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Fisheries Division

AGE AND GROWTH CHARACTERISTICS OF
LAKE PEND OREILLE KOKANEE, 1956

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AGE AND GROWTH CHARACTERISTICS OF
LAKE PEND OREILLE KOKANEE, 1956

By
Charles R. Whitt
Fishery Biologist II

Boise, Idaho
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ABSTRACT

In 1956, an intensified investigation of age and growth characteristics of Lake Pend Oreille kokanee was initiated to determine irregularities in the life cycle of this species. Review of age and growth data collected in earlier years indicated that prior to 1956 the kokanee catch was predominated by fish in their fourth year of life. An exception was noted in 1953 collections, in which a small sample of scales (from 17 fish) was predominately fish in the fifth year of life.

Analysis of 645 scales collected in 1956 indicated that 39.4 per cent were of fish in their fifth year of life and 33.7 per cent were in their fourth year of life. Scale samples collected from spawning fish in December, 1956, indicated that five-year fish were predominant in numbers in the spawning runs. The average length of 627 kokanee measured in April, 1956, was 8.1 inches as compared to 10.2 inches for 661 fish measured in December, 1956. Male kokanee exceeded females in average length and weight, and were taken in larger numbers by fishermen.

AGE AND GROWTH CHARACTERISTICS OF LAKE PEND OREILLE KOKANEE, 1956

INTRODUCTION

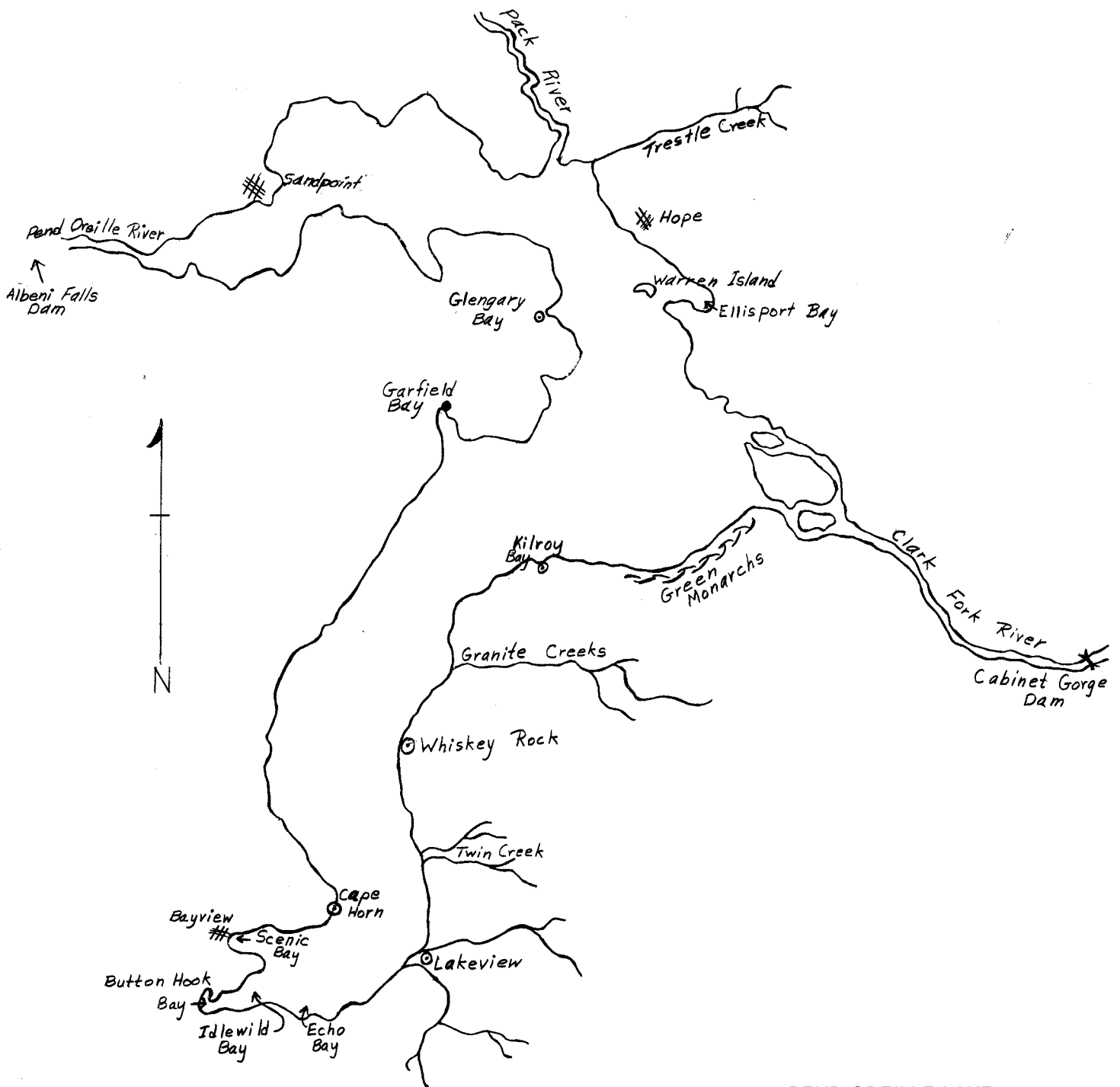
The exact date of introduction of kokanee in Lake Pend Oreille is not known, although it is generally believed that kokanee came from Flathead Lake, Montana, by migrating down the Clark Fork River during the early nineteen-thirties. Early records concerning the growth and development of kokanee populations in Lake Pend Oreille are lacking, but reports indicate they have passed through two similar patterns. During the early and middle thirties local residents state that kokanee often attained weights of two pounds. In the late thirties and early forties their size decreased and by the middle forties kokanee averaged about one-seventh of a pound at maturity. The fish remained small in size until the late forties when they began to increase in size. By 1952 they often exceeded weights of one-half pound at maturity. Since 1952, the size has decreased gradually and spawning fish in 1956 averaged about one-third of a pound in weight.

In 1951 a creel census study was started to determine the effects of dam construction on the Lake Pend Oreille fishery. The project was scheduled for eight years, or two complete life cycles of the kokanee. The harvests for the first four years would come from fish spawned and hatched prior to, and the harvests for the second four years from kokanee spawned and hatched after dam construction. Thus, conditions provided the basis for an analysis of effects of dam construction to a full cycle of kokanee, representing four different groups of fish.

In 1955 some question arose as to the composition of the different age classes in the Lake Pend Oreille catch. A study on nearby Priest Lake gave some indication of a highly significant proportion of five-year fish existing in the kokanee catch (Bjornn, 1957). Since the original stock of kokanee in Priest Lake came from Lake Pend Oreille and fish from both lakes supposedly had a four-year cycle, the possibility of variation in longevity arose.

Further investigation showed that the Priest Lake kokanee catch was predominately five-year fish. Length frequency data from kokanee taken in the early months of 1956 indicated the possibility that five-year fish were predominant in the Lake Pend Oreille catch. The need for age-growth analysis, including study of collections of previous years, was indicated. Of value to the project would be the percentage composition of year classes in the annual catch and of age groups in the spawning population, the growth increment as shown by length frequency data taken from fish appearing in the catch, and growth history as determined by scale studies.

In May 1956, Mr. Keith White, Biologist, U. S. Army, Corps of Engineers, was assigned to assist with project work. Mr. White collected a large number of the scales and the length measurements and assisted with age de-terminations. Ages shown in Tables 1 to 5 are from readings made by Mr. White. The author has examined the scales used for Tables 1, 3, 4, and 5, and is in general agreement with this data.



PEND OREILLE LAKE
and
TRIBUTARIES

TECHNIQUES USED

Scale samples and length measurements in 1956 were collected from the areas around the lake representing most of the points where kokanee were landed. Since kokanee are a "schooling" fish during part of the year, this method of field data collection made it possible to analyze differences which might occur between areas (schools) of fish. The majority of the data were collected at boat docks from boats on the lake. Collections were distributed throughout each month fish were being landed. The map shows the location of areas on the lake mentioned in this report.

Length measurements were made from angler catches from February through October, and from spawning fish in December. Measuring boards were used to take total lengths and each length was taken to the nearest millimeter. When possible sex and weight data were recorded with the lengths (Appendix C). Other information recorded included place caught, date, type of fishermen (sport or commercial), and method of fishing.

Scale samples were collected during the same period as above. Data recorded with each scale sample included date and place caught, and total length. When possible sex and weight of the fish were taken. About 25 scales were taken from each fish from the area above the lateral line and directly below the insertion of the dorsal fin. Four scales from each fish were cleaned and mounted for age analysis. Scales were mounted in gelatin and read with the aid of an Eberbach scale projector provided by the Cooperative Wildlife Research Unit, College of Forestry, at the University of Idaho.

In order to clarify the meaning of "age class" as used herein, all ages are listed by "age class;" e.g., a 3-year fish is in its third year of life and has two annuli, a 6-year fish is in its sixth year of life and has five annuli. Scales of three-, four-, five-, and six-year fish are shown in Plates 1-4.

FINDINGS

Age Determination by Scale Readings

Kokanee scales are small and difficult to age. Scales from kokanee of Lake Pend Oreille appeared to differ considerably from kokanee scales taken from other bodies of water in northern Idaho. A year's growth was sometimes composed of only four to six circuli, as shown in Plates 3 and 4 for the 4th, 5th, and 6th years' growth, and an annulus sometimes distinguished by only one faint circulus (note Plates 2, 3, and 4).

The main difficulty encountered in age determinations of Pend Oreille kokanee was distinguishing between true and false annuli. The false annuli, sometimes referred to as "split winter checks," generally occurred during the second and third growing seasons. The false check occurring in the second year usually consisted of two to four narrowing circuli. Good examples of this type of check are shown in Plates 2 and 4. False annuli found in the

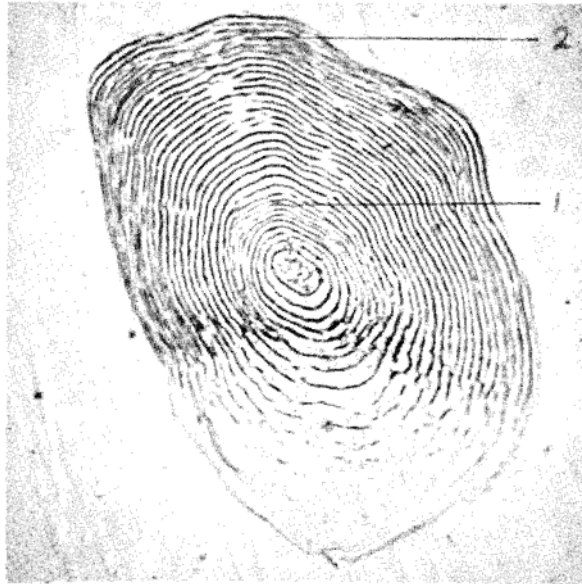


Plate 1. Three-year kokanee with two annuli, collected September 15, 1956 at Garfield Bay, Lake Pend Oreille, Idaho. (x28)

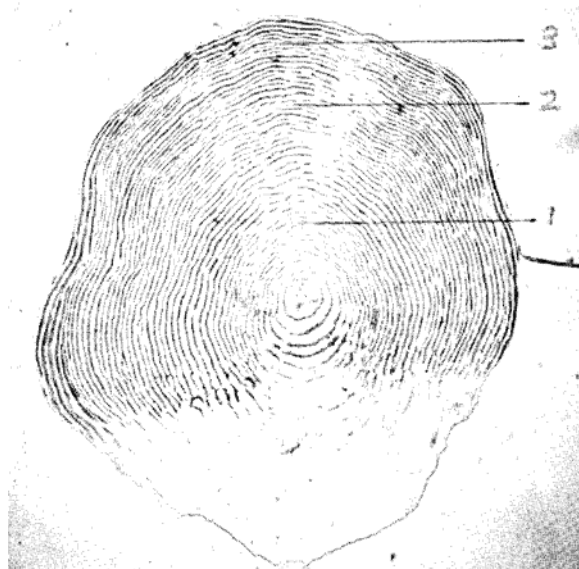


Plate 2. Four-year kokanee with three annuli, collected September 15, 1956 at Hope, Lake Pend Oreille, Idaho. (x28)



Plate 3. Five-year kokanee with four annuli, collected March 14, 1956 at Bayview, Lake Pend Oreille, Idaho. (x28)



Plate 4. Six-year kokanee with five annuli, collected March 14, 1956 at Bayview, Lake Pend Oreille, Idaho. (x28)

third growing season were more difficult to read since they were usually exemplified by having only one, two or three narrow circuli (Plate 2). It should be emphasized that these checks were not consistent and that only about 75 per cent of the scales showed the check in the second year. The check found in the third year occurred on less than a third of the scales examined.

Annulus Formation. It appears that annulus formation occurs sometime in June. As is typical of most growth curves the growth increment decreases towards the end of life. This phenomenon is demonstrated by kokanee in their fifth or sixth years of life, as little or no summer growth is shown on the margin of the scale even on those taken in September. If scale growth of older fish occurs during the summer growing period, the growth is laid down on scales in very narrow circuli which are difficult to distinguish from the narrow winter circuli of the previous year. Younger fish, on the other hand, and especially those in their third year of life, show substantial growth increases in June, or sometimes May, and the new circuli are very apparent.

Age Determination of Spawning Fish. Age determination of maturing fish after the month of October is exceedingly difficult because of scale resorption. As is true of many fish, scale resorption of Pend Oreille kokanee literally destroys the value of the scale for aging. Female fish, however, often appear on the spawning areas in a "green" or "unripe," condition with scales unresorbed. Scales from these fish are usually satisfactory for aging. Among male kokanee, scale resorption begins earlier and is more pronounced, and by the latter part of October they are seemingly without scales. The fragments of the scales left in the scale pockets are of little or no. value in determining the ages of male kokanee.

Scale Collection Data for 1948 to 1956

1948 Collection. In 1948, 13 scale samples were collected from the Clark Fork River and Pend Oreille Lake from June through September. Age determinations for the 1948 collections are shown in Table 1.

Table 1. Age and length frequency distribution of kokanee, Lake Pend Oreille, Idaho, 1948.

Total length (inches)	Age Class			
	3-year	4-year	5-year	6-year
7.0	1			
7.5		1		
8.0		1		1
8.5		3		
9.0		4		
9.5			2	
Per cent of total	7.7	69.2	15.4	7.7

1951 Collection. From June through September, 1951, 151 scale samples were collected from lake, Pend Oreille, and 13 scale samples were collected in December from spawning fish whose ages were either difficult or impossible to determine due to scale resorption. It is not known whether this is a random sample nor how it was collected. It is assumed that the scales were taken from fish in the creel with the exception of the 13 spawners. Table 2 shows the ages of the 1951 scale collection.

Table 2. Age and length frequency distribution of kokanee, Lake Pend Oreille, Idaho, 1951.

Total length (inches)	Age Class			
	3-year	4-year	5-year	6-year
7.0	6	4	1	
7.5	1			
8.0	4	1		
8.5	2	3		
9.0		13	3	
9.5	1	27	6	
10.0		24	7	1
10.5		12	3	
11.0		11		
11.5		7		1
12.0			1	
Totals		102	21	2
Per cent of total	10.1	73.4	15.1	1.4

1952 Collection. Only three scale samples were collected in 1952. One fish sampled in July measured 19 inches in length and was aged as a 4-year fish. Two fish sampled in December measured approximately 12 inches and were 3- and 5-year fish.

1953 Collection. Two small collections were made in 1953. The first collection of 11 scale samples was taken in the fall from spawning fish. The age-length frequency distribution is shown in Table 3.

Table 3. Age and length frequency distribution of kokanee, Lake Pend Oreille, Idaho, 1953.

Total length (inches)	Age Class			
	3-year	4-year	5-year	6-year
9.0	0	1	2	
9.5	0	2	1	
10.0		0	1	
10.5		0	2	
11.0		0	1	1
Totals	0	3	7	1
Per cent of total	0	27.3	63.6	9.1

The second series of 17 scale samples was collected in February and March for which length data are lacking. Age frequency data are shown in Table 4.

Table 4. Age frequency distribution of kokanee, Lake Pend Oreille, Idaho, 1953.

	Age Class			
	3-year	4-year	5-year	6-year
Frequency	3	3	10	1
Per cent of total	17.6	17.6	58.9	5.9

The combined age group frequencies for both series of data are shown in Table 5.

Table 5. Age frequency distribution for 28 kokanee, Lake Pend Oreille, Idaho, 1953.

Collection	Age Class				Total
	3-year	4-year	5-year	6-year	
Fall	0	3	7	1	11
Spring	3	3	10	1	17
Total	3	6	17	2	28
Per cent of	10.7	21.4	60.7	7.2	100

1954 Collection. One hundred and forty-one scale samples were collected randomly from the creel during 1954. Most of the collection was taken during the period from February to June, but includes a few samples taken in September. The ages as determined by Dr. Willis H. Rich are shown in Table 6 (Jeppson, 1955).

Table 6. Age and length frequency distribution of kokanee, Lake Pend Oreille, Idaho, 1954.

Total length (inches)	Age Class		
	3-year	4-year	5-year
6.5	7		
7.0	3		
7.5			
8.0	1	1	
8.5		15	
9.0		38	
9.5		26	
10.0		24	
10.5		14	1
11.0		9	1
11.5			1
Totals	11	127	3
Per cent of total	7.8	90.1	2.1

1955. No scale collections were made.

1956 Collection. In 1956, plans were formulated to provide a detailed and comprehensive age and growth study of Pend Oreille kokanee. The initial plans called for 500 length measurements and 50 or more scale samples to be collected each month throughout the fishing season. A total of 7,566 lengths and 1,132 scale samples were collected (see Appendix A).

A total of 615 scale samples were used in age analysis. This represents about 0.31 per cent of the fish counted in the fishermen's creels during 1956. Monthly samples, except for February and October, ranged from 61 to 107 scales, (Table 8).

Prior to the time the length and scale collections were made Dr. Willis H. Rich recommended that special collections be made of 'immatures' or 'three-year fish.' These collections were avoided when analyzing the 645 scale samples. Some chance exists, however, that a few samples may have been biased by selection of 'immatures' due to incomplete notations on the field-data forms.

Age determinations for the 1956 collections were made by the author. The age-length frequency distribution for these data is shown in Table 7.

Table 7. Age and length frequency distribution of kokanee, Lake Pend Oreille, Idaho, 1956.

Total length (inches)	Age Class				
	3-year	4-year	5-year	6-year	7-year
5.0-5.5	2				
6.0	6				
6.5	27				
7.0	24		1		
7.5	6	25	4		
8.0	6	55	14	4	
8.5	4	45	60	22	
9.0		37	86	45	2
9.5		33	43	17	
10.0		21	38	6	
10.5		1	6	1	
11.0			1	2	
11.5			1		
Total	75	217	254	97	2
Average length	6.9	8.7	9.1	9.1	9.0
Per cent of total	11.63	33.64	39.38	15.04	0.31

For comparative purposes the age group composition, by months, is shown in Table 8.

Table 8. Age-group composition and mean lengths in mm, of kokanee, by months, Lake Pend Oreille, Idaho, 1956.

Month		Age Class					Total
		3-year	4-year	5-year	6-year	7-year	
Feb.	Total	3	1	1	1		6
	Per cent	50.0	16.7	16.7	16.7		
	Mean length	171.6	222.0	223.0	228.0		
Mar.	Total	9	24	33	29	1	96
	Per cent	9.4	25.0	34.4	30.2	1.0	
	Mean length	166.3	218.1	223.1	226.2	230.0	
Apr.	Total	3	20	25	13		61
	Per cent	4.9	32.8	41.0	21.3		
	Mean length	179.7	211.1	225.0	232.3		
May	Total	22	32	34	18	1	107
	Per cent	20.6	29.9	31.8	16.8	0.9	
	Mean length	169.8	210.8	228.6	235.2	229.0	
June	Total	8	37	41	13		99
	Per cent	8.1	37.4	41.4	13.1		
	Mean length	176.1	214.9	228.4	233.0		
July	Total	10	39	50	8		107
	Per cent	9.3	36.5	46.7	7.5		
	Mean length	183.6	227.8	235.1	240.8		
Aug.	Total	12	28	18	4		62
	Per cent	19.4	45.2	29.0	6.4		
	Mean length	191.4	242.3	249.9	247.3		
Sept.	Total	4	34	49	9		96
	Per cent	4.2	35.4	51.0	9.4		
	Mean length	200.5	247.3	255.6	257.4		
Oct.	Total	4	2	3	2		11
	Per cent	36.4	18.2	27.3	18.2		
	Mean length	212.0	245.0	257.7	251.0		
Total in each age group		75	217	254	97	2	645
Per cent of total		11.6	33.7	39.4	15.0	0.3	100.0
Mean length		179.7	225.5	235.8	235.1		

Figure 1 shows the monthly percentages of each age class, as shown in Table 8, applied to the monthly creel census totals (Whitt, 1957). The months of February and October have been omitted due to inadequate sample sizes.

When the monthly percentage composition of age classes in Table 8 is applied to the monthly catches as shown in Figure 1, the total percentages of the various age groups are changed slightly. The three-year fish in the catch from March through September becomes 10.3 per cent as compared to 11.6 per cent in the total scale sample. The percentages for four-, five-, six-, and seven-year fish are 32.1, 38.8, 18.4, and 0.4 per cent, respectively. These changes are due to the variance of sample size each month in proportion to the catch.

During the December spawning migration in Granite Creek, 38 scale samples were collected. Three of these samples were taken from male fish, The three from male fish and 10 of the 35 samples from female fish were not used in age-analysis because of scale resorption. The age-length frequency distribution for the remaining 25 female fish is shown in Table 9.

Table 9. Age and length frequency distribution of 25 spawning kokanee from Granite Creek, Lake Pend Oreille, Idaho, 1956.

Total length (inches)	Age Class		
	4-year	5-year	6-year
8.0	1		
8.5			
9.0	2	3	
9.5	3	3	
10.0	1	7	2
10.5		3	
Total	7	16	2
Average length	9.3	9.8	10.0
Per cent of total	28.0	64.0	8.0

Size and Growth Data

Length Data. The average lengths of kokanee by months, along with average lengths by sex are shown in Table 10. Sex was determined for 2914 of the 7566 kokanee measured for total length.

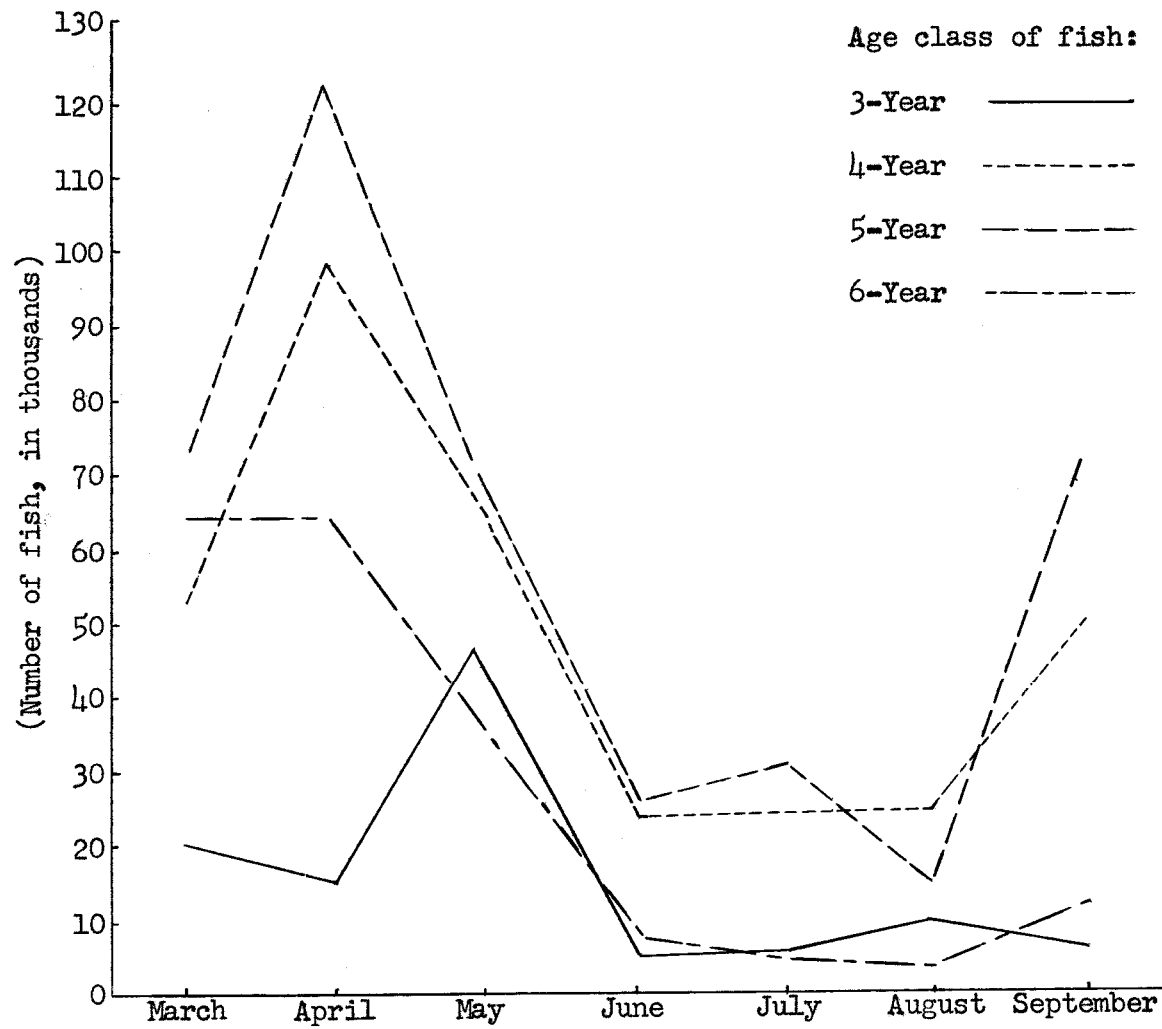


Figure 1. Total kokanee catch by age classes for the months March through September, Lake Pend Oreille, Idaho, 1956.

Table 10. Average length of kokanee by months, Lake Pend Oreille, Idaho, 1956.

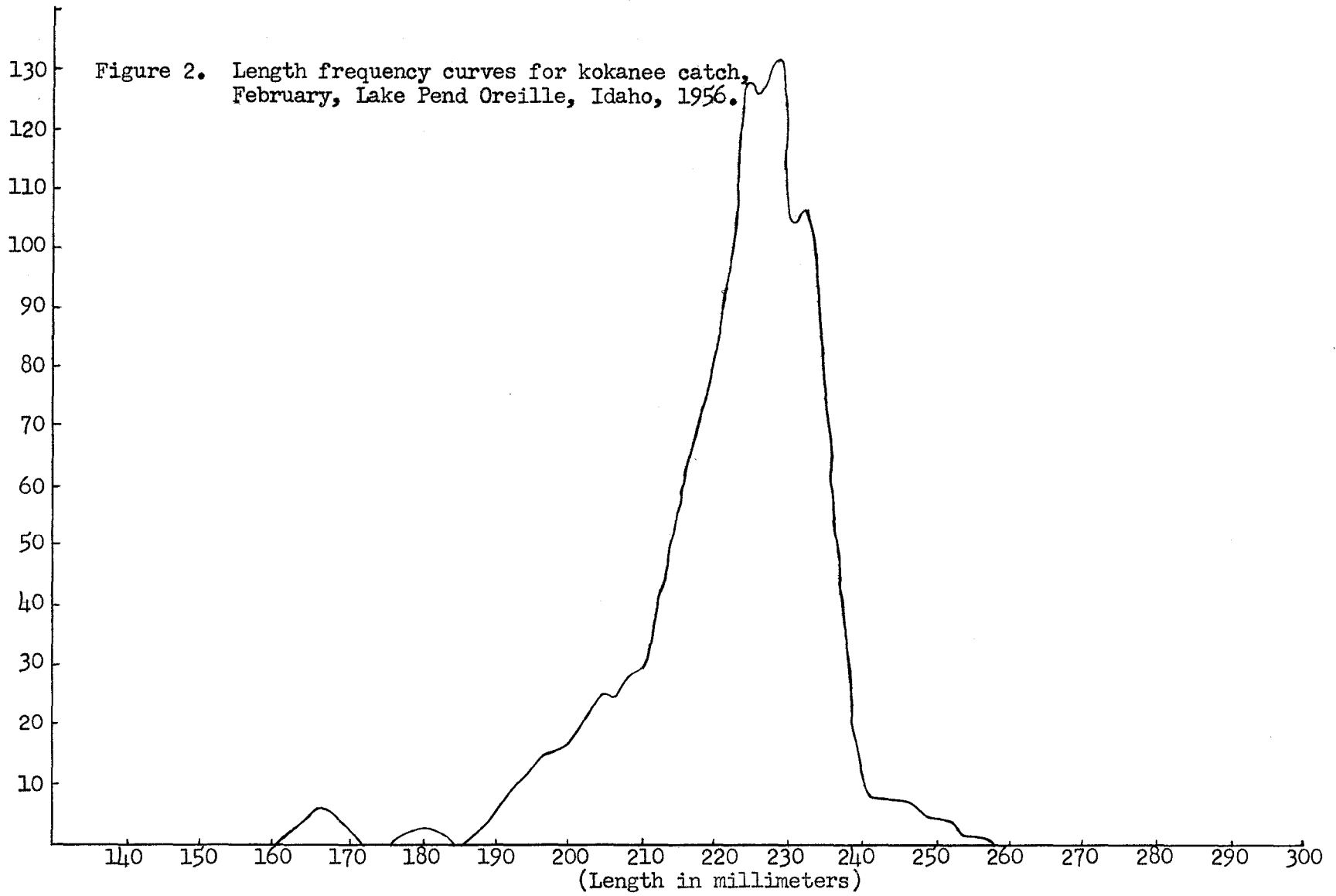
Month	Average length in inches (combined sexes)	Frequency	Average length in inches		Frequency
			Male	Female	
February	8.8	271			
March	8.5	640	8.6	8.5	210
April	8.4	627	8.5	8.5	240
May	8.6	1470	8.4	8.3	193
June	8.6	966	8.8	8.5	413
July	8.7	945	8.8	8.5	350
August	9.0	612	9.3	8.9	152
September	9.5	1239	9.7	9.3	562
October	10.0	135	10.1	9.8	133
November					
December	10.2	661	10.4	10.0	661
Total		7566			291)4

Table 11 shows the variations in mean lengths of kokanee landed at different lake areas. Dr. Rich notes in his report of the 195) data that such differences existed and suggested that racial differences might be responsible.

Table 11. Mean length of kokanee by landing locality, Lake Pend Oreille, Idaho, 1956.

Month	Whiskey Rock	Twin Creeks	Lake- view	Echo Bay	Idle- wild Bay	Button- hook Bay	Scenic Bay	Cape Horn
Mar.		8.5	8.6	8.5			8.5	8.6
Apr.		8.4	8.4					
May	9.0		8.4	8.8	8.9	8.9	8.9	8.8
Month	South of Garfield Bay				Garfield Bay and North			
May	8.9				8.6			
June	8.6							
July	8.7				9.0			
Aug.	8.9				9.0			
Sept.	9.4				9.6			

To help substantiate ages of kokanee as determined by scale readings, a series of length-frequency graphs were plotted. These graphs are plotted by months and are shown in Figures 2-10. Since monthly collections varied in sample size, each month was plotted proportionately. The largest number of lengths was taken in May (Table 10), and each total for other months was divided into the May total to derive a factor. The total number of lengths in each two-millimeter grouping was multiplied by the factor as derived above, thus the areas under all curves are equal. The curves are smoothed using the method of a "running average by threes."



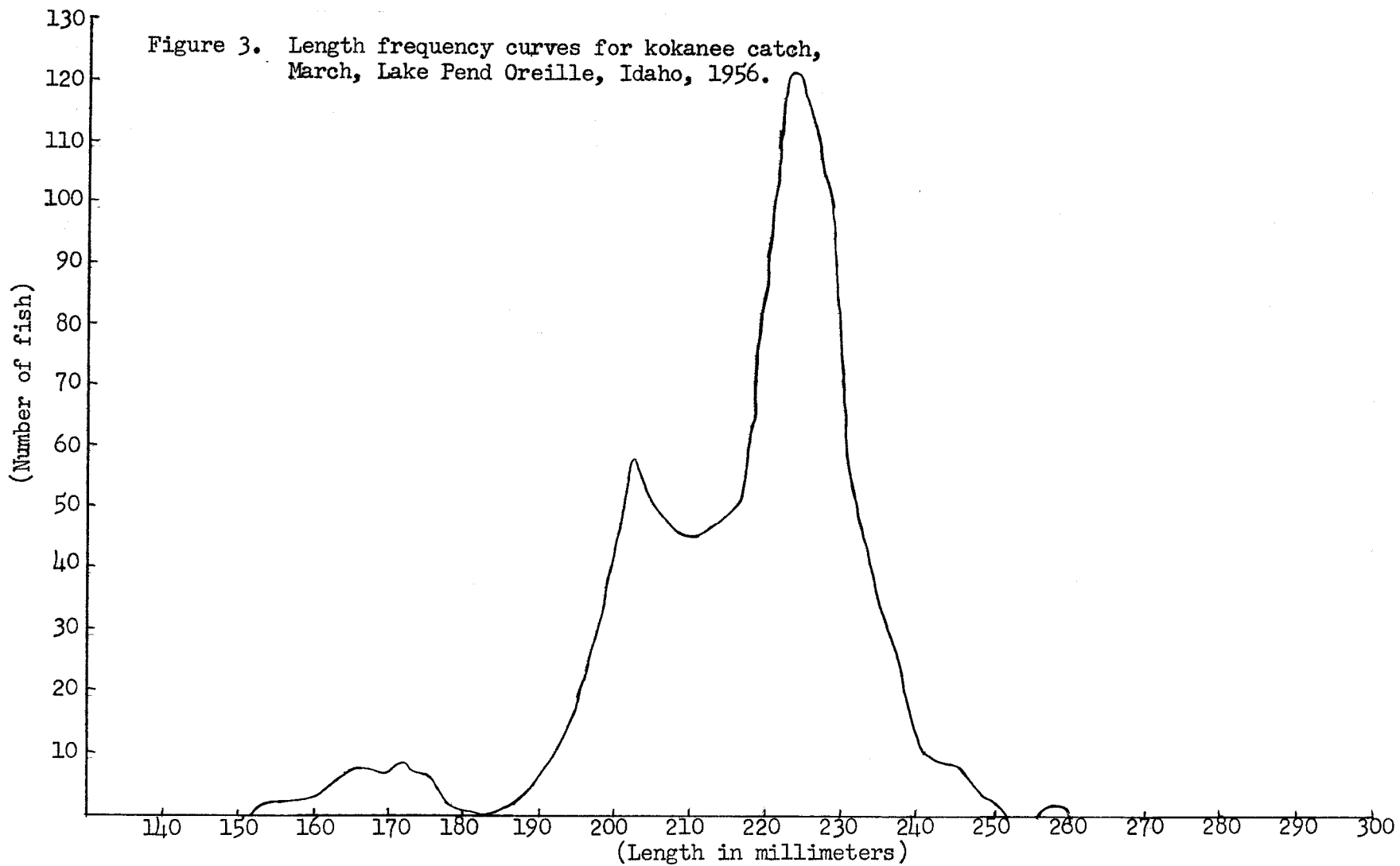


Figure 4. Length frequency curves for kokanee catch,
April, Lake Pend Oreille, Idaho, 1956.

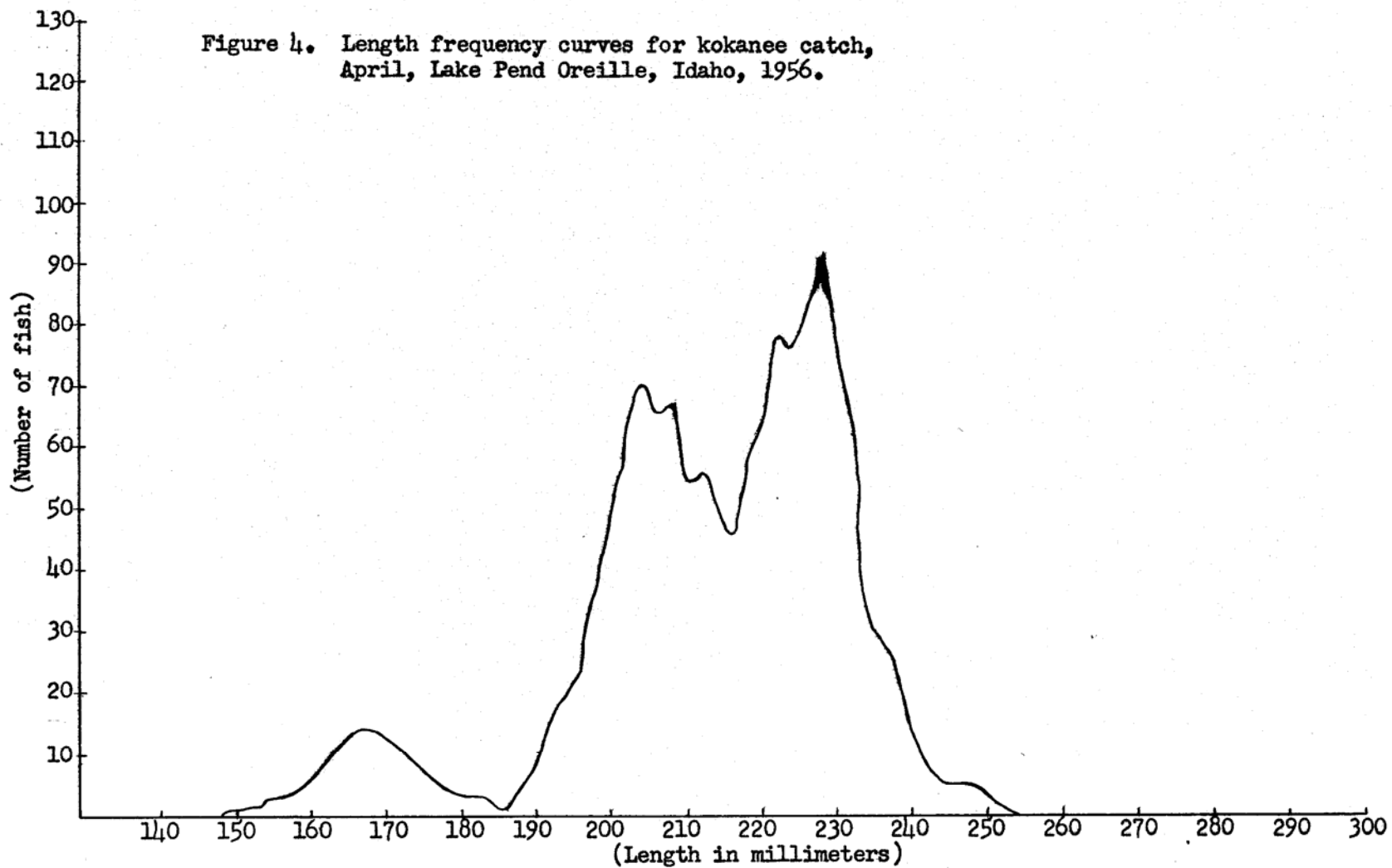


Figure 5. Length frequency curves for kokanee catch,
May, Lake Pend Oreille, Idaho, 1956.

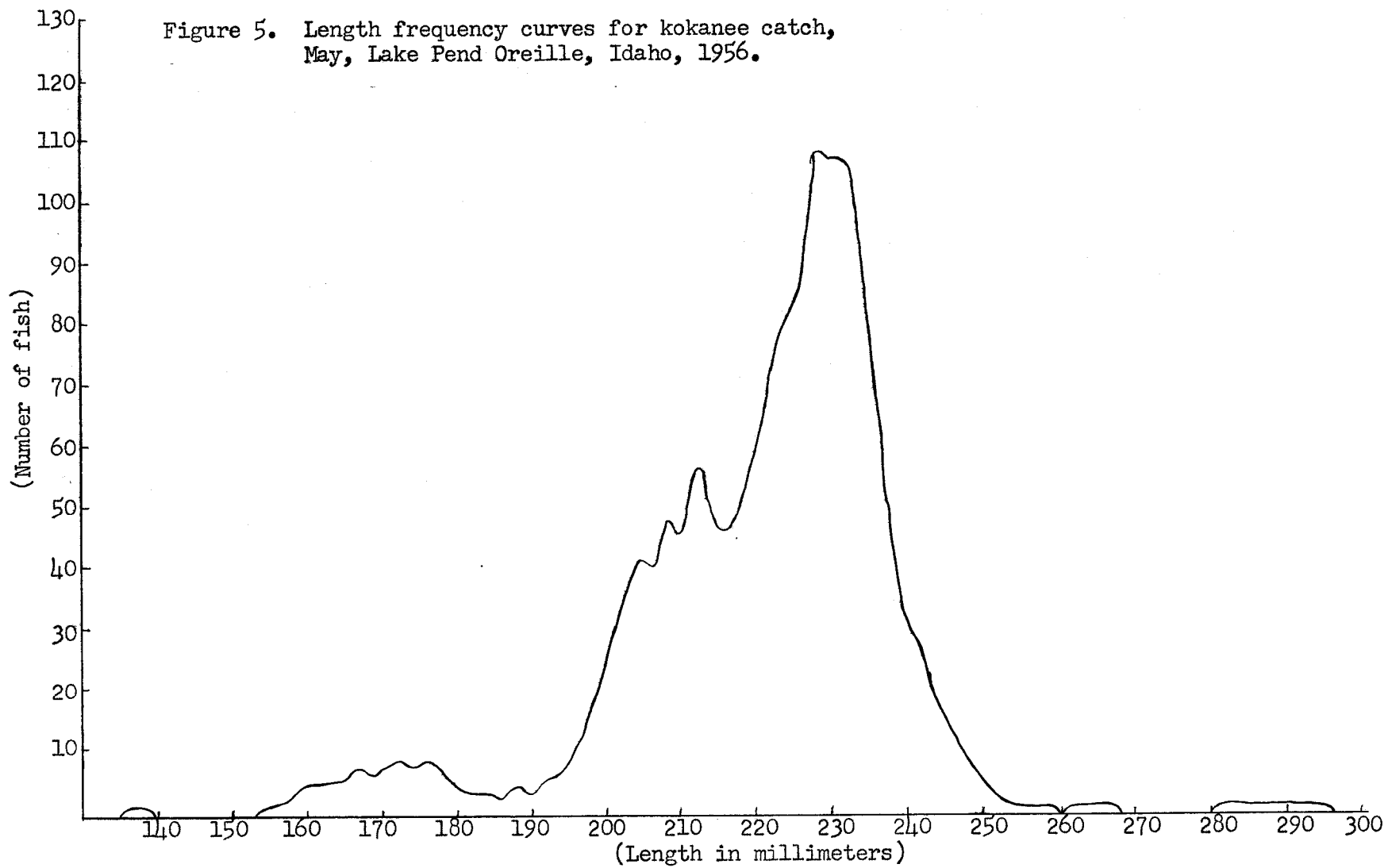


Figure 6. Length frequency curves for kokanee catch,
March, Lake Pend Oreille, Idaho, 1956.

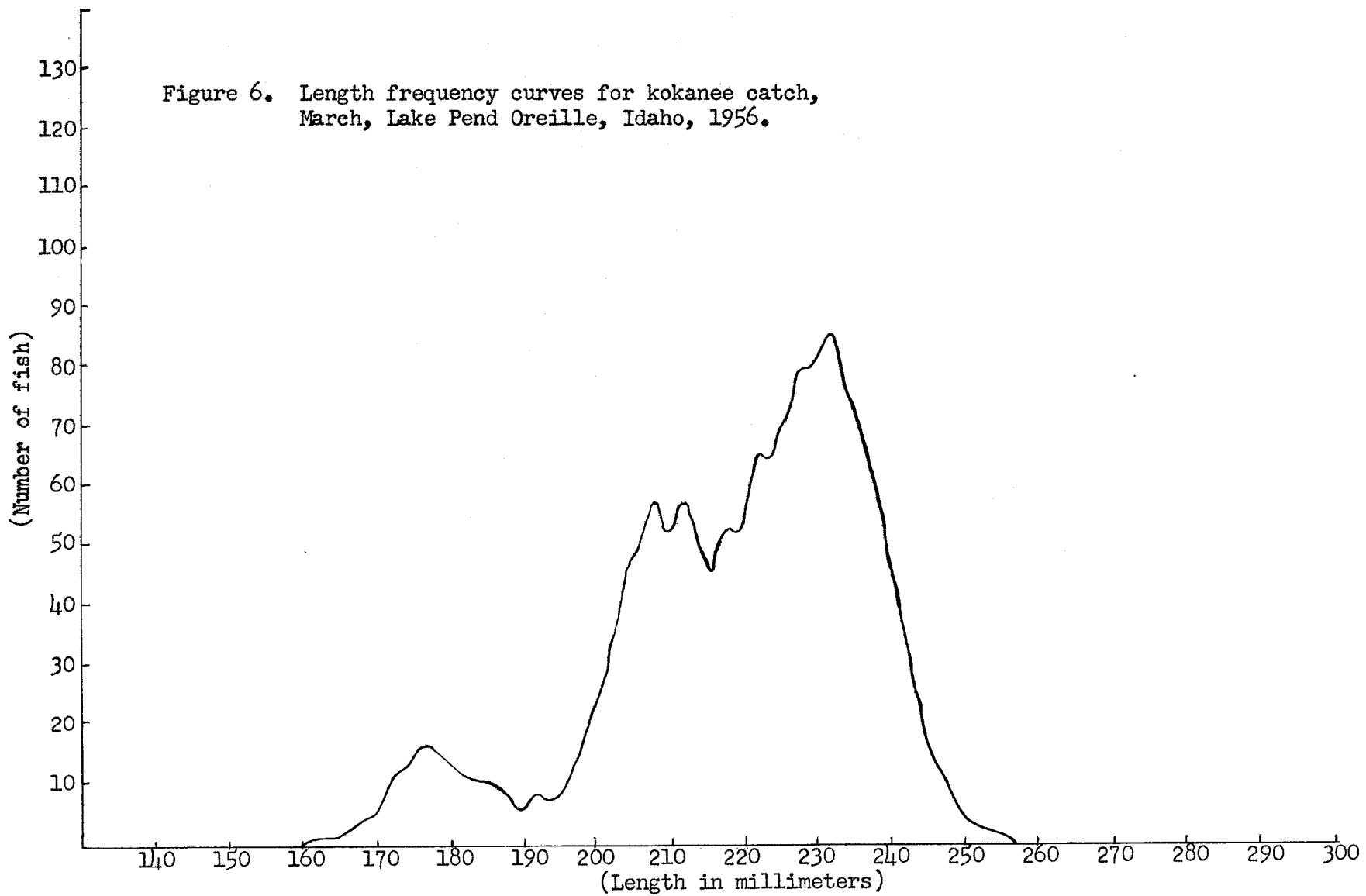


Figure 7. Length frequency curves for kokanee catch,
July, Lake Pend Oreille, Idaho, 1956.

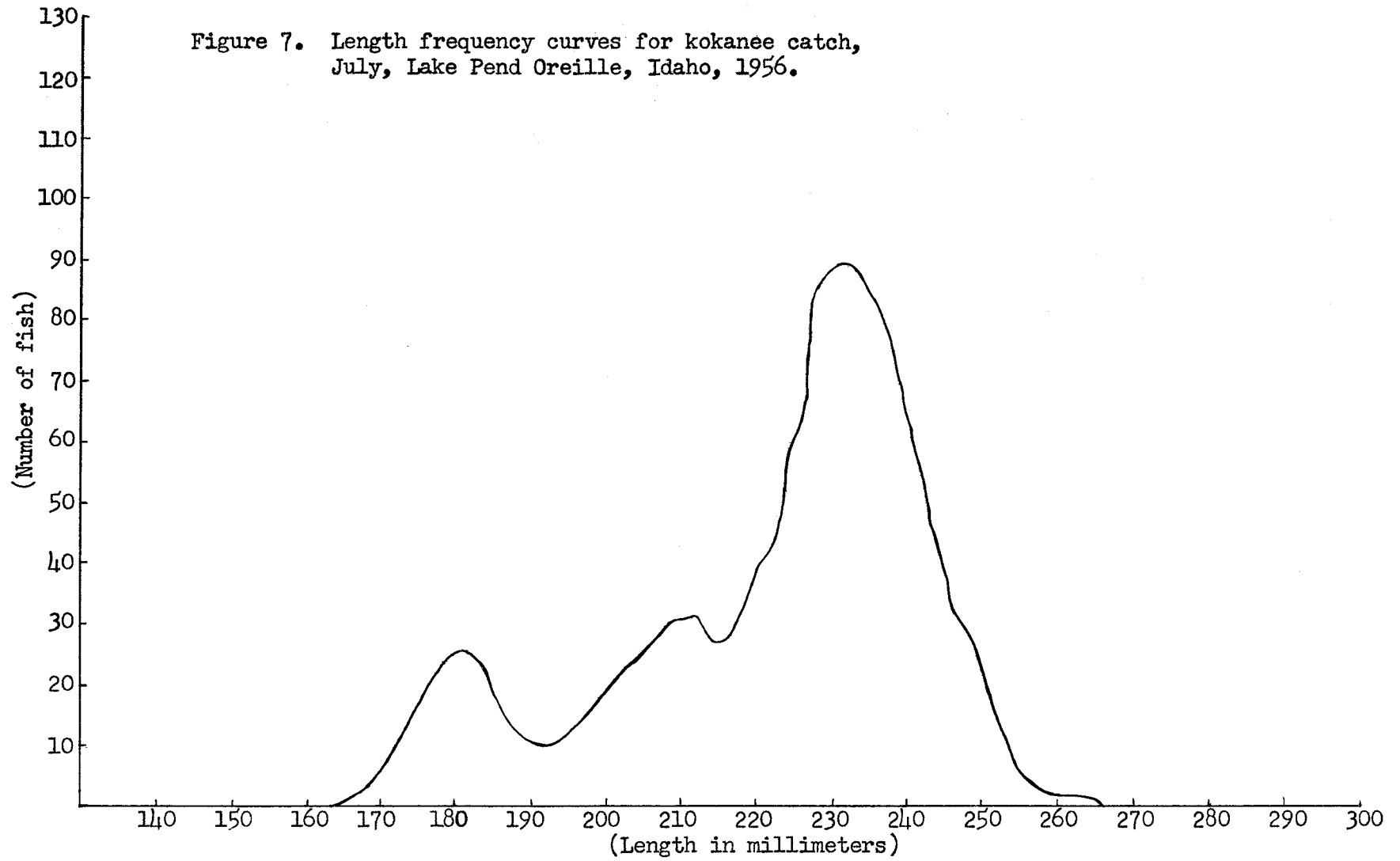


Figure 8. Length frequency curves for kokanee catch, August, Lake Pend Oreille, Idaho, 1956.

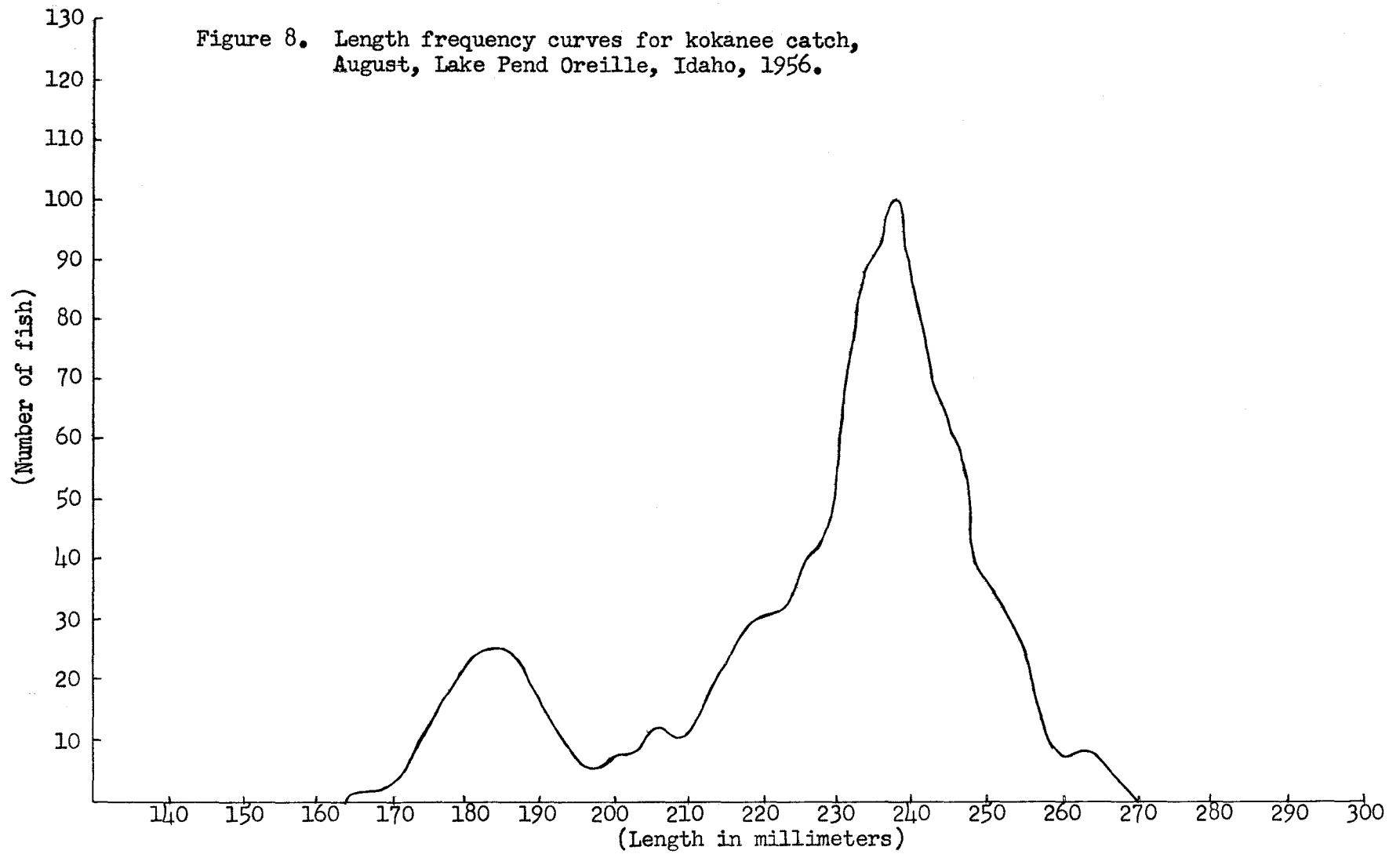


Figure 9. Length frequency curves for kokanee catch,
September, Lake Pend Oreille, Idaho, 1956.

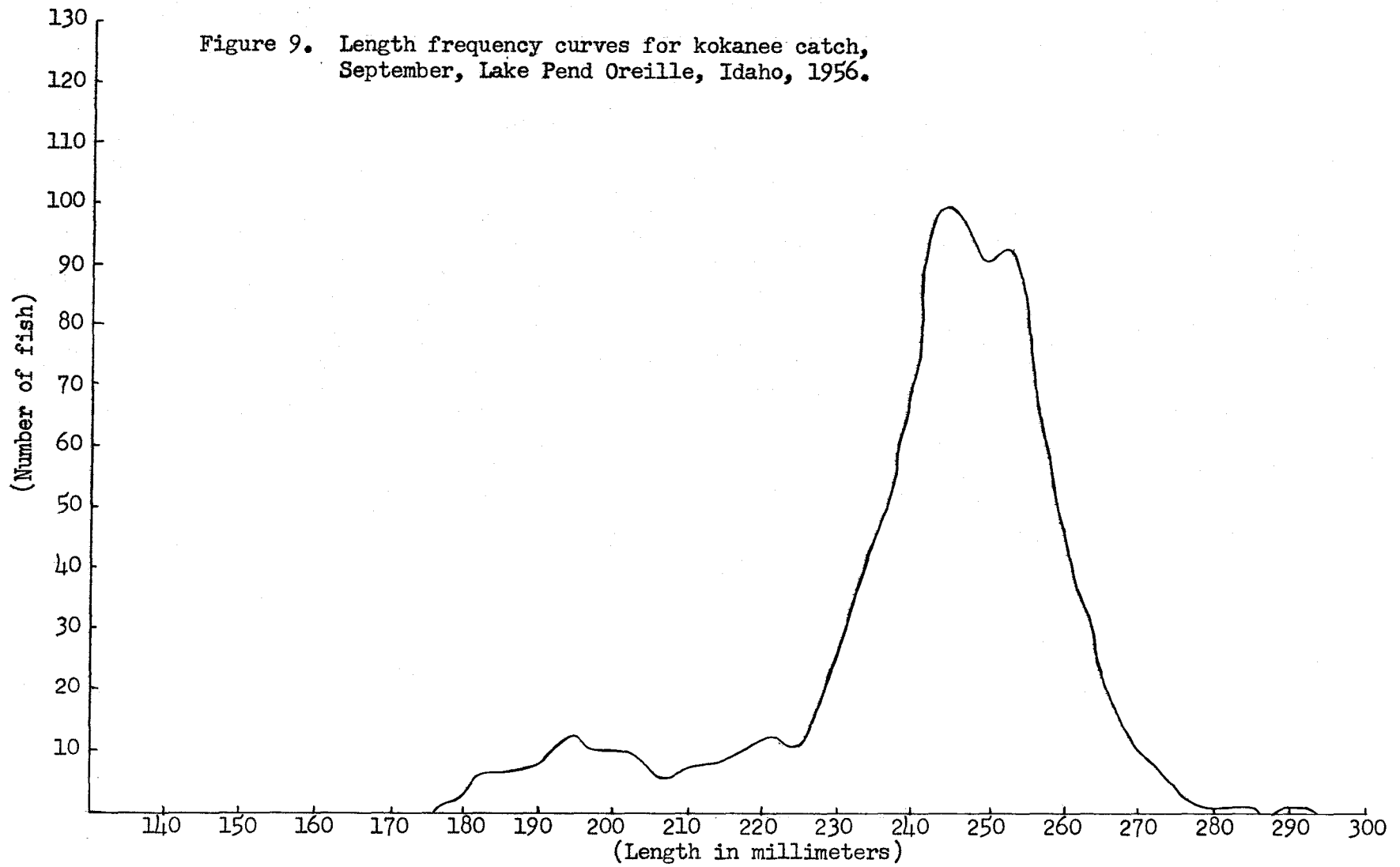
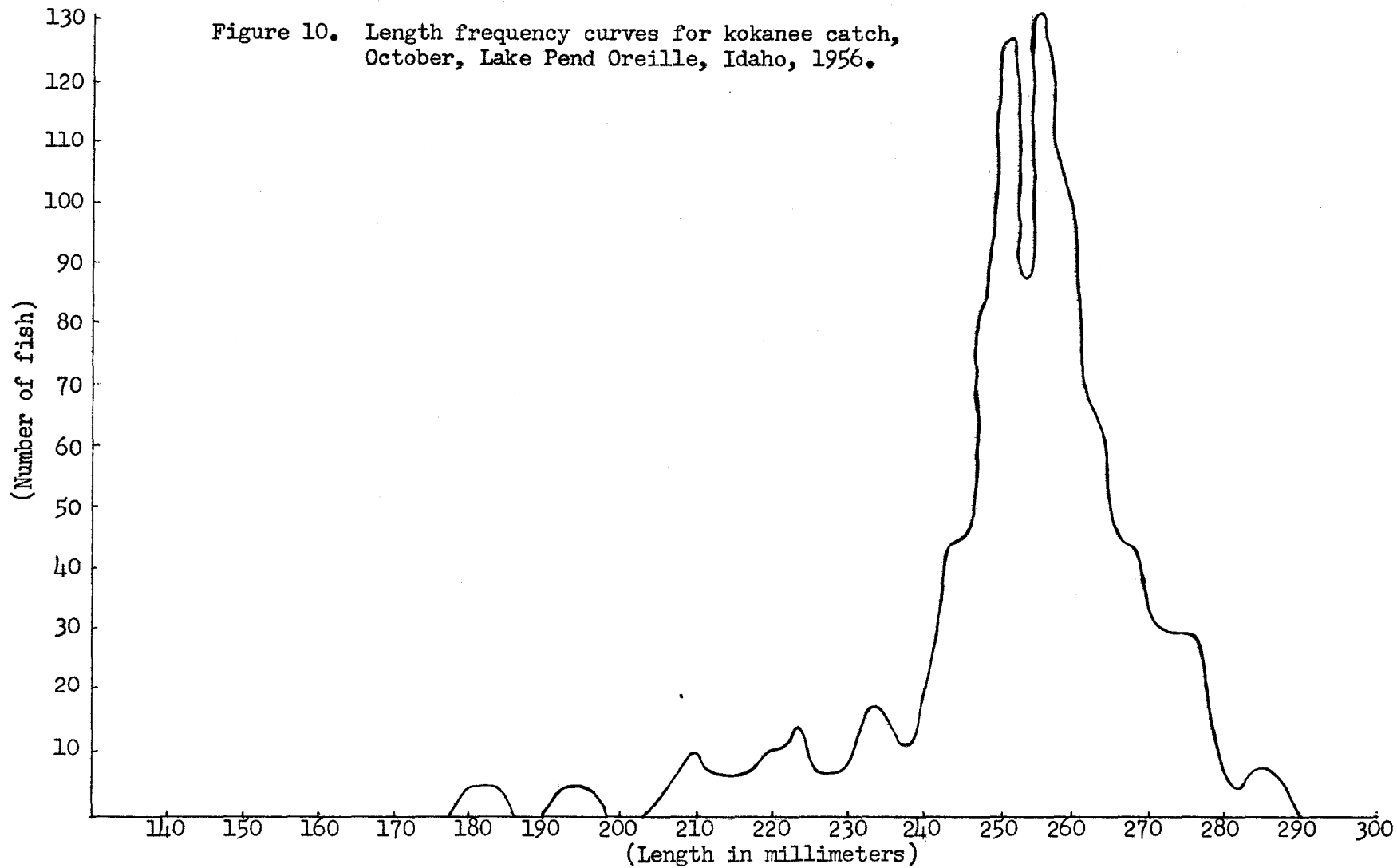


Figure 10. Length frequency curves for kokanee catch, October, Lake Pend Oreille, Idaho, 1956.



A total of 160 scale radii measurements, selected throughout the year, was used to calculate the length of kokanee at the end of the first year's growth. Twenty scales from each year class, equally distributed by months when possible, were selected from the periods of February through June, and July through October. Similarly, 120 measurements were selected to calculate the total length of kokanee at the end of the second year's growth, as shown in Table 12.

Table 12. Calculated lengths of kokanee by body-scale relationship method, Lake Pend Oreille, Idaho, 1956.

Age class	Number	Estimated length in inches at end of	
		1st year	2nd year
3-year	40	2.3 (1954)*	(1954)*
4-year	40	2.6 (1953)	6.5 (1953)
5-year	40	2.4 (1952)	6.5 (1952)
6-year	40	2.2 (1951)	6.1

*Year in which growth occurred.

Weight Data. During 1956 a portion of the random scale samples collected included weight data. Table 13 shows the weight differences (and gains) for the various age classes from all weights collected during March, April, and December.

Table 13. Age-weight data of kokanee before and after the general growing season, Lake Pend Oreille, Idaho, 1956.

Age class	Weight in ounces	
	March and April	December
3-year	1.3 (11)*	
4-year	2.3 (16)	3.8 (6)*
5-year	3.0 (45)	5.0 (9)
6-year	3.3 (22)	5.0 (2)
7-year		5.3 (1)

*Number of fish weighed.

Additional weight samples were collected in conjunction with the length data shown in Table 10. Shown in Table 14 are the data for 97 random weights taken in March and 63 in December.

Table 14. Average weight data for combined and individual sexes, before and after the general growing season, Lake Pend Oreille, Idaho, 1956.

Month	Combined sexes	Weight in ounces	
		Female	Male
March	3.0 (97)*	2.8(47)*	3.1 (50)*
December	5.0 (63)	4.8(33)	5.2 (30)
General	General gain, ounces	2.0	2.1

*Number of fish weighed.

Sex ratio data for 2,253 kokanee examined in the fishermen's creel and 661 fish spawning in Granite Creek are shown in Table 15. Sex determinations were made from examination of gonads from catches throughout the fishing season, and from the external features of spawning kokanee.

Table 15. Sex ratio of kokanee in the fishermen's catch and of spawning fish in Granite Creek, Lake Pend Oreille, Idaho, 1956.

Month	Sex ratio in per cent	
	Females	Males
March	46.8	53.2
April	45.9	54.1
May	39.1	60.9
June	39.2	60.8
July	31.2	68.8
August	29.0	71.0
September	25.1	74.9
October	25.8	74.2
December	51.3*	48.7*

*Sex ratio of spawning fish in Granite Creek.

ANALYSIS AND DISCUSSION

The scale collections in 1948 through 1954 are meager and age analysis data inadequate for specific comparisons with the 1956 data. The trends exhibited by these data do permit broad and general comparisons. The age-group composition for 1948 through 1954 indicates that during these years the catch was composed of fish predominantly four years old with the exception of a small sample in 1953. In contrast, the 1956 data indicate that five-year fish predominated the catch. The percentages of the various age groups by months, shown in Table 8, applied to the total kokanee catch by months revealed that approximately 57.6 per cent of the catch was made up of fish five years old or older. From these data it would appear that a change in the longevity of the kokanee cycle has occurred. It might be surmised that the change in 1956 is temporary and stems from some such factor as an abundant spawning population one year followed by a much smaller spawning population the following year.

Examination of the spawning survey data indicates this portion of the investigation should be expanded in future years to provide additional data for the study of racial differences. Since scales from spawning fish are not too satisfactory for age determination work, it would also seem advisable to collect otoliths in addition to scales for age analysis work. Observations at Granite Creek during the spawning migration indicated that size and sex ratio of incoming fish varied widely through the season; thus, the collections of lengths, sex ratios, etc., should be taken more frequently than those collected in 1956.

The scale samples collected from Granite Creek spawners contained at least three age groups. The fact that both four- and five-year fish are well represented in the spawning population would add significance to the assumption that it might be difficult to measurably affect a year's harvestable population

by fishing pressure or spawning losses, since recruitment from other age groups would tend to fill any void.

The data in Table 10 show the average length of kokanee by months. The lengths for combined sexes indicate that very little growth occurs before June and that no accelerated growth takes place until the latter part of July. Comparisons of length and weight data by sex reveal that male fish are predominantly larger than the females.

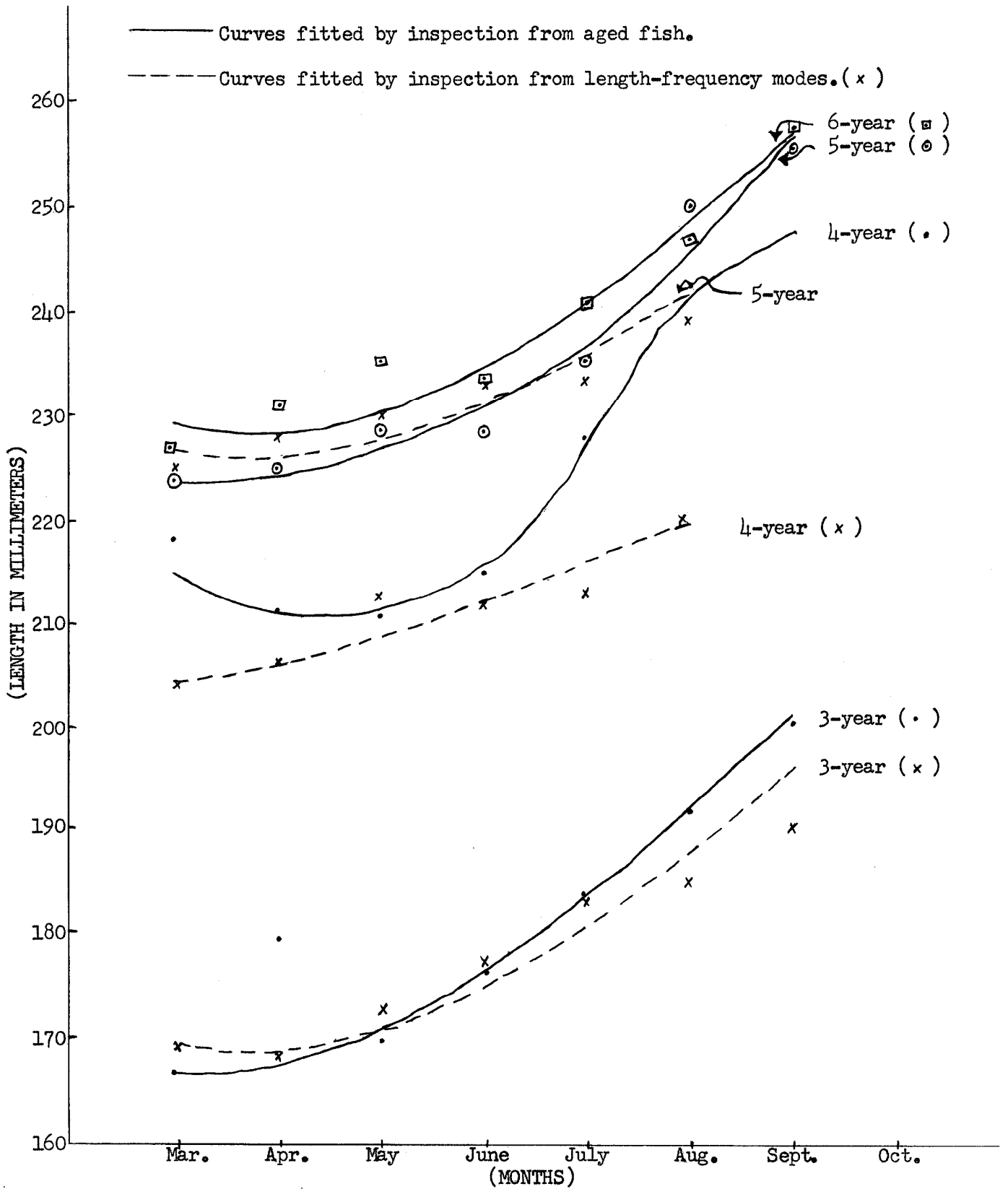
The average lengths for the early months of 1956 appear to be contradictory; i.e., the average for February exceeds the average for March, etc. There are several explanations for these discrepancies. Sampling does not seem to explain these differences since the sizes of the March and April samples are approximately equal. The best explanation is that since very little growth takes place before June the average length depends, to a large extent, upon the percentage composition of the various age groups in the sample.

Another factor which may explain, or at least affect, the mixed averages in Table 10 is the possibility of racial differences. As previously pointed out, Dr. Rich found differences in the 1954 data which led him to believe that variations existed between schools of fish. Table 11 was prepared for determination of any variation that might occur between schools. Unfortunately, it is difficult to obtain monthly records from each school or area and, consequently, Table 11 does not provide a good comparison for all months. Part one of Table 11 shows that during the month of May there were distinct differences between areas. Part two of the same table also shows a definite trend towards larger fish for the north end of the lake as compared to the south end. An examination of the May data showed that the proportion of immature fish in the catch, as described above, was only 4 per cent in the south end as compared to 10 per cent in the north end. The variation in the May data is possibly due to this factor. The tendency for fish to be larger in the north end of the lake has been noticed by commercial fishermen for several years and is evidenced by an increase in the poundage for a limit catch.

The data shown in Figures 2 through 10 appear to substantiate the scale reading by showing modes representing the various age groups in Table 7. Figure 1 does not show three major modes, which may be due to the small size of the sample. The figures for March through July are in general agreement and show three definite modes. The first mode represents three-year fish, while the second and third represent four- and five-year fish. Since very little growth occurs during the latter years of life, the mode representing six-year fish intergrades with the right half of the mode which represents five-year fish. The fish shown measuring 280 to 292 millimeters in May are probably seven-year fish. It is evident that the mode representing four-year fish disappears in August. This is probably due to the fact that four-year fish are faster growing than the older age groups and thus overlap in length with five-year fish during the latter part of the growing season. These data establish the fact that fish in the older age groups cannot be identified by length observations alone. Figure 11 shows growth curves representing age groups, and modes from Figures 2 through 10.

Data relating to calculated lengths of kokanee at the end of the first and second year of growth are shown in Table 12. The greatest growth incre-

Figure 11. Comparison of annual growth of kokanee in Lake Pend Oreille plotted from length-frequency modes and from average length of aged fish, 1956.



ment percentage-wise is attained during the second year of life, The growth increment for the first year appears to exceed that of the third year and each year thereafter the increment becomes less than the preceding year.

Tables 13 and 14 show that kokanee in the creel averaged approximately 3 ounces at the start of the season. Kokanee weighed on the spawning beds averaged about 5 ounces. The general gain of some two ounces shown in Table 14 is slightly more than that of the whole population since three-year fish averaged at the start of the season are not included in the average in December.

The sex ratio data collected in 1956 follows a trend as described by Dr. Rich for the 1954 data. Examination of gonads from several thousand fish in 1954 revealed that approximately 60 per cent of the catch was male fish. In 1956, the percentage of male fish in the catch was even more pronounced, averaging 66 per cent. The sex ratio of spawning fish in 1956 was almost equal, being 51.3 per cent females and 48.7 per cent males, as compared with 54.7 and 45.3 per cent, respectively, in 1954. It appears from this that the male fish is much more aggressive than the female and that the degree of aggressiveness or susceptibility to the angler's hook increases as the season progresses. It would appear also, considering total harvest and spawning escapement in 1956, that the number of males exceeds the number of females at the start of the year.

RECOMMENDATIONS

The age and growth data collected in 1956 show a probable change in the life cycle of the Pend Oreille kokanee, It seems desirable, therefore, that further study be given to the cyclic tendencies of the kokanee. It is further recommended that data collections be made so that tests for differences between areas of the lake, especially those differences occurring in the spawning population, might be made.

ACKNOWLEDGEMENTS

Sincere thanks are extended to Mr. Keith White for his assistance in collecting scales and length data in the field and his interpretation of scale samples and to Messrs. Kenneth Mosher, Willis Rich, and Ted Bjornn for assistance given Mr. White with his age determinations.

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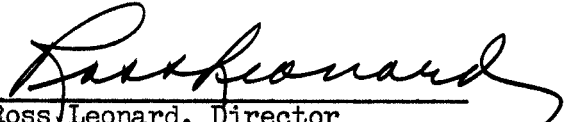
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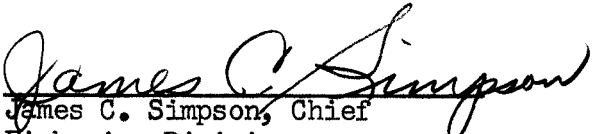
Charles R. Whitt
Fisheries Biologist II

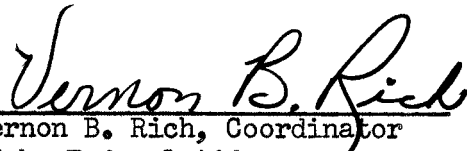
April 20, 1958

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

By 
Ross Leonard, Director

By 
James C. Simpson, Chief
Fisheries Division

By 
Vernon B. Rich, Coordinator
Idaho Federal Aid

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APPENDIX A

Date	Place caught	Number of scales	Collector
February 13	Bayview	6	Whitt
March 3	"	24	"
10	"	19	"
13	"	23	"
14	"	55	"
April 26	"	61	"
May 9	"	68	"
16	Garfield	20	"
18	"	1	"
29	"	19	Whitt & White
June 13	Bayview	8	Whitt
14	"	35	Whitt & White
25	Garfield	4	White & Heath
26	Bayview	7	Whitt
26	"	3	White
26	"	6	"
26	"	12	"
26	"	1	"
26	"	3	"
26	"	2	"
26	"	27	"
27	"	32	"
27	"	17	"
27	"	12	"
27	"	15	"
27	"	41	"
27	"	5	"
July 8	"	12	"
14	"	15	"
14	"	3	"
14	"	19	"
14	"	5	Whitt
14	"	6	White
14	"	12	Whitt
14	"	6	White
14	"	24	"
14	"	13	"
14	"	42	"
14	"	15	"
19	Garfield	6	"
24	"	10	White & Heath
26	Bayview	5	White
27	"	2	"
28	Garfield	11	White & Heath
30	Hope	12	White

APPENDIX A (continued)

Date	Place caught	Number of scales	Collector	
August	23	Hope	11	White
	24	Garfield	8	White & Heath
	24	"	18	White
	21	"	25	"
September	6	"	8	"
	6	"	11	"
	6	"	6	"
	6	"	8	"
	6	"	3	"
	6	"	4	"
	8	Bayview	19	"
	8	"	17	"
	10	"	27	"
	11	"	15	"
	11	"	10	"
	11	"	10	"
	11	"	9	"
	13	"	7	"
	13	"	12	"
	13	"	4	"
	15	Hope	13	"
	15	"	13	"
	15	"	3	White & Heath
	15	"	22	" "
	16	Garfield	9	White
	16	"	4	"
	16	"	9	"
	16	"	"	"
	18	Hope	12	White & Heath
	18	"	7	" "
October	3	"	4	White
		Bayview	7	"
	25	"	11	"
December	2	Granite Creek	14	Whitt & White
	31	" "	24	White

APPENDIX B

Summary of kokanee length data collections, Lake Pend Oreille, Idaho, 1956.

Date	Place Caught	Class of Fishermen	Method of Fishing	Number of Lengths	Collector
February	7 Bayview	Commercial	Handlining	25	Whitt
	8 "	"	"	51	"
	9 "	"	"	29	"
	11 "	"	"	1	"
	21 "	"	"	122	"
March	2 Lakeview	Sport	"	24	"
	6 Echo Bay	Commercial	"	223	"
	8 Scenic Bay	"	"	170	"
	10 Cape Horn	Sport	"	18	"
	14 Echo Bay	"	"	55	"
	15 Cape Horn	"	"	37	Whitt & Miller
	27 Cedar Creek	"	"	113	Whitt
April	6 Twin Creeks	Commercial	"	145	Whitt & Miller
	13 Lakeview	Sport	"	62	Whitt
	16 "	"	"	192	"
	26 "	"	"	113	"
	30 Twin Creeks	Commercial	"	115	"
May	8 Green Monarchs	"	"	168	Whitt & Miller
	8 Kilroy Bay	"	"	325	"
	9 " "	"	"	160	Whitt
	9 Granite Creek	"	"	108	"
	9 Lakeview	Sport	"	67	"
	16 Green Monarchs	"	"	66	"
	24 Echo Bay	"	Trolling	20	White
	24 Cape Horn	"	"	28	"
	27 Scenic Bay	"	"	67	Whitt & White
	27 Idlewild Bay	"	"	174	"
	27 Echo Bay	"	"	15	" "
	27 Button Hook Bay	"	"	"	" "
	28 " " "	"	"	51	White
	28 Idlewild Bay	"	"	38	"
	29 Whiskey Rock	"	"	25	Whitt & White
	29 " "	Commercial	Handlining	144	" "
June	5 Echo Bay	Sport	Trolling	18	White
	7 Scenic Bay	"	"	28	"
	7 Button Hook Bay	"	"	21	"
	8 " " "	"	"	16	"
	8 Idlewild Bay	"	"	78	"
	8 Echo Bay	"	"	53	"
	14 Button Hook Bay	"	"	96	"
	14 Idlewild Bay	"	"	63	Whitt & White
	14 Scenic Bay	"	"	24	" "
	14 Echo Bay	"	"	81	" "
	21 Button Hook Bay	"	"	23	White

APPENDIX B (continued)

Date	Place Caught	Class of Fishermen	Method of Fishing	Number of Lengths	Collector
June	21 Echo Bay	Sport	Trolling	8	White
	23 " "	"	"	35	Whitt
	23 Idlewild Bay	"	"	33	"
	23 Cape Horn	"	"	25	"
	23 Button Hook Bay	"	"	17	"
	23 Garfield Bay	"	"	15	White
	25 " "	"	"	7	White & Heath
	25 Scenic Bay	"	"	46	Whitt & White
	25 Echo Bay	"	"	23	White
	26 Idlewild Bay	"	"	41	Whitt & White
	26 Cape Horn	"	"	29	" "
	26 Scenic Bay	"	"	36	" "
	27 " "	"	"	26	White
	27 Echo Bay	"	"	101	"
	27 Idlewild Bay	"	"	17	"
	27 Button Hook Bay	"	"	6	"
July	8 Button Hook Bay	"	"	12	"
	12 Green Monarchs	"	"	14	White & Heath
	14 Scenic Bay	"	"	161	Whitt & White
	14 Echo Bay	"	"	26	White
	14 Idlewild Bay	"	"	79	"
	14 Cape Horn	"	"	41	"
	16 Kilroy Bay	"	"	38	"
	18 Green Monarchs	"	"	24	"
	18 Garfield Bay	"	"	23	"
	19 Green Monarchs	"	"	10	"
	21 Cape Horn	"	"	63	Whitt
	22 Scenic Bay	"	"	96	Whitt & White
	22 Cape Horn	"	"	25	White
	24 Warren Island	"	"	33	"
	24 Garfield Bay	"	"	62	White & Heath
	24 Green Monarchs	"	"	9	" "
	25 Cape Horn	"	"	2	White
	25 Scenic Bay	"	"	49	"
	26 Cape Horn	"	"	12	"
	26 Echo Bay	"	"	26	"
	27 Cape Horn	"	"	31	"
	28 Green Monarchs	"	"	35	White & Heath
	28 Garfield Bay	"	"	22	" "
	28 Kilroy Bay	"	"	11	" "
	30 Ellisport Bay	"	"	27	White
	30 Green Monarchs	"	"	14	"
August	4 Idlewild Bay	"	"	11	Whitt
	5 Whiskey Rock	"	"	16	"
	9 Scenic Bay	"	"	22	"
	9 Echo Bay	"	"	33	"
	9 Twin Creeks	"	"	19	"
	11 Trestle Creek	"	"	220	Whitt & Miller
	12 " "	"	"	129	" "

APPENDIX B (continued)

Date	Place Caught	Class of Fishermen	Method of Fishing	Number of Lengths	Collector	
August	12	Glengary Bay	Sport	Trolling	24	Whitt & Miller
	13	Lakeview	"	"	28	Whitt
	13	Echo Bay	"	"	9	"
	19	" "	"	"	34	"
	23	Warren Island	"	"	11	White
	24	Garfield Bay	"	"	38	"
	24	Green Monarchs	"	"	18	"
September	6	Garfield Bay	"	"	40	"
	8	Idlewild Bay	"	"	14	Whitt
	8	Echo Bay	"	"	83	White
	8	Cape Horn	"	"	19	"
	10	Echo Bay	"	"	8	"
	10	Lakeview	"	"	27	"
	11	"	"	"	80	Whitt
	11	Cape Horn	"	"	21	Whitt & White
	11	Echo Bay	"	"	56	White
	12	Lakeview	"	"	45	"
	12	Cape Horn	"	"	26	"
	12	Button Hook Bay	"	"	18	"
	12	Idlewild Bay	"	"	9	"
	12	Scenic Bay	"	"	60	"
	13	Cape Horn	"	"	63	Whitt & Hansen
	13	Echo Bay	"	"	52	" "
	13	Idlewild Bay	"	"	22	White
	13	Ellisport Bay	"	"	118	White & Heath
	15	Green Monarchs	"	"	41	" "
	16	" "	"	"	145	Whitt & White
	16	Garfield Bay	"	"	52	White
	18	Ellisport Bay	"	"	53	White & Heath
	18	Green Monarchs	"	"	4	" "
	19	Echo Bay	"	"	69	White
	19	Lakeview	"	"	48	"
	20	Echo Bay	"	"	33	"
20	Lakeview	"	"	24	"	
20	Idlewild Bay	"	"	9	"	
October	3	Ellisport Bay	"	"	5	"
	14	Lakeview	"	"	55	"
	14	Echo Bay	"	"	61	Whitt & White
	27	Lakeview	"	"	14	White
December	2	Granite Creek	Spawners		300	Whitt & White
	18	" "	"	"	225	" "
	31	" "	"	"	136	White

