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SHAD MANAGEMENT IN RESERVOIRS *

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ABSTRACT

Management of some form is mandatory for the continuance or restoration of successful fishing in the majority of reservoirs in the Southern States. The selective killing of gizzard shad and some species of rough fish with rotenone shows promise as a management tool for some reservoirs. The use of rotenone as a selective toxicant in four Kentucky reservoirs is discussed. The total poundage of gizzard shad was drastically reduced in three reservoirs and this species was eliminated from a fourth reservoir. A definite improvement in fishing success was noted as a result of this chemical reduction of shad, buffalo, and carp. Also, an increase in the spawning success and apparently better survival of bass occurred following the selective kill.

INTRODUCTION

It has long been apparent that some form of management is necessary if satisfactory fishing is to be restored or maintained in the majority of reservoirs in the Southern States. It is generally thought that control or partial eradication of such species as the gizzard shad, *Dorosoma cepedianum,* buffalo, *Ictiobus,* species, and carp, *Cyprinus carpio,* which dominate many of these reservoirs, would favorably influence fishing success. Swingle (1950) states that "large groups of unharvested adult fishes, regardless of whether they are bluegills or gizzard shad or another species, have a depressing effect on the "C" groups in a population which could be dissipated if harvesting were practiced." Removal, whether by netting, partial eradication or other means, of species which are undesirable or which rank low on the palatability scale is essentially a form of harvest of these species.

Methods of harvest, or controls, for this group of fishes fall into three general categories: physical, biological, and chemical. Physical methods include netting, gigging, drawdowns, etc. Biological methods are presently focused on the introduction of non-indigeneous piscivorous species such as walleye, *Stizostedion vitreum,* white bass, *Roccus chrysops,* and, more recently, a freshwater race of the striped bass, *Roccus saxatilis.* Chemical controls at present are primarily restricted to the use of rotenone compounds, applied in such a manner and quantity that the effect is largely that of a selective toxicant. It is, however, highly probable that other chemical compounds providing more effective control at lower cost will be available in the future. Such dividends could come from such a program (presently engaged in by the U. S. Fish and Wildlife Service) of testing various toxicants for a selective kill of undesirable fishes.

There is currently considerable interest in the selective killing of gizzard shad with rotenone. At least six states have participated in such operations to date. The present paper deals with the selective killing of gizzard shad in four Kentucky impoundments. Inasmuch as the work is still in progress, the results are of a preliminary nature.

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DESCRIPTION AND HISTORY

Although two of the impoundments in which a selective kill was accomplished are relatively small, they are included to establish the chronology and general course of the work.

The first selective kill of gizzard shad in Kentucky was made during October, 1954 in Carpenter's Lake in western Kentucky and has been described previously by Bowers (1955). This 70-acre state-owned impoundment contained largemouth bass, *Micropterus salmoides,* bluegill, *Lepomis macrochirus,* crappie, *Pomoxis,* species, green sunfish, *Lepomis cyanellus,* longear sunfish, *Lepomis megalotis,* warmouth, *Chaenobryttus coronarius,* bullhead, *Ictalurus,* species, drum, *Aplodinotus grunniens,* gizzard shad and several species of minnows. Gizzard shad were very abundant as shown by rotenone samplings in the summer of 1954.

An 1100-acre eastern Kentucky flood control reservoir (Dewey Lake) was the first major impoundment to be selectively poisoned in Kentucky for the control of gizzard shad. The initial selective poisoning was carried out in March, 1955 and has been described by Carter (1956).

Principal species were largemouth and spotted bass, *Micropterus punctulatus,* crappie, flathead, *Pilodictis olivaris,* and channel catfish, *Ictalurus punctatus,* redhorse sucker, *Moxostoma* species, carp and gizzard shad. Five rotenone samplings in 1954 yielded an average of 102 pounds of gizzard shad per acre out of an average total of 181 pounds per acre of all species. Numbers and weights of game fish taken in population samplings had declined since the lake was impounded in 1950. An annual creel census showed a gradual decline in fishing success to below a reasonable norm.

Shanty Hollow, a 106-acre state-owned lake, located in southwest Kentucky, was the third Kentucky impoundment in which a selective kill of gizzard shad was attempted. This selective kill was made in April, 1955. The population was composed primarily of largemouth and spotted bass, bluegill, redear sunfish, *Lepomis microlophus,* longear sunfish and warmouth. Gizzard shad made up 21 percent and 15 percent of the total poundages of fishes taken in rotenone samples in 1953, and 1954, respectively. Fishing was reportedly mediocre.

The largest Kentucky impoundment in which a selective kill of gizzard shad has been attempted to date is 3,600-acre Herrington Lake, located in the fertile central section of the state. The initial selective poisoning was made in March-April, 1956. Principal species in Herrington Lake were largemouth bass, spotted bass, smallmouth bass, white bass, white crappie, bluegill, longear sunfish, green sunfish, channel and flathead catfishes, smallmouth buffalo, drum, longnose gar and gizzard shad. Carp were also represented by a small number of large individuals.

Constructed in 1925 by private power interests, Herrington Lake has a long history of reputedly good fishing but the catch declined to such an extent in the early fifties that it became known locally as "The Dead Sea."

METHODS AND MATERIALS

Various concentrations of rotenone and methods of application have been used in effecting a selective kill in these impoundments. In Carpenter's, Dewey, and Shanty Hollow Lakes, initial application of rotenone were based on 0.1 p.p.m. of the rotenone compound or carrier (five percent rotenone) applied to the total lake volume. Initial application in Carpenter's was with powdered cubé delivered through a small motor-driven spray rig; at Dewey Lake the initial application was emulsifiable rotenone applied by a crop-spraying aircraft; and at Shanty Hollow and Herrington Lakes the rotenone was delivered beneath the lake surface into the propwash of an outboard motor. Powdered cubé was used at Shanty Hollow and emulsifiable rotenone at Herrington.

Herrington Lake posed a peculiar problem in that it is essentially a gorge filled with water, has a maximum depth of 260 feet, and reportedly averages over 70 feet in depth. The cost of rotenone to treat the entire volume at a concentration of 0.1 p.p.m. of the rotenone compound would of course, be prohibitive; therefore, it was necessary to recourse to something less than complete treatment. Partial coverage, via the distribution of slightly diluted emulsifiable rotenone in the form of bands, had proved effective in the second poisoning of Dewey

Lake. This banding effect was accomplished by means of a Venturi-tube arrangement which siphoned the rotenone emulsion from a container into the propwash of an outboard motor as the boat was maneuvered back and forth across the lake at definite intervals. The effectiveness of this method of selective poisoning is dependent to a large extent on the movement of the shad through the bands of rotenone.

Two selective kills annually, one in April and the second in July or September, were carried out on Herrington Lake in 1956 and 1957. A single selective kill was made in September, 1958.

RESULTS

Accurate measurement of any improvements effected through management in reservoirs is more often than not an exceedingly difficult task—selective killing of shad is no exception. However, it would appear that a significant improvement in the fish population would eventually be reflected in an increased catch; therefore, wherever possible, as complete a creel census as circumstances would permit was taken prior to and following the selective kill.

A second criterion of success to receive attention was a check on the population composition prior to and after the shad kill. Favorable changes expected were (1) a significant reduction in the weight representation of gizzard shad, buffalo, and carp within the population and (2) increased spawning success and survival of game species, especially black bass and white bass. Population samplings with rotenone, and in some cases nets, were relied on to furnish this information.

Growth rates also were examined for possible changes.

Carpenter's Lake. Approximately 285 pounds of gizzard shad per acre were killed by the initial treatment. Two years of reportedly (no creel census was taken) good fishing followed the selective kill. Fishing then tapered off to somewhere near its former level despite selective poisonings in 1956 and 1957. An estimated 114 pounds of gizzard shad per acre were removed in 1957 and somewhat less than this in 1956. Shad were recovered at the rate of 115 pounds per acre from a one-half acre population study area in 1958.

Dewey Lake. Fishing during April, following the initial selective kill of gizzard shad in March, 1958, was reported to have been better than at any time since impoundment. Creel census figures fail to corroborate this, presumably because of a less thorough census prior to the selective kill.

Prior to the selective kill spawning by the gizzard shad and other forage species was light, consequently, the growth and survival of the game species was adversely affected. Following the selective poisoning, however, the gizzard shad spawned heavily and large numbers of forage-size shad were available to the predators as forage.

The most pronounced change effected by selective poisoning was a drastic reduction in the pounds of gizzard shad per acre (Table I). The new level, approximately one-third of the former pounds per acre, has been maintained by poisoning annually in the fall. A second pronounced change was a contant lowering of the poundage of rough fish (primarily carp and redhorse suckers) with each selective poisoning. Game fish were apparently reduced from 17.1 pounds per acre prior to the selective poisoning to 7.4 pounds the summer following the selective poisoning. Some of the decreased poundage may be attributable to

TABLE I

REPRESENTATION OF VARIOUS GROUPS OF FISHES TAKEN IN ROTENONE SAMPLINGS OF DEWEY RESERVOIR DURING THE YEARS 1954-58

	Game Fish Percentage by			*Panfish* Percentage by			*Rough Fish* Percentage by			*Forage Fish** Percentage by			*Total*
	No.	*Wt.*	*Lbs. Per Acre*	*No.*	*Wt.*	*Lbs. Per Acre*	*No.*	*Wt.*	*Lbs. Per Acre*	*No.*	*Wt.*	*Lbs. Per Acre*	*Lbs. Per Acre*
1954	6.5	9.4	17.1	52.3	19.4	35.1	3.6	14.8	26.8	37.6	56.4	102.0	181.0
1955	13.5	10.1	7.4	56.1	30.6	22.2	1.1	15.6	11.2	29.3	43.4	31.5	72.3
1956	15.2	25.5	8.7	24.4	6.2	2.1	5.2	25.6	8.8	55.3	41.8	39.4	59.0
1958	40.4	33.1	25.3	33.5	20.3	8.9	1.2	6.7	5.1	25.0	40.0	36.2	75.5

* Over 99 percent of the weight of this group was gizzard shad.

error inherent in rotenone samplings; however, at least a portion of this decreased poundage is apparently due to the greatly increased harvest of game fish during the two months following the selective poisoning. The poundage of game fish has increased steadily since the initial reduction; however, crappie account for most of the increased poundage.

Although selective poisoning resulted in a greatly increased spawn of bass, crappie, shad and bluegill in 1955, the number of young-of-the-year of most species declined somewhat during the following years.

Shanty Hollow Lake. This lake was poorly buffered (total hardiness 25 p.p.m.) and an estimated 500 adult bass died as a result of the selective kill. However, as revealed by subsequent observation and rotenone samplings, an apparent total kill of shad resulted—an experience unique in selective poisoning operations in Kentucky.

Fishermen stayed away from Shanty Hollow for a long period following the selective kill in the erroneous belief that the bass population had been badly decimated. However, through demonstrative good catches by Departmental personnel, fishermen were persuaded to return to the lake and were gratified with their catches.

Unfortunately, for comparative purposes, no creel census has been done at Shanty Hollow. However, population studies in 1958 show an improvement in the percentage of harvestable fish (67 percent in 1958 as compared with 55 percent in 1954).

Herrington Lake. Numerous shad of all sizes died as a result of the initial selective kill in March-April, 1956. Numerous large buffalo and carp were killed in all except the deeper portions of the lake. A large number of small black bass (8 inches and less) died as a result of this operation. With the exception of one large creek area poisoned on April 24, the kill of adult bass was minimal.

Fishing improved very slowly during 1956. However, population studies revealed a greatly increased spawn of all species, including gizzard shad.

The second selective poisoning of 1956 was made in July to eliminate a portion of the tremendous number of young-of-the-year shad then in the lake. Despite an apparent good kill of these small shad, fishing failed to improve significantly, during the fall months.

The third selective poisoning of Herrington Lake was made in April, 1957. Large numbers of both adult and subadult shad, as well as buffalo and large carp, were killed. The catch of game fish and other species improved significantly during the spring of 1957.

Depth distribution studies made during 1957 indicated that the shad became more or less concentrated in the top 30 feet of water in early September as a result of summer stratification. The third kill of shad, therefore, was planned to coincide with this period of concentration.

Studies conducted by Bassett (1956) revealed a much slower rate of descent for Pro-Noxfish than for Chem Fish Regular (the latter had been used previously at Herrington). On the basis of this information, it appeared that the slower rate of descent of the Pro-Noxfish might improve the kill of young-of-the-year shad which normally inhabit the surface waters during the late summer and early fall months. Also, the amount of emulsifiable rotenone was increased to 0.4 of a gallon per surface acre as compared with 0.2 of a gallon used during July, 1956.

The results were striking, as revealed by subsequent rotenone samplings in 1957 and 1958. Better than a 95 percent kill of young-of-the-year shad was obtained. The catch of game fish upsurged three days after completion of the kill and continued at a high level through the early spring of 1958, as corroborated by creel census.

A single selective kill was made in 1958. Although this operation was carried out during the last week of September, as in 1957, the fall overturn had already begun and the results do not appear to be on a par with those obtained in 1957. Table II shows a year-by-year reduction in the total poundage of shad recovered by rotenone samplings. The poundage dropped from 282 pounds per acre in 1955, prior to the beginning of selective killing, to 35 pounds per acre in 1957. The 1958 poundage was virtually unchanged from that of 1957.

TABLE II

SUMMARY OF FISH RECOVERED IN ROTENONE SAMPLINGS OF HERRINGTON LAKE FROM 1955 THROUGH 1958

Year	*Lbs. Per Acre of Game Fish*	*Lbs. Per Acre of Panfish*	*Lbs. Per Acre of Rough Fish*	*Lbs. Per Acre of Forage Fish**	*Total Lbs. Per Acre*
1955	41	18	37	282	378
1956	38	16	31	122	198
1957	52	8	15	35	110
1958	26	6	27	43	100

* Over 95 percent of the weight of this group was gizzard shad.

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RESERVOIR OPERATION FOR STATUTORY PURPOSES

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ABSTRACT

The Corps of Engineers of the Department of the Army plans and constructs authorized flood control and multiple-purpose reservoirs under the general provisions of the Flood Control Acts of 1936 and 1944 and other legislation authorizing specific reservoir projects. The 1944 Act delegates to the Secretary of the Army responsibility for prescribing regulations for the use of flood control or navigation storage at all reservoirs, except those of the TVA, constructed wholly or in part with Federal funds.

Effective functional operation of reservoirs is a most important factor in insuring that they accomplish the purposes for which they were designed and produce the benefits which justified their construction. Flood control, navigation, and power development, singly or in combination, are the major purposes for which reservoir projects have usually been authorized in Southeastern United States. Where uses of reservoir sites for agriculture, forestry, fish and wildlife conservation, and recreation were not inconsistent with the project operation for its authorized purposes, they were developed as an active part of the project.

The management of the fishery resource of a Federal reservoir is recognized as the responsibility of the state(s) in which the project is located. The Corps of Engineers cooperates with states to the extent possible in operating water levels for fishery benefits. Water-level management on reservoirs operated primarily for flood control is generally compatible with fish-management programs. Regulation schedules on multiple-purpose reservoirs are not subject to drastic

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