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METHODS FOR THE CONTROL OF STUNTED PANFISH POPULATIONS

Thesis for the Degree of M. S.
MICHIGAN STATE UNIVERSITY
Joseph Bruce Hunn
1957

THESIS

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METHODS FOR THE CONTROL OF STUNTED PANFISH POPULATIONS

by

JOSEPH BRUCE HUNN

AN ABSTRACT

Submitted to the College of Agriculture of Michigan
State University of Agriculture and Applied Science
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Fisheries and Wildlife

1957

Approved Peter I. Tack

Joseph Bruce Hunn

To cope with the problem of stunted panfish populations, the fisheries manager of today commonly employs one or more of the following methods of control: (1) poisoning (complete or partial), (2) netting, (3) water drawdown, (4) stocking or (5) destruction of spawn.

During the summer of 1956, a cooperative experiment was begun by the Institute of Fisheries Research and the Lake and Stream Improvement section of the Fish Division of the Michigan Department of Conservation to control stunted panfish populations by partial poisoning with rotenone. As part of the experiment, an attempt was made to determine the percent kill by two methods: 1) comparative netting and 2) by ratio sampling. Comparative netting was done with trapnets fished before and after poisoning in the same location for equal periods of time. Ratio sampling consisted of sampling the poisoned fish for marked fish which had been released prior to poisoning.

The estimated percent kill for each lake is as follows: Saddle Lake -- comparative netting 36%, ratio sampling 18.5%; Lower Scott Lake -- comparative netting39.5%, ratio sampling 58.1%; East Basin of Turk Lake -- comparative netting 89.7%, ratio sampling 41.8% and West Basin of Turk Lake -- comparative netting 86.0%, ratio sampling 32.6%. The great variation in results is most likely due to insufficient and biased sampling.

Probably the most promising method of estimating population reduction is comparative netting using the large seine. The large seine takes a representative sample of the population in large enough numbers to make it economically justifiable.

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CHECK LIST OF FISHES

Lepisosteus productus - spotted gar

Amia calva - bowfin

Ictiobus sp. - buffalo
Erimyzon sucetta - lake chubsucker
Catostomus commersonnii - white sucker

Cyprinus carpio - carp
Semotilus atromaculatus - creek chub
Notemigonus crysoleucas - golden shiner
Hyborhynchus notatus - bluntnose minnow
Opsopoeodus emiliae - pugnose minnow
Notropis cornutus - common shiner
Notropis heterodon - blackchin shiner
Notropis heterolepis - blacknose shiner

Ameiurus nebulosus - brown bullhead
Ameiurus natalis - yellow bullhead
Schilbeodes sp. madtom

Umbra limi - mudminnow

Esox americanus vermiculatus - grass pickerel
Esox lucius - northern pike

Perca flavescens - yellow perch
Boleosoma nigrum - Johnny darter
Poecilichthys exilis - Iowa darter

Micropterus salmoides - largemouth bass
Chaenobryttus coronarius - warmouth
Lepomis cyanellus - green sunfish
Lepomis megalotis - longear sunfish
Lepomis gibbosus - pumpkinseed
Lepomis macrochirus - bluegill
Ambloplites rupestris - rock bass
Pomoxis nigro-maculatus - black crappie

INTRODUCTION

INTRODUCTION

Stunted panfish populations are a problem for the fisheries manager throughout the United States. This condition usually comes to his attention through routine surveys or complaints that fishing is poor and most of the fish are small.

On further investigation, he may encounter some or all of the following characteristics of a stunted population:

1. The fish are slow growing.
2. Fish generally are in poor condition.
3. A small percentage of the fish are "keeper" size.
4. Usually one age-group predominates.
5. Few old fish are present.
6. Males predominate in young fish; females are predominant in older fish. (Eschmeyer, 1937).
7. Few predators are present, most of which are large.
8. Many centrarchid hybrids occur.

Overcrowding, which is one of the major causes of stunting, is due to a shift in the population "balance" - the unstable equilibrium between numerous fish species and countless environmental situations (Johnson, 1949). This shift may occur naturally or may be the result of selective fishing.

Climatic factors seem to affect population balance by influencing spawning success and survival of certain species. The lake herring (*Leucichthys artedi*) populations of Lake Erie fluctuate with the turbidity;

year class strength in whitefish (<u>Coregonus clupeaformis</u>) in some Canadian lakes is inversely correlated with the strength of autumn winds; and abundance of Kamloops trout (<u>Salmo gairdneri kamloops</u>) is affected by spring run-off (Larkin, 1955). It is also known that northern pike spawning is influenced by spring water levels.

Some biologic factors involved in stunting may be (1) abundant aquatic vegetation, (2) cannabalism and mutual predation, (3) flexible growth rates which allow fish to grow slowly rather than starve, and (4) the high reproductive potential of prey species.

By concentrating his fishing efforts on large fish, especially predators, man harvests fish in a disproportionate relation to their numbers in the population. This harvest of predators is significant because predators are a key factor in controlling the numbers of prey.

Further damage to population "balance" is done when people destroy spawning grounds of predators and create new spawning sites for prey species by making desirable water front real estate.

Out-moded fishing regulations have also contributed to stunting by controlling the harvest of prey species which should be cropped extensively. Through education it is hoped that further liberalized fishing for warmwater prey species may be authorized in this state as they have been in other states. Controls on predator harvest should be kept until further studies are made concerning predator-prey relationships as affected by sport fishing.

Clarke (1954) states, "Perhaps the most generally harmful effect of increasing numbers among animal populations is the competition for food." The adverse effects on the individual as well as the population are expressed in the growth rate. Odum (1954) expresses it as follows: growth rate equals the intrinsic rate of growth minus self-crowding effects minus detrimental effects of the other species.

Objectives of the Study

The material presented herein covers all present-day methods of control of stunted panfish populations with special emphasis given to the work done in Michigan during the summer of 1956. The data from this work are presented to show the results of two methods used to measure population reduction.

POPULATION REDUCTION METHODS

POPULATION REDUCTION METHODS

The two basic methods of control are 1) complete removal of the population and restocking and 2) partial reduction of the stunted species with or without further corrective measures.

Poisoning

Methods of poisoning with rotenone are many. Rounsefell and Everhart (1953) list 7 methods of dispersal ranging from hand application to spraying by plane. Pond poisoning methods are covered by Swingle, Prather and Lawrence (1953).

Lake stratification has been a problem in poisoning. Smith (1950) states, "In lakes with depths over 25 feet, difficulty has been encountered in obtaining a complete kill of fish by poisoning, presumably as a result of an inadequate dispersal of the poison in toxic concentrations to all depths."

With the development of new emulsified rotenone products, the thermal barrier problems may be eliminated. Bassett (1956) in testing new rotenone products found that, "From the standpoint of efficiency and economy, Pro-Noxfish is recommended for shallow, well circulated lakes; Chem Fish for deeper or stratified lakes, and Chem Fish Special for special problem waters." Pro-Noxfish is a product of S. B. Penick Company and Chem Fish and Chem Fish Special are produced by the Chemical Insecticide Corporation.

In the past low temperatures have made poisoning with rotenone ineffective. Brown and Ball (1943) found that rotenone was ineffective under 45^{o} F. Today, however, poisons have been perfected so that poisoning can be effective with water temperatures as low as 39^{o} F. This means that poisoning can be done during overturn which would facilitate complete poisoning.

Partial poisoning is possible when lakes are stratified. King (1953, 1954), attempting population control work on Lake Hiwassee, Oklahoma, poisoned only the shoal areas. In 1951, 20 acres of the 154 acres were poisoned. In 1952, 30 acres were poisoned. Age-growth studies after two years indicated no change in growth rate. Due to the failure of the previous poisonings, the entire shoreline was treated in 1953 and 1954. A substantial growth acceleration in largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus) and redear sunfish (Lepomis microlophus) was noted after the 1953 application. King (op. cit) states that, "Evidence from other partial fish population removals indicates that about 50 per cent of the water volume must be treated before definite growth increases can be noted." Work in Michigan indicates that a good partial kill will result from treating most or all of the surface area when the lakes are stratified (Greenbank, 1941).

Leonard (1938) gives the concentration of 0.50 p.p.m. as the lowest concentration of rotenone for killing fish. At this concentration rotenone is generally accepted as being lethal to most fish.

Complete poisoning. Complete poisoning is used throughout the nation for renovation of trout waters, destruction of rough fish populations, and the elimination of stunted panfish. Many fisheries managers feel this is the most economical way to control stunted panfish. With limited budgets and personnel to handle the work, many states are restricted to this technique. Even though it is the most economical way to treat the stunted panfish problem, it is still costly, especially when treating large bodies of water with rotenone. The use of toxaphene will reduce treatment costs if a satisfactory concentration can be found (Hooper and Grzenda, 1956).

Following the complete elimination of the fish population, restocking often presents a problem. Which fish to plant, when, and in what numbers can be difficult questions. If the problem were solely biological, its solution wouldn't be too difficult but the interests of the fishing public must be considered.

"The human idea of management is to alter a fish population to produce a larger harvestable crop of desirable fishes even if some deviation from the natural is required" (Johnson, 1949). Many people have considered the idea of planting only one species, a suitable predator. Combinations of two or three species have received some attention. An increase in the standing crop in lakes and ponds is noted as the number of species of fish increases, but the maximum crops of selected individual species occur when only one or two species are present (Carlander, 1955). The use of one or two species of fish per body of water would mean a large standing crop and a specialized sport fishery because fisherman would have to choose the lake(s) for fishing on the basis of the kind of fish they desired.

Partial poisoning. With the advent of rotenone, partial poisoning has become a common management practice in many states. Partial poisoning may be selective, but selective poisoning need not be partial. Selective poisoning with rotenone can be used for gizzard shad and yellow perch. The concentration used is such that these fish are killed but the LD_{50} (concentration at which 50 per cent of test animals die) for other species is not reached (Burdick, Dean and Harris, 1955).

Partial poisoning may be directed at a certain group in the population by the method of application. Littoral areas may be poisoned in an attempt to kill smaller prey fish with a minimum kill of large prey and predators. Spawning areas may also be poisoned to reduce certain species.

Removal of competition at all levels is one of the advantages of partial poisoning with rotenone (Grice, 1957). Other points in favor of the use of rotenone are (1) it is easy to handle and apply, (2) it is non-toxic to humans and livestock, (3) it is low in cost of labor and materials needed as compared to netting and (4) the fish are edible if taken soon after poisoning.

The major drawbacks of partial poisoning is the inability to determine the extent of the kill of the various species. This inability is mainly due to the fact that our sampling techniques and population estimates only give us an "educated" guess as to what the population is.

On small bodies of water, such as farm ponds, sampling with a seine may give some indication as to the population composition according to size groups. In the southern part of the United States, the number of intermediate size panfish is used to measure the degree of "balance" (Swingle, 1950). No such figures as those given by Swingle are known for northern states.

For large bodies of water, change in growth rate seems to be the best criterion on which to base the efficacy of the poisoning. It must be noted, however, that these changes usually last but a few years and then the treatment must be repeated.

Partial poisoning may be augmented by planting of predators in an effort to establish the necessary predators.

Netting

Since poisoning with rotenone has become popular, the use of nets to control stunted panfish has become secondary. The chief reason for this change is economic. Grice (1957) shows that in the state of Massachusetts the cost of poisoning is only one-sixth that of netting. In addition, nets are usually selective as to the species and size groups taken.

Intensive netting can temporarily improve the growth rate of the species being removed but has little effect on the remainder of the population. Boussu (1955) removed approximately 80 percent of the crappies from a 24-acre lake, and only the young-of-the-year and yearling crappies showed an increased growth rate. Grice (1957) got similar results. In both of these cases, the predator population failed to increase significantly.

Netting today is primarily used for work on the control of rough fish, with most of the work being done with large seines. Seining is done in late fall or early spring because at this time aquatic vegetation is less abundant, the water temperature is low and the fish are usually concentrated in particular areas.

O'Farrell (1956) states that "for effective rough fish removal, all lakes must be seined at least annually." The use of seines is usually limited by the availability of good seining beaches.

Richer and Gottschalk (1940) found in Indiana that the removal of a large portion of the rough fish resulted in increased abundance of game fish and improved angling success. Rose and Moen (1952) obtained comparative results in Iowa. Johnson (1949) states that: "Complete removal of all carp would allow a replacement of 15-20 pounds of game fish for every 100 pounds of carp lost, and only if the aquatic environment were suitable for game fishes."

Water Level Manipulation

Water drawdown is an effective technique for control of stunted panfish in reservoirs and drainable lakes and ponds. Bennett (1951) states that "the use of a drain valve for the management of fish populations in artificial lakes surpasses all other techniques in value, and no farm pond or artificial lake built for recreation should be planned without an outlet so situated and of such a size that all water and fish in the impoundment will pass under the dam to the downstream side where a simple screen can be installed to trap the fish."

In reservoirs, drawdown is sometimes augmented by seining of game species and poisoning of rough fish.

Other manipulations of water levels can help bring about suitable conditions for an increase in predator pressure. By drawing down in the winter, the predators and the prey species are concentrated, thereby increasing the probability of predation. Maintaining high springtime levels will favor pike spawning, steady levels in May and June may aid bass spawning, and lowering of the levels after this will shorten panfish spawning periods (Johnson, 1949).

Water drawdown is equally applicable to farm ponds. The degree of drawdown depends on the location of the pond. In the north, there is always danger of winterkill after drawdown in ponds and shallow lakes (Bennett, 1954).

Water level manipulation is becoming a widely used management practice for fish population control in large drainable bodies of water.

Stocking

"'Therapeutic' stocking is an old idea revived for new reasons. If removal of undesirable species is so expensive and often futile, aid might be obtained from living predatory fishes which could control obnoxious or overcrowded species and furnish good angling themselves" (Johnson, 1949). Northern pike, muskellunge, walleyes, largemouth bass, channel catfish, and striped bass have all been used. These fish are desirable sport fish as well as possible population regulators. However, little evaluation has been made of the results of planting predators as a management practice.

> "Two questions arise immediately: How many predatory fish are needed to do the job and how can they be produced? Partial answers are now available. Expansion of rearing pond facilities for raising prodigious quantities of hungry fingerlings or yearlings is now under way, not with the old aim of scattering a few thousand into each lake but to pour in at

least 50 to 100 fingerlings per surface acre in lakes where control of other fish is needed and where such quantities of fingerlings are not naturally produced.

As for the number of carnivorous fishes required, only an empirical answer is to be had. Analysis of test-net data on 253 Minnesota lakes indicates that dominance or control of fish populations there can be achieved by pike only when its weight comprises 25 to 30 per cent of the total fish weight present. If yellow pikeperch are dominant predators, they must comprise 45 to 50 per cent of all fish weight" (Johnson, 1949).

The idea of using predators such as the bowfin or gar has received some thought but adverse public opinion has prevented such plantings. These species might exert predator pressure throughout most of their life without being greatly reduced in number by fishing.

Destruction of Spawn and Spawning Sites

The use of chemicals for destruction of spawn and fry has received some attention in the eastern states.

In Vermont, Stewart (1956) is experimenting with "Canrite", a commercial creamery detergent, for destruction of eggs and fry of yellow perch and pumpkinseed sunfish. "Canrite" ($NaHSO_4$) was dispersed in granular form over concentrations of egg masses, resulting in a high percentage of kill.

Jackson (1956) conducted experiments in New Hampshire for the control of the common sunfish Lepomis gibbosus by placing NaOH pellets in the nests. Eggs and fry were killed in from 3-5 minutes in a concentration of 5 p.p.m.

Experiments in New Jersey show that $CuSO_4$ can be used as a spawn-destroying agent. Essbach (1956) found that 5.6 mg. per liter of $CuSO_4$ gave a 95 percent kill of yellow perch eggs, and those that hatched quickly died. The use of $CuSO_4$ is greatly complicated because its toxicity is directly affected by alkalinity, pH and the amount of organic matter present.

The use of chemicals for destruction of spawn and fry needs much further research before it can be seriously regarded as an effective management tool.

Mechanical destruction of spawn and spawning sites is possible but usually on a small scale. Raking, trampling and dragging can be used to destroy panfish nesting areas in farm ponds or other small bodies of water.

The control of aquatic vegetation to prevent stunting is common practice in pond culture but as yet has had little application on large bodies of water. At the present time in Florida, this technique is being used but no evaluation is available. Similar work is being done in Michigan to determine the affects of removal of aquatic vegetation on growth rate of fish.

Aquatic vegetation will probably become an extensive problem as more and more lakes approach late stages of eutrophication.

METHODS OF ESTIMATING THE PERCENT KILL OF THE FISH POPULATION

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Miller (1950) states that: "The literature is conspicuously short of data on either (a) the completeness or otherwise of kills, (b) the proportion of the whole population actually recovered, supposing a kill was complete, and (c) the rapidity with which repopulation with undesirable species takes place."

There are two means commonly used to determine population reduction (1) reduction in catch per unit effort of net (gillnet, trapnet, seine) or (2) ratio sampling of a known number of marked fish in the poisoned populations. Netting has definite disadvantages: (1) selectivity of the gear, (2) the amount of time required to get sufficient samples, and (3) the investment needed for the gear. Of the three types of gear, the large seine seems to offer the best solution. The seine can be used effectively both in spring and fall. It can also be used to remove desirable game fish before poisoning.

Ratio sampling by the Petersen mark and recapture method may be used to determine the percent reduction, the theory being that the marked fish should be killed in the same proportion as the unmarked fish. By taking a random sample of the poisoned population, the number of marked fish per unit of pickup (lbs., barrels) can be determined. This ratio is then multiplied by the total number of pickup units to get the estimated kill of the marked fish. The estimated kill is then divided by the known number of marked fish to determine the percent kill. The main problems are (1) how many fish to mark (2) what size fish to mark

(3) which species to mark (4) how large a sample to take and (5) over what period of time should these samples be taken.

The number of fish to be marked is usually governed by the means of obtaining the fish but as many fish as possible should be marked. The size of fish to be marked is dictated by how effective the pickup will be. The sample size and the time of sampling will probably be governed by the amount of time alotted for the project.

The percent of recovery of marked fish after poisoning has been variable. Krumholz (1944) in checking the fin-clipping method for estimating fish population had an 86 percent return. Ball (1944) in poisoning Third Sister Lake recovered 23.4 percent of the marked fish. In poisoning Ford Lake, Ball (1945) recovered 54 percent of the marked fish. In all of the above experiments, the men conducting the tests were trying for a complete kill.

The use of the ratio sampling method is probably not economically justifiable in view of the sampling method developed with the large seine in such states as Iowa, Wisconsin and Minnesota. If a lake is sampled each year at the same time (spring or fall), the seine should give comparable samples of the fish population. The seine also takes a large number of fish which can be used for growth and size frequency distribution studies without destroying the fish. The use of the large seine will be limited by the water depth and obstructions on the lake bottoms.

METHODS OF CONTROL USED IN MICHIGAN

METHODS OF CONTROL USED IN MICHIGAN

The control of stunted fish populations in Michigan was begun by R. W. Eschmeyer in 1934 with his work on stunted yellow perch. Eschmeyer (1937, 1938) suggested three methods to alleviate the condition: (1) increase food by fertilization, (2) removal of a considerable portion of the population, and (3) complete removal of the population followed by stocking with other species.

Partial or complete removal was accomplished by using rotenone, and rotenone augmented by dynamite to circulate the deep water. These waters were later stocked with trout.

In 1937 Eschmeyer began an experiment to determine the effects of population reduction in warmwater lakes. The lake chosen for the experiment had two distinct basins with a connecting channel. The channel was blocked and one basin poisoned in an attempt to completely destroy the population. Following detoxification the obstruction was removed and the fish allowed to move into the other basin. Beckman (1940, 1942), continuing the study, found that the reduction in population was followed by improved growth rate of the rock bass. This increased growth rate was maintained for four years. In further studies, Beckman (1948) found that the improvement of growth following winterkill is only temporary and that differential kill in favor of rough fish often occurs.

During the summer of 1956 the Institute for Fisheries Research and the Lake and Stream Improvement Section of the Fish Division of the Michigan Department of Conservation started a cooperative experiment to develop techniques for stunted panfish control and methods of evaluating these techniques.

Selection of Lakes

The choice of lakes for the experiment was based on the slow growth rate of the bluegill populations and the poor fishing reputation. The lakes chosen for the experiment were Saddle Lake, Van Buren County; Lower Scott Lake, Allegan County; and Turk Lake, Montcalm County. All of these lakes are in the southwestern part of the state.

Basic Methods Used in Summer of 1956

Preliminary work on all lakes consisted of marking all fish over 3.5 inches taken by seine, trapnet and hook and line. These fish were released in the center of the basin of the lake except in Saddle Lake where they were released at site of capture. The fish were grouped into one-inch size groups (3.5 to 4.5 inches, 4.5 to 5.5 inches, etc.).

The poisoning was done with Noxfish, an emulsified rotenone product of the S. B. Penick Co. The rotenone was sprayed over the surface with a Carter Centrifuge Pump powered by a Briggs and Stratton engine. The amount of rotenone applied was theoretically sufficient to give a concentration of 0.5 p.p.m.

Sampling of the poisoned fish took place during the first three days after poisoning. The fish were picked up and put into barrels for handling purposes. The fish were sorted as to species. Scale samples were taken and size frequency distributions recorded. In addition the average number per pound was determined for most species. Fish under 3.5 inches were not sampled.

Bottom transects were made to determine the number of fish remaining on the lake bottom. The transects were made within 24 hours of the poisoning. For each transect, a line of known length was laid out and the swimmer using a Scott Hydro-Pak followed this line counting all fish within one foot either side of the line. From the transect counts, estimates as to the number of fish per acre were made.

Estimation of Percent Kill

The percent kill was estimated in two ways, 1) reduction in catch per unit effort of trapnets and 2) by ratio sampling.

The catche per unit effort of trapnets from before and after poisoning were compared to get the percent reduction (see Table IX, Appendix). These trapnet sets were 24 hour sets in the same location.

SADDLE LAKE

SADDLE LAKE

Saddle Lake, T1S, R15W, Sections 9, 10, 15, 16, 22, Van Buren County, is a 290-acre lake with a maximum depth of 32 feet. The bottom types are fibrous peat, mud and sand. The lake is drained by Barber Creek which is part of the Black River drainage. About 80 percent of the lake is shoal, and approximately 45 percent of the lake has dense aquatic weed beds.

The following fish are found in Saddle Lake and Barber Creek: bluegill, pumpkinseed, warmouth, black crappie, largemouth bass, brown and yellow bullhead, madtom, carp, golden shiner, blackchin shiner, spotfin shiner, blacknose shiner, bluntnose minnow, pugnose minnow, yellow perch, Iowa darter, mudminnow, creek chub, lake chubsucker, and grass pickerel, northern pike, spotted gar, and bowfin.

Preliminary work on Saddle Lake consisted of marking fish over 3.5 inches which were caught by seines and trapnets. Seining, begun on July 12, 1956, met with only limited success, so trapnetting was begun July 16th and was carried on until July 20th. Trapnetting yielded 1077 fish.

From July 12-20th a total of 2886 fish were marked by fin clipping and released at the site of capture. Of these fish, 1910 were marked in areas to be poisoned.

Poisoning of Saddle Lake was done from July 24th to August 6th in 9 areas ranging in size from 3 to 43 acres. The area poisoned (148 acres) represents 51 percent of the total surface area and 25 percent of the total volume. These areas were enclosed by a blocking seine(s) 10 feet high and of one-inch-bar mesh. It was hoped that this would prevent migration into or out of the poisoned area.

After each area was poisoned, a sample of fish was taken. Of the 62 barrels picked up from the 9 areas, 11.5 were studied. The total pickup must be considered miminal as not all of the lake could be completely covered. The pickup was done with scap nets and scooping devices mounted on boats.

On the day after the area had been poisoned, bottom transects were made to determine the number of fish remaining on the lake bottom. In the 9 areas, 44 transects were made with 40,632 square feet of bottom being viewed. A total of 249 fish were found, giving an estimate of 266 fish per acre. Since these transects were made within 24 hours of the poisoning, it is not known how many of these fish came to the surface to be included in the pickup in the following days. Fish continued to come to the surface for 4 or 5 days; large northern pike, gar pike and bowfin were the last to come up.

In sampling 11.5 barrels, 66 recaptures were recorded (see Table I, Appendix). If this sample is a random sample of the poisoned population, the ratio sampling method may be applied. The estimated percent kill by the ratio sampling method was 18.5 percent. The estimated percent kill by comparative netting is 75.7 percent.

The use of ratio sampling during the summer of 1956 was beset with many problems: (1) there were not enough men to work the samples, (2) samples were taken only on the first few days following poisoning because of the shortage of manpower and time, and (3) the biased pickup. Members

of the pickup crew knew that the biologists were looking for marked fish and therefore made an effort to find these fish. Furthermore, large game fish were picked up first so as to prevent adverse public relations.

After the lake had been poisoned, nets were fished in the poisoned areas and in the non-poisoned area. The 12 nets fished in the poisoned areas showed a 36 percent reduction in numbers while the 4 nets in the non-poisoned area showed a 95 percent reduction. The combined percent reduction was 75 percent. This large discrepency in percent reduction may be explained by movement of fish into the areas of reduced competition, a seasonal migration of the fish or sampling variation.

The estimated kill of fish over 3.5 inches is 50 pounds or 476 individuals per acre for the poisoned area. No estimate of the weight of fish under 3.5 inches was made for Saddle Lake (see Table II, Appendix).

In taking weights, it was hoped that an imbalance in the predator-prey ratio could be shown. The predator-prey ratio by weight for fish over 3.5 inches in Saddle Lake, with mud pickerel, bowfin, garpike, northern pike and largemouth bass considered as predators, is 1:5.

Ricker (1955) distinguishes 3 types of numerical relationships between predators and a species of prey they attack: "A. Predators of any given abundance take a fixed fraction of the prey species during the time they are in contact, enough to satiate them. The surplus prey escapes. B. Predators at any given abundance take a fixed fraction of prey species present, as though there were captures at random encounters. C. Predators take all the individuals of the species that are present, in excess of a certain minimum number."

In type B the number of prey species eaten is proportional to the abundance of predators and to the abundance of prey.

Poundage ratios of predators to prey fish species have been used to indicate "balanced" populations. Swingle (1950) gives a predator-prey ratio of 1:3.0-6.0 as most desirable for ponds. This ratio is based on the weight of all fish in the pond. Moyle (1949) gives the ratio of 1:6 for Minnesota lakes. This ratio is based on seining data from littoral areas of 68 game-fish lakes. The average poundage of large predaceous fishes (pike, pikeperch and bass) is compared to that of all other fish combined.

In the present study, all predator-prey ratios were within the desirable range given by Swingle (1950) except the west basin of Turk Lake which was 1:17. Due to the biased pickup of large predatory fish mainly the bass and the time of sampling, the estimates of the pounds of predators are too high. In making the estimates it was presumed that fish would be picked up at the same rate throughout the pickup period. This assumption was incorrect. The difference in rate at which various species came to the surface caused the estimated number of bass to be too high. Krumholz (1950) in poisoning a pond in Indiana recovered 87.1 percent of his marked bass but all of them in the first 3 days after poisoning. Marked green sunfish came to the surface for 8 days with the greatest number coming to the surface the third day.

In order to improve predator spawning success so that the prey species can be controlled, the prey species must be reduced. Partial poisoning augmented by predator planting seems to be the best answer. The selection of predators will vary from lake to lake. The most efficient predator according to Johnson (1949) is the northern pike. By placing pike at the top with a predator rating of 100, the yellow pikeperch (walleye) would have a rating of 50 and the largemouth bass a rating of 20 (in northern waters). The predator rating of bowfin, gar and grass pickerel are unknown.

The problem of rearing enough predators to meet the demands for population control and fishing pressure is complex and difficult. Should predators be planted on a put and take basis? Should efforts be concentrated on improving habitat for predator spawning? How much artificial propagation is needed? Are any changes in fishing regulations necessary? Answers to these questions will have to be temporary while basic research on predators is conducted. Information is lacking on food preferences, size relationships, buffer relationships and density relationships.

Artificial propagation and transfer from other lakes will probably be necessary for stocking of newly poisoned lakes. Northern pike are being successfully reared in natural ponds and shallow lakes. Walleyes and bass are reared in artificial situations.

With increased fishing pressure on the predatory species, it may be necessary to reduce the catch by increasing the size limits. By so doing, predators would be able to exert their influence on the prey species for greater periods of time.

Figures 1 and 2 (see Appendix) show the growth rate and size frequency distribution of Saddle Lake bluegills.

LOWER SCOTT LAKE

LOWER SCOTT LAKE

Lower Scott Lake, T1N, R15W, Sections 4, 9, 10, Allegan County, is a 127-acre lake with a maximum depth of 8 feet. The bottom is fibrous peat with some sandy areas. A stream from Upper Scott Lake flows into Lower Scott Lake whose water level is maintained by a dam in the outlet which flows into the Black River. The lake is 100 percent shoal and aquatic weed beds cover approximately 75 percent of the lake bottom.

The following fish are found in the lake: bluegill, pumpkinseed, warmouth, black crappie, largemouth bass, yellow perch, Johnny darter, northern pike, grass pickerel, carp, golden shiner, blackchin shiner, brown and yellow bullhead, lake chubsucker, buffalo and bowfin.

From August 24th to 28th, 1305 fish over 3.5 inches, caught by hook and line, large seine and trapnet, were marked and released in the middle of the lake.

On August 28th, 100 acres (79 percent of the area and 82 percent of the volume) were poisoned with Noxfish. The pickup and sampling followed the same basic procedure. Of the 50 barrels picked up, 7 were sampled (see Table III, Appendix). Because all fish could not be picked up, the pickup crew was requested to make an estimate of the number of barrels of fish remaining. They estimated that 60 barrels of fish remained (see Table IV, Appendix).

Bottom transects were again made within 24 hours of poisoning with an estimate of 251 fish per acre being made from two transects totaling 4,330 square feet.

A total of 54 recaptures were recorded in the sampling. During sampling, a difference in the rate of species return was noted.

	August 28	August 29	August 30
bluegills	3	3	12
pumpkinseed	14	8	2
largemouth bass	4	-	2
black crappies	5	-	1

A differential rate of return by size and species has been noted by other workers (Brown and Ball, 1943; Krumholz, 1950). This differential may be caused by fish getting entangled in aquatic vegetation, the nature of the fishes reaction to the poison, by different rates of decomposition or by lack of a swim bladder.

The estimated kill from comparative netting showed a 39.4 percent kill while ratio sampling showed a 58.1 percent kill.

The predator-prey ratio was 1:3 for fish over 3.5 inches.

Figures 3 and 4 (see Appendix) gave the growth rate and size frequency distribution of the bluegills in Lower Scott Lake.

TURK LAKE

TURK LAKE

Turk Lake, T10N, R8W, Sections 3, 9 and 10, Montcalm County, is a 151-acre lake with a maximum depth of 20 feet. The bottom types are pulpy and fibrous peat, marl and sand. The lake has two distinct basins, east (91 acres) and west (60 acres), connected by a small channel. Turk Lake Creek drains the lake and flows into the Flat River.

Species of fish found in Turk Lake are: bluegill, pumpkinseed, warmouth, green sunfish, longear sunfish, rock bass, black crappie, largemouth bass, yellow perch, northern pike, white sucker, carp, common shiner, and blackchin shiner.

From August 1st to 14th, 1991 fish over 3.5 inches, caught by hook and line, seine and trapnet, were marked and released in the center of the east basin of the lake. The east basin was divided into two areas (24 acres and 67 acres) and all of the surface area treated. The two areas were separated by blocking seines.

The total pickup was 56 barrels with an estimated 25 barrels remaining. In sampling 8.3 barrels, 87 recaptures were recorded (see Table V and Table VI, Appendix).

Bottom transects indicated 332 fish per acre on the lake bottom 24 hours after poisoning. While swimming these transects, it was noted that fish were alive in water greater than 12 feet in depth. This indicates that only 27 percent of the volume was actually poisoned.

The predator-prey ratio was 1:3.

Estimated kill by ratio sampling was 41.8 percent and from comparative netting 89.7 percent. However, samples taken by trapnetting were so small as to cast doubt on the validity of the results.

In the west basin, 1069 fish were marked and released in the center of the basin. On August 21st the entire surface area was poisoned. Live cages set at varying depths showed all fish to be dead within 24 hours of poisoning.

The pickup of all fish amounted to 45 barrels of which 10 were studied. In sampling 10 barrels, 77 recaptures were observed (see Table VII and Table VIII, Appendix).

Bottom transects revealed 518 fish per acre.

The predator-prey ratio was 1:17.

The estimated kill by the ratio sampling method was 32.6 percent and by comparative netting 86.0 percent.

Figures 5 and 6 (see Appendix) give the growth rates and size frequency distribution of Turk Lake bluegills.

STANDING CROP

STANDING CROP

Clarke (1954) defines standing crop as "the abundance of the organisms existing in the area at the time of observation; it may be expressed as number of individuals, as biomass, as energy content, or in some other suitable terms." Standing crops of fish do not necessarily bear a close relationship to fish production but usually the standing crop is the only available estimate of fish production in a body of water (Carlander, 1955).

The estimated standing crop in pounds for the three lakes are as follows:

Lake	Estimated Total Pounds Killed	Estimated Percent Kill	Estimated Standing Crop	Pounds Per Acre
West Turk	4800	32.6	14,724	245
East Turk	8800	41.8	21,053	231
Lower Scott	9900	58.1	17,039	134
Saddle	7400	18.5	40,000	138

The estimates are based on the results of the ratio sampling method of estimating the percent kill. Although this method has many weak points, the estimates are not unreasonable for intermediate to hard (M.O. alkalinity 50-150 p.p.m.; over 150 p.p.m.) warm water lakes in the southern part of the state. The standing crops in pounds per acre are considerably higher than those reported by Ball (1948b). Ball (op. cite) found that the average standing crop in ponds per acre for "bass-type" lakes for the state of Michigan was 81.3).

The estimated standing crop for Saddle Lake is probably low as only 50 percent of the lake was sampled, and much of this area was shoal with clean sand bottom.

These data show that these lakes can and do support large fish populations which if properly managed could provide much sport fishing.

SUMMARY

SUMMARY

Of all the methods used to control stunted panfish populations, poisoning and water drawdown have been the most successful. Complete poisoning, although a difficult goal to attain, gives the fisheries manager a controllable starting point in his efforts to produce the most desirable fish. A similar situation may be created by the draining of a pond or lake.

Partial poisoning has one main drawback, the evaluation of the poisoning. Today, as in the past, age-growth studies are the criteria on which the efficiency of the poisoning is based. The age-growth method has been used for the lack of something more comprehensive. The lack of a comprehensive study was largely due to inadequate sampling techniques.

During the summer of 1956 two methods were tried in an effort to detect what had happened to different segments of the fish populations upon being partially poisoned with rotenone. Comparative netting with trapnets and ratio sampling of marked fish both proved inadequate due to lack of proper sampling. Insufficient netting before and after poisoning failed to establish a large enough sample to make results reliable. Biased pickup plus insufficient sampling gave questionable results for the ratio sampling estimates. Because each of these methods requires much time and effort, it seems likely that their use will be limited to research rather than management practices.

The proper use of the large seine as a sampling technique holds great promise in attempting to evaluate partial poisoning as a control

measure. With the large seine, which takes fairly representative samples, size frequency distribution and species abundance can be determined. In addition, scale samples for concurrent age-growth studies can be readily taken.

The large seine is not a panacea but a sampling tool. Much research is still necessary on such subjects as predator food preference, predator-prey size relationships, population densities and buffer species before a more intelligent management program for warm water lakes is forthcoming.

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APPENDIX

TABLE I

ESTIMATED NUMBER OF RECAPTURES FOR SADDLE LAKE

Species	Number of marked fish	Recaptures in 11.5 barrels	Total barrels picked up	Estimated total recaptures	Estimated percent kill
Bluegill	701	4	62	22	3.1
Pumpkinseed	456	21	62	113	24.7
Black crappie	85	2	62	11	12.9
Yellow perch	135	8	62	43	31.8
Warmouth	77	6	62	32	41.5
Lake chub sucker	131	3	62	16	12.2
Golden shiner	160	1	62	5	3.1
Bullhead	105	13	62	70	66.6
Largemouth bass	49	8	62	43	87.7
Bowfin	5	-	62	-	-
Carp	1	-	62	-	-
Spotted gar	2	-	62	-	-
Hybrids	2	-	62	-	-
Grass pickerel	1	-	62	-	-
Total	1910	66		355	18.5

TABLE II

Species	Pounds in 11.5 barrels	Total barrels picked up	Estimated total pounds	Number of fish per pound	Estimated total number
Bluegill	388	62	2095	14.7	30,800
Pumpkinseed	105	62	567	12.2	6,900
Yellow perch	95	62	513	9.6	4,900
Golden shiner	67	62	362	11.0	4,000
Black crappie	22	62	119	6.1	700
Lake chub sucker	159	62	859	8.2	7,000
Warmouth	133	62	718	14.8	10,700
Grass pickerel	22	62	119	8.6	1,000
Bullhead	127	62	686	3.4	2,300
Bowfin	3.5	62	19	.6	11
Largemouth bass	182	62	983	2.1	2,100
Spotted gar	4	62	22	1.0	22
Carp	285*	62	285*	.06	19*
Northern pike		62	40*	.3	10*
Total		62	7400		70,500

*Totals known

Figure 1. Saddle Lake - Growth Rate of Bluegills

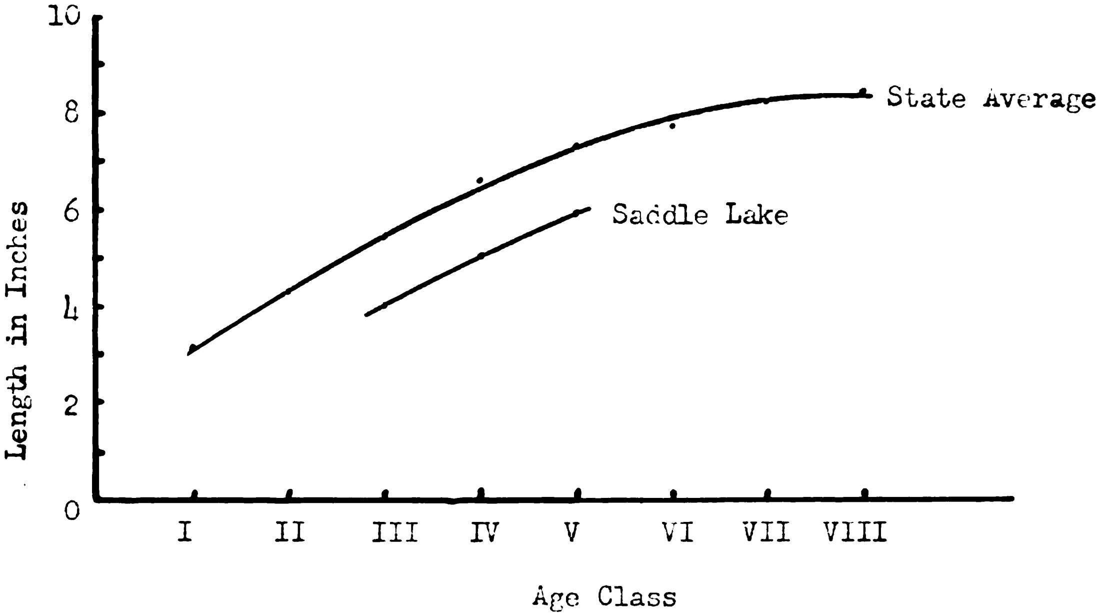

Figure 2. Saddle Lake - Size Frequency Distribution of Bluegills

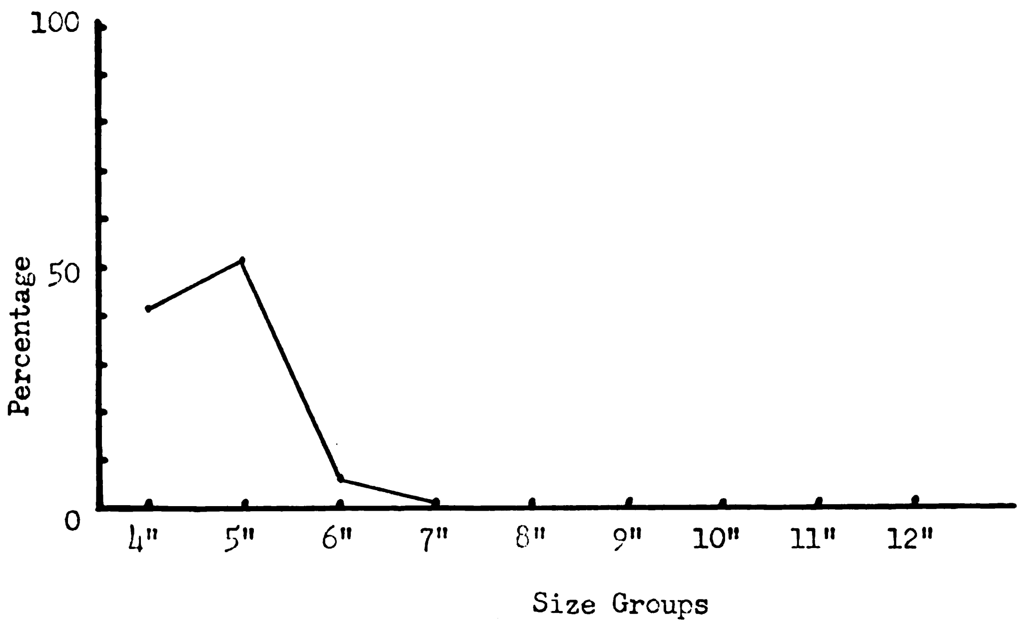

TABLE III

ESTIMATED NUMBER OF RECAPTURES FOR LOWER SCOTT LAKE

Species	Number of marked fish	Recaptures in 7 barrels	Estimated total barrels	Estimated total recaptures	Estimated percent kill
Bluegill	704	18	110	286	40.6
Pumpkinseed	288	24	110	374	130.9
Largemouth bass	32	6	110	99	309.3
Black crappie	78	6	110	99	126.9
Warmouth	12	-	110	-	-
Northern pike	5	-	110	-	-
Bullhead	169	-	110	-	-
Yellow perch	1	-	110	-	-
Hybrids	7	-	110	-	-
Golden shiner	4	-	110	-	-
Lake chub sucker	2	-	110	-	-
Bowfin	2	-	110	-	-
Grass pickerel	1	-	110	-	-
Total	1305	54		758	58.1

TABLE IV

ESTIMATED KILL OF FISH OVER 3.5 INCHES IN LOWER SCOTT LAKE

Species	Pounds in 1 barrel	Estimated total barrels	Estimated total pounds	Number of fish per pound	Estimated total number
Bluegill	17.5	110	1925	21.4	41,200
Pumpkinseed	15.7	110	1727	14.2	24,500
Black crappie	0.8	110	88	4.0	400
Largemouth bass	15.6	110	1716	3.9	6,700
Yellow perch	0.5	110	55	13.3	700
Bullhead	2.1	110	231	2.8	600
Lake chub sucker	17.6	110	1936	2.9	5,600
Golden shiner	1.5	110	165	11.0	1,800
Warmouth	3.7	110	407	30.0	12,200
Grass pickerel	1.2	110	132	6.0	800
Buffalo	4.0	110	440	0.05	22
Carp	5.2	110	572	0.1	57
Northern pike	3.3	110	363	.25	91
Bowfin	1.4	110	154	.21	32
Total			9900		94,700

Figure 3. Lower Scott Lake - Growth Rate of Bluegills

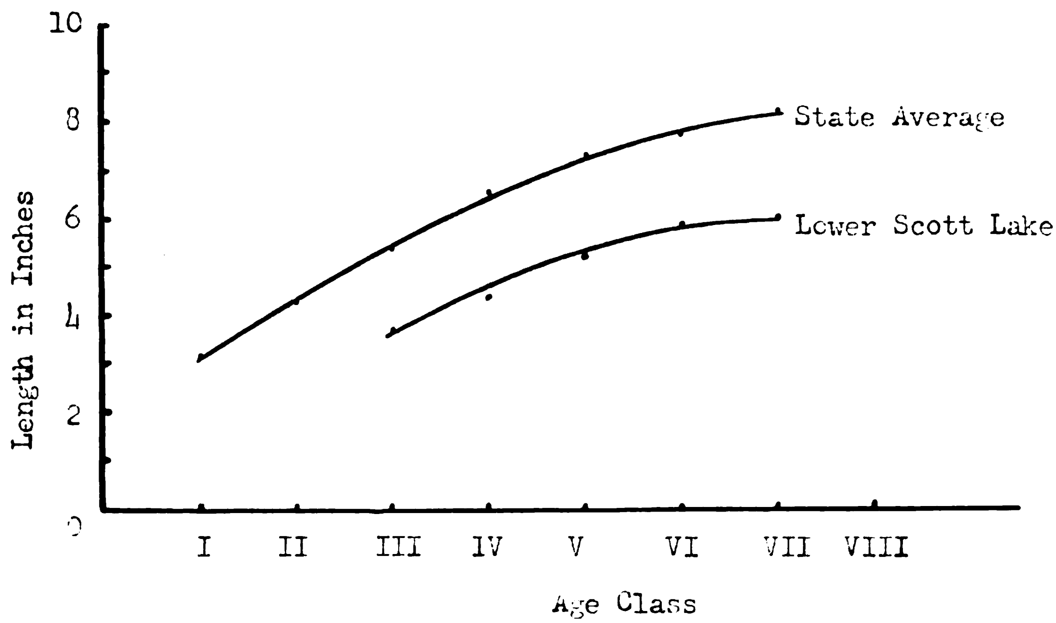

Figure 4. Lower Scott Lake - Size Frequency of Distribution of Bluegills

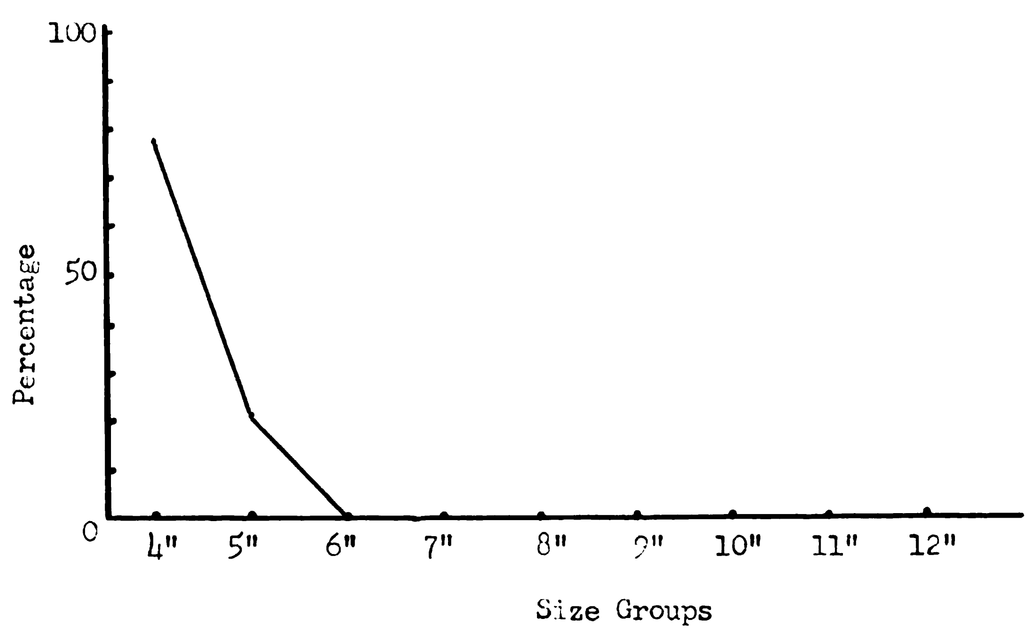

TABLE V

ESTIMATED NUMBER OF RECAPTURES FOR THE EAST BASIN OF TURK LAKE

Species	Number of marked fish	Recaptures in 8.3 barrels	Estimated total barrels	Estimated total recaptures	Estimated percent kill
Bluegill	1221	26	81	251	20.6
Pumpkinseed	224	23	81	226	100.9
Black crappie	159	2	81	16	10.1
Warmouth	48	3	81	32	66.6
Yellow perch	88	6	81	57	64.8
Largemouth bass	41	13	81	130	317.1
White sucker	17	1	81	8	47.1
Bullhead	104	10	81	97	93.3
Longear sunfish	22	2	81	16	72.7
Northern pike	8	-	81	-	-
Rock bass	7	-	81	-	-
Bowfin	8	-	81	-	-
Green sunfish	44	-	81	-	-
Total	1991			833	41.8

TABLE VI

ESTIMATED KILL OF FISH OVER 3.5 INCHES IN THE EAST BASIN OF TURK LAKE

Species	Pounds in 5.3 barrels	Estimated total barrels	Estimated total pounds	Number of fish per pound	Estimated total number
Bluegill	219.25	81	3355	24.1	80,900
Pumpkinseed	78.25	81	1197	5.2	6,200
Largemouth bass	115.0	81	1760	6.5	11,400
Black crappie	48.75	81	746	14.5	10,800
Yellow perch	40.75	81	623	13.7	8,500
Warmouth	19.75	81	302	16.7	5,000
Bullhead	23.75	81	363	5.4	2,000
Northern pike	14.50	81	222	.5	100
Bowfin	6.75	81	103	.4	40
White sucker	10.0	81	150	1.6	200
Total			8800		125,100

TABLE VII

ESTIMATED NUMBER OF RECAPTURES FOR THE WEST BASIN OF TURK LAKE

Species	Number of marked fish	Recaptures in 10 barrels	Total barrels picked up	Estimated total recaptures	Estimated percent kill
Bluegill	453	26	45	117	25.8
Pumpkinseed	266	34	45	153	37.5
Green sunfish	16	1	45	5	31.2
Longear sunfish	7	-	45	-	-
Warmouth	19	1	45	5	26.3
Black crappie	79	-	45	-	-
Yellow perch	53	3	45	14	26.4
Largemouth bass	24	2	45	9	37.5
Northern pike	9	1	45	5	55.5
White sucker	51	2	45	9	17.6
Bullheads	71	7	45	32	45.0
Rock bass	4	-	45	-	-
Bowfin	3	-	45	-	-
Hybrids	12	-	45	-	-
Common shiner	1	-	45	-	-
Carp	1	-	45	-	-
Total	1069			349	32.6

TABLE VIII

ESTIMATED KILL OF FISH OVER 3.5 INCHES IN THE WEST BASIN OF TURK LAKE

Species	Pounds in 5.3 barrels	Total barrels picked up	Estimated total pounds	Number of fish per pound	Estimated total number
Bluegill	260.0	45	2210	34.9	77,100
Largemouth bass	29.25	45	248	8.1	2,000
Pumpkinseed	92.50	45	788	20.1	15,800
Yellow perch	86.75	45	738	23.3	17,200
Black crappie	24.25	45	207	12.5	2,600
White sucker	13.0	45	113	1.7	200
Warmouth	30.25	45	256	16.7	4,300
Bullhead	24.0	45	203	4.0	800
Northern pike	2.75	45	23	22.2	500
Total			4800		120,500

Figure 5. Turk Lake - Growth Rate of Bluegill

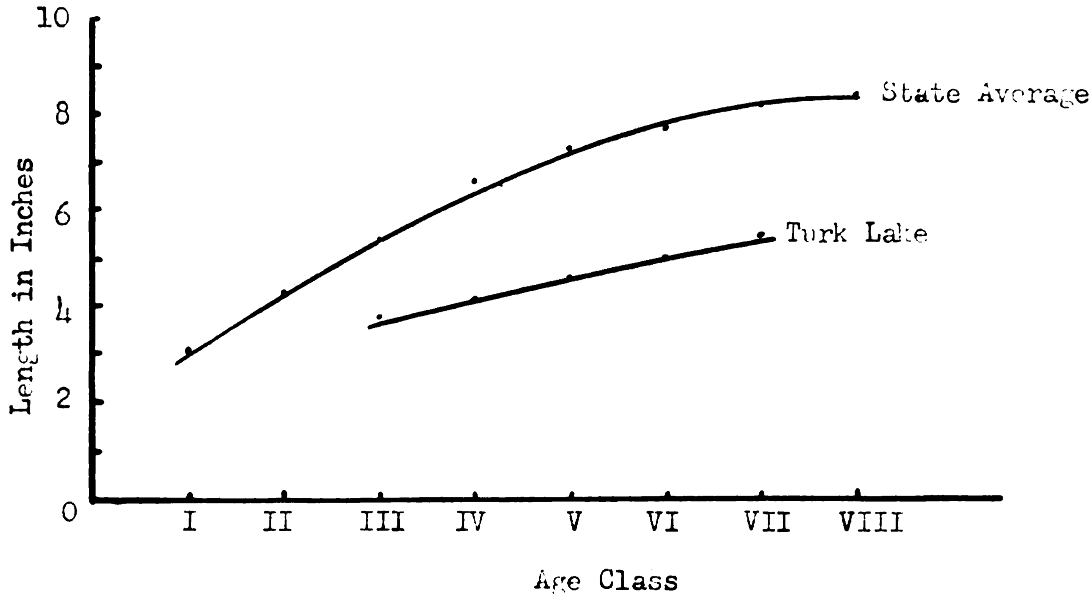

Figure 6. Turk Lake - Size Frequency Distribution of Bluegills

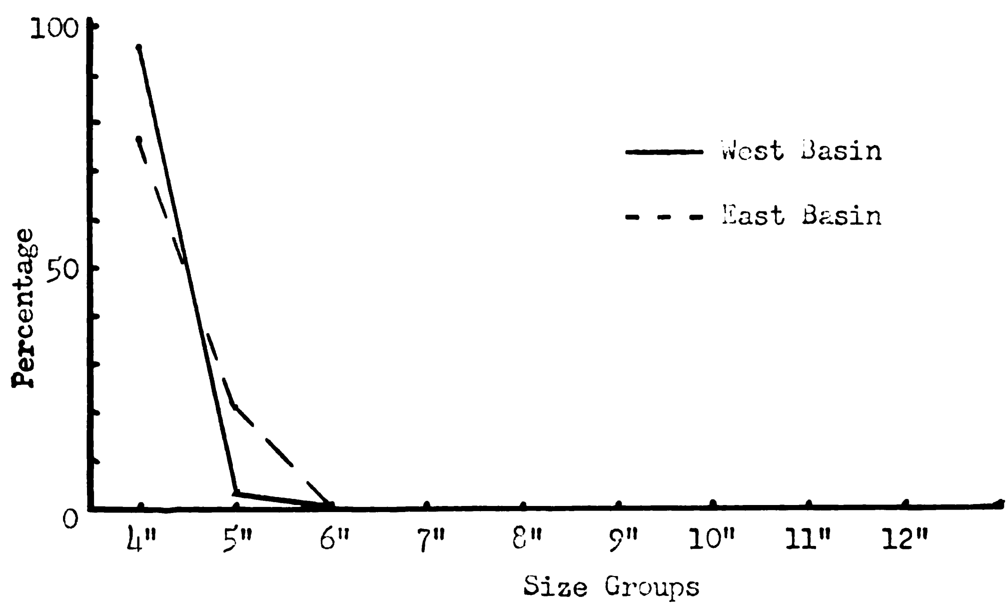

TABLE IX

NUMBERS OF FISH CAUGHT BY COMPARABLE 24 HOUR TRAPNET SETS BEFORE AND AFTER POISONING

Species	Saddle Lake B	Saddle Lake A*	Lower Scott Lake B	Lower Scott Lake A	Turk Lake B	Turk Lake A	Turk Lake East Basin B	Turk Lake East Basin A	Turk Lake West Basin B	Turk Lake West Basin A
Bluegill	861	170	129	79	14	5	10	2	4	3
Pumpkinseed	33	20	75	38	14	3	7	1	7	2
Black crappie	41	13	45	43	59	1	41	0	18	1
Largemouth bass	20	18	17	11	25	2	10	2	15	0
Northern pike	1	1	4	2	0	2	0	2	-	-
Yellow perch	-	-	-	-	5	0	1	0	4	0
Bullheads	113	36	137	74	56	3	28	2	28	1
Warmouth	4	0	1	0	2	4	2	0	0	4
Bowfin	3	1	-	-	2	2	2	2	-	-
Spotted gar	1	1	-	-	-	-	-	-	-	-
White suckers	-	-	-	-	24	0	6	0	18	0
Hybrids	-	-	-	-	0	2	-	-	0	2
Total	1077	260	408	247	201	24	107	11	94	13
Percent Reduction	75.71**		39.47		88.06		89.72		86.17	

*B - Before poisoning; A - After poisoning.
**From trapnets fished inside and outside the poisoned areas.

ROOM USE ONLY

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