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HYDROACOUSTIC ASSESSMENT OF JUVENILE SOCKEYE SALMON IN BABINE LAKE, BRITISH COLUMBIA, IN 1975

by

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ABSTRACT

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Among the many salmon enhancement projects underway on the Pacific Coast the Babine spawning channels developed in the 1960's were early examples with high production targets. These aimed to achieve numbers and distribution of fry which would ensure full utilization of planktonic food organisms in Babine Lake. Numerous projects have been undertaken to assess their effectiveness in this regard.

One such project was a hydroacoustic survey of the abundance and distribution of sockeye salmon fry in October, 1975. This utilized a Ross 200A echo sounder and associated equipment modified for fry enumeration work and programmed to yield absolute target densities.

Surveys were done at night when fry usually banded in the upper 20 fathoms. These indicated a distribution unlike that observed by Johnson in 1957 and 1958 some years prior to the enhancement program, but very like that observed by McDonald, and McDonald and Hume from 1971 - 1977. The 1975 data appear to confirm the effective use of the lake basins noted by other investigators in recent years. The estimate of 48.5 million fry in the main basins of Babine Lake is about 25% larger than the estimated corresponding smolt migration the following spring and these values may fairly reflect overwinter mortality.

Hydroacoustic surveys of this sort appear to be a useful means of asssessing both fry distribution and abundance in Babine Lake.

Résumé

Parmi le grand nombre de projets actuels de mise en valeur des saumons sur la côte du Pacifique, les chenaux de fraie du lac Babine aménagés au cours des années 1960 ont été les premiers à comporter des objectifs de production élevés. Ils visaient à obtenir un nombre et une distribution d'alevins qui garantiraient une utilisation intégrale des organismes planctoniques présents dans le lac Babine. De nombreux projets ont été entrepris pour évaluer leur efficacité à cet égard.

Un levé hydroacoustique de l'abondance et de la distribution des alevins de saumon rouge effectuée en octobre 1975 constituait un de ces projets. On a utilisé, pour ce faire, un sondeur à écho Ross 200A et des appareils connexes modifiés pour permettre le dénombrement des alevins et programmés pour fournir des densités cibles absolues.

Les levés ont été faits la nuit, au moment où les alevins se rassemblent habituellement dans les 20 premières brasses. La distribution obtenue était différente de celle observée par Johnson, en 1957 et 1958, quelques années avant le programme de mise en valeur, mais très semblable à celle observée par McDonald, et par McDonald et Hume de 1971 à 1977. Les données de 1975 semblent confirmer l'utilisation efficace des bassins du lac notée par d'autres chercheurs au cours des dernières années. L'évaluation de 48,5 millions d'alevins dans les principaux bassins du lac Babine est d'environ 25 % supérieure à celle de la migration correspondante de saumoneaux le printemps suivant et il se peut fort bien que ces valeurs reflètent la mortalité survenue au cours de l'hiver.

Les levés hydroacoustiques de ce genre semblent constituer un moyen utile pour évaluer aussi bien la distribution des alevins que leur abondance dans le lac Babine.

LIST OF TABLES

LIST OF FIGURE CAPTIONS

HYDROACOUSTIC ASSESSMENT OF JUVENILE SOCKEYE SALMON IN BABINE LAKE, BRITISH COLUMBIA, IN 1975

INTRODUCTION

Many enhancement projects are now under way on the Pacific Coast as both government and private industry seek increased Pacific salmon production for public use or profit. These include spawning channels to augment production from established natural systems; fertilization of lake nursery areas to increase basic productivity and essential food organisms; control programs to remove or reduce predators, or competitors for food, and floating ponds and impoundments for rearing juveniles to marketable size.

One of the earliest major enhancement programs was undertaken by the Canadian Department of Fisheries at Babine Lake, B.C. in the mid 1960's. Here spawning channels were designed to increase by about one million fish the annual catch of sockeye salmon in the Skeena River commercial fishery. This program was to be carefully evaluated over several generations of sockeye and to this end a substantial number of special projects were undertaken. These included full enumeration of young salmon produced in spawning channels, assessments of the distrib- and abundance of juveniles in Babine Lake at various times and seasons and improved procedures for enumerating smolts leaving the lake each spring.

As early as 1959, after several years of intensive investigation Johnson (MS. 1961) suggested that under conditions of natural production Babine Lake sockeye fry were neither as abundant as appeared possible in view of the large lake surface area and abundant food organisms, nor were they distributed in Babine Lake in a pattern which would ensure optimum utilization of the planktonic food organisms. Johnson concluded that the southern and central lake regions were particularly underpopulated.

These conclusions strongly influenced the decision to construct artifical spawning channels at Fulton River near the lake's longitudinal mid point, and at Pinkut Creek near the south end. Fry produced at these locations were expected to become well distributed in the underutilized lake regions. There have been a number of post-enhancement assessments of lacustrine fry distribution during summer and autumn (e.g. McDonald, 1973), and in general these suggest that the fry travel extensively in the lake and that all main lake areas are heavily occupied by fry at one time or another during the spring-fall growing period.

In October 1975 the authors conducted a hydroacoustical survey using equipment adapted in part at the University of Washington Fisheries Research Institute in a number of U.S. and Canadian salmon producing lakes and elsewhere (see Mathisen, et al. 1977).

The object of our survey was to assess the lacustrine distribution of juvenile sockeye salmon and estimate their total numbers at the latest practicable time before severe autumn lake conditions rendered such work impossible.

The numerical estimate, while of lesser priority than the assessment of distribution would be useful for improving information concerning both summer and winter mortality rates. This could be done by comparing our October, 1975 estimates with routine estimates of migrating fry in the spring and migrating smolts in 1976. (Babine Lake smolts emigrate after a single year in fresh water thus a single year class would be enumerated.)

Extensive background data on the Babine system and the development program appear in numerous departmental publications.

AREA OF INVESTIGATION

Babine Lake, located near the Province's geographical mid point, is about 185 km long, 3 - 5 km wide and discharges in a northerly direction through Nilkitkwa Lake, then westward via the Skeena River to enter the sea near Prince Rupert, B.C.

The morphometry of Babine and Nilkitkwa Lakes have been extensively described by Johnson (1965) who for working convenience identified 11 lake divisions. These are roughly analogous to a series of "lake basins" and they have been adopted in the present paper (Fig. 1). Morphometric data of each division are summarized in Table 1 and lake surface areas have been used as weighting factors for the average fish density determined from the hydroacoustic survey, expressed as numbers of fish per surface m^2, in each section. Theoretically it would have been better to find an average density per unit of volume for each depth stratum and use the corresponding section strata volumes as weighting factors. But since the littoral shelf areas in Babine Lake

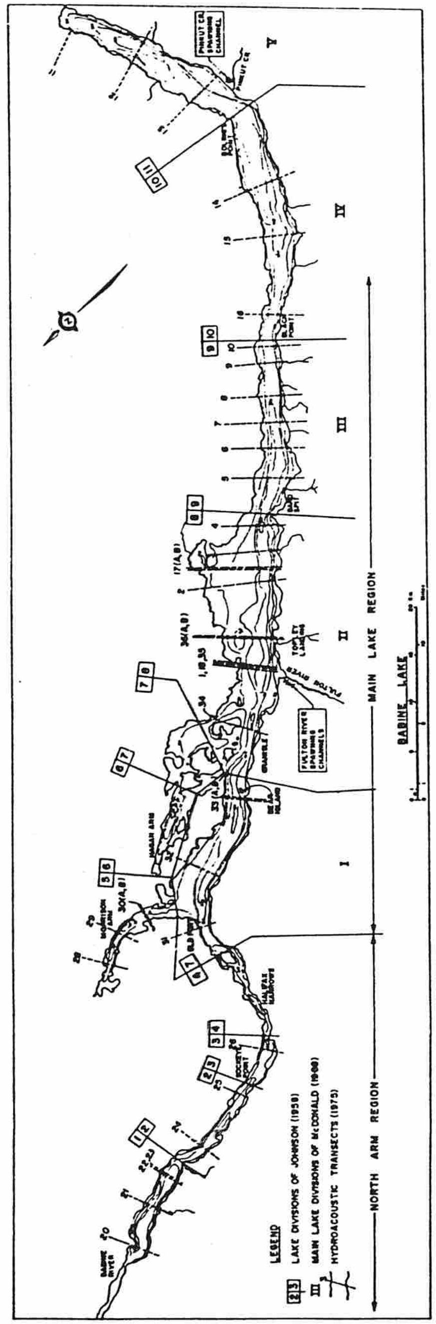

FIGURE 1 Babine Lake showing the different lake divisions referred to in this report.

are narrow in most sections the adopted simplication does not introduce a serious bias, and our method of calculation was considered quite adequate for present purposes.

METHODS AND MATERIALS

DATA ACQUISITION SYSTEM

The components were a Ross 200 A echo sounder, an interface amplifier and a Sony 560 D stereo tape recorder. A narrow beam transducer (8° full angle) completed the system. Three modifications were incorporated in the Ross Sounder. The single turn gain control potentiometer was replaced with a 10-turn Helipot, an isolation amplifier was added to decouple the signal output, and a calibration oscillator was added.

The 10-turn gain control allowed repeatability of the signals. The isolation amplifier was added so that the high impedance vacuum tube circuitry of the echo sounder receiver would be unaffected by the cabling to other parts of the data acquisition system.

The calibration oscillator provides a signal of known amplitude and frequency, which was recorded prior to data collection and gives a measure of receiver gain for later standardization.

The interface amplifier converts the 105 kHz to 5 kHz carrier frequency, which is compatible with the frequency response of the tape recorder. An attenuator on the output amplitude allows control of the signals in steps of 0, -6, -12, -20 dB. A second channel converts the synchronization pulse to a positive pulse for recording. Finally the interface unit has an amplifier for microphone input and a voice log.

SIGNAL PROCESSING

The various techniques for estimating fish densities and the mathematics of echo integration have been described by, Ehrenberg and Lytle (1972). In this particular case the input amplifier has a variable gain for the purpose of adjusting target voltages to a suitable amplitude. The rectifier envelope detects the target reflection pulses, while the filter sifts out most of the 5 kHz frequency input before the sampling circuit samples the detected voltage pulses at a predetermined rate.

The A-D converter brings the analog signals into digital form prior to squaring, which normalizes the voltage measurements to the original target reflection intensities. These

TABLE 1 Morphometric data for Nilkitkwa Lake and Babine Lake. (After Johnson 1965 (a))

Lake or Lake Region	A = Area		V = Volume	Z (mean depth)	$\bar{Z}_m$ (max. depth)	Z/Z_m	L[1]	D_l[2]	l[3]	% of total drainage area from which inflow enters
	km²	miles²	km³	m	m		km		km	
NILKITKWA LAKE	4.87	1.88	0.038031	7.81	21.0	0.37	22.7	2.91	8.8	
Horseshoe Bay	0.0829	0.032	0.000511	6.16	16.0	0.38	1.16	1.11	0.6	.002[6]
Lower Basin	2.3386	0.903	0.016103	6.89	20.0	0.34	12.44	2.30	5.1	100.0
Upper Basin	2.4500	0.946	0.021417	8.74	21.0	0.42	9.10	1.65	3.7	99.2
BABINE LAKE	490.60	189.42	27.010	55.10	186.0	0.30	564.7	7.19	150.2	
Outlet to 9-Mile Pt.	21.94	8.47	0.534	24.34	46.0	0.53	31.5	1.90	12.7	95.4
9-Mile Pt. to Sockeye Pt.	13.39	5.17	0.262	19.57	36.0	0.54	25.9	1.99	10.9	92.8
Sockeye Pt. to Halifax Pt.	9.06	3.50	0.115	12.69	25.0	0.51	17.0	1.59	7.2	90.9
Halifax Pt. to McKendrick Is.	9.01	3.48	0.165	18.31	33.0	0.56	27.5	2.59	9.0	89.0
Morrison Arm	17.72	6.84	0.202	11.40	31.0	0.37	49.5	3.32	13.4	10.2
Hagan Arm	14.25	5.50	0.405	28.42	83.0	0.34	33.4	2.49	9.0	0.9
McKendrick Is. to Bear Is.	52.32	20.20	3.290	62.88	144.0	0.44	43.2	1.68	17.5	87.1
Bear Is. to Sandspit	169.72	65.53	7.326	43.17	141.0	0.31	184.1	4.00	28.8	73.1
Sandspit to Black Pt.	50.43	19.47	3.065	60.78	120.0	0.51	41.8	1.66	18.7	40.6
Black Pt. to Boling's Pt.	74.75	28.86	6.659	89.08	186.0	0.48	57.8	1.89	25.1	33.2
Boling's Pt. to Lakehead	58.01	22.40	4.987	85.97	167.0	0.51	53.0	1.96	20.3	28.7

[1] L = length of shoreline, including islands.

[2] D_l = development of shoreline = $\frac{L}{2\sqrt{\lambda A}}$

[3] l = length of lake or basin.

4 = assuming no entry of water from the Lower basin of Nilkitkwa Lake.

are proportional to the biomass of the reflecting targets.

CONVERSION OF INTERGRATED VALUES INTO NUMBER ABSOLUTE DENSITY ESTIMATES

The underlying assumption here is that all fish are of the same size and that their target strength in dorsal aspect is a fixed constant. In practice this is not the case since juvenile sockeye salmon differ in length and there are other targets in the lake such as kokanee and trout. In this case the biomass was converted into numbers on the basis of an average sized Babine Lake juvenile sockeye salmon.

Thus there remains the problem of scaling the integrated values so that they correspond to numbers, and of determining the effective pulse volume insonified during one transmission.

BEAM ANGLE

The manufacturer of a transducer will normally produce a diagram of the directivity pattern or the distribution in space of emitted energy. This can then be used to estimate the effective beam angle. Practically the boundaries of sample volume are set by the signal to noise ratio. In Babine Lake the ambient noise level was set at 0.02 V-peak at the depth of maximum interest or a depth reading on the oscilloscope of 45 ms corresponding to a depth of 32.76 m.

Maximum target amplitude on the acoustic axis near the maximum depth of interest was found to be 1.1 V-peak.

The signal to noise ratio

$$= \frac{1.1 \text{ V-p}}{02 \text{ B-p}} = 55$$

or in dB notation 20 log 55 = 34.8/dB.

Depth (ms)	Depth (m)	Cone Rad. (m)	Depth Interval (ms)	Pulse volume ($V= \pi r^2h$) (m^3)
10	7.3	.68	5-15	10.63
20	14.6	1.38	15-25	43.77
30	21.8	2.07	25-35	98.47
40	29.1	2.75	35-45	173.80
50	36.4	3.44	45-55	271.96

On the plot of directivity pattern (Fig. 2), the point corresponding to -17.4 dB gives a beam angle, β = 10.75°.

From this value the various pulse volumes can be obtained by simple calculation, as follows:

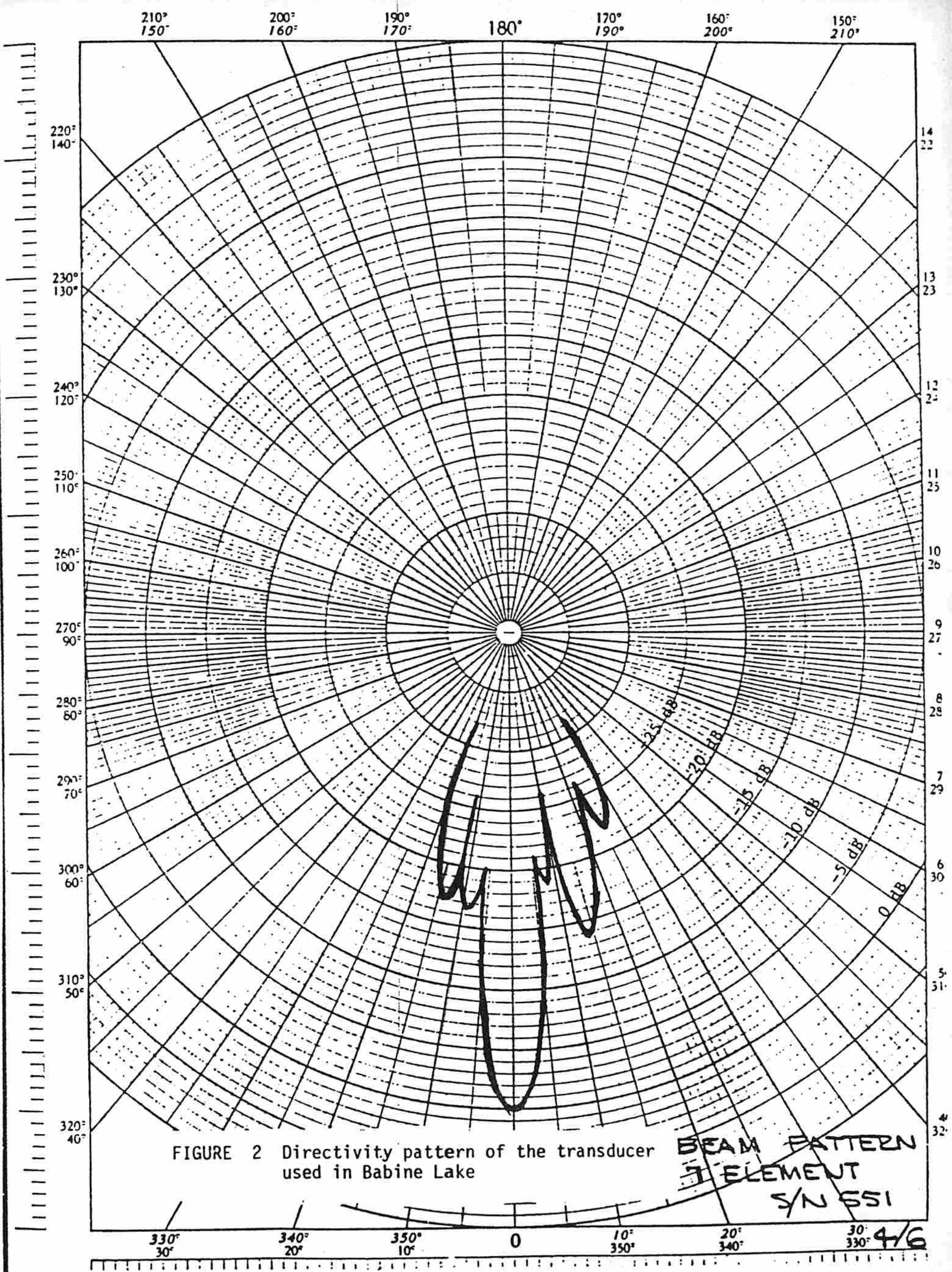

FIGURE 2 Directivity pattern of the transducer used in Babine Lake

SCALING FACTORS

Fish density, λ is computed from the expression $\lambda = \frac{I}{A\ B\ P}$ where;

I = Integrated voltage

P = number of transmission (pings) in one transect,

A = a factor related to fixed system parameters and the mean scattering cross section, and

B = a factor correcting for deviation from linearity in the TVG function.

The common procedure for experimental scaling is to integrate a series of short sections of about 2 min. duration for the established time depth intervals. Provisional scaling factors are used, in this case A was set equal to 1 and the B's were estimated on the basis of past experience. Absolute density estimate can be derived from oscilloscope counts of single targets, detectable above an established detection threshold. This threshold is corrected for deviation from linearity of the TVG ramp function. The attenuation was considered negligible and omitted. From these sets of values a linear regression line can be calculated to relate absolute densities to integrated squared voltages and the line can be used to predict densities for any integrated voltage. Next, the correct B-values are computed, and substituted back into the integration equation. The computer output now gives absolute densities.

RESULTS AND DISCUSSION

Only transects, run at night, were used to calculate population densities. Sockeye salmon juveniles which may in daylight form feeding schools, or may be heterogeneously distributed in the water column, will at night aggregate in a loose but rather homogeneous band which may extend from 5 to 15-20 m., ideal for this type of hydroacoustic stock assessment. This may be seen from transects no. 19 and no. 27 which were run from Fulton River across the lake early in the afternoon while transects no. 18 and no. 35 were run at essentially the same place at night. The difference in density is illustrated in Fig. 3 and Fig. 4 and quantified in Table 2. Not only is the day value about 1/4 of the night densities but the few remaining day targets are found about 20 m deeper than during the night. Narver (1970) traced the vertical distribution of

TABLE 2 Comparison of night and day transects in the vicinity of Fulton River.

Transect No.	Start Time	No. Pings (P)	Mean no./ $100m^2$ of lake surface	% Vertical Distribution by Depth (m)						
				4-11	11-18	18-26	26-33	33-40	40-48	48-55
NIGHT RUNS										
18	05:20	2,891	13.87	29.0	53.3	14.5	2.8	.2	.1	-
35	00:06	3,431	23.58	21.2	55.8	18.9	4.0	.1	-	-
Average Night Observations:			18.73	25.1	54.6	16.7	3.4	.1	.1	-
DAY RUNS										
19	15:48	3,593	5.97	15.4	1.5	50.9	28.1	1.9	1.9	3.7
27	16:22	3,659	3.15	9.0	1.9	45.4	34.7	.9	1.9	.5
Average Day Observations:			4.56	12.2	1.7	48.2	33.9	1.4	1.9	2.1

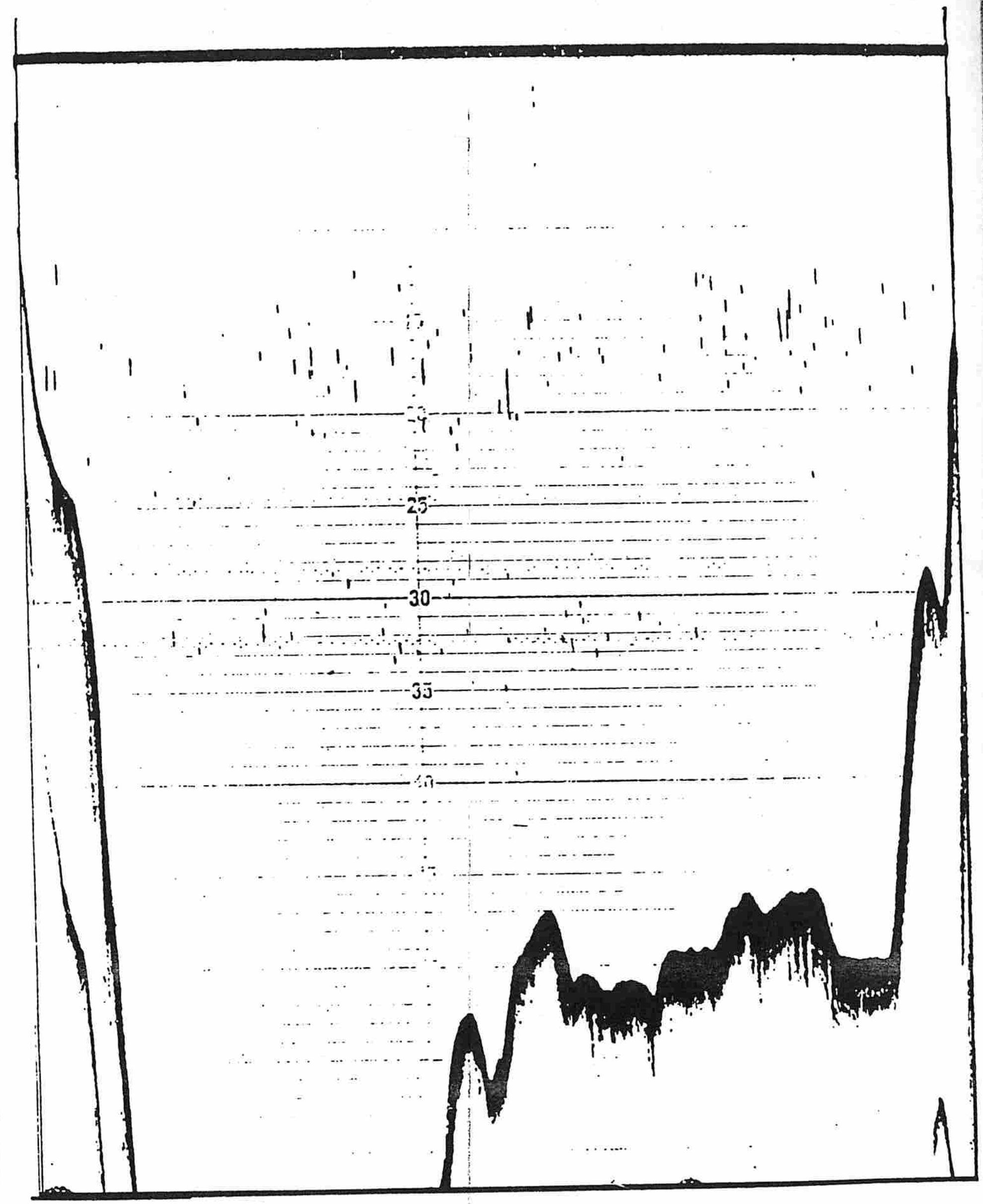

Figure 3. Transect No. 19: daytime transect.

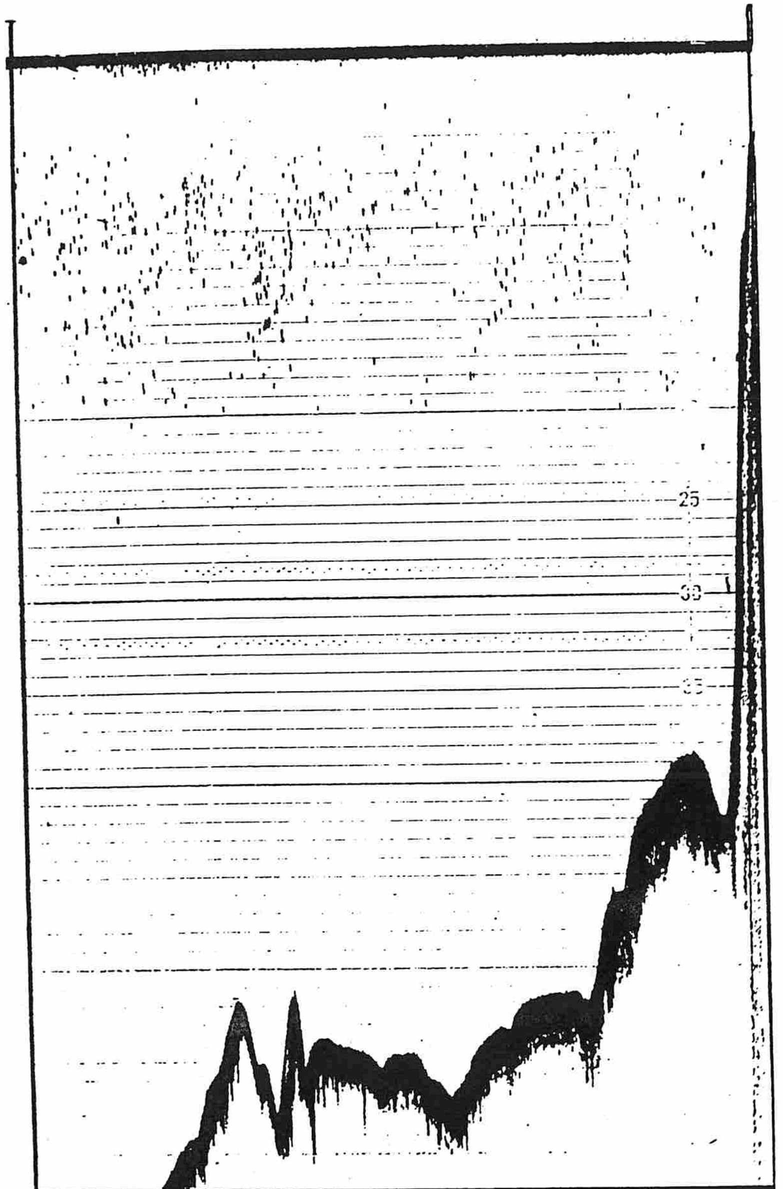

Figure 4. Transect No. 18: night transect

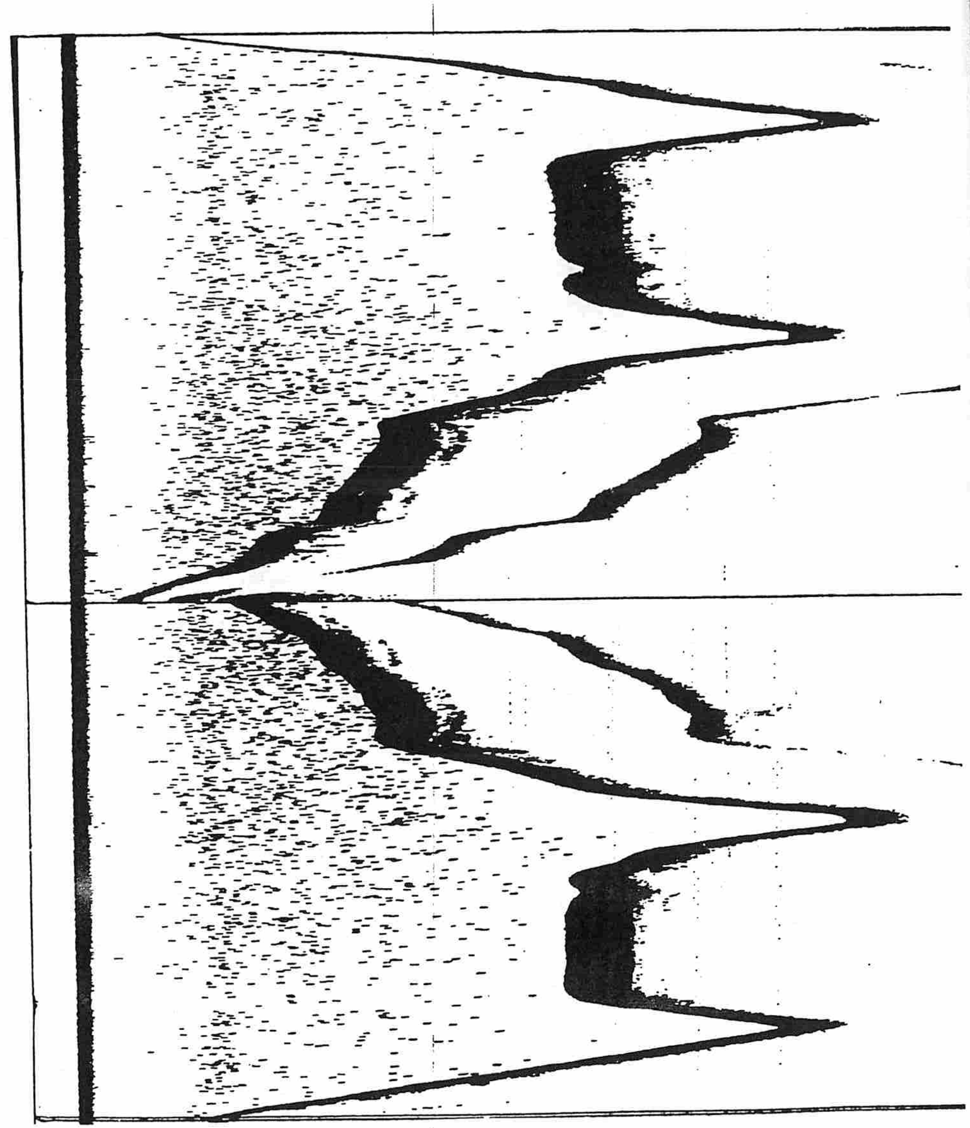

Figure 5. "Back to back" transects No. 22 and No. 23

underyearling sockeye in Babine Lake and described two rather distinct layers of fish with mid levels on the order of 15 m apart during daylight hours. These ascended toward the surface at dusk, descended soon afterward only to rise again at dawn, and (p. 289) "---most remained within the top 15 m through hours of darkness". The scatter in our daytime surveys and the contrasting day and night depth distribution are consistent with Narver's extensive and detailed observations.

The repeatability of the surveys is very good. Transects no. 22 and no. 23 were made back to back within a 30 min. period and gave us average densities 109.152 g/100 m^2 and 109.109 g/m^2 respectively, or a difference of .041 g/m^2, (Fig. 5).

The distribution of targets within sections revealed lowest densities near the shores on either side of the transect and maximum densities in the middle of the lake. One typical example is illustrated by transect no. 33 in section 7 where the transect was integrated in 2 min. intervals (Table 3).

TABLE 3 Transect no. 33 integrated in approximately 2 minute intervals.

Segment	Number of Transmission P	Density g/100 m^2
A 1/	295	14.639
B	239	27.855
C	241	20.077
D	240	34.248
E	241	31.671
F	241	22.376
G	240	19.038
H	401	12.051

*1/ on SW side near Granisle Village.

Incidentally, these segments provided the data for calculations of B-values discussed earlier.

The length of each transect is measured by the number of "pings" or pulses integrated, each ping representing a time interval of 1/2 sec.

The population estimates are summarized to each of the 11 lake regions in Table 4. While there were large numbers of fish in all parts of the lake surveyed, they were

TABLE 4 Fish densities observed in Babine Lake October 6 - 9, 1975 (listed by section from lake outlet).

Transect No.	Targets 100 m^2	Mean No. 100 m^2	Surface Area (km^2)	Population Estimate x 10^6
Section 1: Outlet to 9-Mile Pt.				
20	10.522	4.22		
21	78.696	39.14		
22	109.152	66.06		
Section means:		36.47	21.94	8.002
Section 2: 9-Mile Pt. to Sockeye Pt.				
24	25.969	12.39		
25	48.394	43.93		
Section means:		28.16	13.39	3.771
Section 3-4: Sockeye Pt. to McKendrick Is.				
26	6.520	5.55		
Section means:		5.55	18.07	.994
Section 5: Morrison Arm				
28	7.845	2.41		
39	2.259	1.39		
30	4.303	4.26		
Section means:		2.69[1]	31.97	.859

[1]Weighted mean

TABLE 4 - cont'd...

Transect No.	Targets 100 m^2	Mean No. 100 m^2	Surface Area (km^2)	Population Estimate x 10^6
Section 6 & 7: McKendrick Is. to Bear Island and Hogan Arm[1]				
31	21.689	19.69		
32	15.764	14.10		
33	21.731	20.01		
Section means:		17.93	52.32	9.383
Section 8: Bear Is. to Sandspit				
34	10.133	6.16		
35	30.291	23.58		
36	26.038	15.42		
18	15.269	13.87		
17	11.168	5.77		
1	6.402	3.91		
2	5.462	2.96		
3	14.896	3.36		
4	7.423	3.82		
Section means:		8.76	169.72	14.869
Section 9: Sandspit to Black Pt.				
5	11.511	5.51		
6	46.438	21.92		
7	25.793	12.39		
8	30.759	14.22		
9	39.806[1]	26.44[1]		
10	59.629	27.16		
Section means:		17.94	50.43	9.047

[1]Towed body turned over. Estimate obtained by integrating values obtained before and after that event: i.e., $\frac{24.38 + 29.94}{2}$.

TABLE 4 - cont'd...

Transect No.	Targets 100 m^2	Mean No. 100 m^2	Surface Area (km^2)	Population Estimate x 10^6
Section 10: Black Pt. to Boling's Pt.				
16	34.373	25.89		
15	20.056	15.67		
14	10.714	5.70		
Section means:		15.75	74.75	11.776
Section 11: Boling's Pt. to Lakehead				
13	12.461	5.14		
12	5.719	2.81		
11	1.606	.45		
Section means:		2.80	58.01	1.524
ALL SECTIONS COMBINED:				60.23

particularly large in section 1 near the outlet and again in the more southerly sections 8, 9 and 10. The first region probably drew most of its fish from the natural spawning grounds in the Upper Babine River since McDonald (1969, p. 264) found no evidence of significant movement of underyearlings in either direction through the narrows between the North Arm and Main Lake regions. The second region doubtless included fish from both natural spawning grounds in streams around the lake perimeter and from the extensive Fulton River and Pinkut Creek enhancement facilities both of which lie within areas 8 - 11. These results indicate a wide distribution of fry through the lake in October, 1975 and we consider them as positive evidence of the effectiveness of the enhancement facilities in achieving a satisfactory distribution of juveniles in the lake.

Incidentally the lower density found in section 11 at the south end is not surprising. McDonald (1969) found that fish were concentrated in the south during mid summer but that there was a shift northward during late summer and autumn. In 1966 over 60% of the population was by October located between Newman Peninsula and Sandspit. At the time of our survey about 30% of the main lake population is estimated to have occupied that area.

LACUSTRINE DISTRIBUTION COMPARED WITH OTHER YEARS

There is hazard in comparing the size and distribution of fish populations from year to year even when estimates are obtained by the same people and gear in the same season; when none of these desired factors prevail the comparisons are indeed tenuous.

However there is considerable interest in knowing if patterns of distribution and abundance have persisted over the years. Comparisons with data of Johnson (1958) obtained in mid summer with townets and with those of McDonald (1969) and McDonald and Hume (unpublished) for several years with seine nets are informative. Johnson's estimates in the main lake south of Old Fort were grouped to just three areas while those of the later authors and ourselves were in five areas. They correspond as follows:

Areas of Johnson	Later Areas Designation
1	1
2	2 + 3
3	4 + 5

In Figure 6 we have compared our estimates of underyearlings per 100 m^2 in 1975 with those of Johnson in 1956 and 1957 (Johnson, 1958). The dearth of fish in Area 1 in Johnson's surveys may result because of low production in that part of the lake in those early years, or it may be that fish produced there had moved elsewhere in mid summer as suggested by McDonald (1969, p. 250).

In that paper McDonald reported that fry were distributed throughout the main lake basins (Areas 1 - 5) in October 1966 but that largest numbers and highest density per unit surface area occurred in Area 2.

That is similar to the distribution found by McDonald and Hume (unpublished MS) in several later years. Their index to abundance in the five areas in October is reproduced in Figure 7 with our 1975 data inserted in their series for comparison.

McDonald and Hume used "indices" calculated from the geometric mean catch per seine set x surface area so their indices are not precisely the same as our estimate of fish per unit surface area. The distinction is likely not very important here and the pattern of densities in the 5 areas in the 5 years is remarkably similar, e.g., heaviest in areas 2 and 4; lightest in areas 1, 3 and 5.

The similarity of our 1975 distribution, with McDonald and Hume's 1972, 1973 and 1977 distributions is particularly close.

THE POPULATION ESTIMATE

The hydroacoustic population estimated in Areas 3 - 11 is 48.5 million sockeye salmon in October 1975. This can be related to a "main lake" smolt estimate of 38.8 million (± 1.6. million) obtained by Department of Fisheries and Oceans staff at the outlet of the lake in May and June 1976. (See MacDonald and Smith 1980, for discussion of the methodology for estimating the daily and seasonal Babine Lake smolt output and ascribing confidence limits.)

The difference between fry estimates in the autumn of 1975 and smolt estimates in the spring of 1976 is 9.7 million which suggests an overwinter reduction of 20% in population size. Unfortunately there are a number of factors which auger against a simple conclusion that one in five main lake fish did not survive the winter. These include of course possible significant error in the population estimates themselves and the likely presence of some fish other than sockeye juveniles among the

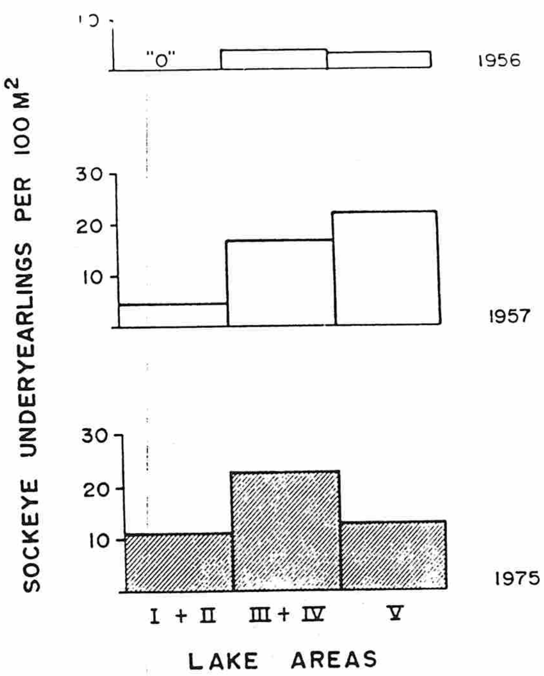

Figure 6. Comparison of fry distribution pattern obtained by hydroacoustic methods (1975) with those obtained by townetting in 1956 and 1957 (Johnson, 1958)

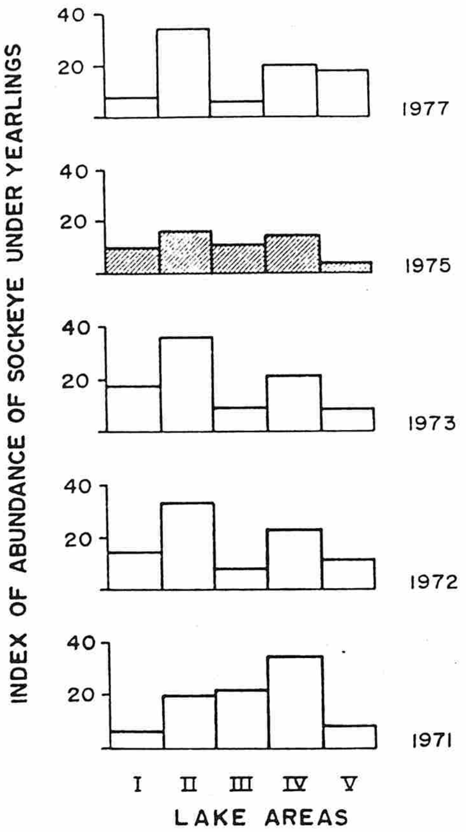

Figure 7. Comparison of fry distribution pattern obtained by hydroacoustic methods (1975) with those obtained by seining in 1971, 1972, 1973 and 1977 (McDonald and Hume, unpublished MS).

targets contributing to the autumn estimate.

Little is known of the overwinter mortality among sockeye stocks but clearly it is quite variable from lake-to-lake and for different year classes in the same lake. At Babine, Smith (1973) found large numbers of young sockeye infested with the cestode parasite Eubothrium salvelini. Infection rates varied greatly from year to year and he provided some evidence to suggest that the parasite could induce mortality to the host - particularly in association with other forms of stress, e.g., food scarcity or heavy predation.

It is also known that young of kokanee, the non-anadramous variety of Oncorhynchus nerka abound in the lake in some years and these could make up a part of the lacustrine fish community measured by the hydroacoustic gear. However these we consider unlikely to be of a magnitude which would radically change our estimates of juvenile sockeye abundance.

SUMMARY AND CONCLUSIONS

This project had two main objectives: (1) to assess by hydroacoustic means the lacustrine distribution of juvenile sockeye late in the autumn and (2) to compare an estimate of juvenile abundance obtained at that time with numbers of smolt of the same brood year emigrating seaward at the lake outlet in the following spring.

Our assessment indicated an October pattern of post-enhancement distribution in the main basins of Babine Lake which was very similar to those found in 1966 by McDonald (1969) and McDonald and Hume (unpublished MS) using seine gear in each of 1970, 1971, 1972 and 1976. The pattern was unlike that found by Johnson in the pre-enhancement period in 1957 and 1958. However, populations were then very small and the estimates were made in August.

We conclude that while our data cannot be used as evidence that the spawning channels caused a more favourable use of the total lake area than prevailed before their development, it does help to confirm a pattern of distribution in October 1975 which was remarkably like that measured in several other recent years. McDonald and Hume, in their unpublished MS point out that no reduction in mean size of underyearlings has been detected in years since the spawning channels came into production. If the observed distributions had been unfavourable this would hardly have been the case so we judge the observed distribution to be satisfactory in terms of effective utilization of the lake's planktonic food organisms.

The population estimate derived from our hydroacoustic data was about 1.25 times that obtained for smolts from the corresponding lake regions the following spring. Unfortunately few estimates have been made of overwinter mortality of sockeye juveniles so this and the likely inclusion of some kokanee and other juvenile fishes in the echo traces argues for caution in assuming that October - June losses were about 20%.

However this figure appears reasonable and we conclude that hydroacoustic surveys of the general type carried out in 1975 certainly merit further testing and perhaps use, both for assessing future distribution of juvenile sockeye in Babine Lake, and for obtaining late autumn forecasts of pre smolt abundance.

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