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LAKE WASHINGTON SOCKEYE SALMON STUDIES

1975-1976

by

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INTRODUCTION

Acoustic techniques for the assessment of sockeye salmon were developed under the University of Washington Sea Grant Program and have been applied to studies of juvenile sockeye salmon in Lake Washington since 1969, and to assessment of adult sockeye returning to Lake Washington since 1971. These population estimates provide valuable information for the management of the Lake Washington sockeye salmon run, and support for the studies has been provided by the Washington Department of Fisheries since 1974. Results of the acoustic surveys during the past year are described in this contract report.

MATERIALS AND METHODS

Survey Equipment and Procedure

The acoustic data-acquisition system consisted of a Ross 200 A echo sounder with modifications for data collection on magnetic tape. The system is detailed in Thorne et al. (1972) and Nunnallee (1975).

Five acoustic surveys of the adult sockeye salmon were conducted from June 10 to July 29, 1975, the period of major migration into Lake Washington. The transect pattern, shown in Figure 1 has been used since 1973. All surveys were run at night to take advantage of the maximum dispersion of adults. Boat speed was 6 to 8 knots except for selected transects which were run at 3 to 4 knots to provide data for more accurate measurements of the sampling volume.

Only one survey on the juvenile salmon was conducted this year. The acoustic series, which consisted of the same 12 evenly spaced orthogonal transects as in previous years, was run on February 29, 1976. The associated trawling series with a 3 m IKMT from the RV Commando was conducted on February 25-26. The five sampling locations are shown in Figure 2.

Data Analysis: Adult Salmon Surveys

The targets recorded on magnetic tape were counted using thresholds previously established for Lake Washington adult sockeye salmon. Target strength measurements and comparisons among lock counts, tower counts, and acoustic counts from the past years have indicated that a threshold equivalent to a -38 decibel (dB) acoustic target strength gives the most accurate estimate of adult sockeye salmon. Thresholds of -41, -38, and -35 dB were used in this study in order to evaluate the sensitivity of the technique to the choice of threshold.

The area sampled by the echo sounder at the mean depth of the adult distribution was calculated using the same procedure as previous years. This technique is based on the duration of targets within the acoustic beam. The number of fish echoes counted over each threshold was divided by the sampling area to determine the number of fish per unit surface area for each transect. Total numbers in the transects were calculated by extrapolation over the surface areas represented by the transects.

Data Analysis: Juvenile Sockeye Salmon Survey

The acoustic data from the juvenile salmon surveys were again analyzed by digital echo integration techniques (Thorne et al., 1975). The integrator was calibrated by means of regression against fish densities derived from oscilloscope counting techniques. This procedure is essentially an indirect method of determining the mean acoustic target strength of the fish. Because of considerable variation in size and species composition throughout the lake, it was necessary to derive three separate regression relationships, one for all depths in the area south of the Mercer Island Bridge, one for depths above 25 m, and one below 25 m north of the bridge. The regression for the southern area, where the highest densities were encountered, is illustrated in Figure 3.

The integration analysis resulted in estimates of total fish abundance in various depth and area strata. The species composition from the net tows corresponding to these strata was then used to allocate the abundance to the various species, and total abundance for each species in the lake was calculated by summing over the strata.

In addition to the acoustic estimates, the net tows were used to estimate density by assuming a swept volume of 1000 m^3 per min of tow, as in previous years. These densities were then extrapolated by the volume of the strata to derive estimates of total lake abundance. The net and acoustic estimates of total abundance are completely independent, but the species composition of the two estimates are obviously the same.

RESULTS AND DISCUSSION

Adult Salmon Surveys

The estimates of fish in Lake Washington based on the three counting thresholds are shown in Table 1. The estimate of targets exceeding the -41 dB threshold was 35,500 on June 10. The numbers increased rapidly to a level varying between 247,000 and 275,000. The estimate of targets exceeding the -38 dB threshold was initially 16,000 and increased to a level of about 180,000 fish. The fish exceeding the -35 dB threshold was 10,000 initially and increased to a level varying between 137,600 and 165,400.

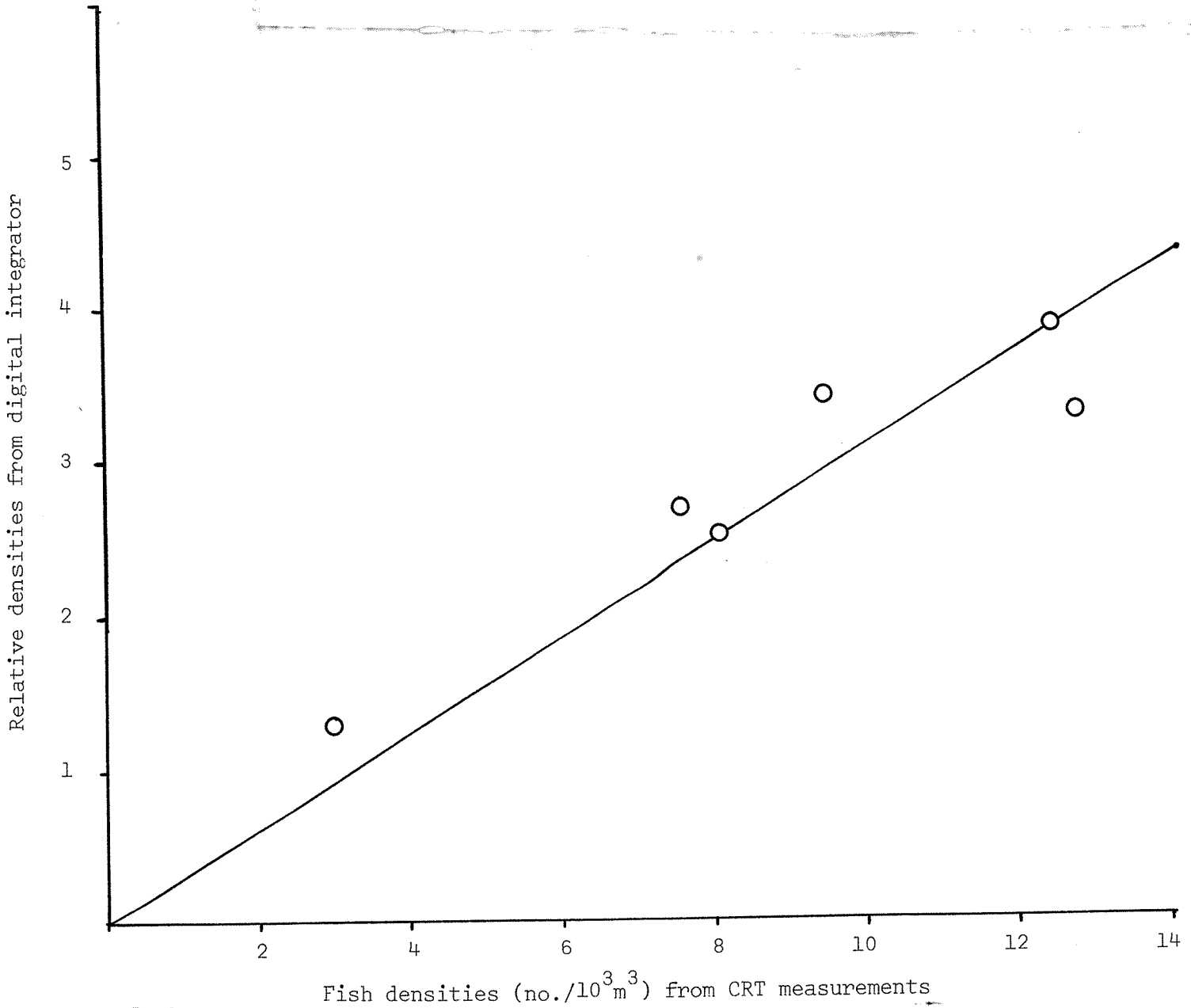

Fig. 3. Relation between output of digital integrator and fish densities determined from oscilloscope measurements for southern Lake Washington

Table 1. Results of Lake Washington adult sockeye salmon surveys during 1975, based on -35, -38, and -41 dB target strength thresholds

	Population estimates (thousands)		
Date	-35	-38	-41
June 10 (background)	10.0	16.3	35.5
July 16	80.0	100.3	148.4
July 23	154.2	181.1	262.3
July 28	137.6	182.1	275.0
July 29	165.4	179.9	247.1
Mean of last two series minus background	141.5	164.7	225.5

The estimates of June 10 were considered as resident or background counts. Subtracting these values from the mean of the final two series results in population estimates of 225,100, 165,000, and 141,500 for the -41, -38, and -35 dB thresholds, respectively. As noted earlier, target strength studies and previous comparisons indicate that the -38 dB threshold should provide the most accurate estimate of adult sockeye salmon. The estimate varies appreciably with the threshold. However, since calibration accuracy within 1 dB is readily obtainable, errors resulting from calibration should be minor. The largest variance components are probably those associated with sampling and sampled area measurements. The calculated sampling area for the system has varied from 2.0 to 3.4 m^2 over the past four years. A value of 2.45 m^2 was used in 1975. Presumably, most of this variability is derived from variation in mean target strengths, depth distribution, and transducer directivities.

Juvenile Sockeye Salmon Surveys

The acoustic and net haul estimate of the 1974 year-class sockeye salmon in each of the five sampling areas and the total lake are presented in Table 2. The acoustic estimate for the total lake was 763,625. The corresponding net estimate, 849,070, is in good agreement. The fish distribution was primarily in the southern half of the lake.

These presmolt sockeye salmon of the 1974 year-class are progeny of about 120,000 spawners. Under favorable conditions, one would expect over two million smolts. The results of both net and acoustic surveys indicate that the population is far below this level. Previous studies have demonstrated that acoustic surveys provide an accurate estimate of the limnetic population. However, the population may be underestimated when fish are distributed near bottom in the south end of Lake Washington, as was the case this year.

The other major problem area is the species composition information. The trawl estimate of the percent of 1974 year-class sockeye salmon in the limnetic population was only 18.3, the lowest since the series began in 1969, and only one sockeye was caught north of the Evergreen Point Bridge. The detailed results of the net tows are given in Table 3. Many of the hauls are replicated to provide a measure of the variability. Undoubtedly, the net tows represent the largest component of variance when the percent composition is as low as indicated this year.

Unfortunately, this is the first time since the initial series in 1969, that only one survey was conducted. The smaller populations are more difficult to estimate with precision, but provide less economic justification for additional effort. The greatest area of uncertainty is the net tows, but at $700 per night for boat charter, it is difficult to justify more than the minimum of two nights for sampling.

Table 2. Acoustic and net haul estimates and percent species composition of the 1974 year-class juvenile sockeye salmon in 5 sampling areas and total Lake Washington during February 1976.

Area	Acoustic estimate	Net estimate	Percent of 1974 year-class sockeye salmon
1	0	0	
2	23,025	15,420	1.6
3	162,650	69,940	11.9
4	231,510	329,610	37.2
5	346,440	429,100	16.7
Total	763,625	849,070	18.3

Table 3. Results of net tows in various areas of Lake Washington, February 25 and 26, 1976

Area	Haul	Depth (m)	Sockeye 1974 YC	Smelt 1974 YC	Smelt 1975 YC	Stickle-back	Other	Percent of 1974 YC sockeye
5	1	15	5	4	13	14	0	14
	2	22	12	2	11	34	1	20
	3	28	13	3	8	20	5	27
	4	15	4	11	7	1	0	17
	5	22	7	0	6	50	2	11
	6	28	6	1	11	28	3	12
4	7	15	0	10	3	1	0	0
	8	15	1	17	9	1	1	3
	9	22	4	3	12	2	1	18
	10	28	11	0	4	1	1	65
	11	35	21	2	4	0	4	68
	12	35	14	0	5	3	2	58
3	13	15	0	4	4	3	0	0
	14	22	1	3	6	1	0	9
	15	28	2	1	4	3	0	20
	16	35	1	0	1	1	0	33
	17	50	1	0	3	0	3	14
2	18	15	0	4	0	1	0	0
	19	22	0	3	5	4	0	0
	20	28	0	2	5	19	1	0
	21	35	0	0	4	8	0	13
	22	50	1	2	5	0	0	0
1	23	15	0	2	4	14	0	0
	24	22	0	1	3	10	0	0
	25	28	0	2	0	8	0	0

Despite these problems, the results of the 1976 juvenile sockeye salmon surveys indicate that the 1974 year-class presmolt population is less than would be expected from the parent population under normal conditions, and may result in the lowest return since 1963.

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