The black bullhead demonstrated a remarkable ability to recover from losses due to removals. Although 3827 fish that weighed 1149 pounds had been removed prior to the last estimate, and as much as 96 percent of the estimated population had been removed in the winter of 1958, the population numbers remained almost unchanged from that of 1958 when the 1960 winter estimate was made. The winter estimate in 1960 indicated 8688 bluegill in the lake. This amount was almost identical to that remaining in the summer estimate after the removal but the population weight had decreased by 253 pounds. Declining growth rates and condition index, increased numbers of small fish and fewer of desirable sizes indicate that bluegill have been most seriously affected by the removals.

Both good and bad effects have been demonstrated when bluegill and black bullhead catfish were removed to the extent of 42 pounds per acre and the total standing crop was reduced by as much as 19 percent. While there appears to be a definite trend toward some improvement in the redear and warmouth populations, largemouth bass and white crappie exhibited more detrimental than beneficial effects. Although redear and warmouth populations did improve, the net effect within the space of three years failed to materially improve fishing. Apparently the removal of large amounts of less desirable fish did not, in itself, provide sufficient environmental improvement to stimulate greater production of either the largemouth bass or white crappie. Other factors, such as the abundance of aquatic plants as well as the fertility of the water, probably assert equally important influences on the environmental conditions which provide for greater production of these species. In order to achieve favorable results, it would seem wise to employ additional measures which may include one or all of weed control, fertilization and corrective stocking. At any rate it can be said that the reduction of populations of less desirable species of fish in ponds and small lakes by trapping will not immediately produce greatly improved populations of the more desirable species.

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TOXAPHENE AS A FISH ERADICANT IN FLORIDA

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ABSTRACT

Experiments to determine concentrations of toxaphene lethal to fishes in a variety of lake types and to discern selective fish-killing properties of the material were conducted. Concentrations ranging from 1 to 85 parts per billion were placed in fourteen bodies of water varying in size

from 0.5 to 2,100 acres. Vegetative cover varied from 0 to 95 percent, methyl orange alkalinity from 2 p.p.m. to 74 p.p.m., and hydrogen-ion concentrations from 5.1 to 9.5. Bottom types included gravel, sand, silt and mud.

Differences in concentrations required to cause total kills of fish populations in treated lakes appeared to be related to bicarbonate alkalinities, bottom types, amounts of plankton, vegetation and the sizes of fish present.

INTRODUCTION

Toxaphene, a chlorinated camphene which is prepared primarily as an insecticide, is also toxic to warm blooded animals and fishes. It has been used extensively for total fish eradication in many waters. Concentrations of toxaphene reported to have been used have varied over a wide range. They were effective for carp, buffalo, catfish and many other species (Dean,[1] Hemphill, 1954; Mayhew, 1959; Gebhards,[2] and Lewis[3]). Toxaphene studies have also been conducted in the states of Wisconsin and Washington (personal communications, Lyle M. Christenson and Clarence F. Pautzke). Prior to this study it was reported that small fishes were killed when amounts sub-lethal to larger fishes were introduced into lakes (Fukano, 1958). Several accounts indicated that toxaphene was extremely toxic to aquatic invertebrate organisms (Cushing, 1957). However, other invertebrates survived at concentrations which were lethal to all the fishes present (Stringer, 1958; Hooper, 1957).

This study attempted to determine approximate minimal concentrations of toxaphene required to destroy, both in part, and in entirety, the populations of some of the lake types in Florida. Material used was an emulsifiable concentration of six pounds of technical toxaphene (chlorine content 67-69 percent) per gallon. It was introduced directly into the lakes or was diluted with water prior to application.

RESULTS IN VARIOUS TYPES OF WATERS

Fourteen bodies of water were treated with the toxicant. As a result, total fish kills occurred in four and partial kills in the others. The four having the total kills were Gravel Pits 1 and 2, Marschell Pond, and Gates Pond No. 1. Of these Gravel Pits 1 and 2 and Marschell Pond each had a pH of 6.5 and a methyl orange alkalinity of 4 p.p.m. Gates Pond No. 1 had a pH of 6.0 and a methyl orange alkalinity of 3 p.p.m. All had clear water, sand or gravel bottoms with little vegetation. Fifteen parts per billion of toxaphene in single applications destroyed all the fish populations of the first three areas. Thirty-six p.p.b. were used to kill all in Gates Pond No. 1 (Table 1). Fish populations of three ponds which had some similar physical and chemical features, except that they were heavily vegetated (Table 2), were not completely destroyed with total concentrations applied at the rate of 83, 25 and 16 p.p.b. These ponds were respectively, Wewahitchka (pH 7.5, m.o.a. 6 p.p.m.), Gates No. 2 (pH 5.1, m.o.a 3 p.p.m.) and Gates No. 3 (pH 5.6, m.o.a 2 p.p.m. Three applications (13.5, 27.0 and 42.5 p.p.b.) were made over a three months period at Wewahitchka Pond. Gates 2 and 3 were each treated with a single application of the toxicant.

Lake Desoto, Phoshate Pit No. 1, Phosphate Pit No. 2, Lake Hollingsworth, Lake Parker and Lake Trafford had hydrogen-ion concentrations of 7.5 to 9.5, and total alkalinities varying from 29 to 74 p.p.m. These six areas had large quantities of plankton and also had silted or mud bottoms, (Table 3). Complete fish kills did not occur when the total amount of toxaphene applied ranged from 20 to 85 p.p.b. Repeated applications of the toxicant were made to the above waters at irregular time intervals. Generally, the greatest extent of kills in these occurred to those treated with the larger concentrations. However the total concentration in a lake was not necessarily the sum of the amounts applied. In those areas in which applications were made over a prolonged period detoxification may have been complete prior to the latter applications.

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BEHAVIOR AND MORTALITY

Observation of the effects of cumulative concentrations on several species of fish were made at Lake Trafford, Hollingsworth, Desoto and Parker, and in Phosphate Pits numbers 1 and 2.

Gizzard shad were present in three of these lakes: Trafford, Hollingsworth and Parker. At Lake Trafford five applications each of 8 p.p.b. were made through a 25-day period. Following the first treatment, schools of gizzard shad broke water in vicinities where outboard motors were operated. After 16 p.p.b. had been introduced, the shad leaped wildly in water disturbed by motors, and occasionally they jumped into the boats. Some were seen to surface as far as 300-400 yards away from the boats. Killing effect of the 16 p.p.b. concentration was obscured by results of the application on the same day of 0.1 p.p.m. of five percent rotenone. Subsequent additions of toxaphene were followed by the above described shad activity, but progressively fewer individuals of larger size-groups remained alive. At Lake Hollingsworth an initial application of 24 p.p.b. killed most of the gizzard shad and was not followed by the leaping activity observed at Lake Trafford. This activity was again observed at Lake Parker following a 15 p.p.b. application which destroyed many small shad. Some of the largest and a few of the smaller shad were not killed at Lake Hollingsworth until the concentration was increased to 84 p.p.b. At that concentration all were apparently destroyed. Some of the larger and a few of the intermediate-sized shad remained alive in Lake Parker following an application of 85 p.p.b.

TABLE 1.

CHEMICAL AND PHYSICAL FEATURES OF FOUR WATERS WITH COMPLETE FISH KILLS.

Name	*Marschell Pond*	*Gravel Pit No. 1*	*Gravel Pit No. 2*	*Gates Pond No. 1*
Area (acres)	3.0	2.0	0.5	6.0
Average depth (feet)	3.4	6.4	9.0	4.5
Acre feet	25.2	12.8	4.5	27.0
pH	6.5	6.5	6.5	6.0
Methyl orange alkalinity	4	4	4	3
Bottom type	sand	gravel	gravel	sand
Visibility	clear	clear	clear	clear
Percent of vegetative cover	0	0	0	5
Total concentration of toxaphene applied (p.p.b.)	15	15	15	36

TABLE 2.

CHEMICAL AND PHYSICAL FEATURES OF THREE WATERS SIMILAR TO THOSE OF TABLE 1 WHICH DID NOT HAVE COMPLETE KILLS

Name	*Wewahitchka Pond*	*Gates Pond No. 2*	*Gates Pond No. 3*
Area (acres)	2.1	4.8	9.0
Average depth (feet)	1.5 to 3.5	4.5	6.1
Acre feet	3.2 to 8.4	21.6	54.9
pH	7.5	5.1	5.6
Methyl orange alkalinity	6	3	2
Bottom type	sand	sand & silt	sand & silt
Visibility	clear	clear	clear
Percent of vegetative cover	95	30	55
Total concentration of toxaphene applied (p.p.b.)	83	25	16
Number of applications	3	1	1
Concentration of each application (p.p.b.)	13.5 27.0 42.5	25	16
Days elapsed between applications	0 18 66	0	0
Total days elapsed	84	0	0

TABLE 3.

CHEMICAL AND PHYSICAL FEATURES OF SIX WATERS WHICH WERE UNLIKE THOSE OF TABLES 1 AND 2 AND DID NOT HAVE COMPLETE FISH KILLS

Name	*Phosphate Pit No. 1*	*Phosphate Pit No. 2*	*Lake Desoto*	*Lake Hollingsworth*	*Lake Trafford*	*Lake Parker*
Area (acres)	9.3	21.6	28.0	360	1,400	2,180
Average depth (feet)	13.3	17.9	6.8	5.9	5.7	8.1
Acre feet	123.7	386.6	185.0	2,124	7,980	17, 571
pH	8.4	9.2	8.3	9.5	7.5-8.6	9.5
M.O.A.	34	74	67	42	53	44
Bottom type	mud	mud	mud	sand & silt	mud, sand & silt	sand & silt
Visibility	low	low	low	low	low	low
Plankton	abundant	abundant	abundant	abundant	abundant	abundant
Percent of vegetative cover	0	0	5	1	1	1
Total concentration of toxaphene (p.p.b.)	25	20	35.5	84	41	85
Concentration of	2	2	7.0	24	8.5	15
each application	2	1	11.0	31	8.0	70
(p.p.b.)	2	1	8.5	29	8.0	..
	4	8	9.0	..	8.0	..
	7.5	8	..	..	8.5	..
	7.5	..	..	..	..	..
Days elapsed	0	0	0	0	0	0
between	8	7	36	18	4	5
applications	20	21	13	6	4	..
	11	134	29	..	13	..
	123	126	..	..	4	..
	122	..	..	..	..	..
Total days elapsed	284	288	78	24	25	5

Bluegill were found in each of these six waters. Concentrations as low as 2 to 3 p.p.b. in Phosphate Pit No. 1 and Phosphate Pit No. 2 killed a number of small individuals. However, appreciable mortality of medium sized and larger individuals of this species did not occur until the concentrations were increased to approximately 10 p.p.b. The largest proportion of the kill of intermediate-sized bluegill in Lake Hollingsworth took place after application of a 24 p.p.b. concentration. All were eliminated from that lake following the 84 p.p.b. treatment. Some larger bluegill remained following each of the toxicant introductions in Phosphate Pit No. 1, (25 p.p.b.), Phosphate Pit No. 2 (20 p.p.b.) and in Lake DeSoto (35 p.p.b.), Trafford (41 p.p.b.) and Parker (85 p.p.b.). After the 16 p.p.b. and the 24 p.p.b. dosages bluegill were seen to jump from the water along the shore areas when disturbed by outboard motors in Lake Trafford. This activity was also noted at Phosphate Pit No. 1 after a total of 10 p.p.b. had been introduced. Redear sunfish in Lakes Trafford, Hollingsworth, Parker and DeSoto appeared to be affected by toxaphene in the same manner as the bluegill.

Black crappie was present in Phosphate Pit No. 2, and in Lakes Trafford, Hollingsworth and Parker. Observations of the effects of toxaphene on this species at Lakes Trafford and Hollingsworth also indicated that a mortality of smaller fish of this species was obtained at a lower concentration than was required for larger ones. They remained in Lake Trafford and in Phosphate Pit No. 2 following all treatments. Seine sample results showed they were eliminated from Lake Hollingsworth after an increase to 55 p.p.b.

Initially largemouth black bass were present in five of the six areas. Although a kill of smaller bass occurred in each lake, medium and larger-sized fish remained at the 55 p.p.b. concentration in Lake Hollingsworth. A substantial kill of medium-sized (12 to 14 inches) individuals in Hollingsworth followed the cumulative application of 84 p.p.b. However spot poison samples and seinings showed large bass were present following the 84 and 85 p.p.b. applications at Lakes Hollingsworth and Parker as well as in the other three areas which had lesser concentrations administered.

Smaller sizes of the southern brown bullhead were highly susceptible to toxaphene. Great numbers of these were killed in Lakes Desoto and Parker at concentrations of 7 to 16 p.p.b. Numerous larger fish remained in Lake Parker following the 85 p.p.b. application. A few of these large bullheads were killed at Lake Trafford. However, some remained alive following the final application. Observations at Hollingsworth showed young to be present, apparently as a result of reproduction, which must have taken place after treatments.

Shortnose gar was not killed by the applications in four areas in which it was found. Bowfin was seemingly not affected in Lake Trafford, the only place of the six in which it was observed. Observations of effects on golden shiner were not extensive but the species appeared to have been effected much as blugill. *Gambusia* was killed in large numbers at low concentrations. However, they were not eliminated since they were observed to be present following treatment in all areas. *Notropis maculatus* and *Fundulus seminolis* were not taken during samples subsequent to the applications at Lake Hollingsworth and Lake Parker. One dead gold fish was found after the 84 p.p.b. cumulative Hollingsworth applications. Chub sucker and round flyer were killed in small numbers at Lake Desoto during the applications but remained in that lake. Threadfish shad was observed to be present in small numbers at Hollingsworth prior to the 24 p.p.b. concentration. After that they were no longer seen. However, this species persisted in Lake Parker following the 85 p.p.b. treatment.

Due to several reasons, concentrations expressed as parts per billion should be considered as only approximations. Those reasons are that unknown degrees of detoxification occurred because of the elapsed time periods between applications and differing climatic conditions. Also inlets and outlets at Lake Hollingsworth, Parker and Trafford probably influenced the results in those lakes. Small errors in water volume determinations caused by area, depth calculations and slight changes in water levels during the period of applications also contributed to the inaccuracy in p.p.b. expressions.

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REMOVAL OF LONGNOSE GAR FROM RIVERS AND STREAMS WITH THE USE OF DYNAMITE

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ABSTRACT

During the summer and fall of 1957, experiments with dynamite were conducted to determine an effective method of removing concentrations of longnose gar, *Lepisosteus osseus*, from the large coastal streams of North Carolina. A "suspended series" of charges was the most effective method tested. Charge of 3 sticks of dynamite, suspended at depth of 8 to 10 feet produced the best lethal range. Selective blasting with this method provided efficent removal of longnose gar. During one day's operation, over 3½ tons of gar were removed while killing 8.3 pounds of game fish.

INTRODUCTION

During the summer and fall of 1957, experiments with dynamite were conducted to determine an effective method of removing concentrations of longnose gar, *Lepisosteus osseus*, from the large coastal streams of North Carolina. The water in these streams is highly stained and has very low velocity. Wind tides affect the majority of these streams to the extent that it is not uncommon for the current to run upstream. The banks are low and bordered primarily by swamps. The tests were conducted in Pine Tree Creek, Brice's Creek, Batchler's Creek, Green's Thoroughfare, Turkey Quarter Creek, Taylor's Creek, Gar Creek and Hog Island Thoroughfare in Craven County, Tranters Creek, Old Tar River and Bear Creek in Pitt County, Bay River and Upper Broad Creek in Pamlico County and Trent River in Jones County.

METHODS

Sixty percent dynamite was selected as the energy vehicle due to its stable properties and availability. The first series of tests were conducted with the use of electrical detonation. This proved ineffective due to the excessive amount of travel through the blasting area to rig wires and lay charges. The depths encountered in the streams, 10 to 35 feet at mid-channel, hindered anchoring of the charge end of the detonating wire on those charges suspended off the bottom.