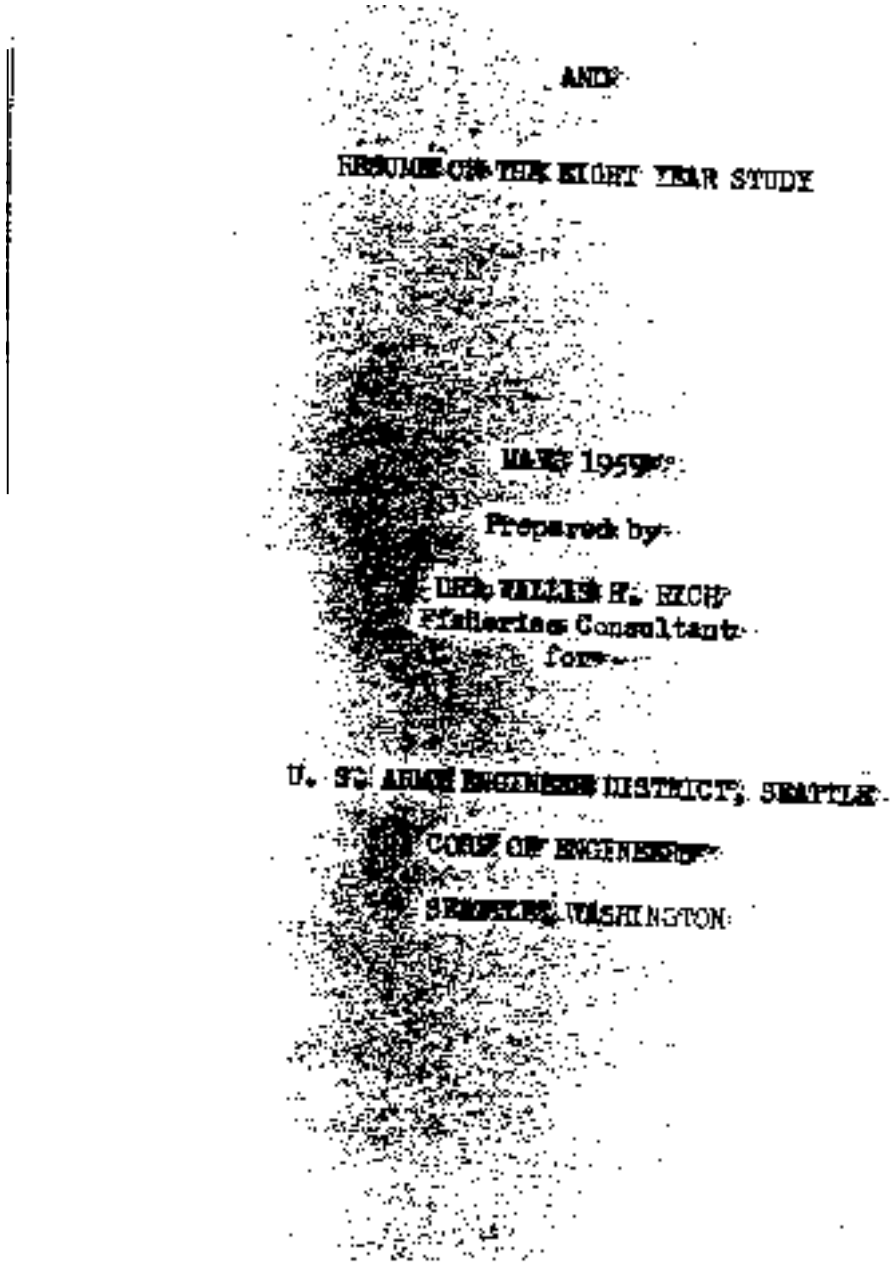
CONSULTANT'S REPORT

PBNII ORBILLE LAKE, IDAHO

ANAEZ3I&' CFA CRMM, CENSUS DATA FOR 1958



PEND OREILLE LAKE KOKANEE:
ANALYSIS OF CREEL CENSUS DATA THROUGH 1958
and
RESUME OF THIS SERIES OF REPORTS

A. ANALYSIS THROUGH 1958

This analysis of the Creel Census Data for 1958 has made use of preliminary figures supplied by the Idaho Department of Fish and Game. The final figures are not yet available but past experience has shown that preliminary tabulations such as those I have used do not differ materially from the final tabulations and may, therefore, be used with reasonable safety. The analysis follows the methods presented and adequately explained in the earlier reports of this series. (See list.) The pertinent data and derived statistics for all years are presented in Tables 1 and 2 herewith.

TABLE 1

Data from Creel Census Reports and derived statistics, 1951 - 1958

Sport Fishery: Resident and Non-resident Fishermen; Hope, Garfield and Bayview; April through October

Year	f	h	k		h/f	k/f	k/h
1951	9861	**56550**	101290		5.7	10.3	1.8
1952	10051	55009	82328		**5.5**	8.2	1.5
1963	**12548**	70502	118707		5.6	9.5	1.7
1954	11898	63428	**114349**		5.3	9.6	1.8
		Base years,		**X**	**5.52**	9.40	1.70
		1951 - **1954**		s	0.17	0.88	0.14
1955	9869	50117	70419		5.1	7.2	1.4
1956	11703	**55168**	94957		4.7	8.1	1.7
1957	**9918**	**47304**	**81285**		4.8	**8.2**	1.7
1958	10786	**52727**	**115369**		**4.9**	10.7	**2.2**
		1955 - 1958		**X**	4.88	**8.55**	1.75
				s	0.17	1.50	**0.33**

Commercial Fishery: All localities; April and May only

1951	83	667	**7428**		8.0	**89.5**	11.1
1952	**94**	685	9487		7.3	101.0	13.8
1953	**550**	**3517**	**45029**		6.4	**82.0**	12.8
1954	664	**3967**	**53042**		6.0	80.0	13.4.
		'Base years,		J1	6.92	88.12	12.78
		1951 - 1954		s	0.90	**9.54**	1.16
1955	**509**	**3201**	**35228**		**6.3**	**69.4**	11.0
1956	**534**	**3569**	**48395**		**6.7**	90.7	13.5
1957	**315**	1911	**23362**		6.1	**74.2**	12.2
1958	**546 .**	**3522**	**50312**		6.5	92.1	14.3
		1955 - 1958		X	**6040**	81.60	12.75
				s	**0.26**	11.50	1.45

T.%BLE 2

Comparison of the indices for each year 1955 - 1958 end for the four years combined with those of the base years. P is for negative **deviations only.** **Figures for 1955 -** 1957 ara repeated from the preceding report.

Years		Sport Fishery k/f	'_ `i	Commercial Fishery	k/h
1955	t	2.24	1.93	1.76	1.34
	P	**00056**	0.076	0.088	0.136
1953	t	1.32	**0000**	**-0.25**	**-0.56**
		0.139	0.500	0.590	**0.693**
1957	t	1.22	0.00	1.31	**0.45**
	P	**6.156**	**0.50**	0.143	**0.329**
1958	t	-1.32	-3.19	-0.37	**-1.18**
	P	0.861	0.975	0.637	**0.839**
1955-1958	t	0.978	-0.278	**0.875**	**0.032**
	P	0.182	0.625	0.2 08	**0.490**

A feature of particular interest in the data for 1958 lies in the fact that each of the four indices of relative abundance (k/f and k/h for both Sport and Commercial Fisheries) is higher than the corresponding indices for the base years (1951-1954), In fact, with one exception, each is higher than any other of the same category recorded for any of the previous years of record. The single exception is the index k/f for the commercial fishery. This index in 1958 was 92.1 while in 1952, (one of the base years) it was 101.0. As a result of these high indices for 1958 the t values are all negative and the probability values (P) are each greater than 0.50. (Table 2) This is explained in the report for 1956, pp. 3 and 4. It provides strong evidence that the abundance of kokanee in 1958 was greater than in any other of the years 1951 - 1957.

In this connection it is interesting to note that Charles R. Whitt (at that time with the Idaho Department of Fish and Game) made, independently, estimates of the four indices for 1958 in December of that year. Mr. Whitt made use of the first preliminary tabulations; but his results were almost identical with mine. At the meeting of the Technical Committee at Sandpoint, Idaho, in December, 1958, he gave the following figures which are to be compared with those of Table 1:

	h/f	k/f	k/h
Sport Fishery	4.90	10.72	2.19
Commercial Fishery	6.43	91.81	14.29

I have continued to present the index k/f for the Sport Fishery in spite of the fact that my reports on the data for 1956 and 1957 showed that this index may be unreliable because of the downward trend in the value of h/f, the mean number of hours of fishing per man per day. This mean for 1958 was 4.8 - one tenth of an hour higher than in 1957 - but is

still reasonably consistent with the trend shown in Figure 1, page 5, of the report for 1956.

The comparison of the means of the indices of relative abundance for the period 1955-1958 with those of the base years is especially interesting and significant. From the two bottom lines of Table 2 herewith it is quite clear that there has been no statistically significant reduction in relative abundance. For the index k/f for both the Sport and the Commercial Fisheries the probability (P) is approximately 0.20, which is far above any acceptable level of significance. This is to be interpreted to mean that, if real abundance was the same during the two periods, a value of the index for the second period as low or lower than the one observed would occur by chance about once in five similar pairs of samples. The difference between the indices k/h are of even less significance. For the Sport Fishery the mean for the period 1955-58 is actually higher than that of the base years, 1.75 as compared with 1.70. The corresponding probability value is approximately 0.60 which is interpreted to mean that an index for the second period as low or lower than 1.75 would occur by chance about three times in five. And for the Commercial Fishery the mean for 1955-58 is 12.75 as compared with 12.78 for the base years; P is approximately 0.50 signifying that a value as low or lower than 12.75 would be expected by chance about half the time. (See next to the last paragraph of Section B.) These conclusions are strongly supported by the fact that the indices in 1958, the last year of record, were all greater than the means for the base years.

B. RESUMÉ

The construction of two dams in the Pend Oreille and Clark Fork Rivers during 1950 and 1951 introduced new ecological conditions that the people interested in the important Kokanee Fishery of Pend Oreille Lake feared would adversely affect the abundance of *those fish* and therefore the quality of the fishery. The Cabinet Gorge Dam of the

Washington Water Power Co., located in Clark Fork about 20 miles above the lake, cuts off important kokanee spawning areas and its operation results in daily fluctuations of 6 or 7 feet in the river between the lake and the dam. Kokanee also spawn in this stretch of the river and these fluctuations cause heavy loss of the eggs.

The Albeni Falls Dam of the Corps of Engineers causes annual fluctuations in the lake level of as much as 12 feet. The normal period of draw-down is in the late fall and early winter; and the kokanee spawning occurs chiefly between November 20th and December 20th. Considerable numbers of kokanee spawn in favorable areas along the lake shores, chiefly in the shallow water. If the draw-down occurs after the eggs are laid, as is likely to occur in the normal operation of the dam, the eggs deposited in the exposed gravels are destroyed.

There was no doubt about these losses, but the question remained as to whether they would affect the abundance of kokanee surviving to maturity and providing the stock drawn upon by the fishery and a spawning population adequate to insure the future supply. Or would these losses be compensated for by decreased mortality among the survivors or "swamped by the effect of fluctuations in environmental factors" other than those modified by the dams? (The probable effect of Albeni Falls Dam on the Kokanee Fishery, p. 12.)

Wisely, the Idaho Department of Fish and Game initiated a comprehensive Creel Census study in 1951 - the first year in which either of the dams could have affected the reproduction of kokanee. The Department was aided in this, financially and otherwise, by the two constructing agencies and by the **U. S.** Fish and Wildlife Service. The creel census was planned by a competent statistician, Dr. Daniel Embody. It has been slightly modified from time to time in the interest of greater accuracy but, in essence, it has consisted of virtually complete data of landings on 5 days each month at each of 4 localities - Hope, Sandpoint,

Garfield, and Bayview. Censuses were taken, therefore, on 20 days each month. For each locality the 5 days on which the census was to be taken were selected at random except that they were to include one Saturday, one Sunday and 3 week days. Individual fishermen were interviewed and a record made of (1) his "type" - Resident, Non-resident or Commercial; (2) the number of hours he fished; (3) his catch of kokanee; and (4) his catch of each of several other species of game fish and of non-game fish. These daily records were then tabulated by months and localities so as to show, for each day and for each category of fishermen (1) the total number of fishermen interviewed; (2) the total number of hours of fishing **they** reported; and (3) the total number of fish of each species or category they caught.

The first analyses of the resulting data were directed toward determining the total annual catch of kokanee. I began my participation in the study late in 1953 and undertook a different approach; namely, to determine a "catch per unit of effort." Fishery biologists in general consider that some type of "catch per unit of effort" more accurately reflects relative abundance of fish than estimates of total catch because the latter "are affected so greatly by the amount of effort expended to produce the catch; and the amount of effort is affected by numerous causes, some of them economic while others are related to weather conditions." (Study of the Kokanee Fishery, 1954-55, Supplement No. 2, p. 2.)

After various preliminary studies of the Creel Census Data and experiments with different combinations, I decided, in part arbitrarily, to consider only the catch of kokanee, to separate the records of Sport and Commercial fishermen, to combine the records of Resi= dent and Non-resident sport fishermen, to combine the data on the Sport Fishery for the **seven** months April through October and for ohiyi three of the localities (Hope, Garfield and Bayview), and td combine

the data on the Commercial Fishery for all localities but for April and May only. The bases for these selections are given in the report for 1954-55, Supplement No. 2. In that report, however, the data for the Commercial Fishery included those for the month of June. But the next year this fishery was closed by regulation at the end of May so that only the months of April and May could be used in getting annual totals that would be comparable in all years.

These combinations then gave for each of the two fisheries "annual totals" of (1) the number of fishermen interviewed (fisherman-days), for which I have used the symbol f ; (2) the number of hours of fishing reported (fisherman-hours), symbolized by h; and (3) the number of kokanee caught, symbolized by k. These "annual totals," obviously, are not totals for the entire fishery because they include only data for selected localities, selected months and selected days. They do, however, include a very large part of the information collected by the Creel Census. Since the census was taken on only 5 days each month in each locality this factor alone would mean that these "annual totals" would be approximately one sixth (16.7%) of the actual totals and the elimination of some months in both fisheries and of one locality in the case of the Sport Fishery would bring the percentage still lower. However, in a fishery as extensive and complex as this one a sample approaching 16% of the total is excellent.

From these "annual totals" I derived three significant statistics: (1) the mean number of hours per fisherman per day, h/f; (2) the mean, number of kokanee caught per fisherman k/f; and the mean number of kokanee caught **per hour, k/h. The static h/f** has been used to 'show whether there has been any systematic change in the number of hours-of fishing per fisherman. The other two statistics, k/f and k/hi; are' indices (measures) of relative abundance - i.e., they are mea-sur-es• of

catch per unit of effort. These two statistics were, as would be expected, highly correlated.

As the study advanced, however, it became apparent that, over the 8-year period, the mean number of hours of fishing, as recorded, was becoming less. In the sport fishery the mean was about 5.6 hours during the first three years and about 4.8 hours during the last three years. In the commercial fishery the mean was highest during the first two years (8.0 in 1951 and 7.3 in 1952) but has fluctuated only slightly around an average of **6.33 since then.** There is no way of knowing whether this apparent drop in fishing time is a real phenomenon or not. If it is, as I think likely, the index k/h would be the more reliable. If not, k/f would be the better index. I have, therefore, presented both indices throughout this study and, in the final analysis, both lead to the same conclusion; namely, that there has been no significant change in abundance. (Section **A** above.)

This conclusion has been reached by applying the statistical "t-test" to determine whether each index for 1955 and later years was significantly less than the corresponding index for the "base years" 1951-54. The selection of these years as a basis for comparison was made because of considerable evidence that the Pend Oreille Lake koka.nee are predominantly in their fourth year at the time they enter the **fishery.** Some of thisi **evidence** has come from age determinations made by microscopic examination of kokanee scales. For many years scales have been thus used to determine the age of fish. With some species this gives excellent results; with others it is difficult or impossible. I examined a few of the kokanee scales that had been collected in 1951 and **1953** and a sample of 141 taken in **1954.** On the basis of considerable experience with the scales of Pacific Salmon I decided that about 90% were in their fourth year.

Mr. Keith White, a temporary employee of the Corps of Engineers, and Mr. Charles Whitt, then with the Idaho Department of Fish and Game, later studied more extensive scale collections made in 1956 and concluded that the majority of Pend Oreille Lake kokanee were in their fifth and sixth years. As a general principle, however, the determination of age from scales should always be supported by evidence entirely independent of scale readings. This is commonly provided by marking experiments and/or the study of length-frequency distributions in random samples of fish of all ages, neither of which is practicable in the case of the Pend Oreille Lake kokanee.

There are, however, other independent lines of evidence which support the conclusion that the dominant age of these fish is four years. One of these is the fact that the number of kokanee spawning in the Clark Fork between the lake and Cabinet Gorge Dam was sharply reduced in 1955 and has continued so. This occurred four years after the dam was completed and placed in operation.

A second line of evidence comes from the length-frequency distributions of the kokanee taken in the fishery, which are distinctly bimodal. One mode centers around 175 mm total length and the other around 250 mm. The two modal groups are sharply separated but the small size group contains only from 2.5% to 10% of the entire samples. In general these small fish have been recorded as "immature" and they are not found in the spawning populations. All observers agree that these are chiefly, if not entirely, in their third year. "The large size group must, therefore, consist of fish in their fourth year and older. If it contains more than one age group in large proportions one would expect that the large size **group** itself would show evidence of multimodality. However, within sexes, which are distinctly different in size, there is **no** good evidence of such multimodality. If only a single age group is dominant in this larger size group the most reasonable conclusion is that it consists of fish in their fourth year. (Report for

i 6, pp. 6 and 7.)

A third independent line of evidence lies in the fact that there are no, or at least very few, immature fish in the larger size group as one would expect if it contained, for example, four or five year fish that would not mature for at least another year.

I feel quite confident, therefore that the dominant age is four years. This is important from the standpoint of determining which of the years included in the creel census are to be taken as the "base years" representing conditions and abundance unaffected by the dams. If the dominant age is four years it is obvious that the majority of the fish in the **lake during 1954 and** earlier years came from the spawning of 1950 and earlier years and that their abundance could not have been affected by the dams. Similarly the kokanee in the lake during 1955 and later years were derived from the spawnings of 1951 and later years. Clearly, then, the years 1951-54 constitute the "base years" with which the later years are to be compared.

To return to the comparison of the indices for the years **1955-58** with those of the base years. The statistical t test was used to determine the significance of observed differences. The statistic t is calculated by simple and well known methods which are given in most texts on elementary biometry and need not be explained here. (See especially R. A. Fisher, Statistical Methods for Research Workers, Section 24.1.) From the statistic t the probability, P, that the observed difference could have happened purely by chance is determined from tables such as Fisher's Table **IV.** A common usage is to consider that the difference is not statistically significant unless the probability is equal to or less than .05 - one chance out of twenty. In this study we are interested only in determining the probability of a <u>negative</u> deviation as great or greater than the one observed. Fisher's Table IV, and most other t tables, gives

the probability that a difference either positive or negativewill be e lualed or exceeded, but Fisher :3tate:s (Section 24) that "If it is proposed to consider the chance of exceeding the value of t, in a positive (or negative) direction only, then the values of P should be halved." It is to be noted, however, that, in the cases in which the observed index is greater than the corresponding base index, the value of P/2 as determined from Fisher s table is the probability of ,getting, by chance, an observed index as great or greater than the one observed; so that the probability of getting an index as small or smaller than the one observed is 1 - P/2. The P values recorded in Table 2 of Section A above have been determined by these methods and their interpretation is covered in the last paragraph of Section A.

The 8-year study of the effect of the dams that was originally planned is now completed. Presumably the study will now be discontinued, at least with the extensive coverage that has prevailed, especially since it has failed to produce evidence of reduced abundance of kokanee that can be ascribed to the effects of the two dams. I think, however, that a simplified, less extensive creel census might well be continued. The importance of the fishery and the interesting biological features of the problem would seem to justify this.

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The Probable Effect of Albeni Falls Dam on the Kokanee Fishery of Pend Greille Lake, Idaho, February, 1954.

Study of the Kokanee Fishery of Pend Oreille Lake, Idaho, 1954-55, April, 1955.

Supplement No. 1. - Scale Studies, July, 1955

Supplement No. 2. - Analysis of Creel Census Data, 1951 through 1954, February, 1956.

Supplement No. **3. -** Analysis of Creel Census Data for 1955 (Revised), May, 1956

Pend Oreille Lake Kokanee, Analysis of Creel Census Data for 1956, June, 1957.

Pend Oreille Lake Kokanee, Analysis of Creel Census Data for 1957, April, 1958.

Pend Greille Lake Kokanee, Analysis of Creel Census Data for 1958 and Rāsum May, 1959.