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MANUSCRIPT REPORT SERIES

No. 1096

Comparison of the Fecundity of Sockeye Salmon *(Oncorhynchus nerka)* in the Skeena River Catch with the Fecundity of those in the Escapement

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INTRODUCTION

Skeena River sockeye salmon are caught by the fishery mainly with gillnets. It is generally recognized that gillnets are selective for size. Foskett (1958) compared the size of sockeye sampled from the Rivers Inlet catch with the size of those sampled from the spawning grounds. He observed that the fishery tended to select the larger 4-year-olds, the smaller 5-year-olds, and none of the 3-year-olds. The selective action of gillnets in the Skeena fishery is described by Milne (1955). More recently Larkin and McDonald (1968) estimated that the Skeena River fishery selectively removed 5-year-olds at a rate 1.5 times that of 4-year-olds, and took none of the 3-year-olds.

The purpose of this report is to compare the fecundity of sockeye of the Skeena catch with that of the escapement.

METHODS AND MATERIALS

For the period 1962 to 1966, a total of 5,262 and 9,869 sockeye from the Skeena catch and escapement (Babine Lake which produces about 90% of the Skeena run), respectively, were sampled for age, sex and length. From these samples, the number of age-1.2[1] and /-1.3 female sockeye in each year's catch and escapement was estimated. Then the number of females of each age in each centimeter hypural length category (hypural length: the distance from the posterior orbit of the eye to the hypural plate) in the catch and the escapement was estimated for each year.

The number of eggs (and average weight per egg) contained by females of each age and length category in the catch and escapement was estimated for each year. The formula (Aro, MS, 1961), derived from 442 Babine sockeye from the years 1946, 1947, 1949-53, and 1956, used to estimate the numbers of eggs was:

$$Y = 82.3X - 1627.9$$

where Y = the number of eggs, and X = fork length in centimeters.

Because the above regression formula was based on fork length, the hypural length samples of sockeye from the catch and escapement in latter years had first to be converted to fork lengths. Conversion was made using the formula (Bilton et al., 1967):

$$Y = 21.4685 + 0.7861X$$

where Y = hypural length in millimeters, and X = fork length in millimeters.

The average weight per egg was estimated using the formula (Bilton, 1970):

$$Y = 0.0348 + 0.3242X$$

where Y = weight per egg in grams (× 100), and X = hypural length in centimeters.

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[1] The European system of age designation (Koo, 1962) is used in this report.

RESULTS

The data indicate that the fishery selects the larger fish of both age groups (Fig. 1). Virtually all fish 55 cm and over (regardless of age) were caught by the fishery (Fig. 2). On the other hand almost all fish 40 cm and less escaped the fishery. Comparison of weighted estimates of the average size of age-1.2 and /-1.3 fish from the catch with those from the escapement indicate fish in the catch were consistently larger (Table 1). Tests for significance of difference in size were made using smaller unweighted length samples of 1.2 and 1.3 females from the annual catch and escapement. In every case the differences in size were statistically significant (Table 2).

Because females on the average were larger in the catch than in the escapement they contained on the average more eggs and larger eggs (Table 1). Tests for significance of difference in numbers of eggs and in size of eggs were made using the smaller unweighted samples used to test for differences in length. In every case the differences in number and size of eggs was statistically significant (Table 2).

DISCUSSION

The results indicate the fishery selected significantly larger 1.2 and 1.3 female sockeye containing significantly more and larger eggs (the reason for the apparent selection of the larger age-1.3 fish, as well as the larger age-1.2 fish, is puzzling and not known at present). What do such differences represent in total numbers of eggs and weight of eggs contained by 1.2 and 1.3's in the real catch where selection occurs when compared with a non-selective theoretical catch? Estimates of total number and weight of eggs contained by 1.2 and 1.3's in the real and theoretical catches for the years 1962 to 1966 are given in Table 3. For 1.2's, the real catch accounted for 10.9 to 19.8 million eggs in excess of the estimated number taken by the theoretical catch and for 1.3's, from 4.8 to 44.2 million eggs. Similar differences in total weight of eggs are indicated. For 1.2's, the real catch accounted for 7.9 to 20.5 million grams in excess of the estimated weight of eggs taken by the theoretical catch, and for 1.3's from 3.2 to 11.2 million grams.

It is difficult to assess the effect of such size selection by the catch on the Skeena sockeye stock over the past 50 years. Examination of length data of catch samples does not indicate any consistent change in the size of the fish. However, it is recognized the fishery tends to catch approximately the same size segment of the stock each year. Therefore, changes in size of fish in the stock may have occurred but have gone undetected. The cropping of the larger eggs by the catch may be of disadvantage to the stock. Larger eggs on the average result in larger fry which tend to grow more rapidly than those from smaller eggs (Higgs, 1942; Brown, 1946; Svardson, 1949; Bilton, MS, 1970). Foerster (1954) demonstrated that larger yearling sockeye survive better than the smaller yearlings. Thus the cropping of the larger eggs by the catch could reduce the per cent survival. Further, as mentioned earlier, selection by the catch accounted for an additional 4.8 to 44.2 million eggs from the total stock that otherwise would have been in the escapement. If a 0.1% survival rate from

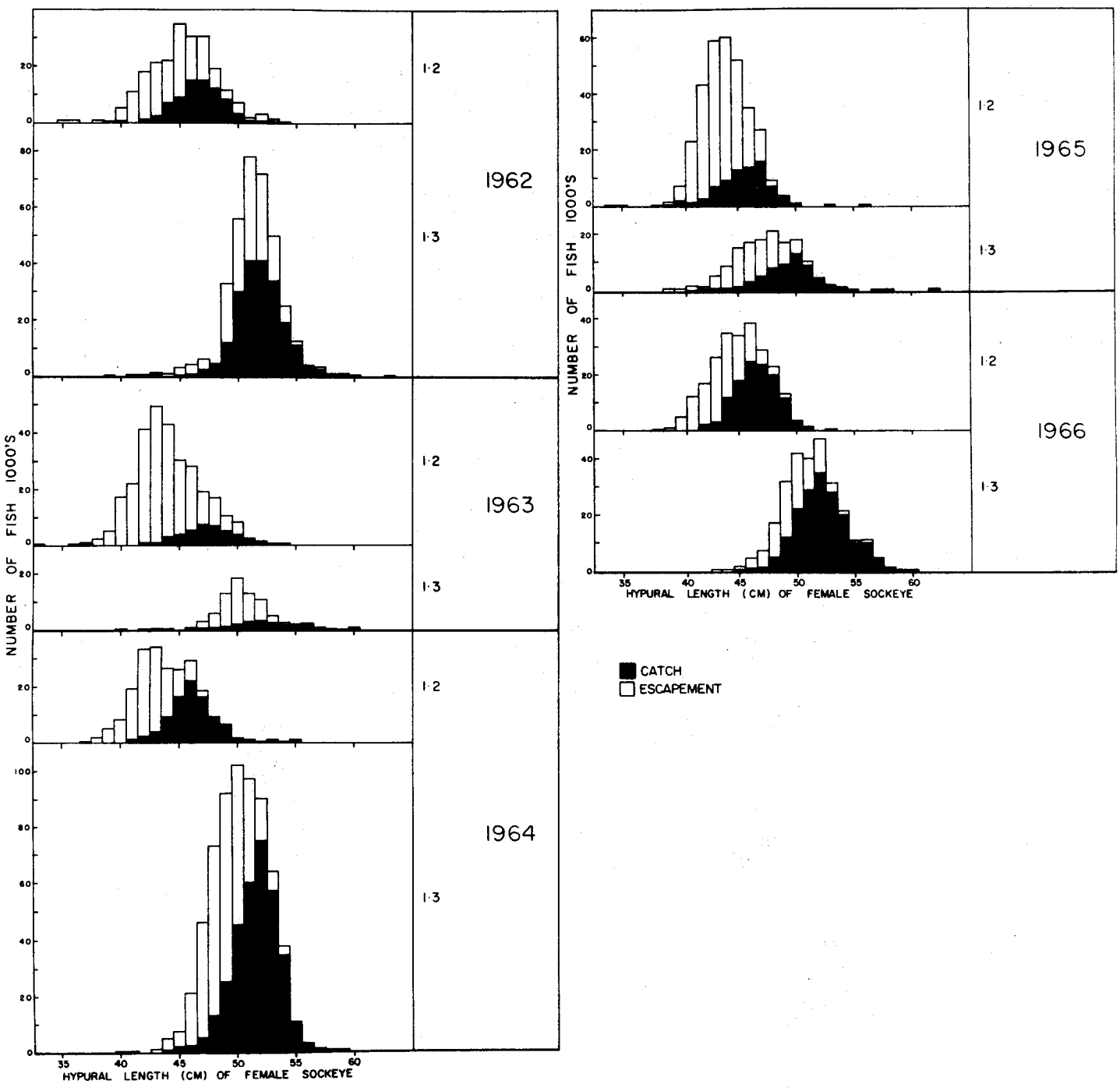

Fig. 1. The size composition of age-1.2 and /-1.3 female sockeye in the Skeena catch and escapement for the years 1962 to 1966.

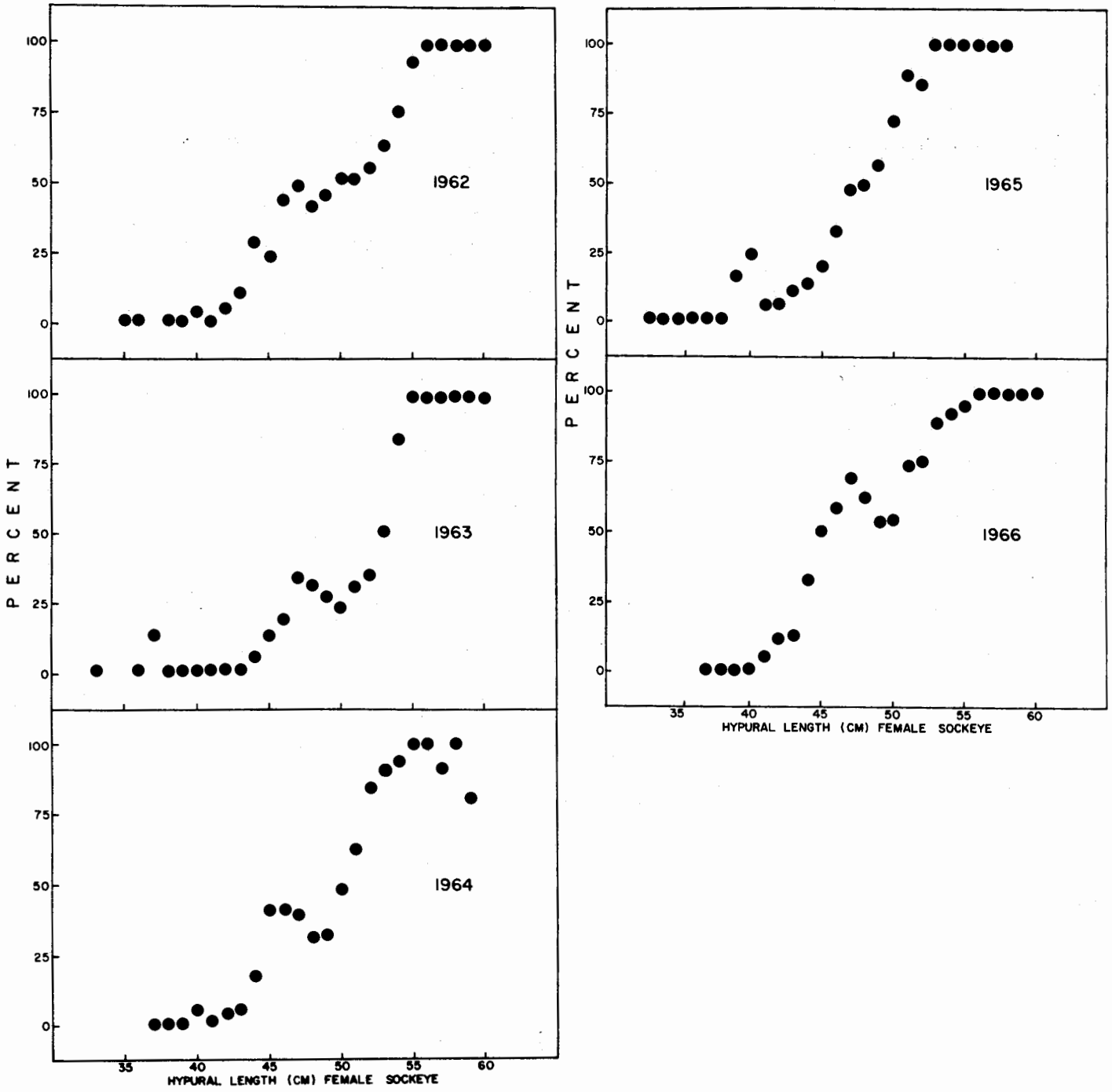

Fig. 2. The percentage of each length group present in the total stock (catch + escapement) of female sockeye that was removed by the fishery for the years 1962 to 1966.

Table 1. Estimated total numbers of eggs and total weight of eggs contained by all age-1.2 and/-1.3 female sockeye in the catch and escapement annually, for the years 1962 to 1966.

Age	Year	Catch (C)	Escape (E)	Stock C + E	% C of C + E	No. eggs x10^6				Wt. eggs, grams x10^6				Mean no. eggs per female			Mean wt. per egg, grams			Mean length cm		
						C	E	C + E	% C of C + E	C	E	C + E	% C of C + E	C	E	Diff.	C	E	Diff.	C	E	Diff.
1.2	1962	75,536	148,848	224,384	33.7	230.96	422.62	653.58	35.3	35.128	61.609	96.737	36.3	3,058	2,839	219	0.1521	0.1458	0.0063	46.75	44.66	2.09
♀	1963	39,907	258,763	298,670	13.4	124.68	705.05	829.73	15.0	19.226	100.191	119.417	16.1	3,124	2,725	399	0.1542	0.1421	0.0121	47.40	43.58	3.82
	1964	92,656	128,417	221,073	41.9	278.61	336.52	615.13	45.3	41.952	46.626	88.578	47.4	3,007	2,620	387	0.1506	0.1385	0.0121	46.25	42.59	3.66
	1965	79,155	247,922	327,077	24.2	231.71	675.65	907.36	25.5	34.347	95.711	130.058	26.4	2,928	2,725	203	0.1482	0.1416	0.0066	45.51	43.56	1.95
	1966	125,034	119,641	244,675	51.1	379.58	326.65	706.23	53.7	57.439	46.382	103.821	55.3	3,036	2,730	306	0.1513	0.1420	0.0093	46.53	43.62	2.91
	Av.															302.8			0.0093			2.88
1.3	1962	206,756	168,702	375,458	55.1	740.94	578.73	1,319.67	56.1	124.881	94.797	219.678	56.8	3,584	3,430	154	0.1685	0.1638	0.0047	51.86	50.37	1.49
♀	1963	21,368	58,323	79,691	26.8	78.82	197.11	275.93	28.6	13.565	31.930	45.495	29.8	3,689	3,380	309	0.1721	0.1619	0.0102	52.88	49.87	3.01
	1964	336,934	316,986	653,920	51.5	1,195.43	1,038.89	2,234.32	53.5	200.189	165.058	365.247	54.8	3,548	3,277	271	0.1675	0.1589	0.0086	51.51	48.88	2.63
	1965	59,439	85,900	145,339	40.9	198.54	260.04	458.58	43.3	31.986	39.303	71.289	44.9	3,340	3,027	313	0.1611	0.1509	0.0102	49.49	46.44	3.05
	1966	175,404	91,923	267,327	65.6	632.11	308.63	940.74	67.2	106.936	49.782	156.718	68.2	3,604	3,357	247	0.1691	0.1613	0.0078	52.04	49.64	2.40
	Av.															258.8			0.0083			2.52

Table 2. Mean length, number of eggs per female, weight per 100 eggs per female, sub samples of 1.2 and 1.3 sockeye in the catch and escapement for the years 1962 to 1966. Table shows t values.

Age			1962		1963		1964		1965		1966	
			Catch	Escape	Catch	Escape	Catch	Escape	Catch	Escape	Catch	Escape
1.2	Length	$\bar{x}$	46.55	43.81	47.30	43.22	46.25	42.46	45.57	42.81	46.52	42.81
	(cm)	S.D.	1.74	2.49	2.22	2.57	2.30	1.93	2.06	2.00	1.87	1.85
		N	29	49	46	81	70	43	54	55	48	59
		t	5.56		9.99		9.41		7.15		9.89	
	Egg number	$\bar{x}$	3037.64	2749.94	3115.06	2792.92	2983.83	2606.71	2933.64	2644.95	3034.89	2644.01
	per female	S.D.	180.85	266.26	229.43	272.41	196.80	206.30	216.04	215.54	193.04	201.08
		N	29	49	46	81	70	43	54	55	48	59
		t	56.70		76.99		97.22		72.54		101.19	
	Weight per 100	$\bar{x}$	15.09	14.21	15.34	14.34	14.93	13.77	14.78	13.88	15.09	13.88
	eggs (grams)	S.D.	0.57	0.81	0.72	0.83	0.62	0.63	0.67	0.65	0.61	0.60
		N	29	49	46	81	70	43	54	55	48	59
		t	3.16		4.30		5.35		4.06		5.63	
1.3	Length	$\bar{x}$	51.80	49.86	52.75	49.93	51.57	48.19	49.42	46.15	52.11	48.94
	(cm)	S.D.	1.93	2.21	2.57	1.65	1.93	1.91	1.93	1.95	2.07	2.02
		N	72	79	53	47	74	133	42	107	63	111
		t	5.84		6.81		11.90		9.11		9.95	
	Egg number	$\bar{x}$	3577.56	3377.80	3675.01	3387.14	3554.21	3207.06	3332.62	2997.42	3609.90	3285.25
	per female	S.D.	201.12	227.50	266.70	169.58	200.71	198.56	198.75	202.14	214.78	209.33
		N	72	79	53	47	74	133	42	107	63	111
		t	59.13		68.33		119.89		91.77		100.12	
	Weight per	$\bar{x}$	16.79	16.16	17.10	16.19	16.71	15.63	16.03	14.97	16.89	15.87
	100 eggs (grams)	S.D.	0.63	0.71	0.83	0.53	0.62	0.62	0.62	0.63	0.67	0.65
		N	72	79	53	47	74	133	42	107	63	111
		t	3.32		3.87		9.21		5.17		5.64	

NOTE: Underlined values of t indicate significance at the 5 per cent level of probability.

Table 3. The total number of eggs and total weight of eggs contained by 1.2 and 1.3 female sockeye in the real and theoretical Skeena catches 1962 to 1966.

Age			1962	1963	1964	1965	1966
					Number eggs $x10^6$		
1.2	real		230.92	124.68	278.61	231.71	379.58
	theoretical		220.02	110.86	257.81	219.58	360.89
	difference	No.	10.90	13.82	19.80	12.13	18.69
		%	4.7	12.4	7.8	5.5	5.2
1.3	real		740.94	78.82	1195.43	198.54	632.11
	theoretical		726.71	73.98	1151.23	187.54	617.25
	difference	No.	14.23	4.84	44.20	11.00	14.86
		%	2.0	6.5	3.8	5.9	2.4
					Weight of eggs grams $x10^6$		
1.2	real		35.13	19.22	41.95	34.35	57.44
	theoretical		32.56	15.95	37.12	31.47	53.05
	difference	No.	2.57	3.27	4.83	2.88	4.39
		%	7.3	17.0	11.5	8.4	7.6
1.3	real		124.88	13.56	200.19	31.99	106.93
	theoretical		120.97	12.19	186.66	29.15	102.83
	difference	No.	3.91	1.37	13.53	2.84	4.10
		%	3.2	11.2	7.2	9.7	4.0

egg to returning adult is used (an approximate estimate for Babine sockeye) the selection by the catch reduced the stock by 4,800 to 44,200 fish.

In summary, present salmon management techniques are primarily aimed at achieving optimum numbers of fish on the spawning grounds. Because there is increasing stress on salmon stocks by the encroachment of civilization and industry the time has now arrived when salmon managers should also begin to consider the quality of the fish comprising the spawning escapement.

It seems strange that salmon have been and are harvested in a manner where the largest members are continually cropped, leaving the smaller members to perpetuate the species.

REFERENCES

Aro, K. V. MS, 1961. Summary of salmon enumeration and sampling data, Babine River counting weir, 1946 to 1960. Fish. Res. Bd. Canada, MS Rept. (Biol.) No. 708, 63 p.

Bilton, H. T. MS, 1970. Maternal influences on the age at maturity of Skeena River sockeye salmon (Oncorhynchus nerka). Fish. Res. Bd. Canada, Tech. Rept. No. 167, 20 p.

Bilton, H. T., E. A. R. Ball, and D. W. Jenkinson. 1967. Age, size and sex composition of British Columbia sockeye salmon catches from 1912 to 1963. Fish. Res. Bd. Canada, Nanaimo Biol. Sta. Circ. (Statistical Series) No. 25, 4 p.

Brown, Margaret E. 1946. The growth of brown trout. J. Exp. Biol., 22: 118-155.

Foerster, R. E. 1954. On the relation of adult sockeye salmon (Oncorhynchus nerka) returns to known smolt seaward migrations. J. Fish. Res. Bd. Canada, 11(4): 339-350.

Foskett, D. R. 1958. The Rivers Inlet sockeye salmon. J. Fish. Res. Bd. Canada, 15(5): 867-889.

Higgs, A. 1942. Big trout from big eggs. The Salmon and Trout Magazine, No. 106, p. 216-230.

Koo, T. S. Y. 1962. Age designation in salmon. Studies of Alaska red salmon. Univ. Washington Press, Seattle. p. 37-48.

Larkin, P. A., and J. G. McDonald. 1968. Factors in the population biology of the sockeye salmon of the Skeena River. J. Anim. Ecol., 37, p. 229-258.

Milne, D. J. 1955. The Skeena River salmon fishery, with special reference to sockeye salmon. J. Fish. Res. Bd. Canada, 12(3): 451-485.

Svardson, Gunnar. 1949. Natural selection and egg number in fish. Inst. Freshwater Research, Drottingham, Sweden, Rept. No. 29, p. 115-122.