*Answer:* Needs will continue to be met in the most feasible way by available personnel. May be by new branch personnel or by existing organizations.

*Question:* Why was the National Park Service omitted from the list of agencies served?

*Answer:* The omission was not intentional. Work with the Park Service in the past has been primarily of a research nature in the past few years but the Division of Sport Fish and Wildlife still has the responsibility for providing everyday management requirements.

# STUDIES OF GIZZARD SHAD REDUCTION AT LAKE BEULAH, FLORIDA

*By* MELVIN T. HUISH
*Florida Game and Fresh Water Fish Commission*
*Fisheries Experiment Station*
Leesburg, Florida

## ABSTRACT

Four experiments with 0.1 p.p.m. or less of 5 percent emulsified rotenone were conducted at Lake Beulah, Florida. Lake Beulah, an eighteen-acre lake with an average depth of 14.9 feet characteristically had a heavy plankton production.

Estimated pounds of gizzard shad killed progressively declined during the four experiments although concentrations of rotenone were increased. The first kill was estimated at 23,455 pounds of shad; second kill, 7,976 pounds; third kill, 1,528 pounds; and fourth kill, 1,060 pounds. Small numbers of fish of other species were also killed.

Length-frequency studies of gizzard shad indicated an over populated condition existed at the time of the first poisoning. Thereafter reproduction and rapid growth of this species occurred. Evidence exists that threadfin shad may have been eliminated from Lake Beulah following the use of the selective poisoning technique.

Total kill calculations included results from bottom sample screens. An inverse relationship existed between average temperature and the percent of all fish killed which did not float to the surface.

## INTRODUCTION

Efforts to selectively reduce a large gizzard shad population with small quantities of rotenone were started at Lake Beulah in 1955. Lake Beulah, in Lakeland, Florida, is 18 acres in area, has an average depth of 14.9 feet and receives drainage from several streets and lawns in its vicinity. The lake was characterized, as were other Lakeland lakes, by heavy plankton production and almost yearly fish kills which were comprised principally of gizzard shad.

Temperature and chemical conditions of the lake apparently were favorable for fish production except during periods of fish kills. An analysis of chemical determinations at the surface of Lake Beulah is presented in Table I. Oxygen values varied from 4.8 p.p.m. to 13.6 p.p.m. All $CO_2$ determinations were 0. pH varied from 7.0 to 8.9 and total Methyl Orange alkalinity readings indicated p.p.m. from 74 to 81. Calculations of concentrations of 5 percent emulsified rotenone used during the study were based on surface area of the lake and average depth ascertained with planimeter readings of an aerial photograph and 100 soundings. Much of the lake is at least 20 feet deep; the deepest area 28 feet. The depth increases rapidly from shore to the 10 foot level.

Gill net, trawls, and minnow nets were used with indifferent results to sample the fish population. Rather than eliminating significant portions of the population with further sampling, reliance was placed on the information obtained with the nets and observations of gizzard shad activity in the lake. This information indicated a large portion of the fish population was comprised of gizzard shad. Four treatments with a 0.1 p.p.m. concentration or less of 5

TABLE I

CHEMICAL ANALYSIS OF LAKE BEULAH

| Date | Air Temp. (F.) | Surface Temp. (F.) | pH | $O_2$ p.p.m. | $CO_2$ p.p.m. | Total MO p.p.m. | Secci Readings (Inches) |
|---|---|---|---|---|---|---|---|
| Mar. 27, 1955 | .. | 68 | 7.0 | 4.8 | 0 | .. | ... |
| Mar. 28, 1955 | .. | 66 | .. | .. | .. | .. | ... |
| Mar. 28, 1955 | .. | .. | .. | 8.0 | 0 | .. | ... |
| Mar. 29, 1955 | .. | 62 | .. | .. | .. | .. | ... |
| Mar. 12, 1956 | 91 | 75 | 8.5 | 13.6 | 0 | 81 | ... |
| Mar. 14, 1956 | 90 | 75 | 8.0 | 8.8 | 0 | 79 | ... |
| July 19, 1956 | 90 | 87 | 8.7 | .. | .. | .. | 14.5 |
| July 19, 1956 | 99 | 90 | 8.9 | 8.4 | 0 | .. | ... |
| July 20, 1956 | 100 | 89 | 8.5 | 7.6 | 0 | .. | 16.5 |
| July 15, 1956 | 95 | 90 | 8.0 | 5.8 | 0 | .. | ... |
| July 15, 1957 | 95 | 92 | 7.5 | 7.0 | 0 | .. | ... |

TABLE II

CALCULATED KILL OF GIZZARD SHAD AND CONCENTRATION OF POISON USED ON LAKE BEULAH

| Date | 3/28/55 | 3/12/56 | 7/18/56 | 7/15/57 |
|---|---|---|---|---|
| Amount of Chemical | 5 gals. | 5 gals. | 5 gals. | *10 gals. |
| P.P.M. Concentration | .06 | .06 | .07 | .10 |
| Estimated Total Kill of Gizzard Shad | 23,455 | 7,976 | 1,528 | 1,060 |
| Average Pounds of Gizzard Shad Killed Per Surface Acre | 1,303 | 443 | 85 | 59 |

* Water level was higher during this experiment.

percent emulsified rotenone were used. The material was applied by means of a drum and faucet device mounted on an outboard boat. Except during the first treatment no effort was made to distribute the poison in deeper waters. Results of the four applications demonstrated a progressive decline in calculated kill of gizzard shad (Table II). The calculated kill of gizzard shad following application of a 0.06 p.p.m. concentration on March 28, 1955 was 23,455 pounds (1,303 pounds per surface acre). In addition there was a total of 913 pounds of threadfin shad destroyed. Nearly a year later (March 12, 1956) a 0.06 p.p.m. application destroyed 7,986 pounds of shad; five months later (July 18) 1,528 pounds resulted from a 0.07 p.p.m. application. A fourth treatment of 0.10 p.p.m. concentration on July 15, 1957 reduced the remaining population by 1,060 pounds (59 pounds per acre).

Estimated poundage of species killed other than gizzard shad (Table III) are listed. Chief of these were threadfin shad (*Dorosoma petensis vanhyningi*). All population samples subsequent to the first application indicated no threadfin were present. Although kills of gizzard shad with this method did not do substantial damage to most of the other species, there was a strong suggestion threadfin shad were eliminated from Lake Beulah.

Samples of gizzard shad killed as a result of the treatments (Table IV) indicated the largest percent of the kill was in the 9.0 and 9.5 inch size classes during March 1955. An over population of gizzard shad was indicated by measurements and general observation of their condition. Reproduction of shad, as indicated by measurements of March 1956, occurred between the time of the first treatment and the second. Most gizzard shad at the time of the second poisoning were in smaller size classes; 4.0, 4.5 and 5.0 inches. The data suggests the severe reduction of 1955 resulted in healthier but fewer shad. Measurements in July 1956, indicated further reproduction had taken place between March and July 1956. Gizzard shad killed during the fourth poisoning were largely in the 5.0 and 5.5 inch size classes. Smaller size classes in each of the poisonings were more strongly affected than the larger.

TABLE III

ESTIMATED POUNDS OF FISH KILLED IN SELECTIVE POISONING EXPERIMENTS CONDUCTED ON LAKE BEULAH

| *Date* | *3/28/55* | *3/12/56* | *7/18/56* | *7/15/57* |
|---|---|---|---|---|
| *Species:* | | | | |
| Bass | 5.0 | 60 | .... | 30 |
| Crappie | .8 | 30 | .... | 20 |
| Bluegill | 1.5 | 60 | .... | 30 |
| Shellcracker | .3 | 10 | .... | 15 |
| Warmouth | .2 | .... | .... | .... |
| TOTAL GAME SPECIES | 7.8 | 160 | ....* | 95 |
| White Cat | 1.5 | .... | .... | .... |
| Gizzard Shad | 23,455.5 | 7,976 | 1,528 | 1,060 |
| Threadfin Shad | 913.0 | .... | .... | .... |
| Miscellaneous Rough Fish | .... | 10 | .... | .... |
| TOTAL ROUGH SPECIES | 24,370 | 7,986 | 1,528 | 1,060 |
| GRAND TOTAL | 24,378 | 8,146 | 1,528 | 1,155 |

* Estimates of fish killed other than gizzard shad were not made. Small poundages of bluegill and bass were killed.

TABLE IV

COMPARISON OF THE LENGTH-FREQUENCY OF GIZZARD SHAD TAKEN DURING THE FOUR SELECTIVE POISONING EXPERIMENTS IN LAKE BEULAH (EXPRESSED AS PERCENTAGES)

| | *3/55* | *3/56* | *7/56* | *7/57* |
|---|---|---|---|---|
| 3.0 | . . | . . | 0.8 | . . |
| 3.5 | . . | 0.6 | 34.0 | . . |
| 4.0 | . . | 15.8 | 46.5 | . . |
| 4.5 | . . | 39.2 | 26.4 | 13.5 |
| 5.0 | . . | 19.7 | 2.3 | 30.3 |
| 5.5 | . . | 8.3 | . . | 25.8 |
| 6.0 | . . | 1.9 | . . | 5.6 |
| 6.5 | . . | .2 | . . | 3.4 |
| 7.0 | 7.0 | . . | . . | 1.1 |
| 7.5 | . . | . . | . . | . . |
| 8.0 | 1.1 | . . | . . | . . |
| 8.5 | 14.8 | . . | . . | 3.4 |
| 9.0 | 60.2 | 1.6 | . . | 4.5 |
| 9.5 | 20.4 | 6.2 | . . | 4.5 |
| 10.0 | 2.3 | 3.3 | . . | 6.7 |
| 10.5 | 1.1 | 1.5 | . . | . . |
| 11.0 | . . | .9 | . . | . . |
| 11.5 | . . | .6 | . . | . . |
| 12.0 | . . | .3 | . . | . . |
| 12.5 | . . | . . | . . | . . |
| 13.0 | . . | . . | . . | 1.1 |
| TOTAL NUMBER | 88 | 797 | 129 | 89 |

Moorman (1951) found in checking population studies during 1949 and 1950, recoveries of marked fish were always incomplete and ranged from 22 to 65 percent. Carlander (1952) stated several figures from various ponds of marked fish recovery following poisonings. These were as follows: Johnson pond, crappie 14 percent, bluegill 65 percent, bullheads 71 percent and largemouth bass 94 percent; Blom pond, bullheads 91 percent. A statement in his 1952 study regarding results of 1948 work is "The percentage collected differed so much between species even in the same pond that it was impossible to get a

satisfactory estimate of the species composition from rotenone treatments unless the percentage collected was determined for each species." Results of that study (Carlander, 1948), following the poisoning of a small pond in Marion County, Iowa, produced a recovery of 38 percent bluegill, 14 percent white crappie, 33 percent largemouth bass, 80 percent black bullhead, and 91 percent of the golden shiner that had been marked prior to the poisoning. Ball (1945) introduced 456 marked fish into Ford Lake, Michigan to check the efficiency of recovering the total fish population following poisoning. There was a recovery of 58.9 percent of all marked bluegills and 44.7 percent of the trout. He stated "The percentage recovery of all groups of fish was lower than anticipated and poses a question as to the validity of population estimates derived from the pickup of fish following poisoning." Krumholz (1944) stated "There is no way of knowing how nearly complete the recovery of poisoned fish was inasmuch as many fish, particularly small ones, may sink at once to the bottom and disintegrate there. Fortunately the preferred habitat of small fish is along shore, so that recovery of a large percentage is possible if one is careful."

Unfortunately gizzard shad were found in abundance in open water rather than along shore as were the fish referred to by Krumholz. Further, lakes with heavy populations of gizzard shad in Florida have been found to have low visibility limits. Two Secchi readings of July 19, 1956 indicated visibility as 14.5-16.5 inches at Lake Beulah. Also larger ovoid lakes have greater percentages of open water area than shoreline area as compared to the small ponds discussed by the several authors. To achieve an index of total kill open water bottom areas should be considered. It may be satisfactory "dead floating" and "dead on the bottom" ratios can be achieved. To do so will require development of sampling methods and consideration of temperature effects.

Studies of a method of determining amount of kill on the bottom were conducted at Lake Beulah and the results incorporated in total kill estimates. Briefly the method consisted of placing at random 3 x 4 foot framed screens of ½-inch hardware cloth on the bottom of the lake. Upon completion of estimating kill at the surface the screens were lifted and fish on them used to calculate the total number remaining on the bottom. Average weight data was then applied to calculate total pounds on the bottom. Difficulties with the method were apparent. Eight, eleven, fifteen and seventeen screens were used during the four treatments. Although variation of number of fish on the screens was not large many more screens would have been desirable to establish the basis for calculated results since only a small area of the bottom could be sampled with the method used. One reason fish may not come to the surface is that many bury themselves in the mud. A fish landing on a screen would not be buried and more apt to float thus minimizing calculated results.

TABLE V

COMPARISON OF CALCULATED ESTIMATES OF DEAD SHAD ON THE SURFACE AND THOSE ON THE BOTTOM WITH WATER SURFACE TEMPERATURE AT TIME OF EXPERIMENT

| *Date* | *% of Weight of Shad on Bottom* | *% of Weight of Shad on Surface* | *Total Lbs. of Shad Estimated Killed* | *Temp. of Water at Time of Poisoning* |
|---|---|---|---|---|
| Mar. 28, 1955..... | 81.8 | 18.2 | 23,455 | 66° F. |
| Mar. 12, 1956..... | 60.3 | 39.7 | 7,976 | 75° F. |
| July 18, 1956..... | 44.4 | 55.6 | 1,528 | 89° F. |
| July 15, 1957..... | 29.2 | 70.8 | 1,060 | 91° F. |

Studies of effect temperature of water may have on percent of fish on the bottom are presented (Table V). Lower temperatures were accompanied by a larger percentage of calculated total kill remaining on the bottom. The lowest surface temperature (66° F.) of March 25, 1957 was accompanied by the largest percent (81.8) screen estimate on the bottom. Warmer water was accompanied by lesser percentages; 75° F., 60.3 percent; 89° F., 44.4 percent; 91° F., 29.2 percent. The coefficient of correlation was –.97 with two degrees of freedom and was significant at the 95 percent level. A stratification study conducted on July 26, 1957 indicated there was not a large difference between the temperature at the surface and at the bottom of Lake Beulah (Table VI). A

surface temperature of 87° F. was accompanied by a temperature at the bottom of 82° F. It is not likely a recent overturn caused uniformity of temperature since oxygen and carbon dioxide demonstrated marked differences between surface water and deeper water.

A small amount of sport fishing for bream, bass, and catfish occurred during the program. No adverse effects on sports fishing were noted. However, some fishermen claimed better bass catches following treatments. Sports fishermen data were considered an unreliable source of information because of the few people fishing on the lake (as with most other lakes in Lakeland). Minnow seine samples taken April 5, 1957 indicated the presence of numerous small bass and bluegill as well as black crappie.


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*Question:* How much time elapsed after poisoning before the screens were raised?

*Answer:* About four days.

*Question:* Did you assume that the fish found on the screens would never float?

*Answer:* Yes.

*Question:* How much of the fish was left after four days?

*Answer:* The skelton of the fish.

*Question:* What other fish were killed?

*Answer:* About 0.5-1.0% of total, mostly threadfin. On the second poisoning a few game species were killed.

*Question:* What was the treatment interval?

*Answer:* About 4-5 months.

*Question:* Did you completely eliminate shad?

*Answer:* Yes, in this lake.

*Question:* What concentration appeared best?

*Answer:* 0.1 p.p.m. seemed best and killed fewer game fish.

*Question:* What method of application was used?

*Answer:* From boats with stirring from outboard motors in small lakes. For large lakes, airplanes application has been made.

*Question:* How long did it take to obtain a complete kill?

*Answer:* 1½-2 days at lower temperature or ½ day at high temperature.

*Question:* Did screens aid in dead fish recovery?

*Answer:* Yes, but did not rely upon them entirely.

*Question:* Was the amount of poison used based upon the volume of water in the lake?

*Answer:* Yes.

*Question:* Were population studies made afterward?

*Answer:* No, not in Lake Beulah but were made in other lakes treated. Shad young-of-the-year were eliminated and game fish especially black bass increased.

*Question:* Would the screen method have possibilities as a sampling method?

*Answer:* Yes, if the area sampled was not too large.