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M. P. Shepard, R. J. LeBrasseur, G. C. Futcher and T. H. Bilton.

Appendix no. MPS-1

Preliminary account of the sockeye run to Williams Creek, 1952.

William's Creek, the principal tributary to Lakelse Lake, carries approximately 80 percent of the sockeye population spawning in the Lakelse Lake area. In 1939 and from 1944 to the present counting, weirs have been operated on the three channels of the creek entering the lake to enumerate the sockeye entering the spawning area. In addition to the three main channels, a fourth channel drains from Williams Creek into an adjacent non-sockeye stream - Blackwater Creek. Previous to this year it was not believed that sockeye ascended this branch. This year, however, it became evident that this branch permits the passage of an appreciable number of sockeye from the lake to the upper spawning stretches of Williams Creek. Early in the run a barrier made of chicken-wire frames was established across the branch. This did not form a complete barrier to the passage of fish, but did retard the fish sufficiently to permit rou h observations on the relative magnitude of the Blackwater run. This year as part of the Williams Creek program, weekly counts were made of the number of fish on the spawning grounds. The counts showed that many more fish had reached the grounds than could be accounted for by the counts made on the three main fences. These excess fish must have reached the spawning ground b migrating up the Blackwater branch of Williams. There is strong evider that this Blackwater branch run has occurred in at least the last two (eg. the exa erated survival figures obtained from the Lakelse River yearling count - see app.). However, as previous operators of the Williams Creek fence did not make surveys of the spawning grounds, th magnitude of the earlier runs cannot be accurately assessed.

Fence Counts.

The first sockeye were counted through the fences on July 8th. Until Aug. 5th the run consisted mainly of injured and diseased fish in unripe condition (see app.). None of these fish appeared to spawn, the majority dying within a few days of their arrival at the creek. A run of healthy, ripening fish began early in August, reached its peak on Aug. 13th and continued until the first week in September. The early run of unspawned fish constituted approximately 5.5~~%~~ percent of the total run. A total of 2791 fish were counted through the fence. The sex composition of the run is in the table below.

The lengths and weights of approximately 10~~%~~ percent of the run were recorded. The average egg content of unspawned females was determined by examining the ovaries of 26 females. The testis volumes of 31 males were recorded. Egg counts and testis measurements were made on 165 fish found dead on the fence to compare the gonads of spawned and unspawned fish. Another 525 dead fish were examined to determine what proportion of the fish had spawned.

A preliminary analysis of the measurement data has been carried out; the complete results will be reported at a later date.

From Here

Spawning ground surveys.

Five surveys were made to enumerate the sockeye present on spawning grounds and to inspect the condition of the spawners. The size of the spawning population was estimated as follows:

By graphic interpolation from the five counts made, (Plotting No fish seen vs. days & measuring area of curve underneath.) the total number of fish that would have been counted if daily surveys had been conducted was calculated (P_1). By tagging fish at the fence and recovering tags from dead fish, the average life span of fish after they reached the spawning grounds was determined (L). From these two figures the number of individual fish <u>seen</u> on the grounds (P_2) can be estimated:

area under graph line represents "No fish days", which is divided by the life span to obtain no. individual fish seen.

(1) $$P_2 = \frac{P1}{L}$$

It has been repeatedly demonstrated that only a proportion of the total number of spawners are counted on surveys. To determine what proportion of the total population was actually counted, a number of fish were tagged at the fence (B_1) five to ten days before an intensive survey. The number of tagged fish seen on the survey (C_1) was noted. Theoretically, from these figures the proportion of the total population seen on this survey would be:

(2) $$m = \frac{C_1}{B_1}$$

However, it became evident that some tags were going unnoticed; eg. it was impossible to recognize the presence of tags on fish lying in deeper pools or in turbulent water, although these fish could be counted as individuals.

A correction can be made for this differential visibility of tags. A large but undetermined number of fish tagged at the Lakelse River counting fence passed through the Williams fences and the Blackwater channel. By comparing the proportion of these tags noted in carefully examined samples of fish with the proportion of the river tags noted on stream surveys, a correction factor (k) for the number of Williams tags (C_1) observed on the survey can be calculated;

(3) $$k = \frac{C_2/A_1}{C_3/A_2}$$

Where C2 represents the number of Lakelse River tagged fish in a sample of carefully examined fish collected on Williams Creek containing A1 individuals. C_3 represents the number of Lakelse River tags observed on surveys at Williams Creek in which A_2 fish were observed. The samples used to obtain C_2 and A_1 consisted ~~were~~ fish passing through the Williams and Blackwater branch fences and fish found dead on the upstream spawning grounds of Williams Creek. From these figures the total spawning population (P_N) may be estimated:

(4) $$T_N = \frac{P_2}{mn} = \frac{P_1}{L} \cdot \frac{B_1}{C_1} \cdot \frac{C_3/A_2}{C_2/A_1}$$

For the 1952 spawning run at Williams Creek:

$P_1 = 82,500$ $\quad P_2 = 5,890$
$L = 14$
$B_1 = 183$
$C_1 = 66$ $\quad m = 0.360$ $\quad T_N = 10,037 \doteq 10,000$
$A_1 = 3,758$
$C_2 = 97$
$C_3 = 164$ $\quad n = 1.630$
$A_2 = 10,156$

Thus although only 2,791 live fish passed through the Williams fences, at least three times as many fish were present on the grounds. In all probability these fish passed up through the Blackwater channel. As evidence of such a large run occurring, during one two-hour observation period at the peak of the run, over 200 fish passed through the Blackwater branch fence, whereas the maximum daily count through any of the main Williams fences was 178 fish. As mentioned previously, it is likely that this Blackwater branch run has occurred in other years. to Lou In the following table the runs of previous years are listed, and assuming that approximately the same proportion of the run ascended the Blackwater branch in the last two years as in this year, the estimated total runs to Williams have been calculated.

Year	Numbers of Males	Numbers of Females	Numbers of Jack males	Ratio Males:Females	Total Fence count	Estimated run
1939	12,350	11,735	----	1.05:1	24,085	24,085[1]
1944	----	----	----	----	----	20,000[2]
1945	----	----	----	----	----	50,000[2]
1946	----	----	----	----	----	34,000[2]
1947	----	----	----	----	----	15,000[2]
1948	----	----	----	----	----	26,400
1949	2,685	3,000	22	.90:1	5,707	?
1950	1,026	480	----	2.14:1	1,507	5,300
1951	2,259	1,898	----	1.19:1	4,157	14,900
1952	1,461	1,252	78	1.22:1	2,791	10,000

[1] Blackwater channel probably not open.

[2] From spawning ground surveys made by J. R. Brett <u>et al.</u>

It is hoped that the obvious need for a counting fence across the Blackwater branch will be remedied next year. Plans for an iron picket fence have been drawn up by Mr. J. Martell and the fence should be in operation by mid-July of 1953.

Calculation of Fiducial Limits on the Population Estimate

To calculate error limits for the population estimate, large sample statistics have been utilized.

In the expression:

$$(4) \qquad T_h = \frac{P_1}{L} \cdot \frac{B_1}{C_1} \cdot \frac{C_3/A_2}{C_2/A_1}$$

Tn is subject to error derived from sampling errors associated with P_1, L, C_1, C_2 and C_3. B_1, A_1 and A_2; constants representing the numbers of fish in three different samples, and are not subject to sampling error. P_1, the estimated total number of fish that would have been seen if daily creek surveys had been made is subject to systematic errors rather than random sampling errors; variation in the ability of different surveyors to observe fish is an important source of error in this case. An estimate of the error might be obtained by comparing the numbers of fish seen during simultaneous surveys made by two or more individuals or two or more surveys made on the same day by a single observer. Although the above procedures have been carried out elsewhere (e.g., see App. No. ; Ann. Rep. Pac. Biol. Stn., 1952, by the author), it was not feasible to carry out such a programme on Williams Creek this year. However, the number of fish seen during each survey (p_1, $p_2 \ldots p_a$) is a relatively large number and errors in counting would tend to be small. Therefore, assuming that p_1, $p_2 \ldots p_a$ are not subject to too wide a range of variability, the accuracy of P_2 is dependent on how accurately the graph ~~of P_1~~ relating "p" with time reflects the course of the run. The more frequently creek surveys are carried out, the more accurately ~~will~~ the graph will reflect the pattern of the true run. Considering the length of stream life of the fish (approx. 14 days), it is likely that during weekly surveys the possibility of seeing every fish that ascended Williams was realized. If surveys had been made at intervals greater than the life-span of the fish, then some doubt as to the representative nature of the graph might be raised. In view of these considerations, P_1, though subject to systematic error, can be considered a constant for the purposes of the present calculation.

Rearranging (4) we obtain:

$$(5) \qquad T_n = \left[P_1 \cdot \left(\frac{B_1 \cdot A_1}{A_2}\right)\right]\left[\frac{C_3}{L \cdot C_1 \cdot C_2}\right]$$

$$(6) \qquad = K_1 \cdot \frac{C_3}{L \cdot C_1 \cdot C_2}$$

where K_1 = a constant $= P_1 \frac{B_1 A_1}{A_2}$

Using large sample statistics (Tuttle and Satterly, pp. 217-219, 1925) the standard error of T_n may be estimated:

$$(7) \qquad \text{If } \bar{X} = K x_1^a \cdot x_2^b \cdot x_3^c \ldots\ldots$$

where K is any constant and a, b, c, ... may have any value, integral or fractional, positive or negative.

$$(8) \qquad \text{Then } R^2 = a_1^2 r_1^2 + b^2 r_2^2 + c^2 r_3^2 \ldots\ldots$$

where R = "relative" standard error of $\bar{X}$ and $R\bar{X}$ = the standard error of $\bar{X}$

r_1 = relative standard error of $\bar{x}_1$

(9) $$= \frac{s_{\bar{x}_1}}{\bar{x}_1}$$

The standard error of T_n may be calculated by determining the standard errors of C_1, C_2, C_3 and L and applying formula (8). The standard error of L may be obtained by ~~directien~~ direct calculation.*

$L = 14$, $S_L = 3.1$, $S_{\bar{L}} = .8$

* C_1, C_2 and C_3 represent numbers of tagged fish occurring in large samples of fish examined. As C_1, C_2 and C_3 are small with respect to the numbers of fish examined, distributions of values of the C's obtained in a large number of similar samples would be best approximated by the Poisson distribution. In this case, the standard error of the C values may be estimated.

(10) $$S_{\bar{c}} = \sqrt{C}$$

Thus $S_{\bar{c}_1} = \sqrt{66} = 8.12$

$S_{\bar{c}_2} = \sqrt{97} = 9.84$

$S_{\bar{c}_3} = \sqrt{164} = 12.80$

from (8)

		Powers
$r_{c_1} = \frac{8.12}{66} = .123$		$a = -1$
$r_{c_2} = \frac{9.84}{97} = .101$		$b = -1$
$r_{c_3} = \frac{12.80}{164} = .078$		$c = 1$
$r_L = \frac{.8}{14} = .057$		$d = -1$

(9) Thus as $R_{TN}^2 = (a)^2(r_{c_1})^2 + (b)^2(r_{c_2})^2 + (c)^2(r_{c_3})^2 + (d)^2(r_L)^2$

(10) $$R_{TN}^2 = (-1)^2(1.23)^2 + (-1)^2(.101)^2 + (1)^2(.078)^2 + (-1)^2(.057)^2$$

$$= .0151 + .0102 + .0061 + .0032$$

$$= .0346$$

$$R_{TN} = .186$$

$$S_{\bar{TN}} = 10,000 \times .186$$
$$= 1,860$$

95% Fiducial Limits are $T_N \pm 2S_{\bar{TN}}$ = 13,920; 6,180.