ILLINOIS NATURAL HISTORY SURVEY
Bulletin

Printed by Authority of
the State of Illinois

Stocking and Sport Fishing at Lake Glendale (Illinois)

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DEPARTMENT OF REGISTRATION AND EDUCATION

NATURAL HISTORY SURVEY DIVISION
Urbana, Illinois

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Volume 29, Article 2
July, 1966

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*Employed on co-operative projects with one of several agencies: University of Illinois, Agricultural Extension Service, Illinois Department of Conservation, National Science Foundation, United States Department of Agriculture, United States Fish and Wildlife Service, United States Public Health Service, and others.

Contents

This report is printed by authority of the State of Illinois, IRS Ch. 127, Par. 58.12. It is a contribution from the Section of Aquatic Biology of the Illinois Natural History Survey.

(26576—5000—7-66)

Stocking and Sport Fishing at Lake Glendale (Illinois)

DONALD F. HANSEN

PROBABLY most fisheries biologists in the United States would agree that good fishing in new impoundments depends to a considerable extent on the species, sizes, and numbers of fish used in the stocking and also on the time or times of the year that the introductions are made. Fairly dependable stocking procedures have been developed for ponds of 1 or 2 acres; however, little experimentation has been done to find equally dependable procedures for stocking large lakes or reservoirs. The possibility of contamination with unwanted species, the large numbers of fish needed to carry out some stocking plans, and the expense of carefully evaluating stocking results are the principal drawbacks to stocking experiments in large impoundments.

In April, 1940, the Illinois Natural History Survey stocked two newly built recreation reservoirs in southern Illinois, Lake Glendale (82 acres) in Pope County and Pounds Lake (33 acres) in Gallatin County, with largemouth bass, *Micropterus salmoides* (Lacépedè), and bluegills, *Lepomis macrochirus* Rafinesque.

This combination of fishes, which had recently been introduced by Swingle & Smith (1938:2) for small ponds in Alabama, soon became a popular combination for ponds in various other parts of the United States. The purpose of the bass-bluegill stocking at Lake Glendale and Pounds Lake was to determine the value of this combination for lakes of moderate size in Illinois.

Because the bass fishing that followed the 1940 stocking at Lake Glendale was disappointing to anglers, fish of all kinds were removed in a draining-rotenoning census operation in the fall of 1946, and the lake was restocked, again with bass and bluegills but at different rates and with fish of different sizes than were used initially. Swingle & Smith (1938:2 and 1942:13) had recommended stocking ponds with comparatively large numbers of fry or fingerling fish; one recommendation for unfertilized ponds was 400 bluegills (bream) and 30 bass per acre. Both Glendale and Pounds had been stocked with comparatively small numbers of adult bass and bluegills in 1940; Glendale was restocked with a mixture of adult and yearling bass and bluegills in 1946. The 1946 Glendale stocking was considerably heavier in number of fish per acre than the 1940 stocking of the two lakes. Bass fishing at Lake Glendale showed great improvement in the second summer after the 1946 stocking, but the improvement did not hold up. In the fall of 1950, the lake was almost completely drained (frontispiece), the bass population was censused, and large numbers of bass were removed. The evaluation of angling that followed the 1946 stocking is concluded with the 1950 fishing season.

Various bass-bluegill stocking procedures employing fry or fingerlings, adult fish alone, or mixtures of adults and fingerlings have been evaluated by Surber (1949), Swingle (1951), and Smith, Kirkwood, & Hall (1955). In these studies, stocking success was

Frontispiece.—The Lake Glendale basin after the October, 1950, draining. The mainstream channel and tributary channels are plainly visible. Beds of rooted aquatic vegetation are seen as dark bands running approximately parallel with the lake margin. Water can be seen in the lower half of the mainstream channel; also, in a small area of the lake bottom near the dam, and in a small pool to the right of the beach (the beach is the large light area near the dam).

measured in such terms as standing crops of young and adult fish, balance of bass and bluegills, or evidence of overpopulation of one or both species. The principal basis for evaluation of the stocking procedures at Lake Glendale was the quality of the hook-and-line fishing.

Neither of the stocking procedures used in the present study was among those reported by other workers. The 1940 stocking rates for adult largemouth bass and bluegills were almost the same as the rates used by the Illinois Department of Conservation when it provides adult fish for large publicly-owned waters. For this reason, the results of the present study have special significance in this state.

ACKNOWLEDGMENTS

The following employees of the U.S. Forest Service in the Shawnee National Forest of southern Illinois cooperated in the study reported here: Arlie W. Toole, Roy N. Olson, and E. N. Lee, Forest Supervisors; Wilfred James, District Ranger; and J. T. Turner, Forestry Technician.

The hook-and-line catch was recorded by various operators of the Lake Glendale concession: Louis H. Walker, R. B. Veach, and Mr. and Mrs. Roy W. Schoettle and their employees.

Jacob H. Lemm, Melvin T. Huish, Quentin Pickering, and Wallace Hart, employed by the Illinois Natural History Survey, and Ray Brown, Guy Bellamy, William Davidson, Leonard Deevers, Paul Smith, John Savage, Ralph Guthrie, Roy Cox, Bruce Muench, and Truman Dick, employed by the State Department of Conservation, helped with the census operations either in 1946 or 1950.

The following men were employed by the Natural History Survey as test fishermen at Lake Glendale: Harry K. Phinney in 1944, Melvin T. Huish in 1945 and 1946, Charles S. Stubbs in 1947, and Maurice G. Kellogg in 1948, 1949, and 1950.

The annual fish harvests for the early years of the study were totaled by Elizabeth Brown Chase and for the later years by the University of Illinois Statistical Service.

Esden Jerrels, concessionaire, and his assistant, Arland Black, collected the data on fishing at Pounds Lake in the period 1943–1946.

Many helpful criticisms of the manuscript have been made by George W. Bennett and R. Weldon Larimore of the Illinois Natural History Survey's Section of Aquatic Biology. James S. Ayars, Technical Editor of the Survey, 1937–1965, edited the manuscript.

Illustrative material was provided by the following persons: Charles L. Scott, formerly photographer of the Illinois Natural History Survey, for the frontispiece and for Fig. 2 and 5; J. B. Stall of the Illinois Water Survey and R. B. Collier of the U.S. Geological Survey for Fig. 1; Joe Dexter of Robbs, Illinois, for Fig. 3; James S. Ayars for Fig. 6, 8, and 9; and William L. Taylor, draftsman of the Illinois Natural History Survey, for Fig. 7.

LAKE GLENDALE

Lake Glendale, which lies within the U.S. Forest Service Glendale Recreation Area in the Shawnee National Forest, is an artificial lake of 82 acres located 2 miles north of Dixon Springs in Pope County, southeastern Illinois. The dam for the lake was completed in the fall of 1939, and the basin filled with water during that winter and the following spring. In addition to fishing, the Glendale Recreation Area offers camping, picnicking, swimming, and rowboating.

The Lake Glendale watershed consists of 1,400 acres of forest or abandoned farmland. Water enters the lake from a temporary stream at the east end and from numerous well-vegetated gulleys on the north and south sides. The lake is 0.8 mile long and 0.2 mile wide at the widest point (exclusive of bays) and it has a shoreline of 3.2

miles. When the lake is at full stage, the maximum depth (near the dam) is 22 feet, if measured at the top of the original stream bank, or 24 to 25 feet, if measured at the middle of the channel (contour map, Fig. 1). The average depth of the lake is 10.9 feet. The contour map shows that the lake bottom slopes more steeply along the south shore than along most of the north shore. The shoreline is marked by numerous bays. A large part of the lake bottom was under cultivation up to the time the dam was built.

In most years during the 1940's, the water was turbid from March into May but relatively clear through the summer months. In 1944, for example, a secchi disc could be seen to a depth of 12 inches in March, 3 feet in early July, and 7 feet in mid-July. The high transparency of the water in the summer months was presumed to be related to the nearly complete suspension of farming on the 1,400-acre Lake Glendale watershed. By 1946, silt had been deposited to a depth of about an inch over most of the lake bed. In the area close to the mouth of the main tributary stream (an area comprising several acres), and at least in the lower third of the original stream channel, the accumulated silt had reached a depth of about a foot.

In midsummer during the years of this study, the upper layer of warm water, the epilimnion, extended from the surface to depths of 8 to 12 feet, the depth depending on air temperatures and the amount of mixing by recent winds.

Compared with most lake waters in northern and central Illinois, the water in Lake Glendale is extremely soft. A water sample collected from the lake in April, 1944, had a total hardness of only 27 parts per million. This is similar to the hardness of the water in six small farm ponds in the neighborhood (Hansen et al. 1960:350).

Although the loess forest soils in Pope County are relatively poor for agriculture (compared with loess soils in most parts of Illinois), they can be farmed profitably if they are properly treated. The minimum treatment recommended by agronomists consists of periodic applications of ground limestone and of phosphorus fertilizer. On some Pope County farms, complete fertilizers are regularly used in addition to the limestone and phosphorus fertilizer. R. J. Webb, Superintendent of the University of Illinois Dixon Springs Agricultural Center, which adjoins the Glendale Recreation Area, is of the opinion that these materials have probably been used on only a small percentage of the land draining into Lake Glendale. The lake water has never been fertilized.

The following description of the aquatic plant distribution in Lake Glendale is based on a detailed map prepared by Harry K. Phinney when he worked for the Illinois Natural History Survey during the summer of 1944. Plant distribution in that year was typical for most of the period covered by the present study, that is, 1942–1950. Cattails, *Typha latifolia* Linnaeus (Fig. 2), which later almost disappeared from the lake, formed a nearly continuous fringe around the lake margin, growing from the water's edge to a depth of 3 to 3.5 feet. From the outer edge of the cattails to a depth of about 10 feet the bottom was almost covered with *Chara* sp. American lotus, *Nelumbo lutea* (Willdenow) Persoon, grew thickly in the largest bay on the north side but nowhere else on the lake. Small beds of the yellow water lily, *Nuphar advena* (Aiton) Aiton f., grew in the shallow water at the east end of the lake and in most of the bays. Patches of *Potamogeton illinoensis* Morong, some as much as 150 feet across, grew in shallow water in all parts of the lake (the plant later became scarce). The narrow-leaved pondweed, *Potamogeton foliosus* Rafinesque, which was a serious nuisance to swimmers and fishermen in the shal-

Fig. 1.—Contour map of Lake Glendale and shoreline. Elevations are shown in feet above sea level. The spillway is 418.38 feet above sea level. (Scale: 1 inch=600 feet.)

Fig. 2.—Cattail and willow border at Lake Glendale. Much of the shoreline looked like this in the 1940's and early 1950's.

low parts of the lake in 1954, was restricted to a few small patches in 1944. Several other plants, including arrowhead (*Sagittaria* sp.), sedge (*Carex* sp.), sweet flag (*Acorus calamus* Linnaeus), and wild rice (*Zizania aquatica* Linnaeus), were quite scattered, and stands were generally small. Willow trees, *Salix* sp., grew close to the water's edge along most of the shoreline.

STUDY PROCEDURES AT LAKE GLENDALE

In both 1940 and 1946, the intention was to limit the fish stock in Lake Glendale to two species, the largemouth bass and the bluegill. However, in spite of attempts to eliminate fish from the feeder stream by rotenone applications before the 1940 stocking, the stock became contaminated by other species, principally the green sunfish, *Lepomis cyanellus* Rafinesque, and the warmouth, *Chaenobryttus gulosus* (Cuvier); both the green sunfish and the warmouth survived the drawdown and the rotenone treatment that preceded the 1946 stocking.

The 1940 Stocking

The original release of fish in Lake Glendale was made on April 8, 1940, with bass and bluegills taken from Lake Chautauqua, near Havana (central Illinois). Included in the stock used were the following fish, all adults:

70 largemouth bass, 10–14 inches total length (0.9 fish per acre)
215 bluegills, 4–7 inches total length (2.6 fish per acre)

Some of the bluegills were weak when released in the lake, probably as a consequence of having been held for several days in a live box before being transported in a tank to Lake Glendale. The extent of mortality among these

fish was not determined. The bass, although kept in the live box with the bluegills and transported with them, appeared to be lively and in excellent physical condition.

Seine and fyke net catches made at Lake Glendale in the spring of 1941 showed that bass, bluegills, and green sunfish (the green sunfish were probably survivors from the stream population) had reproduced successfully in 1940.

In September, 1941, about a year and a half after the original stocking, a Department of Conservation fish rescue crew released in Lake Glendale a load of several hundred fish that had been seined from a nearby pond. A Department of Conservation law enforcement officer who was present when the fish were unloaded at the lake reported that many of these fish were weak and dying when they arrived. This officer did not count the fish but he estimated that the load had included the following:

275 largemouth bass (35 about 10 inches long, the rest smaller)
500 bluegills
100 warmouths and green sunfish
12 black bullheads, *Ictalurus melas* (Rafinesque)

Since adult bass, bluegills, and green sunfish had been present through two spawning seasons, and all three species had reproduced successfully by the summer of 1941, this load of fish probably had no significant effect on the populations of the three species. However, it may have been the cause of the establishment of two species, neither of which became very important, namely the black bullhead and the warmouth. The bullheads reproduced poorly, if at all; only 9 bullheads were reported caught by fishermen in the period 1942–1946, and only 14 bullheads were found when the fish population was censused in 1946. Only 237 warmouths were caught during the 1946 fishing season (compared to more than 5,000 bluegills) and only about 2,300 warmouths were recovered in the 1946 census.

In June, 1940, the mosquitofish, *Gambusia affinis* (Baird & Girard), was introduced by workers or, more likely, by the staff of the nearby Civilian Conservation Corps work camp at Eddyville, 9 miles away. The small numbers of fish of other species found when the population was censused in 1946—1 longear sunfish, *Lepomis megalotis* (Rafinesque), 5 carp, *Cyprinus carpio* Linnaeus, and 17 golden shiners, *Notemigonus crysoleucas* (Mitchill)—had unknown origins; they may have been introduced by fishermen using live minnows during the 1943 fishing season, the only season in which minnow fishing was allowed.

The 1946 Stocking

The second stocking, which was quite different from the first in terms of numbers and sizes of fish used, was made late in November, 1946, with fish from Lake Glendale which had been stored in a farm pond at the time of the draining operation. The 1946 stocking was much heavier than the 1940 stocking and included young-of-the-year as well as adult bass and bluegills. About one-third as many bass and one-twelfth as many bluegills were returned to the lake as the number of individuals (more than 2 inches in length) counted in the census. Approximately 66 per cent of the bass and 92 per cent of the bluegills had been killed with rotenone in the population census.

The numbers of largemouth bass and bluegills used in the 1946 stocking and their approximate total lengths were as follows:

Largemouth bass
828—3–5.5 inches total length
1,397—6–11 inches total length
23—17 inches total length and larger
Total 2,248 (27.4 fish per acre)

Bluegills
613—2–3.5 inches total length
2,776—4–7.5 inches total length
Total 3,389 *(41.3 fish per acre)*

The bass and bluegills in this stocking were not measured individually but were counted according to easily recognized size categories. Approximately 140 of the bass measured 10 inches or longer and approximately 2,400 of the bluegills measured 6 inches or longer. The weight of the 2,248 bass was the same as that of the 3,389 bluegills, namely, 584 pounds, or 7 pounds per acre.

Although the small quantity of water that remained in the lake bed following the 1946 draining was heavily treated with rotenone to complete the fish census, as described in the section "Population Censuses," a number of warmouths and green sunfish managed to survive. Thus, the 1946 stock of bass and bluegills was contaminated just as the 1940 stock had been contaminated.

Creel Census

A creel census was started at Lake Glendale when the lake was opened to public fishing in May, 1942. It was intended to cover all of the fishing done at the lake. The Lake Glendale concession stand, which was headquarters for boat rentals, was used as the creel-census station. Each sport fisherman, at the beginning of his day's trip, obtained a fishing permit from the creel-census station. At the end of the day's fishing, he reported his results to a station attendant, who recorded the results on a special report form. The state fishing license of each fisherman required to have a license (persons of 18 years and older) was held at the census station during the trip as assurance that results of the trip would be reported.

During the first year of fishing (1942), the information recorded on the report form of each fisherman included the following:

Name and address of the fisherman
Number and aggregate weight, by species, of all fish kept
Estimated number, by species, of all fish caught and thrown back in the water

Beginning in 1943 and continuing through 1950, the following additional information was obtained:

Starting and stopping times of each fishing trip
Types of bait used—such as plugs, flies, worms
Whether fishing was done from a boat or from shore
Whether the fisherman had a state fishing license or was too young to need one

Fishing Regulations

The state fish code during the years 1942–1950 allowed each fisherman to keep 50 bluegills and 10 bass a day and provided for a 10-inch length limit on bass but no length limit on bluegills. Fishing with live minnows was allowed at Lake Glendale only during the 1943 season. The fishing day was limited to the approximate hours of 6 AM to 9 PM Central Standard Time.

The length of the fishing season at Lake Glendale varied somewhat from year to year. The usual opening date corresponded with the opening date of the largemouth bass season in southern Illinois, May 15. The regular season ended with the closing of the concession stand at the lake, the dates varying from September 1 to September 20. Closing dates were determined mainly by weather. Special seasons were set up by the Natural History Survey in 1943 and 1946: in 1943, fishing was allowed each Sunday throughout September, October, and November, and in 1946, fishing was allowed on the five Sundays preceding the regular May 15 opening. Fishermen were allowed to keep largemouth bass as well

as other species during the special 1943 and 1946 seasons. This report includes fish caught during the two special seasons.

The fishing regulations that applied to Lake Glendale were posted on the road leading to the lake from State Highway 145, at the two picnic areas, at the concession stand, and at the boat dock. In spite of the posted regulations, a certain amount of fishing—possibly 5 to 15 per cent of the total—was unreported each year. Some of this was shore fishing from the picnic areas, most of it by people who failed to read the signs. Some fishing was done at night after the closing hour for the creel-census station, and some was done outside the regular season. Possibly some of the fishermen who reported zero catches did not actually leave empty handed. Harvest figures reported here are therefore too low, but it is not believed that the unreported fishing had any serious effect on computed catch rates (catch per trip) or that it invalidated the comparisons of the two stocking efforts.

Length Measurements

In the summer of 1942, Natural History Survey employees measured and recorded lengths of 22 per cent of the bass kept by sportsmen; most of these length measurements were made on May 15, the opening day of the fishing season. No length measurements were made in 1943. In the summers of 1944–1950, Survey employees hired as test fishermen (one each summer) recorded lengths and weights of all kinds and all sizes of fish which they themselves caught during their test fishing trips. The test fisherman on duty in 1944 measured 66 per cent of the bass catch for the year. He measured bass on Sundays from early June through early September. Census clerks (concession stand employees) recorded the lengths of most of the bass kept by sportsmen in the years 1947–1950, but did not record the lengths of other species; their length data included 87 to 96 per cent of the bass harvested by sportsmen in the years 1947, 1949, and 1950 and slightly more than half of the bass harvested in 1948.

Fish lengths (total lengths) were measured to the closest 0.1 inch and grouped into half-inch classes for showing length distribution. For example, the 12-inch class includes fish that measured 11.8 to 12.2 inches and the 12.5-inch class fish that measured 12.3 to 12.7 inches.

Population Censuses

In the two censuses of fish populations at Lake Glendale (the first, in 1946, a census of all species present and the second, in 1950, a census of only the largemouth bass), water was let out of the lake through a drain valve into a dewatering ditch below the dam.

To stop the fish coming through the valve, two screens were installed side by side in slotted concrete pillars about 200 feet below the dam (Fig. 3). The screens were made of 1-inch-mesh poultry netting stretched across frames made of 1.5-inch angle iron, each frame 8 feet long and 2.5 feet high. When small fish began coming through the drain valve they were stopped by placing hardware cloth screens (0.25-inch mesh) over the poultry netting. Planks placed in the slotted pillars in front of each screen raised the water level on the upstream side of the screens to form a seining pool, about 2 feet deep, from which fish were collected.

In 1946, fish remaining in the lake basin were collected and counted after they had been killed with rotenone. In 1950, an estimate of the number of bass remaining in the basin was made by the mark-and-recovery method.

THE 1946 CENSUS OF ALL SPECIES.—Draining of Lake Glendale in 1946 was begun on October 4 and completed October 31.

When leaves that had fallen from nearby trees clogged the 1-inch-mesh screens in the early stages of draining,

Fig. 3.—Weir for collecting fish that moved out of Lake Glendale during the draining operations in 1946 and 1950.

the screens were removed and were not replaced until the level of the lake had been dropped 7 feet. Fish did not begin coming through the drain valve until October 24, when the lake level had fallen 14 feet.

The fish that came through the drain valve were counted, weighed, and then hauled to a nearby farm pond by a crew of five men. This part of the operation required 5 days, October 26–30. The fish were afterward used in restocking the lake.

When as much water as possible had been drained from the lake basin, the larger part of the fish population of 2 inches and longer remained within the basin in a 1,300 foot stretch of the original stream channel (Fig. 4), while small numbers of fish remained in some very small isolated pools in other parts of the basin. The part of the channel where the fish were concentrated was approximately 30 feet wide and had an average depth of about 2 feet. Many of the fish that remained in the channel might have gone out with the drain water if, in the late stages of draining, the water could have been let through the drain valve more rapidly and without interruptions. However, continuous rapid draining was impracticable: (i) because the drain water might have topped the screens, which were partially clogged with leaves, and (ii) because fish would have come through the valve faster than they could have been processed.

Early in the afternoon of November 6, a treatment of 11 pounds of powdered derris (5 per cent rotenone) was applied to the channel and the isolated pools; this was followed by a second treatment of the same waters with 15 pounds of derris on the afternoon of November 8. The volume of water treated was about 2 acre-feet.

A hoop net that was placed in the channel and raised at irregular inter-

vals from October 25 to November 22 (Table 1) showed sharp increases in catches on November 1, following the completion of drainage on October 31 and the confinement of a large part of the fish population in the stream channel. Contributing to the increases may have been accelerated fish activity resulting from severe crowding, extremely high turbidity, and difficulties in locating food. Contributing to still higher catches on November 7 and 8 may have been the rotenone treatment on November 6, a rainstorm and a 3-foot rise in water level on the night of November 6, and a fall in the water level after the drain valve was reopened on November 7.

The indications from Table 1 are that most of the bass and bluegills in the stream channel were killed by the first rotenone treatment and that the remainder were killed by the second; that large numbers of warmouths and green sunfish survived the first treatment and that some survived the second. That more fish were not killed by the first treatment may have been due to the inflow of storm water on the night of November 6, which diluted the concentration of the rotenone.

The apparent elimination of the bass and bluegills and the survival of warmouths and green sunfish suggested by Table 1 is substantiated by later observations. In March, 1947, 4 months after the lake had been restocked with fin-clipped bass and bluegills, the catch in six nets raised on 3 successive days included 1 fin-clipped bass and

Fig. 4.—Part of the stream channel in the Lake Glendale basin, November 26, 1946. A large part of the fish population remained in the channel after the 1946 and 1950 drainings.

75 fin-clipped bluegills but no bass or bluegills that had not been fin-clipped. The same catch included 2 adult green sunfish that had not been fin-clipped. During the summer of 1947, the Natural History Survey test fishermen caught 8 additional green sunfish that had not been fin-clipped. Six of these were large enough to have been survivors of the rotenone treatments. Other fish caught by the test fishermen in 1947 included 66 adult fin-clipped bass, 2 small bass not fin-clipped (scale examination indicated these were young-of-the-year fish), and 23 fin-clipped bluegills (no bluegills not fin-clipped). No warmouths were taken from the lake in 1947, but they were caught by anglers in 1948 and later.

Since the rate of dosage was much heavier than the 3 pounds of derris per acre-foot commonly used, it is likely that the low water temperatures at the time of the treatments were responsible for the slow action of the rotenone. It is also likely that low temperatures were responsible for the incomplete kill, and that they contributed to the slow rate at which dead fish bloated and came to the surface of the water. When the hoop net was examined (but not emptied) about 3 hours after the rotenone was applied on November 6, all but a few fish were found to be alive. As is well known, in warm weather large numbers of dead fish are usually seen at the surface within an hour after rotenone is applied. A few dead bluegills 1 inch long were seen in the channel on November 6, but no live adult fish suffering from the treatment were seen that day; no dead adults were seen on the water surface until November 9. The first large collection of dead fish was made on November 10, and fish continued to rise to the surface through November 21.

Maximum daily air temperatures at

Table 1.—Number of fish caught and number found alive in a single hoop net set in the old creek channel in Lake Glendale October 25–November 22, 1946, during latter part of the draining operation and period of rotenone treatment and recovery of fish killed. Draining of the lake, except for the part of the channel that was too low to drain, was completed on October 31. Rotenone was applied on the afternoons of November 6 and 8. The net was fished continuously but raised only on the dates shown.

Date	*Largemouth Bass*		*Bluegills*		*Warmouths*		*Green Sunfish*	
	Number in Net	Number Alive	Number in Net	Number Alive	Number in Net	Number Alive	Number in Net	Number Alive
Oct. 25	..	..	8	8	..	..	..	..
26	..	..	14	14	..	..	..	..
27	..	..	8	8	..	..	..	..
28	..	..	19	19	..	..	..	..
29	1	1	15	15	2	2	..	..
Nov. 1	21	21	355	355	17	17	1	1
4	11	11	144	144	63	63	2	2
7*	92	0	430	2	191	2	48	3
8	1	1	17	17	145	145	57	57
9	..	..	1	†	22	†	9	†
10‡	..	..	..	..	1	1	..	..
11	..	..	..	..	3	2	2	2
12	..	..	..	..	5	4	6	6
13	..	..	..	..	6	5	7	7
22	..	..	..	..	4**	3	10	10

* When the net was raised and reset without being emptied at 5 PM on November 6, practically all fish in the net were alive. This November 7 catch was observed at 10 AM; at 4 PM the net contained four bluegills, six warmouths, two green sunfish, and one black bullhead, all alive.

† Number alive not recorded. Probably some fish were dead as a result of the application of rotenone on November 8.

‡ On this and subsequent raises, the fish were counted but were left in the net.

** Two of the six warmouths left in the net on November 13 escaped or were eaten by turtles.

Harrisburg, about 25 miles north of Lake Glendale, during the 2 weeks of November 6–19, 1946, ranged from 53° to 69° F., while minimum temperatures ranged from 29° to 54° F. Maximum and minimum air temperatures on the dates of rotenone application were, respectively, 66° and 48° F. on November 6, and 58° and 46° F. on November 8 (U.S. Weather Bureau 1946:66).

Brown & Ball (1943:271–272) recorded an instance in which some of the fish killed with rotenone during a cold period in spring settled to the bottom and completely decomposed without coming to the surface.

The fact that most of the fish that came to the surface were coated with mud as much as one-eighth inch thick suggests that the weight of the mud prevented many fish from rising to the surface (or retarded the rise) even after bloating reached an advanced stage. Probably a large amount of silt which had been kept in suspension by the movements of the live fish settled over the dead fish after they had sunk to the bottom. The turbulence resulting from operating a small motorboat in the channel released some of the dead fish from the silt.

When it was found on November 21 that there were still dead fish on the bottom of the channel, a garden rake was used to release them from measured areas in order that they might be counted. In an area covering 960 square feet (24 × 40 feet) at the extreme downstream end of the channel, a thorough raking released 109 bluegills (primarily adult sizes), 19 largemouth bass (10 inches and smaller), and 7 adult warmouths. The rake was then dragged along the bottom of the channel from the stern of a rowboat for a distance of 900 feet; an area of 1,100 square feet was covered. In this second operation, 42 fish, mainly adult bluegills, were recovered. Obviously most of the dead fish on the bottom were concentrated at the extreme downstream end of the channel.

On the basis of the above counts, the following estimates were made of the numbers of dead fish remaining on the bottom of the channel after the raking:

800 bluegills (165 pounds)
80 largemouth bass (22 pounds)
30 warmouths (5 pounds)

These estimates were added to the counts of the fish that were actually handled. No estimates were made of the number of live warmouths or of live green sunfish that survived poisoning.

All live fish of each species taken during the draining operation were sorted into readily recognized length groups; fish in these groups were counted and were weighed in lots of approximately 50 fish. The dead fish taken after the rotenone treatment were also sorted according to length; they were counted and were then weighed in groups, or group weights were approximated from the counts. All bass of exceptionally large sizes were measured; they were weighed individually or individual weights were approximated from a length-weight curve.

The census included fish of 2 inches or more in length. Some 2- to 3-inch fish may have escaped through the 1-inch-mesh screens before the hardware cloth was installed, but the number of these probably was not significant. Most of the fish less than 2 inches in length were bluegills that measured 0.75 inch to 1.5 inches, fish that probably were spawned 1 or 2 months before the draining operation. No estimate was made of the number of these small bluegills. Several thousand of them passed through the 1-inch-mesh screens before the 0.25-inch-mesh screens were put in place; thousands of others were stranded in the dense growth of water weeds during the initial 4-foot drop in water level. As shown by the following evidence, additional thousands of small bluegills must

have been eaten by adult bluegills, green sunfish, and bass during the late stages of draining, when the young fish were without any kind of weed protection. Eight of 20 large bluegills picked at random on October 26 from among the first lot of adult bluegills to leave the lake in the drain water contained small bluegills, most of them in fresh condition. Counts of these small bluegills found in the stomachs of the eight large bluegills were 2, 2, 3, 16, 18, 22, 24, and 28. A single green sunfish 5.5 inches long contained 13 small fish, all about 1 inch long, presumably bluegills. Two warmouths, one measuring 5 inches and the other 7 inches, had empty stomachs. A 19-inch largemouth bass had an empty stomach, but other bass were seen chasing small fish at the edge of the lake as the water level was falling. Bass predation on small bluegills occurred during the 1950 draining, and it can be assumed to have occurred also in 1946; on September 19–20, 1950, four bass of 8.7–9.8 inches caught on hooks in the creek channel within the lake basin contained 1, 2, 3, and 15 bluegills that were 0.75–1.25 inches long.

Table 2.—Numbers and weights of largemouth bass in Lake Glendale at the time of the October, 1950, draining operation. Numbers and weights of fish removed in the operation were added to numbers and weights of those remaining (estimate made by mark-and-recovery method, Tables 3 and 4) to give the totals.

Census Group	*Length Grouping, Inches*							
	3–6.5 Inches		7–12.5 Inches		Over 12.5 Inches		All Sizes	
	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
Fish collected from drain water	343	10	1,034	373	7	13	1,384	396
Fish removed by other means	. . .	. .	454*	169	. . .	. . .	454	169
Fish remaining (mark and recovery estimate)	. . .	. .	2,415†	903	126‡	397	2,541	1,300
Total	*343*	*10*	*3,903*	*1,445*	*133*	*410*	*4,379*	*1,865*

* Of these fish, 439 were removed by shocking, 4 by angling, 11 by hoop net.
† From estimate shown in Table 3.
‡ From estimate shown in Table 4.

The 1950 Census of the Bass Population.—The 1950 census of the population of largemouth bass was undertaken as a basis for an experimental reduction in the bass population. As in the 1946 census, the lake was lowered in the fall until the only water left was that remaining near the dam in a 1,300-foot stretch of the old stream channel and in isolated pools, which could not be drained (frontispiece). The bass collected at the screens below the drain outlet were counted. Some of the bass that failed to leave the lake during the draining were removed by hoop net and through electric shocking, and some were marked and returned to the water to be used to estimate the remaining population by the mark-and-recovery method. The actual numbers of bass removed by draining, shocking, and netting and the estimated numbers

that remained in the channel are shown in Table 2.

In the marking operation, 154 bass measuring 7 to 12.5 inches were marked by removal of the right pectoral fin. The area of skin from which a scale sample was removed served as a mark for each of 79 bass longer than 12.5 inches.

The population estimates of bass of the two size categories shown in Tables 3 and 4 were obtained from the Schnabel formula cited by Ricker (1942:231) for estimating the size of a population

Table 3.—Estimates of number of 7–12.5-inch largemouth bass remaining in Lake Glendale after part of the population had been removed in the draining operation of October, 1950. The Schnabel method of computing populations from recovery of marked fish was used. The bass in only the first four samples were marked. Because of the length of time the marked fish had to mix with the unmarked fish, the last population estimate is assumed to be the most nearly accurate. This estimate (2,415 fish) is only slightly lower than the one obtained from sample 5 (before 439 bass in samples 5, 6, and 7 had been withdrawn) and was used in calculating the total population (Table 2).

Date	*Sample*	*Number of Fish in Sample* (A)	*Number of Previously Marked Fish in Population at Time of Sampling* (B)	*Product* $(A\ B)$	*Sum of Products* $\Sigma(A\ B)$	*Number of Marked Fish in Sample* (C)	*Cumulative Sum of Marked Fish in Samples* $\Sigma(C)$	*Population Estimate* $\frac{\Sigma(A\ B)}{\Sigma(C)}$
Oct. 11	1*	26	0	....	....	0	..	...
	2	27	26	702	702	1	1	702
	3	54	52	2,754	3,456	3	4	864
	4	52	103	5,356	8,812	1	5	1,762
	5	117*	154	18,018	26,830	6	11	2,439
	6	110*	148	16,280	43,110	6	17	2,536
	7	212*	142	30,104	73,214	11	28	2,615
Oct. 12	8	164	131	21,484	94,698	11	39	2,428
	9	70	131	9,170	103,868	4	43	2,415

* All fish in sample, including marked fish, were withdrawn from population after sample was examined for marks.

Table 4.—Estimates of number of largemouth bass measuring more than 12.5 inches remaining in Lake Glendale after part of the population had been removed in the draining operation of October, 1950. The Schnabel method of computing population from recovery of marked fish was used. The estimate made on October 12 (126 fish) is assumed to be the most nearly accurate and was used in calculating the total population (Table 2).

Date	*Sample*	*Number of Fish in Sample* (A)	*Number of Previously Marked Fish in Population at Time of Sampling* (B)	*Product* $(A\ B)$	*Sum of Products* $\Sigma(A\ B)$	*Number of Marked Fish in Sample* (C)	*Cumulative Sum of Marked Fish in Samples* $\Sigma(C)$	*Population Estimate* $\frac{\Sigma(A\ B)}{\Sigma(C)}$
Oct. 10	1	10	0	...	...	0	..	...
	2	12	10	120	120	0	..	...
	3	21	22	462	582	3	3	194
	4	13	40	520	1,102	5	8	138
	5	5	48	240	1,342	0	8	168
	6	16	53	848	2,190	6	14	156
Oct. 11	7	6	63	378	2,568	3	17	151
	8	9	66	594	3,162	6	23	137
	9	6	69	414	3,576	3	26	138
	10	8	72	576	4,152	5	31	134
Oct. 12	11	20	75	1,500	5,562	14	45	126

while marking is in progress. The population at any one sampling time is computed by the formula $\frac{\Sigma (AB)}{\Sigma (C)}$, in which A is the total number of fish in the sample, B is the number of marked fish in the entire population when the sample is taken, and C is the number of marked fish in the sample. The last in each series of population estimates (for example, the estimates based on Sample 9, Table 3, and Sample 11, Table 4) is assumed to be the most nearly accurate in the series.

The samples used in the mark-and-recovery estimate were obtained with an electric shocker carried in a boat (Fig. 5); the current was furnished by a 115-volt, 11-ampere generator. Samples were obtained in several runs, each covering about one-sixth to one-half of the 1,300-foot section of channel. All parts of this 1,300-foot section were covered in the course of the sampling. Because of the high turbidity of the water, only the fish that rose to the surface could be collected. Fish of each of the two size categories shown in Tables 3 and 4 were not observed on all sampling trips with the shocker; hence the difference in number of samples shown in these tables.

In other tests of the accuracy of mark-and-recovery estimates of largemouth bass populations, a high degree of accuracy was reported in one pond (Carlander & Moorman 1956:663), moderate accuracy in three ponds, especially for bass more than 1 year old (Buck & Thoits 1965:606–607), and considerable inaccuracy in two ponds (Krumholz 1944:290; Hundley 1954:167). The degree of accuracy of the 1950 mark-and-recovery estimate of bass at Lake Glendale is perhaps fairly high due to the fact that the bass were concentrated in a small volume of water instead of being spread over the entire 82 acres. Because the bass were concentrated in a small space, there should have been the good mixing of marked and unmarked fish that is essential to obtaining close estimates of populations. A much larger percentage

Fig. 5.—Electrofishing for a mark-and-recovery estimate of the number of largemouth bass remaining in the stream channel after most of the water in Lake Glendale had been drained off in October, 1950.

of bass over 12.5 inches than below that length were marked, and the accuracy of the estimated population was therefore probably better for the larger bass than for the smaller ones.

STUDY PROCEDURES AT POUNDS LAKE

At the time Lake Glendale was stocked in April, 1940, the Natural History Survey also stocked Pounds Lake (Fig. 6), a 32-acre lake that had just been built on U.S. Forest Service land in Gallatin County, 40 miles northeast of Lake Glendale. A water sample from Pounds Lake, collected in May, 1963, had a total hardness of 26 ppm, which was similar to that of Lake Glendale and the ponds at Dixon Springs.

Pounds Lake was stocked at the rate of 1.7 adult bass and 3.6 adult bluegills per acre. The fish were of the same sizes as those used in stocking Lake Glendale. (Lake Glendale was stocked at the rate of 0.9 adult bass and 2.6 adult bluegills per acre.) The Pounds Lake stock (55 largemouth bass and 120 bluegills), like the stock for Lake Glendale, came from Lake Chautauqua near Havana, Illinois. A rotenone treatment of the stream that feeds Pounds Lake, applied in 1939 before the water was impounded, failed to eliminate all of the green sunfish and yellow bullheads, *Ictalurus natalis* (Lesueur), in the stream. These species reproduced in the lake but were never very abundant. Five hundred mosquitofish, *Gambusia affinis* (Baird & Girard), were released in Pounds Lake by the local forest ranger in 1940.

The gizzard shad, *Dorosoma cepedianum* (Lesueur), a favorite forage fish of bass, was present in Pounds Lake in

Fig. 6.—Fishermen with bluegills at Pounds Lake, May 16, 1942.

the fall of 1947 when the lake was drained, but scales examined from shad collected at that time suggest that this fish was introduced late in 1946 or early in 1947.

Pounds Lake, like Lake Glendale, was opened to fishing on May 15, 1942. Subsequently, except in 1943 and 1946 when the length of the fishing season at Lake Glendale was extended, the two lakes were opened to fishing each year on May 15 (the first day of the largemouth bass season in southern Illinois) and closed some time in September.

Through the cooperation of the Pounds Lake boat concessionaire, creel censuses were made for 6 weeks in 1943 and during most of the next three fishing seasons. The Pounds Lake record included numbers of fish kept by boat fishermen, but it did not include the weight of the fish kept or any data on baits. This record is assumed to have covered most of the fishing that was done during the periods shown in Table 8. The census covered neither private boats nor bank fishing, but Esden Jerrels, the concessionaire, pointed out that very few private boats were brought to the lake in the 1940's and that bank fishing at that time was very light.

In the years 1943–1945, a report was made out for each boat party, including the parties that returned without fish; it showed the number of fishermen in each boat and the number of each species of fish kept by the party. In the 1946 season, records were made for only those trips in which some member of the boat party kept one or more fish; therefore, the catch per trip for that season was not computed.

QUALITY OF FISHING FOLLOWING TWO PROGRAMS OF STOCKING

The success of a fish-stocking program may be measured by the quality of fishing as well as by fish-growth rates, size of standing crop of fish, and "balance" of species in the population.

The quality of fishing for bass and bluegills was markedly different in the two study periods at Lake Glendale. Bluegill fishing was decidedly better in the first period, after the lake had been stocked lightly in 1940 and kept closed to fishing for 2 years. Bass fishing was better in the second period, after the lake had been stocked more heavily in the fall of 1946 and opened to fishing the following spring.

The 2-year delay in opening the lake after the first stocking was necessitated by the small number of fish used in the stocking.

The first period, besides being the better of the two for bluegill fishermen, was also better for those fishermen who were not concerned about the kind of fish they caught; this period was the better in percentage of trips resulting in the capture of one or more fish (Table 5), in the total number and weight of fish harvested annually, and in the average number and weight of fish harvested per trip (Tables 6 and 7).

Striking differences between the two study periods were found in the ratios of total weight of bass to the total weight of bluegills harvested annually. Following the 1940 stocking, annual yields of bluegills (by weight) were 4 to 12 times as large as bass yields, while, for the first three seasons following the 1946 stocking, bluegill yields were smaller than bass yields (Table 7). But the catch of bluegills increased each year after 1947 until in 1950 the weight of bluegills finally exceeded that of bass. In three small unfertilized ponds at Dixon Springs (Hansen et al. 1960:365), the yields of bass were approximately the same as the yields of bluegills, whereas in three small fertilized ponds in the same study area the yields of bluegills were three times those of bass (each average based on three ponds fished for 5 years).

The 1940 introductions of fish at Pounds Lake and at Lake Glendale, with fewer than two adult bass and four adult bluegills per acre, was fol-

Table 5.—General information concerning sport fishing at Lake Glendale in the years following the 1940 stocking (first period) and after the 1946 stocking (second period). The data were derived from creel censuses.

Type of Information	First Period					Second Period			
	1942*	1943	1944	1945	1946	1947	1948	1949	1950
Number of trips†	2,754	1,308	859	973	1,517	407	1,110	1,032	1,544
Number of trips in which fish were kept	691	501	349	342	491	38	357	274	373
Percentage of trips in which fish were kept	25	38	41	35	32	9	32	27	24
Hours of fishing	..	7,174	3,951	4,421	7,380	1,425	4,329	4,748	6,888
Hours per trip	..	5.5	4.6	4.5	4.9	3.5	3.9	4.6	4.5
Hours per acre	..	87	48	54	90	17	52	58	84
Percentage of fishermen using the baits designated									
Plugs	..	18	17	25	22	31	42	34	27
Flies	..	12	19	14	15	9	16	16	13
Worms	..	51	36	47	55	33	17	21	37
Miscellaneous (including more than one bait)	..	19	28	14	8	26	25	29	22
Percentage of trips made by boat	..	80	79	79	69	69	89	88	87
Percentage of fishermen who were licensed (fishermen 18 years and older)	..	93	94	89	93	95	92	93	92

* Information on baits, hours of fishing, use of boats, and license status of fishermen was not collected in 1942.

† Trips were of various lengths. A trip, sometimes referred to as a man-day of fishing, represented the fishing done by one man on one day and could be from 6 AM to 9 PM, but was usually 2 to 8 hours.

lowed by similar fishing in the two lakes. Bluegill fishing (Table 8) was considered by many fishermen to be good at both lakes in the years 1943–1946. Bass fishing was considered poor at both lakes, except for the one good season at Pounds Lake in 1946.

The quality of fishing observed after three different stocking procedures tried in southern Illinois in the 1940's—stocking A used at Lake Glendale and at Pounds Lake in 1940, stocking B used at Lake Glendale in 1946, and stocking C used in three small unfertilized ponds at the Dixon Springs Agricultural Center in 1946—is shown in terms of the catch per hour in Table 9. Catch per hour (rather than catch per trip) was used for the reason that most of the trips to the small ponds were those of the test fishermen and lasted only 2 hours each instead of the 3.5 to 5.5 hours (yearly averages) recorded at Lake Glendale. The best catch rates for bass and bluegills were observed in the ponds. Bass fishing during the best years at Lake Glendale was only about a third as good as bass fishing in the ponds. The ponds contained larger standing crops in pounds of fish per acre than did Lake Glendale (Table 28).

Analysis of Bass Fishing

That bass fishing at Lake Glendale was much better after the second stocking than after the first is shown in the number and weight of bass kept each year and bass kept per trip (Tables 6, 7, and 10). The total bass harvest in 1948, 637 fish weighing 591 pounds, greatly exceeded that of any other year. The best bass harvest in the period 1942–1946 came in the year the lake was opened to angling; throughout this period the catch rates were

Table 6.—Number of fish kept and number kept per trip at Lake Glendale in years following the 1940 stocking (first period) and the 1946 stocking (second period). The record is based on all fishing, sport fishing and test fishing combined, irrespective of baits used. The number in parentheses below each year indicates the total number of trips for that year.

Species	*First Period*					*Second Period*			
	1942 (2,754)	1943 (1,308)	1944 (859)	1945 (973)	1946 (1,517)	1947 (407)	1948 (1,110)	1949 (1,032)	1950 (1,544)
Largemouth bass									
Number kept	279	92	120	61	137	70	637	341	375
Number kept per trip	*0.10*	*0.07*	*0.14*	*0.06*	*0.09*	*0.17*	*0.57*	*0.33*	*0.24*
Bluegill									
Number kept	4,064	4,917	3,060	3,108	5,461	34	375	961	3,064
Number kept per trip	*1.48*	*3.76*	*3.56*	*3.19*	*3.60*	*0.08*	*0.34*	*0.93*	*1.98*
Green sunfish									
Number kept	1,712	432	457	196	150	1	58	64	95
Number kept per trip	*0.62*	*0.33*	*0.53*	*0.20*	*0.10*	..	*0.05*	*0.06*	*0.06*
Warmouth									
Number kept	..	1	65	96	273	..	14	53	97
Number kept per trip	..	..	*0.08*	*0.10*	*0.18*	..	*0.01*	*0.05*	*0.06*
Others*									
Number kept	20	30	140	18	6	..	4	..	14
Number kept per trip	..	*0.02*	*0.16*	*0.02*	..	..	..	..	*0.01*
All species									
Number kept	6,075	5,472	3,842	3,479	6,027	105	1,088	1,419	3,645
Number kept per trip	*2.21*	*4.18*	*4.47*	*3.58*	*3.97*	*2.57*	*0.98*	*1.38*	*2.36*

* Principally hybrid sunfish but a few bullheads.

Table 7.—Pounds of fish kept and pounds kept per trip at Lake Glendale in years following the 1940 stocking (first period) and the 1946 stocking (second period). The record is based on all fishing, sport and test fishing combined, irrespective of baits used. The number in parentheses below each year indicates the total number of trips in that year.

Species	*First Period*					*Second Period*			
	1942 (2,754)	1943 (1,308)	1944 (859)	1945 (973)	1946 (1,517)	1947 (407)	1948 (1,110)	1949 (1,032)	1950 (1,544)
Largemouth bass									
Pounds kept	335	124	86	75	107	53	591	324	315
Pounds kept per trip	*0.12*	*0.09*	*0.10*	*0.08*	*0.07*	*0.13*	*0.53*	*0.31*	*0.20*
Bluegills									
Pounds kept	1,262	1,156	590	655	1,270	8	119	197	682
Pounds kept per trip	0.46	0.88	0.69	0.67	0.84	0.02	0.11	0.19	0.44
Green sunfish									
Pounds kept	324	68	66	36	26	..	12	14	20
Pounds kept per trip	*0.12*	*0.05*	*0.08*	*0.04*	*0.02*	..	*0.01*	*0.01*	*0.01*
Warmouth									
Pounds kept	..	..	10	21	67	..	4	15	31
Pounds kept per trip	..	..	*0.01*	*0.02*	*0.04*	..	..	*0.01*	*0.02*
Others									
Pounds kept	7	6	30	5	2	..	1	..	3
Pounds kept per trip	..	..	*0.03*	..	..	..	..	..	..
All species									
Pounds kept	1,928	1,354	782	791	1,472	61	727	550	1,051
Pounds kept per trip	*0.70*	*1.04*	*0.91*	*0.81*	*0.97*	*0.15*	*0.65*	*0.53*	*0.68*

Table 8.—Number of fish kept and number kept per trip by hook-and-line fishermen at Lake Glendale and Pounds Lake at corresponding times during the 1943–1946 fishing seasons. The fish caught at Pounds Lake were not weighed.

Year	*Lake*	*Dates*	*Number of Trips*	*Largemouth Bass*		*Bluegill*		*Green Sunfish*	
				Number Kept	Number Kept Per Trip	Number Kept	Number Kept Per Trip	Number Kept	Number Kept Per Trip
1943	Pounds	May 15–June 22	847	138	0.16	1,796	2.12	184	0.22
	Glendale	May 15–June 21	932	51	0.05	3,690	3.96	232	0.25
1944	Pounds	June 20–Sept. 3	174*	45	0.26	1,082	6.22	98	0.56
	Glendale	June 22–Sept. 6	342	66	0.19	1,147	3.35	231	0.68
1945	Pounds	May 15–Sept. 15	1,212	66	0.05	3,453	2.85	153	0.13
	Glendale	May 15–Sept. 13	958	61	0.06	3,034	3.17	196	0.20
1946	Pounds	May 1–Aug. 13	†	432	..	2,505	..	375	..
	Glendale	May 1–Aug. 13	1,099	82	0.07	4,351	3.96	68	0.06

* The creel census did not begin at Pounds Lake in 1944 until the heavy fishing was over

† No records were made of trips at Pounds Lake in 1946 unless a fishing party returned with one or more fish. The catch of 432 largemouth, 2,505 bluegills, and 375 green sunfish in 1946 was the total catch of 173 fishing parties which included 359 fishermen. Probably at least a thousand trips were made in 1946.

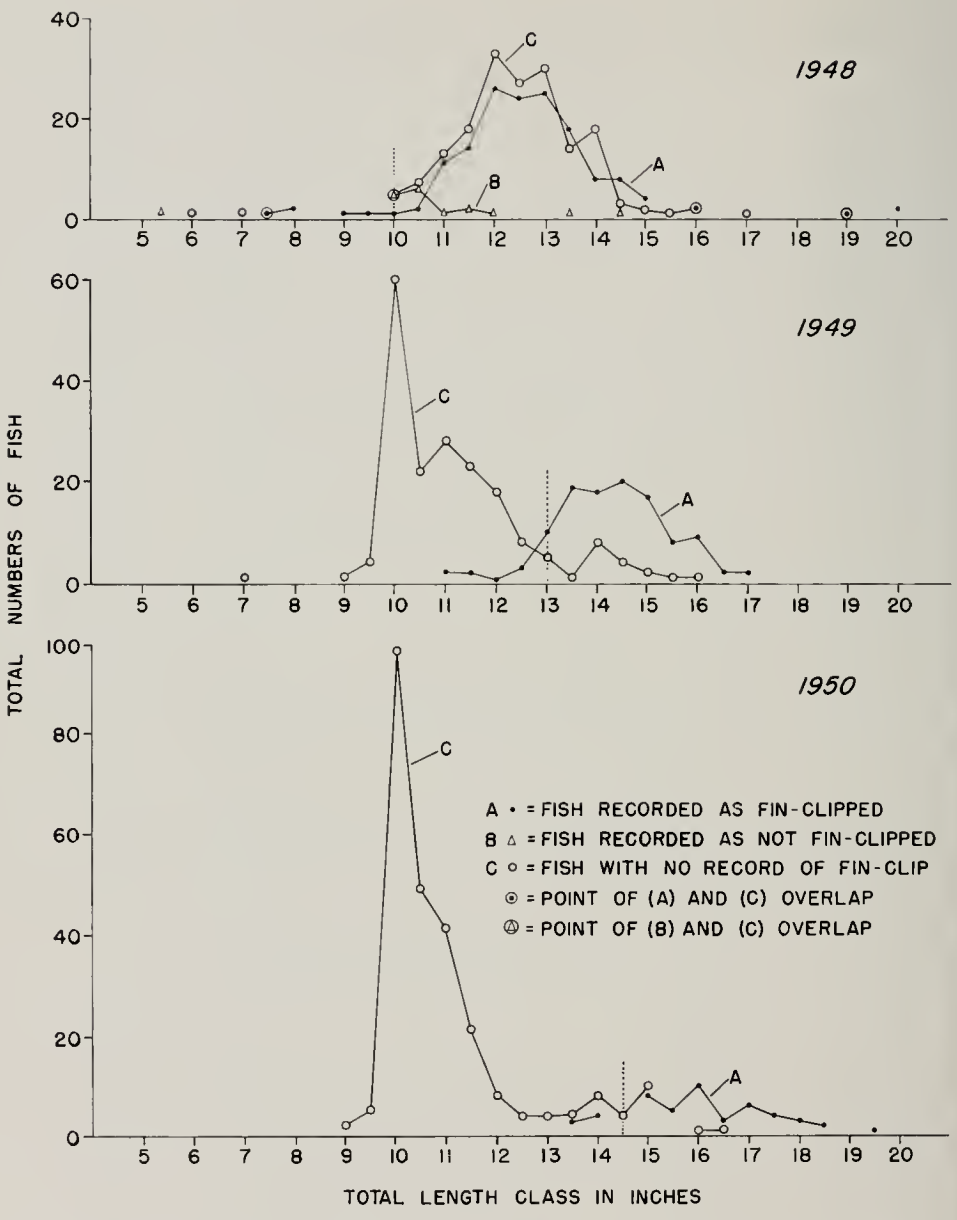

Fig. 7.—Length distributions of largemouth bass harvested by sport fishermen and measured by census clerks at Lake Glendale, 1948–1950. The occurrence of fin-clipped bass (the original stock) in the catch was recorded from time to time by census clerks—more consistently in 1949 and 1950 than in 1948. Fish recorded as fin-clipped are represented by curve A and those recorded as not fin-clipped (in 1948 only) by curve B. Fish for which no record was made of whether they were fin-clipped or not fin-clipped are represented in curve C. Some of the largest and smallest sizes of categories A, B, and C are shown as isolated points. Most of the fish of sizes indicated by the vertical dotted line and larger in each year are assumed to have been the original stock, although some of them were not reported as fin-clipped. Most of the fish of smaller sizes are assumed to have been members of new broods. The distributions of the fish measured indicate that bass of the original stock made up more than 90 per cent of the bass removed by sport fishermen in 1948, about half of those removed in 1949, and about a fifth of those removed in 1950.

Table 9.—Hook-and-line catch rates in southern Illinois waters in which different stocking procedures were used.*

Stocking Procedure, Lake, and Year of Stocking	*Years Fished*	*Largemouth Bass*		*Bluegill*	
		Number Per Hour	Pounds Per Hour	Number Per Hour	Pounds Per Hour
Stocking A					
1–2 adult bass, 3–4 adult bluegills per acre					
Lake Glendale (1940)	1942–1946	0 02	0.02	0 64	0.14
Pounds Lake (1940)	1943–1945	0 03	....†	0.76	....†
Stocking B					
27 fingerling and adult bass, 41 fingerling and adult bluegills per acre					
Lake Glendale (1946)	1947–1950	0 08	0 07	0 25	0 06
Stocking C					
21–36 fingerling and adult bass, 310–412 fingerling bluegills per acre**					
Wells, Boaz, and Elam ponds (1946)	1947–1952‡	0.29	0.21	1.00	0.22

* Data for Lake Glendale and Pounds Lake derived as follows: Catch per trip (Tables 6, 7, and 8) divided by average lengths of trips shown in Table 5. Average lengths of trips at Lake Glendale in 1942 were arbitrarily set at 5 hours. Average lengths of trips at Pounds Lake were assumed to be the same as at Lake Glendale in 1943–1945. Data for Wells, Boaz, and Elam ponds are from Hansen et al. 1960:369.

† Fish caught at Pounds Lake were not weighed.

‡ Largemouth bass were caught each year, beginning in 1947, bluegills each year, beginning in 1948.

** The largemouth bass in this stocking were 6 to 10 inches long; the bluegills were about 1 inch long.

low. Annual harvests ranged from 0.7 to 3.4 bass per acre in the first period and from 0.9 to 7.8 per acre in the second period.

The bass with which Lake Glendale was stocked in 1946 figured prominently in the total bass harvest by sport fishermen in the first 3 years of the 1947–1950 period and contributed heavily to the harvest of the large bass caught throughout the period. The catch by the test fisherman (Table 13) indicates that all of the legal-size bass caught in 1947 were fish used in the 1946 stocking. The length-frequency curves in Fig. 7 suggest that more than 90 per cent of all bass harvested by fishermen in 1948, about half of those harvested in 1949, and about a fifth of those harvested in 1950 were fish used in the stocking. The curves in Fig. 7 also suggest that a great majority of the 10-, 11-, and 12-inch bass caught in 1949 and 1950 were offspring of the 1946 stock.

Catch rates for largemouth bass at Lake Glendale showed a peak in 1948, the second growing season after the 1946 stocking (Table 6). The catch rate for bass after the 1940 stocking was best in 1942; after 1942 catch rates were so low that the year-to-year differences could not be noticed by fishermen. At Pounds Lake the largest numbers of bass were taken in 1946, the seventh growing season (Table 8), but, as the record of the number of fishing trips in this season was incomplete, the catch rate was not calculated. The harvest at Pounds Lake was not observed in 1942, which, in terms of total bass harvest, was the best year in the first study period at Lake Glendale (Table 6). In each of the three unfertilized ponds at Dixon Springs (Hansen et al. 1960:384), a peak in bass catch rates occurred in the first growing season after stocking and one or two additional peaks occurred in the fourth, fifth, or sixth season.

Like the total bass harvest (Table 6), the harvest of bass with artificial baits was considerably better in 1947–1950 than in the earlier period (Table 10). In the fishing done with worms, the bass harvest showed some improvement in the second period, but not one that fishermen would have noticed.

In most years of each period, fly rod lures produced the best bass fishing in terms of number of fish harvested per trip, but casting rod lures produced the best bass fishing in terms of weight of fish harvested per trip (Table 10). The years 1947 and 1948 were the best in either period for catching bass on flies

Fig. 8.—One fisherman's string of largemouth bass caught at Lake Glendale on the day the lake was first opened to fishing, May 15, 1942.

(number of bass per trip); 1948 was the best year for taking bass on plugs and worms. The lack of year-to-year consistency in the catch-rate figures for plugs and flies may have been due in part to sampling errors.

The superior bass fishing that took place on the first day of the 1942 season at Lake Glendale (Fig. 8) was followed by a sharp drop on the second day (Table 11). The cause of this drop was long a subject of discussion and argument among Glendale anglers. Forty per cent of the bass harvested in 1942 were caught on the first day of the season; 75 per cent were caught during the first 15 days of fishing. Most of the bass harvested the first day were caught during the first 4 hours. The good fishing started at 6 AM and ended with the arrival of a cold front and a sharp drop in temperature at about 10 AM. The early season declines in other years, most noticeable in 1948 and 1949, were not as sharp as in 1942.

The phenomenon of a high rate of catch of bass at the beginning of a fishing season, followed by a rapid decline, has been reported at other lakes by Dill (1946:59–60), Bennett (1954: 256–261), and Bowers & Martin (1956: 8–9). Many of the fishermen at Lincoln Trail Lake, east-central Illinois, on the opening day of the 1958 fishing season reported that they caught the majority of their largemouth bass in the first 2

Table 10.—Catch of largemouth bass, and catch per trip, on various types of bait at Lake Glendale.* Fishing with spinning rods and spinning lures had not become popular at the time of this study.

	First Period				*Second Period*			
	1943	1944	1945	1946	1947	1948	1949	1950
Casting rod lures (plugs, etc.)								
Number of trips	231	143	247	334	128	463	350	424
Number of fish kept	47	25	19	20	29	354	148	154
Pounds kept	71.6	30.4	38 0	42 7	28.1	341 3	153 4	161 4
Number kept per trip	*0.20*	*0.17*	*0.08*	*0.06*	*0.23*	*0.76*	*0 42*	*0 36*
Pounds kept per trip	*0.30*	*0.21*	*0.15*	*0.13*	*0 22*	*0 74*	*0.44*	*0 38*
Fly rod lures (flies, poppers, etc.)								
Number of trips	162	162	138	222	38	173	169	201
Number of fish kept	12	54	16	35	27	125	80	92
Pounds kept	11.1	30 1	7 0	18 6	17 1	104 9	79 1	65 3
Number kept per trip	*0.07*	*0 33*	*0.12*	*0.16*	*0 71*	*0 72*	*0.47*	*0.46*
Pounds kept per trip	*0 07*	*0.19*	*0.05*	*0.08*	*0.45*	*0 61*	*0.47*	*0 32*
Worms†								
Number of trips	664	313	454	842	136	190	212	576
Number of fish kept	11	12	15	62	1	25	18	45
Pounds kept	13.5	5 2	14.5	33.8	0 5	23 5	13.5	32.6
Number kept per trip	*0.02*	*0 04*	*0.03*	*0 07*	*0.01*	*0.13*	*0 08*	*0 08*
Pounds kept per trip	*0.02*	*0 02*	*0.03*	*0.04*	....	*0 12*	*0 06*	*0.06*
Miscellaneous baits								
Number of trips	251	241	134	119	105	284	301	343
Number of fish kept	22	29	11	20	13	133	95	84
Pounds kept	27.5	20 4	15.5	11 7	7 6	121.2	77.9	55.9
Number kept per trip	*0.09*	*0 12*	*0.08*	*0.17*	*0.12*	*0 47*	*0.32*	*0.24*
Pounds kept per trip	*0.11*	*0.08*	*0 12*	*0 10*	*0 07*	*0 73*	*0 26*	*0 16*

* Trips represented under casting rod lures, fly rod lures, and worms are those in which the named bait types were the only ones used. Less frequently used baits, such as crayfish and cockroaches, and combinations of baits, such as plugs and worms, on the same trip, are lumped under miscellaneous baits. The total harvest of largemouth bass (all baits) is given in Table 6. The kinds of baits used were not recorded in 1942.

† Includes garden worms, nightcrawlers, manure worms (commercial red wigglers), and certain insect larvae, such as catalpa worms.

Table 11.—Harvest of largemouth bass at Lake Glendale during first 15 days of the 1942 season. The lake was closed to fishing on Monday of each week.

Date	*Number of Trips**	*Number of Bass Kept*
May 15	151	112
16	130	25
17	331	18
18 (lake closed)	..	..
19	55	13
20	27	1
21	40	5
22	36	10
23	53	2
24	188	3
25 (lake closed)	..	..
26	17	4
27	32	3
28	50	5
29	20	2
30	105	7
31	99	3

* Number of trips is the same as number of fishermen visiting the lake or man-days of fishing, irrespective of baits used, and covers all fishermen whether they were fishing especially for bass or not. There were no trips by test fishermen in 1942.

hours of fishing (Lopinot 1958:5). Eschmeyer (1942:101) reported that during the 1940 season at Norris Reservoir, Tennessee, 71 per cent of the fish harvested (many of them largemouth bass) were caught in June, the first month of fishing.

Dill (1946:60) thought that the presence of relatively large numbers of "bass fishermen" during the first few days of a new season was an important factor in the large early-season bass harvest. Bennett (1954:260) suggested that either the more aggressive bass were caught easily during the first few hours of fishing or that under heavy fishing at the start of the season the bass that escaped early capture might become wary of boats and fishermen's baits. Eschmeyer (1942:101) and Byrd (1959:230) believed that the early-season drop in catch (observed in fishes of various kinds) might have resulted primarily from a reduction in the pop-

Table 12.—Average weights (pounds) of the largemouth bass caught and kept by Lake Glendale anglers using different types of bait.*

	First Period					*Second Period*			
	1942†	1943	1944	1945	1946	1947	1948	1949	1950
Casting rod lures (plugs, etc.)									
Number of bass	...	47	25	19	20	29	354	148	154
Pounds of bass	...	72	30	38	43	28	341	153	161
Average weight	...	*1.53*	*1.20*	*2.00*	*2.15*	*0.97*	*0.96*	*1.03*	*1.05*
Fly rod lures (flies, poppers, etc.)									
Number of bass	...	12	54	16	35	27	125	80	92
Pounds of bass	...	11.1	30.1	7.0	18.6	17.1	104.9	79.1	65.3
Average weight	...	*0.93*	*0.56*	*0.44*	*0.53*	*0.63*	*0.84*	*0.99*	*0.71*
Worms‡									
Number of bass	...	11	12	15	62	1	25	18	45
Pounds of bass	...	13.5	5.2	14.5	33.8	0.5	23.5	13.5	32.6
Average weight	...	*1.23*	*0.43*	*0.97*	*0.55*	*0.50*	*0.94*	*0.75*	*0.72*
All baits‡									
Number of bass	279	92	120	61	137	70	637	341	375
Pounds of bass	335	124	86	75	107	53	591	324	315
Average weight	*1.20*	*1.35*	*0.72*	*1.23*	*0.78*	*0.76*	*0.93*	*0.95*	*0.84*

* Trips represented under casting rod lures, fly rod lures, and worms are those in which the named bait types were the only ones used. Less frequently used baits, such as crayfish and cockroaches, and combinations of baits, such as plugs and worms, on the same trip, are lumped under miscellaneous baits. The total harvest of largemouth bass (all baits) is given in Table 6.

† No record of baits was kept in 1942.

‡ Includes garden worms, nightcrawlers, manure worms (commercial red wigglers), and certain insect larvae, such as catalpa worms.

ulation of fish of harvestable sizes. Eschmeyer (1942:110) estimated that the harvest of game fish at Norris Reservoir in June, 1940, was about 14 per cent of the population of legal-size game fish at the beginning of the fishing season and that the harvest for the entire fishing season (June–November) was only about 20 per cent of this population. Bennett (1954:259–260) found at Ridge Lake that the best bass fishing in each of four seasons occurred on the morning of the opening day and dropped off sharply after only a small proportion of the bass population had been caught.

The real reason for the drop in bass fishing success in the course of the opening day of fishing at Lake Glendale remains unknown. Several factors may have been involved. A substantial number of the least wary bass, the most

Table 13.—Size distribution of largemouth bass caught at Lake Glendale by Natural History Survey test fishermen, 1944–1950. Most of the fishing was done with fly rods and small popper flies. An asterisk (*) following a number indicates recorded fin-clipped bass of the 1946 stocking, except as noted for 1948. The legal length of bass at the time of this study was 10 inches. The 10-inch class (below broken line in table) includes fish measuring 9.8–10.2 inches.

Length Class, Inches	*First Period*			*Second Period*			
	1944	1945	1946	1947	1948†	1949	1950
4.0				1			
4.5	3			..	1	1	
5.0	1	1		..	..	1	1
5.5	6	1	2	1	1	2	1
6.0	2	3	7	..	3	3	2
6.5	19	6	10	..	1	1	6
7.0	8	8	7	..	4	7	2
7.5	13	8	5	..	15	17	6
8.0	29	21	25	4*	6	30	24
8.5	92	24	30	4*	6	24	21
9.0	100	20	35	7*	3	28	27
9.5	47	10	31	6*	5	19	35
10.0	54	5	24	9*	..	13	34
10.5	12	4	10	12*	2‡	7	10
11.0	2	..	3	11*	2*	1	2
11.5	1	3	2	7*	7*	4	6
12.0	1	..		4*	6*	3	..
12.5	1	1		1*	4*	1	..
13.0	1	..		..	2*	..	..
13.5	..	1		..	4*	1*	..
14.0	..			..	1*	..	1
14.5	..			..	1*	2*	1
15.0	..			..		1*	
15.5	..			..		1*	
16.0	..			..			
16.5	1			..			
17.0	..			..			
17.5	..			..			
18.0	1			..			
18.5	1			1*			
Total	*395*	*116*	*191*	*68*	*74*	*167*	*179*

* Recorded fin-clipped bass of the 1946 stocking.

† In 1948, the number of fin-clipped bass of the 1946 stocking was based partly on size of fish. It was assumed that, because of their size, all of the fish of 11 inches and longer were of the 1946 stock (*) even though not all of these fish were recorded as fin-clipped. In the various length classes, the numbers of fish actually recorded as fin-clipped were as follows: 10.5-inch length class—1 fish; 11—0; 11.5—5; 12—3; 12.5—3; 13—0; 13.5—1; 14—1; 14.5—1.

‡ One of these two fish was recorded as fin-clipped; the other was recorded as not fin-clipped.

Table 14.—Size distribution of largemouth bass caught at Lake Glendale by sport fishermen under the permit system, as indicated by a sampling of the bass caught. Meaurements in 1942 and 1944 were made by Natural History Survey biologists, those in 1947–1950 by creel-census clerks. The size distributions of boss caught by test fishermen are shown in Table 13 and the total bass harvest in Table 6.

Length Class, Inches	*First Period*		*Second Period*			
	1942*	1944†	1947	1948	1949	1950
10 0	4	30	1	11	60	97
10 5	2	11	3	15	26	49
11 0	7	5	13	25	29	43
11 5	1	3	5	34	25	21
12 0	8	.	..	60	19	8
12 5	3	1	3	51	11	4
13 0	2	1	..	55	15	4
13 5	5	1	..	33	20	7
14 0	7	..	1	26	26	12
14 5	3	..	..	12	24	4
15 0	9	..	..	6	19	18
15 5	3	1	..	1	9	5
16 0	..	..	..	4	10	11
16 5	..	..	1	..	2	4
17 0	..	3	..	1	2	6
17 5	..	1	..	..		4
18 0	..	1	1	..		3
18 5	4		1	..		2
19 0	4			2		
19 5				..		1
20 0				2		
Total	*62*	*58*	*29*	*338*	*297*	*303*

* The fish included in this column represented 22 per cent of the bass harvested by anglers in 1942. They were taken early in the fishing season, most of them on opening day, May 15.

† Lengths observed by a Natural History Survey biologist stationed at the creel-census station on Sundays during June, July, and August.

willing biters, or the most aggressive individuals may have been removed from the lake during the first few hours. Other possibilities are that the appearance of boats, baits, and fishermen frightened many bass to offshore waters, where boat traffic and fishing were comparatively light, while the bass that remained within range of fishermen quickly acquired wariness. Possibly the 112 bass harvested during the first day represented a fairly large proportion of the total population of large bass, although the number of large bass in the lake on opening day is not known.

It should be kept in mind that the initial good fishing at Lake Glendale in 1942 was followed by a drop and not by a complete collapse in fishing success. Undoubtedly, during the fishing season, some recruitment of bass into the catchable population occurred as a result of growth of individuals. Possibly many bass did not develop strong fears of boats and baits, and some bass that developed such fears may have overcome them in the course of the season. One of several bass placed in Phelps Pond near Lake Glendale in 1946 and later marked by removal of scales at each capture, was caught by the test fisherman three times in 1947 between June 20 and July 16. The fish was 9 inches long at its last capture. The bass in this pond were growing slowly, and frequent biting may have resulted from extreme hunger.

While the number of bass harvested at Lake Glendale was greater in the second study period than in the first (Table 6), the average weight of all bass harvested was greater in the first period (Table 12). However, the aver-

age weight of the bass taken on flies was greater in the second period (Table 12). In 1948, the average weight of the bass taken on plugs was about the same as that of the bass taken on flies or worms. In most other years the bass caught on plugs averaged about a quarter pound to more than a pound heavier than those caught on flies or worms.

Although the difference between periods in average weights of bass harvested was small (Table 12), there were important differences between periods in the length distribution of the legal-size bass caught (Tables 13 and 14). In 1944–1946, most of these bass were either just over the legal size, that is, 10–11 inches, or were fairly large, 17 inches or larger. A similar distribution of sizes was found in the 1946 population census (Table 22). The bass caught in 1948–1950 included not only individuals of these sizes, but also large numbers of bass of intermediate sizes, those measuring 12–16 inches.

Hoop nets gave an erratic picture of size distribution of bass in Lake Glendale, but they seemed to show that 12—16-inch bass were more abundant in 1942, 1943, and 1944 than in 1945 and 1946 (Table 21).

One reason the test fishermen caught very few large bass may have been that they fished almost exclusively with small flies and poppers. Also, the test fishermen started fishing 2 to 4 weeks later in the season than other fishermen, which in the opinion of some fishermen in southern Illinois reduced their chances of catching large bass.

According to reports made by sport fishermen to the census clerks, more small bass were caught and thrown back in the lake in 1942–1946 than in 1947–1950 (Table 15). Even in years of the best bass fishing, the number of bass thrown back exceeded the number kept. The sizes of bass under 10 inches in length caught by the test fishermen (Table 13) are assumed to have been approximately the sizes of bass that were caught and returned to the water by the sport fishermen.

Table 15.—Number of largemouth bass kept and number thrown back by fishermen at Lake Glendale.

	First Period					*Second Period*			
	1942	1943	1944	1945	1946	1947	1948	1949	1950
Number of bass kept	279	92	120	61	137	70	637	341	375
Number of bass thrown back*	9,369	3,397	2,659	1,280	1,908	140	1,453	1,477	1,613
Total number of bass caught	*9,648*	*3,489*	*2,779*	*1,341*	*2,045*	*210*	*2,090*	*1,818*	*1,988*
Number of trips	2,754	1,308	859	973	1,517	407	1,110	1,032	1,544
Number of bass thrown back per trip	3.40	2.60	3.09	1.31	1.26	0.34	1.31	1.43	1.04
Number of bass thrown back: number kept	34	37	22	21	14	2	2	4	4
Per cent of catch thrown back	97	97	96	95	93	67	70	81	81

* Based mainly on estimates by fishermen; 1944–1950 includes bass under 10 inches caught by test fishermen.

Analysis of Bluegill Fishing

In terms of year-to-year harvest and harvest per trip, bluegill fishing at Lake Glendale (Fig. 9), in contrast to bass fishing, was much better in 1943–1946 than in 1947–1950 (Tables 6, 7, and 16). A number of experienced fishermen claimed that Glendale in the years 1943–1946 was one of the best bluegill

lakes in southern Illinois. The bluegill harvest per trip at Lake Glendale in this period was about the same as at Pounds Lake, although the best single year was observed at Pounds (Table 8).

Bluegill fishing at Lake Glendale in 1943–1946 (the 4 best years) was not as good as bluegill fishing in three unfertilized ponds near Dixon Springs (Hansen et al. 1960:368–369), but it was better than that recorded in 1961 at two other southern Illinois lakes, namely, Murphysboro (160 acres) and Horseshoe (2,400 acres) (Lopinot 1962: 20–21). The catch rates reported for

Fig. 9.—Bluegills caught at Lake Glendale on opening day, May 15, 1942.

bluegills taken on flies were better at Lake Glendale in 1943–1946 (Table 16) than at Lake Murphysboro in 1955 (Lewis et al. 1957:35). The catch rates reported for bluegills taken on cockroaches at Crab Orchard Lake (61 hours of fishing) were considerably better than the catch rates for bluegills taken on flies, worms, or miscellaneous baits at Lake Glendale in any year (Table 16). The stocking rates used at Murphysboro, Crab Orchard, and Horseshoe lakes are not known. The three lakes contained a greater variety of fish species than Lake Glendale.

Average weights of bluegills kept by Lake Glendale fishermen were similar in the two periods (Table 17). Only in 1942 and 1948 did the bluegills average more than 0.25 pound each. The

Table 16.—Catch of bluegills and catch per trip on various types of bait at Lake Glendale.*

	First Period				*Second Period*			
	1943	1944	1945	1946	1947	1948	1949	1950
Casting rod lures (plugs etc.)								
Number of trips	231	143	247	334	128	463	350	424
Number of fish kept	15	33	84	58	..	16	25	101
Pounds kept	2.8	7.7	17.0	18.9	..	5.2	5.4	20.3
Number kept per trip	*0.06*	*0.23*	*0.34*	*0.17*	*0.00*	*0.03*	*0.07*	*0.24*
Pounds kept per trip	*0.01*	*0.05*	*0.07*	*0.06*	*0.00*	*0.01*	*0.02*	*0.05*
Fly rod lures (flies, poppers, etc.)								
Number of trips	162	162	138	222	38	173	169	201
Number of fish kept	494	394	476	469	1	31	183	141
Pounds kept	101.9	63.4	96.8	100.8	0.3	9.1	35.8	26.9
Number kept per trip	*3.05*	*2.43*	*3.45*	*2.11*	*0.03*	*0.18*	*1.08*	*0.70*
Pounds kept per trip	*0.63*	*0.39*	*0.70*	*0.45*	*0.01*	*0.05*	*0.21*	*0.13*
Worms†								
Number of trips	664	313	454	842	136	190	212	576
Number of fish kept	3,678	1,977	2,280	4,551	7	128	427	1,946
Pounds kept	885.6	388.4	486.8	1,061.4	1.6	40.5	86.6	455.6
Number kept per trip	*5.54*	*6.32*	*5.02*	*5.40*	*0.05*	*0.67*	*2.01*	*3.38*
Pounds kept per trip	*1.33*	*1.24*	*1.07*	*1.26*	*0.01*	*0.21*	*0.41*	*0.79*
Miscellaneous baits								
Number of trips	251	241	134	119	105	284	301	343
Number of fish kept	1,224	701	268	383	26	200	326	876
Pounds kept	267.2	131.0	54.8	89.2	6.0	63.9	69.6	178.9
Number kept per trip	*4.89*	*2.91*	*2.00*	*3.22*	*0.25*	*0.70*	*1.08*	*2.55*
Pounds kept per trip	*1.06*	*0.54*	*0.41*	*0.75*	*0.06*	*0.23*	*0.23*	*0.52*

* Trips represented under casting rod lures, fly rod lures, and worms are those in which the named bait types were the only ones used. Less frequently used baits, such as crayfish and cockroaches, and combinations of baits, such as plugs and worms, on the same trip, are lumped under miscellaneous baits. The total harvest of bluegills (all baits) is given in Table 6.

† Includes garden worms, nightcrawlers, manure worms (commercial red wigglers), and certain insect larvae, such as catalpa worms.

Table 17.—Average weights (pounds) of bluegills caught and kept by anglers at Lake Glendale.

	First Period					*Second Period*			
	1942	1943	1944	1945	1946	1947	1948	1949	1950
Number of bluegills	4,064	4,917	3,060	3,108	5,461	34	375	961	3,074
Weight of bluegills	1,262	1,156	590	655	1,270	8	119	197	682
Average weight	*0.31*	*0.24*	*0.19*	*0.21*	*0.23*	*0.24*	*0.32*	*0.20*	*0.22*

length distributions of bluegills caught by test fishermen is shown in Table 18. (No record was made of lengths of bluegills caught by other fishermen.) The length distribution of bluegills captured in hoop nets during the early spring, 1941–1950, is shown in Table 24.

All of the bluegills harvested by sportsmen in 1947 were fish used in the 1946 stocking, and the largest bluegills harvested in 1948 and 1949 were from the 1946 stock (Table 18). In contrast, most of the large bluegills caught by sportsmen in 1942 and 1943 were fish belonging to the first brood produced in the lake (in 1940). However, the largest bluegills caught in these years —some measuring up to 10 inches— were from the original stock (215 bluegills).

In each year after the light (1940) stocking, the number of bluegills kept exceeded the number thrown back in the lake (Table 19). Not until the fourth year after the heavier (1946)

Table 18.—Size distributions of bluegills caught at Lake Glendale by Natural History Survey test fishermen, 1944–1950. An asterisk (*) following a number indicates recorded fin-clipped bluegills of the 1946 stocking. Most fish were caught with fly rod and small popper flies.

Length Class, Inches	*First Period*			*Second Period*			
	1944	1945	1946	1947	1948	1949	1950
3.0	1						
3.5	1					2	
4.0	8	1			2	1	
4.5	5	..	1		1	5	3
5.0	11	2	1	1*	4	17	6
5.5	51	17	3	1*	4	22	21
6.0	69	69	32	1*	5	21	16
6.5	135	81	68	3*	..	10	18
7.0	86	181	111	12*	2*	1	18
7.5	11	32	38	5*	3*	2*	
8.0	4	1	4		3*	5*	
8.5		..			1*	1*	
9.0		1					
Total	*382*	*385*	*258*	*23*	*25*	*87*	*82*

* Fin-clipped bluegills of the 1946 stocking.

Table 19.—Number of bluegills kept and number thrown back by fishermen at Lake Glendale.

	First Period					*Second Period*			
	1942	1943	1944	1945	1946	1947	1948	1949	1950
Number of bluegills kept	4,064	4,917	3,060	3,108	5,461	34	375	961	3,064
Number of bluegills thrown back*	3,492	3,412	2,216	1,168	1,934	35	657	1,262	2,479
Total number of bluegills caught	*7,556*	*8,329*	*5,276*	*4,276*	*7,395*	*69*	*1,032*	*2,223*	*5,543*
Number of trips	2,754	1,308	859	973	1,517	407	1,110	1,032	1,544
Number of blnegills thrown back per trip	1 27	2 61	2 60	1 22	1 27	0 09	0 59	1 22	1 61
Number of bluegills thrown back: number kept	0.9	0.7	0 7	0 4	0 4	1.0	1.8	1.3	0 8
Percentage of catch thrown back	46	41	42	27	26	51	64	57	45

* Based mainly on estimates by fishermen; 1944–1950 includes bluegills under 6 inches caught by test fishermen.

stocking did the number kept exceed the number thrown back. In each year, the percentage of the catch thrown back was lower for bluegills than for bass (Tables 15 and 19).

Bluegill catch rates at Lake Glendale reached a plateau in the fourth growing season (1943) after the 1940 stocking (Table 6). The catch rates showed steady improvement through the fourth growing season (1950) after the 1946 stocking. As late as 1950, however, the quality of bluegill fishing during the second period was not up to that observed in the better years of the first period. At Pounds Lake, bluegill catch rates rose to a peak in the fifth growing season (1944) after the 1940 stocking (Table 8). In the three unfertilized ponds near Dixon Springs (Hansen et al. 1960:384), there was a tendency toward a gradual improvement in bluegill catch rates, with peak rates coming in the fifth or sixth growing season after the stocking.

Annual harvest rates of bluegills, in number per trip at Lake Glendale, were one and a half to five times as good with worms as with flies (Table 16). Unexpectedly large numbers of bluegills were caught by sport fishermen and test anglers while plug fishing for bass. For example, in 1950, 101 bluegills were caught on plugs in 424 trips and 141 on flies in 201 trips (Table 16).

Fishing for Warmouths and Green Sunfish

Since the numbers of warmouths and green sunfish introduced into Lake Glendale are unknown, and the numbers that survived after the 1946 census are also unknown, a comparison of quality of fishing for the years 1942–1946 and 1947–1950 would have little meaning in this evaluation of stocking rates. The numbers of warmouths caught increased from year to year in 1943–1946 and again in 1948–1950, but the species did not become important during either period (Table 6).

The numbers of green sunfish harvested by fishermen declined in the period 1942–1946 from an initial high in 1942 but increased in the later period (Table 6). More green sunfish of harvestable sizes were reported in the 1946 creel (Table 6) than were found in the population census at the end of the fishing season (Table 27). At no time was fishing as productive for warmouths or green sunfish as for bluegills (Tables 6 and 7). In 1942, the weight of the green sunfish harvest was nearly equal to the weight of the harvest of largemouth bass (Table 7). It would appear from the number of harvestable fish in the population at the time of the census in 1946 (Table 27) and the number harvested by fishermen in that year that green sunfish were more vulnerable to capture than any of the other species at Lake Glendale; the green sunfish were followed in order of vulnerability by the largemouth bass, bluegill, and warmouth. Larimore (1957:70) found that in one Illinois pond largemouth bass of the original stock were more susceptible to capture than warmouths of the original stock.

Lake Glendale warmouths showed a preference for live baits. In 1946, 842 fishermen using worms caught 205 warmouths, while 222 fishermen using artificial flies caught only 8 warmouths (not shown in tables). Larimore (1957: 69) stated that the warmouth in most of its range is taken more commonly on natural baits than on artificial baits.

The green sunfish at Lake Glendale apparently showed a preference for artificial flies. In 1943, the first year in which bait records were kept at Lake Glendale, 162 fly fishermen caught 159 green sunfish, whereas 664 worm fishermen caught 227. However, most of the fly fishing was done along the margin of the lake, a region preferred by green sunfish, whereas a considerable part of the worm fishing was done offshore in water deeper than that usually frequented by green sunfish.

EFFORTS TO IMPROVE FISHING

Following the light stocking at Lake Glendale in 1940 and before any thought had been given to a new stocking (as finally carried out in the fall of 1946), a number of experimental attempts were made to improve fishing in the lake. None of these attempts was effective. For example, in early September, 1944, when the lake level stood 19 inches below full stage, the level was dropped 40 inches more. This drop resulted in a 22 per cent reduction in the lake area, from a normal area of 82 acres to 64 acres. This is not as much of a reduction as is recommended for a successful drawdown (Bennett 1962:160). The lake level remained low through the fall months, rising only 6 inches during a period of 12 weeks, September 8 through November 30; the lake refilled during the winter. It had been speculated that removal of the water from the fringe of cattails surrounding the lake would expose young bluegills to predation by bass and increase the growth rates of the bluegills (through reduced competition for food). However, the young bluegills received protection from underwater plants, particularly chara, as the water dropped below the level of the cattails. Little change could be seen in sizes of bluegills caught after this slight reduction in water level. Bluegills larger than 6 inches caught by test fishermen (Table 18) averaged 6.6 inches in the summer of 1944 before the drawdown, 6.75 inches in 1945, 6.8 inches in 1946 (these averages not shown in table). Furthermore, bluegill catch rates changed only slightly in the 2 years after the reduction (Tables 6, 7, and 16). The reduction in water level was not followed by changes in catch rates of bass or in sizes of bass caught (Tables 6, 7, 10, and 13).

Several changes were made in Lake Glendale fishing regulations in the hope that bass harvests might be improved. The restriction against use of live minnows was dropped for the 1943 season; there was little indication that minnows were more effective than other bass baits. In 14 trips in which minnows were the only bait used, fishermen caught only 2 bass of legal size. In 231 trips in which plugs were used in 1943, fishermen caught and kept 47 bass (Table 10). In another management attempt in 1943, the fall fishing season was extended to include the 12 Sundays in the period September 12 through November 28. During this special season of Sunday fishing, 32 fishermen using plugs harvested 12 bass weighing a total of 8 pounds. During the regular season, May 15 through September 11, 199 fishermen using plugs harvested 35 bass weighing a total of 63 pounds. The number of bass caught per trip was therefore much better during the special season than during the regular season, while weight per trip was slightly better during the regular season. During a special open season early in the spring of 1946, when fishing was allowed on the five Sundays preceding the regular May 15 opening, 155 fishermen using plugs harvested 14 bass having a total weight of 27 pounds. During the regular 1946 season, May 15 through September 22, 179 fishermen using plugs harvested 6 bass weighing 15 pounds.

GROWTH OF FISHES

Because good sport fishing depends on the availability of desirable sizes of fish, the growth in both the original stock and the new broods was studied at Lake Glendale. Year-to-year growth was studied from changes in length-frequency distributions and, to a limited extent, from examinations of scale samples. The scale samples used in making age determinations were collected either before or near the end of the growing season; thus, most of the uncertainties in fish ages caused by variations in time of annulus formation were avoided.

In the first study period, when few largemouth bass were harvested (Table

14), most of the bass in the 12–15.5-inch range were "cannibals"—exceptionally fast-growing individuals that derive their name from the supposition (at least correct for hatchery-reared bass) that they feed principally on their slower-growing brood mates. At the start of fishing in the second study period, the bass harvest was made up principally of fast-growing fish of the 1946 stock; toward the end of the period, they were made up principally of noncannibal members of broods spawned in the lake. Cannibals probably made a less significant contribution to the harvest during the second study period than during the first.

In the years of fair to good bluegill fishing during the first period, and in the one year of fair bluegill fishing in the second period (1950), the bluegill harvests were made up largely of fish from broods produced in the lake after the stockings. In 1947 and 1948, the poor bluegill harvests were made up principally of fish of the 1946 stocking.

Growth of Original Bass

The largemouth bass with which Lake Glendale was stocked in April, 1940, grew rapidly. Those from which scales were obtained were found to have grown much more rapidly than is usual for bass in older populations. Bass of 10–14 inches (the sizes of the bass used in stocking Lake Glendale in 1940) ordinarily increase their weights at the rate of a quarter pound to a half pound a year. Six bass of the 1940 stock caught in hoop nets in March, 1943, had put on weight at the rate of 1 to 2 pounds per year. At that time, they ranged from 18.4 to 21 inches in length and from 3.7 to 6.4 pounds in weight. One of the 1940 original bass taken in the 1946 population census weighed 8 pounds, 9 ounces, and measured 23.4 inches. This is the largest bass that has been recorded from Lake Glendale.

The bass with which the lake was stocked in 1946 grew less rapidly than those of the 1940 stocking but more rapidly than bass in most old populations. Shifts in the modes of the length-frequency distributions for bass caught

Table 20.—Numbers of marked (fin-clipped) largemouth bass of three length categories used in stocking Lake Glendale in the fall of 1946, and size distributions of part of catch of marked fish taken by sport fishermen over the next 4 years. Some marked fish were not measured and some fish with clipped fins were not recorded as having been marked. This table includes only fish that were recorded as marked.

Length Class, Inches	*Numbers of Marked Bass in 1946 Stocking*	*Numbers of Marked Bass Observed*			
		1947	1948	1949	1950
3.0					
3.5					
4.0					
4.5	828				
5.0					
5.5					
6.0					
6.5					
7.0					
7.5			1		
8.0			2		
8.5	1,397		..		
9.0			1		
9.5			1		
10.0			1		1
10.5			2		..
11.0		5	11	2	2
11.5		1	14	2	..
12.0			26	1	..
12.5			24	3	..
13.0			25	10	..
13.5			18	19	3
14.0			8	18	4
14.5			8	20	..
15.0			4	17	8
15.5			..	8	5
16.0			2	9	10
16.5			..	2	3
17.0			..	2	6
17.5			..		4
18.0			..		3
18.5			..		2
19.0			1		..
19.5	23		..		1
20.0			2		
20.5					
21.0					
21.5					
22.0					
Total	*2,248*	*6*	*151*	*113*	*52*

by sportsmen in 1948–1950 (Table 20) indicate that fin-clipped bass placed in the lake at lengths of 3–11 inches were caught at lengths of 10–16 inches in 1948, 11–17 inches in 1949, and 13.5–18 inches in 1950.

The number of bass used in the 1940 stocking (70 individuals) was too small to have much direct influence on the fishing in 1942–1946. The number of bass used in the 1946 stocking (2,248 individuals) was large enough and the growth of these fish was rapid enough to contribute significantly to the catch, especially in 1948 and 1949.

Growth of Bass in New Broods

While most bass hatched at Lake Glendale in 1940 grew quite slowly, scale examinations showed that some individuals—the so-called cannibals—from the 1940 brood and a smaller number from the 1941 brood grew rapidly. By the spring of 1942, after only two growing seasons, the cannibals had reached lengths of 10–15.5 inches (Tables 14 and 21). By the spring of 1943, the cannibals measured 11.5–18 inches, while most of their slow-growing brood mates measured only 7–10 inches. Scales examined from large bass caught in hoop nets in March, 1942, indicate that the bass of 18.5–19 inches caught by anglers in 1942 (Table 14) were fast-growing individuals of the original stock, rather than cannibals.

At the time of the 1946 population census, 21 cannibals from the 1940 brood measured 17.8–21.6 inches, 10 cannibals from the 1941 brood measured 17.1–21.0 inches, and 1 cannibal from the 1943 brood measured 17.1 inches. Measurements of these fish are included in Table 22. The large bass included in this table as members of the 1939 brood were either individuals from the unplanned stocking of 1941 or were members of the 1940 brood that had formed false annuli. Large bass included as members of the 1938 brood might have come from either the 1940 or the 1941 introductions.

Cannibals measuring 10–14 inches in length made up part of the bass harvest in 1948 (curve B and part of curve C in Fig. 7), but most of the harvest in that year was derived from the fast-growing original stock of 1946 (curve A and the greater part of curve C). Undoubtedly, some cannibals were caught in 1949 and 1950, but the extent of their contribution to the harvest in those years cannot be determined.

As a result of the poor growth of most of the bass hatched in Lake Glendale in 1940–1946 and the small number of cannibals in broods other than those of 1940 and 1941, bass of 11–17 inches were scarce in 1944–1946. This scarcity is shown by the sizes of bass caught by test fishermen (Table 13) and by other fishermen (Table 14), and by the sizes of bass in hoop-net samples (Table 21).

Of the 6,861 bass in the 1946 population census (Table 26), 6,784 measured 3–12 inches, 3 measured 12.5–17 inches, and 74 measured 17.5–23.5 inches; of the fish of 12 inches and smaller, not more than 20 are estimated to have been longer than 11 inches.

Evidence from scale examination is that an exceptionally large brood of bass was produced in Lake Glendale in the first spawning season after each stocking, that is, in 1940 and 1947, that the lake became overstocked by these first bass broods, and that the overstocked condition was maintained through natural reproduction in subsequent years. The major part of each brood was at least slightly stunted. Apparently, most of the slow-growing members of the 1940 and 1941 broods died in the lake, or were caught by fishermen, without reaching lengths much above 10 inches. Fishing in the years 1943–1946 and 1949–1950 would certainly have been better if bass reproduction had been less successful.

The slow growth of most individuals of the 1940, 1941, and 1942 broods is suggested by the absence of significant shifts in modes in the length-frequency

distributions of bass under 10 inches collected in hoop nets in March, 1943–1945 (Table 21) and also by scale examinations. In March, 1944, hoop-net samples, the noncannibal bass of the 1940 brood (represented by 11 fish) averaged 10.2 inches after four growing seasons; those of the 1941 brood (6 fish) averaged 9.2 inches after three growing seasons; and those of the 1942 brood (7 fish) averaged 8.1 inches after two growing seasons (these data not in tables).

Approximately the same degree of stunting was observed in broods spawned after the 1946 stocking. Length data and scale samples collected from noncannibal bass at the

Table 21.—Size distribution of largemouth bass taken in early spring hoop-net collections at Lake Glendale. Sampling was carried on for 2, 3, or 4 successive days in April, 1941, and in March of subsequent years, with six 1-inch-square mesh hoop nets raised each day of the sampling period (except as noted below). Numbers of net-days are shown in parentheses below the years. An asterisk (*) following a number in the table indicates fin-clipped bass of the 1946 stocking. Bass proved difficult to catch in the nets from 1946 on.

Length Class, Inches	*First Period*						*Second Period*			
	1941 (32)†	1942 (16)‡	1943 (20)	1944 (12)	1945 (18)	1946 (12)	1947 (18)	1948 (24)	1949 (18)	1950 (18)
4.0									1	
4.5									..	
5.0							1*	2	..	
5.5	1							2	..	
6.0	..	1	1					3	..	
6.5	..	6	..					6	..	
7.0	1	7	1					6	..	
7.5	..	3	9	1	1			4	..	
8.0	..	4	22	4	2			4	1	
8.5	..	1	30	6	7			..	.	
9.0	..	2	23	16	26	1		..	4	
9.5	1	1	2	9	18			..	1	2
10.0		5	2	7	5			1*	..	
10.5		1	..	4	1			4*	1	1
11.0		..	2	1	2			2*	1	
11.5		3	3	1	..			..	..	
12.0		4	3	1	..			1*	..	
12.5		5	1	2	..			..	..	
13.0		2	5	1	..			1*	..	
13.5		5	5	1	..				..	
14.0		11	..	1	..				.	
14.5		2	3	..	..				..	
15.0		2	4	..	..				..	
15.5		2	2	..	..				1*	
16.0		..	10	1	1				1*	
16.5		..	6	..	..					
17.0		..	8	1	1					
17.5		1	5	..	..					
18.0		1	3	..	..					
18.5		2	2	1	1					
19.0		1	..	1	1					
19.5			1	1	1					
20.0			3	..	..					
20.5			1	..	..					
21.0			3	1	1					
Total	*3*	*72*	*160*	*67*	*63*	*1*	*1*	*36*	*11*	*3*

* Fin-clipped bass of the 1946 stocking.

† Eight hoop nets set on April 18, raised on April 20, 21, and 22.

‡ Eight hoop nets set on March 11, raised on March 12 and 14.

time of the October, 1950, population census showed that the 1947 brood (represented by 53 fish) averaged 10.3 inches after four growing seasons; the 1948 brood (10 fish) averaged 9.0 inches after three growing seasons; and the 1949 brood (12 fish) averaged 7.5 inches after two growing seasons.

Large numbers of stunted bass were caught, thrown back in the water, and perhaps recaught by sport fishermen. A sharp drop in the number of bass reported by sportsmen as having been thrown back (from 9,369 in 1942 to 3,397 in 1943, Table 15) suggests either (i) that small bass were harder to catch in 1943 than the year before (an unlikely possibility); (ii) that the number of bass reported thrown back in 1943 was considerably below the actual number (the questioning of fishermen as to the number of fish thrown back was done by technically untrained census takers, but there is no reason to believe that the figures for 1943 were less reliable than the figures for 1942); or (iii) that a considerable number of the 1940 brood died during their third or fourth year of life. Hook injury would seem to have been one of the more likely causes of death.

Although the data suggest a substantial die-off in the 1940 brood at Lake Glendale during the third or fourth

Table 22.—Size distribution of largemouth bass of various ages taken at Lake Glendale during population census in the fall of 1946. The representation of broods shown below resulted from age determinations made from a random sampling of scales of fish of large, small, and intermediate sizes. The bass population was made up mainly of fish less than 10 inches long (Table 27).

Length Class, Inches	*Year Hatched (Brood)*								
	1946	1945	1944	1943	1942	1941	1940	1939	1938
5.5	1								
6.0									
6.5									
7.0									
7.5		2							
8.0									
8.5			2	1					
9.0			2	1	1				
9.5			2	2	..				
10.0			2	2	..				
10.5				2	2				
11.0				..	..	2			
11.5				..	..	..			
12.0				..	..	..			
12.5				..	..	..			
13.0				..	..	1			
13.5				..	..	..			
14.0				..	..	..			
14.5				..	1	..	1		
15.0				..		..	..		
15.5				..		..	..		
16.0				..		..	..		
16.5				..		..	..		
17.0				1		1	..		
17.5						2	..	2	
18.0						1	4	1	
18.5						..	2	1	1
19.0						2	2	2	1
19.5						2	3	1	..
20.0						..	3	1	..
20.5						..	4	1	1
21.0						2	2	3	..
21.5							1		1

year of life, length measurements and scales of captured fish failed to indicate a noticeable acceleration of growth rates in surviving members of the brood.

There was no indication that slow-growing bass of the 1947 brood suffered a die-off of the apparent magnitude described for the 1940 brood.

Scale examinations indicated that most of the stunted bass of the 1940 brood that survived the fourth year of life disappeared in their fifth or sixth year (by the spring of 1946) without reaching lengths much greater than 10 inches. Among bass measuring 7–10 inches taken in seine hauls on April 3–5, 1946 (bass having scales with readable age rings), there were 2 from each of the three oldest broods (1940, 1941, and 1942 broods), 6 from the 1943 brood, and 19 from the 1944 brood.

Williamson & Churchill (1948:1) noted a short life span (4 years or less) for most bass in Punch Lake, a Wisconsin lake in which the growth rate of bass was slow compared with that in most lakes in the Midwest for which growth data are available.

Severe stunting of largemouth bass was observed at Larry Lake, Wisconsin, where the bass failed to reach an average length of 10 inches in 5 years (Bennett 1938:168), and at Cowan's Gap Dam, Pennsylvania (Miller & Buss 1960:3), where the bass required an average of 8 years to reach 10 inches.

Jenkins & Hall (1953:26) observed that growth of largemouth bass in new bodies of water in Oklahoma (except in large reservoirs) was much more rapid during the first 2 years than afterward. Up to the third or fourth year of impoundment, bass reached a length of 10 inches within two growing seasons, but later took 3 or 4 years to reach that length. Jenkins & Hall attributed the slowing down in bass growth to competition between bass and other species rather than to overabundance of bass.

An entirely different pattern of largemouth growth in a new lake was described at Norris Reservoir, Tennessee (Stroud 1948:57–62), where all broods produced during the first 9 years reached average lengths of 10.3–13.0 inches by the end of the second year of life.

The growth in new bass broods at Pounds Lake differed from that at Lake Glendale. Most of the bass spawned in 1940 at Pounds Lake grew at normal rates. There was little evidence of stunting. Cannibals measuring 11–15 inches in 1942 and 11–18 inches in 1943 were caught in hoop-net

Table 23.—Size distribution of largemouth bass caught in 1-inch-square mesh hoop nets at Pounds Lake in March, 1942, March, 1943, and October, 1947. The numbers of net-days are shown in parentheses below the years. The 1947 catch was made after most of the water had been drained from the lake. The March collections of both years were made during the week following the hoop net collections at Lake Glendale.

Length Class, Inches	*1942 (10)*	*1943 (16)*	*1947 (6)*
5.5			1
6.0	2		5
6.5	57		..
7.0	35		..
7.5	4		..
8.0	4		..
8.5	1		5
9.0	..	2	4
9.5	3	3	..
10.0	1	14	..
10.5	2	13	6
11.0	..	7	1
11.5	..	6	3
12.0	1	1	1
12.5	..	..	1
13.0	..	1	..
13.5	1	..	..
14.0	2	1	..
14.5	1	..	..
15.0	3	..	1
15.5	1	..	
16.0		..	
16.5		1	
17.0		..	
17.5		..	
18.0		..	
18.5		..	
19.0		1	
Total	*118*	*50*	*28*

Table 24.—Size distribution of bluegills taken in early spring hoop-net collections at Lake Glendale. Sampling was carried on for 2, 3, or 4 successive days in April, 1941, and in March of subsequent years, with six 1-inch-square mesh hoop nets raised each day of the sampling period (except as noted below). The numbers of net-days are shown in parentheses below the years. An asterisk (*) following a number in the table indicates fin-clipped bluegills of the 1946 stocking.

Length Class, Inches	*First Period*						*Second Period*			
	1941 (32)†	1942 (16)‡	1943 (20)	1944 (12)	1945 (18)	1946 (12)	1947 (18)	1948 (24)	1949 (18)	1950 (18)
3.5	1							2	2	
4.0	2		1		1			1	19	
4.5	6		10	2	3			..	21	
5.0	6	1	50	7	5	4		..	37	2
5.5	1	2	63	66	27	11	2*	..	73	10
6.0	1	13	142	216	174	38	6*	..	71	23
6.5	..	50	268	298	315	89	15*	..	65	24
7.0	..	73	156	288	501	149	17*	6*	27	41
7.5	..	161	91	89	62	103	10*	21*	1	16**
8.0	..	96	38	27	6	7		34*	17*	1*
8.5	1	7	3	1				4*	9*	1*
9.0		2						1*		
9.5		..								
10.0		1								
Total measured	18	406	822	922	1,094	401	50	69	342	118
Not measured	..	468	677	..	238	..	..	..	..	..
Total catch	18	874	1,499	922	1,332	401	50	69	342	118

† Eight hoop nets set on April 18, raised on April 20, 21, and 22.
‡ Eight hoop nets set on March 11, raised on March 12 and 14.
* Fin-clipped bluegills of the 1946 stocking.
** Only one of these 16 fish was fin-clipped.

collections in both lakes (Tables 21 and 23), but many more cannibals were caught in Lake Glendale than in Pounds Lake.

Growth of Original Bluegills

The bluegills placed in Lake Glendale in 1940 and 1946, like the original bass, grew rapidly. A few bluegills of the first stocking (4–7 inches at time of stocking) had reached lengths of 8.5–10 inches when trapped in hoop nets in March, 1942 (Table 24). Bluegills of the second stocking (2–7.5 inches at time of stocking) measured 7–9 inches in length when taken in hoop nets in March, 1948.

The sizes of the fin-clipped originals and of new generations of bluegills caught by the test fishermen (Table 18) suggest that all bluegills in the small 1947 harvest and most of the bluegills of usable sizes in the small 1948 harvest were from the original stock. The relative scarcity of fin-clipped bluegills measuring 6 inches or longer in the catch of the test fisher-

Table 25.—Size distribution of bluegills caught in 1-inch-square mesh hoop nets at Pounds Lake, March 17 and 18, 1942, March 24 and 25, 1943, and October 8 and 9, 1947. The numbers of net-days are shown in parentheses below the years.

Length Class, Inches	*1942 (10)*	*1943 (16)*	*1947 (6)*
3.5			4
4.0	1	2	6
4.5	..	4	5
5.0	1	11	15
5.5	2	24	17
6.0	8	21	32
6.5	25	22	24
7.0	57	17	26
7.5	75	19	42
8.0	28	38	34
8.5	..	10	3
9.0	1		
Total	*198*	*168*	*208*

men after 1948 (Table 18), the relative scarcity of fin-clipped bluegills of these sizes in hoop-net samples after 1948 (Table 24), and a sharp drop in average weights of bluegills from 1948 to 1949 (Table 17) are indications that by 1949 only a small part of the bluegill harvest was coming from the original stock and that few bluegills of the original stock were caught in 1950. It is estimated from the frequency of fin-clipped bluegills of usable sizes in the hoop-net samples that only about 15 per cent of the bluegills of the 1946 stock were harvested. From Fig. 7, it is estimated that about 40 per cent of the bass of the 1946 stock were harvested.

Growth of Bluegills in New Broods

The descendants of the bluegills placed in Lake Glendale and Pounds Lake in 1940 grew rapidly enough to maintain a constant supply of harvestable-size fish in 1942–1946. Sampling with hoop nets (Tables 24 and 25) indicated that the majority of the bluegills spawned at Lake Glendale and at Pounds Lake in 1940 reached the desirable length of 7 inches in two growing seasons. The descendants of the bluegills placed in Lake Glendale in 1946 grew less rapidly and did not contribute much to the bluegill harvest in numbers until 1950. Whereas the March, 1942, hoop-net catch showed bluegills of the 1940 brood to be most abundant in the 6.5–8-inch classes, the March, 1949, hoop-net catch showed bluegills of the 1947 brood to be most abundant in the 5.5–6.5-inch classes (Table 24).

CENSUS OF POPULATION AND STANDING CROP

The number of largemouth bass in the 1946 and 1950 censuses at Lake Glendale and the number of bluegills, warmouths, and green sunfish in the 1946 census are shown in Table 26. Bass measuring 10 inches or larger were more than three times as abundant in the 1950 census as in the 1946 census (Table 27). However, in both censuses the great majority of the usable-size bass (10 inches or longer) measured less than 11 inches. The terminal population of bass measuring 12.5 inches or longer is placed at 77 individuals (actual count) for the entire lake in October, 1946, and at 133 individuals (count and estimate combined) in October, 1950.

Three to 3.7 times as many largemouth bass, 3.9 times as many bluegills, and 5.6 times as many warmouths of harvestable sizes were found in the population censuses as were taken by anglers during the fishing seasons immediately preceding the censuses (Table 27). Comparable figures for the unfertilized Dixon Springs ponds were slightly lower for bass, and the same or higher for bluegills (Hansen et al. 1960:381). The fish recovered at the end of the 1946 and 1950 seasons at Lake Glendale must have included some that had grown to harvestable sizes during the season. It therefore should not be assumed that the harvestable population at the beginning of each season was the sum of the number observed in the census and the number taken out by fishermen.

While the rotenone treatments in the fall of 1946 did not kill all of the green sunfish, the low census count for these fish may be an indication of a population decline that was evident in the angling data for the years 1942–1946 (Table 6).

A great many observations on standing crop, or the total weight of all fish present in a body of water, have been published over the past three decades. Data on both standing crop and yield to anglers from the same water have been scarce, and some of the available data lend little backing to the supposed correlation between fish abundance and fishing success (Bennett 1954:262; Hansen et al. 1960:380).

In the fall of 1946, Lake Glendale had a terminal population or standing

crop of about 86 pounds per acre (Table 26). This terminal population figure did not include fish less than 2 inches long. The number of pounds per acre was as follows: bass 19 pounds, bluegills 62 pounds, warmouths 4 pounds, green sunfish less than 1 pound. The total number of fish of all species (exclusive of 2-inch and smaller fish) came to 37,190 fish (Table 26).

The standing crop of bass in Lake Glendale in 1950 was approximately 23 pounds per acre, or about 4 pounds per acre more than the terminal population of bass in the fall of 1946 (Table 26). Under various programs of stocking at Ridge Lake, the standing crop values for largemouth bass observed at 2-year intervals, 1943–1951, ranged from about 32 to about 50 pounds per acre (Bennett 1954:244). Ridge Lake was originally stocked in 1941 with 435 largemouth bass, or 24 per acre; in 5 census years, the number of bass returned to the lake after the censuses ranged from 22 to 110 per acre (Bennett 1954:236, 240).

The 1946 standing crop value for Lake Glendale was considerably below the published values for six of eight small ponds in the same region (Table 28); it was slightly higher than the values for two of them. No explanation has been found for the fact that the standing crop values for these two ponds were so much lower than the values for the other six. In addition to the possibility that there were actual

Table 26.—Population censuses of largemouth bass and other sunfish in Lake Glendale (fish 2 inches and larger) in the fall of 1946 and estimated population of largemouth bass in the fall of 1950. Only bass were censused in 1950. The 1946 census included fish captured by draining combined with those recovered by rotenone treatment of water remaining in the lake bed. The 1950 census included bass removed from the lake, mainly by draining, combined with a mark-and-recovery estimate of those remaining after most of the water had been drained off.

Year	*Kind of Fish**	*Total Number*	*Total Weight, Pounds*	*Standing Crop, Pounds Per Acre*
1946	Largemouth bass	6,861	1,533	18 7
	Bluegill	27,763	5,102	62 2
	Warmouth	2,327	350	4 3
	Green sunfish	239	29	0 3
	Total	*37,190*	*7,014*	*85.5*
1950	Largemouth bass†	4,379	1,865	22 7

* In addition to the four species named in the table, the 1946 census included the following: 3 bluegill × green sunfish hybrids, 1 longear sunfish, 5 European carp, 17 golden shiners, 14 black bullheads.

† Data from Table 2.

Table 27.—Numbers of fish kept by anglers in 1946 and 1950 in relation to numbers of fish of harvestable sizes present at Lake Glendale in the 1946 and 1950 fall censuses.

Year	*Kind of Fish*	*Fish in Population Censuses*			*Number of Fish Kept by Anglers in Year of Census*	*Ratio: Number of Fish of Harvestable Sizes in Census to Number Kept by Anglers*
		Total Population (Fish 2 Inches or Longer)	Fish of Harvestable Sizes*			
			Number	Per Acre		
1946	Largemouth bass	6,861	418†	5	137	3.0:1
	Bluegill	27,763	21,316	260	5,461	3 9:1
	Warmouth	2,327	1,332	16	237	5 6:1
	Green sunfish	239	103	1	150	. . .
1950	Largemouth bass	4,379	1,377†	17	375	3 7:1

* Harvestable sizes: largemouth bass, 10 inches and longer; other species, 6 inches and longer.

† Seventy-seven of the 418 bass in the 1946 census and 133 (estimated) of the 1,390 bass in the 1950 census were 12.5 inches or longer.

differences in productivity of these waters is the possibility that the extent of recovery of dead fish was not the same in all ponds. Carlander & Lewis (1948:135–136) demonstrated that not all fish killed by rotenone were recovered from a small pond and that the rate of recovery differed among fish species. They pointed out that pond conditions influenee the rate of recovery.

Of the eight ponds represented in Table 28, seven are located in the two southernmost tiers of counties in Illinois, while one is located in northwestern Kentucky. The three Pope County ponds are not more than 2 miles from Lake Glendale. The standing crop value for Lake Glendale was much lower than the values for these three ponds.

The stocking rates (fish per acre) used in the three Pope County ponds were much greater than the rates used in Lake Glendale in 1940: 0.9 bass and 2.6 bluegills per acre in Lake Glendale, 36 bass and 412 bluegills in Wells Pond, 30 bass and 396 bluegills in Boaz Pond, and 21 bass and 310 bluegills in Elam Pond (Hansen et al. 1960:353). The standing crop values for the three ponds were based on censuses made with rotenone 7 years after the ponds were stocked. The stocking rates in the other ponds included in Table 28 are not known. The census of JP-1 was made 5.5 years after the pond was stocked (Turner 1959:7).

Lake Glendale not only had a much lower standing crop value than the three Pope County ponds, it contained fewer fish of harvestable sizes per acre: 5 bass and 260 bluegills per acre in 1946 and 17 bass per acre in 1950 (Table 27). The three Pope County ponds contained 24–59 harvestable-size bass per acre and 442–624 harvestable-size bluegills per acre (Hansen et al. 1960:378).

The finding that Lake Glendale had a much lower standing crop value than the three unfertilized ponds at Dixon Springs is in agreement with the findings of Rounsefell (1946:32–35) for United States and Canadian lakes and of Carlander (1955:550) for Alabama ponds, namely that the number of pounds of fish per acre drops (is negatively correlated) with increase in water area. It is not in agreement with the analysis by Carlander (1955:550) of midwest ponds (drained and undrained ponds considered together) nor with Carlander's final conclusion that "the available data show no significant correlation between standing crop and area of the body of water."

The fact that the standing crop value for Lake Glendale was much below that of the nearby Wells, Boaz, and Elam ponds is of special significance in that these waters are similar in ways that might be expected to affect standing crop. Lake Glendale and the three ponds had been built at about the same time, in the period 1935–1940, and had been stocked 6 to 7 years at the time of the standing crop observations. The composition of fish species included mainly centrarchids: largemouth bass and bluegills in the ponds; largemouth bass, bluegills, warmouths, green sunfish, and only a few individuals of other families in Lake Glendale. All of these waters are soft and, because of similar soils on their watersheds, are probably similar in chemical composition. Of uncertain importance are the differences between the ponds and Lake Glendale in the soil treatments of their watersheds. The fields draining into the ponds had been periodically treated with crushed limestone and fertilizers of various kinds. Probably little if any of the land draining into Lake Glendale had received lime or chemical fertilizer treatment. Undoubtedly, some of the fertilizers applied to the watersheds were washed into the ponds, but whether in sufficient amounts to affect the standing crops materially is open to question. Hansen et al. (1960:384–385) were unable to establish clearly that fertilizer

applications to the watersheds of the ponds affected fishing success in the years of application.

No inverse relationship between standing crop and water area was found when Lake Glendale was compared with two of the eight small ponds included in Table 28, namely Waltonian and JP-1. The fact that the standing crop values for these two ponds were so much lower than standing crop values for other ponds of similar size in the region suggests that these two ponds may not have been typical.

FACTORS THAT DETERMINE FISHING EFFORT

There was little evidence of a close relationship between fishing effort (man-days of fishing per year) and fishing success at Lake Glendale, and the reasons are only partly understood. The relatively intensive fishing in 1942 can be explained by the likelihood that many fishermen were anxious to try out the new lake, by the exceptionally good bass fishing that occurred on the first day of the season, and by fairly good bluegill fishing during the first season. Part or all of the increase in fishing in 1946 may have been due to the return of servicemen to civilian life following World War II. The scarcity of fishermen in 1947 can be accounted for in part by the extremely poor bluegill fishing and in part by the probability that some potential fishermen assumed that the lake was closed in that year, following the draining and restocking of 1946. The sharp increase in fishing in 1948 was probably due to marked improvement in the success of bass fishermen (Table 10).

Of some interest is the fact that, although the Lake Glendale Recreation Area offered fishing for the whole family, at least 89 per cent of the fishing was done by fishermen 18 years of age or older who had purchased licenses (Table 5).

In Michigan, Lagler & De Roth (1953:246) found a relationship between angler attitude (that is, fishing effort), fishing success, and population of legal-size bass in the Loch Alpine ponds, a pair of connected, privately owned ponds near Ann Arbor, Michigan. In 1950, when the population level in Lower Loch Alpine was approximately 17 legal-size largemouth bass per acre, the catch averaged 0.25 keeper bass per fisherman hour. In 1951, when the population in Upper Loch Alpine approximated 6 legal-size bass per acre, the catch was 0.04 legal-size bass per fisherman hour. By midsummer of 1951, the interest in fishing Upper Loch Alpine pond had "waned completely" because fishermen concluded that the pond had been "fished out."

The response of bass fishermen to poor fishing at Lake Glendale was unlike that observed by Lagler & De Roth in Michigan. Creel records and conversations with anglers at Lake Glendale gave no indication that bass fishermen using casting rods and plugs were discouraged in 1946 when their catch of legal-size bass was only 0.06 per trip (Table 10) or about 0.01 fish per hour, and the population of legal-size bass in the lake at the end of the season was only about 5 per acre (Table 27).

An examination of Table 10 will show that although plug fishing at Lake Glendale was carried on most intensively in the years of highest catch rates (1948–1950), there were year-to-year changes in the fishing effort (amount of plug fishing) that cannot be explained entirely by changes in fishing success. For example, a steady increase in number of fishing trips per season occurred in the years 1944–1946, a period in which the catch per trip was declining. The fishing effort by plug fishermen in 1946, a year in which many servicemen were returning to civilian life, was more than twice as heavy as in 1944, and yet the harvest per trip by these fishermen in 1946 was only about a third of that in 1944.

Improvement in success of plug fishermen at Lake Glendale did not result in a corresponding increase in fishing effort. In 1950, a year in which the harvest per trip by sportsmen using casting rod lures was six times by number of fish, three times by weight of fish, the comparable figures for 1946 (Table 10), the number of trips by these sportsmen was less than a third more than the number in 1946 (Table 10). The population of legal-size bass was approximately 17 per acre in 1950 and 5 per acre in 1946 (Table 27).

Either bass fishermen at Lake Glendale were not very sensitive to changes in their own fishing success or factors other than catch rate had a strong effect on fishing effort. One explanation for differences between Lake Glendale and Loch Alpine fishermen in their reactions to poor fishing may be that most anglers who fish in public waters are more tolerant of poor fishing than anglers who fish in privately owned lakes. Perhaps the fishermen in public waters have fewer opportunities to learn the truth about the quality of angling in the waters they fish. The anglers who fish in privately owned waters may get dependable catch information from the record books, from caretakers, or from fellow anglers. Anglers who fish in public lakes usually do not have access to creel records (ready access to these records was not provided at Lake Glendale). They may get catch information from other fishermen, but the information may be less reliable or less detailed than the information available to anglers at club-owned or other privately-owned lakes. The concessionaires at public lakes are not always willing to report poor fishing.

Below are some reasons that year-to-year fishing effort on any one lake may not be closely correlated with fishing success.

1. Many fishermen are unable to detect in their own fishing, or in the fishing of others, year-to-year differences in fishing success that may appear significant to fisheries students.

2. Some fishermen detect year-to-year or week-to-week differences in their success but for various reasons do not react to them. For example, even when they know that fishing is poor they may continue to fish.

3. The total fishing effort on a lake in any one year may be affected by exceptionally good or bad weather, especially if this abnormal weather occurs in spring when fishing is usually heaviest.

4. The fishing effort is likely to vary as the number of potential fishermen varies. For example, an influx of workmen into the surrounding territory may occur in one year and these workmen may be gone the following year.

5. Fishing effort is likely to be affected by national upsets—war, business booms, and depressions.

6. Fishing effort on a lake may be affected by a change in fishing success on neighboring lakes.

7. The interest in a lake aroused by exceptionally good fishing in one year may carry over into several later years, or lack of interest resulting from poor fishing in 1 or more years may result in reduced fishing effort for several succeeding years.

8. News that fishing is good or has improved may travel faster and more widely and thereby affect more people than news that fishing success has dropped off. Only good fishing or a change for the better has much chance of being reported by the news media.

9. In poor fishing years, business people may attempt to revive the interest of fishermen by launching fishing contests or by advertising the capture of exceptionally good strings of fish or the capture of one or more fish of exceptional size.

10. Some fishing effort comes from anglers who are aware that fishing for large fish is poor but are satisfied by captures of small fish.

11. Even though fishing is poor, some anglers fish the same lake year after year because they find it aesthetically satisfying, because they find it convenient, because they like the boats or the sociability of certain lakeshore establishments, or because they do not know where their chances of success may be better.

12. Some fishing is done by anglers who assume that big fish must be present where many small fish are present.

13. Some fishing is done by persistent anglers who believe that fishing success is most apt to come to those who fish hard or often.

14. Presumably, more fishermen of exceptional ability are present in years of good harvests than in years of mediocre or poor harvests.

15. To some extent the fishing effort, like the size of crowds at some sports events, results from factors that are unpredictable and unexplainable.

DISCUSSION

The heavier stocking of Lake Glendale with largemouth bass and bluegills in 1946 (27.4 young and adult bass and 41.3 young and adult bluegills per acre) had several advantages over the lighter stocking in 1940 (0.9 adult bass and 2.6 adult bluegills per acre): (i) It provided a larger population of harvestable-size bass while the offspring of the original stock were too small to harvest. (ii) It resulted in a much better population of 12-inch and longer bass—sizes that please bass fishermen. (iii) It did not necessitate closing of the lake while a new brood of fish was growing to harvestable sizes, since harvestable-size bass were recruited quickly in 1947 from among the 7–9 inch bass used in the 1946 stocking. But the heavy stocking in 1946 was disappointing in several respects: (i) Most of the stock bass, which grew rapidly into fish of 12 inches or longer, had been caught or had died from natural causes by the end of 1949 and had been replaced by other fish, most of which were less than 12 inches in length. (ii) The number of bass in the 1946 stocking, although much larger than the number in the 1940 stocking, did not provide adequate control over their own young. Thus, except for occasional cannibals among the young bass, the new broods of bass produced in 1947 and later were as stunted as those produced after the 1940 stocking. (iii) The number of stock bluegills caught by anglers was small. (iv) The first bluegill brood spawned after the heavy stocking took 2 years longer to reach desirable angling sizes than the first brood of bluegills spawned after the 1940 stocking.

The outcome of stocking 1-acre ponds near Lake Glendale with 1-inch fingerling bluegills at the rate of 310 to 412 per acre and 6-inch to 10-inch largemouth bass at the rate of 21 to 36 per acre suggests the potential value of a similar stocking in Lake Glendale. However, the standing crops in the ponds were well above the standing crops in Lake Glendale (Table 28), indicating much greater fertility of the ponds. Because of the lower fertility of Lake Glendale, the best stocking rates for this lake might be much lower in number of fish per acre than the stocking rates for the ponds. This statement assumes the probability that the number of fish that will grow from fingerling to adult size in a given period will vary from lake to lake with fertility of the water. Fisheries biologists have seldom attempted to adjust the stocking rate to water fertility except in ponds that are to be fertilized.

The good growth of bluegills hatched in Lake Glendale in 1940 when only 2.6 adult bluegills per acre were used in the stocking may have resulted from a chance factor—that the "right" number of young bluegills was produced or that the "right" number survived. The small number of spawners was probably one of the factors; hatching success, disease, and the degree of thinning of the new bluegill brood the

Table 28.—Standing crops of fish in Lake Glendale and in various small ponds in southern Illinois and in one pond in northwest Kentucky. The stocking procedures are known for only the first four waters listed.

Body of Water	*County and State*	*Surface Area, Acres*	*Species of Fish Present**	*Standing Crop, Pounds Per Acre*	*Authority*
Lake Glendale (1946)	Pope, Illinois	82	Lm, Bg, Gr, Wm	86	Hansen (present paper)
Wells Pond†	Pope, Illinois	0.5	Lm, Bg	237	Hansen et al. (1960:378)
Boaz Pond†	Pope, Illinois	0.75	Lm, Bg	308	Hansen, et al. (1960:378)
Elam Pond†	Pope, Illinois	1.25	Lm, Bg	169	Hansen et al. (1960:378)
Waltonian Pond	Saline, Illinois	1	Lm, Bg, Gr	71	Bennett (1943:361)
Delta Pond	Union, Illinois	0.8	Lm, Bg, Wm, Wc	234	Bennett (1943:361)
Upper Lamer Pond	Jackson, Illinois	0.25	Lm, Bg, Gr, Wm, Wc	516	Elder & Lewis (1955:390–392)
Lower Lamer Pond	Jackson, Illinois	0.5	Lm, Bg, Gr, Wm, Wc	285	Elder & Lewis (1955:390–392)
JP–1 Pond	McCracken, Kentucky	0.5	Lm, Bg, Wc	73	Turner (1959:7)

* Lm = largemouth bass, Bg = bluegill, Gr = green sunfish, Wm = warmouth, Wc = white crappie.

† Standing crops in Wells, Boaz, and Elam ponds were observed after prolonged drought. The standing crops for these lakes were computed from the reduced areas shown in this table.

first year by the new brood of bass or other predators were possible factors.

Although the early results of the 1946 stocking at Lake Glendale differed from those of the 1940 stocking, there are indications in the year-to-year trends in fishing success that the final outcome of the 1946 stocking might have been approaching that of the 1940 stocking, that is, good or moderately good bluegill fishing but poor bass fishing.

The stocking tests reported here suggest the possibility that some lakes might be stocked for the special benefit of bass fishermen and others for the special benefit of bluegill fishermen. These tests also suggest greater promise for long periods of good bluegill fishing than for long periods of good bass fishing.

There seems to be no question that more bass measuring 12 inches and larger were caught and removed by Lake Glendale fishermen in 1948 than could be replaced by growth in a single season or in several seasons without adequate thinning of numbers of the smaller bass; nor is there much question that heavy removal of large bass was the main reason for the decline in bass harvest and catch rate from 1948 to 1949 and the further decline from 1949 to 1950.

There is some possibility that the good bass fishing observed at Lake Glendale in 1948 might have continued for several more years if the rate of stocking in 1946 had been a little heavier, and if the removal of the fast-growing original stock bass by fishermen had been severely restricted. It is, of course, possible that a low daily limit would have resulted only in a greater number of fishing trips and no reduction in harvest. Some loss of the original stock would have occurred from natural causes and probably there would have been losses from hook injuries. Most of the marked 6-inch to 10-inch bass used in stocking the Dixon Springs ponds in 1946 were caught

within 2 years; only a few were caught after 3 years. Very few of the bass hatched in Lake Glendale survived beyond the age of 4 or 5 years, and original stocks might not have lasted longer than 5 years under heavier stocking or under special protection for large bass.

The overpopulation of Lake Glendale with small, slightly stunted bass described here for the periods 1942–1946 and 1947–1950 has continued to be a problem. Natural History Survey test fishermen of the past 15 years have caught few bass more than 11 inches in length, while they have caught many less than 10 inches. There is a possibility that anglers might do an effective job of thinning stunted bass populations in Lake Glendale if they were required to remove all or most of the bass caught. The numbers of small bass removed voluntarily since the 10-inch minimum length limit was dropped in 1951 have probably been small. The possibility that large numbers of small bass could be removed by hook-and-line in a thinning program is shown by the records of numbers of bass caught and thrown back by fishermen in the years 1946 and 1950 (Table 15). The number thrown back by fishermen in 1946 amounted to 30 per cent of the number of bass under 10 inches observed in the 1946 population census, and the number thrown back in 1950 amounted to 54 per cent of the number observed in the 1950 census. The good growth of the small bass of the 1946 stocking can be attributed to the small number of bass put back in the lake—one-third of the number of small bass found in the 1946 census. This rate of stocking was equivalent to removing two-thirds of the stunted population in one operation.

The thinning of stunted fish populations by hook-and-line has often been recommended by fisheries biologists. If thinning by this method is contemplated, the possibilities of both underthinning and overthinning should be considered. What percentages of small bass of various sizes caught by fishermen should be removed to assure favorable growth of the remaining stunted bass? Is it possible to remove so many stunted bass that the number remaining is too small to provide good fishing at a later date? Might the removal of large numbers of stunted bass decrease predation so much that overpopulation and stunting in new bass broods would still be a problem?

Accurate estimates of the numbers of bass of various size categories present in lakes before thinning is begun are highly desirable but hard to obtain. During the thinning process, records should be kept of the numbers of bass of various sizes removed by fishermen. The success of the operation would be measured by improvement in the yield and in the catch rate of the larger sized fish. Under a program of adequate thinning, benefits should be detected within a year.

SUMMARY

1. The relative success of two stocking procedures used at Lake Glendale was measured in terms of the quality of hook-and-line fishing that followed the stockings. The initial stocking, in the spring of 1940, was done with adult fish at the rate of 0.9 largemouth bass and 2.6 bluegills per acre; the later stocking, in the fall of 1946, was done with a mixture of yearling and adult fish at the rate of 27.4 largemouth bass and 41.3 bluegills per acre. Warmouths and green sunfish contaminated the lake in both study periods, 1940–1946 and 1946–1950, but the populations built up by these species were small.

2. In the fall of 1946, before the second stocking, a population census was made of all species of fish in Lake Glendale. Fish were collected and counted in a draining and censusing operation that included application of rotenone to small areas that could not be drained.

3. In the fall of 1950, a census was made of the largemouth bass population (but not populations of other species) in Lake Glendale. Fish were collected and counted in a draining and censusing operation that included an estimate, by the mark-and-recovery method, of the numbers of fish remaining in the small undrainable areas.

4. The years 1943–1946, after the lighter stocking, were considered good for bluegill fishing but poor for bass fishing. The years 1947–1950, after the heavier stocking, were better than the earlier years for bass fishing but not so good for bluegill fishing.

5. For fishermen not concerned with the kind of fish caught, the first period was better than the second.

6. The annual bluegill yields (by weight) were 4 to 12 times the bass yields during the first study period; they were smaller than bass yields during the first three seasons of the second study period.

7. The light stocking of adult bass and bluegills used at Lake Glendale in 1940 was used in the same year at Pounds Lake (32 acres), in a neighboring county. Fishing was similar in the two lakes during the years 1943–1946, except that Pounds Lake had one season of good bass fishing, whereas Lake Glendale had none in these years.

8. The best harvest of bass at Lake Glendale after the lighter (1940) stocking was in 1942 (279 bass); the best after the heavier (1946) stocking was in 1948 (637 bass).

9. In the first study period (5 years of fishing), the annual rates of bass harvest ranged from 0.06 to 0.14 fish per trip or from 0.7 to 3.4 fish per acre; in the second period (4 years of fishing), they ranged from 0.17 to 0.57 fish per trip, or from 0.9 to 7.8 fish per acre.

10. The bass of the 1940 stock (70 fish) were so few in number that they did not contribute much to the fishing in 1942–1946. The bass of the 1946 stock (2,248 fish) figured prominently in the total bass harvest in the first three fishing seasons of the second period and contributed heavily to the harvest of large bass throughout the period.

11. In most years, fly rod lures produced the best bass fishing in terms of number of fish harvested per trip; casting rod lures (plugs etc.) produced the best fishing in terms of pounds of fish harvested per trip.

12. In 1942, the first year Lake Glendale was opened to fishing after the 1940 stocking, 40 per cent of the year's harvest of bass was taken on opening day; 75 per cent of the year's harvest of bass was taken during the first 15 days.

13. The average size (pounds) of bass harvested by fishermen was greater in the period of low annual bass harvests (1942–1946) than in the period of better bass harvests (1947–1950).

14. Most bass harvested during the first period (when harvestable-size bass were scarce) were either just above legal size, 10–11 inches, or they were fairly large, 17 inches or larger; those harvested during the second period included not only individuals of small and large sizes but also large numbers of bass of intermediate sizes, 12–16 inches.

15. More small bass were caught and thrown back in the lake during the period of poor bass fishing (1942–1946) than during the period of better bass fishing (1947–1950).

16. In each year of both periods, the percentage of the catch returned to the water was higher for bass than for bluegills.

17. Bluegill catch rates reached a plateau during the fourth growing season of the first period and improved steadily from the first through the fourth growing season of the second period (the last season in which observations were made).

18. As bluegill bait, worms were much better than artificial flies.

19. A drop in the water level of Lake Glendale in the fall of 1944, reducing

the water area 22 per cent, was insufficient to have a significant effect on either the size or the catch rate of bluegills in the following 2 years. Efforts to improve the bass harvest by allowing the use of minnows in 1943, by adding a fall fishing season in 1943, and by adding an early spring season in 1946 were not successful.

20. Bass used in stocking Lake Glendale in 1940 and 1946 grew rapidly and reached large sizes. Most of the bass hatched at Lake Glendale after each stocking grew slowly as a result of overcrowding, but some individuals, the so-called "cannibals," grew rapidly.

21. Evidence from scale examination is that Lake Glendale became overstocked with bass in the first spawning season after each stocking and that the overstocked condition was maintained by reproduction during subsequent spawning seasons. As a result, the major part of each brood was at least slightly stunted. Most of the bass of the 1940 and 1941 broods died in the lake or were caught by fishermen without attaining lengths much above 10 inches.

22. Bluegills of the original stocks, like bass of the original stocks, grew rapidly and attained large sizes.

23. Bluegills of the broods spawned in the lake in 1940, following the lighter stocking, grew rapidly enough to provide fair fishing in 1942; those spawned in 1947, following the heavier stocking, grew slowly and did not contribute much to the fish harvest until 1950.

24. Three times as many bass, 3.9 times as many bluegills, and 5.6 times as many warmouths of harvestable sizes were taken in the 1946 fall population census as were harvested by fishermen in 1946; 3.7 times as many bass of harvestable sizes were estimated to be present in the fall census of 1950 as were harvested by fishermen in 1950.

25. The standing crop of fish (2 inches and larger) in Lake Glendale in the fall of 1946 was 86 pounds per acre: 19 pounds of largemouth bass, 62 pounds of bluegills, 4 pounds of warmouths, and less than 1 pound of green sunfish. The estimated standing crop of bass in the fall of 1950 was 23 pounds per acre.

26. The standing crop value for Lake Glendale was similar to the standing crop values for two small ponds in the region but considerably below the values of 6 other ponds, including three 1-acre ponds within 2 miles of the lake. Lake Glendale contained fewer fish of harvestable sizes per acre than the three nearby ponds.

27. Bass fishermen at Lake Glendale did not lose their interest in bass fishing when the population of legal-size bass stood at 5 fish per acre and the catch rate on plugs averaged only 0.06 bass per trip. No close correlation was found between fishing effort and fishing success.

LITERATURE CITED

Bennett, George W. 1938. Growth of the small-mouthed black bass, *Micropterus dolomieu* Lacépède, in Wisconsin waters. Copeia 1938(4): 157–170.

———. 1943. Management of small artificial lakes. A summary of fisheries investigations, 1938–1942. Ill. Nat. Hist. Surv. Bul. 22(3):357–376.

———. 1954. Largemouth bass in Ridge Lake, Coles County, Illinois. Ill. Nat. Hist. Surv. Bul. 26(2):217–276.

———. 1962. Management of artificial lakes and ponds. Reinhold Publishing Corporation, New York. 283 p.

Bowers, Charles C., and Mayo Martin. 1956. Results of an opening week creel census and tagging study on three state-owned lakes. Ky. Dep. Fish and Wildlife Resources Fish. Bul. 20, 13 p.

Brown, C. J. D., and Robert C. Ball. 1943. An experiment in the use of derris root (rotenone) on the fish and fish-food organisms of Third Sister Lake. Amer. Fish. Soc. Trans. for 1942, 72:267–284.

Buck, D. Homer, and Charles F. Thoits III. 1965. An evaluation of Petersen estimation procedures employing seines in 1-acre ponds. Jour. Wildlife Manag. 29(3):598–621.

Byrd, I. B. 1959. Angling success and seasonal distribution of catch in Alabama's state-owned public fishing lakes. N. Amer. Wildlife Conf. Trans. 24:225–237.

Carlander, Kenneth D. 1955. The standing crop of fish in lakes. Fish. Res. Board Canad. Jour. 12(4):543–570.

———, and William M. Lewis. 1948. Some precautions in estimating fish populations. Prog. Fish-Cult. 10(3):135–137.

———, and Robert B. Moorman. 1956. Standing crops of fish in Iowa ponds. Iowa Acad. Sci. Proc. 63:659–668.

Dill, William A. 1946. A preliminary report on the fishery of Millerton Lake, California. Calif. Fish and Game 32(2):49–70.

Elder, David E., and William M. Lewis. 1955. An investigation and comparison of the fish populations of two farm ponds. Amer. Midland Nat. 53(2):390–395.

Eschmeyer, R. W. 1942. The catch, abundance, and migration of game fishes in Norris Reservoir, Tennessee, 1940. Tenn. Acad. Sci. Jour. 17(1):90–115.

Hansen, Donald F., George W. Bennett, Robert J. Webb, and John M. Lewis. 1960. Hook-and-line catch in fertilized and unfertilized ponds. Ill. Nat. Hist. Surv. Bul. 27(5):345–390.

Hundley, Louis R. 1954. A check on two methods of estimating farm fishpond populations. Prog. Fish-Cult. 16(4):163–168.

Jenkins, Robert M., and Gordon E. Hall. 1953. The influence of size, age, and condition of waters upon the growth of largemouth bass in Oklahoma. Okla. Fish. Res. Lab. Rep. 30. 44 p.

Krumholz, Louis A. 1944. A check of the fin-clipping method for estimating fish populations. Mich. Acad. Sci., Arts, and Letters Papers for 1943, 29:281–291.

Lagler, Karl F., and Gerardus C. De Roth. 1953. Populations and yield to anglers in a fishery for largemouth bass, *Micropterus salmoides* (Lacépède). Mich. Acad. Sci., Arts, and Letters Papers for 1952, 38:235–253.

Larimore, R. Weldon. 1957. Ecological life history of the warmouth (Centrarchidae). Ill. Nat. Hist. Surv. Bul. 27(1):1–83.

Lewis, William M., Bob Brantley, and Ronald Newton. 1957. Boat fishermen's catch at Crab Orchard Lake, Lake Murphysboro and Horseshoe Lake, during 1955. Ill. State Acad. Sci. Trans. for 1956, 49:34–35.

Lopinot, Al. 1958. Opening date creel census of two new Illinois state lakes. Illinois Department of Conservation, Division of Fisheries, Springfield. 5 p.

———. 1962. 1961 creel census summary of Illinois fishermen. Illinois Department of Conservation, Division of Fisheries, Springfield. 24 p.

Miller, Jack, and Keen Buss. 1960. The age and growth of the largemouth bass in Pennsylvania. Pa. Angler 29(10):2–3.

Ricker, William E. 1942. Creel census, population estimates and rate of exploitation of game fish in Shoe Lake, Indiana. Ind. Dep. Cons., Div. Fish and Game, and Ind. Univ., Dep. Zool., Invest. Ind. Lakes and Streams 2(12):215–253.

Rounsefell, George A. 1946. Fish production in lakes as a guide for estimating production in proposed reservoirs. Copeia 1946(1):29–40.

Smith, William A., Jr., James B. Kirkwood, and John F. Hall. 1955. A survey of the success of various stocking rates and ratios of bass and bluegill in Kentucky farm ponds. Ky. Dep. Fish and Wildlife Resources Fish. Bul. 16. 42 p.

Stroud, Richard H. 1948. Growth of the basses and black crappie in Norris Reservoir, Tennessee. Tenn. Acad. Sci. Jour. 23(1):31–99.

Surber, Eugene W. 1949. Results of varying the ratio of largemouth black bass and bluegills in the stocking of experimental farm ponds. Amer. Fish. Soc. Trans. for 1947, 77:141–151.

Swingle, H. S. 1951. Experiments with various rates of stocking bluegills, *Lepomis machrochirus* Rafinesque, and largemouth bass, *Micropterus salmoides* (Lacépède), in ponds. Amer. Fish. Soc. Trans. for 1950, 80:218–230.

———, and E. V. Smith. 1938. Management of farm fish ponds. Alabama Polytechnic Institute Agricultural Experiment Station, Auburn. 6 p.

———, and ———. 1942. Management of farm fish ponds. Ala. Polytech. Inst. Agr. Exp. Sta. Bul. 254. 23 p.

Turner, William R. 1959. The standing crops of fishes in twenty-two Kentucky farm ponds. Kentucky Department of Fish and Wildlife Resources, Frankfort, Federal Aid to Fisheries, Project F-10-R Final Report. 21 p.

U.S. Weather Bureau. 1946. Climatological data: Illinois section. Vol. 51, 80 p.

Williamson, L. O., and W. S. Churchill. 1948. Large mouth bass population in Punch Lake. T41N, R6E, S35, Vilas County. Wis. Conserv. Dep., Fish. Biol. Sect., Invest. Rep. 515. 12 p.

INDEX

Fish species having names of more than one word are listed with the words in normal rather than inverted order: for example, *Largemouth* bass rather than *Bass, largemouth*. Cross references are given only in cases where such listings were believed necessary.

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