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POPULATION ANALYSIS OF BIG BEAR LAKE, OTSEGO COUNTY, MICHIGAN

by
Walter R. Crowe

In recent years the significance of population studies has been generally recognized by fisheries investigators. A knowledge of a lake's population makes it easier to determine the controlling factors which maintain the balance between the parts of that population. Results of stocking may be more easily determined and the effects of the fishermen's "take" may be more accurately judged. Samples of the population selected for growth studies, etc., will be more valuable when we know the composition of the population from which they were taken. Also, a knowledge of the population in any body of water will perhaps serve as a measure or criterion for judging the population in some other body of water.

During the summer of 1940 a population analysis was made on Big Bear Lake, Otsego County, Michigan. Details concerning the lake itself are given in a former report (Institute Report No. 651). The analysis was undertaken in continuation of work started on East Twin Lake in the same region in the summer of 1939. The purpose of the investigation is to evaluate the position of the common sucker in the waters of the state, especially in lakes. In several lakes which

have been brought to the attention of the Department of Conservation in the past few years, the sucker population seems to have increased out of all proportion to the game fish, and we hope to be able to discover what effect these relatively large sucker populations have on the game fish production. Many questions have arisen concerning the sucker, some believing that it is a competitor with the game species, and others maintaining that it is probably beneficial as an important forage species. Big Bear Lake was selected for the investigation because of a relatively large sucker population reportedly present along with a game fish population which was assumed to be more or less average. This report will deal with information that has resulted incidental to the investigation of the value of the sucker in Big Bear Lake.

Procedure was almost the same as that used in the study on East Twin Lake in 1939 (Institute Report No. 590). Personnel and gear used were the same. One change in procedure should be noted here. In 1940 at Big Bear Lake fish were marked differently at each station so that their movements might be determined more accurately, and so that we might be able to judge how well the marked fish were distributed throughout the lake. Also, a far larger series of the fish captured during 1940 was weighed and measured than during 1939, and consequently, our samples are more adequate than those of the summer before. As in 1939, total, specific and relative populations were estimated. A creel census was carried on at the same time as the population study. The data gathered in 1940 are more complete, and more adequate information has resulted.

The estimated total and specific populations as determined from the use of the formula $P = \frac{\Sigma AB}{\Sigma C}$ are presented in Tables XI to XIX inclusive*.

*These tables are not included in this report except in the Institute for Fisheries Research file copy.

Relative populations in per cent were determined by obtaining the sum of the estimated specific populations (18,610) and the percentages are based on the use of this figure; that is to say, the estimated total sucker population of 9,699 represented 52.1 per cent of 18,610. The figure obtained by taking 52.1 per cent of 14,002 (estimated total population by formula) was 7,295 or what is believed to be the actual sucker population in the lake. It was assumed that of the estimated populations (by formula) the figure obtained for the total population would be the most reliable, because the different rates at which the various species were taken in the nets would tend to balance each other in this figure. No estimates are given for the yellow perch, through they are known to be present in considerable numbers. The reason they are not included in the estimates is that only one was taken during the summer's netting, probably due to the size of the perch. It is likely that most of the perch are small in size (under 9 inches), for if many perch over that size are present they would have been captured. Estimated, relative, and actual populations are presented in Table I.

It can be readily seen that the sum of the specific estimated populations (by formula) is larger than the total estimated population. This is to be expected because of the different rates at which the different species are taken in the nets. The two figures would not agree unless all species netted at the same rate and were evenly distributed throughout the lake. All marked fish would also have to be evenly distributed, and nets would have to be evenly spaced. These are a few of the factors which tend to affect results, and it must be borne in mind that the method can hardly be regarded as anything more than a fairly reliable estimate. However, the figures presented probably give a very good approximation as to the composition of the lake's population.

All figures after Table I will be based on the actual populations. The data presented in Table II show the rates at which various species were taken in the nets during the summer of 1940. A total catch for the summer of 2,665 suckers represented 36.5% of the population of 7,295 suckers believed to be in the lake. Thus, according to the table (Table II) the smallmouth was caught most readily. That is, 1,566 smallmouth were caught during the summer, while the population was determined as 1,008; hence, the 155 per cent, i.e., a number were caught more than once. The rock bass was caught the least readily, with only 33 per cent of the population being caught.

The positions of the stations used are shown in the sketch map (Figure 1). The netting, marking and releasing operations are shown in the photographs (Figs. 2 to 10 inclusive). It will be seen from the map that two nets were set at each station, but only one at a time, however; in other words, no more than five nets were operated at any one time. All nets were set with the lead starting from rather close to shore, and the pot usually in from 10 to 15 feet of water. An analysis of the catch at each station is presented in Table III. Five nets were fished for a total of 217 net days, with a catch per net day of 38.8 fish. Station 5 was the best and station 4 the poorest, though nets at all stations fished about as uniformly as might be expected. Nets in station 4 fell down noticeably in the sucker and pumpkinseed catch. Table IV presents an analysis of the fluctuations in the catch at the combined stations from week to week throughout the summer. Since the method used for estimating the population depends upon a sampling technique, the reliability of the estimate depends to a considerable extent upon the consistency of the percentage of recoveries. However, in the formula ΣAB is used to allow for the inconsistencies in the percentage of recoveries. In Table V the daily percentage of recovery is given.

A few comments should be made on the data presented in Table V. Marking of fish was stopped on July 23, when it was felt that the percentage of recovery had grown as constant as might be expected. As can be seen from the table (Table V) the percentage of recovery remained fairly constant until August 17, or for a period of 27 days. There were exceptions as shown by the asterisks. During the last two weeks the percentages of recoveries (with two exceptions, August 31 when only four fish were caught, and August 28) were all well below 15 per cent, a drop of well over 5 per cent in percentage of recovery. In the last two weeks there were 369 bluegills caught, as compared with 318 bluegills caught during the other six weeks. Also, during the last two weeks there were 195 rock bass caught as compared with 132 during the other six weeks. The catch of smallmouth (the species that comprised the greatest number of recoveries throughout the summer) fell off greatly during the last two weeks, which affected the total number of fish recoveries. Turning to the population estimates (Table XI in particular) we find that there is a steady rise in the estimate, which is caused by the drop in percentage of recovery. In conclusion, it seems obvious that the drop in the percentage of recovery, and the consequent rise in the estimated population, is directly connected with the relatively large catch of unmarked bluegills and rock bass, and decrease in number of marked smallmouth during the last two weeks, as compared with the catch during the first six weeks of the investigation. When it was noticed that the percentage of returns had begun to fall off on August 14, we resumed marking of suckers, bluegills, and rock bass in the hope that we might be able to build up the number of returns. However, there was not sufficient time for the additional marked fish to make themselves felt in the estimates, so that the percentage of recovery continued to fall off till the end. However, by August 19 the population estimate had

leveled off, and though the estimate increased towards the end, it made no very great change in the figures.

Another factor on which the reliability of the estimate depends to some extent is the distribution of marked fish throughout the lake, and how well they are taken at all stations. If the marked fish were evenly distributed throughout the lake, and if they moved at random all over the lake, they should not be concentrated near the nets where they were first released, and, since there were five nets in the lake at one time, a fish would have a four to one chance of being recaught in a net other than the one where it was marked and released. The figures in Table VI indicate that this was not the case, but that there was a fifty-fifty chance of fish being taken again near where they were released, instead of an eighty to twenty chance. However, since the stations were distributed over most of the lake, we can assume that the concentration of fish at one net tends to offset the concentration at another, and, also, it should be remembered that the nets were moved once during the summer to minimize the effects of this concentration. However, there was sufficient movement to show that the marked fish, though perhaps not evenly distributed throughout the lake (being somewhat concentrated in five different stations, which in turn were fairly evenly distributed) moved considerably, and were generally taken in all nets.

Several calculations were made from the samples of the different species which were weighed and measured. Table VII shows the composition of the samples from which the calculations were made. Pounds per acre, average weight, average length, and number per acre of adult and sub-adult coarse and game fish are given in Table VIII. The table indicates that 79 per cent by weight of the population of adult and sub-adult fish is composed of suckers.

The number of adult and sub-adult fish per acre was determined as 38.6, and the figure does not include bullheads and hybrid sunfish, which would raise it to very close to 38.8 or the same as the catch of fish per net per day (Table III). In other words, each net caught on an average the fish from one acre per day. In East Twin Lake the nets caught on an average the fish from 1.7 acres. More calculations of this sort might be very valuable, as suggested by Dr. David Thompson of Illinois, for if it is found that the nets fish rather uniformly, this calculation (acres of fish per net day) would enable us to make rapid population estimates on lakes where no great amount of time could be spent. Other data will be available for Craig and Bear lakes in Branch and Hillsdale counties.

A series of scale samples was secured from all species. The results from age determinations made for game species are presented in Table IX. The data indicate that all game species in Big Bear Lake, with the possible exception of rock bass, show at least average growth, and that of the bluegill and smallmouth bass is perhaps better than average. The data presented in Table IX were compiled from scale samples now on hand. Although the scale samples are admittedly inadequate in some respects, the results secured from their examination probably give a close approximation of the growth conditions in the lake. Data secured from scale samples were supplemented by a large series of weights and measurements. It should be pointed out that the great majority of the scales were collected in August, so that, although the summer's growth was probably not quite complete, the greatest part of the growth had been completed when the scales were taken. The average length of the growing season (period between killing frosts) is 130 days (Hubbs and Cooper, 1934 (1935)).

It would be of great interest if we were able to determine what part of a specific population is composed of legal fish, and to what year classes those fish belong. Results from age determinations were compared with the measurements of the fish taken in the nets from which no scale samples were taken. For instance, of 31 scales from smallmouth bass which were examined, 27 were found to have come from fish in their third summer. The range in total length was found to be 7.2"-12.6". Two specimens had lengths of 12.6". The third largest was 11" in total length. The size range for two smallmouth in their fourth summer was from 302 to 310 mm. (11.9"-12.2") in total length. In the sample of smallmouth which was measured, all those having total lengths between 7.0"-11.4" were considered as being in their third summer. The two large fish were not counted because they probably represented extremes. Smallmouth over 11.8" in total length were considered as being in their fourth summer. The sample of weighed and measured smallmouth contained 506 fish, of which 480 or 94.9 per cent had total lengths falling between 7" and 11.4". Therefore, we have concluded that 95 per cent of the adult and sub-adult smallmouth in Big Bear Lake were in their third summer of life in 1940. The figure obtained by taking 94.9 per cent of the population of 1,008 is 957.

The same method was followed for the largemouth bass, of which 79 per cent or 1,787 were in their third summer of life, and for bluegills, of which 74 per cent or 1,082 were in their third summer.

No attempt was made to determine the age composition of other specific populations because of overlap in the total length ranges of the various year classes.

Since no smallmouth were planted in the lake in 1938, the greater part of the smallmouth population (probably all those in their third summer) represents

natural reproduction. For the bluegills and largemouth, this cannot be determined so readily for sizeable plantings of fingerlings of both species were made in 1938. One point of interest in connection with the bluegills is that no scale samples were secured from fish in their fourth summer. A few were secured from fish in their fifth summer. The series of measurements made shows that the lengths of the bluegills fall either intc the range for the II class, or for the IV class. This seems to indicate that the large bluegills in the lake (195 mm. or over in total length) represent naturally spawned fish. No plantings of bluegills were made in the lake in 1936. These data are inconclusive, but will be supplemented this summer (1941). It will be of great interest to learn whether or not most of the smallmouth, largemouth and bluegills are in their fourth summer of life in 1941. Every attempt will be made to secure a larger and more complete series of scale samples for all species.

An attempt was also made to determine what proportion of the game fish populations was legal in 1940. It was assumed that the legal fish in the samples would be proportional to the legal fish in the total populations. That is, 86 of 187 bluegills were of legal size or better. Eighty-six represented 46 per cent of the sample. Forty-six per cent of the population of 1,456 bluegills was determined as 670. Number of legal bluegills per acre was determined by dividing 670 by 362, the acreage of the lake. These data are summarized in Table X.

Besides the creel census and population analysis of Big Bear Lake made during the summer of 1940, a representative sample of stomachs was secured from all species. The results of the creel census and stomach analysis will be presented subsequently.

During the summer of 1941 we hope to continue the creel census and repeat the population analysis in order to check results. It is expected that a sizeable planting of adult tagged smallmouth bass will be made in order that their growth, survival and return to anglers may be followed. Additional stomachs will be secured throughout the summer. More will be learned of the natural spawning in the lake, and in 1941 we hope to get to the lake at the time of the ice break-up, so that we will have an opportunity to observe the suckers spawning. By examination of sucker stomachs and by observations during the spawning season of the game fish, we expect to learn more concerning egg predations by the sucker. Eventually (winter of 1942-43) we plan to remove or materially reduce the sucker population, so that we may learn if part of its numbers are replaced by game fish. However, it will first be necessary to have a good understanding of the angling conditions in the lake over at least two years and preferably three, and to learn whether or not the lake's population is remaining at a fairly constant level. It is quite possible that the population may fluctuate greatly. At present there is no check on adult suckers, except from disease and predators. Very few are taken by anglers, although a few are said to be taken illegally at spawning time in the spring. It may be that the sucker population has increased out of proportion to the game fish because their numbers are not reduced by anglers. During the spring and summer of 1941 we hope to be able to answer at least a part of the questions which have arisen in connection with the common sucker in relation to the game fish present in Big Bear Lake.

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Table I

Relative populations in percentage of coarse and game species of legal and sub-legal size captured by 2-1/4 inch trap nets in Big Bear Lake, Otsego County, Michigan.

Species	Estimated population	Percent of total population	Actual population
Sucker	9,699	52.1	7,295
Largemouth bass	2,987	16.1	2,254
Bluegill	1,940	10.4	1,456
Smallmouth bass	1,333	7.2	1,008
Pumpkinseed	1,325	7.1	994
Rock bass	1,307	7.0	980
Miscellaneous (Bullheads, sunfish hybrids)	19	0.1	15
Estimated total		14,002	
Totals	18,610	100.0	14,002

Table II

Rate at which varicus species* were taken in nets at Big Bear Lake, Otsego County, Michigan

Species	Total catch for summer	Percent of population caught
Sucker	2,665	36.5
Largemouth bass	1,627	72.1
Smallmouth bass	1,566	155.0
Pumpkinseed	1,502	151.0
Bluegill	687	47.2
Rock bass	327	33.4

*Bullheads, etc., not included because so very few were caught.

Table III

Analysis of catch of fish at each station, in Big Bear Lake, Otsego County, Michigan. Figures in red denote catch per net per day. Figures in parentheses under station give the number of lifts at that station.

Station number	Sucker	LM	SM	Ps	Bg	RB	BH	Bg x Ps	Others	Total
1	664	225	153	206	124	11	..	4	..	1,387
(47)	(14)	(5)	(3)	(4)	(3)					(30)
2	582	434	346	432	184	115	11	5	2	2,111
(45)	(13)	(10)	(8)	(10)	(4)	(3)				(47)
3	560	249	300	416	53	34	10	...	..	1,622
(44)	(13)	(6)	(7)	(9)	(1)	(1)				(37)
4	288	248	301	98	41	24	3	...	1	1,004
(39)	(7)	(6)	(8)	(2.5)	(1)					(26)
5	571	471	466	350	285	143	4	8	..	2,298
(42)	(14)	(11)	(11)	(8)	(7)	(3)				(55)
	2,665	1,627	1,566	1,502	687	327	28	20		8,422
(217)										(39) (38.8)

List of abbreviations: LM - largemouth bass; SM - smallmouth bass; Ps - pumpkinseed; Bg - bluegill; RB - rock bass; BH - bullheads; Bg x Ps - bluegill-pumpkinseed hybrid.

Table IV

Table showing the fluctuations in the catch of six species in Big Bear Lake, Otsego County, Michigan, during the summer of 1940.

Date	Sucker	%	Re*	LM	%	Re.	Bg	%	Re.	Sm	%	Re.	Ps	%	Re.	RB	%	Re.
July 6-12	264	53.7	3	99	20.1	2	9	1.8	0	34	6.9	0	83	16.9	2	3	0.6	3
" 13-19	608	41.1	36	298	20.1	20	68	4.6	3	317	21.6	30	157	10.8	18	27	1.8	2
" 20-26	237	22.8	30	337	32.5	56	32	3.1	3	246	24.0	76	163	15.7	37	20	1.9	1
July 27-Aug.2	348	34.2	29	145	14.3	31	43	4.2	5	288	28.4	89	158	15.6	42	34	3.3	0
Aug. 3-9	294	33.6	39	109	12.4	17	67	7.6	4	190	21.7	70	193	22.1	43	23	2.6	0
Aug. 10-16	193	19.8	18	224	23.0	36	99	10.1	5	226	23.3	65	208	21.3	47	25	2.5	1
" 17-23	304	20.4	24	279	18.8	39	240	16.1	9	150	10.1	46	368	24.8	52	145	9.8	8
" 24-31	417	40.9	33	136	13.3	16	129	12.7	12	115	11.3	31	172	16.9	25	50	4.9	2

* Per cent of total week's catch.

** Total number of recoveries for the week.

Table V

Daily percentage of recovery of marked fish in netting operations on Big Bear Lake, Otsego County, Michigan

Date	Number of fish caught	Per cent of recovery
July 17	168	11.3
" 18	230	7.8
" 19	205	10.7
" 20	162	15.4
" 21	146	15.7
" 22	141	22.6
" 23	124	22.5
" 24	140	19.2
" 25	163	20.2
" 26	169	23.0
" 27	125	28.8*
" 28	no lift	
" 29	195	20.0
" 30	104	23.1
" 31	172	19.2
Aug. 1	210	12.9*
" 2	218	22.0
" 3	207	23.7
" 4	no lift	
" 5	169	18.3
" 6	121	21.5
" 7	155	20.0
" 8	115	19.1
" 9	111	15.3
" 10	149	19.5
" 11	no lift	
" 12	215	20.9
" 13	117	27.4*
" 14	133	13.5*
" 15	216	14.4*
" 16	152	13.8*
" 17	152	17.1
" 18	no lift	
" 19	364	11.0
" 20	401	9.2
" 21	213	11.7
" 22	250	14.0
" 23	114	12.3
" 24	118	14.4
" 25	no lift	
" 26	333	10.5
" 27	145	13.8
" 28	152	15.1
" 29	121	7.4
" 30	140	10.0
" 31	4	25.0

*Inconsistent per cent of recovery.

Table VI

Movement of fish in Big Bear Lake, Otsego County, Michigan, during the summer of 1940.

	Sucker	LM	SM	Ps	Bg	RB	BH
No. recoveries	212	217	407	265	41	14	16
No. moved*	94	111	206	138	26	6	8
Per cent moved	44.4	51.2	50.6	52.1	63.4	42.9	50.0
No. not moved**	118	106	201	127	15	8	8
Per cent not moved	55.6	48.8	49.4	47.9	36.6	57.1	50.0

For abbreviations, see footnote after Table IV.

* "Moved" indicates fish which were recaught in a net other than the one at which they were first released.

** "Not moved" indicates fish which were recaptured in net where they were first released.

Table VII

Samples of game species weighed and measured during the summer of 1940 at Big Bear Lake, Otsego County, Michigan

Species	Number caught	Number in sample	Per cent of catch weighed and measured
Largemouth bass	1,627	633	39
Smallmouth bass	1,566	506	32
Pumpkinseed	1,502	443	30
Bluegill	687	187	27
Rock bass	327	88	27

Table VIII

Pounds per acre, average weight in ounces, and average length in inches of adult and sub-adult coarse and game fish in Big Bear Lake, Otsego County, Michigan, as determined from samples taken during 1940.

Species	% of catch weighed and measured	Average weight, oz.	Average length, in.	Number per acre	Pounds per acre
Sucker	43	18.5	14.9	20.2	23.4
Largemouth bass	39	7.8	9.4	6.2	3.0
Bluegill	27	4.2	6.7	4.0	1.0
Smallmouth bass	32	6.3	9.0	2.8	1.1
Pumpkinseed	30	3.5	6.2	2.7	0.6
Rock bass	27	2.7	5.9	2.7	0.5
Total				38.6	29.6

Table IX

Age and growth of game species in Big Bear Lake, Otsego County, Michigan. Average standard and total lengths in millimeters. Average total length in inches and tenths. Figures in parentheses denote number of specimens from which averages were derived.

	0		I		II		III		IV		V		VI		VII	
Species	S.	T.	S.	T.	S.	T.	S.	T.	S.	T.	S.	T.	S.	T.	S.	T.
LM	62 - 77		...		181-222		246-301		276-335		281-342		350-425		358-440	
	3.0"		...		8.7"		11.8"		13.2"		13.5"		16.7"		17.3"	
	(1)		...		(28)		(3)		(3)		(3)		(1)		(1)	
SM	...		135-165		200-245		253-306		...		...		...		...	
	...		6.5"		9.6"		12.0"		...		...		...		...	
	...		(2)		(27)		(2)		...		...		...		...	
Ps	...		52- 66		105-134		129-161		146-183		168-213		...		...	
	...		2.6"		5.3"		6.3"		7.2"		8.4"		...		...	
	...		(2)		(4)		(19)		(4)		(1)		...		...	
Bg	...		...		120-153		...		177-222		...		...		...	
	...		...		6.0"		...		8.7"		...		...		...	
	...		...		(15)		...		(3)		...		...		...	
RB	...		...		112-140		123-153		153-190		...		...		...	
	...		...		5.5"		6.0"		7.5"		...		...		...	
	...		...		(5)		(7)		(3)		...		...		...	
Perch	...		...		112-133		150-179		...		...		...		...	
	...		...		5.3"		7.0"		...		...		...		...	
	...		...		(4)		(3)		...		...		...		...	

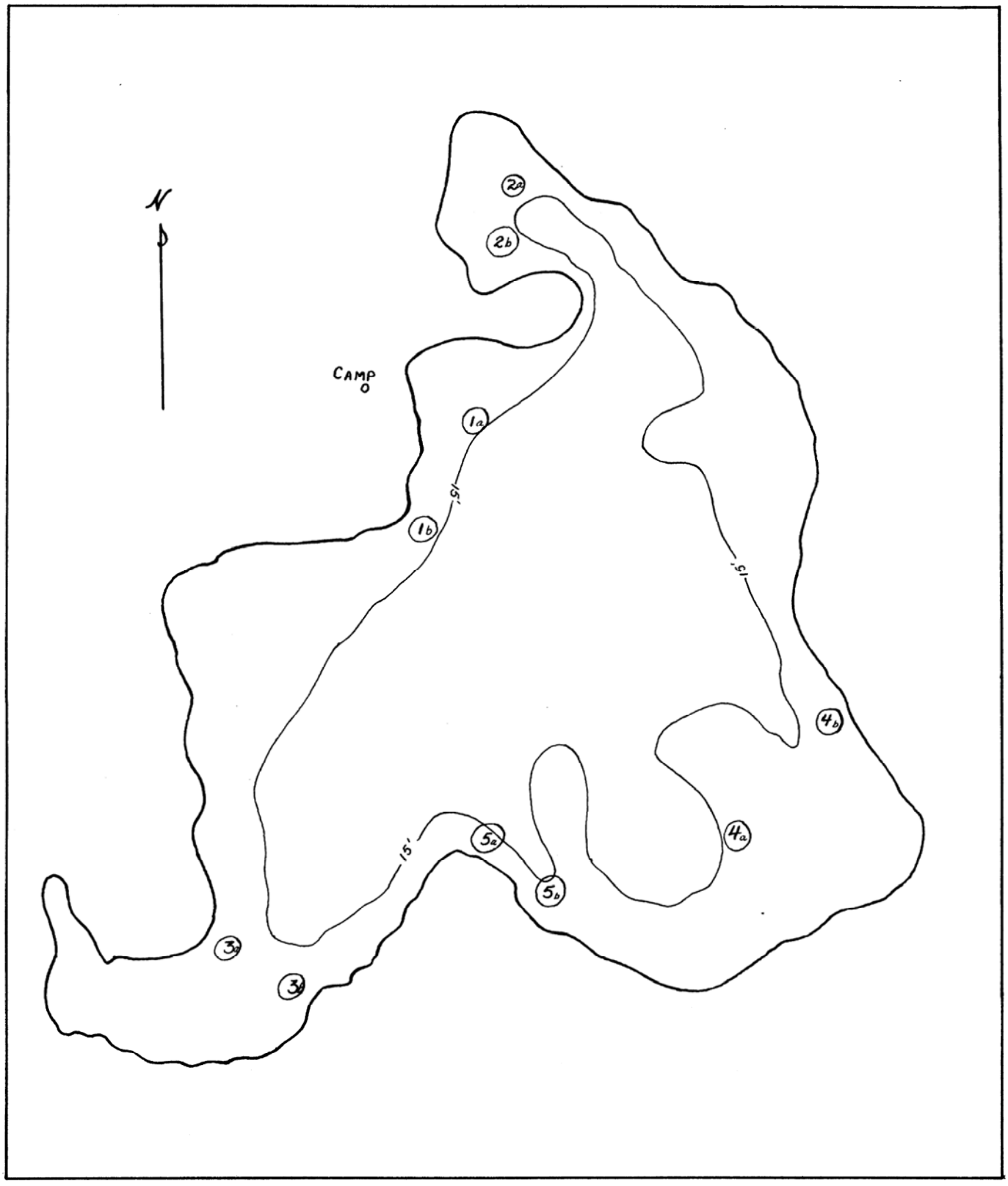
For abbreviations, see footnote after Table IV.

Table X

Estimated populations of legal game species in Big Bear Lake, Otsego County, Michigan, during the summer of 1940.

Species	No. legal fish in sample	% of legal fish in sample	Estimated legal population	
			Total	Per acre
Bluegill	86	46.0	670	1.9
Pumpkinseed	277	62.6	622	1.7
Largemouth bass	155	24.5	551	1.5
Rock bass	28	31.8	312	0.9
Smallmouth bass	63	12.4	125	0.3
Total legal fish			3,034	8.4

Figure 1



Sketch map of Big Bear Lake, Otsego County, Michigan, showing netting stations used during the summer of 1940.

Fig. 2. Setting the lead of a small trap net.

Fig. 3. Setting the pot or crib. Note spreader pole at back of crib.

Fig. 4. Tightening the net.

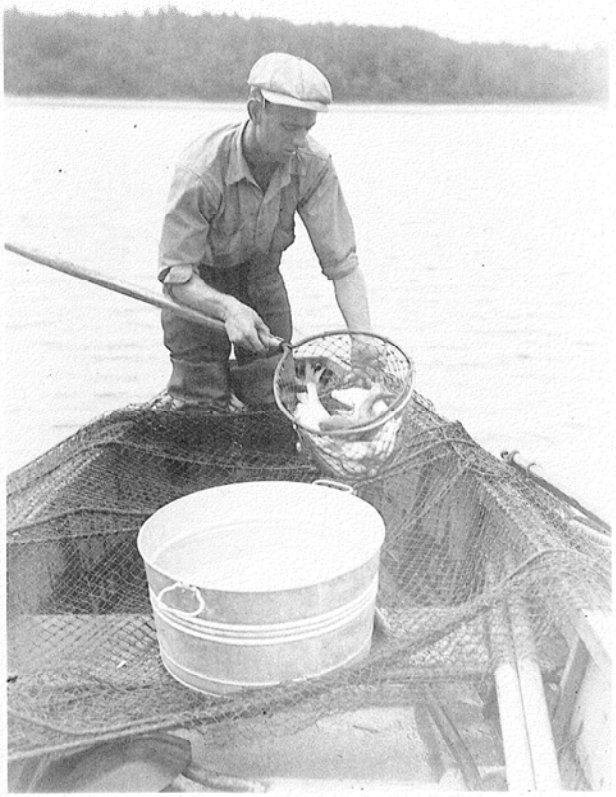


Fig. 5. Emptying fish into tub for marking. Note collapsed crib lying across boat. The remainder of the catch lies in the water at the side of the boat.

Fig. 6. A recovery. Note missing pelvic fin.

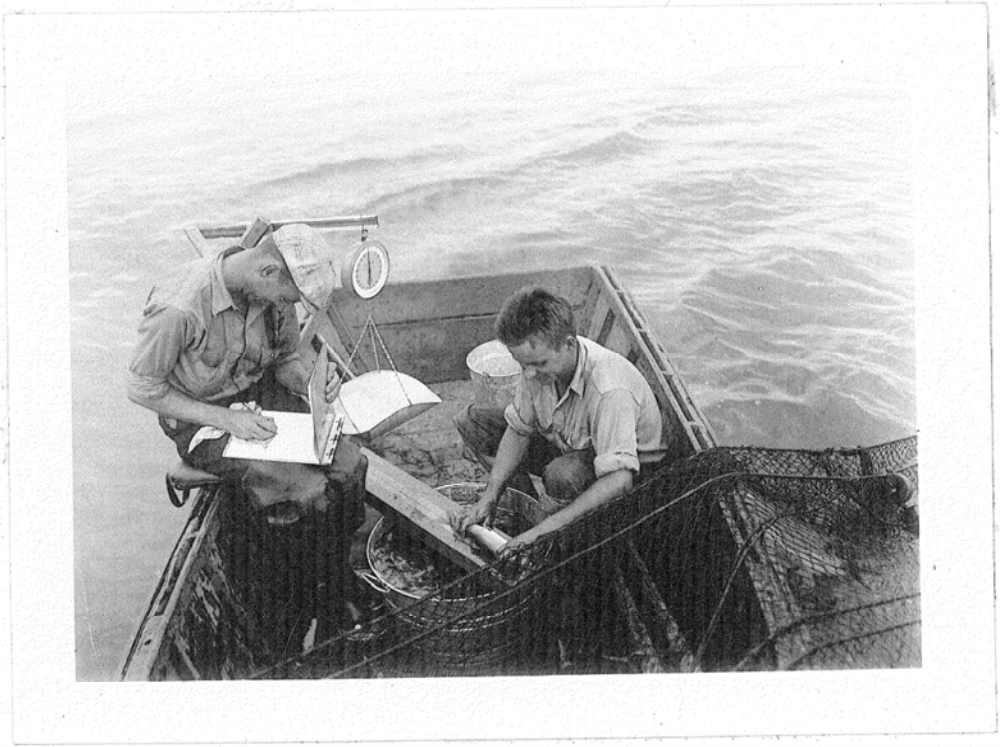


Fig. 7. Measuring a sucker.

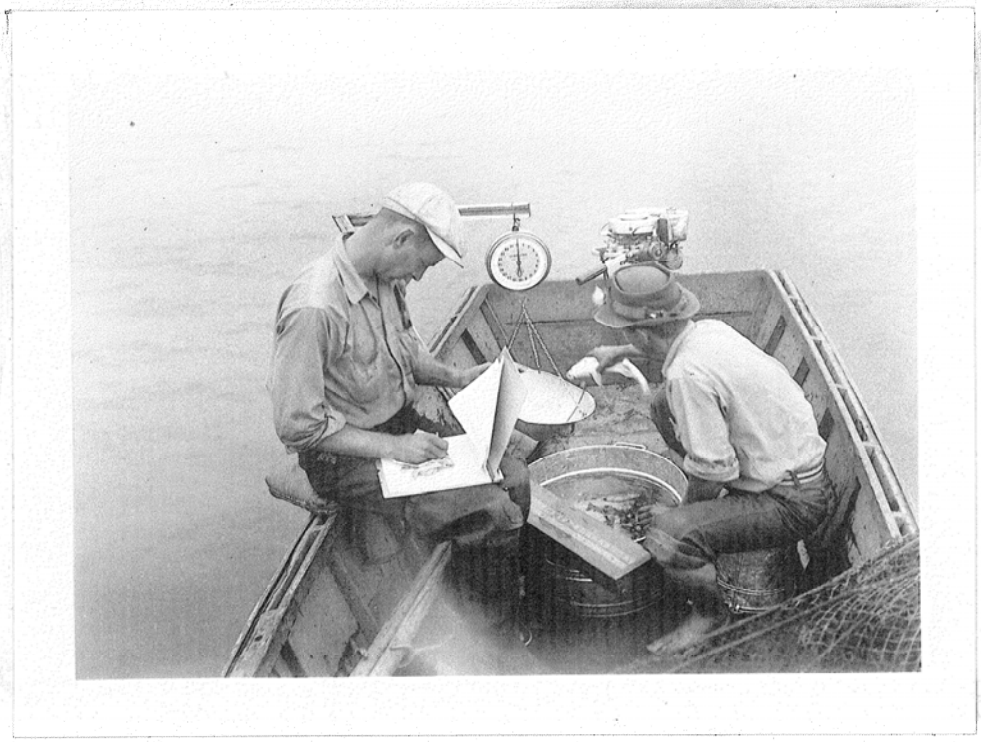


Fig. 8. Weighing a sucker.

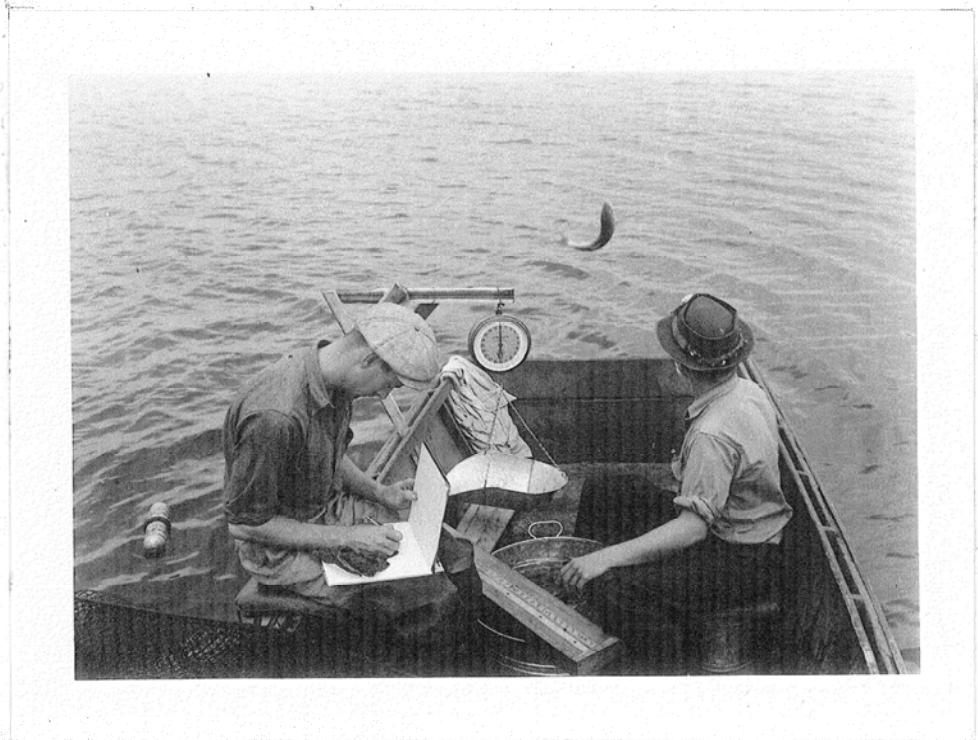


Fig. 9. Releasing a sucker.

Fig. 10. Summarizing data in camp.

NOTE: All pictures used in this report are the property of OUTDOOR LIFE.