The reasons for the poor results obtained with the trout ration are not fully understood. However, it contained small amounts of antibiotic feed supplements, and there is some evidence that antibiotics fed to fish over a long period may reduce rate of growth.

Although there were no significant differences in the gains among the fish fed the three forms of Auburn No. 2 fish feed, there were indications that particle size influenced production. Apparently, the fish were able to find and consume a larger percentage of the feed when the size of the particle was increased. It was observed that the fatheads consumed a considerable amount of the dry mix just after it hit the water and before the particles sank to the pond bottom. The crumbles and pellets sank more rapidly than the dry mix, and it appeared that the fatheads did not eat these forms until after they had softened on the pond bottom.

A SUMMARY OF METHODS USED DURING FLORIDA'S GIZZARD SHAD CONTROL EXPERIMENTS

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ABSTRACT

Determination of a desirable concentration of 5 percent emulsified rotenone in a given lake to control gizzard shad was accomplished by an observational technique. The concentration employed varied from 0.06 p.p.m. to 0.14 p.p.m. The time of year considered best suited for treatment was during the fall. Methods used to apply the toxicant were varied but appeared about equal of results except while using spray planes. The most favorable results occurred when good distribution was secured by using six to twelve hours for application, numerous surface units and dilute mixtures. As many as 4,600 acre feet were treated by one efficiently equipped boat. A table is presented which was used as a basis for calculations of concentrations. At least three successive treatments one year apart were needed for the most effective control of shad. Conclusions regarding stocking were not drawn.

INTRODUCTION

Control of undesirable forage fish populations have been attempted in Florida waters for several years. Selective poison techniques with five percent rotenone have been demonstrated to efficiently destroy large poundages of gizzard shad. These methods as used in Florida are described in this paper.

DETERMINATION OF DESIRABLE CONCENTRATIONS

The determination of a desirable concentration of 5 percent emulsified rotenone required for gizzard shad control in Florida was not predictable since it appeared to be dependent upon several variables. Such variables were the amount of active ingredient in the material to be applied, water temperature, amount of organic material present, nature of the lake bottom and others. An observational technique, based largely upon experience, was found to be a satisfactory method of making the determination. During treatments of small lakes general activity of gizzard shad over the entire lake surface as the concentration approached 0.10 p.p.m. was used as an index. If the shad were more active in some areas than others, as the desired concentration was approached, those areas were avoided during the subsequent application so that activity of shad on the entire lake tended to be uniform. When the surface was "working" with small and some medium sized shad it was believed the kill of shad would be satisfactory. At low temperatures a general activity was difficult to detect. The concentrations required were found to vary from 0.06 p.p.m. to 0.14 p.p.m.

Being unable to see the entire surface of a large lake at one time presented a major difficulty. For that reason a 0.10 p.p.m. concentration was applied since excessive kills of game fish had not occurred at that concentration. Following observations the results of the 0.10 p.p.m. treatment were used to determine if a higher concentration should be applied. Decisions necessarily were influenced by the fish population composition and size classes present in the lake prior to poisoning. Threadfin shad were destroyed at lesser concentrations than gizzard shad (Huish, 1957). For that reason care was taken not to terminate the applications because of distress of that species.

SEASON OF TREATMENT

Several reasons existed which indicated fall selective poison treatments with 5 percent emulsified rotenone were more desirable than those of winter or spring. Smaller fish of a species were affected more strongly than were the larger. Thus spring treatments resulted in kills of young of the year bass, whereas in the fall bass had grown to a size less apt to be affected. Gizzard shad were found to be within the size range of selectivity of treatments during their first year. Late summer and fall treatments in Florida virtually destroyed young of the year gizzard shad and did not result in substantial losses of bass. Those treatments also extended the length of the black crappie sport fishing season in treated lakes.

Selective poisoning at other seasons of the year were not as satisfactory. Observations during cool water treatments showed the need of higher concentrations of rotenone and a tendency of the shad to not come to the surface either while dying or after they were dead. This tendency hampered observations of the numbers affected and determination of the extent of kill. Since all larger gizzard shad were not destroyed at the concentrations used, heavy spawning of shad was not prevented by treating just prior to the spawning period. Also, treatment just after the major spawning season did not prevent substantial reproduction of shad during the year. One advantage of cold water treatments, though, was a reduction of the disposal problem since most of the dead fish decomposed on the bottom.

METHODS

Methods used to distribute the toxicant have included the pouring of material over the side of an outboard boat, pumping into deep water, use of a gravity flow device to place the toxicant into deep water, tubs and drums mounted on or in outboard boats with valves to regulate flow, airboats with spray pumps and spraying from airplanes. Satisfactory results were obtained with the methods used except with aerial applications. Best results occurred when good distribution was secured by using six to twelve hours for application, numerous surface units and dilute mixtures.

The larger lakes of Florida which were selectively poisoned were treated by airboats with spray units, and outboards fitted with racks to hold fifty-five gallon drums (Plates I, II and III). The drums were lowered (Plate IV) complete with faucets and hoses long enough to go out the boats' drain holes or over the transoms. The better mounts allowed the drums to rest as near the bottom of the boats as possible. Fifty-five gallons were distributed in a two-hour period using airboats or 18 h.p. or larger motors operated at maximum speeds on 14-foot boats in water three or more feet deep.. A longer time or faster boats would be desirable to distribute the material in water of lesser depths and at higher temperatures.

One lake comprised of approximately 8,000 acre feet has been treated with three fast boats in eight hours of application and loading. All of the material used on another lake which consisted of nearly 165,000 acre feet was applied with thirty-four boats. The average number of acre feet treated by one boat unit on all Florida lakes is less than that indicated by the figures of these two larger lakes. Experience indicated that 4,000 or more acre feet could be treated in a day by a swift, well equipped boat and an efficient loading operation.

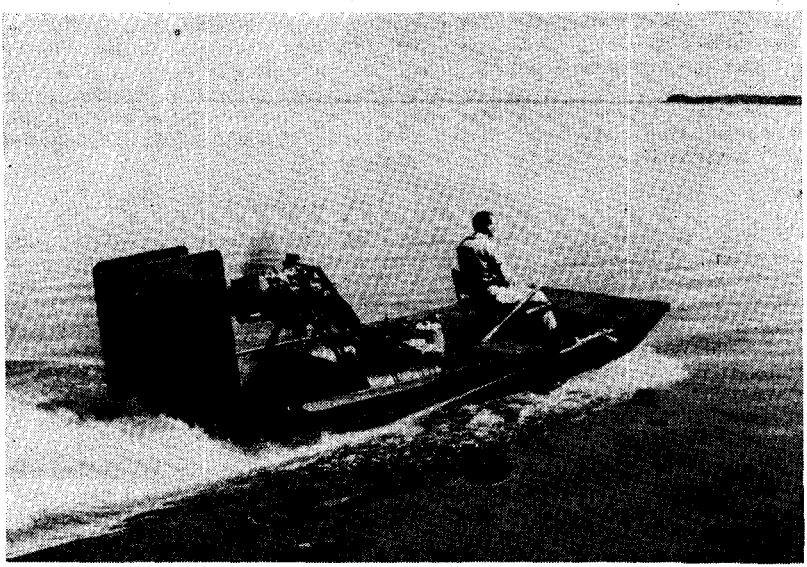

PLATE I. An airboat using Hyacinth Control spray equipment directing rotenone into the turbulent water at its stern. These boats operated at approximately 35 miles per hour.

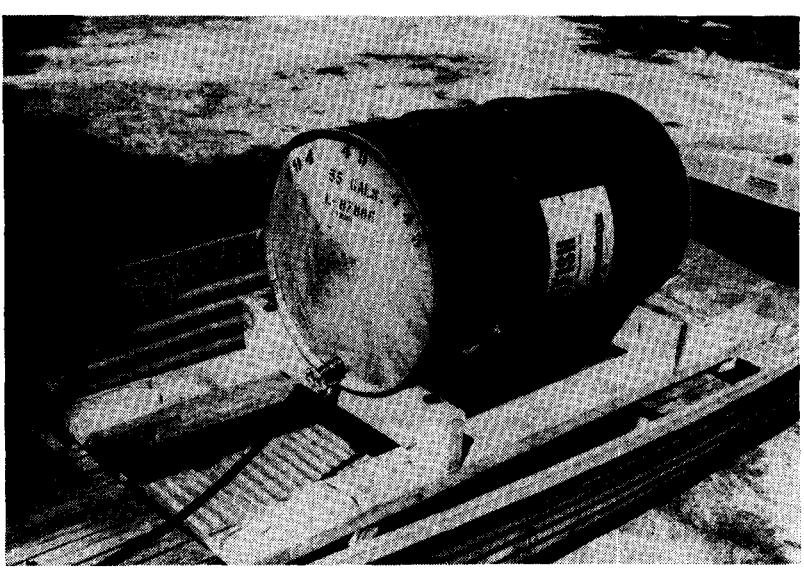

PLATE II. A drum equipped with valves and hose resting on one type of mount.

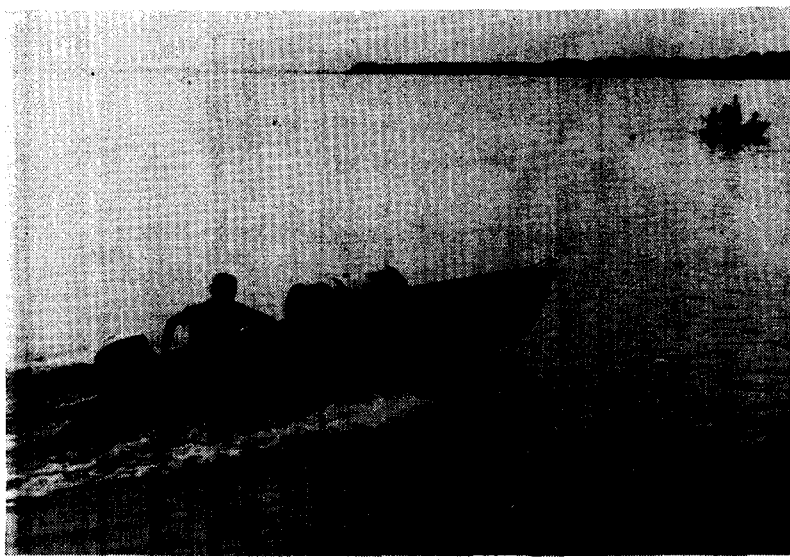

PLATE III. An outboard powered with an 18 h.p. motor applying poison.

A simplified method of calculating the amount of material needed to establish desirable concentrations was used (Table I). When the total acre feet figure was known, determination of the amount of toxicant needed was made using this table. The p.p.m. concentration at any time could be determined quickly also while applications were progressing.

RATES OF APPLICATION OF 5 PERCENT ROTENONE

Parts per million	*Number of Units for Each Acre Foot*			
Concentration	*Cubic Centimeters*	*Pints*	*Quarts*	*Gallons*
0.01	12	0.026	0.013	0.003
0.02	25	0.052	0.026	0.007
0.03	37	0.078	0.039	0.010
0.04	49	0.104	0.052	0.013
0.05	61	0.130	0.065	0.016
0.06	74	0.156	0.078	0.020
0.07	86	0.182	0.091	0.023
0.08	98	0.208	0.104	0.026
0.09	110	0.234	0.117	0.029
0.10	123	0.260	0.130	0.032
1.00	1,226	2.600	1.300	0.325

$$\frac{\text{Total square feet of water surface}}{43.560 \text{ (square feet per acre)}} = \text{Surface acres X average depth in feet} = \text{acre feet of water.}$$

Acre feet determinations were made by use of planimeter readings of aerial photos and/or grid counts (area) and use of an Echo Sounder (depth). The most satisfactory type map of large lakes was found to be one with contour lines. Grid or planimeter readings on the contour lines allowed calculations of amounts of toxicant to be applied at the several depths.

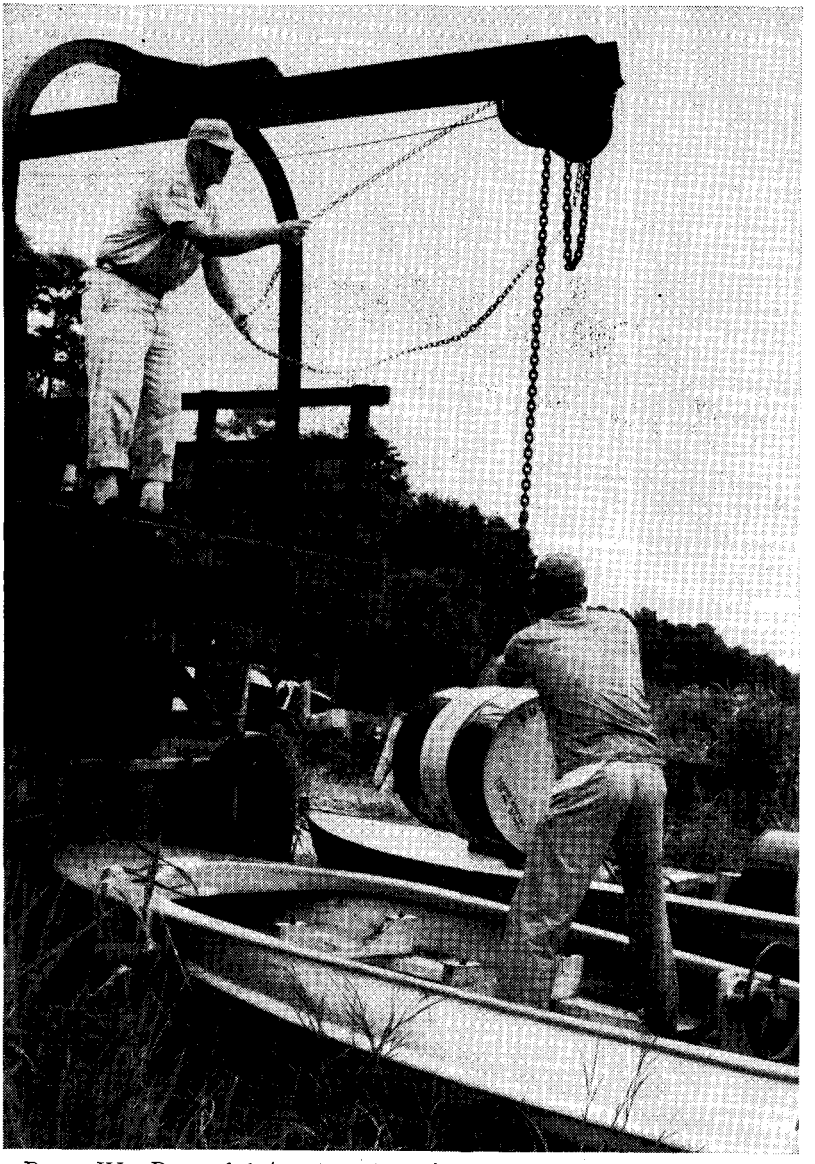

PLATE IV. Rear of 1½ ton truck equipped to carry and load into boats drums of poison.

NUMBER OF TREATMENTS

Assuming the life expectancy of most gizzard shad not to exceed three years in Florida waters (Berry, 1957), then destruction of young of the year shad in three successive years would nearly eliminate gizzard shad from a population. Since some of the shad escape, the treatments are not completely effective. The shad have been eliminated in three treatments from Deer Island Lake. Lake Beulah, with five treatments, has shown a reduction from 1,200 pounds to 43

pounds per acre at the time of the last treatment. Lake Trafford (unpublished) also has had large reductions resulting from three treatments. Those lakes which were treated only once have had a rapid recovery of their shad population.

Whether it is necessary to stock bass following the poisoning or if those present in the lake will reproduce heavily enough to cause a satisfactory increase has not been determined. Providing conditions warranted it would seem desirable to stock at a rate of 200 bass per acre (Swingle, 1953).

Continuing studies will provide answers to several questions arising from the past work. To date the technique has been of value to improvement of sport fishing in some Florida lakes.

ACKNOWLEDGMENTS

The author wishes to extend thanks to Harold Moody and the other members of the Florida Fish Management Division for their participation in the selective poisoning program. These studies would not have been conducted without the Dingell-Johnson Federal Aid to States Fisheries programs. Photographs were supplied by members of the Commissions Information Division.

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APPRAISAL AND MANAGEMENT RECOMMENDATIONS RESULTING FROM A THREE-YEAR COMPARATIVE FISHERY STUDY OF LAKE CATHERINE, LAKE HAMILTON AND LAKE OUACHITA, ARKANSAS

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ABSTRACT

A pattern of high original reservoir productivity followed by gradual decline (in terms of angling success and desirable fish production) has been evidenced in a chain of lakes, of different ages, on the Ouachita River, Arkansas. Lake Catherine, formed in 1923, consists of 3,000 acres; Lake Hamilton, created in 1931, consists of 7,200 acres, and Lake Ouachita, impounded in 1953, covers 40,000 acres. A comprehensive fishery study was conducted during the summers of 1955, 1956 and 1957 to investigate and compare the fishery resources of these lakes and formulate management plans.

Comparison of limnological data indicated that the physical-chemical factors of the water of the three lakes were normal and, in fact, appeared to be optimum for good fish production. Fertility, as determined by plankton collections and