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LARGEMOUTH BASS IN MICHIGAN'S UPPER PENINSULA LAKES[1]

Wilbert C. Wagner

[1]A contribution from Dingell-Johnson Project F-35-R, Michigan

ABSTRACT

Data on the largemouth bass and associated sport fish populations and fisheries were collected from six small Upper Peninsula lakes that were judged to have fair-to-good largemouth bass fisheries. Population estimates of the largemouth bass (≥226 mm long) were made with electrofishing gear prior to the opening of the fishing season. The sport fishery on each lake was censused from the opening of the bass season through Labor Day. Population estimates of all major fish species were made with fyke nets in September.

The number of legal-size (≥12 inches or 305 mm) largemouth bass in the six lakes prior to the opening of the fishing season ranged from 0.6 to 2.7 (mean = 1.6) per ha and the standing crop ranged from 0.47 to 1.99 (mean = 0.97) kg per ha. The bass in this study were 3 to 6 cm shorter than the state average for ages IV through X. Reproduction was not successful every year as some age groups were missing or poorly represented in all study lakes. The estimated catch of largemouth bass per ha ranged from 0 to 3.8 and averaged 1.5. The lake for which the estimated catch was 0 had the highest number and biomass of legal-sized largemouth bass per ha. The correlation between the number of largemouth bass caught and the number of legal-size bass present was not significant but the correlation between number of bass caught and number of pan fish caught was significant. This suggests that many largemouth bass were caught incidentally by anglers that were fishing for pan fish rather than by anglers that sought the bass. Sublegal largemouth bass accounted for 22% of those seen during the creel censuses.

Annual fishing mortality rates (u) were: 0.3972 for legal-size bass; 0.0950 for bass 254 to 304 mm long, and 0.0177 for bass 226 to 253 mm long. Predicted yield in numbers and in weight from 1,000 226-mm bass with three different size limits were calculated. With a 10-inch (254-mm) size limit, 732 bass would be harvested, but more than 50% of the fish would be harvested at age III and age IV when they would average 273 mm and 0.26 kg. With a 14-inch (356-mm) size limit, 586 bass with an average weight of 0.73 kg would be harvested, however, anglers most likely would keep a higher proportion of sublegal fish in the 305- to 355-mm range so much of the effect of a larger size limit would be lost. Thus, the present 305-mm size limit seems best unless there is a great increase in angler acceptance to quality fishing regulations and/or law enforcement.

INTRODUCTION

Largemouth bass (scientific names shown in Table 1) have been assumed to be an important component of the predator fish populations in Michigan's Upper Peninsula warmwater lakes. The northern limits of the range of largemouth bass is a line running east and west just to the north of Lake Superior (Scott and Crossman 1973), thus, the Upper Peninsula is close to the northern limit. The largemouth bass attain their greatest abundance in shallow weedy warmwater lakes and are seldom found more than 6 m deep (Mraz et al. 1961).

Little information is available on the fishing pressure for, or the harvest of, largemouth bass from Upper Peninsula lakes. Creel censuses were conducted during 1976–78 on eight warmwater lakes that had largemouth bass (Ryckman and Lockwood 1985). The catch per hour of largemouth bass ranged from 0.0001 (Big Manistique Lake, 4,099 ha) to 0.0165 (Straits Lake, 76 ha). These fisheries were targeted at predators other than largemouth bass. Jamsen (1979) estimated 366,000 largemouth and smallmouth bass, combined, were caught from all inland waters of the Upper Peninsula, but the proportion of largemouth bass caught is unknown.

Basic data on standing crop, age structure, growth rates, mortality rates, and exploitation rates are lacking for largemouth bass and associated sport fishes in Michigan's Upper Peninsula lakes. These data are needed to determine appropriate management strategies and to evaluate the effectiveness of management practices. These types of information have been obtained for lower Michigan, but conditions are different in the Upper Peninsula where largemouth bass may be overexploited and special regulations may be needed.

This study was made in the Upper Peninsula on six small (less than 80 ha) inland lakes that were judged to have fair-to-good largemouth bass fisheries in comparison to other lakes in the Upper Peninsula. In this report, I quantitatively describe the largemouth bass and associated sport fish populations and their fisheries.

STUDY AREAS

This study was conducted on two different lakes each year during 1983–85. The locations of the study lakes are shown in Figure 1. Characteristics of the lakes were as follows:

Year of study	Lake	County	Surface area (ha)		Maximum depth (m)	Shoreline residential development
			Total	≥3 m		
1983	Stager	Iron	45	34	17	Moderate
1983	Tepee	Iron	46	34	12	Sparse
1984	Chicago	Delta	64	21	5	None
1984	East	Schoolcraft	22	9	9	Sparse
1985	Anderson*	Marquette	20	—	—	Sparse
	Main basin		11	7	9	
	Small basin		9	<1	3	
1985	Big Shag*	Marquette	78	—	—	Moderate
	Main basin		55	44	9	
	Small basin		23	7	6	

*Anderson and Big Shag lakes each consist of two basins connected by a narrow channel.

METHODS

The numbers of largemouth bass ≥226 mm long present in the study lakes were estimated by electrofishing at night along the shoreline with a boomshocker during the 2-week period prior to the opening of the bass fishing season. Bass were marked with serial-numbered Floy anchor tags, fin clipped (to estimate tag loss), measured (total length), scale sampled (10 per cm group from Stager Lake, all from the other lakes), and released. A few bass <226 mm were collected for age data. Most bass from Stager, Tepee, Anderson, and Big Shag lakes were weighed. Although the number of legal-size (≥305 mm long) bass was the main interest, bass 226 to 304 mm were also tagged because some would grow to legal size during the summer.

Separate population estimates and their variances were calculated by the adjusted Petersen method (formulas 3.9 and 3.8, Ricker 1975) for the 226- to 304-mm group and the legal-size group. The catch from days at the beginning of the electrofishing were assigned to the marking sample and those from the latter days were assigned to the recapture sample. The division of the days was made so the number of fish in each group was as equal as possible. Tagged fish recaptured during the marking sample days were excluded from the calculations.

The biomass of largemouth bass ≥226 mm in each lake was estimated. First, a length-weight relationship was calculated from the combined data from the four lakes where the bass were weighed. The biomass was the sum of the calculated weights of the estimated number of bass in each 1-cm group.

Age determinations were made from plastic scale impressions that were examined at a magnification of 34 times. The estimated number of largemouth bass in each lake, by age group, was found by expanding the number of bass of each age by a factor derived from the population estimates. Separate expansion factors were used for bass 226 to 304 mm and ≥305 mm long. An additional expansion factor was used for the Stager Lake estimates to correct for limiting the number of scale samples to 10 per cm group.

Fishing pressure (angler hours) and harvest of fish (number) were determined for the study lakes by a stratified random creel census from the opening of the bass fishing season (the Saturday before Memorial Day) through Labor Day. This period was divided into three strata that were 31 to 35 days long, because fishing pressure was expected to change during the season. These three strata were further divided into weekend and weekday strata because of the anticipated greater fishing activity on weekends. Holidays were included with the weekend strata.

The amount of census effort and procedures varied from year to year depending on available help and hours needed for travel. In 1983, one clerk censused Stager and Tepee lakes by alternating between lakes. Each lake was censused on one weekend day and on one or two weekdays each week. The census day was divided into three 5.5-hour time periods; one period was randomly selected for censusing. Chicago and East lakes were similarly censused in 1984 except that each census day was either an 8-hour long morning or afternoon period. One weekend day and one weekday were censused each week. Procedures at Anderson and Big Shag lakes in 1985 were similar to those in 1984, except that two clerks were employed, thus a census was made at each lake on both weekend days and on two weekdays. The percentages of the total daylight hours during which the censuses were taken were: Stager and Tepee lakes—12%, Chicago and East lakes—14%, and Anderson and Big Shag lakes—28%.

Fishing pressure was determined from boat and shore angler counts. Counts were made every half hour in 1983 and 1984. Only four counts per day were made on Anderson and Big Shag lakes because the clerk needed a boat to observe anglers in the many bays. The time of the first count was randomly selected within a 2-hour period; the remaining three counts were then made every 2 hours.

Anglers were interviewed either at the end of their fishing trips (complete fishing trips) or near the end of the clerk's work day (partial fishing trips). Normally, the two types of interviews would be treated separately but data were so scant they were combined to give larger sample sizes. Information recorded during the interviews included: name and address of anglers, hours fished, species, number and length of fish caught.

Estimated fishing pressure and catch were calculated according to methods given by Ryckman (1981). Separate estimates were made for the three 31- to 35-day periods, the

weekend and weekday strata, and for shore and boat strata; then all estimates were combined to make a single estimate.

Largemouth bass data from the six lakes were combined to determine average parameters representative of the Upper Peninsula. Combining also overcame some of the obvious year-class strength variation in individual lakes. Total instantaneous mortality rate (Z) was determined from the age-frequency catch curve for largemouth bass age IV and older calculated by the least squares method. Annual total mortality (A) equals $1-e^{-Z}$. Annual fishing mortality (u equals the estimated number of legal-size (305-mm) angler-caught bass divided by the estimated population of legal-size bass plus the number of bass growing to legal size during the study period. Annual fishing mortality (u) equals the estimated number of legal-size ($\geq$305-mm) angler-caught bass divided by the estimated population of legal-size bass plus the number of bass growing to legal size during the study period. Annual natural mortality (v) equals annual total mortality minus fishing mortality. Annual fishing mortality was also calculated for the sublegal (226 to 304 mm) catch. Fishing mortality calculations for the legal-size catch included the bass growing to legal size, but I assumed that for the sublegal groups the number growing into the group was balanced by the number growing out of the group. A length-frequency table of the combined population estimates and combined catch estimates was made to aid in the calculations of annual fishing mortality by size groups. Natural mortality was assumed to be the same for sublegal bass as for the legal-size bass.

I predicted the yield with various minimum size limits per 1,000 226-mm bass, the minimum length for which population data were available. I used annual natural and fishing mortality rates to calculate the reduction in number of bass for each year of life until none remained (Ricker 1975, page 237). The yield in kg was found from the predicted number harvested from each age group, the mean length of each group, and the length-weight regression. Multiple census population estimates of the fish in two study lakes were made each year during a 24-day period in September. In each lake, eight small-mesh (13- to 19-mm) fyke nets were fished at random locations and were lifted and moved every other day. All fish in the nets were measured (total length to cm), fin clipped, and released. The Schumacher and Eschmeyer formulas were used to calculate the population estimates and their variances.

RESULTS AND DISCUSSION

The number of largemouth bass (number of recaptures in parentheses) collected for the population estimates are shown below:

Lake	Length group			
	226–304 mm		>305 mm	
	Sample		Sample	
	Marking	Recapture	Marking	Recapture
Stager	64	28 (4)	17	5 (1)
Tepee	4	0	38	11 (4)
Chicago	0	0	14	17 (6)
East	11	13 (2)	18	19 (5)
Anderson	10	28 (6)	7	12 (2)
Big Shag	152	205 (26)	24	22 (4)

The estimated number of largemouth bass 226 to 304 mm and ≥305 mm long and the number per ha in each lake at the beginning of the fishing season are shown in Table 2. The number of bass 226 to 304 mm long ranged from 0 to 14.9 per ha and the number of legal-size fish ranged from 0.6 to 2.7 per ha. There was no relationship between the number of smaller bass and legal bass ($r = -0.15$).

The largemouth bass length (mm)-weight (g) relationship for Stager, Tepee, Anderson, and Big Shag lakes combined was $\log_{10} W = -5.5952 + 3.2860 \log_{10} L$. The calculated weights per ha are show in Table 2. The standing crop of legal-size bass in kg per ha ranged from 0.47 to 1.99 and averaged 0.97. In three southern Michigan lakes the number of legal bass per ha ranged from 2.5 to 10.1 with a mean of 6.7 and the biomass in kg per ha ranged from 2.4 to 8.7 with a mean of 5.2 (Goudy 1981). Overall, the abundance of largemouth bass was about four times greater in southern Michigan lakes and the biomass was about five times greater than in Upper Peninsula lakes.

The estimated number of bass longer than 225 mm in each lake by age group and the mean length at age are shown in Table 3. Some fish of the youngest age shown in the table for Stager, Anderson, and Big Shag lakes were less than 226 mm long so are not included. Thus, the mean length for bass in those age groups is unknown. The bass in this study were 3 to 6 cm shorter than the state average for ages IV through X (Table 3). Clady (1975) reported that growth of largemouth bass in Cub Lake in the western Upper Peninsula also was less than the state average. He theorized that the slow growth was due to the low nutrient content of the water and the short growing season for bass in Upper Peninsula latitudes.

Largemouth bass reproduction apparently was not successful every year as some age groups were missing or poorly represented in all study lakes (Table 3). The most prominent

cases were at Chicago Lake where no bass less than age VI and at Tepee Lake where no bass less than age IV were collected by electrofishing in the spring. However, at each of these lakes, over 200 young-of-the-year bass were caught with fyke nets in the fall which suggests that strong year classes were produced that year.

Many factors have been suggested as being possible causes for poor or missing year classes. These include predation, starvation, disease, parasitism, low dissolved oxygen, temperature fluctuations, turbidity, and wave action (Summerfelt 1975). Kramer and Smith (1962) studied factors affecting year class strength at Lake George, Minnesota, which is at a latitude similar to the southern part of the Upper Peninsula of Michigan. They found that water temperature and wind were the major factors affecting year class strength and that egg survival was influenced by depth of water over the nests and type of bottom on which the nests were built.

Reproduction was not affected similarly in the two lakes studied each year. A good example of this was age-IV bass which were nearly absent at Anderson Lake but at Big Shag Lake they were the most abundant of any year class of any lake in this study.

Total estimated angler hours and catch of major species at the lakes are given in Table 4. The estimated catch of largemouth bass per ha ranged from 0 (East Lake) to 3.8 (Stager Lake) and averaged 1.5. Goudy (1981) found that the catch of largemouth bass ranged from 2.1 to 8.8 per ha and averaged 5.5 in the three southern Michigan lakes that he studied.

Other published largemouth bass catch data for this area include:

Lake and state	Catch per ha		Authors
	Number	kg	
Missaukee, MI	0.76	—	Ryckman and Lockwood (1985)
Brown, WI[1]	16.67	~10	Mraz and Threinen (1955)
Murphy Flowage, WI[1]	6.67	3.14	Snow (1971)
Gladstone, MN[1]	7.00	3.59	Maloney et al. (1962)

[1]No minimum size limit.

At Stager and Big Shag lakes, the number of bass caught was about twice the number of legal-sized bass present at the beginning of the fishing season, because the catch included bass that recruited to the legal size during the fishing season and sublegal fish. Eleven of the 27 (41%) largemouth bass harvested from Stager Lake and 4 of 20 (20%) from Big Shag Lake were sublegal (Table 5). The opportunity for anglers to keep sublegal bass from Tepee and Chicago lakes was limited, since only 4 of 49 bass from Tepee Lake collected by electrofishing

were sublegal and 3 of them were within 5 mm of the legal limit 10 days before the season opened. None of the 25 bass caught by electrofishing in Chicago Lake were sublegal. Goudy (1981) also found a substantial number of the bass harvested were sublegal. He found that of the total number of bass kept by anglers from the three lakes, sublegal fish amounted to 8, 12, and 36%.

The predicted yield in numbers and weight from 1,000 226-mm largemouth bass was calculated for minimum size limits of 254, 305, and 356 mm. The catch-curve regression was based on the number of bass by age group for all lakes combined shown in Table 3. Total instantaneous mortality (Z) was 0.7045 (total annual mortality, A = 0.5056). Annual fishing mortalities for legal size and two size groups of sublegal largemouth bass were calculated from data shown in Table 6. Annual fishing mortality for legal-size fish included the number that would grow to legal size during the census period. Bass grew 30 mm from age V to age VI (Table 3), thus the bass in cm groups 28 to 30 (Table 6) would grow to legal size. Annual fishing mortality (u) was 0.3972 for legal-size bass, 0.0177 for bass 226 to 253 mm long, and 0.0950 for bass 254 to 304 mm long. An annual fishing mortality of 0.0950 was assumed for the 305- to 355-mm group in the yield calculation for the 356-mm minimum size limit. Annual natural mortality for legal-size bass was 0.1084 and that rate was assumed for sublegal bass.

In Michigan most largemouth bass growth occurs during June-September (Latta 1975) but in the Upper Peninsula bass probably grow little after September 1. Little fishing for largemouth bass was done after Labor Day so I assumed fishing mortality was proportional to growth. I also assumed that most natural mortality occurred during the growing season.

To predict the yield, the fishing mortality that was calculated by size group had to be converted to age. Size at age was available for ages IV-X (Table 3). The data were smoothed with a curvilinear regression. Calculated lengths (mm) at age were: III = 212, IV = 254, V = 292, VI = 328, VII = 362, VIII = 393, IX = 424, X = 453, XI = 481, XII = 508, XIII = 534, and XIV = 560. Lengths for ages III and XI-XIV were obtained by extrapolation.

Several length parameters used for predicting yield are not equal to length at age; for instance, the 226 mm with which the yield calculations begin. If age-III fish are 212 mm and age-IV fish are 254 mm then 226 mm is at age III plus 33% of the difference between ages III and IV. The age for 305 mm is V + 36% and 356 mm is VI+ 82%. Mortality rates applied to the partial age groups were proportional to the percentage of growth that occurred in these groups.

The predicted yield in number and weight was calculated for minimum size limits of 254 mm, 305 mm, and 356 mm (Table 7). If the minimum size limit was decreased to 254 mm from the present 305 mm, the yield in numbers would increase by 12% but the weight of those fish would decrease by 21%. Over 50% of the fish harvested would be age III and age IV when they would average only 273 mm long and weigh 0.26 kg. If the minimum size limit was raised

to 356 mm, the yield in numbers would decrease by 9% but the yield in weight would increase by 13%. However, this yield is based on the fishing mortality remaining the same for the sublegal fish in the 305-to 356-mm group as it was for the 254- to 304-mm group. Most likely anglers would keep a higher proportion of the sublegal fish in the larger group so much of the effect of the larger size limit might be lost. An effective 356-mm minimum size limit would only be possible with much more law enforcement and/or angler acceptance of quality fishing regulations.

Populations estimates that were made in September with fyke nets are shown in Table 8. Estimates could not be made for some species because no marked fish were recaptured. The number of fish of those species were probably few judging from the number caught (Table 9). Small (<15 cm) bluegills were present in large numbers (more than 800/ha) in all lakes except East Lake. Although 365 small bluegills per ha were in East Lake, no larger bluegills (≥16 cm) were caught with the fyke nets. Pumpkinseeds were present in five of the lakes, but only at East Lake were small (<15 cm) pumpkinseeds numerous (1,149/ha) and only at Big Shag Lake were the larger (≥16 cm) ones important (76/ha). Yellow perch less than 18 cm long were very abundant (2,330/ha) in East Lake but only 9 larger perch per ha were present. At Big Shag Lake there were 64 larger perch per ha but only 9 smaller perch per ha. Smallmouth bass were present only in Big Shag Lake and they were about one-fourth as abundant as largemouth bass. Northern pike were present in all lakes except Big Shag Lake. However, population estimates for northern pike could be calculated only for Chicago Lake. A few muskellunge were in Big Shag Lake.

The estimated number of other fish caught by anglers during this study are shown in Table 4. There was a significant correlation (4 df; $r = 0.86$) between the number of pan fish caught and largemouth bass caught. The correlation between the number of legal-size largemouth bass present and number of bass caught was not significant (4 df; $r = 0.59$). East Lake had the most legal-size bass per ha (Table 2) but by far the fewest larger size pan fish (Table 8) and number of angler hours per ha (Table 4). At East Lake a large standing crop of legal-size bass did not attract anglers.

The mean length and length frequency of bluegill, pumpkinseed, and yellow perch that were measured by the creel census clerks are shown in Table 10. There are no legal size limits on pan fish in Michigan but the "acceptable size" is considered to be 6 inches (152 mm) for bluegill and pumpkinseed and 7 inches (178 mm) for yellow perch. Some pan fish less than the acceptable size were kept by anglers from nearly all of the lakes, but the highest percentages were: 92% of the bluegill from Tepee Lake, 48% of the pumpkinseed from Anderson Lake, and 40% of the pumpkinseed from Stager Lake.

The percentage of small fish kept by anglers was not always related to the scarcity of acceptable sized fish. For instance, the population estimates showed that the percentage of

acceptable sized bluegill in Chicago Lake was the lowest (1.2%) of any lakes, yet the percentage of acceptable bluegill in the catch was the highest (90%) of any lake. Most anglers at Chicago Lake had fished there previously and knew where to fish to catch the larger bluegill.

SUMMARY

The six lakes in this study had the "better" largemouth bass fisheries in the Upper Peninsula. But, compared to three lakes in the Lower Peninsula, both the bass populations and the fisheries were "poor". The number of largemouth bass, per ha, and their biomass, was four and five times greater, respectively, while number caught per ha was three and a half times greater in the Lower Peninsula lakes. Upper Peninsula largemouth bass grew about 90% as fast as the state average. Reproduction was not successful every year, resulting in some age groups missing or poorly represented in every lake. The correlation between the number of largemouth bass caught and the number of legal-size bass present was not significant, but the correlation between number of bass caught and number of pan fish caught was significant, suggesting that many, perhaps most, largemouth bass were caught incidentally by anglers that were fishing for pan fish rather than by anglers who sought the bass. The predicted yield with minimum size limits of 254, 305, and 356 mm showed that as the size limit increased the expected number caught decreased but the total weight of those caught increased. The present 305-mm minimum size limit seems to be the most suitable in the Upper Peninsula because at the 254-mm limit a majority of the harvest would occur before the bass reached a size that could be considered a sport fish and at the 356-mm limit, the keeping of sublegal fish might increase to the point that the limit would be ineffective.

Predicted yields for the different minimum size limits were based on the average data that were obtained by combining the data from the six study lakes. Wide confidence limits on the population and catch estimates, plus the assumptions that were made due to insufficient data, may have caused considerable error in the predictions.

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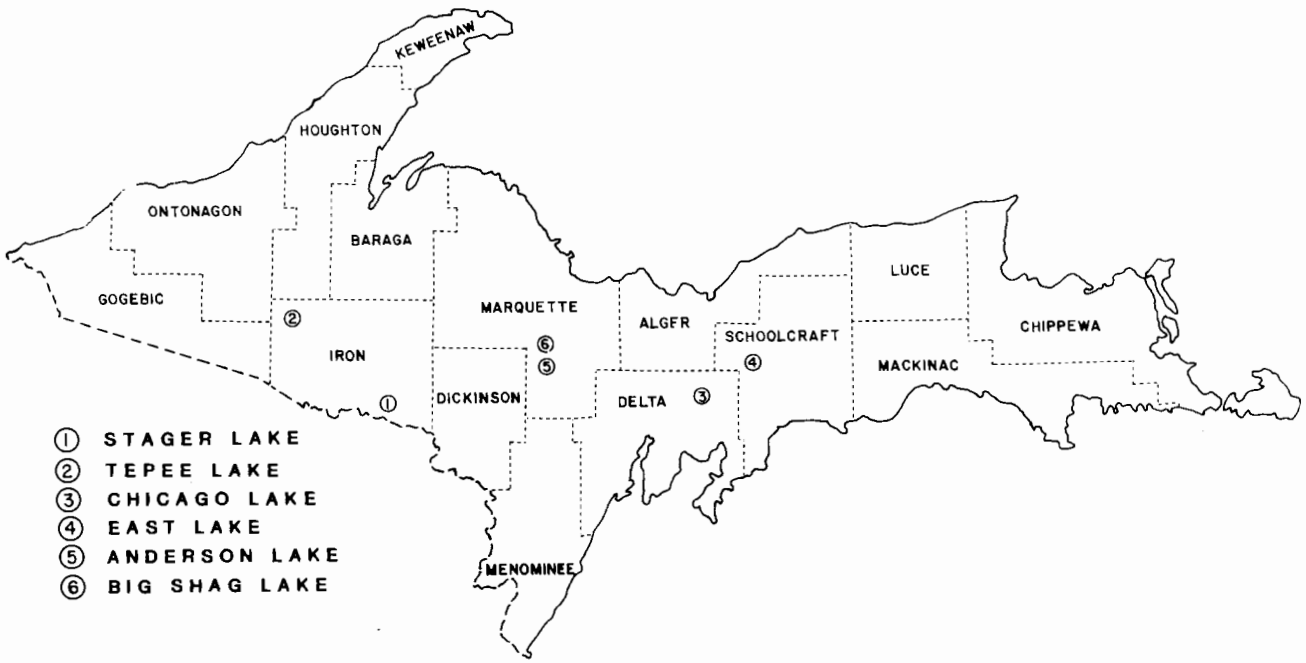

Figure 1. Map of Upper Peninsula of Michigan showing location of largemouth bass study lakes.

Table 1. Names of fishes referred to in this report.[1]

Common name	Scientific name
Brook trout	*Salvelinus fontinalis*
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
White sucker	*Catostomus commersoni*
Bullhead	*Ictalurus* spp.
Rock bass	*Ambloplites rupestris*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
Yellow perch	*Perca flavescens*
Walleye	*Stizostedion vitreum*

[1] From the American Fisheries Society Special Publication No. 12, "A list of common and scientific names of fishes from the United States and Canada", fourth edition (1980).

Table 2. Largemouth bass population estimates and ±2 standard errors, calculated total weight (kg) and kilograms per ha in study lakes when the bass season opened.

Lake and parameter	Size group		Total
	226–304 mm	≥305 mm	
Stager			
Population	371±276	48±45	419±279
Number/ha	8.2	1.1	9.3
Weight	64.06	21.12	85.18
Kg/ha	1.42	0.47	1.89
Tepee			
Population	—[1]	91±57	101±63
Number/ha	—	2.0	2.6
Weight	—	56.55	60.49
Kg/ha	—	1.23	1.32
Chicago			
Population	0	36±20	36±20
Number/ha	—	0.6	0.6
Weight	—	36.58	36.58
Kg/ha	—	0.57	0.57
East			
Population	51±46	60±38	111±59
Number/ha	2.3	2.7	5.0
Weight	15.08	43.75	58.83
Kg/ha	0.69	1.99	2.68
Anderson			
Population	41±26	30±27	71±37
Number/ha	2.0	1.5	3.5
Weight	7.67	19.54	27.21
Kg/ha	0.26	0.65	0.91
Big Shag			
Population	1,160±408	110±80	1,270±416
Number/ha	14.9	1.4	16.3
Weight	269.58	70.11	339.69
Kg/ha	3.46	0.90	4.36

[1]Estimate not made because no marked bass were caught.

Tabie 3. Number and size (cm), by age group, of largemouth bass ≥23 cm long in study lakes prior to the fishing season, calculated from population estimates and scale samples.

Lake and parameters	Age										
	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Stager											
Number	—	6	25	218	133	26	2	2	—	5	—
Mean length	—	—[1]	24	27	29	33	38	44	—	48	—
Range	—	23–26	23–26	24–31	26–33	29–37	38	44	—	47–48	—
Tepee											
Number	—	—	2	25	35	36	—	—	2	—	—
Mean length	—	—	33	32	35	37	—	—	42	—	—
Range	—	—	33	29–36	30–38	34–40	—	—	42	—	—
Chicago											
Number	—	—	—	—	2	4	12	16	2	—	—
Mean length	—	—	—	—	39	44	45	45	45	—	—
Range	—	—	—	—	39	42–46	41–52	40–51	45	—	—
East											
Number	—	53	2	—	24	20	10	2	—	—	—
Mean length	—	29	35	—	36	38	40	38	—	—	—
Range	—	26–31	35	—	34–40	34–41	38–42	38	—	—	—
Anderson											
Number	40	5	3	12	7	—	3	—	2	—	—
Mean length	—[1]	31	33	34	37	—	38	—	47	—	—
Range	23–28	30–32	33–34	32–36	34–39	—	37–40	—	47	—	—
Big Shag											
Number	—	49	1,086	70	36	3	3	16	5	—	3
Mean length	—	—[1]	27	31	35	44	38	42	43	—	44
Range	—	23–24	23–32	30–34	30–38	44	38	39–47	40–47	—	44
All lakes[2]											
Number	—	—	1,118	325	237	89	30	36	11	—	—
Mean length	—	—	26.3	28.3	31.3	36.5	41.4	43.0	44.0	—	—
State mean length	—	—	29.5	33.5	37.3	41.4	44.1	46.6	49.1	—	—

[1] Only the larger individuals in this age group were ≥23 cm.

[2] Data given only for age groups that were present in four or more lakes.

Table 4. Estimated fishing pressure and catch (±2 standard errors).

Lake	Hours fished	Fish caught				
		Largemouth bass	Bluegill	Pumpkinseed	Yellow perch	Northern pike
Stager	3,396	171	2,485	198	268	—
	±390	±103	±906	±123	±168	—
Tepee	1,571	59	216	—	225	—
	±259	±55	±198	—	±221	—
Chicago	2,225	8	1,213	98	—	29
	±299	±16	±711	±118	—	±25
East	240	—	—	7	—	5
	±98	—	—	±14	—	±10
Anderson	2,752	28	776	118	15	78
	±233	±29	±428	±92	±19	±70
Big Shag	10,726	204	6,809	762	1,086	—
	±857	±158	±2,706	±311	±595	—

Table 5. Length-frequency and mean total length of largemouth bass caught by anglers.

Length (cm)	Lake					
	Stager	Tepee	Chicago	East	Anderson	Big Shag
Sublegal						
22	—	—	—	—	—	1
25	2	—	—	—	—	—
27	5	—	—	—	—	1
28	3	—	—	—	—	1
29	1	—	—	—	—	1
Legal						
31	6	—	—	—	—	4
32	2	—	—	—	1	8
33	1	4	—	—	—	1
34	—	1	—	—	—	—
35	—	5	—	—	—	—
36	—	1	—	—	1	—
37	—	1	—	—	2	—
38	—	—	—	—	—	1
39	—	—	—	—	1	—
41	—	—	—	—	1	—
44	—	1	1	—	—	1
46	1	—	—	—	—	1
Not measured	6	—	—	—	—	—
Total	27	13	1	0	6	20
Mean length	29.6	35.3	44.4	—	36.9	32.3
±95% C.L.	1.8	1.8	—	—	3.1	2.5

Table 6. Length frequency of combined population estimates and combined catch estimates of largemouth bass in study lakes.

Length (cm)	Population	Catch
Sublegal		
22	—	10
23	65	—
24	182	—
25	205	16
26	437	—
27	263	51
28	240	35
29	130	18
30	111	—
Total	1,633	130
Legal		
31	49	90
32	41	102
33	20	36
34	44	4
35	17	23
36	30	9
37	42	14
38	25	11
39	22	5
40	16	—
41	12	5
42	12	—
43	7	—
44	14	23
45	4	—
46	2	18
47	11	—
48	2	—
49	—	—
50	3	—
51	1	—
52	1	—
Total	375	340

Table 7. Predicted yield of largemouth bass in number and weight (kg) at three minimum size limits.

	254-mm limit		305-mm limit		356-mm limit	
Age	Number	Weight	Number	Weight	Number	Weight
III	12	2.0	12	2.0	12	2.0
IV	364	93.5	87	22.4	87	22.4
V	180	70.2	197	80.0	69	27.0
VI	89	49.4	182	100.8	88	50.7
VII	44	32.9	90	67.2	167	125.2
VIII	22	20.9	44	42.6	83	79.6
IX	11	13.1	22	26.6	41	49.7
X	5	8.0	11	16.2	20	30.3
XI	3	4.7	5	9.6	10	18.0
XII	1	2.6	3	5.8	5	10.8
XIII	<1	1.5	1	4.3	2	6.0
XIV	—	—	<1	1.8	1	3.5
	—	—	—	—	<1	2.0
Total	732	298.8	655	379.3	586	427.2

Table 8. Population estimates and ±95% confidence limits for species other than largemouth bass in September with fyke nets.

Species and size (cm)	Lake					
	Stager	Tepee	Chicago	East	Anderson	Big Shag
Bluegill						
≤15	37,279	46,621	135,006	8,025	121,936	155,528
	±12,506	±12,997	±37,631	±4,520	±107,910	±125,085
≥16	22,469	1,844	1,685	—[2]	3,385	11,596
	±23,567	±760	±686	—	±3,773	±15,024
Pumpkinseed						
≤15	9,189	—	—[1]	25,273	9,920	13,841
	±6,123	—	—	±47,856	±2,634	±5,608
≥16	690	—	464	311	721	5,937
	±144	—	±366	±339	±482	±2,689
Yellow perch						
≤17	1,564	22,413	—	51,268	12,050	705
	±1,033	±17,490	—	±19,404	±6,991	±1,572
≥18	1,711	492	—	190	64	4,975
	±264	±263	—	±237	±30	±2,631
Smallmouth bass						
≤20	—	—	—	—	—	402
	—	—	—	—	—	±259
21–30	—	—	—	—	—	381
	—	—	—	—	—	±91
≥31	—	—	—	—	—	24
	—	—	—	—	—	±10
Rock bass						
≤15	—	—	1,068	—	—	—
	—	—	±357	—	—	—
≥16	—	—	365	—	—	—
	—	—	±240	—	—	—
Bullhead						
≤22	—	144	13,946	59	—	—
	—	±193	±3,896	±12	—	—
≥23	—	179	2,419	37	—	—
	—	±18	±364	±2	—	—
White sucker						
≤30	576	—	—	478	—	—
	±490	—	—	±476	—	—
≥31	2,713	—	—	2,488	—	—
	±4,714	—	—	±1,834	—	—
Northern pike						
25–50	—	—	673	—	—	—
	—	—	±702	—	—	—
≥51	—	—	47	—	—	—
	—	—	±197	—	—	—

[1]No estimate made because no recaptures were in this size group.

[2]No fish in this size group were collected.

Table 9. Number of fish caught with fyke nets in September for which population estimates could not be made because no marked fish were recaptured.

Lake	Species	Size range (cm)	Number of fish
Stager	Largemouth bass	≤12[1]	78
		13–22	45
		≥23	5
	Northern pike	23–75	8
	Brook trout	18	1
Tepee	Largemouth bass	≤12[1]	233
		13–22	2
	Northern pike	66–98	8
	Walleye	37–45	9
Chicago	Largemouth bass	≤12[1]	207
	Northern pike	≤24	10
East	Largemouth bass	≤12[1]	4
		13–22	3
	Northern pike	45–75	15
Anderson	Largemouth bass	≤12[1]	10
	Northern pike	32–97	16
	White sucker	42–57	34
Big Shag	Largemouth bass	≤12[1]	1
		13–22	6
		≤23	1
	Muskellunge	30–47	6
	Walleye	38–41	5
	White sucker	35–55	14

[1] Young-of-the-year.

Table 10. Mean length (cm) and length-frequency of pan fish measured during creel census interviews.

Species and lake	Mean length	Length group									
		8–9	10–11	12–13	14–15	16–17	18–19	20–21	22–23	24–25	26–29
Bluegill											
Stager	18.1	—	—	1	34	71	120	75	8	1	—
Tepee	14.1	1	2	11	8	1	1	—	—	—	—
Chicago	21.3	—	—	—	1	5	27	23	14	17	11
Anderson	17.8	—	1	4	7	30	57	20	—	—	1
Big Shag	18.3	1	14	10	26	87	298	179	17	—	—
Pumpkinseed											
Stager	15.8	—	—	2	12	17	3	1	—	—	—
Chicago	19.8	—	—	—	—	1	5	2	—	1	—
East	18.3	—	—	—	—	—	1	—	—	—	—
Anderson	16.0	—	1	7	7	3	8	5	—	—	—
Big Shag	16.2	—	5	3	26	52	37	—	—	—	—
Yellow perch											
Stager	19.8	—	—	—	1	3	14	18	5	3	—
Tepee	20.9	—	—	—	1	3	4	6	5	4	4
Anderson	16.8	—	—	—	2	—	—	—	1	—	—
Big Shag	22.2	—	—	—	—	8	20	32	27	42	17

LITERATURE CITED

Bennett, G. W., H. W. Adkins, and W. F. Childers. 1969. Largemouth bass and other fishes in Ridge Lake, Illinois, 1941–1963. Illinois Natural History Survey Bulletin 30.

Clady, M. C. 1975. The effects of a simulated angler harvest on biomass and production in lightly exploited populations of smallmouth and largemouth bass. Transactions of the American Fisheries Society 104:270–276.

Goudy, G. W. 1981. The exploitation, harvest, and abundance of largemouth bass populations in three southeastern Michigan lakes. Michigan Department of Natural Resources, Fisheries Research Report 1896, Ann Arbor.

Jamsen, G. C. 1979. Michigan's 1978 sport fishing. Michigan Department of Natural Resources, Surveys and Statistical Services Report 183, Lansing.

Kramer, R. H., and L. L. Smith. 1962. Formation of year classes in largemouth bass. Transactions of the American Fisheries Society 91:29–41.

Latta, W. C. 1974. Fishing regulations for largemouth bass in Michigan. Michigan Department of Natural Resources, Fisheries Research Report 1818, Ann Arbor.

Maloney, J. E., D. R. Schupp, and W. J. Scidmore. 1962. Largemouth bass population and harvest, Gladstone Lake, Crow Wing County, Minnesota. Transactions of the American Fisheries Society 91:42–52.

Mraz, D., and C. W. Threinen. 1955. Anglers harvest, growth rate and population estimate of the largemouth bass of Brown's Lake, Wisconsin. Transactions of the American Fisheries Society 85:241–256.

Mraz, D., S. Kmiotek, and L. Frankenberger. 1961. The largemouth bass its life history, ecology and management. Wisconsin Conservation Department Publication 232.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada Bulletin 191.

Ryckman, J. R. 1981. Creel census methods in general. Appendix VI-A-9 *in* Manual of Fisheries Survey Methods, J. W. Merna et al., Michigan Department of Natural Resources, Fisheries Management Report 9, Ann Arbor.

Ryckman, J. R., and R. N. Lockwood. 1985. On-site creel surveys in Michigan, 1975–82. Michigan Department of Natural Resources, Fisheries Research Report 1922, Ann Arbor.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184.

Snow, H. E. 1971. Harvest and feeding habits of largemouth bass in Murphy Flowage, Wisconsin. Wisconsin Department of Natural Resources, Technical Bulletin 50.

Summerfelt, R. C. 1975. Relationship between weather and year-class strength of largemouth bass. Pages 166–174 *in* R. H. Stroud and H. Clepper, editors. Black bass biology and management. Sport Fishing Institute, Washington, District of Columbia.