.00000	0.00000	.04800	0.00000	0.00000	0.00000	0.00000
TOTAL	2.19660	5.30519	.09100	0.00000	.04800	.91833	3.85580	13.65612	24.94712

Appendix Table 1. Estimated fish densities within time-depth cells of echosounding transects made during the September, 1973, acoustic survey of Lake Nunavaugaluk. Shaded areas indicate total bottom interference - continued

NUNAVAUGALUK SURVEY TRANS/TIME INT: 5/A 5/B 5/C 5/D 5/E 5/F 5/G

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	5/A	5/B	5/C	5/D	5/E	5/F	5/G
4 - 11	4.51267	21.67200	21.07000	20.46800	9.63200	.90300	0.00000
11 - 18	0.00000	6.29125	1.01792	0.00000	2.77594	1.11300	.18200
18 - 26	0.00000	0.00000	0.00000	0.00000	1.16153	.80800	.25600
26 - 33	0.00000	0.00000	0.00000	0.00000	.38754	.36400	0.00000
33 - 40	0.00000	0.00000	0.00000	0.00000	0.00000	.08242	.09800
40 - 48	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.05600
TOTAL	4.51267	27.96325	22.08792	20.46800	13.95701	3.27042	.59200

NUNAVAUGALUK SURVEY TRANS/TIME INT: 5/H 5/I 5/J 5/K 5/L 5/M 5/N

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	5/H	5/I	5/J	5/K	5/L	5/M	5/N
4 - 11	.30100	.60200	.30100	2.40800	1.20400	.30100	12.34100
11 - 18	.55300	.46200	.83300	2.77200	1.01500	.28000	3.42090
18 - 26	.50400	.76000	2.78400	4.20000	2.32800	.71200	2.17300
26 - 33	.09100	.07000	.25314	0.00000	.82512	.14000	.20478
33 - 40	0.00000	0.00000	.11859	0.00000	0.00000	.34912	0.00000
40 - 48	0.00000	0.00000	.11400	0.00000	0.00000	.06880	0.00000
TOTAL	1.44900	1.89400	4.40373	9.38000	5.37212	1.85092	18.13968

Appendix Table 1. Estimated fish densities within time-depth cells of echosounding transects made during the September, 1973, acoustic survey of Lake Nunavaugaluk. Shaded areas indicate total bottom interference. - continued

NUNAVAUGALUK SURVEY TRANS/TIME INT: 6/A 6/B 6/C 6/D 6/E 6/F

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	6/A	6/B	6/C	6/D	6/E	6/F
INTERVAL:						
4 - 11	15.65200	3.31100	1.80600	0.00000	0.00000	0.00000
11 - 18	4.53087	.46182	1.47700	.09100	0.00000	.37100
18 - 26	0.00000	0.00000	1.16000	.15200	.10400	.10400
26 - 33	0.00000	0.00000	.50050	.07000	0.00000	0.00000
33 - 40	0.00000	0.00000	.01269	0.00000	0.00000	0.00000
40 - 48	0.00000	0.00000	0.00000	0.00000	0.00000	.03200
TOTAL	20.18287	3.77282	4.95619	.31300	.10400	.50700

NUNAVAUGALUK SURVEY TRANS/TIME INT: 6/G 6/H 6/I 6/J 6/K 6/L

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

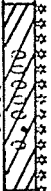
DEPTH (METERS)	6/G	6/H	6/I	6/J	6/K	6/L
INTERVAL:						
4 - 11	.30100	0.00000	.30100	1.20400	1.50500	5.41777
11 - 18	0.00000	0.00000	.37100	.37100	.65100	.45447
18 - 26	0.00000	0.00000	.19200	0.00000	1.06400	.20250
26 - 33	0.00000	0.00000	0.00000	0.00000	.25200	.09187
33 - 40	0.00000	0.00000	0.00000	.04200	.04200	0.00000
40 - 48	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL	.30100	0.00000	.86400	1.61700	3.51400	6.16662

Appendix Table 1. Estimated fish densities within time-depth cells of echosounding transects made during the September, 1973, acoustic survey of Lake Nunavugaluk. Shaded areas indicate total bottom interference. - continued

NUNAVAGALUK SURVEY TRANS/TIME INT: 7/A 7/B 7/C 7/D 7/E 7/F 7/G 7/H 7/I

TIME INTERVALS OF 240 PULSES DURATION

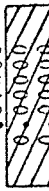

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	7/A	7/B	7/C	7/D	7/E	7/F	7/G	7/H	7/I
4 - 11	.30100	.90300	.90300	.60200	.30100	0.00000	.60200	0.00000	3.31126
11 - 18	1.48254	1.20400	.37100	.28000	0.00000	0.00000	0.00000	.37100	1.57500
18 - 26	.55533	.91200	.56000	.10400	0.00000	0.00000	0.00000	.35200	1.61567
26 - 33	.09292	.34300	.16100	0.00000	0.00000	0.00000	.11200	0.00000	.13802
33 - 40	.01347	.08400	.09800	0.00000	0.00000	0.00000	0.00000	0.00000	.14919
40 - 48		.12667	.07260	0.00000	0.00000	0.00000	0.00000	0.08000	.05633
TOTAL	2.44527	3.57267	2.16560	.98600	.30100	0.00000	.71400	.80300	6.84547

NUNAVAGALUK SURVEY TRANS/TIME INT: 8/A 8/B 8/C 8/D 8/E 8/F

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	8/A	8/B	8/C	8/D	8/E	8/F
4 - 11	3.61200	6.02000	7.52500	2.40800	2.10700	1.20400
11 - 18	3.70242	2.21900	2.49000	1.20400	.37100	.83300
18 - 26	1.26417	1.00800	1.87200	.91200	.15000	.60800
26 - 33	.57108	.34300	.27300	.23100	.07000	.14000
33 - 40	.12180	.13300	.18000	.03879		.06694
40 - 48	.04657	.17600	.23200	0.00000		0.00000
TOTAL	9.31803	9.89900	12.59000	4.79379	2.69800	2.85194

Appendix Table 1. Estimated fish densities within time-depth cells of echosounding transects made during the September, 1973, acoustic survey of Lake Nunavaugaluk. Shaded areas indicate total bottom interference. - continued

NUNAVAUGALUK SURVEY TRANS/TIME INT: 8/G 8/H 8/I 8/J 8/K 8/L

TIME INTERVALS OF 240 PULSES DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METERS)	8/G	8/H	8/I	8/J	8/K	8/L
4 - 11	.30100	.30100	.30100	0.00000	2.40800	5.11513
11 - 18	0.00000	0.00000	0.00000	.46200	1.20143	0.00000
18 - 26	.15200	0.00000	0.00000	.35200	.70807	0.00000
26 - 33	.04900	0.00000	0.00000	.04900	.25159	0.00000
33 - 40	0.00000	.05600	0.00000	0.00000	0.00000	0.00000
40 - 48	0.00000	0.00000	0.00000	0.00000	.05600	0.00000
TOTAL	.50200	.35700	.30100	.86300	4.62509	5.11513

