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PRELIMINARY REPORT ON THE
LAKE GENEVA SMALLMOUTH BASS STUDIES (1958-1959)

Research Report Number 1
August, 1960

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Donald Mraz

Wisconsin Conservation Department
Fish Management Division
Research Section

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INTRODUCTION

The objective of this smallmouth bass study was to obtain information pertinent to the management of this species with particular emphasis on Lake Geneva. Of primary concern was the possible overharvest of smallmouth bass males during the nesting period and subsequent destruction of the nests by predators. Lake Geneva is particularly unique in respect to water clarity and nests as deep as 20 feet can be located quite easily if physical conditions are good.

Factors studied were the age and growth of the Lake Geneva smallmouth bass, angler harvest, fecundity, spawning behavior and hatching conditions, and success of reproduction.

Physical and Biological Character of Lake Geneva

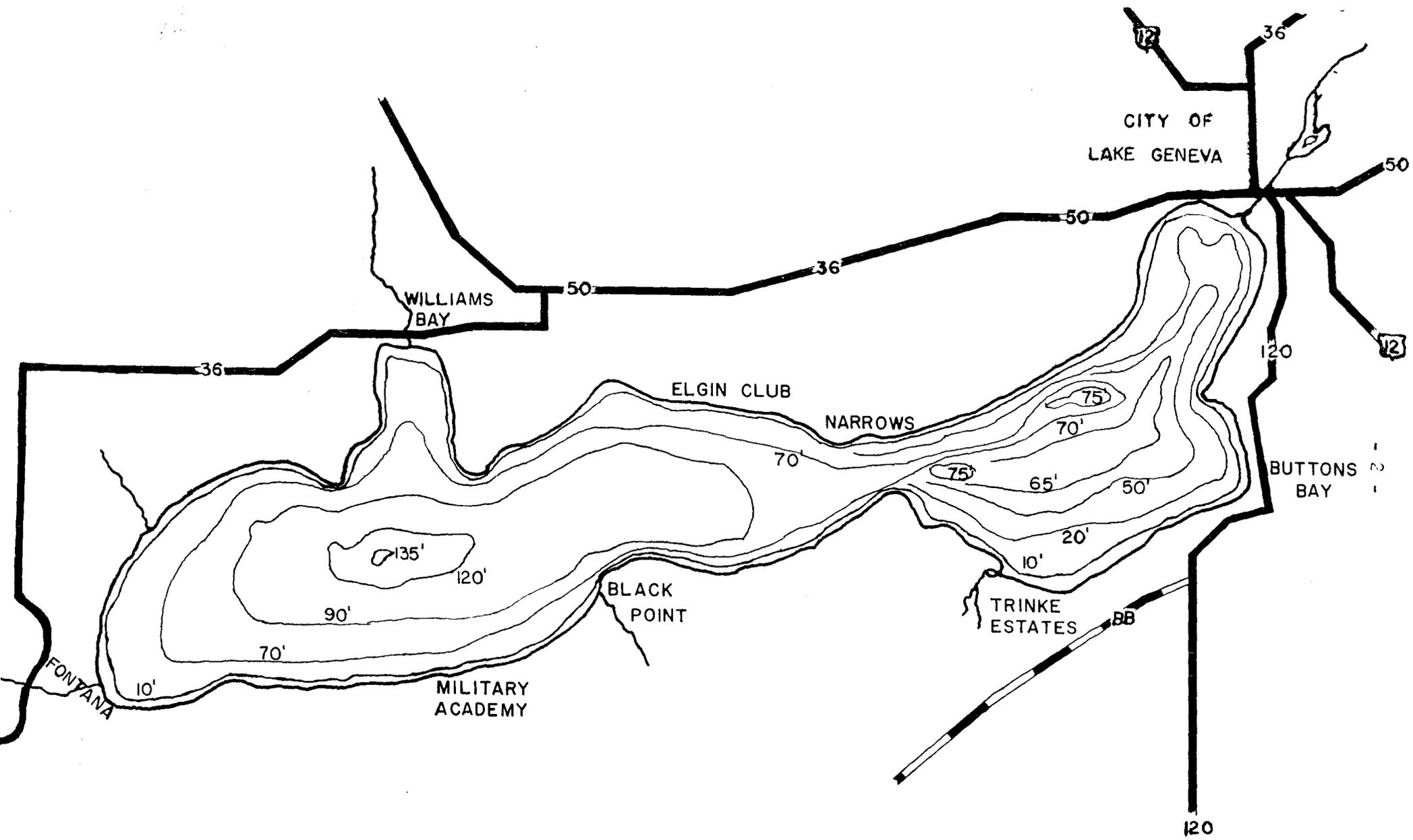
Lake Geneva is located in the southeast corner of Walworth County, Wisconsin, only a few miles from the Wisconsin-Illinois border. It has a surface area of 5,239 acres and is the sixth largest natural lake in Wisconsin. The lake is long and narrow along an east-west axis and has 19.9 miles of shore line.

Lake Geneva has a maximum depth of 135 feet and most of the basin is over 50 feet deep (Fig. 1). It is characterized by extremely sharp drop-offs, with depths varying from 15 to 50 feet only a short distance from shore. The water is green in color and very clear. Secchi disc readings of over 30 feet have been recorded and those of 20 feet are common. The Indian name for the lake is Kishwauketoe, which means clear water.

The lake is spring-fed with only a few very small headwater spring streams flowing into it. The modest outlet which maintains the lake at a near constant level is the beginning of the White River, a branch of the Illinois Fox River.

It is common to find warm surface temperatures of 70 degrees extending down to depths of 35 feet before the lake stratifies to the cooler layer of the thermocline. Oxygen is generally present in midsummer to support fish life to depths of 50 feet or more, although severe cisco kills have been recorded.

With the exception of the area offshore of the Trinke estates and to a certain extent Williams Bay, few extensive beds of aquatic vegetation are found. The hard sand and rocky bottom are not conducive to rooted plant growth. As a result, the fertility of the water is converted initially mainly to the production of algal growth and zooplankton; these in turn are converted to substantial fish populations.



LAKE GENEVA

Figure 1.

The fish populations consist of both warm- and cold-water species. The cold-water species are the cisco, brown trout, rainbow trout and brook trout. There are 21 known warm-water species present, including some but not all minnow species present. Both largemouth and smallmouth bass, walleye, and northern pike are the larger game species present. Most species of the smaller centrarchids are also represented. Rough fish, primarily carp, gar and dogfish, are present but in small numbers.

AGE AND RATE OF GROWTH

Data on the age and rate of growth of Lake Geneva smallmouth were obtained from fish caught by fyke nets, seines and anglers. Because of the small numbers of fish caught, all fish are combined into one sample to arrive at a growth pattern for 1958 and 1959. This presented some distortion of the lengths in Age Group I which is probably the fastest growing of the group. A tabulation of calculated total length in inches at the end of each year of life is shown in Table 1. A straight-line zero intercept was assumed in making these calculations.

This rate of growth compares very favorably with that of other state and out-of-state smallmouth bass populations.

A summary of smallmouth bass measured during creel censuses in 1958 and 1959 is shown in Figure 2. The curved line of best fit drawn by inspection on the 1958 portion of the figure, represents a length-weight relationship for smallmouth bass from Lake Geneva (lengths and weights taken in 1958 and 1959 are combined for this purpose). A Lake Geneva smallmouth bass is about 12.5 inches total length and 3+ years old when attaining a weight of one pound, about 16.0 inches for 2 pounds and 18.5 inches for a weight of 3 pounds. Some female smallmouth will mature at 3 years of age. A 3-year-old female 11.5 inches in length was found to be fully mature as were several others of this age group. The males will also spawn at 3 years of age.

CREEL CENSUS

A creel census was conducted with the cooperation of several boat livery operators. Creel cards were left with them and they were asked to tally fish caught by anglers using their facilities. In addition, project personnel were stationed at Williams Bay and Buttons Bay on weekends and holidays from Memorial Day through Labor Day.

The census renders an index as to what and when catches of various species were made. Because of the large size of the lake, no effort was made to determine what percentage of anglers were contacted or to project the results of the census to an estimate of total harvest. The results of the cooperative census conducted from May 1 (opening day of bass season) through October 23, 1958, and May 1 through September 10, 1959, are shown in Table 2.

During these census periods, anglers caught mostly the 3-, 4-, and 5-year-old smallmouth bass. Twelve per cent of the 458 smallmouth bass caught by anglers in 1958 were less than 10 inches in length (former legal limit), 57 per cent were between 10 and 15 inches, and 31 per cent were larger than 15 inches. In 1959, 12 per cent were less than 10 inches, 51 per cent between 10 and 15 inches, and 37 per cent larger than 15 inches.

The lesser number of angler contacts in 1959 is attributed chiefly to loss of cooperators' interest after the first year. Consequently, the majority of contacts were made by project personnel on weekends and holidays when the bulk of fishing occurred. A few weekends of inclement weather limited angling pressure and hence also reduced the total number of contacts made.

Figure 2. Size- and Age-Group Composition of Angler-Caught Smallmouth Bass from Lake Geneva, 1958 and 1959, and Length-Weight Relationship from the Combined 1958 and 1959 Catch.

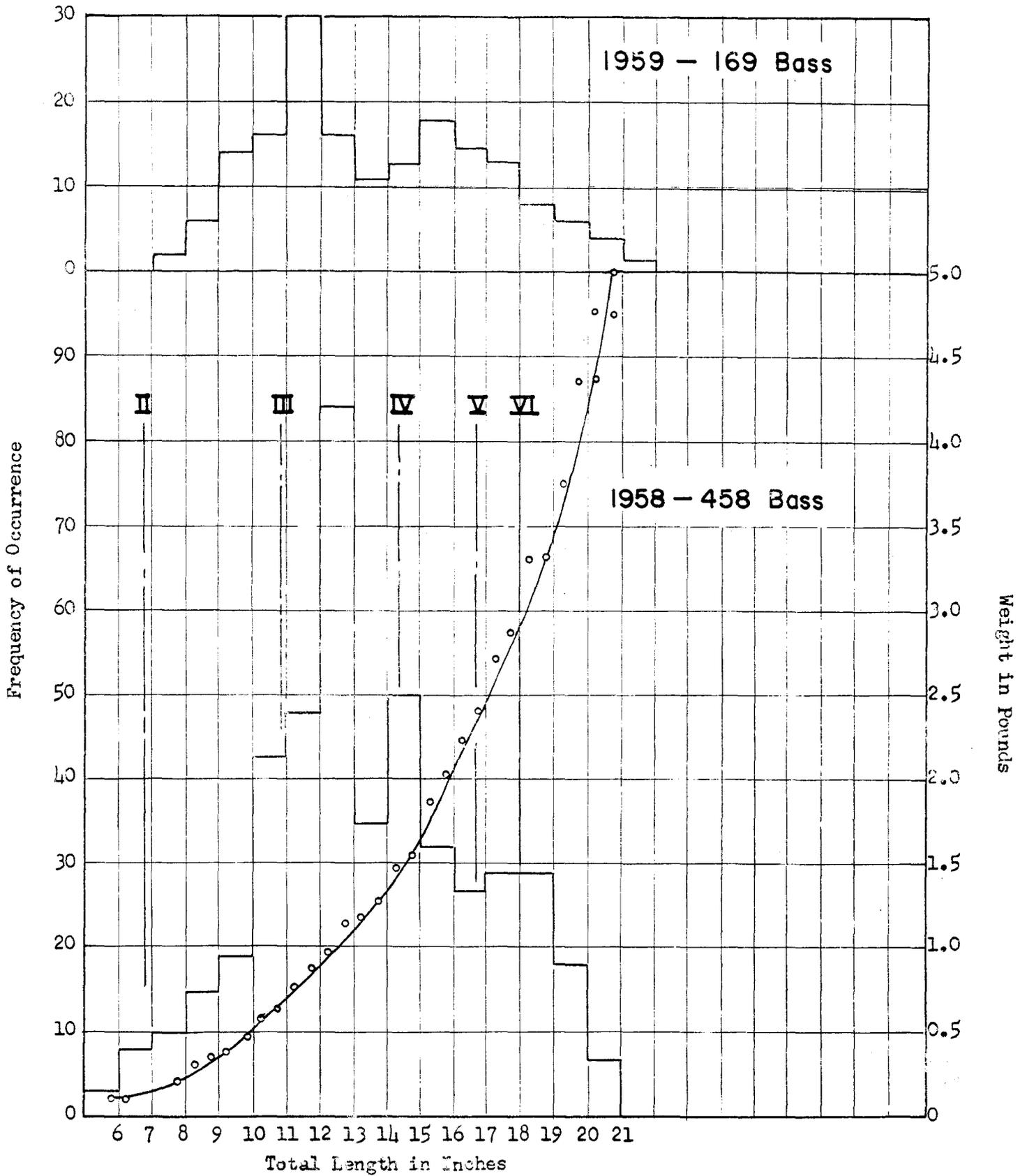


Table 1. Calculated Total Lengths (in inches) at End of Each Year of Life for the Smallmouth bass of Lake Geneva (Straight-line zero intercept assumed).

			1958						
<u>Age Group</u>	<u>Year Class</u>	<u>Number of fish</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
I	1957	25	3.9						
II	1956	39	2.7	7.1					
III	1955	30	2.7	6.2	10.8				
IV	1954	43	2.7	6.9	11.2	14.2			
V	1953	10	2.9	7.2	11.6	14.5	16.6		
VI	1952	5	2.8	5.6	8.9	13.4	16.1	18.1	
VII	1951	3	1.9	5.1	9.1	13.5	15.8	17.2	18.7
Average			2.9	6.7	10.9	14.2	16.3	17.8	18.7
Annual Increment			2.9	3.8	4.2	3.3	2.1	1.5	0.9

			1959						
<u>Age Group</u>	<u>Year Class</u>	<u>Number of fish</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
I	1958	1	2.5						
II	1957	35	2.8	7.1					
III	1956	18	2.6	6.6	11.3				
IV	1955	20	2.9	6.4	10.7	14.0			
V	1954	17	2.8	6.9	10.9	13.9	16.0		
VI	1953	3	3.4	8.2	10.8	15.0	17.2	18.0	
VII	1952	2	2.7	6.2	9.7	13.2	15.6	17.5	18.8
Average			2.8	6.8	10.9	14.0	16.1	17.8	18.8
Annual Increment			2.8	4.0	4.1	3.1	2.1	1.7	1.0

Table 2. Results of Cooperative Creel Census on Lake Geneva in 1958 (May to October) and 1959 (May to September).

	<u>1958</u>	<u>1959</u>	<u>Fishing Index</u> ¹
Species Caught	Number Caught		
Smallmouth bass	494	195	0.39
Largemouth bass	718	593	0.83
Northern pike	279	131	0.47
Bluegill	20,307	10,985	0.54
Perch	6,083	7,811	1.28
Rock bass	6,052	3,361	0.55
Bullhead	3,993	1,470	0.37
Crappie	225	449	2.00
Sunfish	516	430	0.81
Whitebass	324	46	0.14
Walleye	18	11	0.61
Cisco	7	0	--
Brown trout	12	1	--
Rainbow trout	4	1	--
Total	39,032	25,484	0.65
Fishermen Checked	6,685	4,560	0.68
Total Hours Fished	38,385	23,781	0.62

¹ See text for explanation of the derivation of this figure.

Sight observations also indicated that fishing pressure was down somewhat in 1959. In 1958, almost all boats at liveries were rented by 9:00 a. m. on a Saturday morning. In 1959, seldom were all boat liveries at Williams Bay sold out. Two reasons may account for this. One is that nearby Lake Como had been treated with a fish toxicant and the spring and summer of 1959 showed a pronounced response to this treatment. Bluegill, northern pike, and largemouth bass were being caught readily at Lake Como and fishing was considered good. Many of the fishermen on Lake Geneva in 1958 were summer residents at Lake Como which offered no fishing that year.

The other factor was the extremes in fishing success in the two halves of Lake Geneva. In 1958, bluegills could be caught nearly at random throughout the lake. In 1959, the area from the narrows (see Fig. 1) east to the city of Lake Geneva produced excellent bluegill fishing while angling in the area west of the narrows, including Williams Bay and Fontana, was quite poor. Fishermen using the livery at Buttons Bay returned to fish while the Williams Bay fishermen tended to fish elsewhere later.

In 1958, the census was also conducted into October, but entirely through cooperative contacts. In 1959, the census was ended on September 10 due to apparent waning of cooperators' interest. This reduced the total number of fishermen contacted somewhat and, of course, the number of fish reported creeled. Information gathered during the previous fall also showed minimal numbers of smallmouth caught during this period.

Anglers commonly discuss whether fishing was or wasn't better in a given year than in another. This question is roughly answered by the fishing index figure in Table 2. Total numbers of fish caught cannot be compared directly but, by using the 1958 data as a base and assessing it an index of 1.0, a comparison of angling quality can be made. Using total hours fished, we find an index of 0.62 for 1959. In other words, angling hours were down 0.38 of the total 1958 angling hours. If fishing quality were equal in both years, the total catch should be down a similar amount. Therefore, the 1959 catch plus or minus 0.62 of the 1958 catch gives us some indication of better or poorer fishing for individual species and also for total fish creeled in each year. We see that for our total of all species the index is 0.65, or slightly better than 0.62. Species showing a comparative decline are smallmouth bass at 0.39, northern pike 0.47 (understandable with a 22-inch size limit in 1959 and also no fall contacts, a period when northern fishing is generally good), bluegill 0.54, bullhead 0.37, white bass 0.14, and rock bass 0.55. Species showing an increase were largemouth bass at 0.83, crappie 2.00, perch 1.28, and sunfish 0.81.

It is felt that this index is fairly reliable in presenting the over-all fishing success for the various species taken by anglers. The one exception would be rock bass. The number of contacts by cooperators in May of 1958 was much higher than in May of 1959. This species showed a very high harvest rate in May of 1958, and it is felt that if more contacts had been made in 1959 the index would have been higher for this species.

Table 3 represents another treatment of data collected from the census. It compares smallmouth bass harvest by a two-week period as related to fishing effort. About 35 per cent of the smallmouth were taken from May 1 to June 25, while 36 per cent of the censused fishing pressure took place during this period in 1958. In 1959, about 44 per cent of the smallmouth harvest took place from May 1 to June 25, while 35 per cent of the censused fishing pressure took place during this period. As a period, May 1 to June 25 does not appear to be one of extremely more substantial smallmouth bass harvest than one would expect if the spawning period is one of extreme susceptibility. An examination of the finer breakdown by two-week period does show that the period May 29-June 11 yields a considerable number of fish (14.4 per cent of the total caught in 1958 and 25.6 per cent of the total caught in 1959). This period generally finds the start and sometimes the completion of spawning. The smallmouth bass are apparently quite inactive prior to this period as evidenced by low catches and the increase in harvest could as well be attributed to increased feeding activity as well as to spawning activity.

Table 3. Smallmouth Bass Harvest by Two-Week Period as Related to Fishing Pressure, Lake Geneva, 1958 and 1959.

Date	Smallmouth Caught		Per cent of Total During 2-Week Period		Hours Fished		Per cent of Total During 2-Week Period	
	1958	1959	1958	1959	1958	1959	1958	1959
May 1-7	9	2			744.5	452.0		
8-14	8	1	3.4	1.5	1000.5	108.0	4.5	2.4
15-21	3	0			1268.0	65.0		
22-28	15	5	3.6	2.6	1887.5	226.5	8.2	1.2
29-June 4	31	23			1844.5	2038.5		
June 5-11	40	27	14.4	25.6	1958.0	2396.0	9.9	18.6
12-18	36	4			2428.0	1325.5		
19-25	32	24	13.8	14.3	2707.5	1729.5	13.4	12.8
26-July 2	22	20			1590.0	1525.0		
July 3-9	41	12	12.8	16.4	1714.5	1418.0	8.6	12.4
10-16	30	19			1788.5	1277.5		
17-23	25	14	11.1	16.9	2407.5	718.5	10.9	8.4
24-30	48	10			2203.0	1820.5		
31-Aug. 6	33	8	16.5	9.2	2525.0	1619.0	12.3	14.5
Aug. 7-13	27	3			2183.0	1248.5		
14-20	23	1	10.1	2.0	2106.5	914.5	11.3	9.1
21-27	16	12			2487.5	1818.0		
28-Sept. 3	12	2	5.7	7.2	1183.5	1463.5	9.6	13.8
Sept. 4-10	9	8			984.0	1617.0		
11-17	10	*	3.8	4.1	1645.5	*	6.8	6.8
18-24	9	*			649.5	*		
25-Oct. 1	2	*	2.2	*	519.0	*	3.0	*
Oct. 2-22	13	*	2.6	*	559.5	*	1.5	*
<u>Total</u>	494	195	100.0	100.0	38385.0	23781.0	100.0	100.0

* No census data for these periods.

An accumulation of past netting and creel census records from Lake Geneva is shown in Table 4. Variance in type of gear and in effort does not permit accurate comparison, but the records are considered to be indicative of the relative abundance of various species. The 1941 creel census, concerns 277 fishermen contacted from August 24 to September 3 and who fished 1,281 hours (Thomsen, 1941). The average catch over this period was 0.68 fish per hour. In 1958 and 1959, the average catch was 1.02 and 1.07 fish per hour, respectively.

SPAWNING OBSERVATIONS

The spawning period in 1959, was in direct contrast to that of 1958. In 1959, the weather was warm and water temperatures rose slowly but steadily, while in 1958, the temperatures were lower with periods of a few days of warm weather followed by extremely cold weather. Also, in 1959, there was a series of sunny days with little wind and rain, whereas 1958 was cloudy, rainy, and windy. The year 1959 could be considered ideal while 1958 was extremely poor.

Table 4. Summary of Past Gill Netting Records and Creel Census Data for Lake Geneva.

Species	Per cent of Catch					
	1920	Gill Netting		Creel Census Data		
		1941	1956	1941	1958	1959
Smallmouth Bass	18.0	6.5	0.3	23.5	1.3	0.8
Largemouth Bass	0.3	2.0	-	5.9	1.8	2.3
Northern Pike	3.9	19.2	0.5	7.2	0.7	0.5
Walleye	7.7	-	-	-	p1	p1
Perch	29.8	2.3	94.9	4.7	15.6	30.9
Rock Bass	23.8	6.3	0.7	27.6	15.5	13.2
Bluegill	0.7	-	1.8	26.9	52.0	43.1
Sunfish	1.8	-	-	1.7	1.3	1.7
Cisco	8.5	58.7	0.9	-	p 1	-
Sucker	5.2	-	0.1	-	-	-
Trout	0.3 ²	0.5 ³	0.4 ⁴	-	p 5	p 5
Crappie	-	-	-	2.5	0.8	1.7
Bullhead	-	-	0.4	-	10.2	5.7
White Bass	-	4.5	-	-	0.8	0.1

1 - Present, less than 0.1

2 - Brook trout

3 - Rainbow trout

4 - Brown trout

5 - Brown and rainbow trout

Study Areas

The study areas worked repeatedly during the spawning period in both years were from Black Point west to the access road bounding the Military Academy property and the area from the narrows west to the Elgin Club (see Fig. 1). A few nests east of Black Point were also found and included in the study. cursory examination of a major portion of the remainder of the lake failed to locate any heavy nesting concentrations elsewhere. Due to the large size of the lake, it seemed practical to choose the two areas, one on the north and one on the south shore, to work repeatedly, since on many occasions good viewing conditions were limited to only a few hours. Also, advice from local guides and fishermen pinpointed these two areas as heavy spawning locations in past years.

Procedures

The procedure followed to locate nests was fairly simple. The usual square-end work boat was used with one man operating the outboard motor at slow speed while one man stood up on the front seat. The man in front did the observing and, upon seeing a possible nest, tossed an iron weight with string and cork float attached in the vicinity of the nest. By this procedure several nests could be located and a straight transect still maintained. When the observer was out of floats or a desired distance had been covered, the course was retraced to examine the individual nests closely. This was done by one man maintaining the boat over the nest while the other observed the nest through an aluminum nest viewer. If a fish was observed on the nest, a diver went down with a face mask and sampled eggs or fry to determine egg viability and extent of

development. In this operation a kitchen rubber bulb-type baster with an enlarged open end was used. The diver descended with the rubber bulb squeezed shut, placed the open end in the nest, released the bulb to allow a few eggs to be drawn into the baster, placed his finger over the open end to retain the sample, and surfaced.

Nests were marked for specific identification by placing individually-numbered surplus deer tags on the bottom adjacent to them. To subsequently ascertain the identity of an individual nest, a magnet was lowered, the tag picked up, the number checked, and then the tag was replaced.

When two boats and four men were available, one two-man crew would locate nests and the second would follow to make the detailed observations.

1958 Observations

Smallmouth bass spawning observations started June 2, 1958, and continued through June 26. June of 1958 would have to be considered a poor one for "nest hunting". Because of frequent rains and strong winds, water clarity was poor and visibility, even when it was calm, was far from ideal.

Approximately 75 possible nests were marked and rechecked during the month. During this period of observation, no nest was found containing eggs. Several bass were seen in the vicinity of nests, but only two were caught off recently built nests and tagged. Many bass checked during the creel census had not spawned and were reabsorbing eggs in late June and early July.

A maximum-minimum thermometer station was established in late May in both years. Readings were taken each time personnel were working at the lake. Water temperatures ranged from a minimum of 59° to a maximum of 61° on June 2, 1958. It was not until June 23 that both maximum and minimum remained above 65°. This prolonged spell of low temperatures is believed to have been the cause of poor nesting success. Male bass were forming nests as early as June 2 and apparently ready to receive females. They soon deserted the nests, however, and the building of new nests was sporadic. A second period, about the middle of June, resulted in renewed building and repolishing of old nests, but again females did not appear. The early indication of a poor hatch was verified when no young could be found by seining in August and also when no yearlings were found in 1959.

1959 Observations

Smallmouth bass spawning observations in 1959 began on June 1. Water temperature on this date was 65° at the surface and 59° at a depth of 25 feet. As this day was heavily overcast and windy, nests were not located until June 2. June 4, found fry in some of the nests already marked. Some were recently hatched and others in the process of hatching.

By June 8, fry were rising from the nests, some with the yolk sac gone. By June 12, young fish could still be seen in the vicinity of nests but schools were dispersed and scattering well. The development of these smallmouth bass agrees with findings from other investigations of the species; i.e., it takes about 12 days from spawning to dispersal from the nest.

In one area eight male bass were caught, tagged, and released to return to their nests. Three of these were subsequently caught by anglers. In these three instances no eggs or fry could be found in the nest the day following removal of the male. In

another area five males were caught, tagged, and they returned to the nest. As these nests were found a considerable distance from shore, relocation was difficult and the positive outcome is not known. However, none of the tags were returned by anglers. Of eight nests in another area, hatches were obtained from the five where males remained throughout egg incubation and fry development. The three from which males were removed were all failures.

Most of the nests located were in 8 to 12 feet of water. An occasional one was found in deeper or shallower water, but the majority were situated approximately on the 10-foot contour.

While several nests were found in open areas, the smallmouth bass seemed to prefer building the nest where some material such as a concrete block, anchor, crib, log, or sunken boat would afford it protection from one side. Water mains were also popular spots.

Little evidence of nest hunting by anglers was observed during June 1-12, but 15 fish are positively known to have been removed from nests by anglers contacted on the lake during this period. One reason for the apparent lack of interest could be that the bass were spawning earlier than usual, but more likely was the fact that bass nests were scarce. Some fishermen contacted said that it "wasn't worth the effort to have to search that hard for the fish".

When smallmouth bass were found in the fry stage on June 6, extra emphasis was placed on checking anglers. Along with project personnel stationed at boat liveries in Williams Bay and at Buttons Bay, one man went with law enforcement personnel during a license check. Two boats were operated on this check and all boats, both livery and private, were contacted. Creel cards were made out for 210 anglers who had caught 10 smallmouth bass plus several hundred other fish. Five of these 10 bass were taken by a pair of anglers who had been nest hunting for about 6 hours. The day itself was almost perfect for nest locating.

Behavior

While it is generally known the male smallmouth bass defends his nest with a very belligerent attitude, it was significant to note the persistence with which he maintained his established position. Through error and poor "fisherman's luck" the same male was hooked five times before he was successfully netted to be tagged. While he became more cautious after each escape from the hook, he still maintained his position.

It is generally believed that the male smallmouth bass does very little feeding while on the nest. If the male picked up the bait, usually a night crawler harress with rubber worm, and was left to swim without any attempt being made to hook him, he would merely carry the bait a short distance and discard it. On several instances, however, when males were hooked, regurgitation of fish remains were observed, indicating that the male does feed at least to some extent. Defensive action by males never showed an attempt to catch any invading fish but rather only to scare them away by a short charge.

Another point of great interest was the apparent ability of the male to distinguish between the degree of danger of various invaders. On several occasions the bait was near the nest and the male was ready to remove it when a rock bass would appear. The male would lose interest in the bait and turn his attention to the fish and watch it very closely until it left. He would then return and concentrate his efforts on removing the bait.

Fecundity

Ovaries were removed from three females and egg counts made by a volumetric method. The results are as follows:

<u>Length</u>	<u>Weight</u>	<u>Age</u>	<u>Egg Count</u>
13.2 inches	--	IV	4,896
16.0	2.1 pounds	V	5,402
16.3	2.2	IV	5,364

SUCCESS OF REPRODUCTION

Shore line seining with a small-mesh minnow seine was conducted in 1958 to sample young fish present. Thirty-five locations were seined for a total of 1,940 yards (1.1 miles) of shore line. Locations were selected at random and consisted of various habitat and bottom types. A 230-volt A.C. shocker was used in 1959 in lieu of the seine. The same areas that were seined in 1958 were shocked the following year. The results of these sampling efforts are presented in Table 5.

It is interesting to note the relative consistency with which both methods caught fish. There was little change in numbers of the minor species such as suckers, garfish, darter, killifish, etc. Minnows made a tremendous gain in 1959. While only a difference of 300 fish shows in the tally column, on two occasions the generator was turned off to prevent needless shocking of schools of thousands of minnows. The presence of many large schools of minnows about the lake during the summer was also noted. The numbers of bluegills and perch in 1959 probably should be slightly higher than the tabulation indicates. As these species are generally abundant in weed beds, it was extremely difficult to gather fish from the electrical field fast enough to collect them all when large quantities were present.

The difference in collection of no young-of-the-year smallmouth bass in 1958 and 64 in 1959 is significant. The fact that no yearlings were present in 1959 is also important because it verifies the 1958 conclusion that the hatch for that year was a near or complete failure. No nests with eggs were found and no young-of-the-year were located in 1958 and no yearlings were found in 1959. A few yearlings (1957 hatch) were found in 1958 showing that this size fish are sampled with a shore line seine. The capture of 64 young-of-the-year smallmouth bass at established sampling locations indicates that a hatch was brought off in 1959.

Water temperatures in 1959 were ideal during the nesting period with a slow but steady rise in temperatures. The protected nests observed in Lake Geneva that year produced good hatches and other unlocated nests should have done the same. Whether there were enough to create a favorable year class will not be known for several years. Electro-fishing efforts in August indicate that the hatch could not be considered a large one.

Our only past comparison of reproduction is from Pearse (1921) of the University of Wisconsin who made nine seine hauls covering 1,940 meters of shore line and caught 3,155 perch (most of which were in one school near Fontana), 230 largemouth bass, 223 smallmouth bass, 59 bluegills, 30 minnows, 17 rock bass, 15 pumpkinseeds, and 8 suckers.

Table 5. Results of Shore Line Seining in 1958 and Shocker Survey in 1959 to Sample Reproduction in Lake Geneva.

Species	1958		1959	
	Number	Size Range or Average Length (inches)	Number	Size Range or Average Length (inches)
Perch	153	2.0	89	2.5
	647	3.8-4.8	159	4.0-5.0
	4	over 6	34	over 6
Bluegill	10	2.0	39	1.5-3.0
	493	2.8-3.5	118	3.5-4.5
	6	over 5.0	14	over 5.0
Sunfish	156	3.0	51	3.0-4.0
			11	4.5-5.0
Bullhead	4,802 ¹		9,100 ²	3.5
Crappie	59	1.5-2.1	11	2.0
Golden Shiner	8	--	0	--
Rock Bass	4	2.1-5.5	9	3.0
Green Sunfish	1	--	6	2.0-3.0
Longear Sunfish	6	3.0-4.5	0	--
Sucker	1	3.5	11	4.0-6.0
Carp Sucker	1	6.5	0	--
Minnows ³	1,036	--	1,310 ⁴	--
Longnose Gar	8	6.0-8.0 ⁵	3	12.0
Killifish	75	--	10	--
Darter	1	--	1	--
White Bass	0	--	3	3.5
Largemouth Bass	13	1.6-2.6	21	2.3-4.0
	5	6.5-7.3	1	6.5
Smallmouth Bass	0	--	3	10.0-15.0
	5	5.8-7.1	64	2.5-4.0
			0	--
Total	7,419		11,068	
				plus several thousand minnows

¹ Four schools, numbers estimated

² Ten schools, numbers estimated

³ *Notropis* spp.

⁴ Plus several thousand in 2 schools encountered in shocking area

⁵ One 35 inches also caught

TAGGING

Three separate efforts were made in 1958 to obtain smallmouth bass for tagging studies. Three seine hauls in May and fyke net sets in June and August yielded only 45 fish of tagging size. No nets were set in 1959 because of the apparent few numbers of fish present. In 1958, 13 tags were voluntarily returned by anglers from the 45 released, a return of 28.9 per cent. Four were returned in 1959 for a total of 17 of the 45 or 37.8 per cent. If two "reliable rumor" tags are included, the return over the 2-year period would be 42.2 per cent.

It was hoped this portion of the project would yield considerable information on smallmouth bass exploitation but with the few tags involved it is difficult to draw a firm conclusion. The return of 28.9 per cent the first year is about what was anticipated for this species under liberal regulations, based upon studies conducted in other states.

With the few returns it was impossible to develop any movement pattern for the smallmouth. In general, the fish were taken in approximately the same area in which they were released. One tagged fish had moved from the Military Academy area to the Riveria Pier area in the city of Lake Geneva, a distance of over 5 miles, during the period June 12 to October 12, 1958.

RESIDENCE OF ANGLERS

During 1958, census clerks were asked to tally the home residence of anglers contacted. Since most of the contacts were made at boat liveries, the persons questioned were generally transients, except the several local residents who keep boats moored in the Williams Bay and Fontana areas.

The results of this questionnaire are presented in Table 6. There were 6,685 contacts made and information concerning home residence was obtained for 6,468. Nearly 72 per cent of the anglers contacted for this information resided in Illinois.

Table 6. Home Residence of Anglers Contacted by Creel Census Clerks at Lake Geneva in 1958.

<u>Illinois</u>		<u>Wisconsin</u>		<u>Other States</u>		<u>No Record</u>
Chicago	1,756	Kenosha	470	Indiana	16	217
Rockford	619	Delavan	272	Ohio	6	
Harvard	170	Racine	211	Colorado	2	
Elgin	168	Milwaukee	136	Montana	2	
110 other Cities	1,229	32 other Cities	626	Texas	2	
City Unlisted	697	City Unlisted	86			
Total	4,639		1,801		28	217
Per cent of total knowns	71.7		27.9		0.4	---

BOAT COUNTS

To further explore the fishing potential by boat owners on the lake itself, a count was made of boats housed on the lake on July 24, 1958 (Table 7). The strictly arbitrary category of Row and small outboards includes all rowboats, canoes, and boats with outboard motors of less than 25 h.p. The category of Outboard 25+ includes boats with large motors, and while each motor was not examined closely, all large-sized motors were included here. Inboards includes all speedster-type cruisers as well as cabin boats with no outboards attached. Sailboat is the other category. While counts in some categories may be somewhat inaccurate, particularly in Sailboats where there may be a constant plus and minus depending on where races are held, the total count of 2,255 boats or about 1 for every 2 acres of water surface illustrates the use the lake does receive both from a potential angler viewpoint and general water usage.

Table 7. Type and Number of Boats Present on Lake Geneva, July 24, 1958.

<u>Type of Boat</u>	<u>Number</u>
Row and small outboards	1,054
Outboard 25+ h.p.	385
Inboards	586
Sailboats	<u>230</u>
Total	2,255

MISCELLANEOUS DATA

During 1958 and 1959, the bluegill was the main fish creeled at Lake Geneva. In 1958, phenomenal bluegill fishing was experienced and in 1959, it was still an excellent fishery. Perch were coming into the catches in 1959 in considerable numbers and the next few years should produce some good perch fishing.

Samples of both species were taken for aging and these data are presented in Table 8. The growth rate of both is excellent.

Table 8. Ages of Bluegills and Perch from Lake Geneva, 1959.

<u>Species</u>	<u>Sample Date</u>	<u>Age</u>	<u>Number</u>	<u>Average Length in Inches</u>	<u>Size Range in Inches</u>
Bluegill	Aug. 1, 1959	II	6	6.7	6.0-7.3
		III	104	7.8	6.7-8.8
		IV	9	8.0	7.7-8.5
Perch	Sept. 5, 1959	II	31	7.5	6.8-8.3
		III	5	8.7	8.5-8.8

Lake Geneva has experienced several severe cisco kills in the past. In all incidents it was a problem of oxygen depletion in the lower layer and unfavorably water temperatures in the thermocline. Water chemistry data are virtually limited to periods immediately after kills were noted. Several vertical series of temperature-oxygen determinations were taken during 1958 and 1959 and some of the data are presented in Table 9 and Figure 3 to illustrate development of the thermocline. The cisco were in no danger in either year.

A compilation of fish stocked in Lake Geneva from 1933 through 1959 is presented in Table 10. Concentration has been on walleyes and trout, neither of which is creeled in any numbers.

DISCUSSION

Lake Geneva, in common with other waters, has been subject to extreme variations in abundance of the various fish species. Past records, although scattered, substantiate this point very well. Perch apparently have been up and down several times over the past 40 years. The bluegill has apparently seldom been as abundant as it was in 1958 and 1959. The white bass has reportedly been present in large numbers at times and readily caught. Since the cisco fishery is extremely specialized it is difficult to draw a conclusion other than that the species is more or less controlled by summer kills. The latest in 1955 resulted in thousands of dead fish washing ashore.

Table 9. Series of Temperature-Oxygen Determinations Taken During the Summer of 1958 at Lake Geneva.

Depth Feet	June 2, 1958		June 17, 1958		July 3, 1958	
	Temperature (degrees F.)	Oxygen (p.p.m.)	Temperature (degrees F.)	Oxygen (p.p.m.)	Temperature (degrees F.)	Oxygen (p.p.m.)
S	60.0	10.0	65.0	6.2	69.0	9.0
5	60.0		64.0		69.0	
10	60.0		64.0		68.0	
15	59.0		63.5		68.0	
20	59.0		63.0		67.5	
25	56.0		62.0		66.0	
30	55.5		62.0		65.0	
35	55.5		59.0		64.0	
40	53.0		57.0		61.0	
45	53.0		54.0		56.0	
50	52.0	9.8	52.0	9.3	54.5	9.8
55	49.0		50.5		51.0	
60			49.0		50.0	
65			48.0		49.0	
70			47.5		48.5	
75			47.0		48.0	
80			47.0		48.0	
85			47.0		47.5	
90			46.0		47.0	
95			46.0		46.5	6.0
100			46.0		46.5	
	July 22, 1958		August 15, 1958		September 18, 1958	
S	73.0	9.4	76.0	9.6	69.0	9.0
5	72.0		75.0		68.0	
10	72.0		75.0		68.0	
15	72.0		75.0		68.0	
20	71.5		75.0		68.0	
25	71.0		74.5		68.0	
30	71.0		72.0		68.0	
35	69.0		66.5		67.5	
40	65.0		64.0		67.5	
45	60.5		62.0		67.0	
50	55.0	7.2	58.5	6.4	65.0	5.6
55	52.5		55.0		57.0	
60	51.5		52.5		52.5	
65	50.5		50.0		51.5	
70	49.5		49.0		50.5	
75	49.0	6.0	48.0	4.1	50.0	1.8
80	48.5		48.0		49.0	
85	48.0		48.0		48.5	
90	48.0		47.0		48.0	
95	47.5		47.0		48.0	
100	47.0	3.8	47.0	3.3	48.0	0.9

Figure 3. Temperature-Oxygen Profile, Lake Geneva, August 15, 1958.

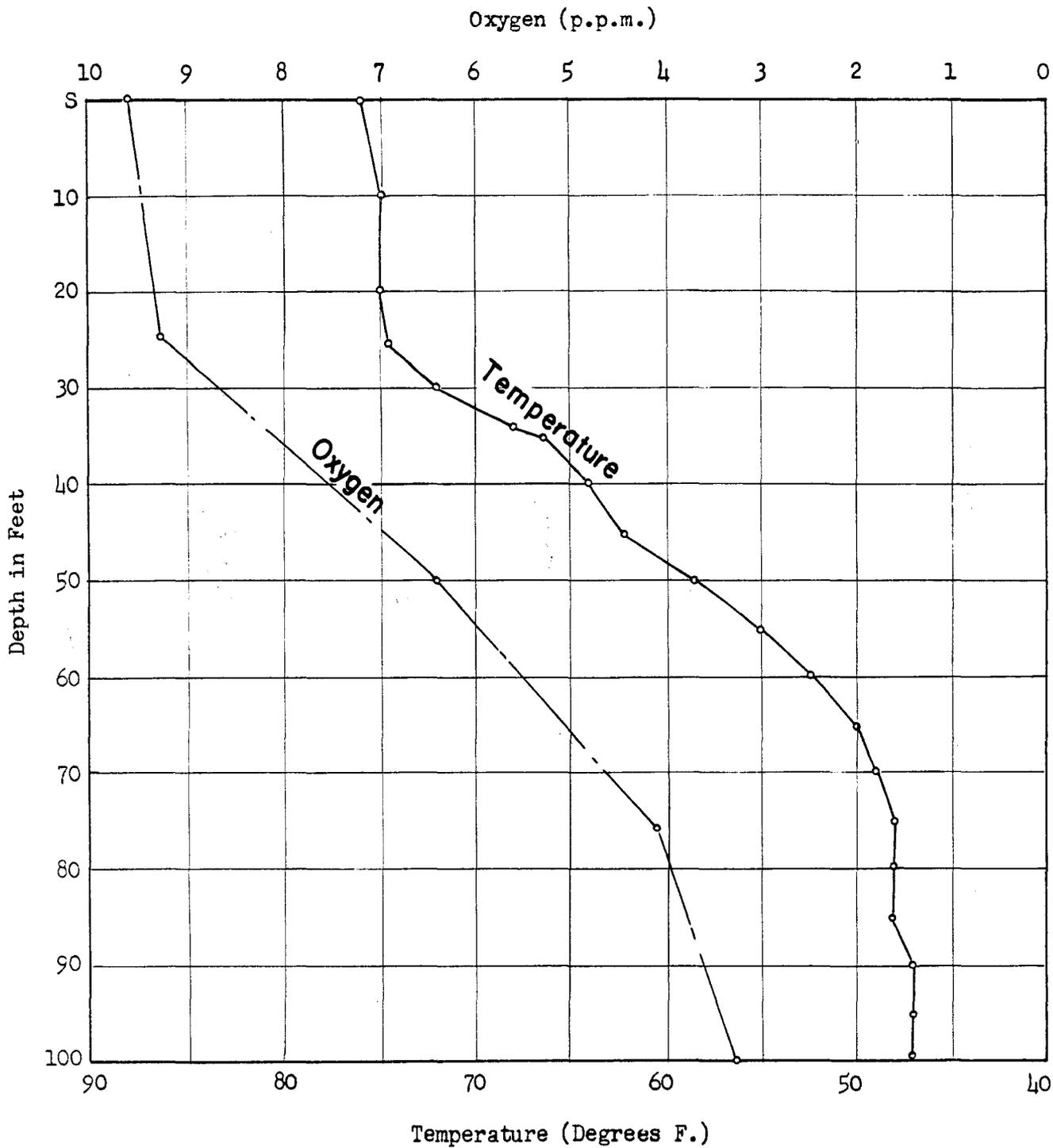


Table 10. Record of Fish Stocked in Lake Geneva During the Period 1933 Through 1959.

<u>Year</u>	<u>Species</u>	<u>Size</u>	<u>Number</u>
1933	Perch		500
	Black Bass		17,068
1934	Perch	fry	666,650
	Brown Trout (inlet)	flg.	4,080
	Walleyes	fry	959,600
	Black Bass	flg.	480
1935	Black Bass	flg.	5,475
	Walleyes	fry	3,885,000
	Northern Pike	flg.	1,500
	Crappies, Bluegills		7,500
	Bass		4,800
	Perch, Bluegills	flg.	3,000
1936	Black Bass		10,000
	Bluegills		1,850
	Perch		352,640
	Walleyes		1,055,000
1937	Walleyes	fry	7,737,450
	Smallmouth Bass	adult	47
	Smallmouth Bass	flg.	37
	Largemouth Bass	flg.	9,000
	Perch	adult	10,000
	Perch	flg.	10,000
	Bluegills	flg.	7,500
	Bullheads	flg.	11,000
	Bluegills	adult	2,000
	1938	Bluegills	flg.
Bullheads		flg.	3,000
Largemouth Bass		yrlg.	122
Largemouth Bass		flg.	18,000
Perch		flg.	8,000
Walleyes		fry	10,278,904
1939		Bluegills	adult
	Bullheads	adult	500
	Bullheads	flg.	12,500
	Largemouth Bass	flg.	29,500
	Perch	adult	1,700
	Perch	flg.	20,000
	Smallmouth Bass	adult	25
	Smallmouth Bass	yrlg.	177
	Sunfish	adult	200
	Sunfish	yrlg.	500
	Walleyes	fry	9,900,000
	1940	Brown Trout	2 yr.
Largemouth Bass		flg.	35,000
Walleyes		fry	9,900,000

Table 10 (Continued)

<u>Year</u>	<u>Species</u>	<u>Size</u>	<u>Number</u>
1941	Bluegills	flg.	15,000
	Largemouth Bass	flg.	35,000
	Smallmouth Bass	flg.	5,000
	Walleyes	fry	3,000,000
1942	Largemouth Bass	flg.	57,000
	Bullheads	flg.	60,000
1943	Largemouth Bass	flg.	31,000
1944	Largemouth Bass	flg.	10,000
1945	Largemouth Bass	flg.	25,000
	Smallmouth Bass	flg.	3,000
1946	Bluegills	flg.	8,000
	Largemouth Bass	flg.	4,000
1947	Largemouth Bass	flg.	2,500
1948	Largemouth Bass	flg.	11,360
1949	Largemouth Bass	flg.	10,000
	Smallmouth Bass	flg.	10,000
	Brown Trout	flg.	25,500
1951	Smallmouth Bass	flg.	13,650
1955	Brook Trout	flg.	19,068
	Brown Trout	flg.	11,000
	Rainbow Trout	flg.	45,893
	Rainbow Trout	legal	48,742
	Rainbow Trout	adult	293
1956	Rainbow Trout	legal	37,192
	Rainbow Trout	adult	437
	Walleyes	flg.	30,000
1957	Brown Trout	legal	4,919
	Rainbow Trout	flg.	10,000
	Rainbow Trout	legal	37,260
	Walleyes	flg.	49,500
1958	Rainbow Trout	legal	394
	Walleyes	flg.	49,500
1959	Walleyes	flg.	61,900

Pearse (1921) comments that in 1921, the dominant species were the perch, smallmouth bass, rock bass, northern pike, sucker and walleye. There were small numbers of bluegill, largemouth and trout. His statement is based on a gill net survey. Nelson and Hasler (1942), comment that in 1941, perch had declined until they were among the least abundant species present and the walleye had almost completely disappeared. Cisco were very abundant, as were rock bass, and bluegills had increased in numbers. The northern pike was the most abundant game fish present. These investigators even suggested that the season, bag, and size limits be removed to control northern pike and rock bass.

During the study period, 1958 and 1959, the bluegill was extremely abundant and the perch entered the fishery in large numbers in 1959. The rock bass was very abundant and the bullhead, a relative newcomer, was becoming very abundant. The largemouth bass was apparently much more abundant than either the smallmouth bass or northern pike. The walleye was present but the number creel was still very small even after stocking approximately 50,000,000 of this species during the past 25 years. The crappie and sunfish populations remain quite low although crappies were on an increase. The white bass population was at a very low ebb. The extent of the trout population is unknown even after efforts of heavy stocking to provide fishing for this species. Rough fish of all species are relatively scarce.

The above is a general summary of the known fish species in Lake Geneva. Since the smallmouth bass is of primary concern here, this species is discussed further.

In 1954, the opening date of smallmouth and largemouth bass angling seasons was set at May 15 instead of the former June 20. The size limit was also removed. This meant anglers could fish for these species during the spawning season starting in 1954. Subsequent changes advanced the season to May 1.

Since smallmouth bass populations are rather limited in the southern part of Wisconsin, Lake Geneva was unique in having past records of a substantial population for many years. An opinion was voiced by many that fishing the smallmouth bass while on the nests would deplete the population, not due to the fish being caught but rather due to subsequent nest destruction by predators and consequent loss of the hatches. As mentioned earlier, Lake Geneva has extremely clear water and under favorable conditions nests can be located in water 20 feet deep. The smallmouth population was very low during the 1958 and 1959 study period. Few young smallmouth bass were caught by anglers in either year (12 per cent of total smallmouth bass creel) when it is generally expected that removal of the size limit will increase harvest greatly.

Observations indicated that few fish spawned in either year. The success of the hatch in 1958 is considered negligible. This, it is believed, was due primarily to unfavorable weather conditions and would have been the case regardless of the extent of the adult population present. In 1959, few fish were observed spawning and while the hatch was significantly greater than in 1958 and spawning conditions were ideal, it is not believed to have been of great magnitude. It is conceivable that if more adults had been present a tremendous hatch may have resulted.

During 1959, although few nests were observed, those which were unmolested did bring off good hatches. However, when males were removed, the eggs or fry were destroyed.

From the data on hand there is no reason to expect there will be a substantial number of spawning fish in 1960 or 1961. Because of a poor hatch in 1958, the number of fish that will be 3- and 4-years-old and expected to spawn in 1961 and 1962 will be low. The situation should be much better by 1963 when the effect of the 1959 hatch is felt.

All the data indicate that for some reason - whether it be due to fishing of smallmouth bass off nests or to other factors - the smallmouth population is extremely low at the present time. The problem is how best to attempt to increase their numbers. Stocking records show the lake has not been stocked with smallmouth except on a few occasions and then the numbers planted have not been great considering the size of the lake. It seems reasonable, therefore, to assume that the population has been made up of native fish and a population increase should come from natural reproduction. If this line of reasoning is followed, it would seem logical to afford the smallmouth bass protection where needed.

While the number of nests available from which data could be obtained was small, it was found that the unguarded nests did not produce young fish while those which were guarded did. Consequently, it is felt that for the next few years it would be advantageous to afford at least some protection during the spawning period. While this will not guarantee the population will recover either immediately or rapidly, it is felt that such is the most logical procedure in light of the data on hand. Should the population recover, other measures could be tested to learn more about the reasons for success and failures of smallmouth bass hatches in given years. An alternative could be a closed season to afford more protection during spawning periods and preserve spawning stock. However, such action would result in a waste of some of the adult stock that probably would die of old age.

Future study of the problem should include spawning observations and reproductive success through shocker surveys at the already established sampling sites. Creel census can be resumed again in 1963 and 1964. The feasibility of establishing fish refuge areas should be investigated in line with the portion of the spawning population needed to be left unmolested to successfully reproduce the species. Luring of spawners into certain areas by placing large stones or concrete blocks on the bottom should also be attempted. Further work to determine the extent of nest damage by predators during various stages of egg and fry development should also be undertaken.

SUMMARY

1. The objective of the study was to obtain information pertinent to the management of smallmouth bass with particular reference to Lake Geneva, a 5,239 acre, clear-water lake in Walworth County.
2. The smallmouth bass in Lake Geneva exhibit excellent growth. They are 12.5 inches long (3+ years) at a weight of one pound, 16.0 inches for two pounds, and 18.5 inches for three pounds. Some of the Lake Geneva smallmouth bass will mature at 3 years of age or about 11 inches.
3. About 12 per cent of the smallmouth bass creeled by anglers were less than 10 inches in length in both 1958 and 1959, 57 and 51 per cent between 10 and 15 inches, and 31 and 37 per cent over 15 inches in 1958 and 1959, respectively.
4. A creel census showed the bluegill to be the most abundant fish caught by anglers in 1958 and 1959. The smallmouth bass harvest was low in both years and declined in 1959 from 1958. General fishing success for all species combined was about the same both years.
5. A summary of smallmouth bass harvest with respect to hours fished did not show any unusual number of fish creeled during the spawning period. However, the number of nesting males available and the number of anglers "nest hunting" were so few that it was difficult to ascertain the rate of catch off the nests.

6. Approximately 72 per cent of the anglers checked during the 1958 census were non-residents, mainly from Illinois.
7. A count of boats at Lake Geneva showed 2, 255 to be present, or about 1 per every 2 acres.
8. Nesting conditions in 1958 were very poor with cold weather believed to be the cause of a hatch failure. Conditions in 1959 were ideal and while a hatch did develop it was not considered large.
9. In situations where a male smallmouth bass was present on a nest throughout incubation, successful hatches resulted. In instances where the male was removed, the nests were failures.
10. Shore line seine hauls in 1958 did not yield a single young-of-the-year smallmouth bass and only a few yearlings. An A.C. shocker survey of the same areas in 1959 produced 64 young-of-the-year but no yearlings. Minnows were extremely abundant in 1959.
11. Few fish were available for tagging. A voluntary return of about 40 per cent of fish tagged in 1958 was experienced over a 2-year period.
12. Samples of bluegills and perch show good growth for these two species.
13. A review of past data indicates that Lake Geneva has experienced extreme fluctuations in populations of the various species, particularly perch.
14. The management suggested is to attempt to increase the Lake Geneva smallmouth population which is very low at present by encouragement of natural reproduction, primarily through protection during the spawning season.
15. Future study should include observations and determination of reproductive success through shocker surveys at already established sampling sites. The feasibility of fish refuge areas and attempting to lure spawning bass into certain areas to concentrate spawning should be investigated.

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