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HYDROACOUSTIC FISH STOCK ASSESSMENT SURVEY IN BECHAROF AND UGASHIK LAKES

by

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INTRODUCTION

The Alaska Department of Fish and Game is advancing an enhancement program for juvenile sockeye salmon production in the Egegik District of the Bristol Bay area. Initially, the utilization of spawning and nursery areas in Becharof and Ugashik Lakes is being evaluated. As part of this work members of the Fisheries Research Institute, University of Washington, conducted a hydroacoustic survey to assess the distribution and abundance of the pelagic fish stocks in these lakes. The preliminary findings are described in this report.

MATERIALS AND METHODS

The surveys in Becharof and Ugashik Lakes were conducted between September 12-30, 1974. Ten transects were made in the Island Arm and three in the main portion of Becharof Lake (Fig. 1). Transect number eight was replicated. Vessel failure and inclement weather prevented completion of two transects in the northwestern region of the main lake. Ruth Lake was not surveyed because low water in Ruth Creek precluded access by boat. Twelve transects were run in Ugashik Lake (Fig. 2).

Transect design and spacing were conditioned by the physical shape of each lake area, bathymetric configuration, and time available between periods of adverse weather. Transects were run perpendicular to the longitudinal axis of the regions surveyed and in a zig-zag pattern. Battery powered flashing lights were placed at the beginning and end of most transects during daylight to facilitate navigation. All echo sounding was done at night after daytime fish schools dispersed and provided separate fish targets.

The survey was conducted from seventeen foot outboard powered Boston Whalers in Ugashik Lake, the Island Arm, and for transect number one in the main body of Becharof Lake. Transects number two and three in the main lake were run from the R/V Iliaska. Boat speed was measured and calibrated to engine tachometer readings by a Gurley current meter (Table 1).

A description and operational procedure of the acoustic data acquisition unit are given by Thorne, Nunnallee, and Green (1972). Basically the system consists of a modified 105 kHz Ross 200A echosounder (transceiver and chart recorder), interface amplifier,

and a Sony 560D magnetic tape recorder (Fig. 3). The acoustic data is collected at 105 kH_Z and converted by the interface amplifier to a frequency (5 kH_Z) compatible to the dynamic range of the tape recorder. It is then recorded on magnetic tape and becomes available for later analysis. The Ross transducer is a seven element barium titanate type which produces an eight degree beam at the -3dB point. During the survey the transducer was mounted on a plywood towing vehicle and suspended alongside the boat about one half meter below the surface. The system was monitored by a portable battery powered Hewlett-Packard 1205 A oscilloscope. Power to the system was supplied by 12 V DC automobile batteries through a frequency controlled alternating current inverter manufactured by the Terado Co. A 1.75 Kw Onan gasoline powered generator (115 V, 60 Hz) furnished by the Alaska Department of Fish and Game was used on occasions when difficulty in maintaining fully charged batteries was encountered.

The technique used to determine effective sample volume consists of measuring the radius of the sounder cone at planes corresponding to the upper and lower limits of the depth intervals analyzed by a direct target counting procedure (Nunnallee, 1973). The pulse sample volume for each depth interval is approximated by the frustum of a right circular cone. Since the upper and lower radii and the height are known, volumetric estimates can be calculated. The effective sample volume per sounder pulse for the present survey was determined from transect number eight in the Island Arm of Becharof Lake (Table 2).

The acoustic data collected during the survey will be processed by a digital integrator system (DDAPS) and the output calibrated to give estimates of absolute fish densities for each transect at defined time and depth intervals. This information will then be utilized to make total population estimates. These estimates will not be apportioned according to fish species. Although surface townet hauls were made during the survey period, the catches do not provide a sufficient basis for deriving species composition throughout the water column. Townet data from Iliamna Lake (Naknek-Kvichak District) show that vertical stratification by species occurs in certain areas and a similar condition may exist in Ugashik and Becharof Lakes.

A target strength analysis based on randomly selected and measured target amplitudes, assumed proportional to fish length, will be done to determine if length frequency distributions differ among various lake regions. Also, the replicated transect will be analyzed by 2.5 minute segments to study the results in a two-way balanced analysis of variance design.

PRELIMINARY RESULTS

Initial processing of the data indicated that most fish detected were distributed above 50 m. Analysis therefore will be done over six 7.3 m depth intervals extending from 3.7 to 47.5 m. Targets above 3.7 m are eliminated by system noise and pulse length.

Some fish density estimated for the Island Arm and the main portion of Becharof Lake and Ugashik Lake have been made initially by direct target counting procedures using oscilloscope displays of several 300 pulse time segments (2.5 min.) in areas of highest fish concentration, as indicated by the echograms (Table 3).

The greatest densities were found in the southern end of the Island Arm. Echograms of transects one through five indicate a fairly uniform distribution throughout the water column from a maximum depth of 33 m. Densities in the deeper (60 m) central portion of the Island Arm were considerably less with an uneven distribution. Most of the targets were found in closer proximity to the bottom than to the surface, especially where the bottom configuration changed rapidly.

Two types of distributions were observed in the main body of Becharof Lake. Along transect number one few fish were detected above 20 m; the majority were more closely associated with the bottom which varied in depth between 30 and 65 m. The distribution and densities generally appeared similar to those observed in the central portion of the Island Arm. In the middle region of the main lake (transects two and three) most of the fish were stratified between 7 and 22 m and the concentration was fairly uniform. Few targets were noted below 22 m except at the beginning and end of each transect. Density samples calculated in the middle of transect two ranged from 2.5 to 5.9 fish/$10^3 m^3$.

The overall pelagic fish concentration in Ugashik Lake was considerably less than observed in Becharof Lake. The greatest number of targets per unit volume was confined to a relatively small area in the southwestern portion of upper Ugashik Lake (end of transect four and beginning transect five). These densities were comparable to those calculated from the main part of Becharof Lake.

One recommendation at the present time for future work on Becharof and Ugashik Lakes is that fish capture gear capable of sampling to a depth of at least 40 m is needed. Echograms made during the survey indicate substantial concentrations of fish between 20 and 40 m in certain areas. The ability to identify species composition thoughout the water column would enable future acoustic studies to quantify pelagic fish abundance by species.

LITERATURE CITED

Nunnallee, E. 1973. A hydroacoustic data acquisition and digital data analysis system for the assessment of fish stock abundance. Univ. Washington, Fish. Res. Inst. Circ. 73-3. 47 pp.

Thorne, R., E. Nunnallee, and J. Green. 1972. A portable hydroacoustic data acquisition system for fish stock assessment. Univ. Washington, Div. Mar. Res., Seattle, Washington. WSG Publ. 72-4. 47 pp.

Table 1. Summary of transect data from the acoustic survey in Becharof and Ugashik Lakes, September 12-30, 1974

Location	Transect No.	Date	Time Start	Time Stop	Engine RPM	Heading
Becharof Is. Arm	1	14 Sept	2045	2050	2600	NW
"	2	" "	2100	2112	2000	E
"	3	" "	2208	2215	2600	W
"	4	" "	2225	2230	2600	E
"	5	" "	2255	2300	2600	NW
"	6	" "	2258	0005	2000	NW
"	7	15 Sept	0030	0045	2600	E
"	8	" "	2050	2112	2600	E
"	8A[1]	16 Sept	2056	2116	2600	W
"	8B[1]	" "	2118	2138	2600	E
"	9	15 Sept	2215	2241	2600	W
"	10	" "	2353	0018	2600	NE-N[2]
Main Lake	1	16 Sept	0104	0230	3000	NE
"	2[3]	17 Sept	2050	2220	1500	NNW
"	3[3]	" "	2225	2342	1500	SW
Ugashik Lower	1	21 Sept	2047	2144	3000	S
"	2	" "	2235	2248	3000	NE
"	3	" "	2255	2308	3000	NW
"	4	" "	2320	2330	3000	NNE
"	5	22 Sept	0057	0155	3000	N
"	6	26 Sept	0117	0204	3000	S
Upper	1	25 Sept	1944	2019	3000	W
"	2	" "	2021	2055	3000	SE
"	3	" "	2138	2207	3000	SE
"	4	" "	2225	2309	3400	W
"	5	" "	2311	0001	3400	SE
"	6	26 Sept	0007	0034	3000	W

[1] Replicate transect series.
[2] Course change during transect to avoid an island.
[3] Conducted from R/V Iliaska, all other transects run from 17 ft outboard powered Boston Whalers.

Table 2. Estimated cone radii and volume per pulse for depths indicated

Depth (m)	Cone radius (m)	Depth interval (m)	Vol/pulse (m^3)
3.7	.4	3.7 - 11.0	14.67
11.0	1.14	11.0 - 18.3	46.25
18.3	1.68	18.3 - 25.6	84.24
25.6	2.14	25.6 - 32.9	128.92
32.9	2.59	32.9 - 40.2	178.53
40.2	2.98	40.2 - 47.5	231.20
47.5	3.36		

Table 3. Density estimates for selected areas of high fish concentration in Becharof and Ugashik lakes

Location	Transect No.	Depth interval (m)	Time interval (2.5 min)	Density (fish/$10^3 m^3$)
Becharof Is. Arm	2 (near end)	3.7-11	1	47.7
			2	84.5
			3	126.2
		11.0-18.3	1	32.5
			2	35.8
			3	42.1
	8 (near end)	11.0-18.3	1	13.0
			2	11.4
			3	5.6
Main Lake	2 (near middle)	11.0-18.3	1	2.5
			2	3.6
			3	3.2
			4	5.6
			5	5.9
Ugashik Upper	5 (near start)	11.0-18.3	1	4.61
			2	4.07
			3	3.89

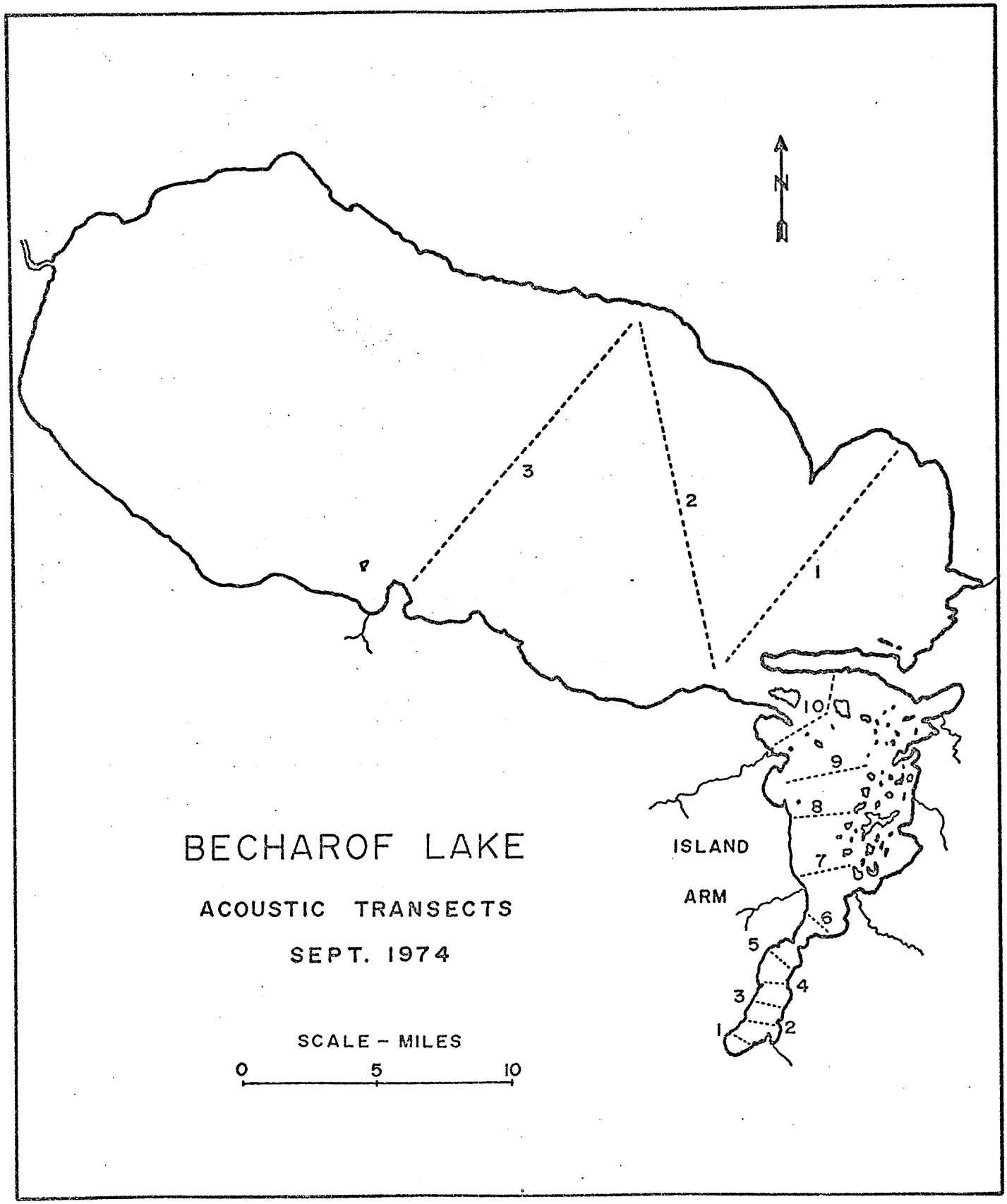

Fig. 1. Locations of acoustic transects (dotted lines) completed in Becharof Lake between September 12-30, 1974.

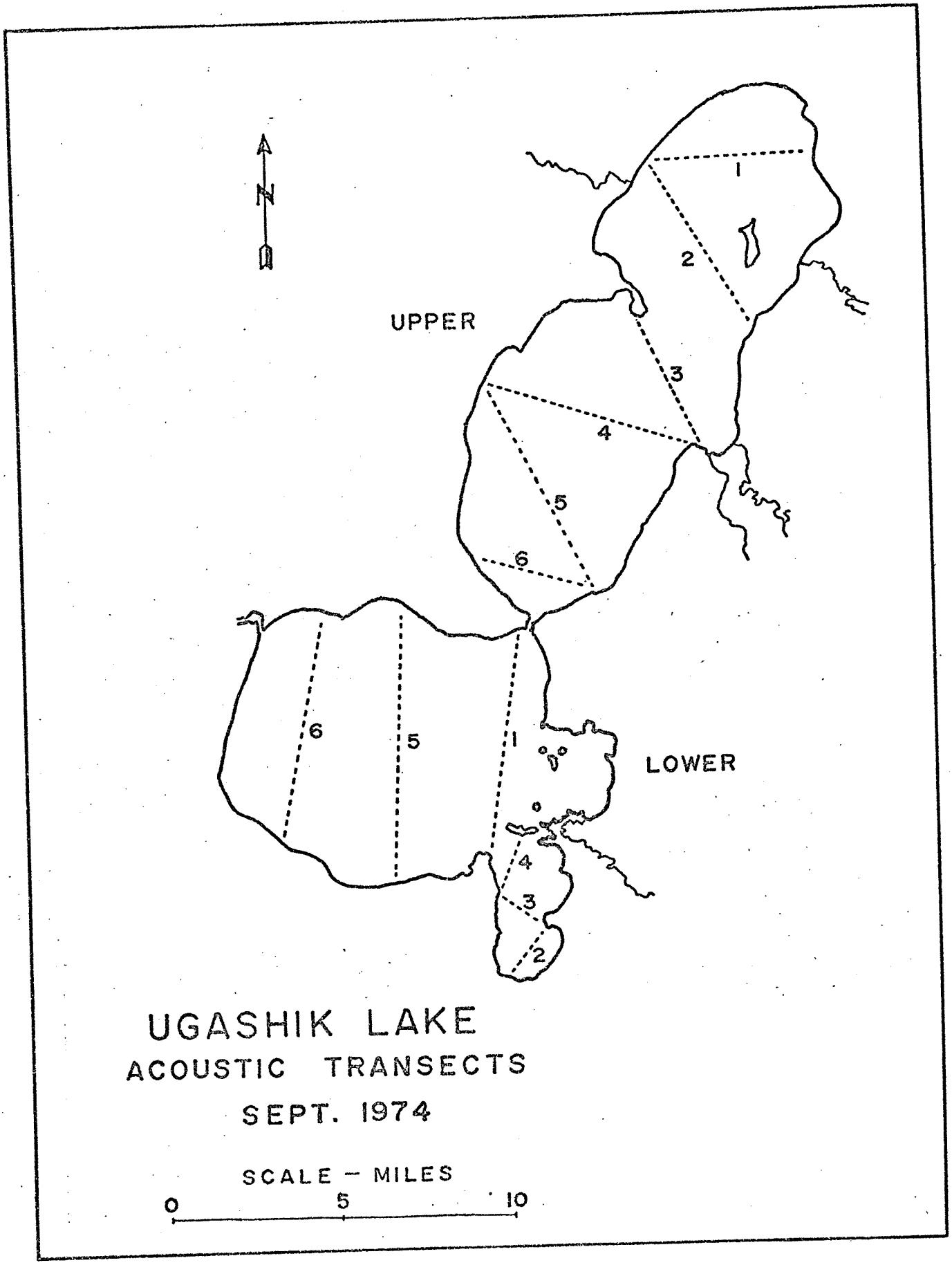

Fig. 2. Locations of acoustic transects (dotted lines in Ugashik Lake between September 12-30, 1974.

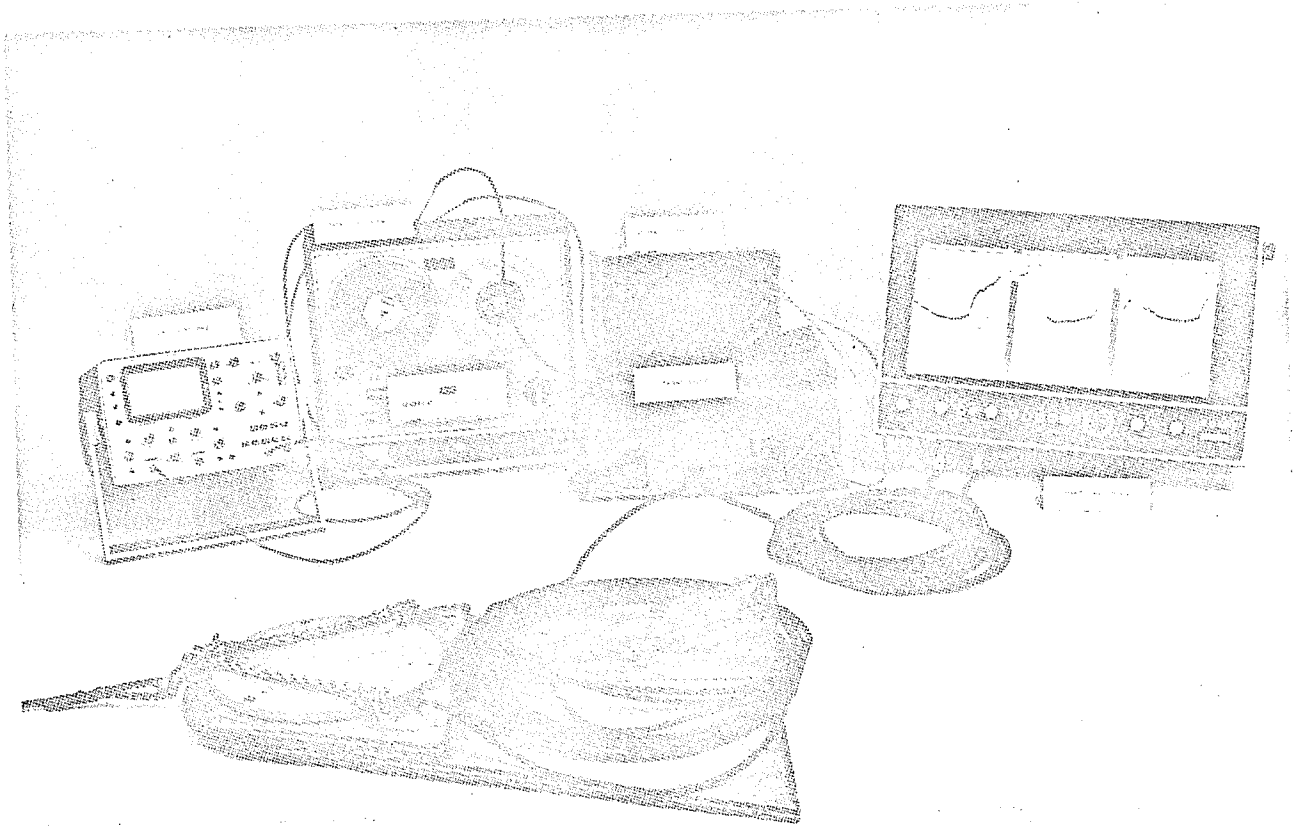

Fig. 3. Photograph of data acquisition system components.