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AN INTRODUCTORY STUDY OF THE YOUNG SOCKEYE SALMON IN LAKELSE LAKE, B. C.

As part of the propagation and lake studies on Lakelse lake it was deemed necessary to assemble and analyse the available information on young sockeye and review it in the light of the literature from the Cultus lake work.

I. PROPAGATION STUDIES

Certain counts and estimates have been made on the adult sockeye salmon of Lakelse lake. These are tabulated below:

Table I. Counts and estimates (in brackets) of adult sockeye salmon at Lakelse lake.

Year	Williams Cr.	Eliza Cr.	Scully Cr.	Others	Total
1932					(6,000)
1933					(4,000)
1937	(5,000)	(1,000)		(3,000)	(9,000)
1939	24,085		(2,000)	(7,000-10,000)	(33,000-36,000
1944	(20,000)	(2,000)	(2,300)	(700)	(25,000)
1945	(50,000)	(4,500)	(1,800)	(400)	(56,700)
1946	(35,500)	(2,000)	(2,200)	(300)	(40,000)

The 1932-1937 records are from hatchery estimates, the 1939 from Pritchard and Cameron, and the 1944-1946 from the Skeena River investigation.

Data for sockeye migrants from the lake are available for only one year, 1946, when the total estimate was 557,400. The age of these migrants showed that they arose almost completely from the parent year of 1944. In that year the total adult sockeye salmon run to the Lakelse lake system was estimated at 25,000. By applying to this figure the sex ratio recorded from counts made on the spawning streams (46% males, 54% females) and utilizing the data on egg counts made on Williams creek, Lakelse lake, in 1939 by Dr. A.L. Pritchard and Mr. W.M. Cameron (3,888 eggs per female), the percent survival from egg deposition to migrant can be calculated as approximately 1.06%.

This approximate reckoning may be compared with the results obtained by Dr. R.E. Foerster at Cultus lake, B.C. of percentage survivals of 1.13, 1.05 and 3.23, and by Mr. J.T. Barnaby for Karluk lake, Alaska, of from 0.45% to somewhat less than 1.0%.

II. FOOD AND FOOD SUPPLY

the others. (Ricker rates Epischura to Bosmina in a 10:1 ratio).

Plankton crustacea - Abundance, Size, Vertical Distribution

Ricker (loc. cit. p. 454) postulates "factors to account for the extent of predation of sockeye upon different plankters". Abundance is of prime importance. With regard to size, the larger organism usually is preferred. Habitat selection would be important if a plankter occupied an entirely different zone from the sockeye. Other factors might be greater agility, lesser visibility or different diurnal migrations.

In Lakelse lake, the actual plankton crustacea available for young sockeye has been studied by Brett (MS) and Alderdice (MS) for 1944 and 1945 respectively. Samples were taken with a #10 mesh net in 1945 when the most thorough study was made. The chief Entomostran species were: Epischura nevadensis, Cyclops bicuspidatus, Cyclops serrulatus, Bosmina longispina and Diaphanosoma leuchtenbergianum.

According to Alderdice (loc. cit.) Cyclops occurred

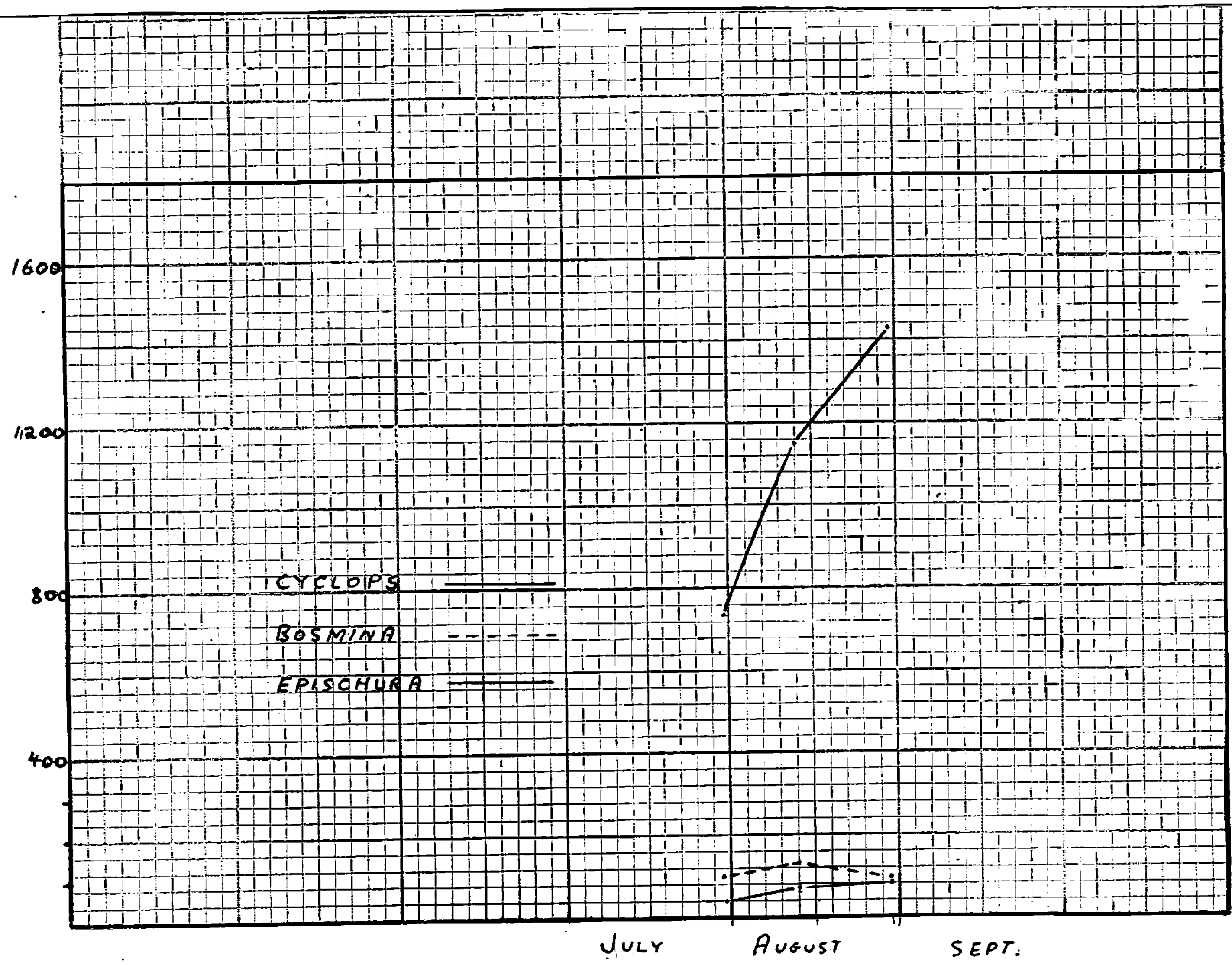

Figure 1. Relative abundance of Entomostraca, Lakelse lake, July 29-August 28, 1944. The unit is individuals per 10 metre haul.

Theoretical

Several points of interest have been suggested. One is the effect on the lake of the sudden removal of an actively feeding population of fish as the yearling sockeye migrate out of the lake in the spring. Assuming that the population is all of the same age group (which is true for practical purposes of Lakelse) we have a population whose food demands build up fairly rapidly after leaving the gravel (by July 15, 1945 they averaged 5.6 cms. in length and as migrants in May & June 1946, 7.6 cm.) to a peak in July and August, followed by a decline through the winter and then another rise the following spring. Figure 3 illustrates this for the Cultus data of Ricker (1937, pp. 453).

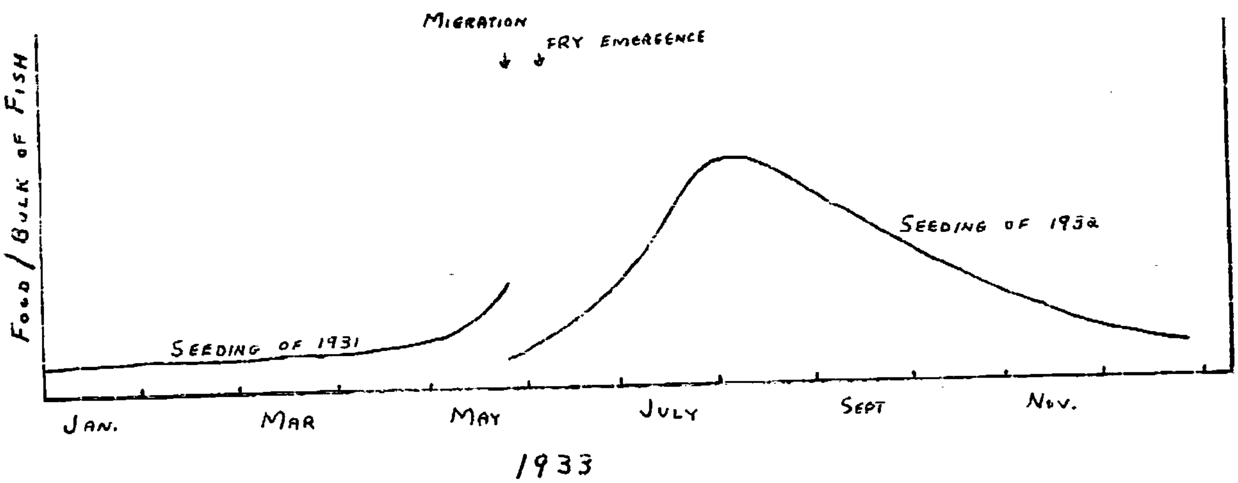

Figure 3. Smoothed curve of the average quantity of food in milligrams wet weight found in the stomachs of fingerling sockeye, Cultus lake, 1932-1933.

\# The contents were centrifuged for 30 minutes as for the fry stomachs, Table I.

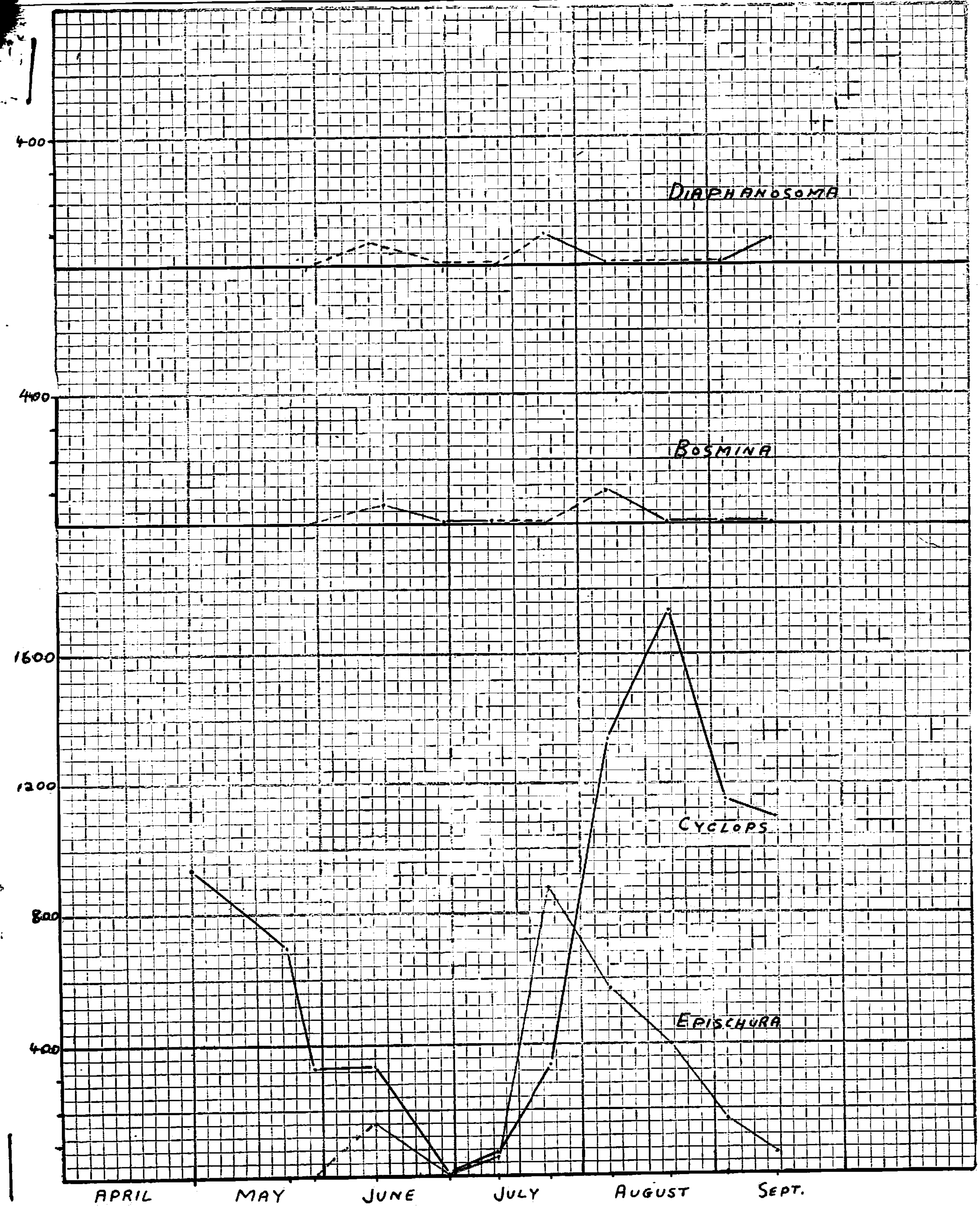

Figure 2. Seasonal variation in abundance of Entomostraca, Lakelse lake, 1945. The unit is individuals per 10 metre haul.

Natural Feeding Range

Ricker (1937) for Cultus lake suggests that "most of the summer feeding of wild sockeye fingerlings is done at levels higher than 20 metres, and probably between 15 metres and about 5 metres, which includes the whole of the thermocline, a narrow strip of hypolimnion, and part of the epilimnion". This statement is based on an experiment involving holding 50 young sockeye at depths of 10 metres and 20 metres for two days. On analysis of the stomach contents there was a statistically significant difference in the average food consumed although Daphnia and Cyclops, the chief foods, were probably present in equal quantities at both depths. He suggests that illumination and lower temperature were responsible. Also, Ricker feels that for Cultus, "extensive feeding in the upper epilimnion seems barred by the scarcity of food there, unless diurnal migrations of the crustacea are sufficient to add greatly to the number inhabiting the region in early morning or late evening".

The only time in which sockeye fingerlings were observed alive in Lakelse lake was during July of 1945 when considerable numbers were found near the north-western shore of Blackwater bay, jumping and "sporting" about in shallow water. It might be suggested that they were feeding on a concentration of plankton driven into the bay by the prevailing southerly winds and it is just possible that although it is not their usual habit, such migrations may not be as rare as often thought.

Considering that the southern half of Lakelse lake has a depth of only 6.5-8.5 metres it is most likely that the sockeye inhabit chiefly the northern part containing the "deep hole". Their depth range may be greater than that in Cultus lake on the basis of temperature since the late summer thermocline is frequently lower than 15 metres (45 feet). However their active feeding is probably limited downwards by reduced illumination.

Interspecific Competition for Food.

Certain "lake resident" fish may at times compete with sockeye for the available pelagic plankton. Of these the young coho (O. kisutch) which are present in fair numbers in the lake, (72,000 were counted migrating out of the lake in the spring of

1946) may compete when yearlings. Young cutthroat (Salmo clarkii), young squawfish (Ptychocheilus oregonensis), Rocky mountain whitefish (Prosopium williamsoni) and possibly even the peamouth (Mylocheilus caurinus) may be of some importance although they are probably active only at the borders of the pelagic zone in which sockeye apparently feed.

Intraspecific Competition for Food.

Ricker (1937 pp. 468) considers that "significant intraspecific competition for plankton food is suggested by the size of the standing crop in certain years which is rather small in relation to the number of sockeye and their food consumption. It is suggested also by the fact that the available summer food decreased much more rapidly in years of large sockeye populations, than in others. It is confirmed by the significantly reduced growth rate of sockeye in those years."

Some indication of the intraspecific competition for food may be obtained from length measurements of the yearling migrants when considered together with the "lake population" of young sockeye during the year.

Brood Year	Potential Egg Deposition	No. of Migrants	% Survival	No. in Sample	Av. Length	Standard Deviation
1943	--	--	--	280	8.5 cm.	--
1944	52,448,000	557,400	(1.06)	210	7.60 cm.	- .327

When further data on propagation is accrued a better understanding of the relationships should be possible.

Food of Yearling Migrants

Thus, there is a short period during May and June when the demands by sockeye on the lake's food is relatively light, that is, after one population has moved out and the next year's fry are just beginning to feed. However this period in Lakelse coincides pretty well with the period following the spring peak of <u>Epischura</u> and <u>Cyclops</u> (see Figure 2) at least in 1945 and it would appear that little significance need be attached to it.

Since the population of young sockeye is decreasing continuously throughout their period of residence in the lake, (Foerster, 1938) and the growth rate is following an upward sigmoid pattern with emphasis on rapid growth during the summer (Ricker, 1938), it might be logical to assume that the overall food demand would follow a more or less horizontal line from the balancing of factors. Such does not appear to be the case, because of the extremes of growth during the summer (Figure 4).

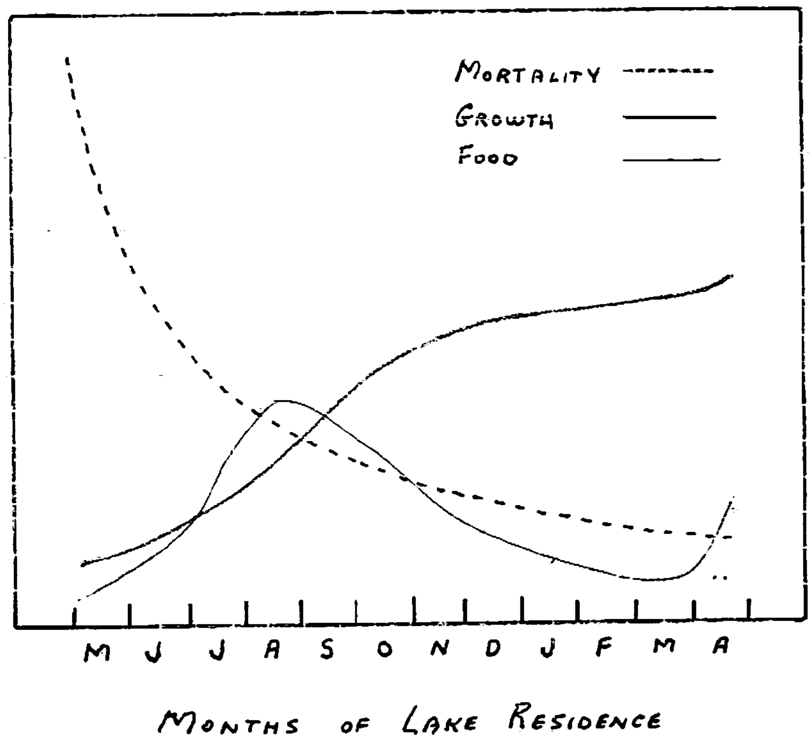

Figure 4. Mortality rate, growth rate and food demand of young sockeye in Cultus lake. The curves are merely smoothed approximations of those presented by Foerster(1938, p. 190) and Ricker (1938, p. 10) and 1937, p. 453) respectively.

Literature

There seems to be some uncertainty in the Cultus lake work over the question of food as a limiting factor for yoûng sockeye. Ricker (1937 p. 466) suggests that "in spite of the reduced growth" of sockeye in years when the population density in the lake is high (see Foerster, 1944) "it has been shown that (Foerster, 1936)# even the smallest migrants do not suffer extra mortality in the lake. Nor is there evidence that they are handicapped in the struggle for existence during their later marine life. Hence it can be inferred that, in the years of small sockeye populations, the available plankton of the lake is either not being used completely or not being used to best advantage. There seems no nutritional obstacle in the way of having a lake support, every year, fingerling sockeye populations considerably larger than the average, and possibly as large as the largest yet observed".

In other words, food is limiting for the "big" year populations only.

However, the inference in much of Foerster's work is that food is the important limiting factor. For example, the cyclical trend in the Cultus population discussed by Foerster (1944, p. 277). "Big" spawning runs occurred every four years, 1927, 1931, and 1935. A cyclic trend might result from "a heavy drain on the food resources of the lake during the year of heavy population and a gradual recovery of the plankton supplies in subsequent years, thus building up to a peak, as it were, in time to meet the great demand of the succeeding "big year"."

Also in the predator control work, Foerster and Ricker (1941) point out that the survival rate is increased mainly as a direct effect of reduced predation and "because of the smaller number of fry now needed to produce each migrant, the drain upon the lake's food supply in summer is relieved and the maximum number of migrants which the lake can produce each year appears to be greatly increased."

Here Ricker quotes the natural propagation data for Cultus = 1925, 1927 & 1930 with percent survivals of 1.13%, 1.05% and 3.16% despite the extremely heavy spawning of 1927.

III. Summary and Conclusions with Suggestions for further work.

(1) The percent survival of sockeye salmon from egg deposition to migrant for the brood year of 1944 has been estimated at 1.06%.

(2) For young sockeye taken during July and August, the main foods were the large copepod Epischura and the smaller Cladoceran, Bosmina. Cyclops and Diaphanosoma were taken very little. Thus some information has been gathered on the food habits of the young sockeye but before any definite conclusions can be drawn on food demand it will be necessary to have more samples covering a greater time range. It would appear that the time of greatest stress on the food supplies is late June and early July, prior to the summer pulses of Epischura and Cyclops. Anything which will give a lead on the question of food as a limiting factor to production will be of value.

(a) Possible methods for collecting young sockeye are: from predator stomachs (taken in the pelagic zone), blasting, some type of trap with hoops supporting fine netting to be dropped through the water, or seining at certain times of year.

(b) Studies of seasonal and annual variations in the plankton must be continued, possibly with the addition of a plankton trap for examining vertical distribution of the plankters. The diurnal movements of the plankters should also be studied since Ricker suggests that feeding may occur near the surface at night if the Entomostracans tend to move upwards. In this regard the question arises as to whether active feeding can occur in the dark.

(c) Some idea of the vertical distribution of the young sockeye should be obtained, either by means of the hoop trap mentioned above or by repeating Ricker's holding experiment.

(3) Interspecific competition for food has been rather lightly dismissed but this may not be justified. Some study of the food, habitat and growth rates of the young of other species is indicated, especially for peamouth.

(4) Sampling of the yearling migrants from the lake should be continued (100 per week or more) for population density studies.

(5) The effects of predation and possible consequences of predator removal have not

been discussed above. If the rate of digestion and the average number of fingerlings taken per predator per unit time were known it might be possible to work back from the number of fry lost to an estimate of the predator population.

In Lakelse, removal of predators would also require removal of competitors to prevent increased competition from young of the forage fish taking over the place of the young of the predators.

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