

Fisheries Research Institute
College of Fisheries
University of Washington
Seattle, Washington 98195

HYDROACOUSTIC SURVEY IV OF SHUSWAP LAKE,

BRITISH COLUMBIA, CANADA

by

Robert L. Johnson, Ole A. Mathisen,
and Norman A. Lemberg

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INTRODUCTION

This report contains the results of the fourth consecutive, annual hydroacoustic survey of the pelagic fish populations of Shuswap Lake by the Fisheries Research Institute, University of Washington, Seattle, under contract to the International Pacific Salmon Fisheries Commission. The primary objective of the survey was to provide an estimate of the abundance of fish and their distribution in the limnetic zone of Shuswap Lake, British Columbia. It is assumed that the stocks of resident fishes remain fairly stable from year to year so that differences in total population estimates are due to changes in abundance of juvenile sockeye salmon.

The data acquisition was completed October 16-19, 1974, and these dates are comparable to those of the previous surveys in 1971, 1972, and 1973.

MATERIALS AND METHODS

Data Acquisition

The methods remained the same as on earlier surveys as well as the sampling design except for the deletion of the Little Shuswap transects. The locations of the transects are shown in Fig. 1, and a summary of the field log is given in Table 1 with corresponding transect numbers for the previous years. The transects were renumbered after the survey to provide a logical numbering sequence for future surveys. The equipment used in the data acquisition remained the same as in previous years with the exception of the inverter. A Torado Inverter was replaced by a Nova Inverter, Model 2560-12. The Commission provided a boat for the survey.

Analysis

Analysis of the data stored on magnetic tape included estimation of acoustic sample volume, echo integration, and calculation of fish densities, population sizes, and target strengths as outlined by Nunnallee et al., 1973.

The potential egg deposition was estimated in the same manner as in last year's report and used to estimate survival from eggs to fry in October. Fish densities were estimated for each transect and the population sizes computed for the individual arms of Shuswap Lake. Target strength analysis was performed on data collected in Salmon Arm, from which

Table 1. Summary of the field log for the hydroacoustic survey of Shuswap Lake, British Columbia, Canada, in 1974

Date	Location	Time		Corresponding transect numbers			
		Start	Duration (min)	1974	1973	1972	1971
10/16-17	Main Arm	2058	10	1	38	6	2
		2120	15	2	39	8	3
		2145	17	3	40	9	4
		2214	21	4	41	10	5
		2251	24	5	42	11	6
		2332	26	6	11	12	7
		0025	20	7	12	13	8
		0103	9	8	13	26	9
		0210	11	9	14	25	10
		0231	13	10	15	24	11
		0244	13	11	-	-	-
10/17-18	Seymour Arm	1947	10	17	16	14	14
		2006	5	16	17	16	15
		2020	20	15	18	17	16
		2045	20	14	-	-	-
		2121	16	13	19,20	18	17
		2154	10	12	21	19	18
10/17-18	Anstey Arm	2237	12	30	22,23	23	23
		2257	8	29	24	22	22
		2319	16	28	25	21	21
		2351	16	27	26	20	20
		0021	16	26	37	30	19
10/18-19	Salmon Arm	1921	12	18	27	29	24
		1936	10	19	28	31	25
		1958	14	20	29,30	32	26
		2024	10	21	31	33	27
		2044	14	22	32,33	34	28
		2111	21	23	34	35	29
		2145	20	24	35	36	30
2222	22	25	36	37	-		

the lengths of fish could be computed and compared with previous year's estimates.

RESULTS

Fish Densities

The fish densities ranged from 2.01 to 26.54 fish/are (100 m²), slightly higher than the densities in 1973 which extended from 1.03 to 5.84 fish/are (Table 2). Appendix A contains the number of fish/are and number of fish/1000 m³ throughout the water column divided into seven depth strata together with the total number of fish/are for each transect or portion thereof. The mean numbers of fish/are by transects for 1974 are plotted in Fig. 1 together with corresponding values for 1971, 1972, and 1973.

Population Estimates

A population estimate was made of the fish in each of the three areas of Shuswap Lake, the Main Arm, Seymour-Anstey Arm, and Salmon Arm. One representative transect from each area was analyzed and the results extrapolated over the surface area of each section bounded by the 18 m depth contour line. The results for the years 1971, 1972, 1973 and 1974 are given in Table 3.

Survival Estimates

The survival from egg to fry stage in October has been computed for each year when a hydroacoustic survey was conducted. Since the acoustic estimate only gives the total number of fish targets, one must estimate the resident fish population and deduct this from the total population estimates in order to derive a number for the salmon population in a year (Fig. 2).

It has been assumed that the resident fish population remains fairly stable. Because of the very small salmon escapement in 1972, the acoustic population estimate is therefore very close to that of the resident fish population. A minor correction can be made by assuming that there is a 5 percent survival from egg to fry stage in October. This gives a juvenile sockeye salmon population estimate of 0.64 million and a resident fish population estimate of 6.89 million (Table 4). If the figure is deducted from the total population estimates for the years 1971 through 1974 one can estimate the survival from egg to October fry abundance for the same years as done in the above-mentioned table.

If we assume that the low survival in 1970/71 was the result of unfavorable environmental conditions as observed in Alaska and elsewhere

Table 2. Mean numbers of fish/are observed in Shuswap Lake, British Columbia, in October of 1971, 1972, 1973, and 1974

Transect number	Area	Mean number of fish/are			
		1971	1972	1973	1974
1	Main Arm	70.60	5.35	1.03	12.61
2		75.00	17.25	1.80	18.59
3		26.70	5.19	6.21	10.38
4		56.30	4.35	2.03	13.02
5		25.60	5.68	1.93	7.72
6		27.80	8.44	3.61	8.18
7		8.80	5.94	1.34	8.03
8		9.10	7.72	1.66	8.36
9		19.40	6.58	5.22	9.69
10		14.60	6.65	5.84	4.19
11 ¹		-	-	-	5.14
12	Seymour Arm	17.60	10.19	1.23	6.45
13		12.40	13.12	3.56	7.11
14 ¹		24.50	12.69	2.21	8.03
15 ¹		-	-	-	7.89
16		25.20	6.88	1.95	3.72
17		12.40	8.07	4.10	6.18
18	Salmon Arm	26.00	26.10	4.16	25.48
19		37.30	16.82	1.56	15.69
20		21.60	22.80	3.17	11.01
21		24.90	23.88	3.38	14.21
22		16.80	28.89	3.26	7.97
23		15.00	25.73	2.34	7.13
24		24.90	18.80	2.34	11.36
25		-	19.29	2.78	10.55
26		12.40	14.26	3.10	5.14
27		Anstey Arm	10.60	11.34	2.28
28	7.70		8.92	1.26	8.21
29	6.60		7.87	2.48	7.35
30	6.60		10.13	1.62	11.35

¹Replicate of previous transect.

Table 3. Estimated fish populations in Shuswap Lake, British Columbia, Canada, by statistical areas, in October of 1971, 1972, 1973, and 1974

Area	Population estimates ($\times 10^6$)			
	1971	1972	1973	1974
Little Shuswap Lake	- ¹	2.09	- ²	- ¹
Main Arm, Shuswap Lake	32.05	7.08	2.94	3.69
Seymour-Anstey Arm, Shuswap Lake	9.73	7.63	1.73	1.97
Salmon Arm, Shuswap Lake	21.92	21.13	2.86	3.25
TOTAL Shuswap Lake	63.70 ³	37.93	7.53	8.91

¹No survey.

²Negligible number of fish seen on echograms.

³Revised population estimates.

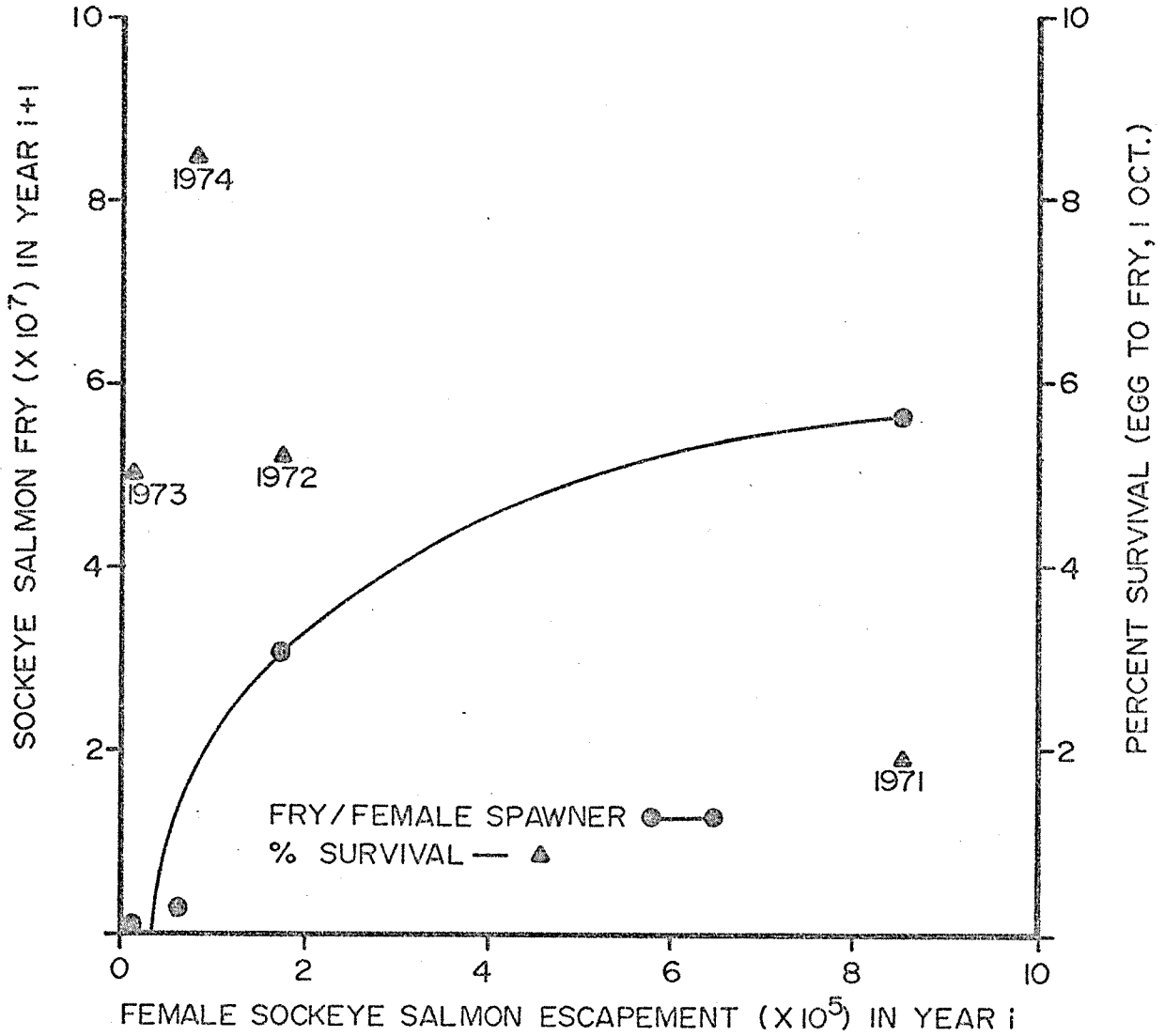


Fig. 2. The relationship of the number of spawning female sockeye salmon to the number of fry surviving in October the following year.

Table 4. Derivation of a sockeye salmon spawner-recruitment (fry) survival curve and of a resident pelagic fish population estimate for Shuswap Lake, British Columbia, Canada, 1971, 1972, 1973, and 1974

	Year of observation				
	1970	1971	1972	1973	1974
Number female sockeye salmon ¹	849,818	167,887	3,583	6,708	
Potential ₂ egg depositions (X 10 ⁶)	3,025.4	597.7	12.8	23.9	
Lake population estimates (X 10 ⁶) ³		63.7	37.93	7.53	8.91
5-percent egg survival (X 10 ⁶)				0.69	1.19
Resident fish population estimate (X 10 ⁶) ⁴		6.89	6.89	6.89	6.89
Sockeye fry population estimate (X 10 ⁶)		56.81	31.04	0.64	2.02
Eggs/fry ⁵		53.25	19.25	20.00	11.83
Percent survival		1.9	5.2	5.0	8.5

¹ Female sockeye salmon escapement from Annual Report of Int. Pac. Salmon Fish. Comm., for the years 1970, 1971, 1972, and 1973.

² Average fecundity = 3,560 eggs (Op. cit.).

³ Derived by hydroacoustic techniques.

⁴ Assumed stable through 1971, 1972, 1973, and 1974.

⁵ Survival of eggs to fry in early October of following year.

then a 5-8 percent survival may reflect the normal survival in off-years of the cycle. An increase in years preceding the peak year has also been observed in Bristol Bay.

Target Strength Analysis

The target strength was measured for targets observed in transects 3 and 4 of Salmon Arm because of the uniformity of the targets displayed on the echograms. Two depth intervals were chosen on the basis of stratification of fish. The sockeye salmon were found primarily in the 18-26 m depth zone while the larger resident fish were found in the 40-48 m interval. This separation resulted in a sharply divided bimodal distribution within a comparable range of the target strengths of 1972 (Fig. 3) but smaller than determined in 1973.

The important point to note is that a good indication of mean target strength and relative mean target sizes can be determined from the target strength distributions; however, it is difficult to translate target strength into absolute fish sizes.

ACKNOWLEDGMENTS

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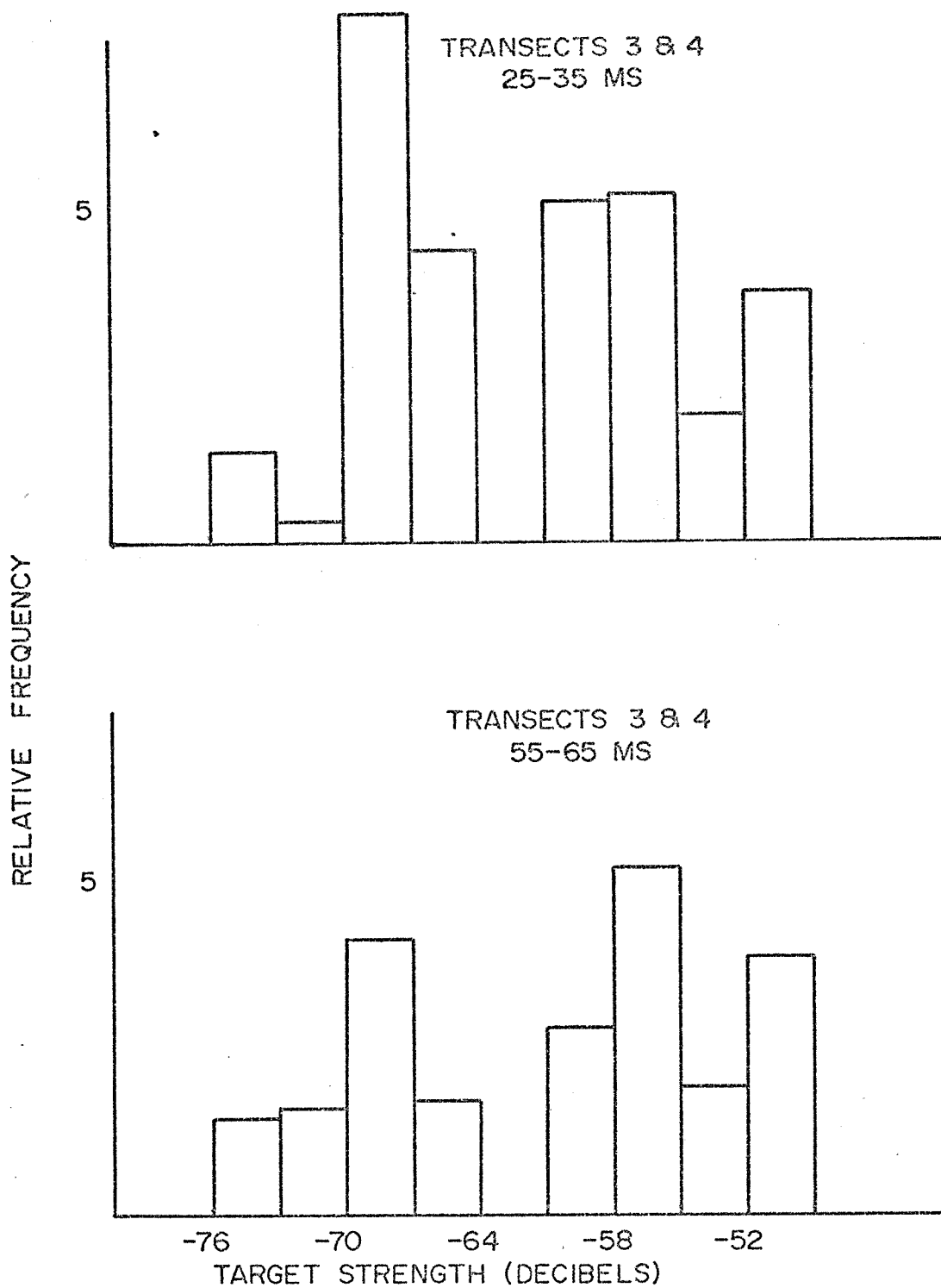


Fig. 3. The distribution of measured target strengths of transects 3 and 4 at two distinct concentrations (by depth) in Shuswap Lake.

APPENDIX A

Numbers of fish/are and fish/1000 m³ of
the water column within nine depth strata
of each transect of Shuswap Lake, British
Columbia, Canada, 1974 hydroacoustic survey.

MAIN ARM 1974 SURVEY

TIME INTERVALS OF VARIABLE DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METER)	1	2	3	4	5	6	7	8	9
4 - 11	1.61903	.91114	.54625	.51201	.55187	.50752	.48473	.46452	2.24215
11 - 18	2.91580	4.08906	2.07374	2.10181	1.71446	1.32712	1.38326	.93248	.62260
18 - 26	2.31839	5.77828	1.64690	1.52740	1.02662	.97541	.97199	1.01524	1.20303
26 - 33	2.19163	1.75937	1.81551	1.63026	1.08012	1.63587	1.61342	2.01760	2.10742
33 - 40	1.80990	2.47793	2.23654	.95774	.86230	1.38887	1.45623	1.81551	1.93901
40 - 48	.43454	1.17555	.43454	1.14187	1.10257	.91058	1.01275	.97570	.68884
48 - 55	.43454	.43454	.43454	4.18449	1.37764	1.34396	1.05205	1.01837	.52885
TOTAL	11.72363	16.62588	9.18802	12.05557	7.71559	8.08933	7.97443	8.23942	9.33191

DENSITY PER 1000 CUBIC METERS

DEPTH (METER)	1	2	3	4	5	6	7	8	9
4 - 11	2.21795	1.24814	.74829	.70138	.75598	.69523	.66401	.63632	3.07144
11 - 18	3.99424	5.60145	2.84074	2.87919	2.34858	1.81797	1.89487	1.27736	.85268
18 - 26	3.13296	7.80849	2.22554	2.06405	1.38733	1.31812	1.31351	1.37195	1.62572
26 - 33	3.00223	2.41010	2.48700	2.23323	1.47961	2.24092	2.21016	2.76384	2.88688
33 - 40	2.47931	3.39442	3.06375	1.31197	1.18124	1.90256	1.99484	2.48700	2.65618
40 - 48	.59526	1.61034	.59526	1.56420	1.51037	1.24737	1.38733	1.33658	.94362
48 - 55	.59526	.59526	.59526	5.73218	1.88718	1.84104	1.44116	1.39502	.72445

MAIN ARM 1974 SURVEY 10 11

TIME INTERVALS OF VARIABLE DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METER)	INTERVAL: 10	11
4 - 11	.53390	.60351
11 - 18	.76070	1.03521
18 - 26	.83599	1.06077
26 - 33	1.05706	1.00152
33 - 40	.74442	.88961
40 - 48	.44251	.57320
48 - 55	.45059	.43454
TOTAL	4.82577	5.59856

DENSITY PER 1000 CUBIC METERS

DEPTH (METER)	INTERVAL: 10	11
4 - 11	.73137	.82673
11 - 18	1.04205	1.41809
18 - 26	1.12972	1.43347
26 - 33	1.44885	1.37195
33 - 40	1.01975	1.21892
40 - 48	.60618	.78520
48 - 55	.61725	.59526

SEYMOUR-ANSTNEY ARMS 1974 SURVEY 17 16 15 14 13 12 30 29 28

TIME INTERVALS OF VARIABLE DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METER)	17	16	15	14	13	12	30	29	28
4 - 11	.08299	-.08441	1.07852	.76384	.54976	1.80382	1.55815	2.30684	.72757
11 - 18	.80595	.59889	.97323	1.04226	.83519	1.64004	.78372	4.89217	2.75138
18 - 26	1.10515	.99012	1.02096	1.08144	.84664	.69485	.86798	.77548	1.48463
26 - 33	.68780	.27719	3.99140	3.04384	2.89176	1.42947	1.24230	1.33588	3.20761
33 - 40	.75916	-.05984	1.56985	1.90910	1.94420	.57081	.00344	.59187	.83753
40 - 48	.86561	-.03937	.39066	.55444	.53923	.54040	-.04042	-.00708	.03503
48 - 55	1.89740	.32983	.10522	.18126	.18945	-.00357	.02801	.01748	.63164
TOTAL	6.20406	2.01240	9.12984	8.57616	7.79622	6.67561	4.44318	9.91265	9.67540

DENSITY PER 1000 CUBIC METERS

DEPTH (METER)	17	16	15	14	13	12	30	29	28
4 - 11	.11369	-.11563	1.47742	1.04635	.75309	2.47098	2.13445	3.16005	.99667
11 - 18	1.10404	.82040	1.33320	1.42775	1.14410	2.24663	1.07359	6.70160	3.76901
18 - 26	1.49345	1.33801	1.37967	1.46140	1.14410	.93898	1.17295	1.04795	2.00625
26 - 33	.94219	.37971	5.46767	4.16964	3.96131	1.95818	1.70178	1.82998	4.39399
33 - 40	1.03994	-.08198	2.15048	2.61521	2.66328	.78194	.00472	.81078	1.14731
40 - 48	1.18577	-.05393	.53515	.75950	.73867	.74027	-.05538	-.00799	.04799
48 - 55	2.59918	.45182	.14414	.24830	.25952	-.00490	.03837	.02395	.86527

SEYMOUR-ANSTEY ARMS 1974 SURVEY 27 26

TIME INTERVALS OF VARIABLE DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METER)	INTERVAL: 27	26
4 - 11	.04322	3.51177
11 - 18	.41269	.62696
18 - 26	1.53206	2.13685
26 - 33	4.19027	6.19068
33 - 40	1.80382	2.21326
40 - 48	.11107	.48308
48 - 55	.10990	-.12641
TOTAL	8.20322	15.03619

DENSITY PER 1000 CUBIC METERS

DEPTH (METER)	INTERVAL: 27	26
4 - 11	.05920	4.81064
11 - 18	.56560	.85886
18 - 26	2.07035	2.88763
26 - 33	5.74010	8.48039
33 - 40	2.47098	3.03186
40 - 48	.15215	.66175
48 - 55	.15055	-.17316

SALMON ARM 1974 SURVEY 18 19 20 21 22 23 24 25

TIME INTERVALS OF VARIABLE DURATION

DENSITY PER 100 SQUARE METERS SURFACE AREA

DEPTH (METER)	18	19	20	21	22	23	24	25
4 - 11	1.44791	1.52844	.73344	.56507	.31838	.40915	.47137	1.11118
11 - 18	5.01295	3.02912	1.57236	2.89004	2.47277	2.69238	2.15067	2.05551
18 - 26	6.07600	4.27277	3.87205	2.73669	2.41760	1.44549	2.43986	1.69037
26 - 33	3.79777	1.52844	2.03355	1.35275	.57898	.76126	3.43175	3.14625
33 - 40	3.31462	4.96903	2.44349	.64340	.39451	.51383	1.77001	1.81394
40 - 48	3.38050	.53872	.21077	3.06573	.33521	.55263	.67927	.33302
48 - 55	3.51227	.21077	.21077	3.24142	1.31615	.56581	.51310	.43404
TOTAL	26.54203	16.07729	11.07643	14.49509	7.83360	6.94055	11.45604	10.58430

DENSITY PER 1000 CUBIC METERS

DEPTH (METER)	18	19	20	21	22	23	24	25
4 - 11	1.98345	2.09375	1.00472	.77407	.43613	.56048	.64572	1.52216
11 - 18	6.86706	4.14948	2.15392	3.95895	3.38736	3.68820	2.94613	2.81571
18 - 26	8.21081	5.77401	5.23250	3.69823	3.26702	1.95336	3.29711	2.28428
26 - 33	5.20242	2.09375	2.78568	1.85306	.79313	1.04282	4.70102	4.30993
33 - 40	4.54057	6.80689	3.34725	.88137	.54042	.70388	2.42469	2.48484
40 - 48	4.63083	.73797	.28872	4.19962	.45920	.75703	.93051	.45619
48 - 55	4.81133	.28872	.28872	4.44030	1.80294	.77508	.70287	.59457