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April 2, 1941

REPORT NO. 661

PROGRESS REPORT

OF

INVESTIGATION OF THE WINTER FISHING PROBLEM

ON

SEVERAL SOUTHERN MICHIGAN "BLUEGILL LAKES"

By

O. H. Clark

GENERAL OUTLINE

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PROGRESS REPORT ON INVESTIGATION OF THE WINTER FISHING PROBLEM ON SEVERAL SOUTHERN MICHIGAN "BLUEGILL LAKES"

WINTER 1937 - 1938
SUMMER - 1938

WINTER 1938 - 1939
SUMMER - 1939

WINTER 1939 - 1940
SUMMER - 1940

The Michigan Department of Conservation, through the Institute for Fisheries Research, has conducted quite a number of intensive lake censuses over several years, and considerable data have been collected pertinent to the winter fishing problem. In the past three years these censuses have been conducted on a number of southern Michigan lakes with the purpose of determining the conditions on the southern, so-called bluegill lakes, the major objective being to obtain data evaluating the inter-relationships of the different seasonal catches of the anglers.

Population studies were made on two lakes, utilizing the system used by Dr. David Thompson of the Illinois Natural History Survey. Scale samples were taken and growth rate studies made. A commercial fisherman with his gear was employed to assist in obtaining the necessary numbers of fish for the population estimates. Weights and measurements were recorded on approximately 10,000 fish in the two lakes where population determinations were made. Separate reports, previously submitted on a number of the lakes upon which censuses have been conducted, have been used in this paper for the purpose of comparison, and the reports listed in the bibliography at the end Starting with the winter of 1940-41, the investigation by creel census and population analysis has

been concentrated on Bear Lake, Hillsdale County, and Craig Lake, Branch County. It is planned to conclude this investigation at the end of the summer fishing season of 1941.

The particular lakes encompassed in this report, and referred to throughout the paper as the five lakes, are: Bear, located in Hillsdale County; Craig in Branch County; Christiana in Cass County; Paw Paw in Berrien County; and Stearns Bayou in Ottawa County. A sixth lake, Hamlin, located in Mason County, is also used, but on this lake the census was conducted for only one year. Comparisons are drawn with other censuses from other lakes, notably Fife Lake in Grand Traverse and Kalkaska counties and the lakes in the Waterloo Area of Jackson and Washtenaw counties, and Pike and Fowler lakes in Hillsdale County. The selection of the above five lakes was the result of considerable preliminary investigation in an effort to obtain lakes that enjoyed both summer and winter fishing. (Most lakes in the state at the present writing are fished very lightly or not at all in the winter season.) The local Conservation Officers, District Supervisors, and local residents were queried regarding the final selections. In the case of Bear Lake, it seems we slipped a bit for our records failed to approximate the reported high winter fishing pressure of the period preceding the investigations Craig Lake enjoyed a sustained high winter pressure, being considered locally a winter-fishing lake. This seems to be caused by greater ease of access at that period of the year, as well as by the good winter fishing results.

Previous to this, considerable data had been gathered and been reported on lakes from the more northern areas such as Fife Lake, and in these the different seasonal compositions of the catches were such as to

largely complement each other, instead of largely competing as they did in the more southern lakes. The preponderance of the bluegill in the catches on southern lakes accounts for this latitudinal difference. For the above reasons, with the exception of Hamlin Lake the lakes selected were located in the southern portion of the state, and all were properly defined as bluegill lakes, as the subsequent data substantiated.

Supervision

Creel censuses on these lakes have been under the direct supervision of the employees of the Institute for Fisheries Research. Following is a list of the census clerks for the different periods of census:

1938 - 39

Lake	Winter	Summer
Bear	Hugh Case	Lawrence Bush
Craig	Ronald Myers	Paul Barrett and Clifford Smith
Christiana	Harold Bowditch	Harold Bowditch
Paw Paw	H. L. Thompson	Robert Matthews with assistants James O'Brien, Robert Hirsch, Raymond Love; Mr. Thompson gave voluntary help
Stearns Bayou	Jack Brass, Jr.	Orville Falk
Hamlin	-	Gerald McCrimmon, directing CCC enrollees
Waterloo Project Lakes: Clear, Big Portage, Sugarloaf	WPA labor under the supervision of Mr Phillip Olin of the National Parks Service, with George Eder directing in the field.	

1939 - 40

Lake	Winter	Summer
Bear	Lawrence Bush	Basil Hughes
Craig	Hugh Case	Orville Falk and John Ford
Christiana	Harold Bowditch	Harold Bowditch
Paw Paw	Edwin Neumann and Ralph Peters	Dexter Reynolds and assistants Robert Hirsch, Edwin Neumann, Ralph Peters
	Mr. Thompson gave voluntary help both seasons	
Stearns Bayou	Jack Brass, Jr.	Robert Matthews
Hamlin		Gerald McCrimmon to March 1, 1940 Dexter Reynolds from March 1 - June 23, 1940

Periods of Census

Data were accumulated for the period from December 26, 1938 through March 31, 1939. The census was resumed June 25th, the opening day of the season, and was continued through October 15th. On Christiana Lake the period was extended to ice formation, and on Bear and Craig Lakes through November 6 in 1940. However, for the sake of direct comparison, the records in this report are taken through October 15th as on the other lakes. On Hamlin Lake, which comes under the pike lake designation, the winter season ended March 1st and the summer season began May 15.

Methods

The methods used in the creel census on all the lakes have been discussed in other reports, R W. Eschmeyer 1936 and O H Clark 1939, and the same methods were used throughout these investigations The

records for Hamlin Lake were taken by the Ludington State Park CCC Camp under the direction of an Institute employee. The censuses on the Waterloo Project lakes were conducted by WPA employees under periodic supervision by an Institute staff member. On those lakes where the censuses were conducted entirely by Institute employees, an effort was made to obtain records of all fishing on those waters. Variations occurred in the completeness of coverage. Due to differences in physical conditions, the coverage was approximately 99 per cent on Bear Lake, 80 per cent on Craig Lake, 98 per cent on Christiana Lake, 80 to 85 per cent on Paw Paw Lake, 90 to 95 per cent on Stearns Bayou, and 80 to 85 per cent on Hamlin Lake. In this report the number of fishermen not contacted has not been used in the computations.

Records

For the winter of 1938-39 on the five lakes censused, not including Hamlin Lake, records of 10,132 fishermen were taken.

For the summer of 1939, a total of 39,913 records were taken, including 23,348 records on the five lakes and 16,565 records from Hamlin Lake.

For the winter of 1939-40, a total of 13,066 records were taken, which total included 11,737 records on the five lakes and 1,329 records from Hamlin Lake.

For the summer of 1940, a total of 18,008 records were taken on the five lakes, with no records from Hamlin Lake.

Table I gives in tabular form the number of records secured from the various lakes, seasonally, over the census periods

Table I

Lake	Winter 1937-38	Summer 1938	Winter 1938-39	Summer 1939	Winter 1939-40	Summer 1940
Bear	311	3,342	202	2,698	254	1,834
Craig	...	...	2,478	3,745	2,687	3,196
Christiana	...	...	1,295	3,540	632	3,214
Paw Paw	...	...	2,515	10,029	4,170	7,054
Stearns Bayou	...	...	3,642	3,336	3,994	2,710
Hamlin	...	...	...	16,565	1,329	. .
Totals	311	3,342	10,132	39,913	13,066	18,008

For the five lakes listed in Table I for which we have data comprising two consecutive years (Hamlin omitted), we find a total of 63,225 fisherman-days, 41,356 for the two summer periods and 21,869 for the winter. This indicates a two to one ratio for the summer and winter seasons, but these figures were obtained not from an average southern lake, but from lakes notably above average except Bear in their respective areas for their winter fishing pressure. On these same five lakes for the same periods, a total of 241,939 legal fish were taken--121,666 during the winter period and 120,273 in the summer. In other words, half the number of fishermen in the winter caught about the same number of fish as were removed in the summer.

Legal sized fish: In the winter of 1938-39 on the five lakes 59,790 fish were taken. In the summer of 1939 on the six lakes 130,130 legal sized fish were taken, which figure included 72,757 on the five lakes and 57,373 fish on Hamlin Lake. In the winter of 1939-40, there were ~~66,701~~ 66,633 legal sized fish recorded, which total included ~~61,701~~ 61,808 on the five lakes and 4,825 on Hamlin Lake. In the summer of 1940 the total

number of legal sized fish taken was 47,507 on the five lakes, with no records taken from Hamlin Lake, no census being conducted there.

Under-sized fish: The number of undersized fish recorded for the winter of 1938-39 was 17,303 with no census on Hamlin Lake. In the summer of 1939 a total of 42,311 undersized fish were recorded, which total included 36,122 on the five lakes and 6,189 from Hamlin Lake. In the winter of 1939-40 there were 11,940 undersized fish recorded, of which 11,835 were on the five lakes and 105 on Hamlin Lake. For the summer of 1940 the number of undersized fish taken on the five lakes was 26,491--no census on Hamlin Lake. Without a doubt, the figures for the undersized fish caught are far below the actual numbers, since many fishermen do not accurately recall the number of fish of less than legal size, but in all probability they do indicate the trend from year to year in the relative abundance of the small fish as compared with those of legal size. The truth of this statement depends on the assumption that the percentage of fishermen giving incorrect answers as to the number of illegal fish in the catch would tend to remain constant.

Catch per Hour

The highest catch per hour--2.6-- for all lakes was recorded from Craig Lake for the two successive winter periods. The lowest catch per hour for the winter period of 1938-39 was 0.8, which occurred on Christiana and Pike lakes. In 1939-40, the lowest catch per hour was on Bear Lake, where the record was 0.3. The highest summer catch per hour occurred on Paw Paw--1.1.

The average catch per hour for the entire year for non-trout waters as recorded in the general census was 1 4 for 1938 and 1 1 for 1939 This census is conducted by the Conservation Officers over the entire state, the fishing records reporting the catch up to the time of contact by the

Officer. Figures from the general census cannot be closely compared with the results from the intensive censuses.

Table II shows the catch per hour for each of 11 lakes for the winter and summer periods 1938-39-40.

Table II

Catch per Hour

Lake	Winter 1938-39	Winter 1939-40	Summer 1939	Summer 1940
Bear	0.98	0.3	0.8	0.7
Craig	2.6	2.6	0.7	0.7
Christiana	0.8	1.4	0.6	0.7
Paw Paw	1.6	0.9	1.1	1.1
Stearns Bayou	1.6	1.7	0.9	1.0
Hamlin	...	0.8	0.97	...
Pike	0.8	...	1.3	...
Fowler	0.99	1.2	...	...
Sugarloaf	...	0.7	1.1	...
Clear	...	1.6	1.8	...
Big Portage	...	0.5	0.9	...

The catch per hour in winter was almost twice as great as in summer, being 1.65* in winter against 0.9 in summer. The average ice fisherman fished 20 minutes longer per day than did the summer fisherman. Thirty-eight and one-half per cent of the summer anglers caught no fish, while 32 per cent of the winter fishermen went home empty handed.

* 1 65 and 0 9 derived by dividing total number of fish caught on the five lakes by the total number of hours fished, for winter and summer periods.

Table III shows the average catch per fisherman and the average number of hours per fisherman-day Figure No 1 shows the catch per hour by seasons for the six lakes intensively censused, together with a seasonal average for the four seasons, for all lakes except Hamlin.

Table III

Average Catch Per Fisherman and Average Number of Hours Per Fisherman-day

Lake	Winter 1938-39		Winter 1939-40		Summer 1939		Summer 1940	
	Hours	Catch	Hours	Catch	Hours	Catch	Hours	Catch
Bear	2.8	2.7	2.3	0.8	3.0	2.4	2.8	2.0
Craig	3.4	9.0	3.3	8.6	3.3	2.4	2.7	1 9
Christiana	3.4	2.7	3.7	5.1	3.0	1.8	3.1	2 2
Paw Paw	3.7	5.7	3.1	2.8	3.6	4.1	2.9	3 1
Stearns Bayou	3.3	5.2	3.4	5.9	3.2	2.9	3.4	3 3
Hamlin	...	...	4.7	3.6	3.6	3.5	...	.
Pike	2.9	2.2	...	...	2.9	3.7	...	.
Fowler	3.0	3.0	2.2	2.7	...	...	...	.
Sugarloaf	...	...	5.0	3.4	3.7	4.0	...	.
Clear	...	...	4.0	6.3	3.8	7.0	...	..
Big Portage	...	...	4.6	2.2	4.6	4.0	...	.

Table III gives the average catch per fisherman and the average by number of hours per fisherman-day by seasons for eleven lakes. The average catch per fisherman-day was highest for both winter seasons on Craig Lake, where the average angler fished 3.35 hours to catch 8.8 fish. The smallest average catch for the two winter seasons occurred on Bear Lake, with the average angler fishing 2 55 hours to catch 1 75 fish The highest average catch per fisherman for the two summer seasons was on Paw Paw Lake, where the average fisherman fished 3.25 hours to catch 3.6 fish per day. The lowest for the

Figure 1

CATCH PER HOUR BY SEASONS

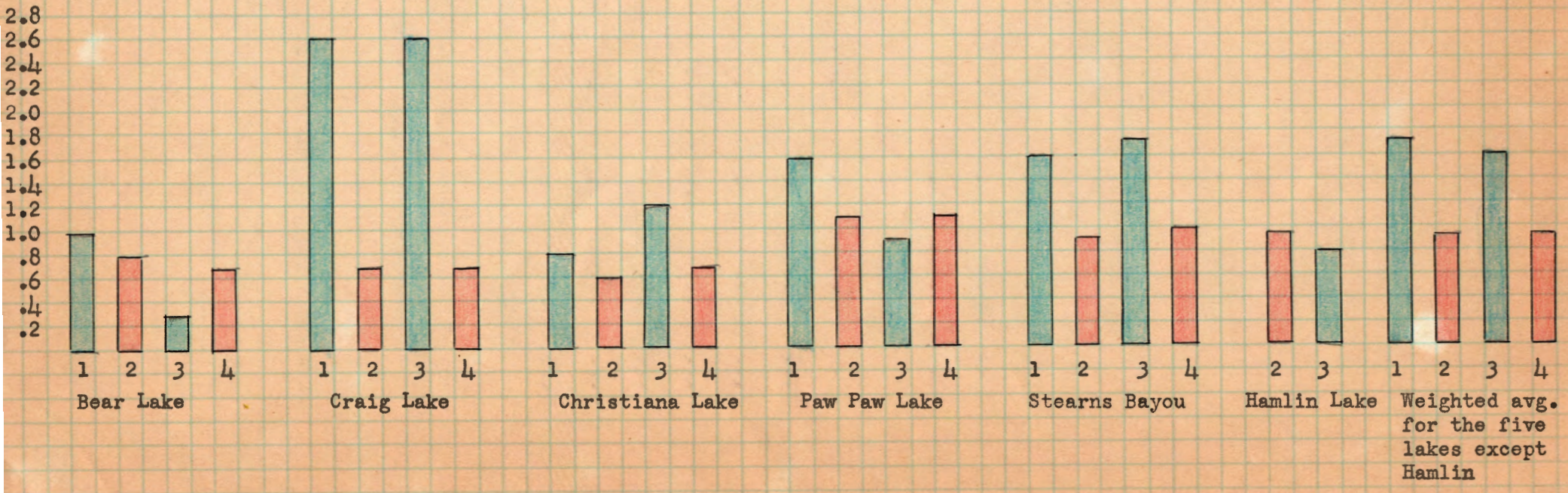
FOR THE SIX LAKES INTENSIVELY CENSUSED

1 - Winter of 1938-39

2 - Summer 1939

3 - Winter 1939-40

4 - Summer 1940



two summer periods was recorded on Christiana Lake, where the average fisherman fished 3.05 hours to catch 2 fish per day

Fishing Pressure

Fishing pressure, based on the number of fishermen per acre of lake surface, presents a picture that needs some qualification when applied to a particular lake. Extreme variations occur in the amount of fishable and productive water. For instance, a lake with 60 per cent of its area in water over 40 feet deep generally would sustain less successful intensive fishing than a lake in which 60 per cent of its water area comprised water from 2 to 20 feet in depth. In other words, the successful pressure, everything else being equal, would vary with the proportion of deep to shallow water. A lake with a fishing pressure of 10 fishermen per acre of lake surface per year may be relatively more heavily fished than one with a pressure of 50 fishermen per acre. The fishing intensity on most waters tends to vary as the average angler's success varies. However, an appreciable lag occurs in this relationship. Where fishing pressure has been high, with a correspondingly high success factor, the pressure may continue high for a notable period following the decline in the fisherman's catch. In addition, rumor and reputation have a marked effect on local fishing pressures. Nearly twice the fishing pressure was recorded for the summer than for the winter. Table IV gives the average number of fishermen per acre of lake surface by seasons for the two-year period for the six lakes, except Hamlin Lake, where the census was conducted for but one year.

Table IV

Average Number of Fishermen Per Day Per Acre

Lake	Acreage	Winter 1938-39	Winter 1939-40	Average Winters	Summer 1939	Summer 1940	Average Summers
Bear	104	1.94	2.4	2.17	25.9	15.4	20.6
Craig	122	20.3	22.0	21.1	30.7	25.0	27.8
Christiana	179	7.2	3.5	5.3	19.7	17.0	18.3
Paw Paw	857	2.9	4.8	3.8	11.7	7.5	9.6
Stearns Bayou	83	43.9	48.1	46.0	40.2	19.8	30.0
Hamlin	4,982	...	0.27	...	3.3	...	...
Average for five lakes (except Hamlin)				*8.1			**15.2

*8 1 is the average for both winter seasons for five lakes, Hamlin excepted

**15.2 is the average for both summer seasons, except Hamlin. These averages are based on the total number of fishermen for the two years, by winter and summer seasons, divided by total acreage, except Hamlin.

The total number of fishermen per acre of lake surface on the five lakes for 1939 was 24.9 and for 1940 it was 20.45, a decrease of 4.45. This decrease may be explained by the poor weather conditions during the summer season, especially the first two weeks. The smaller number of resident licenses sold during 1940 may also be reflected in these figures The greatest annual pressure occurred both years on Stearns Bayou, being 84.1 and 67.9. The least pressure was on Paw Paw--14.6 and 12.4. The greatest winter fishing pressure was also on Stearns Bayou. In the summer of 1939 Stearns Bayou also stood at the top with 40.2. In 1940 the summer pressure was highest on Craig Lake--25 0 The least pressure occurred on Bear Lake for both winter seasons--1 94 and 2 4 For the summer the least pressure was found on Paw Paw--11 7 and 7 5 The figures

for Hamlin Lake indicated a winter pressure in 1939-40 of 0 27 and a summer pressure of 3 3, much lower than the smaller, more southern lakes.

Catch Per Acre

When comparing the average number of fish caught per acre of lake surface for the two winter seasons and the two summer seasons, exclusive of Hamlin Lake records, we find that 45.27 fish per acre were removed for the winter season and 44.59 fish per acre for the two summer seasons, indicating that the production in terms of catch per acre was almost the same. Table V shows the catch per acre for the six lakes by seasons. It can be seen from the table that the greatest catch per acre for all four seasons occurred on Stearns Bayou, ranging from 284.75 fish the winter of 1939-40 to 109.6 in the summer of 1940. The least numbers taken were from Hamlin Lake the winter of 1939-40, 0.97 fish and 11.5 in the summer of 1939.

Table V

Average Number of Fish Caught Per Acre of Lake Surface

Lake	Acreage	Winter 1938-39	Winter 1939-40	Average Two Winters	Summer 1939	Summer 1940	Average Two Summers
Bear	104	5.2	2.5	...	61.2	34.76	...
Craig	122	182.1	188.9	...	73.09	49.46	...
Christiana	179	19.75	18.03	...	35.60	38.93	...
Paw Paw	857	16.85	13.65	...	48.37	25.47	...
Stearns Bayou	83	229.40	284.75	...	115.69	109.06	...
Hamlin	4,982	...	0.97	...	11.52	...	...
Average*/				45.27			44.59

*/ The averages are for the two winter and the two summer seasons, excepting Hamlin Lake, based on total fish caught divided by the total acreage

Pounds of Fish Per Acre of Lake Surface

From the netting operations on Craig and Bear lakes conducted in the spring of 1940, weights and lengths were obtained by actual measurements, from nearly all the fish caught. From these records the figures obtained showed the average length of all fish netted to be 9 inches for both lakes. The average weight of fish caught in Craig Lake was 9.1 ounces, and in Bear Lake 8.4 ounces. The comparison of the average lengths and weights of all fish caught on these lakes is interesting, for from the examination of the scale samples of fish taken from both lakes, we find the rate of growth considerably higher on Bear Lake than on Craig Lake. Yet in spite of the faster growth rate, the average weight of the fish on this lake was less. This was particularly true of the bluegills, which constituted about 50 per cent of the total number netted on both lakes. Table VI shows the average length and average weight by species of all fish netted the spring of 1940.

These figures, together with the population estimates, also made possible the computation of the total number of pounds of legal fish per acre of lake surface for the two lakes. The gear failed to obtain a sufficient number of yellow perch to properly evaluate the perch population and these are not included in the above figures. On Craig Lake we find a total of 264.2 pounds of legal fish present in the spring of 1940--excluding yellow perch--and 527.6 pounds in the fall of 1940, a difference of 263.4 pounds. The probable reason for this increase will be explained later in this report. On Bear Lake in the spring we find the total number of pounds of fish per acre of lake surface to be 65.63, and in the fall 93 4 pounds, a difference of 27 77 pounds--yellow perch again excluded

Table VI

Composition and Character of Fish Populations
As Determined Through Netting Operations

Species	Pop. Estimate Spring	Pop. Estimate Fall	Average Length*	Average Weight*	Pounds Per Acre and Per Cent of Total Weight %	Spring	Fall	%
			CRAIG LAKE					
Largemouth bass	5,852	8,860	12.8"	15.2 oz.	17.27	45.6	69.3	13 1
Bluegill	52,956	167,072	7.3	4.0	40.9	108.0	342 2	64 8
Sunfish	1,088	2,275	6.1	3.7	0.76	2.0	4 3	0 8
Yellow perch	...	...	...	...	...	...	.	..
Black crappie	15,476	8,526	8.3	5.3	15.5	41.0	23 2	4 4
Rock bass	...	288	7.6	6.0	...	...	1 4	0 26
Warmouth	1,571	1,075	7.3	6.2	1.9	5.0	3 4	0 64
Northern pike	520	310	25.0	60.7	5.98	15.8	9.5	1 8
Brown bullhead	4,435	7,229	11.4	14.9	12.8	33.7	54 9	10.4
Yellow bullhead	244	1,556	9.3	7.7	0.64	1.7	11 1	2 1
Carp	...	...	...	...	...	...		
Dogfish	632	437	18.3	35.2	4.3	11.4	8 3	1 6
Totals	82,774	197,628	9.0	9.1		264.2	527 6	
			BEAR LAKE					
Largemouth bass	2,140	628	11.2	11.0	21.48	14.1	4 1	4 3
Bluegill	10,753	22,085	7.8	6.2	61.0	40.0	82.2	88.7
Sunfish	485	...	6.6	4.1	1.8	1.2		.
Yellow perch	...	...	...	...	...	...	.	.
Black crappie	49	...	10.4	11.5	0.7	0.46	.	.
Rock bass	131	125	7.6	6.4	0.79	0.52	0 48	0 51
Warmouth	354	583	6.5	4.2	1.9	1.25	1.46	1 56
Northern pike	...	...	...	...	...	...	.	.
Brown bullhead	544	356	11.1	14.2	7.0	4.6	3 0	3 2
Yellow bullhead	321	440	9.5	8.1	0.8	1.5	2.1	2 2
Carp	...	...	...	...	...	...		.
Dogfish	165	...	17.6	20.6	3.0	2.0	.	
Totals	14,942	24,217	9.0	8.4		65.63	93.34	

* Based on spring measurements.

Using the average weight per unit length for individual species as obtained from the netting operations on these two lakes, the pounds of fish per acre caught by the angler were computed for Bear, Craig, Christiana, Paw Paw lakes, and Stearns Bayou for the winter of 1939-40 and the summer of 1940 Figure 2 shows the pounds of fish caught per acre of lake surface for the two seasons.

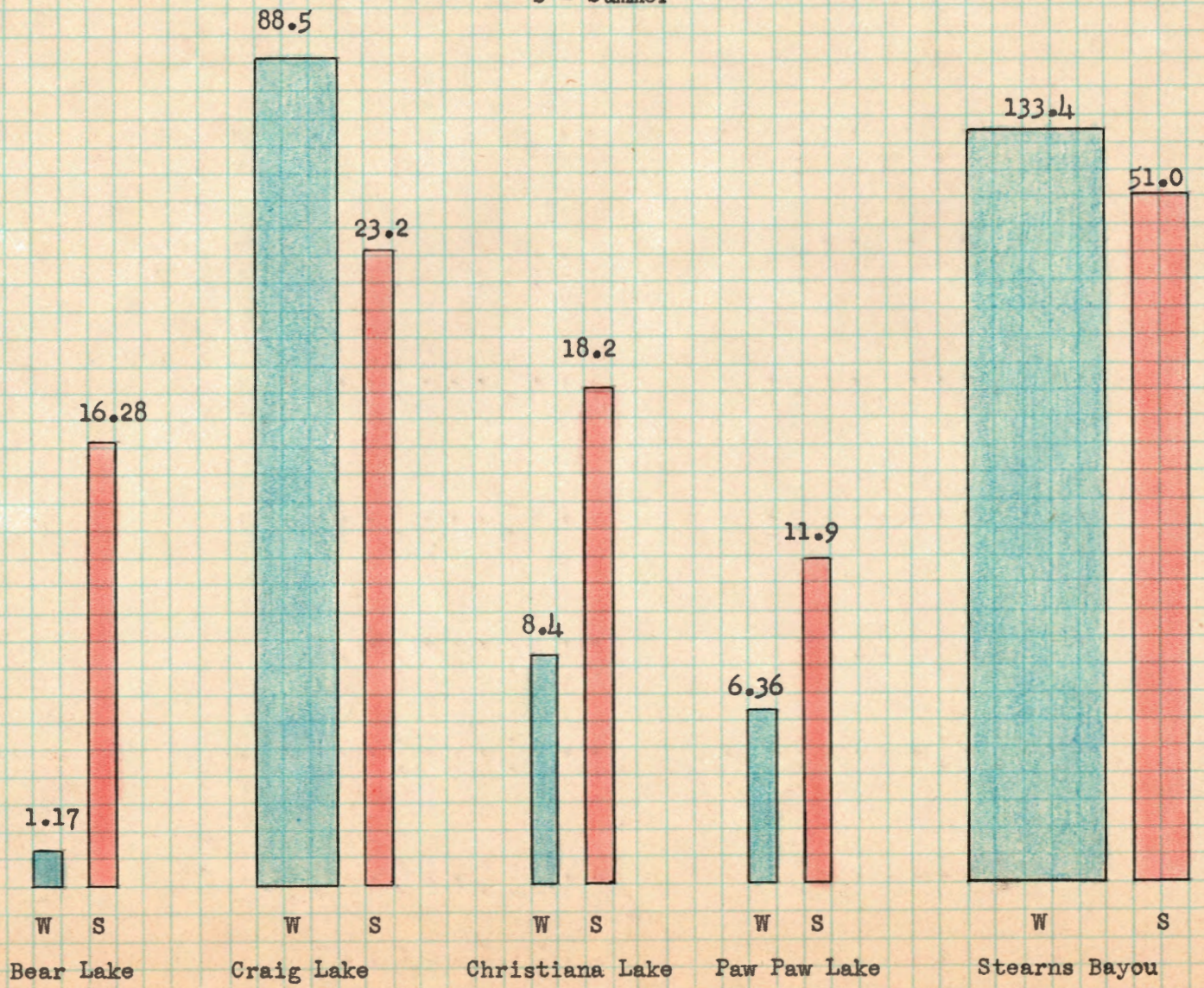
Figure 2

POUNDS OF FISH PER ACRE CAUGHT WINTER 1939-40 AND SUMMER 1940

(Weight-length figures taken from fish captured in operations on Craig Lake - Spring 1940)

W - Winter

S - Summer



The poundage per acre removed from Stearns Bayou was ~~much~~ ~~the~~ highest for both seasons, being 51 pounds for the summer and 133.4 for the winter. Craig Lake was second with 23.2 pounds for the summer and 88.5 for the winter. Bear Lake had the least number of pounds per acre, 1.17 removed in winter, and Paw Paw had the least number of pounds removed in summer, 11.9 pounds per acre. It should be remembered that the relationship between length and weight varies somewhat from lake to lake, and the above computations are based on the average weights obtained from but two lakes, Craig and Bear.*

Comparisons between the poundage figures from netting and poundage of the fisherman catch on Craig Lake show 88 1/2 pounds of fish per acre removed by the winter angler out of 527.6 pounds available, as estimated by the fall netting operations, leaving 439.1 pounds per acre available for the summer fisherman. On Bear Lake 1.17 pounds of fish per acre were taken by the fishermen in the winter out of 93.34 pounds potentially available, according to the netting estimates, - less than two per cent of the total poundage being harvested. Yellow perch again were not included in the estimated total available.

Comparisons of Fish Caught per Acre of Lake Surface With Estimated Fish Populations Per Acre

Figures 3 and 4 show the comparisons of fish caught per acre with the estimated per acre populations of legal fish. The population estimates do not include yellow perch.

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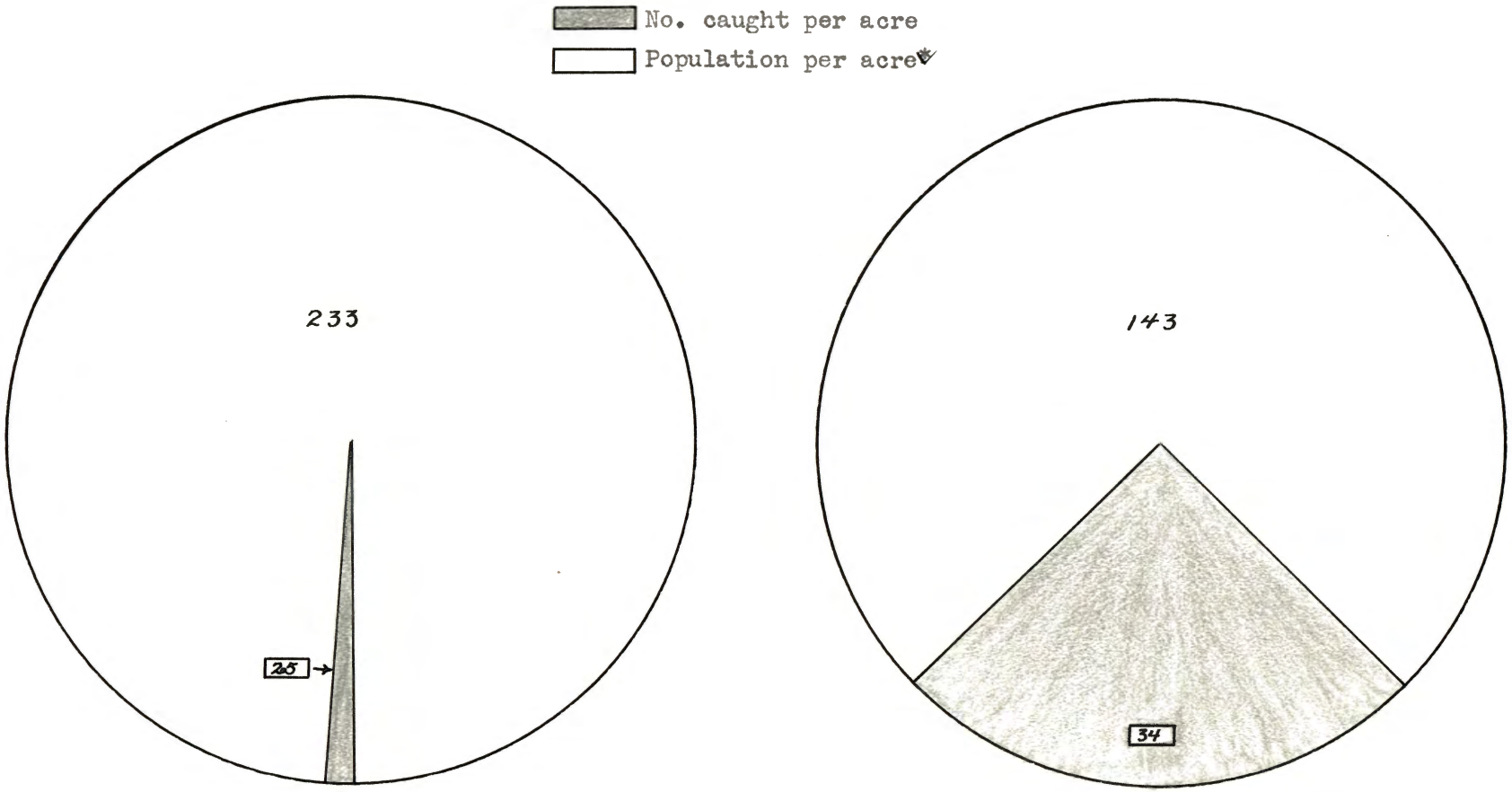
* The average weight of yellow perch was taken from the state average as figured by Eschmeyer and Beckman.

Figure 3

Comparisons of Number of Fish Caught per Acre with Estimated Populations per Acre of Lake Surface
- Bear Lake -



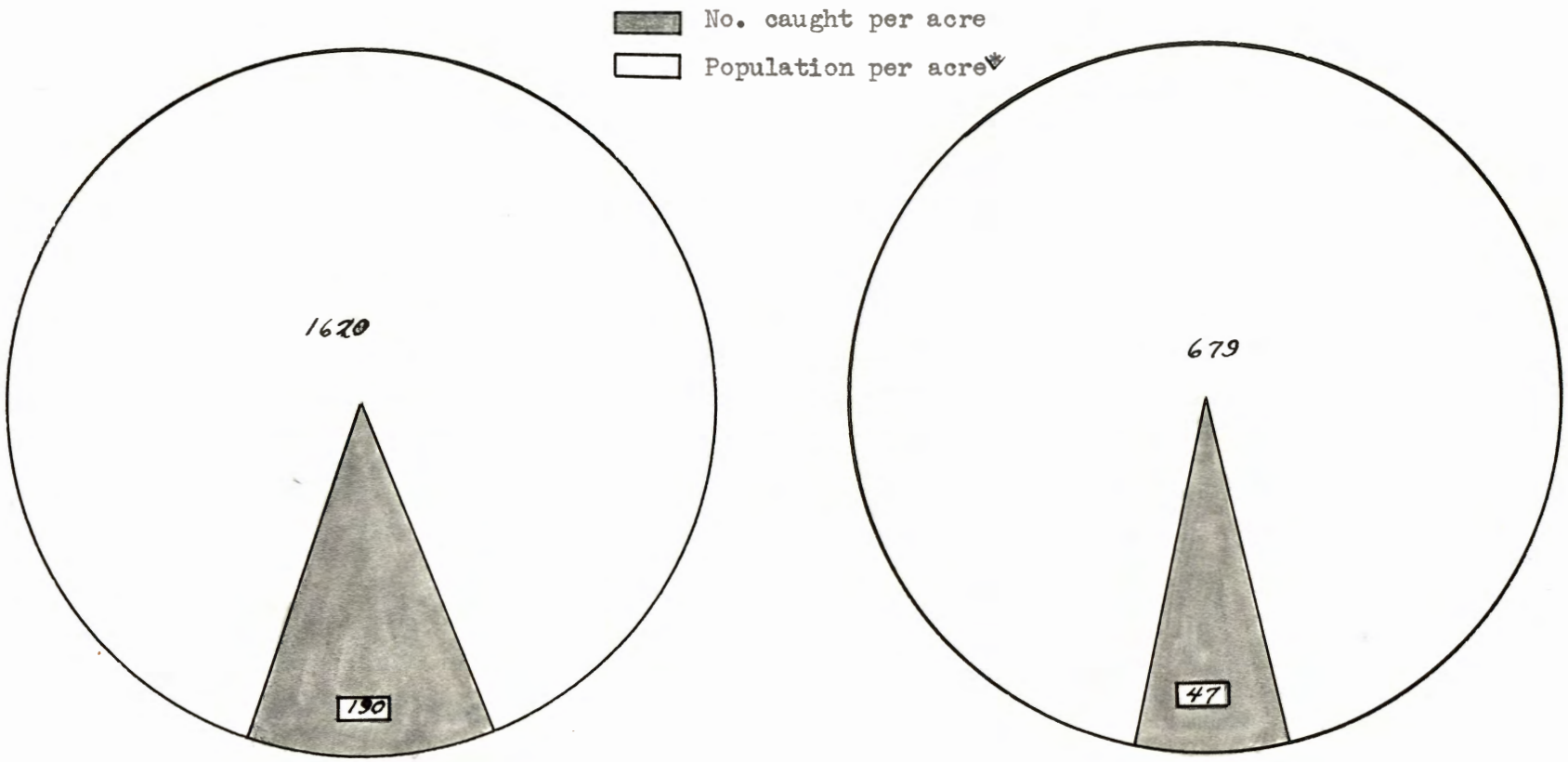
No. 1
Number of Fish Caught per Acre of Lake Surface in the Winter of 1939-40 Compared with the Estimated Population per Acre, of Legal Fish Present in the Fall of 1940.

No. 2
Number of Fish Caught per Acre of Lake Surface in the Summer of 1940 Compared with the Estimated Population per Acre, of Legal Fish Present in the Spring of 1940.

*Yellow perch not included in population estimate.

Figure 4

Comparisons of the Number of Fish Caught per Acre with Estimated Populations per Acre of Lake Surface
- Craig Lake -



No. 1
Number of Fish Caught per Acre of Lake Surface in the Winter of 1939-40 Compared with the Estimated Population per Acre of Legal Fish Present in the Fall of 1940.

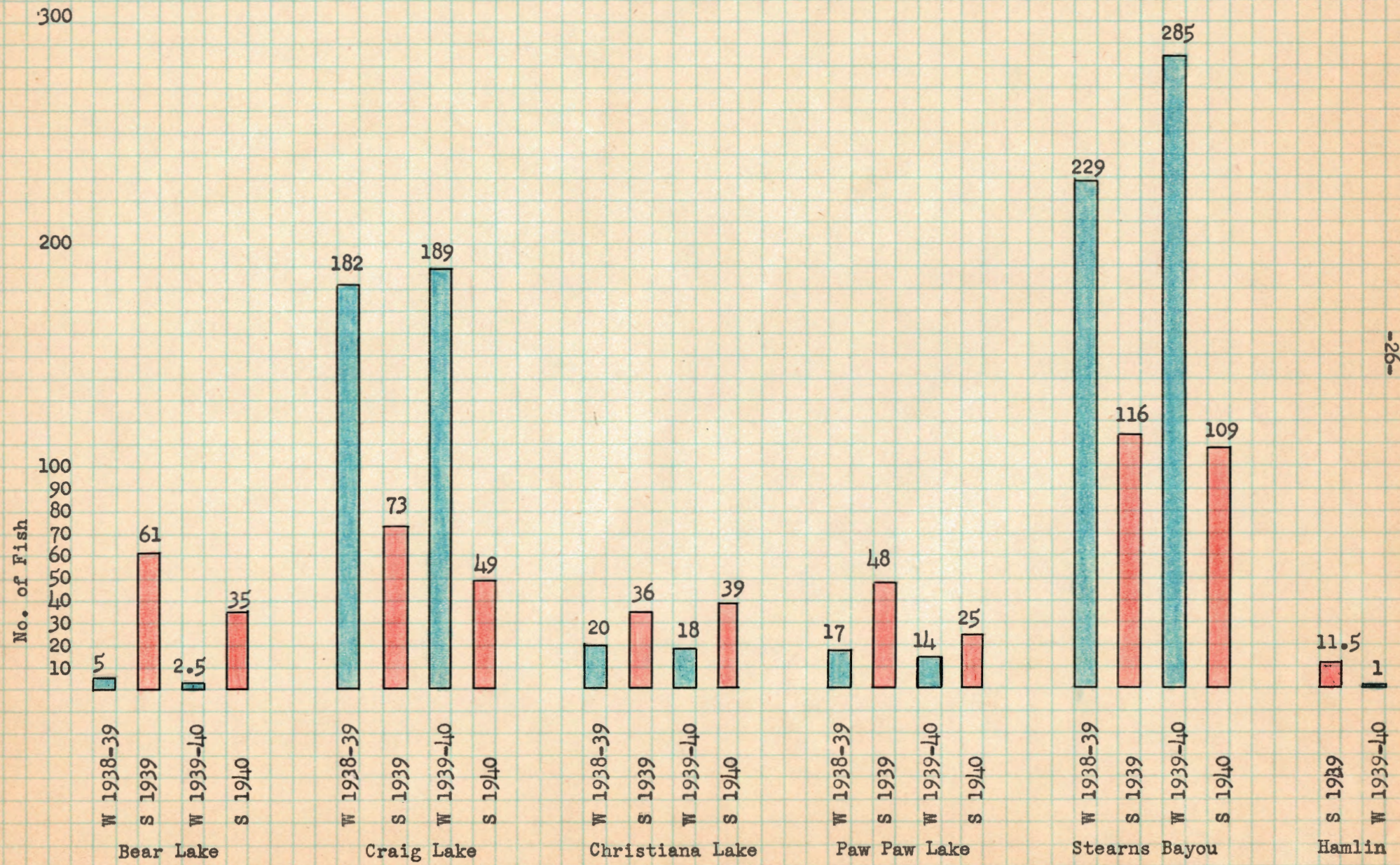
No. 2
Number of Fish Caught per Acre of Lake Surface in the Summer of 1940 Compared with the Estimated Population per Acre of Legal Fish Present in the Spring of 1940.

*Yellow perch not included in the population estimate.

Figure 5 shows the average number of fish caught per acre of lake surface by seasons for Bear, Craig, Christiana, Paw Paw, Stearns Bayou and Hamlin Lake.

Figure 5

AVERAGE NUMBER OF FISH CAUGHT PER ACRE OF LAKE SURFACE BY SEASONS



Percentage of Fishermen Catching No Fish

The percentage of fishermen catching no fish, out of the total number of fishermen for each lake for both winter and summer seasons, when used as a measure of comparison with other lakes, indicates the relative chances of success or lack of success which the average angler may expect to attain. It is based only on whether the angler caught or did not catch fish. Generally speaking, the percentage of fishermen catching no fish rises as the catch per hour declines. For instance on Craig Lake for the winter of 1939-40, 14 per cent of all anglers caught no fish, the lowest figure for any lakes censused. The catch per hour for this period was 2.6, the highest on any lake censused. Table VII shows the percentage of fishermen catching no fish, compared with the catch per hour on 11 lakes for the winters of 1938-39 and 1939-40, and the summers of 1939 and 1940, with certain exceptions apparent when the table is studied.

The smallest percentage of fishermen catching no fish was recorded from Craig Lake for the two winter seasons where 15 per cent and 14 per cent were unsuccessful. The greatest percentage of fishermen catching no fish for the 1938-39 winter season was recorded from Big Portage, where 53 per cent were unsuccessful. For the winter of 1939-40, Bear Lake has the highest percentage catching no fish, with a record of 69 per cent

The smallest percentage of fishermen catching no fish for the summer of 1939 occurred on Clear Lake with 21 per cent, and for the summer of 1940 on Paw Paw Lake with 33 percent. On the five lakes for the two winter seasons, 32 per cent caught no fish. The figure was identical for both years Thirty-seven per cent caught no fish in the summer of 1939, and 40 per cent were unsuccessful in 1940 On the individual lakes

Table VII

Percentage of Fishermen Catching No Fish Compared With Catch Per Hour

Lake		Winter 1938-39	Winter 1939-40	Summer 1939	Summer 1940
Bear	No fish %	36%	69%	41%	38%
	Catch per hour	(0.98)	(0.3)	(0.8)	(0.7)
Craig	"	15%	14%	41%	48%
		(2.6)	(2.6)	(0.7)	(0.7)
Christiana	"	44%	33%	48%	48%
		(0.8)	(1.4)	(0.6)	(0.7)
Paw Paw	"	44%	48%	29%	33%
		(1.6)	(0.9)	(1.1)	(1.1)
Stearns Bayou	"	31%	25%	44%	38%
		(1.6)	(1.7)	(0.9)	(1.0)
Hamlin	"	...	47%	27%	...
			(0.8)	(0.97)	
Pike	"	46%	...	32%	...
		(0.8)		(1.3)	
Fowler	"	38%	40%	...	...
		(1.0)	(1.2)		
Sugarloaf	"	38%	39%	38%	...
		(1.0)	(0.7)	(1.1)	
Clear	"	42%	24%	21%	...
		(0.7)	(1.6)	(1.8)	
Big Portage	"	53%	63%	36%	...
		(0.4)	(0.5)	(0.9)	

the percentage of anglers catching no fish ranged widely. In the summer of 1939 on Paw Paw Lake 29 per cent caught no fish, and 48 per cent were unsuccessful on Christiana Lake. The 1940 summer figures were 33 per cent for Paw Paw Lake and 48 per cent on Christiana and Craig lakes. In the

1938-39 winter season, 15 per cent caught no fish on Craig Lake and 44 per cent on Christiana Lake and Paw Paw The 1939-40 winter season indicates that 14 per cent on Craig Lake and 69 per cent on Bear Lake caught no fish. It is to be seen from the above figures that the success factor as indicated by the catch per hour and the percentage of unsuccessful anglers for the winter season shows that Craig Lake leads in angler success the list of lakes studied, although the summer figures for this lake are actually less than the average for the five lakes. Locally this condition is explained by the simple expedient of recognizing a large winter influx into this lake from adjacent waters. Our marking operations do indicate that movement out of this lake does occur. However, we were unable to confirm or deny a counter compensating movement into the lake, as no fish were marked in the adjacent waters. However, the marked increase in fish population in the fall netting study over that in the spring strongly suggests this possibility. The winter pressure on the other lakes of the chain, with the exception of Morrison Lake, is similarly high, suggesting that were a large movement into Craig Lake in the early winter to take place, a similar movement would be indicated into Randalls and Cemetery lakes, unless of course a phenomenally large productivity occurred in some one or combination of lakes in the chain. It would appear that a more likely explanation might be the high productivity in Craig Lake itself and the entrance into the winter catch of a large number of fish from the age group slightly sub-legal during the summer season. It is desired that further studies be made in order that this contention of disproportionate movement into or out of the lake may be proved or disproved The most consistently good fishing for both seasons

was recorded from Stearns Bayou Pressures were more nearly equal summer and winter, with the winter pressure somewhat heavier. The higher figure for 1939-40 was due to publicity given the lake by the Grand Rapids papers, where weekly totals from the census records were published. As in Craig Lake, the fish are locally reputed to move out of and into other bayous of the Grand River during the warmer months. The higher than average summer success indicated by creel records would tend to cast some doubt on this hypothesis. The percentage of fishermen catching no fish computed by weekly intervals, for each of the two summers for Bear Lake shows a slightly rising trend for both summers, ranging from approximately 36 per cent at the beginning to approximately 44 per cent by the middle of October. On Craig Lake a gradual rise occurs for both summers ranging from about 42 per cent to 48 per cent. Christiana Lake for the two seasons showed a rise from about 38 per cent to 54 per cent to the middle of August and a decline from then to October 15th to about 25 per cent. Paw Paw Lake showed a considerable difference between the summer of 1939 and the summer of 1940. The trend was down in 1939 from about 40 per cent to about 10 per cent, and in 1940 the trend was up from about 20 per cent at the beginning of the season to around 40 per cent at the end. On Stearns Bayou the trend for both summers was down, from about 60 per cent at the beginning to about 20 per cent at the close. These relationships are shown in Figures 6 through 16, which indicate the weekly changes in the percentage catching no fish, by lakes, and compared with the catch per hour for the two summer periods. See the next ten pages for these graphs.

Figure 6

BEAR LAKE

PER CENT OF FISHERMEN CATCHING NO FISH,
BY WEEKLY PERIODS, COMPARED WITH THE CATCH PER HOUR
WINTERS 1938-39 AND 1939-40

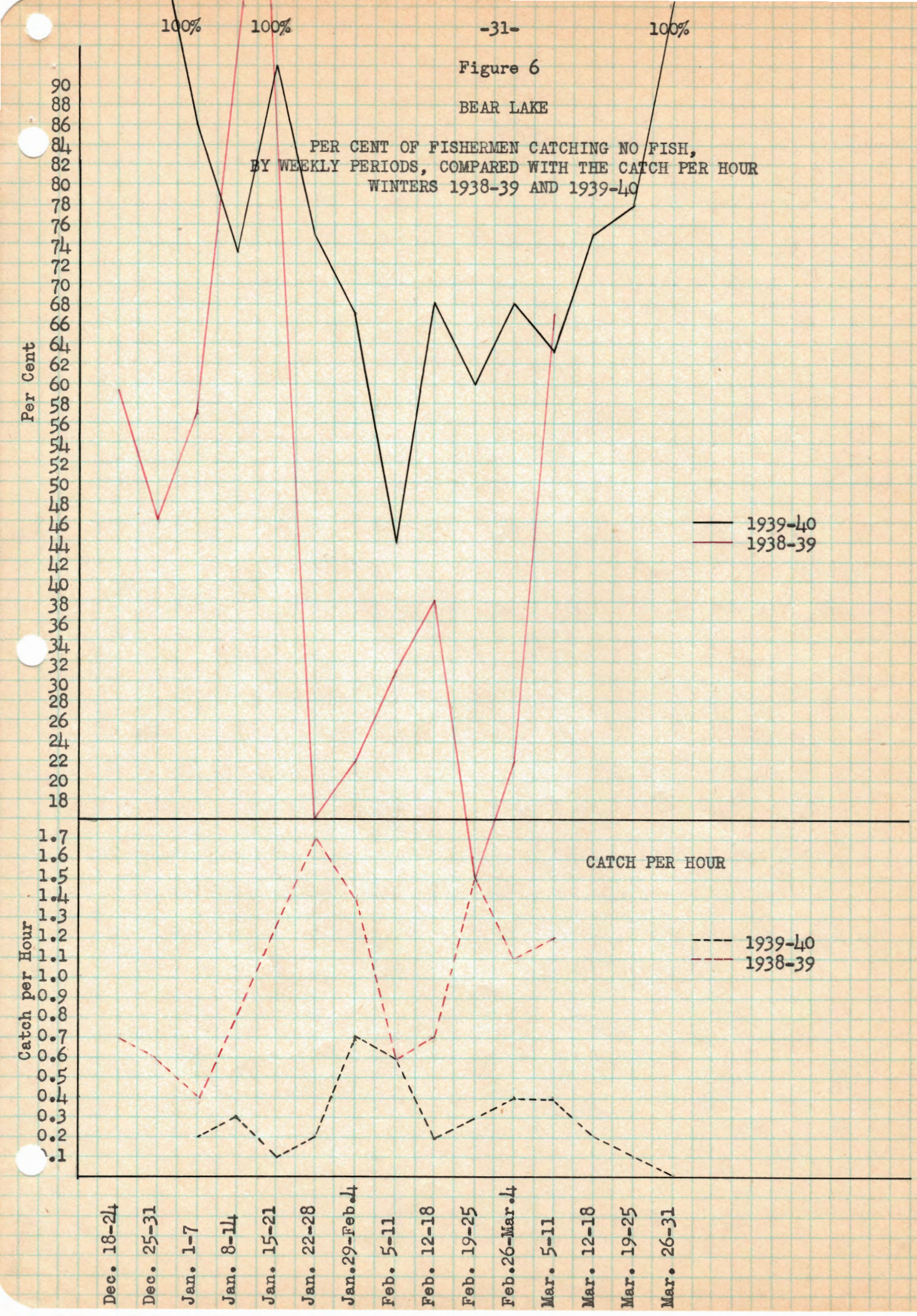


Figure 7

BEAR LAKE

PER CENT OF FISHERMEN CATCHING NO FISH,

BY WEEKLY PERIODS, COMPARED WITH THE CATCH PER HOUR

SUMMERS 1939 AND 1940

Figure 8

CRAIG LAKE

PER CENT OF FISHERMEN CATCHING NO FISH, BY WEEKLY PERIODS,
COMPARED WITH THE CATCH PER HOUR
WINTERS 1938-39 AND 1939-40

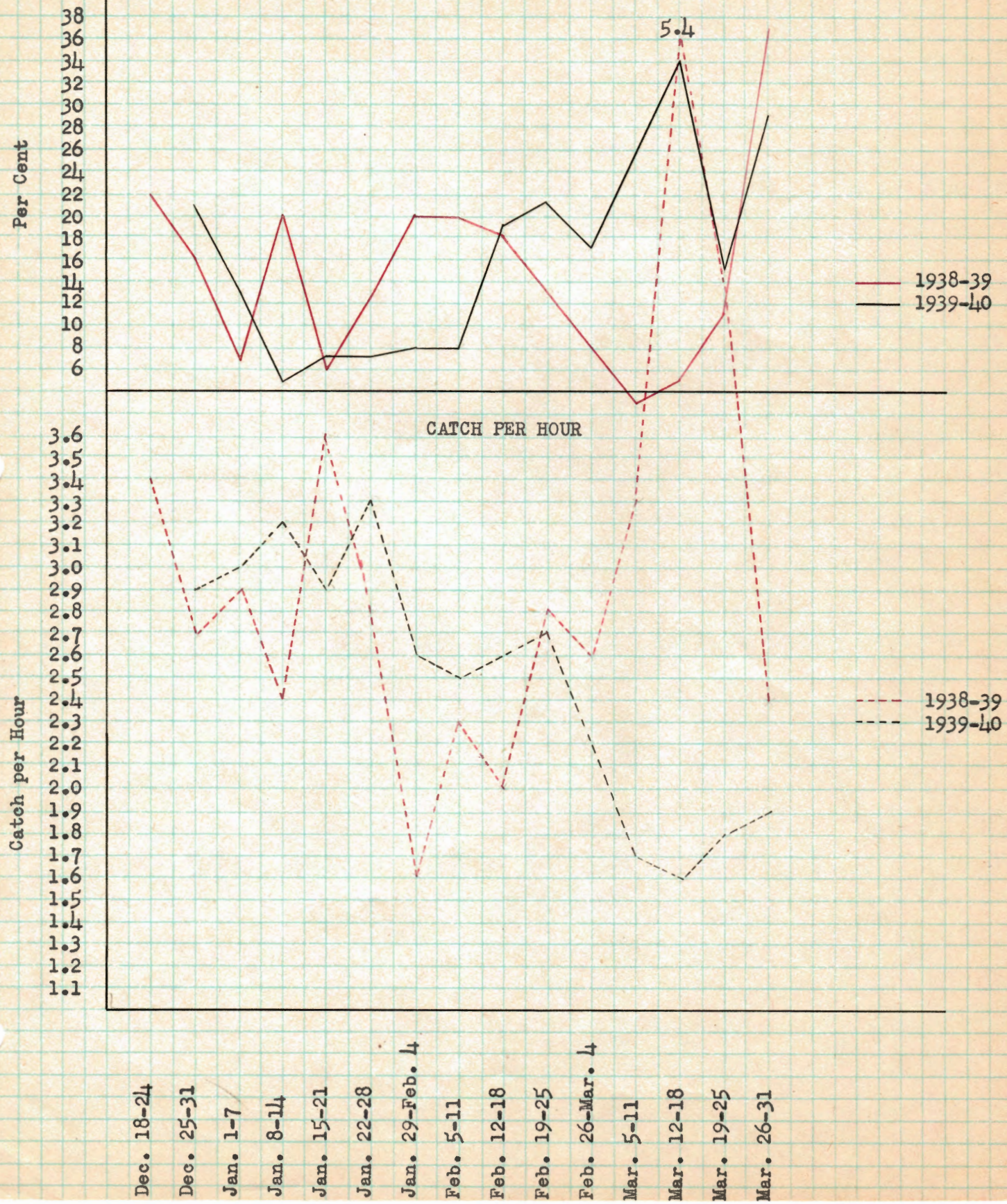


Figure 9

CRAIG LAKE
PER CENT OF FISHERMEN CATCHING NO FISH, BY WEEKLY PERIODS,
COMPARED WITH THE CATCH PER HOUR, SUMMER 1939 AND 1940

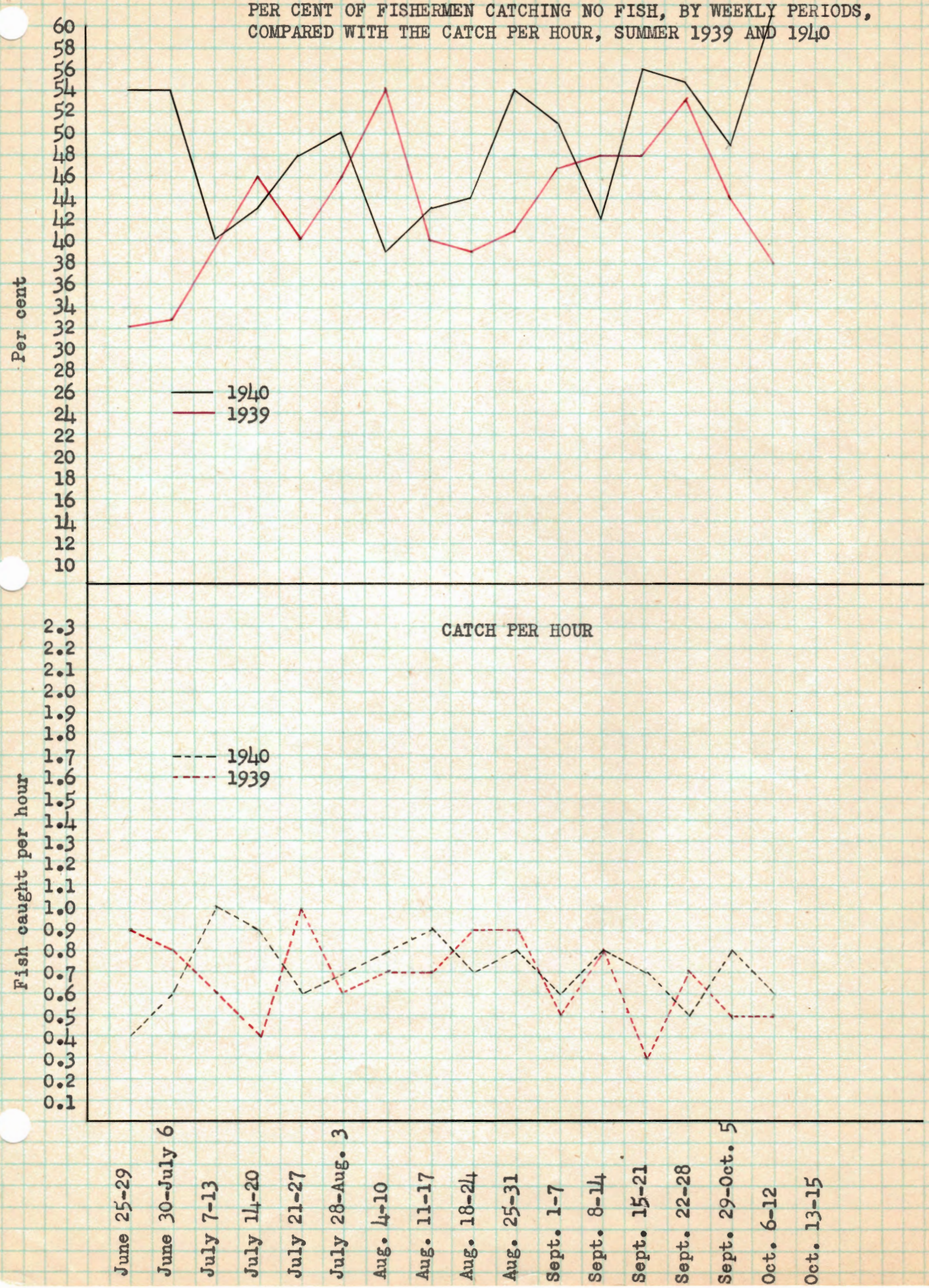


Figure 10
CHRISTIANA LAKE

PER CENT OF FISHERMEN CATCHING NO FISH, BY WEEKLY PERIODS,
COMPARED WITH THE CATCH PER HOUR
WINTERS 1938-39 AND 1939-40

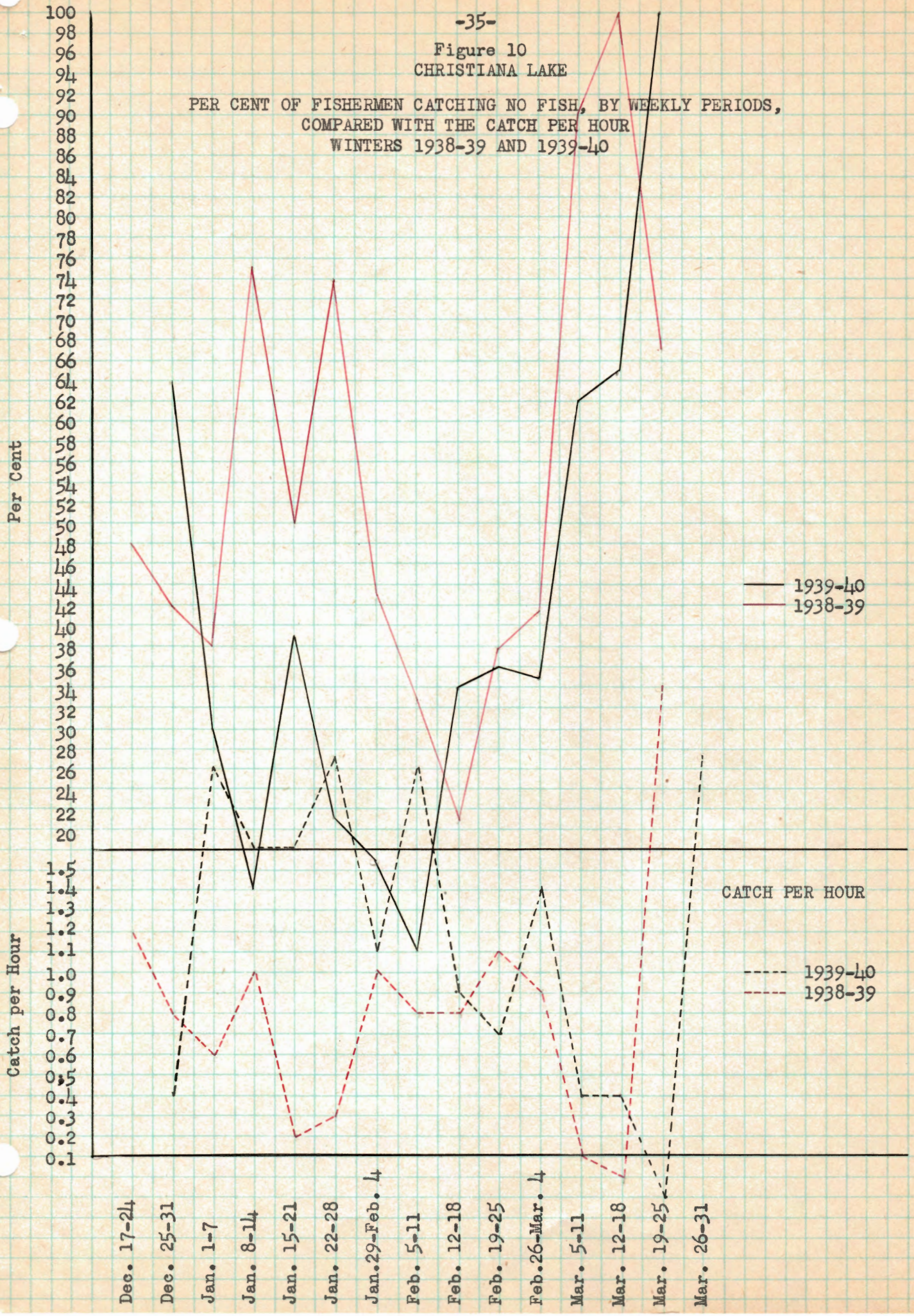


Figure 11

CHRISTIANA LAKE

PER CENT OF FISHERMEN CATCHING NO FISH, BY WEEKLY PERIODS,
COMPARED WITH THE CATCH PER HOUR
SUMMERS 1939 AND 1940

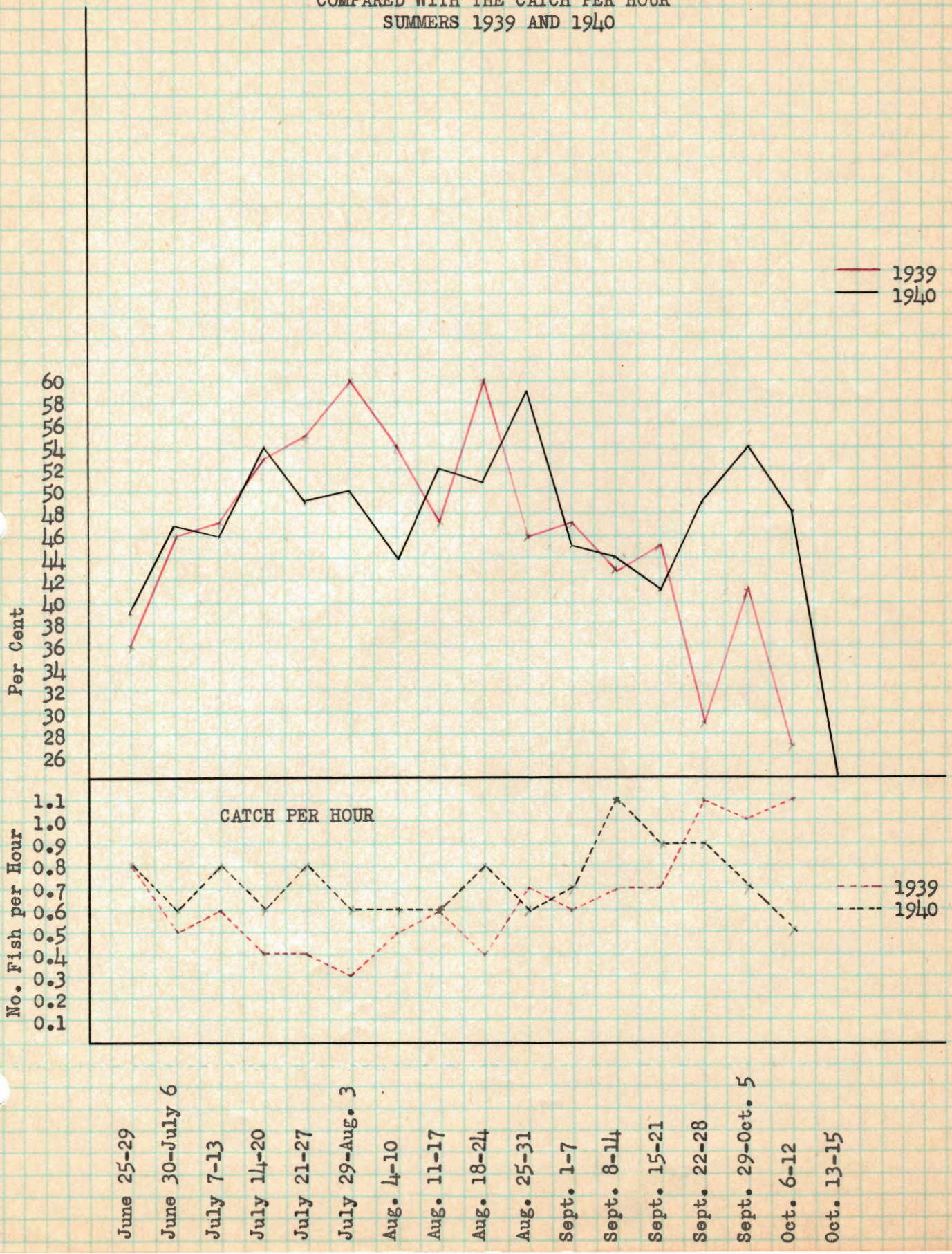


Figure 12

PAW PAW LAKE
PER CENT OF FISHERMEN CATCHING NO FISH, BY WEEKLY PERIODS,
COMPARED WITH THE CATCH PER HOUR
WINTERS 1938-39 AND 1939-40

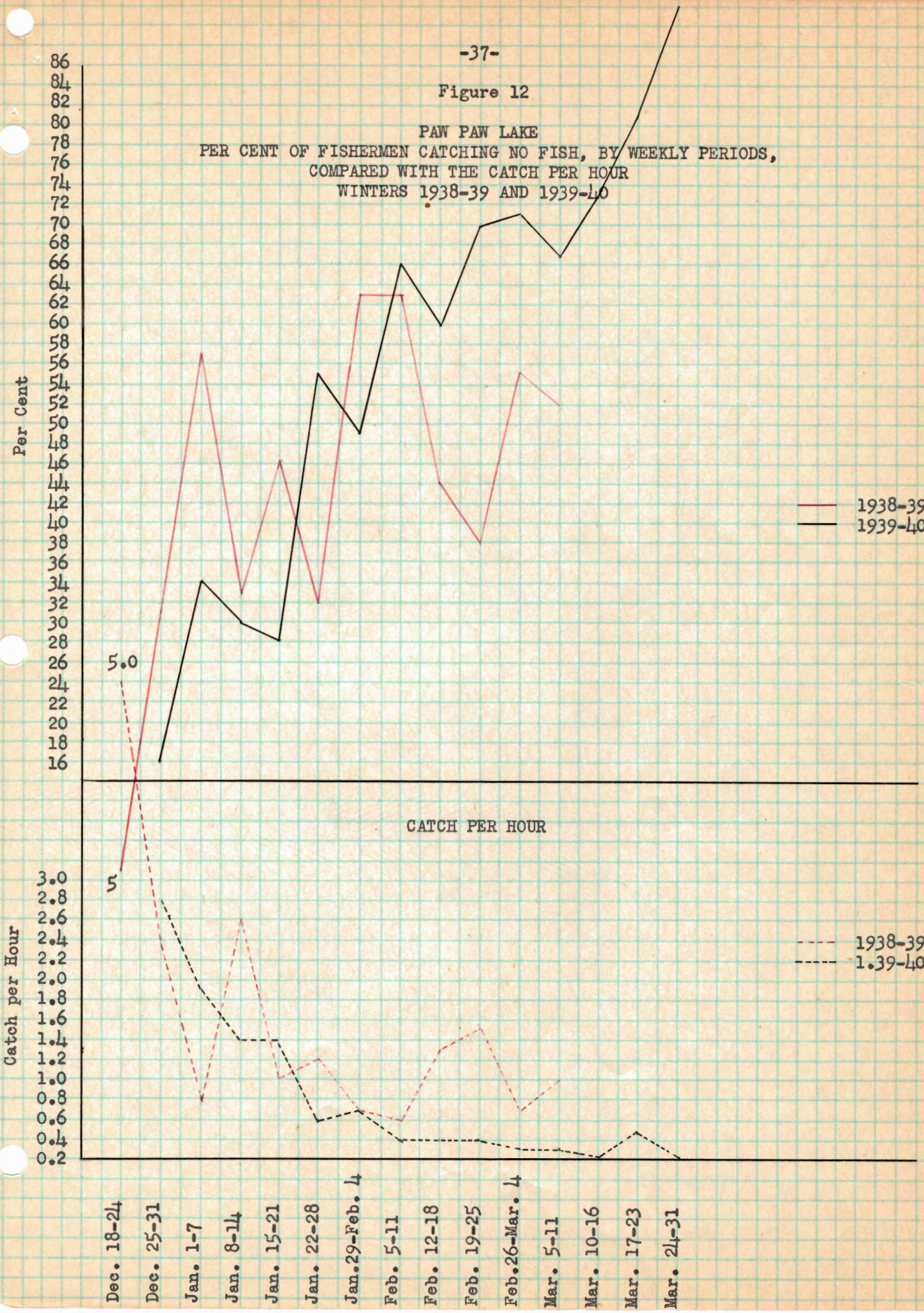


Figure 13

PAW PAW LAKE

PER CENT OF FISHERMEN CATCHING NO FISH, BY WEEKLY PERIODS,
COMPARED WITH THE CATCH PER HOUR
SUMMERS 1939 AND 1940

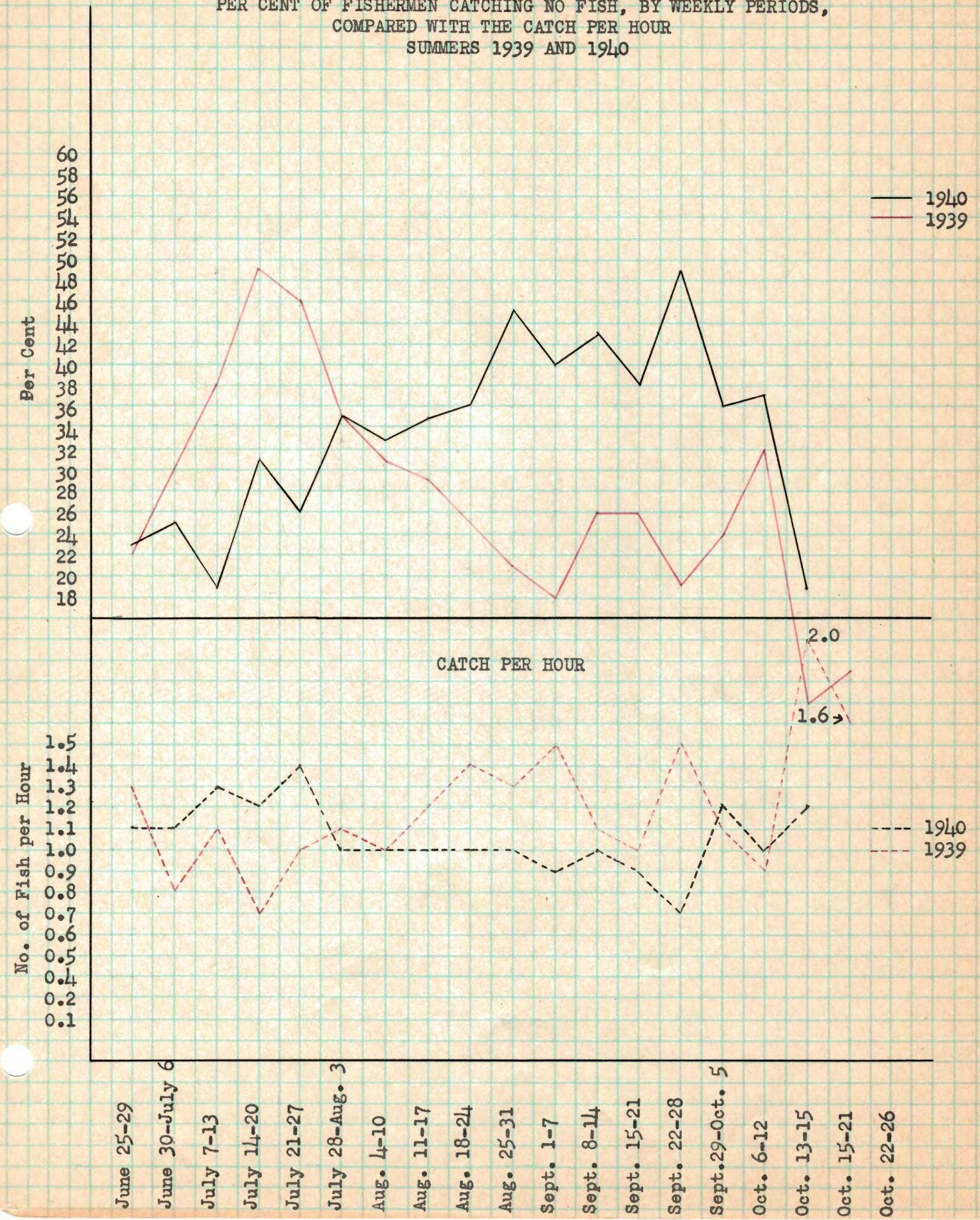


Figure 14

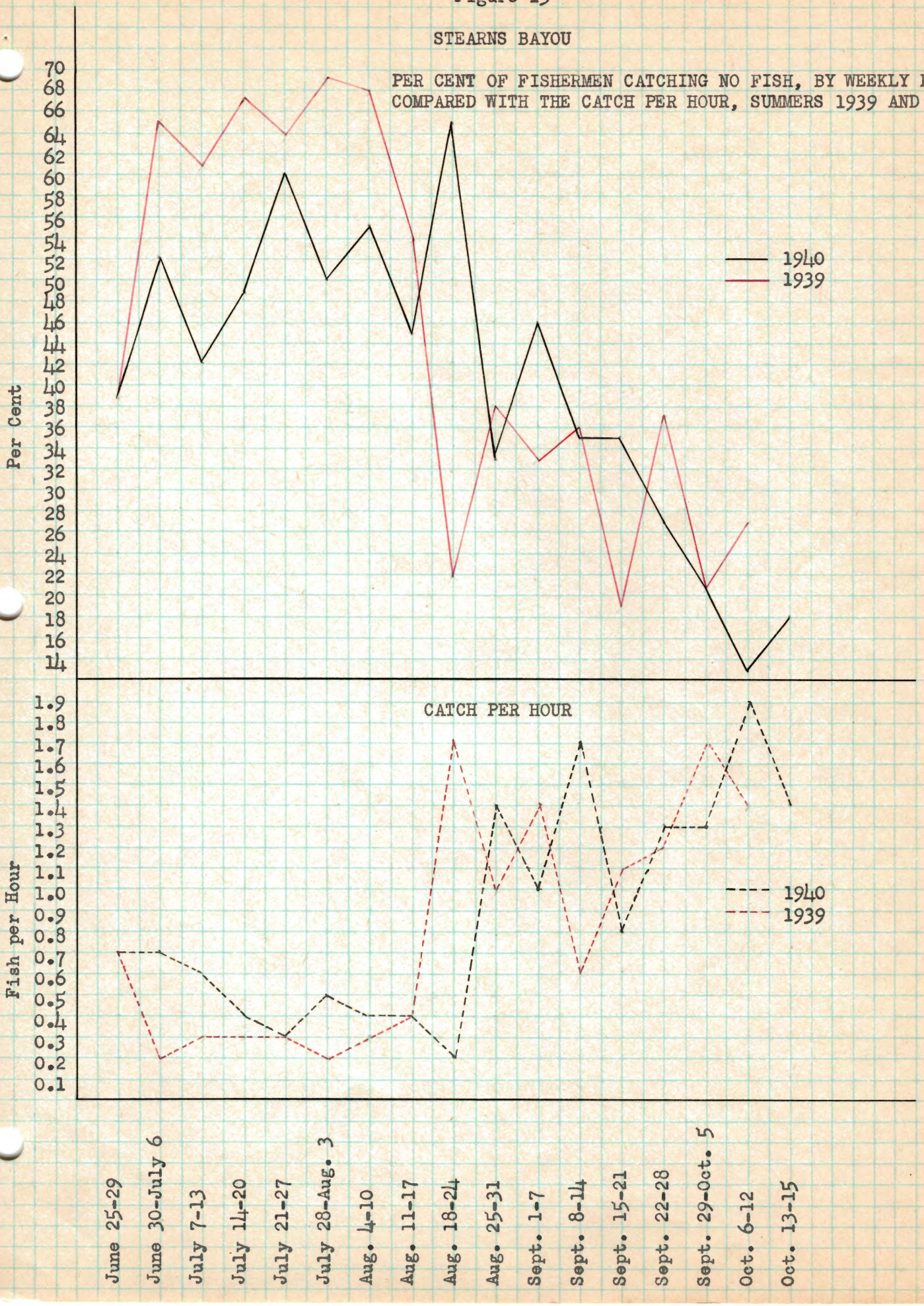
STEARNS BAYOU

PER CENT OF FISHERMEN CATCHING NO FISH, BY WEEKLY PERIODS,
COMPARED WITH THE CATCH PER HOUR
WINTERS 1938-39 AND 1939-40

Figure 15

STEARNS BAYOU

PER CENT OF FISHERMEN CATCHING NO FISH, BY WEEKLY PERIODS, COMPARED WITH THE CATCH PER HOUR, SUMMERS 1939 AND 1940



Size of Fish

The average size of all fish caught in the summer of 1939 and the summer of 1940 was 8.05 inches. In the winter of 1938-39 and the winter of 1939-40 the average size was 7.35 inches, a difference of 0.7 of an inch per fish longer in the summer periods. This difference in size between summer and winter is of significance since it may substantiate the theory that a large number of fish in the age class approaching legal size comes into the legal size classification during the latter part of the summer and early fall, thus adversely affecting the average size of the fish caught in the winter. In addition to this, the fact that not many bass are legally taken in the winter would also tend to affect the average size. On southern lakes this size discrepancy is most important in the bluegill catch because of their preponderance in the total catch. In comparing the two winters and the two summers, we find the average size of all fish caught on the five lakes for the winter of 1938-39 to be 7.3 inches, and that for the winter of 1939-40 to be 7.4 inches; for the summer of 1939 the average size of all fish caught was 8.0 inches, and for the summer of 1940, the average was 8.1 inches. This shows an increased length for the winter of 1939-40 of 0.1 of an inch per fish, and for the summer of 1940, the same increase of 0.1 of an inch. This is a rather small increase to be significant, but may indicate an upward trend. If so, it is further evidence that the increase in fishing due to winter angling is not depleting the stock. Christiana Lake showed the greatest average size of any of the five lakes for the winter of 1938-39 with an average size of 8.1 inches. Christiana Lake likewise led in the winter of 1939-40 with the average size of 8.4 inches, as well as in the summer

of 1939 with the average size of 8.7 inches. In the summer of 1940 Bear Lake had the greatest average size of 8.8 inches. The smallest average size on all five lakes was found on Craig Lake the winter of 1938-39, where the average size was 7.1 inches. For the summer of 1939 and the summer of 1940, Stearns Bayou had the smallest average size with 7.3 inches for 1939, and 7.2 inches for 1940. In the summer of 1940 the largest average size of bluegills was 7.7 inches, taken on Christiana Lake. The smallest average length bluegills were 6.5 inches, taken on Craig Lake. The largest average size of largemouthed bass in the summer of 1940 was 13.8 inches, taken on Christiana Lake, and the smallest average sized largemouthed bass was from Bear Lake in the summer of 1940 where the bass averaged 11.9 inches. The inter-relationship between size of fish and fishing pressure is discussed under fishing pressure. Figure 16 gives the average size of all fish caught by seasons for the six lakes intensively censused, with the average for five lakes, Hamlin excluded.

Figure 16

AVERAGE SIZE OF ALL FISH CAUGHT

BY SEASONS FOR THE SIX LAKES INTENSIVELY CENSUSED

1 - Winter of 1938-39

2 - Summer 1939

3 - Winter of 1939-40

4 - Summer 1940

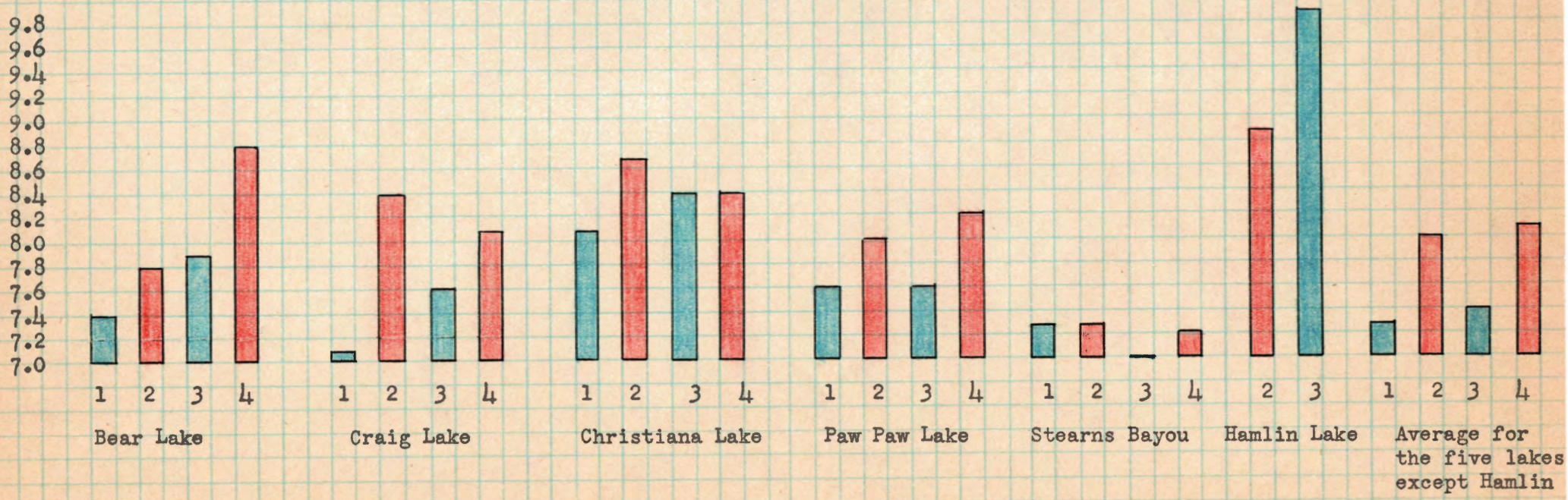


Table VIII

Percentage Composition of the Catches and Average Size by Species
Summer and Winter Comparisons 1938 - 1940

	Summer 1939		Summer 1940		Winter 1938-39		Winter 1939-40	
	%	Ave. Size	%	Ave. Size	%	Ave. Size	%	Ave. Size
CHRISTIANA								
L. M. Bass	8.08	13.9	6.51	13.8	Trace	...	Trace	...
Bluegill	41.22	7.5	44.38	7.7	84.22	7.9	88.10	8.2
Sunfish	3.34	6.9	3.04	6.6	0.37	6.6	1.24	6.9
Yellow Perch	20.64	7.0	13.26	7.0	2.26	7.5	0.37	7.3
Black Crappie	10.75	9.3	27.72	8.2	2.68	10.4	3.68	8.4
Rock Bass	5.00	7.5	1.83	7.6	Trace	8.5	Trace	...
Warmouth	Trace	7.4	0.43	7.5	9.02	7.5	3.07	...
N. Pike	0.75	23.1	0.62	24.7	Trace	...	0.31	24.2
Bullheads	7.09	11.5	1.36	12.7	0.37	9.7	0.34	12.5
Dogfish	1.35	18.0	0.67	18.9	0.81	17.8	2.20	18.7
	98.22		99.82		99.73		99.31	
BEAR LAKE								
L. M. Bass	6.52	12.9	14.96	11.9	Trace	12.8	...	...
Bluegill	63.84	7.2	35.70	7.6	83.18	7.4	8.25	7.7
Sunfish	2.31	7.0	3.67	6.6	4.20	6.7	2.06	6.4
Yellow Perch	13.81	7.2	16.92	7.8	2.74	9.4	46.39	7.6
Black Crappie	1.18	10.2	0.27	10.1	1.27	8.1	1.55	7.6
Rock Bass	3.55	7.4	3.73	7.3	...	...	23.71	7.9
Warmouth	1.23	6.9	0.99	7.0	7.67	6.3	13.40	7.5
N. Pike	...	...	...	...	...	...	...	...
Bullheads	6.12	8.7	21.90	9.3	Trace	...	0.51	...
Dogfish	1.12	15.6	1.46	15.9	...	...	3.61	17.9
	99.68		99.60		99.06		99.48	
PAW PAW LAKE								
L. M. Bass	2.36	12.5	5.07	12.8	Trace	11.7	...	...
Bluegill	73.05	7.8	60.96	7.7	76.36	7.3	97.48	7.6
Sunfish	2.19	6.7	1.39	6.7	0.085	6.8	0.28	7.5
Yellow Perch	7.62	7.1	7.08	6.9	1.03	7.0	0.55	7.3
Black Crappie	11.20	9.0	19.20	8.7	22.06	8.5	1.61	9.5
Rock Bass	1.15	7.1	3.64	7.0	0.14	6.8	Trace	7.0
Warmouth	1.48	6.7	0.93	7.1	Trace	6.5	Trace	7.0
N. Pike	0.12	22.1	0.17	25.1	Trace	27.0	Trace	32.0
Bullheads	0.60	10.4	0.84	10.6	Trace	10.0	...	...
Dogfish	0.11	18.3	0.15	19.8	Trace	16.7	...	...
S. M. Bass	0.06	12.1	0.03	12.5	...	...	...	...
	99.94		99.46		99.77		99.92	
STEARNS BAYOU								
L. M. Bass	4.26	13.0	3.60	12.5	Trace	11.7	Trace	...
Bluegills	80.18	6.8	80.78	...	89.67	7.2	93.50	6.9
Sunfish	2.70	6.6	0.86	6.2	...	...	...	...
Yellow Perch	6.35	6.9	3.61	6.4	1.31	7.1	0.95	6.7
Black Crappie	2.37	7.9	5.50	8.0	8.72	8.3	5.29	8.2
Rock Bass	0.62	6.8	1.23	6.7	Trace	7.0	Trace	7.0
Warmouth	1.02	6.5	1.82	6.4	...	...	...	...
N. Pike	0.73	21.5	0.59	21.1	0.24	23.3	0.25	24.0
Bullhead	0.92	10.5	1.32	9.3	...	...	...	...
Dogfish	0.34	...	0.44	16.7	...	...	...	...
	99.49		99.75		99.94		99.99	

Table VIII (Continued)

	Summer 1939		Summer 1940		Winter 1938-39		Winter 1939-40	
	%	Ave. Size	%	Ave. Size	%	Ave. Size	%	Ave. Size
CRAIG LAKE								
L. M. Bass	9.59	13.2	9.74	13.2	Trace	10.5	Trace	11.1
Bluegill	45.14	7.2	37.54	6.5	92.23	7.0	95.28	7.5
Sunfish	7.83	7.0	6.94	6.3	0.95	6.6	0.53	7.2
Yellow Perch	18.60	7.1	23.66	6.5	1.04	7.5	1.48	7.5
Black Crappie	1.40	8.3	1.72	7.9	0.56	8.8	2.03	9.6
Rock Bass	0.12	7.6	0.18	7.3	0.19	7.8	Trace	8.3
Warmouth	1.0	6.9	1.31	7.5	4.94	7.5	0.31	7.8
N. Pike	1.41	25.7	1.36	20.9	...	...	0.19	25.2
Bullheads	13.79	9.2	16.12	9.7	Trace	9.5	Trace	9.2
Dogfish	0.91	17.0	1.36	18.7	...	...	Trace	...
	99.79		99.93		99.91		99.82	

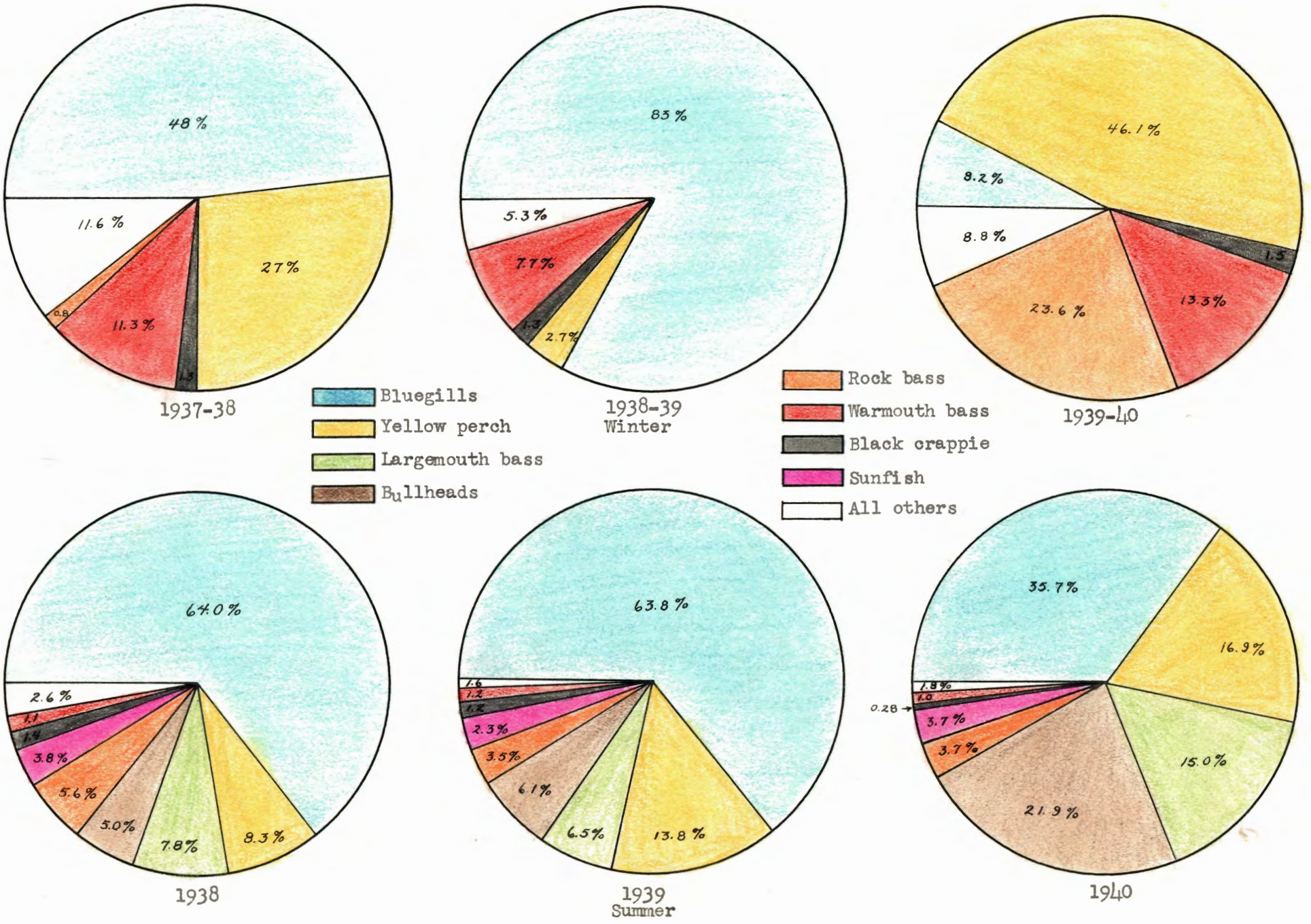
	Summer 1939		Winter 1939-40	
HAMLIN LAKE	%	Ave. Size	%	Ave. Size
L. M. Bass	3.64	14.4	Trace	13.3
S. M. Bass	3.04	13.3	Trace	18.2
Bluegill	45.86	8.1	79.61	8.1
Sunfish	6.19	7.4	1.07	6.8
Yellow Perch	10.05	7.9	5.66	8.2
Black Crappie	5.27	9.9	0.14	12.2
Rock Bass	19.43	8.2	Trace	10.1
Walleye Pike	2.64	16.5	0.89	19.8
N. Pike	0.44	21.9	5.96	24.5
Bullhead	2.78	12.5	Trace	12.8
Dogfish	0.14	20.4	2.27	20.5
Gar	Trace	28.7	Trace	21.8
White Bass	Trace	13.0	...	...
Red Horse	Trace	14.2	...	...
Sucker	Trace	15.1	3.12	19.3
Sheepshead	0.29	20.1	Trace	27.5
Muskellunge	Trace	33.2	0.23	37.4
Rainbow Trout	Trace	16.7	...	...
	99.77		98.95	

Composition of the Catch

The preceding table (Table VIII) indicates the relative abundance of the different species in the catch by lakes for summer and winter for two years, together with the average size by species. Bluegills dominate the catch on the five lakes, ranging from 80 per cent of the total catch on Stearns Bayou for the summers 1939 and 1940, to 41 per cent bluegills on Christiana the summer of 1939, and 36 per cent on Bear Lake for the summer of 1940.

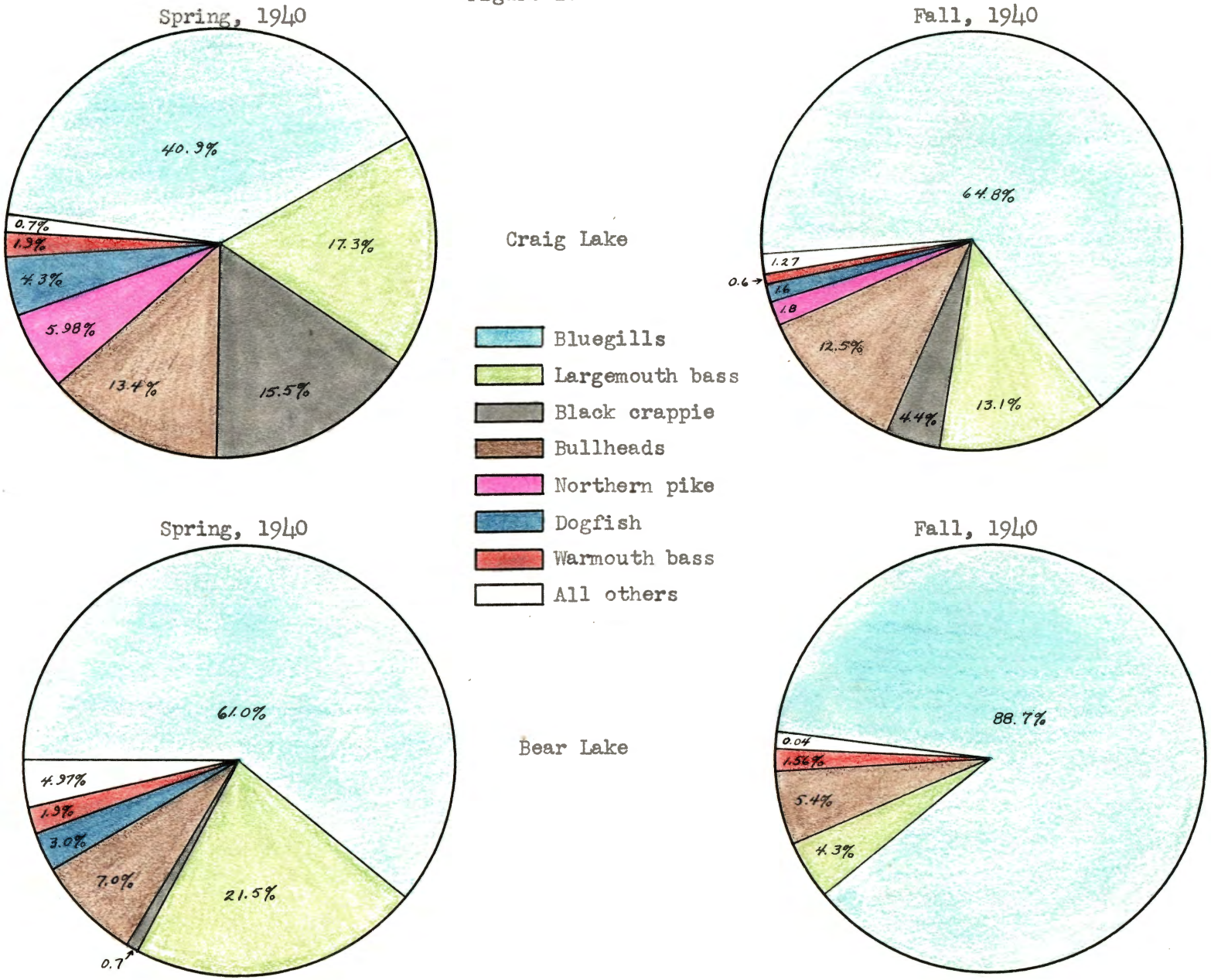
The highest percentage of bluegills in the catch in the winter of 1938-39 was from Craig Lake, where 92 per cent of the total catch were bluegills. In the winter, bluegills dominate the catch in four of the five lakes, Bear being the exception where yellow perch constituted 46.5 per cent in the winter of 1939-40. The preceding winter indicated that on Bear Lake 83 per cent of the total catch were bluegills. Early information for the 1940-41 season on Bear Lake suggests that bluegills will again dominate the catch. Considerable variation occurs from year to year in the percentage values of the different species to the total catch. This, as has been suggested before by Eschmeyer and Clark and others, may be due to a cyclic condition. The period over which these studies have been made is too short to make it possible to advance any definite conclusions as to causes or to be able to predict the timing of these population changes. The average for the five lakes demonstrates the dominance of bluegills in the total catches for both seasons of both years. However, the winter dominance of bluegills is much more pronounced than in the summer. Figure 17 graphically shows the composition of the catch for the more important species for 3 years on Bear Lake. Figure 18 shows the percentage of the total weight of legal fish for the more important species as estimated from the spring and fall population determinations on Craig and Bear Lakes. Figures 19, 20, 21, 22 show the percentage composition by species of the total catch on the five lakes by seasons.

Figure 17



Composition of the Catch on Bear Lake in Percentage of the Total Catch, by Species, for the Winters 1937-38, 1938-39, 1939-40 and the Summers of 1938-39-40.

Figure 18



Per Cent of the Total Weight of Legal Fish for the More Important Species
as Estimated from the Spring and Fall Population Determinations on Craig and Bear Lakes

Figure 19

Composition of the Catch from Bear, Craig, Christiana, Paw Paw Lakes and Stearns Bayou, by Species, in Percentage of the Total Catch for the Winter, 1938-39

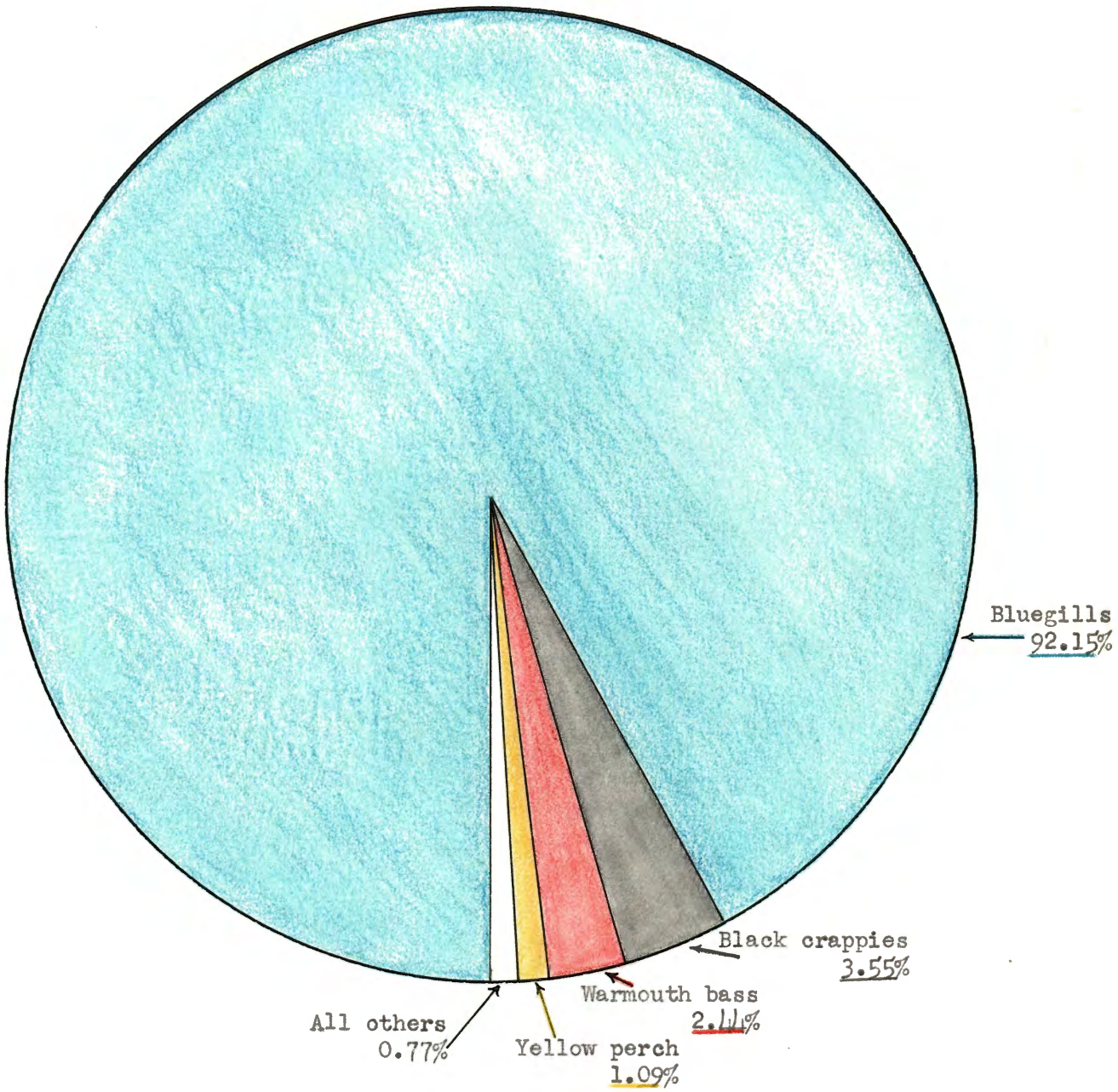


Figure 20

Composition of the Catch from Bear, Craig, Christiana, Paw Paw Lakes and Stearns Bayou, by Species, in Percentage of the Total Catch for the Winter, 1939-40

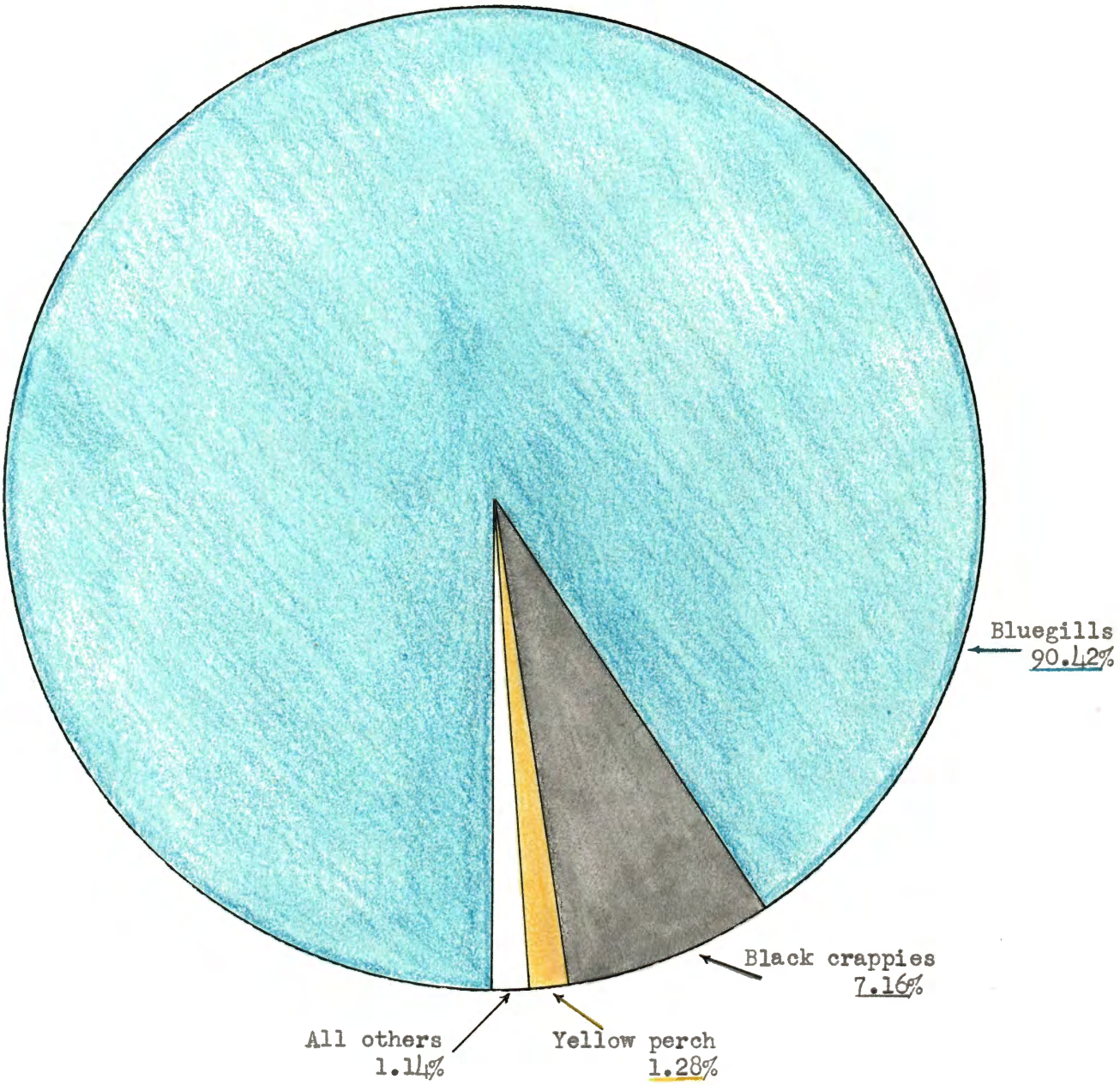


Figure 21

Composition of the Catch from Bear, Craig, Christiana, Paw Paw Lakes and Stearns Bayou, by Species, in Percentage of the Total Catch for the Summer, 1939

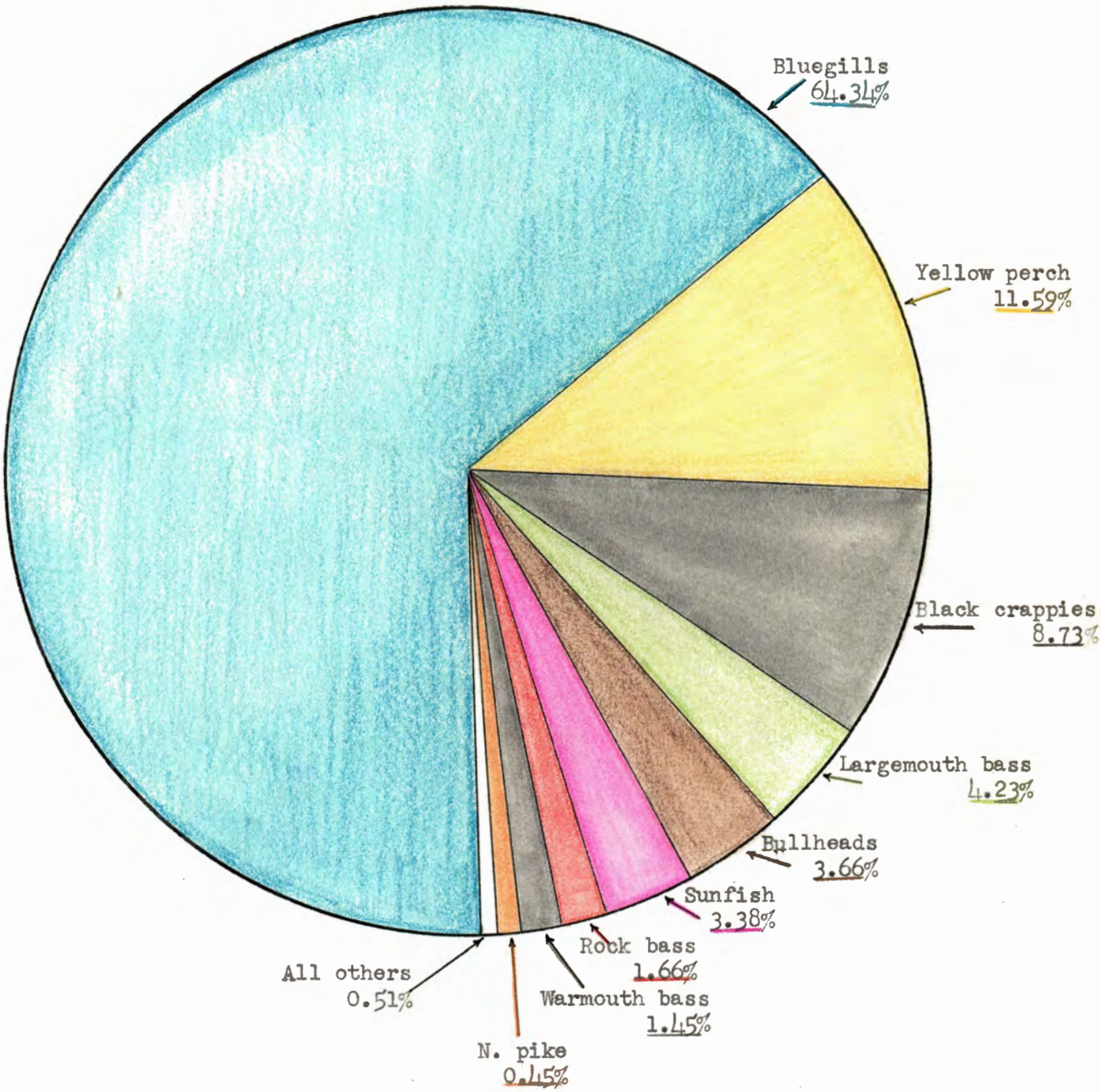


Figure 22

Composition of the Catch from Bear, Craig, Christiana, Paw Paw Lakes and Stearns Bayou, by Species, in Percentage of the Total Catch for the Summer, 1940

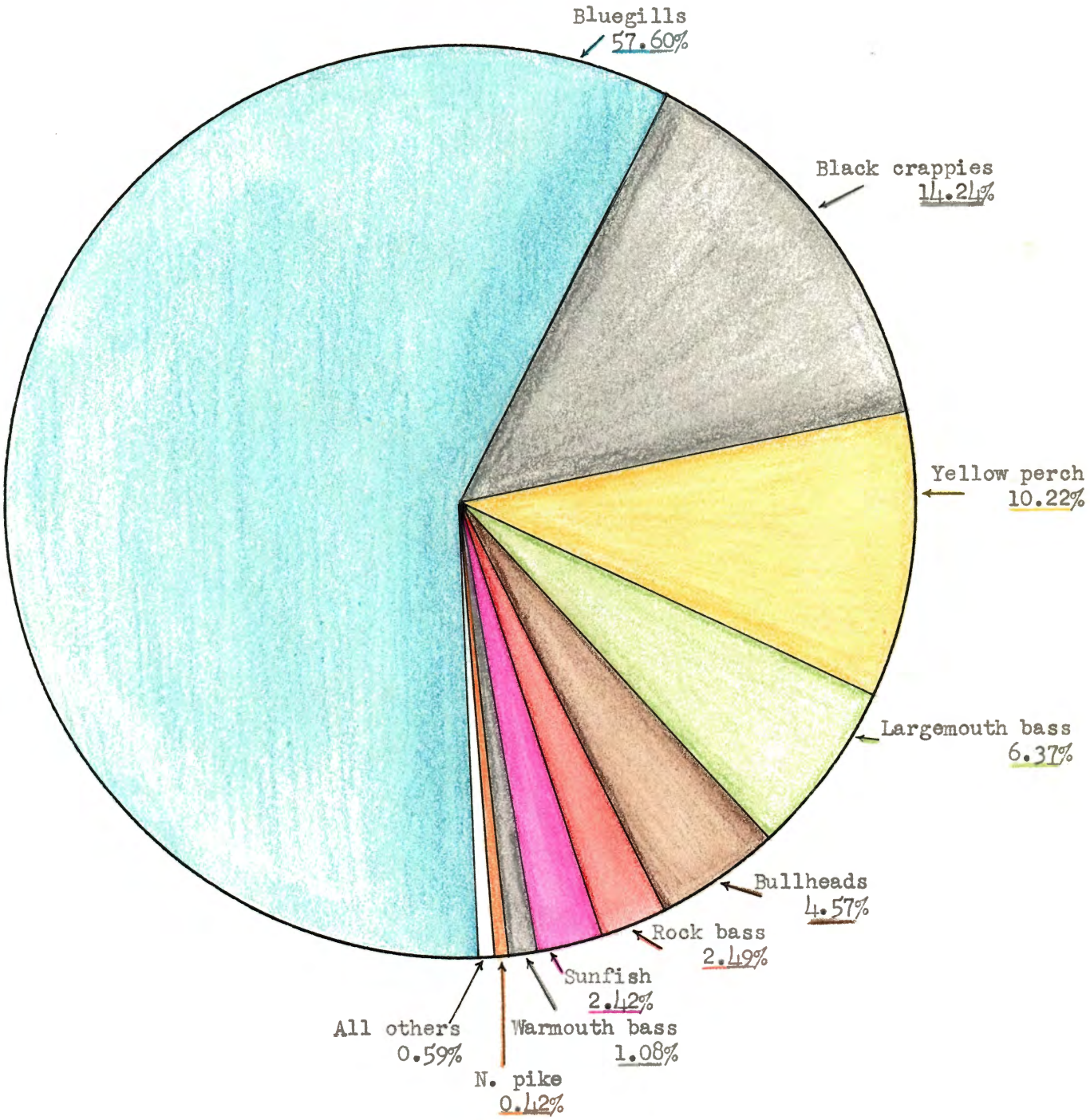


Table IX gives the percentage values by species averaged for the five lakes by seasons for the two years.

Table IX

Percentage Composition by Species of the Total Catch for Bear, Craig, Christiana, Paw Paw Lakes, and Stearns Bayou, Comparisons 1939-40 Catches Winter and Summer

	Summer 1939		Summer 1940		Winter 1938-39		Winter 1939-40	
Species	Number	%	Number	%	Number	%	Number	%
L. M. Bass	2,781	4.23	3,016	6.37	14	0.02	28	0.04
Bluegill	42,325	64.34	27,273	57.60	55,085	92.15	55,958	90.42
Sunfish	2,227	3.38	1,146	2.42	287	0.48	177	0.29
Perch	7,629	11.59	4,838	10.22	655	1.09	789	1.28
Crappie	5,748	8.73	6,743	14.24	2,120	3.55	4,425	7.16
Rock Bass	1,095	1.66	1,181	2.49	48	0.08	72	0.12
Warmouth	952	1.45	514	1.08	1,460	2.44	198	0.32
Pike	296	0.45	217	0.46	55	0.09	114	0.18
Bullhead	2,412	3.66	2,164	4.57	24	0.04	29	0.05
Dogfish	316	0.48	256	0.54	29	0.05	87	0.14
Totals	65,781		47,348		59,777		61,777	
Per Cent		99.97		99.99		99.99		100.00
	4 species down and 6 up in summer of 1940				3 species down and 7 up in winter of 1939-40			

We see here that bluegills constitute more than ninety per cent of the winter catch and between 42 per cent and 57 per cent for the summer. The table indicates a slight reduction in the bluegill percentage for 1940 over the 1939 figures for both seasons. Similarly sunfish and warmouth bass were down. Yellow perch were down slightly in the summer and up a little for the winter in the two year comparison. Contrarily, black crappies showed a percentage increase for both seasons. Largemouthed bass and bullheads increased in percentage in the summer of 1940. Pike and dogfish remained fairly constant in their percentage of the total catch.

Age and Growth of Bluegills

In conjunction with their regular census duties, the creel census clerks assisted members of the staff of the Institute for Fisheries Research in obtaining scale samples and lengths and weights from a total of 1,642 bluegills from Bear, Craig, Christiana, Paw Paw Lakes, and Stearns Bayou, and Hamlin Lake. These samples were mounted and their age and growth determined under the direction of W. C. Beckman of the Institute staff, and the findings made the subject of a separate report (Report No 649) Age groups I to X are represented in the collections. Age group IV has the largest number of specimens, which is in agreement with the state distribution. Age groups I and X are not used in this discussion because of the small number of individuals. Table X shows the number of fish in each age group.

Table X

Distribution of Age-groups of Combined Summer and Winter Bluegills

	Age-groups							
Lake	II	III	IV	V	VI	VII	VIII	IX
Bear	96	49	66	24	18	1	2	
Craig	30	49	133	141	133	25	16	.
Christiana	15	121	93	87	85	29	9	3
Paw Paw	1	37	43	29	18	4	2	3
Stearns Bayou	26	38	42	28	34	13	2	.
Hamlin	...	...	...	...	...	13	59	25
Totals	168	294	377	309	288	85	90	31
Percentage	10%	18%	23%	19%	18%	5%	5%	2%
Totals for all lakes in State represented by scale samples	375	876	1025	757	511	169	130	34
Percentage	10%	23%	26%	20%	13%	4%	3%	1%

As is clearly shown in the table, age groups III, IV and V comprise a majority of the fish caught Variation occurred from lake to lake in the rate of growth, with the highest rate recorded from Bear Lake, followed by Christiana Lake. The poorest growth up to the sixth summer occurred in Craig Lake. After the sixth summer, the growth rate was lowest for the bluegills from Stearns Bayou. Samples were taken throughout the year and all collections combined in the averages. For the entire state the records show that bluegills usually reach legal size--6 inches--in their fourth summer of life. This figure is derived from the averaged lengths of 4,184 samples from the lakes distributed over the state. In Bear Lake bluegills attained a length of 6 inches during their second summer. In Paw Paw Lake, Christiana, and Stearns Bayou this size was attained in the third summer, while in Craig Lake it took 4 summers for the average bluegill to reach legal size. The bluegills at 4 years in Bear Lake were 1 3/4 inches longer than the state average at 4 years The greatest increment for any year occurred in Christiana Lake, where the average increase for the third year of life was 2 1/4 inches. The youngest legal bluegill caught from Hamlin Lake as shown by the samples was 7 years old and was 7 1/2 inches long. The creel census records from Hamlin Lake indicated an average length for bluegills of 8.1 inches, suggesting an average in excess of 7 years.

An impression is extant that winter-caught fish, especially bluegills, generally average larger than do those caught in summer. This view is not verified by the findings in the study of the size of winter-caught bluegills as recorded in the Beckman report. Further substantiation of

this is found in the creel census records from Bear, Craig, Christiana, Paw Paw Lakes and Stearns Bayou, where averages for the two summer seasons indicate an average size for all fish caught in the summer of 8.05 inches against 7.35 inches for those caught in winter. This smaller average size in winter may be partially explained by the fact that the age group approaching or partially attaining legal size during the summer has by late fall come more or less completely into the legal size classification, producing a proportionately larger number of fish just over the legal limit which are available to the winter angler.

Another misapprehension that seems to prevail is that a larger number of female bluegills are caught in the winter than are caught in summer, and it is contended that this condition limits the spawning potential for the following season. The ratio of males to females for the winter for the five lakes is 1 male to 1.32 females. In the summer the ratio is 1 male to 1.21 females. The ratio for the entire year is 1 male to 1.27 females. For the entire state the ratio is 1 male to 1.12 females. Thus there are 47 per cent males to 53 per cent females for the entire state, this figure being based on 3,450 specimens. The combined total for the lakes under discussion for the winter is 43 per cent males to 57 per cent females, compared with the summer ratio of 45 per cent males to 55 per cent females, indicating that there are 2 per cent more females caught in winter than in summer, a figure so small as to be of questionable significance On Christiana Lake the ratio was about 1 male to 2 females for both seasons The males in Paw Paw Lake were dominant 1 male to 0.88 females in the winter catch, and in the summer the ratio was 1 male to 0.21 females. The average for the year indicates 2 males to 1 female. Stearns Bayou similarly indicated a dominance of males, 1 male to 0 19 females in the winter and 1 male to 0 81 females in the summer, the yearly average being about 2 males to 1 female. These figures do not uphold the prevalent view of

a dominance of females in the winter catch, nor do they indicate a sufficiently great disparity between the numbers of each sex caught to adversely affect the bluegill population. See Beckman report.

From these data it may be suggested that the fishing pressure on Craig Lake could be increased with benefit to that water, for the poor showing in the average rate of growth might be favorably changed were a larger number of bluegills removed, thereby providing additional food for those remaining. This same condition may hold for Stearns Bayou. Both of these lakes enjoy the heaviest winter pressure of the six lakes. This heavier winter pressure and higher success factor, from what evidence has been gathered, has obtained for some years past without notable change in the total yield to the angler other than what may be explained by normal fluctuation in populations. On Bear and Christiana Lakes were have different conditions which are not too clear. Christiana Lake has been relieved of some of its winter fishing pressure by prohibiting non-resident fishermen the use of its waters during that portion of the winter period following January 1. A rise in the success factor on this lake during the past summer indicates superficially a relationship between the former higher winter pressure and the pressure reduction in the winter of 1939-40 This increased fishing success, however, may have been due to a cyclic fluctuations or other factors yet unknown rather than to a decrease in fishing the previous winter. On Bear Lake for the last four years the fishing has been light. Prior to census operations, Bear Lake was purported to have had heavy winter fishing pressure, and the subsequent low catch per hour was thought by local residents to be the direct result of this reputed over-fishing Little in the records indicate this theory

to be valid We do have on this lake the greatest growth rate (the highest of any of the lakes involved in this paper) coupled with a low success factor. Why, under apparent conditions of ample food and spawning facilities the bluegill population has not built up to a higher point has not been determined.* It may be that in the period immediately preceding the taking of the creel census on Bear Lake, when as is locally reputed good bluegill fishing was available, a large population of the predatory species was developing. This population of predatory fish would not reach its peak concurrently with the bluegill population, but would lag, reaching its high point possibly a year or so later. This would then result in a high adverse ratio between the bluegill population and the predatory species, holding the former definitely in check. This period of ascendancy of the piscivorous fish may extend for a number of years. Conditions on Bear Lake would indicate that this may have happened there, for the largemouth bass catch in the summer of 1940 constituted 15 per cent of the total legal fish caught for that season. In the summer of 1939 largemouth bass represented 6 1/2 per cent of the catch. The percentage of largemouth bass in the total catch on Bear, Craig, Christiana, Paw Paw lakes and Stearns Bayou for the summer of 1940 was 6.37 per cent. For the summer of 1939 on these lakes it was 4.23 per cent. The percentage of legal largemouth bass present in Bear Lake in the spring of 1940 as computed from the data obtained by netting operations was 24 1/2 per cent. Further investigations on this lake may lead to conclusions pertinent to this question.

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* Early reports from Bear Lake for the winter of 1940-41 indicated a considerable increase in the bluegill catch.

On Craig Lake, where the bluegill population is high and the rate of growth poor, we found in the spring of 1940 from the netting operations that legal sized largemouthed bass constituted 8 per cent of the total population. In other words, where the bluegill growth rate was high, as in Bear Lake, we found that more than 3 times the percentage of the total population was represented by largemouth bass than in Craig Lake, where the bluegill growth rate was low. With more than 3 times the percentage of largemouthed bass in Bear Lake than in Craig Lake, we find that the bluegills attain legal size in their second summer on Bear Lake, and on Craig Lake in their fourth summer. On all five lakes, as the percentage of bass increases in the total catch of legal fish, the percentage of bluegills declined and vice versa, as shown in Table XI.

Table XI

Percentage of Largemouthed Bass in the Total Catch
Compared With the
Percentage of Bluegills in the Total Catch for the
Summers of 1939 and 1940

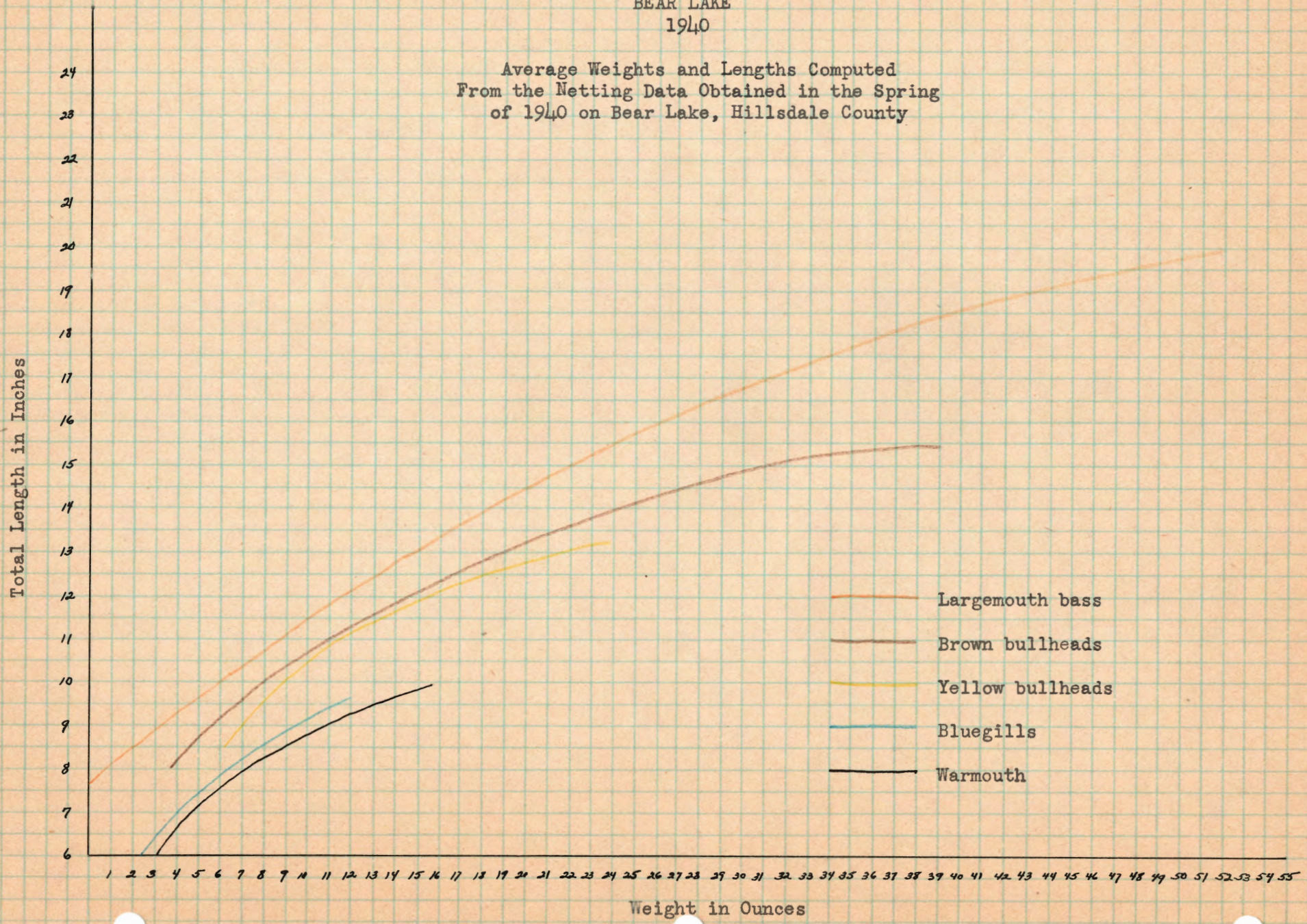
Lake	Year	L.M.Bass %	Bluegill %	Percentage Difference L.M. Bass	Percentage Difference Bluegill
Bear	1939	6.52%	63.84%		
	1940	14.96	35.7	+8.44%	-28.14%
Craig	1939	9.59%	45.14%		
	1940	9.74	37.54	+0.15%	- 7.60%
Christiana	1939	8.08%	41.22%		
	1940	6.51	44.38	-1.57%	+ 3.16%
Paw Paw	1939	2.36%	73.05%		
	1940	5.07	60.96	+2.71%	-12.09%
Stearns Bayou	1939	4.26%	80.18%		
	1940	3.6	80.78	-0.66%	+ 0.60%

R W Eschmeyer in his "Summary of the Four Year Creel Census on Fife Lake," found in 1934 that 3 per cent of the catch of legal fish were largemouth bass, and in 1937, 5 per cent were largemouth bass. For those same periods the bluegills constituted 18 per cent in 1934, and 43 per cent of the total catch of legal fish in 1937. This lake is not considered a bluegill lake, and the percentage and number of piscivorous fishes was much higher than in the southern Michigan lakes under discussion. Likewise, he found a close correlation between the abundance of the larger piscivorous fishes such as basses, walleyes, pike and northern pike, and the size of the pan fish--yellow perch, bluegills, sunfish, rock bass, etc Figure 23 shows average weights and lengths computed for Bear Lake from the netting data obtained in the spring of 1940.

Figure 23

BEAR LAKE
1940

Average Weights and Lengths Computed
From the Netting Data Obtained in the Spring
of 1940 on Bear Lake, Hillsdale County



Percentage of Female Anglers

In the winter of 1938-39 on the five lakes, Bear, Craig, Christiana, Paw Paw, and Stearns Bayou, out of all anglers 4.36 per cent were women In the winter of 1939-40 there was a slight decrease over the two year period, the percentage of women anglers being 3.25 per cent. The percentage of women anglers for the summer of 1939 was 21.79 per cent, and in the summer of 1940 the percentage increased to 22.22 per cent. Both the winter decrease and the summer increase are probably too slight to be of real significance. These figures indicate the relative constancy of the proportion of female anglers to male. A little more than 20 per cent of the anglers in the summer periods were women, while only 3 1/2 to 4 per cent of the winter fishing was enjoyed by women. For the entire two year period for the five lakes, 13.04 per cent of the anglers were women, a figure approximating that obtained from the state-wide general census for 1939. The percentages of female anglers by seasons, for the two year period (three years on Bear Lake and one year for Hamlin Lake), are listed in the summary tables for the individual lakes.

Non-resident Fishing

The percentage of the total number of fishermen represented by non-residents on eleven lakes upon which intensive censuses have been conducted was 33 1/2 per cent for the summer of 1939. For the summer of 1940 the percentage of non-resident fishermen was 50.1 per cent, an increase of 16.6 per cent. This increase may be explained in part by the general improvement in economic conditions. For the winter of 1938-1939, the percentage of out-state anglers was 15.9 per cent, and in the winter of 1939-40, it was 11 3 per cent, a decrease of 4 6 per cent, probably largely due to the exclusion of non-resident anglers from fishing in a

number of southern counties of the state after January 1, 1940 Craig and Christiana lakes were affected by this regulation Table XII shows the percentage of non-resident anglers by winter and summer seasons on each of the eleven lakes censused.

Table XII

Percentage of Non-resident Anglers

Lake	Winter 1938-39	Winter 1939-40	Summer 1939	Summer 1940
Bear	6.4	12.6	43.3	57.8
Craig	16.0	0.7	72.9	72.9
Christiana	77.1	16.8	86.4	87.2
Paw Paw	2.2	0	22.3	24.8
Stearns Bayou	0.2	0.1	10.4	7.9
Hamlin	...	3.1	61.5	...
Pike	6.9	21.4	27.9	...
Fowler	2.4	24.7	...	...
Sugarloaf	...	0	1.8	...
Clear	...	0	5.0	...
Big Portage	...	0	3.7	...
Total Average	15.9	11.3	33.5	50.1

A study of this table shows the percentage of summer non-resident anglers greatly exceeds that for the winter and seems to decrease progressively in the winter time as you go farther north with probably some few exceptions. In the winter of 1938-39 Christiana Lake, closest to the southern border of the state of any of the lakes studied, had 77 per cent of its total number of fishermen non-resident. This dropped to 16.8 per cent in the winter of 1939-40 due largely to the excluding regulation (none could fish legally after January 1). The table indicates a similar drop from a similar cause on Craig Lake from 16.0 per cent in the winter of 1938-39 to 0.7 per cent in the winter of 1939-40. Four of the lakes showed no non-resident anglers in the winter of 1939-40. The greatest percentage of non-resident anglers in the summer were found on Christiana Lake, 86 4 per cent in 1939, and 87 2 per cent in 1940 The smallest

percentage in 1940 was found on Stearns Bayou--7 9 per cent In the summer of 1939 three lakes in the Waterloo Area had a non-resident percentage of 1.8 for Sugarloaf, 5.0 for Clear, and 3.7 for Big Portage. The records indicate that no non-residents fished any of these lakes in the winter of 1939-40. A study of the table, together with the geographical locations of the lakes in relation to the Ohio-Indiana-Michigan borders, indicates that our winter fishing group is largely local. As has been stated before, the high figures for winter fishing on some of the southern lakes in the state are due to their location near urban centers of population near the border. It may be well to emphasize at this point that the regulation prohibiting non-resident fishing in the winter time in certain southern Michigan counties affects a very small number of individuals and it may be a question whether there is any benefit proportionate to the ill feeling engendered by the regulation. From the data collected, the possibility appears that the effects of increased fishing pressure might prove an actual benefit.

Comparisons with Other Lakes

From 1933 to 1936 records were obtained from intensive censuses on 24 Michigan lakes, most of which were located in the northern portion of the state. On six of these lakes we have comparative records for both summer and winter, which data are given in Table XIII.

Table XIII

Comparison of Results of Intensive Census in Summer and Winter on Six Michigan Lakes*

Lake	Period of Census	County	Area, Acres	Ave. Hours per Fisherman-day	Fish Caught: Per Hour	Fish Caught: Ave. Size, Inches	Catch Per Acre
Fife		Grand Traverse and Kalkaska	800				
	Sum 1934			2.6	1.7	8.3	13 3
	Win 33-34			4.5	0.1	16.9	0 3
	Sum 1935			2.5	1.3	8.1	14 2
	Win 35-36			5.3	0.1	12.0	0.2
Budd		Clare	150				
	Sum. 1935			3.2	1.5	7.5	94 8
	Win 35-36			...	...	...	.
Clear		Ogemaw	380				
	Sum 1934			3.0	0.8	8.1	4 8
	Win 33-34			3.8	0.45	9.7	0.3
Clear		Montmorency	160				
	Sum 34-35			2.8	0.9	9.3	3 8
	Win 33-34			4.0	1.5	7.4	1 0
	Win. 34-35			2.7	0.3	8.0	Trace
Bear		Otsego	375				
	Sum 1935			2.9	0.8	9.1	3 6
	Win. 33-34			1.5	...	...	.
Pleasant		Oakland	86				
	Sum. 1935			4.2	1.0	7.7	117.4
	Win 35-36			3.1	0.1	19.6	0.7
Ave or total							
	Sum		2,751	3.0	1.1	8.3	36 0
	Win		2,911	3.6	0.4	12.3	0 3

* Hazzard, A S. and Eschmeyer, R. W. 1938.

On the other 18 lakes we have data for the winter seasons shown in Table XIV.**

** Hazzard, A S and Eschmeyer, R. W 1938.

Table XIV

Results of Intensive Winter Census on Eighteen Lakes

Lake	County	Area, acres	Average hours per fisherman-day	Fish caught: Per hour	Fish caught: Ave. size, inches	Catch per acre	Year
Muskallonge	Montmorency	90	4.7	0.2	11.5	0.5	33-34
Hess	Newaygo	750	5.2	0.4	8.9	2.8	"
Round	Jackson	30	3.7	0.05	23.4	0.3	"
Wamplers	Jackson	800	5.5	0.1	19.2	0.5	"
Crescent	Oakland	150	3.0	0.2	10.6	1.1	"
Houghton	Roscommon	18,950	5.7	0.2	14.3	0.3	35-36
Lower Hamlin	Mason	3,100	3.9	0.3	11.0	0.1	"
Hubbard	Alcona	3,420*	4.2	0.3	11.7	0.1	"
Grand	Presque Isle	5,000	4.9	0.5	10.9	0.04	"
Long	Presque Isle and Alpena	4,600	4.0	0.4	11.3	0.04	"
Ocqueoc	Presque Isle	320	...	...	...	...	"
Manistee	Kalkaska	845	5.0	0.1	20.0	0.06	"
Pickerel	Kalkaska	133	5.7	0.4	11.8	0.65	"
Higgins	Roscommon	9,600	3.8	0.6	10.2	0.1	"
Margrethe	Crawford	1,640	5.3	0.1	22.5	0.2	"
W Twin	Montmorency	1,000	2.9	3.8	7.8	3.3	"
N. Manistique	Luce	2,000	3.8	3.5	8.3	0.8	"
Independence	Marquette	1,848	4.4	0.2	21.0	0.2	"
Total or average		57,187	4.2	0.6	13.3	0.3	

* Area of the half of the lake censused.

Comparing the data from these lakes with data obtained from Bear, Craig, Christiana, Paw Paw Lake and Stearns Bayou, we find the average catch per hour higher in the southern lakes; the average size less; and the catch per acre greater in the southern lakes. Hazzard and Eschmeyer found that in general the fewer fish caught the larger the average size, and in comparing the records from these two sections of the state, this finding seems substantiated. They found that the average size of the more northern fish was greater in the winter than in the summer, a condition the opposite from that found in the studies on the southern lakes, due in all probability to the dominance of bluegills in the catch in southern lakes The majority of the northern lakes covered by the

intensive censuses show a higher percentage of pike and walleyes in the catch. On the six lakes where both summer and winter censuses have been conducted, the average catch per hour for the summer was 1.1 fish; for the winter 0.4 fish; and the average winter catch for the 24 lakes was 0.6. This winter figure is considerably less than that obtained on the five lakes in the southern portion of the state where the catch per hour was 1.65 for the two winter periods. The summer catch per hour on the northern five lakes, however, was lower, being 0.9.

Data by Individual Lakes

Tables XV, XVI, XVII, XVIII, XIX, and XX give the data by individual lakes, and Table XXI gives combined totals for Bear, Craig, Christiana, Paw Paw Lakes, and Stearns Bayou. A study of these tables indicates the complexity of, and the wide variations in, each body of water. The catch per hour in summer varies from 0.6 fish per hour on Christiana for 1939 to 1.1 on Paw Paw in 1938-39. In the winter it varies from 0.3 on Bear Lake in 1939-40 to 2.6 on Craig in 1938-39-40. The average for all these lakes in summer was 0.9 and in winter 1.65. The percentage of fishermen catching no fish varies from 48 per cent in the summer on Christiana Lake for both summers and Craig Lake the summer of 1939-40, to 29 per cent on Paw Paw Lake the summer of 1939. For the winter period it varies from 67 per cent in 1939-40 to 14 per cent on Craig Lake the winter of that same year. The average for the five lakes in the winter was 32 per cent; in the summer 38.5 per cent.

Bear Lake:

Bear Lake lies about 5 miles southwest of Hillsdale, Michigan within the drainage system of the St. Joseph River, tributary to the Maumee. The lake comprises 104 acres. Adjacent to and connected with it by channels

are Pike, Fowler, and Wilson lakes and Cambria Mill Pond. The shore is largely marshy and a few cottages, approximately ten, are concentrated at the south end of the lake. At present the lake supports one boat livery and a store selling tackle and other fishing equipment. A peripheral band of marl extends around the lake, changing to pulpy-peat in the deeper portions, covers about 75 per cent of the total bottom area. Several rather large shoal areas are present, dropping off to a maximum depth of 53 feet. Vegetation is moderately abundant over most of the shoal area The area adjacent to the lake is covered mostly with swamp hardwoods and in some places tamarack. Bear Lake was selected in 1937 as being representative of the southern bluegill lakes and because the concensus of opinion among the local residents and the representatives of the Conservation Department in the district was that this lake was typical of the area and sustained summer and winter fishing in volume sufficient for comparison. However, the subsequent 3-year census failed to substantiate this reputation for reasonably heavy winter fishing pressures. The reason for this was considered locally to be a result of previous high pressure causing a reduction in the fish available to the angler. The data accumulated by the Institute does not verify this explanation. From the 3-year census on Bear Lake, it is apparent that the number of fish removed by the winter angler was insignificant compared with the summer take. The following table, No. XV, summarizes the Bear Lake data for the 3-year period.

Table XV

General Data Bear Lake
3-Year Period

	Number of Fishermen			Taking no fish		Total No. of hours fished	No. of legal-sized fish caught	Catch per hour	Catch per fisherman ~~day~~	Ave. size of all fish caught (inches)	No. of illegal fish caught	Ave. No. of hours per fisherman day
	Male	Female	Total	No.	%							
Winter 1937-38	301	10	311	240	77	...	238	0.3	0.8	8.4	204	...
Summer 1938	2,636	706	3,342	1,278	38	...	8,301	0.6	2.5	8.2	755	...
Winter 1938-39	194	8	202	72	36	558.50	547	1.0 or 0.98	2.7	7.4	538	28
Summer 1939	2,047	651	2,698	1,105	41	8,153.50	6,409	0.8	2.4	7.8	4,914	3.0
Winter 1939-40	242	12	254	174	69	574.25	195*	0.3	0.8	7.9	123	2.3
Summer 1940	1,408	426	1,834	694	38	5,063.25	3,616	0.7	2.0	8.8	1,612	2.8

*67 Mud pike were taken out of Bear Lake but were not included in the calculations.

Number and Average Size of Each Species for Three-Year Period

	Winter 1937-38		Summer 1938		Winter 1938-39		Summer 1939		Winter 1939-40		Summer 1940	
Species	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size
Largemouth bass	2	13.0	651	12.7	4	12.8	418	12.9	...	...	541	11.9
Smallmouth bass	...	...	6	13.6	...	...	...	...	...	...	...	...
Bluegill	115	7.6	5,317	7.5	455	7.4	4,092	7.2	16	7.7	1,291	7.6
Sunfish	6	7.2	320	6.6	23	6.7	148	7.0	4	6.4	133	6.6
Yellow perch	66	8.8	688	7.8	15	9.4	885	7.2	90	7.6	612	7.8
Crappie	3	8.0	116	10.3	7	8.1	76	10.2	3	7.6	10	10.1
Rock bass	2	7.5	468	7.4	...	...	228	7.4	46	7.9	135	7.3
Warmouth bass	27	6.5	96	7.0	42	6.3	79	6.9	26	7.5	36	7.0
Bullheads	7	9.3	414	9.9	1	13.0	392	8.7	1	9.0	792	9.3
Mud pike	2	14.0	87	11.1	...	...	...	...	67	9.1	...	...
Dog fish	8	22.1	127	15.3	...	...	72	15.6	7	17.9	53	15.9
Garpike	...	...	8	20.1	...	...	...	...	...	...	1	30.0
Sucker	...	...	...	...	...	...	...	...	1	20.5	...	...
Golden shiner	...	...	...	...	...	...	17	6.2	1	No size	2	7.0
Carp	...	...	3	15.2	...	...	...	...	...	...	10	28.7

Craig Lake.

Craig Lake has an area of 122 acres and is the northernmost of a chain of lakes, lying about 6 miles north of Coldwater, Michigan. This lake was selected for the census purposes because of its reputation for heavy winter fishing over a considerable number of years. In 1940 there were 4 cottages and one boat livery on the lake. A large percentage of the fishing is done by anglers coming into the lake from other lakes in the chain. Much of the shore is marshy, and very little of it is timbered The lake has a mixed marl and fibrous-peat bottom with several marshy islands and much shallow water, and in times past has been heavily dredged and the marl taken to the cement plant near Coldwater. The drainage to the west is through the Coldwater River. Craig Lake has a heavy growth of Chara. Its maximum depth is 25 feet. Only a small area of water in the lake is over 20 feet deep. The channel between Craig Lake and the next lake to the south, Morrison Lake, is wide and has been dredged to a maximum depth of 15 feet, providing ample means for fish to move back and forth between the two lakes. A similar channel connects the other lakes in the chain and has been dredged to provide sufficient depth for the transporting of marl barges. These channels likewise permit easy movement of the fish from one body of water to another. Table XVI summarizes the Craig Lake data for the 2-year census period.

Table XVI

General Data - Craig Lake, Branch County
Two-year Period

Date	Number of Fishermen			Taking no fish		Total No. of hours fished	No. of legal-sized fish caught	Catch per hour	Catch per fisherman	Ave. size of all fish caught (inches)	No. of illegal fish caught	Ave. No. of hours per fisherman day
	Male	Female	Total	No.	%							
Winter 1938-39	2,328	150	2,478	362	15	8,427.00	22,215	2.6	9.0	7.1	10,614	3.4
Summer 1939	2,981	764	3,745	1,521	41	12,531.00	8,918	0.7	2.4	8.4	4,847	3.3
Winter 1939-40	2,513	174	2,687	380	14	8,998.50	23,049	2.6	8.6	7.6	6,583	3.3
Summer 1940	2,497	699	3,196	1,543	48	8,658.50	6,035	0.7	1.9	8.1	5,025	2.7

Number and Average Size of Each Species for Two-year Period

Species	Winter 1938-39		Summer 1939		Winter 1939-40		Summer 1940	
	No.	Ave. Size	No.	Ave. Size	No.	Ave. Size	No.	Ave. Size
Largemouth bass	6	10.5	855	13.2	16	11.1	588	13.2
Smallmouth bass	...	...	17	12.1	...	...	...	...
Bluegill	20,490	7.0	4,026	7.2	21,963	7.5	2,266	6.5
Sunfish	211	6.6	699	7.0	123	7.2	419	6.3
Yellow perch	232	7.5	1,659	7.1	342	7.5	1,428	6.5
Black crappie	125	8.8	125	8.3	469	9.6	104	7.9
Rock bass	43	7.8	11	7.6	4	8.3	11	7.3
Warmouth bass	1,097	7.5	82	6.9	71	7.8	79	7.5
Walleye	...	...	3	21.0	...	...	...	...
Northern pike	...	...	126	25.7	43	25.2	82	20.9
Green sunfish	...	...	3	7.2	...	...	...	...
Bullhead	10	9.5	1,230	9.2	16	9.2	973	9.7
Dogfish	...	...	81	17.0	1	20.0	82	18.7
Garpike	...	...	...	...	...	...	1	30.0
Sucker	...	...	...	...	1	14.0	...	...
Golden shiner	1	7.0	1	8.0	...	...	2	7.0

Christiana Lake.

Christiana Lake has an area of 179 acres and lies about 6 miles south of Cassapolis, Michigan, near the Indiana line and the cities of South Bend and Elkhart. Its proximity to these urban centers resulted in a high non-resident fishing pressure, and in the winter of 1939-40 regulations were passed prohibiting non-residents from ice fishing after January 1. Christiana Lake together with Painter Lake and Juno Lake are connected by wide channels, forming one large body of water. Most of the development on the three lakes is on Juno and Christiana with about 40 cottages on the latter, mainly along the east shore. A large proportion of the shore on Christiana and Painter is marshy. The source of water for the three lakes is the Christiana River, which flows into Painter Lake and out of Christiana into Eagle Lake. A maximum depth of 40 feet was recorded by the Institute survey. The lake has a relatively even basin with a considerable area of water over 20 feet deep with moderately heavy growth of vegetation in the shallower waters. Table XVII summarizes the data for Christiana Lake for the two year period. On this one lake, in order to determine the fishing pressure in the late fall period, the census was continued in 1939 from October 15 to December 23, at which time the ice formed. The records show that 197 additional fishermen took 260 fish in this period. This data is given in the appendix. The following table does not include these additional figures since for comparative purposes October 15th was taken as the closing date on all the lakes.

Table XVII

General Data - Christiana Lake, Cass County
Two Year Period

Date	Number of Fishermen			Taking no fish		Total No. of hours fished	No. of legal-sized fish caught	Catch per hour	Catch per fisherman	Ave. size of all fish caught (inches)	No. of illegal fish caught	Ave. No. of hours per fisherman day
	Male	Female	Total	No.	%							
Winter 1938-39	1,210	85	1,295	565	44	4,374.75	3,537	0.8	2.7	8.1	3,586	3.4
Summer 1939	2,777	763	3,540	1,686	48	10,625.25	6,373	0.6	1.8	8.7	3,258	3.0
Winter 1939-40	594	38	632	207	33	2,363.75	3,228	1.4	5.1	8.4	884	3.7
Summer 1940	2,483	731	3,214	1,543	48	9,915.00	6,969	0.7	2.2	8.4	3,524	3.1

Number and Average Size of Each Species for Two Year Period

Species	Winter 1938-39		Summer 1939		Winter 1939-40		Summer 1940	
	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size
Largemouth bass	1	15.5	515	13.9	2	11.0	454	13.8
Smallmouth bass	...	...	7	13.1	...	...	4	12.6
Bluegill	2,979	7.9	2,627	7.5	2,844	8.2	3,093	7.7
Sunfish	13	6.6	213	6.9	40	6.9	212	6.6
Yellow perch	80	7.5	1,316	7.0	12	7.3	924	7.0
Crappie	95	10.4	685	9.3	119	8.4	1,932	8.2
Rock bass	2	8.5	319	7.5	4	6.9	128	7.6
Warmouth bass	319	7.5	79	7.4	99	7.4	30	7.5
Walleye	...	...	1	24.5	...	...	...	...
N. Pike	3	30.0	48	23.1	10	24.2	43	24.7
Bullhead	13	9.7	452	11.5	11	12.5	95	12.7
Dogfish	29	17.8	86	18.0	71	18.7	47	18.9
Sucker	...	...	1	14.0	...	...	...	...
Garpike	...	...	22	22.4	1	12.0	7	25.4
Redhorse	...	...	1	39.0	...	...	...	...
Mud pike	3	13.5	1	18.0	14	12.9	...	...
Carp	...	...	...	...	1	11.0	...	...

Paw Paw Lake.

The area of Paw Paw Lake is 855 acres. It is located just north of Watervliet, Michigan. This is the most highly developed of the lakes under discussion, having in excess of 2,000 cottages lining the shores, several boat liveries, pavilions, stores, etc., available to the public The state has acquired frontage at the north end on Sherwood Bay, providing public access for the fishermen. The lake is used heavily in the summer by both fishermen and speedboat enthusiasts and considerable local friction has developed between these two groups. The lake is fed primarily by the Paw Paw River, which also serves as the outlet. Several rather extensive areas of weed beds are found in the shallower waters. A considerable portion of the lake is over 20 feet deep with a maximum depth of 90 feet. Table XVIII summarizes the data for Paw Paw Lake over the two year period.

Table XVIII

General Data - Paw Paw Lake, Berrien County
Two Year Period

Date	Number of Fishermen			Taking no fish		Total No. of hours fished	No. of legal-sized fish caught	Catch per hour	Catch per fisher-man	Ave. size of all fish caught (inches)	No. of illegal fish caught	Ave. No. of hours per fisher-man day
	Male	Female	Total	No.	%							
Winter 1938-39	2,458	57	2,515	1,103	44	9,211.25	14,444	1.6	5.7	7.6	168	3.7
Summer 1939	8,574	1,455	10,029	2,912	29	36,288.00	41,454	1.1	4.1	8.0	12,355	3.6
Winter 1939-40	4,167	3	4,170	2,005	48	12,965.00	11,702	0.9	2.8	7.6	366	3.1
Summer 1940	6,123	931	7,054	2,326	33	20,437.50	21,835	1.1	3.1	8.2	9,014	2.9

Number and Average Size of Each Species for Two Year Period

Species	Winter 1938-39		Summer 1939		Winter 1939-40		Summer 1940	
	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size
Largemouth bass	...	...	978	12.5	9	11.7	1,107	12.8
Smallmouth bass	...	...	25	12.1	...	...	56	12.5
Bluegill	14,081	7.6	30,283	7.8	8,936	7.3	13,310	7.7
Sunfish	40	7.5	907	6.7	10	6.8	304	6.7
Yellow perch	79	7.3	3,159	7.1	121	7.0	1,547	6.9
Crappie	232	9.5	4,642	9.0	2,582	8.5	4,194	8.7
Rock bass	1	7.0	477	7.1	17	6.8	795	7.0
Warmouth bass	2	7.0	614	6.7	2	6.5	204	7.1
Walleye	...	...	...	...	...	...	3	26.7
Northern pike	6	32.0	51	22.1	3	27.0	38	25.1
Bullheads	...	...	250	10.4	1	10.0	184	10.6
Dogfish	...	...	44	18.3	8	16.7	34	19.8
Garpike	...	...	11	21.3	1	15.0	13	21.6
Mud pike[1]	1	20.0	1	25.0	...	...	2	19.0
Carp	...	...	1	4 lbs.	6	16.7	4	27.2
Sucker	2	18.0	11	15.9	6	17.8	34	17.5
Redhorse	...	...	...	...	...	...	6	16.4

[1] Probably northern pike.

Stearns Bayou.

An area of 83 acres, Stearns Bayou lies about 6 miles southeast of Grand Haven. It is one of a series of finger-like arms connected with and near the mouth of the Grand River. There is one boat livery and but few cottages on its shores. The lake has considerable shoal area with a pulpy-peat bottom, and is considered locally an excellent fishing lake both winter and summer. Table XIX summarizes the data for Stearns Bayou for the two year period.

Table XIX

General Data - Stearns Bayou, Ottawa County
Two Year Period

Date	Number of Fishermen			Taking no fish		Total No. of hours fished	No. of legal-sized fish caught	Catch per hour	Catch per fisher-man	Ave. size of all fish caught (inches)	No. of illegal fish caught	Ave. No. of hours per fisher-man day
	Male	Female	Total	No.	%							
Winter 1938-39	3,519	123	3,642	1,113	31	12,155.00	19,047	1.6	5.2	7.3	2,397	3.3
Summer 1939	2,791	545	3,336	1,463	44	10,574.25	9,603	0.9	2.9	7.3	10,748	3.2
Winter 1939-40	3,851	143	3,994	1,016	25	13,755.50	23,635	1.7	5.9	7.0	3,879	3.4
Summer 1940	2,223	487	2,710	1,039	38	9,275.00	9,052	1.0	3.3	7.2	7,316	3.4

Number and Average Size of Each Species for Two Year Period

Species	Winter 1938-39		Summer 1939		Winter 1939-40		Summer 1940	
	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size
Largemouth bass	3	11.7	410	13.0	1	10.0	326	12.5
Smallmouth bass	...	...	5	12.4	...	...	1	12.0
Bluegill	17,080	7.2	7,700	6.8	22,099	6.9	7,313	...
Sunfish	...	...	260	6.6	...	...	78	6.2
Yellow perch	249	7.1	610	6.9	224	6.7	327	6.4
Crappie	1,661	8.3	228	7.9	1,252	8.2	503	8.0
Rock bass	2	7.0	60	6.8	1	7.0	112	6.7
Warmouth bass	...	...	98	6.5	...	...	165	6.4
Northern pike	45	23.3	71	21.5	58	24.0	54	21.1
Bullhead	...	...	88	10.5	...	...	120	9.3
Dogfish	...	...	33	19.5	...	...	40	16.7
White bass	...	...	18	8.8	...	...	1	8.0
Sheepshead	...	...	8	10.0	...	...	...	...
Channel catfish	...	...	13	9.6	...	...	9	16.4
Sucker	...	...	1	20.0	...	...	3	16.7
Carp	7	no size	...	...	...	...	...	...

Hamlin Lake.

Hamlin Lake has an area of 4,982 acres and lies about 8 miles north of Ludington and about 1/2 mile from Lake Michigan. The lake is formed by a dam in the Sable River which forms both its inlet and outlet. On the west side of the lake between it and Lake Michigan lie the Ludington State Park and the Ludington CCC Camp. The majority of the development is on the south and east shores. The north side of the lake is a sand dune area, its difficulty of access accounting for the slight development. The upper portion of the lake, called Upper Hamlin, is shallow and rather heavily silted. Lower Hamlin, which is the main portion of the lake, reaches a maximum depth of about 50 feet with rather even bottom, with a narrow strip of sand along the shore, the balance being pulpy-peat. By local agreement the level of the lake is drawn down each winter and raised the following spring. The east side of Lower Hamlin has three large indentations locally termed bayous, each of which supports a boat livery The upper lake is relatively shallow due to the silting in by the Sable River which enters at the east end of Upper Hamlin and leaves at the south end of Lower Hamlin. The dam at the lower end of the lake prevents fish movement, resulting in a transfer project each spring whereby the fish are moved from the river to the lake. Hamlin is considered a first class fishing lake. Table XX summarizes the data for Hamlin Lake over its one year of census.

Table XX

General Data - Hamlin Lake, Mason County
One Year Period

Date	Number of Fishermen			Taking no fish		Total No. of hours fished	No. of legal-sized fish caught	Catch per hour	Catch per fisherman	Ave. size of all fish caught (inches)	No. of illegal fish caught	Ave. No. of hours per fisherman day
	Male	Female	Total	No.	%							
Summer 1939	13,154	3,411	16,565	4,475	27	59,314.50	57,373	0.97	3.5	8.9	6,189	3.6
Winter 1939-40	1,218	111	1,329	621	47	6,245.75	4,825	0.8	3.6	9.9	105	4.7

Species	Summer 1939	Winter 1939-40
Largemouth bass	2,087	3
Smallmouth bass	1,742	7
Bluegill	26,313	3,841
Sunfish	3,550	52
Yellow perch	5,768	273
Crappie	3,023	21
Rock bass	11,146	9
Walleye pike	1,516	43
Northern pike	244	288
Bullhead	1,597	6
Dogfish	83	110
Garpike	10	7
White bass	2	...
Redhorse	15	...
*Pickerel	49	...
Sucker	33	151
Sheepshead	169	2
Shad	2	...
Carp	5	1
Rainbow trout	5	...
Mud pickerel	6	...
Brown trout	1	...
Muskellunge	4	11
Dace	1	...
Channel cat	2	...
Totals	57,373	4,825

* Probably northern pike.

Table XXI gives combined totals for the five lakes, Bear, Craig, Christiana, PawPaw and Stearns Bayou, for a two year period.

Pike and Fowler lakes are closely associated and similar to Bear Lake with no development on either, and for these reasons were incorporated in the census area. Pike Lake has an area of 19.4 acres, and Fowler an area of 15 acres. The ice fishing on Bear Lake concentrates at the north end of the lake at a point of access to and from the other lakes, a condition which made it possible for the census clerk to easily cover all three lakes and obtain approximately 90 per cent of the fishing records in the winter time on Pike and Fowler lakes. The summer condition on Bear Lake was different, the fishing being widely scattered and requiring considerably more of the census clerk's time on that lake with the result that only a partial census on Pike and Fowler lakes was possible in the summer periods. Table XXII shows the general data for Pike Lake, and Table XXIII for Fowler Lake, over the three year period of census.

Table XXI

Combined Totals for Bear, Christiana, Craig,

Paw Paw, and Stearns Bayou for Two Year Period

Date	Number of Fishermen			Taking no fish		Total No. of hours fished	No. of legal-sized fish caught	Catch per hour	Catch per fisher-man	Ave. size of all fish caught (inches)	No. of illegal fish caught	Ave. No. of hours per fisher-man day
	Male	Female	Total	No.	%							
Winter 1938-39	9,709	423	10,132	3,215	32	34,726.50	59,790	1.7	5.9	7.3	17,303	3.4
Summer 1939	19,170	4,178	23,348	8,687	37	78,172.00	72,766	0.9	3.1	8.0	36,122	3.3
Winter 1939-40	11,367	370	11,737	3,778	32	38,657.00	61,876	1.6	5.3	7.4	11,835	3.3
Summer 1940	14,734	3,274	18,008	7,145	40	53,349.25	47,507	0.9	2.6	8.1	26,491	3.0

Table XXII

General Data - Pike Lake, Hillsdale County
Three Year Period

Date	Total No. fishermen	Fishermen taking no fish		No. legal-sized fish caught	Catch per hour	Catch per fisherman	Ave. size of all fish caught, inches	No. illegal fish caught	Ave. No. hours per fisherman-day
		No.	%						
Winter 1937-38	304	148	...	650	0.82	2.1	8.2	156	2.6
Summer 1938	314	82	...	1,044	0.9	3.3	8.0	16	3.8
Winter 1938-39	131	60	46%	283	0.8	2.2	7.5	289	2.9
Summer 1939	305	97	...	1,125	1.3	3.6	7.8	...	2.8
Winter 1939-40	234	121	...	480	0.9	2.0	8.2	...	2.1
Summer 1940	...	...	...	...	...	...	...	...	...

Number and Average Size of Each Species
Three Year Period

Species	Winter 1937-38		Summer 1938		Winter 1938-39		Summer 1939		Winter 1939-40		Summer 1940	
	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size
Largemouth bass	13	11.5	35	13.1	...	...	19	12.9	36	11.9	...	...
Smallmouth bass	...	...	...	...	...	...	...	...	...	...	...	...
Bluegill	626	8.1	889	7.8	250	7.5	973	7.7	304	7.1	...	...
Sunfish	2	7.5	35	6.8	6	6.8	12	6.5	3	7.5	...	...
Yellow perch	...	...	36	7.9	1	7.0	51	7.2	5	7.0	...	...
Crappie	8	11.7	7	9.2	24	8.5	13	9.2	128	9.7	...	...
Rock bass	...	...	3	7.5	...	...	3	8.0	3	7.0	...	...
Warmouth bass	1	6.0	...	...	1	6.0	9	6.8	...	...	...	...
Bullheads	...	...	33	8.9	1	7.0	34	8.7	...	...	...	...
Mud pike	...	...	...	...	...	...	...	...	1	8.0	...	...
Dogfish	...	...	3	15.3	...	...	3	14.7	...	...	...	...
Garpike	...	...	...	...	...	...	...	...	...	...	...	...
Sucker	...	...	...	...	...	...	...	...	...	...	...	...
Golden shiner	...	...	...	...	...	...	8	6.1	...	...	...	...
Carp	...	...	...	...	...	...	...	...	...	...	...	...

Table XXIII

*General Data - Fowler Lake, Hillsdale County

Three Year Period

Date	Total No. fishermen	Fishermen taking no fish		No. legal-sized fish caught	Catch per hour	Catch per fisherman	Ave. size of all fish caught, inches	No. illegal fish caught	Ave. No. hours per fisherman-day
		No.	%						
Winter 1937-38	104	55	...	271	1.2	2.6	8.2	23	2.1
Summer 1938	5	0	...	37	1.6	7.4	8.8	0	4.7
Winter 1938-39	164	63	38%	491	1.0	3.0	7.3	153	3.0
Summer 1939	...	...	...	...	...	...	...	...	...
Winter 1939-40	247	98	...	673	1.2	2.7	7.7	...	2.2
Summer 1940	...	...	...	...	...	...	...	...	...

Number and Average Size of Each Species

Three Year Period

Species	Winter 1937-38		Summer 1938		Winter 1938-39		Summer 1939		Winter 1939-40		Summer 1940	
	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size	No.	Ave. size
Largemouth bass	5	11.8	7	13.1	...	...	...	...	11	11.3	...	...
Smallmouth bass	...	...	...	...	...	...	...	...	...	...	...	...
Bluegill	263	8.1	27	7.9	469	7.3	...	...	603	7.5	...	...
Sunfish	1	8.0	3	7.0	9	6.6	...	...	17	6.5	...	...
Yellow perch	...	...	...	...	1	10.5	...	...	7	9.5	...	...
Crappie	...	...	...	...	9	8.4	...	...	27	9.7	...	...
Rock bass	...	...	...	...	...	...	...	...	3	8.0	...	...
Warmouth bass	1	8.0	...	...	...	...	...	...	1	7.0	...	...
Bullheads	...	...	...	...	2	8.0	...	...	3	10.0	...	...
Mud pike	1	10.0	...	...	...	...	...	...	...	...	...	...
Dogfish	...	...	...	...	...	...	...	...	...	...	...	...
Garpike	...	...	...	...	...	...	...	...	...	...	...	...
Sucker	...	...	...	...	...	...	...	...	...	...	...	...
Golden shiner	...	...	...	...	1	8.0	...	...	1	6.5	...	...
Carp	...	...	...	...	...	...	...	...	...	...	...	...

* Clark, O. H., Analysis of Fish Catch, Fowler and Pike lakes, Hillsdale County, Mich., Report No. .

Table XXIV summarizes the data for Bear, Craig, Christiana, Paw Paw, Stearns Bayou, and Hamlin lakes for comparative purposes.

Table XXIV

Summary of Records, by Seasons, for the Six Lakes

	Bear	Craig	Christiana	Paw Paw	Stearns Bayou	Hamlin
Catch per hour:						
Summer 1939	0.8	0.7	0.6	1.1	0.9	0.97
Summer 1940	0.7	0.7	0.7	1.1	1.0	...
Winter 1938-39	0.98	2.6	0.8	1.6	1.6	...
Winter 1939-40	0.3	2.6	1.4	0.9	1.7	0.8
Number of fishermen:						
Summer 1939	2,698	3,745	3,540	10,029	3,336	16,565
Summer 1940	1,834	3,196	3,214	7,054	2,710	...
Winter 1938-39	202	2,478	1,295	2,515	3,642	...
Winter 1939-40	254	2,687	632	4,170	3,994	1,329
Number of legal fish:						
Summer 1939	6,409	8,918	6,373	41,454	9,603	57,373
Summer 1940	3,616	6,035	6,969	21,835	9,052	...
Winter 1938-39	547	22,215	3,537	14,444	19,047	...
Winter 1939-40	262	23,049	3,228	11,702	23,635	4,825
Number of undersize:						
Summer 1939	4,914	4,847	3,258	12,355	10,748	6,189
Summer 1940	1,612	5,025	3,524	9,014	7,316	...
Winter 1938-39	538	10,614	3,586	168	2,397	...
Winter 1939-40	123	6,583	884	366	3,879	105
Per cent taking no fish:						
Summer 1939	41	41	48	29	44	27
Summer 1940	38	48	48	33	38	...
Winter 1938-39	36	15	44	44	31	...
Winter 1939-40	67	14	33	48	25	47
Average size:						
Summer 1939	7.8	8.4	8.7	8.0	7.3	8.9
Summer 1940	8.8	8.1	8.4	8.2	7.2	...
Winter 1938-39	7.4	7.1	8.1	7.6	7.3	...
Winter 1939-40	8.2	7.6	8.4	7.6	7.0	9.9
Fish per fisherman:						
Summer 1939	2.4	2.4	1.8	4.1	2.9	3.5
Summer 1940	2.0	1.9	2.2	3.1	3.3	...
Winter 1938-39	2.7	9.0	2.7	5.7	5.2	...
Winter 1939-40	1.0	8.6	5.1	2.8	5.9	3.6
Hours per fisherman-day:						
Summer 1939	3.0	3.3	3.0	3.6	3.2	3.6
Summer 1940	2.8	2.7	3.1	2.9	3.4	...
Winter 1938-39	2.8	3.4	3.4	3.7	3.3	...
Winter 1939-40	2.3	3.3	3.7	3.1	3.4	4.7

Netting Operations

It was decided in the spring of 1940 to conduct population estimates on Craig and Bear lakes following the plan used by Dr. David H. Thompson of the Illinois Natural History Survey. A commercial fisherman with his gear, Mr. Ralph Curl of Black River, Michigan, was employed to do the netting. Mr. Curl had done similar work for the Institute for Fisheries Research under the direction of Mr. Walter Crowe in the northern part of the Lower Peninsula.* The nets were placed in Bear Lake the first of May, and from one to 5 nets were continuously operated and lifted daily until the 27th of May, when the gear was transferred to Craig Lake. Similar netting operations were conducted on Craig Lake until the 23rd of June, when the opening of the fishing season on the 25th necessitated the removal of the nets. Netting was resumed simultaneously on both lakes beginning the 25th of September, 1940, and extended to November 7th. Nets were lifted on alternate days in each lake and population estimates were computed for each lake after each period of netting. This was done daily in the spring season and every other day in the fall season. The author was assisted in this work by Mr. Walter Crowe and Mr. Floyd Ames of the Institute staff, together with the two census clerks in the fall, Mr Basil Hughes on Bear Lake, and Mr. John Ford on Craig Lake. It was considered that valuable data would be obtained as to total populations of legal fish, populations by species, lengths and weights of fish, making it possible then to compare this data with data obtained from the creel census, thereby determining the ratio of angler take to total populations. Data on the extent of movement within each lake and into

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connected adjacent waters were obtained by different markings of the fish at their different locals of capture. Much of the material has yet to be analyzed and will be made the subject of a separate report. However, the total populations by species, the difference between the spring and fall populations, are of sufficient interest for purposes of comparison to warrant inclusion in this paper, and frequent references to these data have been made. In the spring a total of 7,304 fish were marked on Craig Lake, 291 of these being jaw-tagged and the balance fin-clipped, and 566 of these were recaptured. On Bear Lake for the spring a total of 2,554 fish were marked, 217 of these being jaw-tagged and the balance fin-clipped, with 421 of this total recaptured. In the fall on Craig Lake, a total of 7,674 fish were marked by fin-clipping, and 985 of these were recaptured. On Bear Lake in the fall a total of 848 fish were marked by fin-clipping, and out of this total 76 were recaptured.

Percentage of the Total Number of Fishermen Catching More than Fifteen Pan Fish Per Day

Table XXV shows the percentage of the total number of fishermen catching more than 15 pan fish per day together with the percentage of pan fish over 15 caught for the summer of 1939 and the winter of 1939-40 on Craig, Christiana, Paw Paw, Stearns Bayou, Hamlin, and the lakes in the Waterloo Area Big Portage, Clear and Sugarloaf, and the total average percentages for all these lakes. Bear Lake had too few winter records to be included.

From the table it may be seen that were the legal limit reduced to 15 pan fish per day, in the summer time 4 per cent of the total number of anglers would be affected and a theoretical saving of 5 per cent of the total number of fish. These figures are approximately double for the

Table XXV

Lakes	Summer 1939 % fishermen taking over 15 pan fish	Summer 1939 % pan fish over 15	Winter 1939-40 % fishermen taking over 15 pan fish	Winter 1939-40 % pan fish over 15
Craig	1%	2%	17%	11%
Christiana	1	2	10	12
Paw Paw	3	4	3	6
Stearns Bayou	...	...	11	13
Hamlin	2	3	10	19
Big Portage	5	7	2	6
Clear	13	12	9	8
Sugarloaf	4	6	5	4
Average %	4.1%	5.1%	8.4%	9.9%

winter season, being 8.4 per cent of the total number of fishermen who caught over 15 fish, and 9.9 per cent of the total number of fish that would in theory be saved for the future angler. The question if the legal limit were reduced to 15 would the fish thus saved tend to improve the subsequent fishing, the answer would be in the negative by the author As has been explained previously, it is quite possible that an actual increase in the number of fish removed would provide a greater yield, not less. To illustrate: a stock raiser may only pasture a given number of head of cattle per unit acreage. Were he to exceed this, his maximum yield would be decreased because of insufficient food. A good stockman will harvest a proportion of his stock each year and by so doing will maintain a maximum yield per unit area. Data so far collected for the lakes indicate that we are not yet cropping maximum numbers of fish commensurable with maximum yield.

Summary and Conclusions

The material submitted in this paper is based on the analysis of 84,772 records of which 81,119 were obtained over the two year period from the winter of 1938-39 through the summer of 1940 on Bear, Craig, Christiana, and Paw Paw lakes and Stearns Bayou and one year on Hamlin Lake, and 3,653 records from Bear Lake the winter of 1937-38 and the summer of 1938 Each fishing record comprised the total fishing done in one day by one angler. Table I in the appendix gives the summarized data from these records by seasons for these six lakes.

The previously suggested decrease in the average size of the fish as the catch per hour increases, is substantiated by the findings from the analysis of the data given in this paper. The two year census shows no significant change in the catch per hour for the two winter seasons, and no change for the two summer periods. The catch per hour in the winter was almost twice as great as in the summer, ranging from 0.9 in summer to 1.65 in winter.

The average catch per acre of lake surface for the above six lakes for the winter and the summer periods was almost identical.

Craig Lake supported populations of fish (based on population estimates from netting operations) weighing 527.6 pounds per acre of lake surface, Bear Lake had a population weighing 263.4 pounds per acre of lake surface. These figures are on the conservative side inasmuch as the perch population was not included, since an accurate estimate of the perch could not be determined.

Sixteen per cent of the total poundage of legal fish in Craig Lake was removed by the winter angler Less than 2 per cent of the estimated total poundage of legal fish was removed by the winter angler on Bear Lake.

Five per cent of the total number of fish caught in the summer time represent the number of fish caught in excess of an assumed 15 fish limit and 10 per cent in the winter time. From the analysis of the data, a reduction in the limit from 25 to 15 pan fish would not, in general, benefit the waters censused.

On the five lakes, Bear, Craig, Christiana, Paw Paw, and Stearns Bayou, winter-caught fish averaged 0.7 of an inch less in length than the summer-caught fish. The figures do not substantiate the popular impression that winter-caught fish average larger than summer-caught fish

Bluegills constituted about 91 per cent of the catch in the winter periods, and about 61 per cent in the summer periods. The percentage composition of the catch varied widely in different lakes. When one or more species fall in percentage of the total catch, other species tend to increase proportionately.

On the two lakes, Bear and Craig, where population estimates were made, there was a large population of bluegills in excess of the winter take and apparently not available to the summer angler because of a natural loss in the winter from disease, old age, etc., that might better have been harvested by the ice fisherman.

The data indicate no unbalanced sex ratio in the catch for the six lakes above listed. There is little variance in the percentage of female bluegills in the winter and summer catches.

Figuring that the total population of legal fish in Craig Lake in 1940 potentially available to the angler, as being the estimated fall population plus the preceding summer's catch, we find a per acre average of 1,667 legal fish Of these fish, 11 4 per cent were removed by angling both summer and winter Assuming the average age to be five

years, then over a five-year period 950 fish per acre would be caught out of a possible 7,385 legal fish available and 6,435 of the potential crop would not be directly harvested by the angler. A theory may be advanced that if all the legal fish over the five-year period were harvested, the actual number of fish in the lake might be increased by about 15 per cent, but the poundage would tend to remain constant. This percentage is arrived at by figuring that a total catch of all legal fish would reduce the average size of those remaining to approximately the minimum legal size. With the total poundage remaining constant, an increase in numbers would result proportional to the decreased size. The figure is based on the assumption that all the conditions in the lake remain constant. No depletion of the necessary seed stock under these ideal conditions would occur, for the fish would spawn ahead of the opening of fishing each year, and the age group just short of legal size in the fall would be the breeders the following spring. It is the author's suggestion that an experiment on a small lake with neither inlet nor outlet, under the full control of the Institute for Fisheries Research, could be used to determine the effect of heavy take of legal fish upon the remaining populations. This could be accomplished by heavy netting and removal of legal fish each fall for several years.

Growth rates were higher on Bear Lake and Christiana Lake, and lowest on Craig Lake, Hamlin, and Stearns Bayou. Bluegills on Bear Lake reach legal size in their second summer; on Craig Lake the fourth summer; on Hamlin the seventh summer.

The female angler constituted 3.85 per cent of the total number of anglers for the winter periods on the five lakes, and 22 per cent in the summer periods.

Non-resident winter fishermen may be a problem only locally on certain individual lakes. In the winter of 1938-39, before the regulation was invoked prohibiting out-state anglers from winter fishing in some southern counties of the state, 15 per cent of the total number of fishermen were non-resident, and for the following summer 41 per cent of the total number of anglers were non-resident. The data seem to indicate that generally speaking, the ice fisherman fishes local waters, and the effect on fishing by non-residents in the winter time is negligible.

It may be that increased fishing pressure would actually benefit rather than harm the lakes censused. The state seems to have ample inland waters to take care of all present fishing pressure without detriment to the total angler take.

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Appendix

The detailed tabular data is filed with the Institute for Fisheries Research:

Lake survey maps for Bear, Craig, Christiana, Paw Paw, Hamlin, and Clear lakes.

By weekly intervals, data for each of the eleven lakes: Bear, Craig, Christiana, Paw Paw, Stearns Bayou, Hamlin, Big Portage, Clear, Sugarloaf, Pike and Fowler.

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