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In the fall of 1945, members of the biological staff began returning from military service and by the end of the biennium almost all of the personnel had resumed active duty. However, a shortage of trucks and other equipment and of qualified assistants limited field work in 1946.

Three full-time members of the staff resigned to accept positions of greater responsibility in other organizations. Dr. Louis A. Krumholz joined the Indiana Lake and Stream Survey. Dr. Eugene Roelofs became Research Associate in the Institute of Textile Technology, Charlottesville, Virginia. Mr. Pat Galvin entered private business.

During the two fiscal years of the biennium, 105 typewritten reports were submitted to the Lansing office for consideration of the factual information and recommendations on fish management of inland waters. Certain of these reports have been published by the Department or by technical journals as indicated by the footnotes which appear on the following pages.

A series of popular articles summarizing the Institute findings as related to certain phases of fish management appeared in Michigan Conservation and were combined as a pamphlet for general distribution.1/

FISHERIES SURVEYS

The program of lake and stream surveys was continued on a small scale. In 1944, one survey party resumed the inventories on most of the public

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+/ Resigned during biennium

1/ Westerman, Fred A. and Albert S. Hazzard. For better fishing! Michigan Department of Conservation, 1945.

lakes in the Waterloo area in Jackson and Washtenaw counties. In 1945, the program was limited to the study of a few waters incidental to other activities by field parties; the Twin Lakes at Indian River in Cheboygan County, Hart and Eagle Lakes at Fort Custer, and several lakes in Marquette County were studied. In 1945, field survey parties spent most of their time doing water analyses on lakes to determine their suitability for supporting trout, and netting lakes to determine the survival of trout, bass and other fish from hatchery plantings. Several lakes, in which plantings of bass, bluegills, perch and other warm-water species has been discontinued, were netted to determine the abundance of the young of these species resulting from natural reproduction. These netting operations, following the discontinuance of warm-water fish plantings, have revealed an abundance of young fish in most instances. In June, 1946, one party began a summer inventory survey of three groups of lakes which were recently acquired by the State for public fishing: the Rifle River Lakes of the Jewett Estate in Ogemaw County, the Haymarsh Lakes in Mecosta County, and the Fish Lake group in Barry County.

At the beginning of each year management recommendations are submitted to the Department for all lakes which have been inventoried by the Institute. This list for 1946, prepared with reference to the fish planting program, cited 344 lakes. No fish plantings were recommended for 258 lakes, 75 percent of the total; these are mostly warm-water lakes in which natural reproduction of bass, pike, bluegills, perch, etc. was found to be adequate. Fish plantings (mostly trout) were planned for 86 lakes as follows: rainbow trout, 49 lakes; brook trout, 24; lake trout, 8; brown trout, 3; largemouth bass, 3; smallmouth bass, 3; northern pike, 1; walleyed pike, 1; and bait minnows, 4. For a few of the lakes, more than one species are recommended. The experimental trout plantings in lakes involve approximately 343,000

fingerlings and 93,000 legal-sized or two-year-old fish of the four species combined.

Winter lake mapping was done by three field parties in 1944-45 and five parties in 1945-46. They mapped 93 lakes. This brings the total of mapped lakes in Michigan to approximately 1,700 (including those done by the C.C.C. for the Conservation Department, and by the United States Forest Service). The 93 lakes mapped during the present biennium are distributed by counties as follows: Marquette, 32; Oakland, 13; Ogemaw, 9; Barry, 9; Baraga, 7; Mecosta, 6; Kalamazoo, 4; and eight other counties, 11 lakes. The larger of these lakes are Gun and Pine in Barry county, Cass, Pine, Walled and Pontiac in Oakland county, and Chippewa in Mecosta county. Each of these larger lakes required from two to six weeks to map, while many of the smaller lakes required only one day each.

MINNOW INVESTIGATIONS

In order to assist bait dealers in overcoming the acute minnow shortage, experiments in propagation of the more popular species were expanded. During the spring of 1946, tests were initiated in 31 ponds, totaling 45.89 acres, at seven hatcheries and rearing stations. Special emphasis has been placed upon the culture of certain desirable species, namely, creek chubs, common suckers and golden shiners. In addition, some investigation in culture of the fathead minnow, the pearl dace and the five-scale dace has been undertaken. This overall study involves fertilization and feeding experiments, establishing satisfactory stocking rates, methods of hatching, and production figures.

In order to determine the most desirable species to be cultured, and in what season and in what size range the scarcity existed, a postcard questionnaire was mailed to each dealer in the state (based on the 1945 dealer list).

Results of this poll (37 percent returns) indicated that 94 percent of the dealers had experienced a minnow scarcity, and that the greatest scarcity occurred during July and August and in the 2- to 6-inch class. On learning that the state was planning to expand bait minnow research, 95 percent of the dealers were in favor of the project. Further, 93 percent of the dealers indicated their desire to purchase excess minnows which might be available from these experiments.

TOXICITY TESTS

The DuPont Company of New York, greatly interested in reducing or destroying altogether the toxic substances in plating wastes, have been actively engaged in research on this subject for the past few years. As a means of evaluating the actual reduction in toxicity, the Institute has cooperated in running a series of fish toleration tests.

The polysulphide treatment of cyanide wastes, earlier proposed by the DuPont Company, was found to have certain limitations in its use. Cyanide wastes treated in this manner initially were less toxic than before and would remain so in the absence of chlorine. However, it has become the common practice to chlorinate water supplies and the effluent of sewage treatment plants. When the polysulphide treated waters come in contact with the chlorinated effluents, the cyanide content resumes its original toxicity. To offset this condition, the DuPont Company has proposed the alkali-chlorination method of treating cyanide plating wastes. The chlorine reacts with the cyanides, forming cyanogen chloride, which hydrolyses to ammonium carbonate in the presence of hydroxide alkalinity. Further breakdown results in the production of ammonia and carbon dioxide, relatively much less toxic to fish life.

To determine how effective this method of treatment of cyanide waste was in reducing the toxicity, a series of fish toleration tests were undertaken during the late fall of 1945 and terminated in the spring of 1946.

Partial analyses of the results indicate that a very significant reduction in toxicity is brought about by this method.

In anticipation of the widespread use of DDT[1] for insect control and the possible contamination of public waters by its indiscriminate use, a series of experiments were undertaken in 1944-45 to determine the toxic effect of DDT to fish.

Samples of the DDT products tested and analyses of the same were furnished by Geigy Company, Inc., of New York. Both loose and tight emulsions, ranging from 5 to 20 percent DDT concentration, as well as larvicides and insecticides ranging from 20 to 40 percent DDT were used. In all cases, excepting wettable DDT powder, the tolerance limit for fingerling brook trout was below 0.1 part per million. It was found that the tolerance limit of brook trout to wettable DDT (non-soluble in water) was established at between 10 and 15 parts per million. From these studies, it can be assumed that any DDT products in solvent form are highly toxic to brook trout, and that the use of this substance in or near any waters containing this species should be undertaken with the greatest of care.

FISH MORTALITIES

Fish losses during the spring and early summer and occasionally in late fall are of common occurrence in a rather large number of lakes annually, though usually not in the same lake each year. Frequently the fish exhibit no signs of disease which could be held responsible. The most plausible explanation of such mortalities is that over-population exists which

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[1] Dichlor-diphenyl-trichlorethane

may have resulted in weakness due to disease or malnutrition, and that these fish are unable to endure the sudden rise or fall of water temperatures. This is a problem which merits further investigation, although it seems to be generally true that fishing benefits, rather than suffers from such reduction in numbers.

Other "natural" losses occur during winter months when a heavy covering of snow over lake ice persists for a long period without thaws. This results in so-called "winterkill". A heavy winterkill of fish occurred during 1944-45 in many lakes, mostly in the southern part of the state. A questionnaire submitted to the Conservation Officers, together with observations by Institute staff members, resulted in a tabulation of 51 lakes with a heavy winterkill. Judging from subsequent reports, the actual number of lakes probably exceeded 75. The 51 lakes, with a combined area of 4,183 acres, sustained a mortality estimated conservatively at 2,000,000 fish, of which approximately one-third were legal-sized pan and game fish. Winter oxygen tests showed that the mortality was confined to lakes in which the dissolved oxygen was depleted to less than one part per million at all depths. The kill was, to a considerable extent, selective by species, destroying bass and bluegills more than perch, pike and bullheads.

Previous winterkills were heavy in 1935-36, and light in 1939-40 and 1940-41. The extensive loss in 1944-45 was the second heavy kill within a decade. Although our records on earlier winterkills are not satisfactory, we know that the decade of 1935-45 was especially bad in this respect. The results of a study (by John Greenbank of the Institute) on winterkill conditions in Michigan lakes during the period of 1937 to 1943 have been published recently.[1]

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[1] Greenbank, John, 1945. Limnological conditions in ice-covered lakes, especially as related to winter-kill of fish. Ecol. Monographs, 15: 343-392. Oct., 1945.

Mortality of fish at hatcheries and rearing stations were investigated insofar as personnel permitted, and some assistance in the control of disease was given. The return of the staff pathologist in the spring of 1946 made possible an expansion of this service. Sulfamerazine, found by the United States Fish and Wildlife Service to be effective against furunculosis, was used with some success in the control of this dreaded bacterial disease of trout.

FISH LIFE HISTORIES

Extensive tagging experiments were carried on at Houghton Lake and the Muskegon River in 1939, 1940 and 1942, as part of an investigation on the life history and habits of the northern pike. A total of 864 northern pike[1] were tagged; and, of these, 230 (26.6 percent) were recovered, almost exclusively by anglers, through the end of 1945. Maximum speed of travel during the spawning migration was found to be 0.5 mile per hour in one instance. The maximum recorded distance traveled by an individual pike was 49 miles. There is some evidence that pike utilize more or less well-defined local summer habitats; migrate annually to the same, conveniently located spawning areas; and return after each annual spawning run to the local summer "ranges" previously occupied by them. Growth data, available from a limited number of recoveries, showed that the growth rate of the pike that were large at the time of tagging did not differ greatly from those that were small at the same time. Some of the larger pike apparently possess a growth potential as great as the smaller ones.

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[1] Carbine, W. F. and Vernon C. Applegate. The movement and growth of marked northern pike (Esox lucius, L.) in Houghton Lake and the Muskegon River. Mich. Acad. Sci., Arts and Letters, 1946. In press.

Coincident with the northern pike experiments at Houghton Lake, 100 walleyes were taken in weirs, tagged, and released in 1939 and 1940.[1] Recoveries of tagged walleyes to the end of 1945 have totaled 19 (19.0 percent). The results of this tagging experiment and personal observations seem to indicate a high rate of exploitation and an early cropping of the walleyes soon after they reach the legal length of 14 inches. Tagged walleyes were recovered as early as 15 days and as late as 796 days after tagging. Distances traveled by tagged walleyes varied from 0.5 to 130.5 miles. Studies were made on the food and feeding habits of 633 young northern pike collected in the course of the investigation. It was desired to learn what organisms were used as food by the young fish as they began to feed and increased in size. Numerous collections of small perch, minnows and other fish which were found in the same waters with the young pike were made and the stomachs examined to determine to what extent each species preyed on the young pike or competed with them for certain food organisms. The stomachs of 642 yellow perch from 2.0 to 4.7 inches long, and 598 minnows and other small fish from 1.5 to 6 inches long were examined.

Northern pike fry first began to feed at a length of 0.4 of an inch. The first food consisted entirely of microscopic crustacea. As the young pike increased in size, larger food organisms were eaten, until they became primarily fish eaters at a length of about two inches. The feeding sequence as the young pike increased in size was as follows: small microscopic crustacea, larger microscopic crustacea (water fleas), insects, and fish and tadpoles. Rather extensive cannibalism was found to exist among the small pike. They began to eat each other at a length of 0.8 of an inch. Cannibalism apparently continued as long as there was a pronounced difference in

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[1] Carbine, W. F. and Vernon C. Applegate. Recaptures of tagged walleyes, Stizostedion v. vitreum (Mitchill), in Houghton Lake and the Muskegon River, Roscommon County, Michigan. Copeia, 1946, No. 2, pp. 97-100.

in size among the young pike.

The effect on the pike population of the perch, minnows and other fish present in the same waters was without doubt considerable. It is probable that they contributed a great deal to the high mortality of young pike on the hatching and rearing grounds, which was found to occur during each year of the investigation. The small perch competed with the young pike for the insect food available, and preyed extensively on the pikes. Of the perch stomachs which contained food, 20.6 percent contained young northern pike which made up 62.0 percent of the total volume of the stomach contents. Other fish which were found to eat young pike were the mud minnow, creek chub, blackchin shiner and northern mimic shiner. Only four of the 19 species of fish associated with the young pike did not offer active competition for the food items which were of importance in the diet of the pike.

INSECT LIFE HISTORY

An investigation of the life history of the burrowing mayflies found in the lakes and streams in the state was begun in the spring of 1946. The nymphs of the mayfly genus (Hexagenia) under consideration are known to fishermen and bait dealers as "wigglers". This investigation was undertaken because of lack of information on the life history and habitat requirements of these insects and their importance as fish food at the various stages in their life cycle. Since the nymphs (wigglers) are becoming increasingly important and valuable as bait for winter fishing, it is necessary to secure life history information which will provide a basis for regulating the commercial digging of these nymphs for fishing bait.

Preliminary collections of adult mayflies and nymphs have been made on six lakes and four streams. Mayfly eggs have been fertilized artificially, hatched, and the young nymphs reared for several weeks in the laboratory.

Grown nymphs have been reared to the adult stage so that identifications of the species can be made. Work is being carried on to determine the distribution of the nymphs in lakes and streams and the type of bottom that they must have in order to thrive.

AGE AND GROWTH OF FISHES

Studies on the age and growth of fishes from scale readings were resumed early in 1946. Tables established for the average size at various ages of the game fishes are being revised. These tables have been useful in evaluating the growth of fish in individual lakes as compared with the compiled state averages.

Two studies relating to age and growth were completed. These included the length-weight relationship and the relationship between standard and total length of seven important game fishes.[1] These studies enable workers to compare growth in weight of specimens from individual lakes with weight of fish according to the state average. With the establishment of a state average in weight for the various lengths of fish the investigator can determine the relative position of the lake with regard to growth in fish weight, and make management suggestions accordingly.

The determination of ratios between standard length (length of the fish to the end of the vertebral column, a measurement used by many workers) and total length (greatest measurable length of the fish, with the mouth closed and the lobes of the tail compressed to give the greatest length) permits investigators to compare their work with that of others using one or the other measurement.

A collection of "key" scales was made during the summer of 1946, and

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[1] Beckman, William C. The length-weight relationship and factors for the conversions between standard and total lengths for seven Michigan game fishes. Trans. Amer. Fish. Soc., Vol. 75. In press.

a study of the body-scale relationship is being conducted to increase our knowledge of fish growth, and also to enable investigators to determine more accurately the growth rates of fishes. Knowing the ratio between fish growth and scale growth permits calculation of the size of the fish at various ages represented on the scale. This increases many times the number of lengths available for each age-group, and with increased numbers the accuracy is increased.

Studies are also being conducted on the periodicity of growth in fishes. Collections were made at intervals throughout the spring and summer of 1946, and will be continued during the fall and winter, and all through the year 1947. An attempt will be made to determine when the growth of the fish occurs, or if growth is more rapid during any particular period.

With the placing of some lakes under special fishing regulations, it was considered necessary to follow the growth of the fishes in these special lakes. Consequently a collection of scales was made from each of the designated lakes and samples will be taken periodically during the entire period these lakes are under this classification. By following the changes, if any, in growth rate of fishes in these lakes much basic data will be obtained regarding the effect of changes in the present laws on existing fish populations.

The effect of reduction in the density of fish populations is under investigation. Work begun in the past is being continued and enlarged as additional lakes have been added to the list. Lakes that had suffered winterkill during the winter 1944-45 are being checked for any changes in fish growth rates.

A study was made of the age and growth of the lake trout that have been planted in inland Michigan lakes. Data were obtained which indicated that the scale method of age determination was invalid for the populations of this

species studied. Recoveries of marked plantings which were made in Birch Lake, Cass County (1940), Crystal Lake, Benzie County (1941), and Higgins Lake, Roscommon County (1941) provided growth data from fish of known age. Lake trout in these three lakes averaged 9.0 inches in their third summer of life, 13.0 inches in their fourth summer, 16.6 inches in their fifth summer, 20.0 inches in their sixth summer, 23.4 inches in their seventh summer, and 26.7 inches in their eighth summer.[1]

HUNT CREEK FISHERIES EXPERIMENT STATION

The Hunt Creek Fisheries Experiment Station, established in 1939, has continued to serve as a field laboratory and testing area for brook trout problems, and in a minor way during the war years as an investigative center for fisheries problems in northeastern Michigan.

Complete fishing and catch records have been obtained each trout season since 1939 on 2-1/2 miles of Hunt Creek, on Fuller Creek, and on East Fish Lake. On Hunt Creek, in 1944, with an increase of 17.6 percent in hours of angling over 1943, angling quality dropped from a high of 0.70 fish per hour in 1943 to 0.56 fish per hour in 1944. In 1945, angling hours were almost the same as in 1944, but angling quality dropped still further to 0.49 fish per hour. The 1946 records to July 1 indicate that fishing pressures will approach the pre-war peak noted in 1941.

On East Fish Lake creel census records demonstrated that the presence of large brook trout reversed the war-time trends in fishing intensity noted for other trout waters. Despite travel conditions, the number of anglers using the lake has increased each year since 1943. In 1944, 311 anglers fished 651 hours and captured 108 legal brook trout weighing 79.1 pounds, or

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[1] Applegate, V. C. Preliminary report on the age and growth of the lake trout, Cristivomer n. namaycush, in inland Michigan lakes. Copeia. In press.

0.17 fish per hour. In 1945, 436 anglers fished for 922 hours and caught 169 legal brook trout weighing 130.6 pounds, or 0.18 legal trout per hour. Pressure during 1946 will approximate that of 1945, but it appears now that the catch will be only about half that of 1945.

The drawing card at East Fish Lake is the possibility of catching brook trout weighing from 1 to 3 pounds. The record fish to date weighed 3 pounds 1 ounce and was 20-3/8 inches long.

Previous research at the station had indicated a slow growth rate for the stream brook trout, and a comparatively high mortality before reaching the legal size of 7 inches. Angling records show that from 6 to 10 undersized fish are returned to the water for each 7-inch fish that is creeled. Accordingly it was suggested that a portion of the stream system should have a six-inch size limit to test the possible effect of the lower size limit on fishing for the larger brook trout in future years. Early in 1946 an order was drawn by the Conservation Commission making 6 inches the legal size for brook trout in Sections C, D, and E of the experimental sections of Hunt Creek, and in Fuller Creek (a branch of Hunt Creek) west of the water wheel. This order is in effect for five years.

Anglers keeping 6-inch brook trout receive a duplicate copy of their creel census sheet to validate the possession of the short fish. The creel census totals for these waters, both before and after the change in size limits, should tell whether or not a lowered size limit will interfere with the catch of larger trout in future years. Up to July 1, 1946, about twice as many 6- to 7-inch fish had been removed from these waters as fish over 7 inches. The "short" fish were saving many anglers from the ignominy of an empty creel.

Because the stream improvement devices installed in Section B in 1941

produced a definite increase in angling quality in that section in the years following the installation,[1] it was decided to test the effect of stream improvement devices on a stream section with totally different environmental characteristics, and also try out a different mode of construction. Section A, a relatively wide, open, sandy-bottomed, slow-flowing portion of Hunt Creek was improved by the placement of a series of deflectors and digger logs at the close of the 1945 trout season. These deflectors were constructed by utilizing either triple or single wooden, sheet piling to form a watertight deflecting structure. These were driven from 3 to 5 feet below the stream bottom and projected from the bottom to low water level. The use of a jet pump aided in cutting down the installation time. Creel census data, before and after the improvement of Section A, taken in the regular course of the station operations will give an answer to the value of this work.

Two-way fish traps have been operated on several of the tributaries almost continuously since the establishment of the station. Six traps are now in operation. Trout more than four inches long are jaw-tagged; and those of smaller sizes are marked by removing a different fin or fin combination for each trap. The daily records kept for each weir indicate considerably more movement into the main stream of Hunt Creek than out of it. Despite the majority of fish moving into the main stream, the contribution of the tributary streams to the anglers' catch, as determined from the number of marked fish found in the creels, has varied only from 0.7 percent to 3.0 percent of the total catch of the experimental sections since 1942.

Studies have been under way since the fall of 1943 to determine the number of young produced by a known number of adult brook trout of known sizes. Each fall a known number of adults are tagged, weighed, and

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[1] Shetter, David S., O. H. Clark, and Albert S. Hazzard, 1946. The effects of deflectors in a section of a Michigan trout stream. Trans. Am. Fish. Soc., Vol. 76, 1946. (In press).

measured, and placed in one of the screen raceways and allowed to spawn. After spawning the adults are removed. In July or August of the following year, when the young are readily seen, they are removed, measured, weighed and counted. For comparative studies, the number of spawning redds in three miles of stream in the vicinity of the station were counted during the falls of 1944 and 1945. Numerous redds were opened with the aid of a shovel and their eggs collected by use of a fine-meshed seine. The eggs, if present, were counted. It was found that by no means all of the cleaned redds contain eggs. A cruise of the entire length of the main stream of Hunt Creek in the fall of 1944 indicated that natural reproduction took place in almost every mile of stream that year.

Population studies and the improvement of gear and techniques for conducting them have occupied much of our attention in the past biennium. There appears to be considerable variation in the brook trout population from season to season in the same year, and between different parts of the stream at the same season. It is felt that when the techniques of the stream population study are perfected so that we can make reliable population estimates, some of the variations in fishing quality which have occurred under various amounts of angling pressure may be more readily explained.

FINGERLING LAKE TROUT FIN-CLIPPING EXPERIMENTS

In April, 1944, the Great Lakes Trout Committee, composed of representatives from all states bordering on the Great Lakes and representatives of the United States Fish and Wildlife Service, drew up a program of investigation of the lake trout in the Great Lakes. A part of this program entails the marking (by fin-clipping) of a large number of hatchery-reared, lake trout fingerlings for a three-year period to ascertain the length of time between release and when they enter the catches of commercial fishermen,

and to give some indication of the percentage of survival from the fingerling to the adult stages. Planning the fin-clipping operations and setting up control experiments on the effect of fin-clipping on the trout were delegated to the Michigan Department of Conservation. Cooperation and assistance has been received each year from representatives of the Wisconsin Department of Conservation and the United States Fish and Wildlife Service. The latter organization has furnished the experimental fish and made available the hatchery building at Charlevoix, Michigan, for the clipping operation.

In September, 1944, the dorsal and adipose fins were clipped. A total of 100,280 marked, lake trout fingerlings were planted in the vicinity of the Fox Islands from Patrol Boat #1. In 1945, the right pectoral was removed, and a total of 159,712 marked, lake trout fingerlings were planted off the Big Reef northwest of Charlevoix.

Each year two groups of control fish are set aside and sent to the Marquette Hatchery. One group consist of equal numbers of marked and unmarked fish to be held in the same pond to determine comparative growth and mortality among marked and unmarked fish. The other group consists solely of marked fish which are held alone to determine how much, if any, regeneration of the clipped fins takes place.

Inspection of the controls to date indicates that there is comparatively little regeneration of clipped fins, but that mortality of the fin-clipped fish is about 7 percent greater than among the unclipped fish. Growth, so far, is approximately the same for clipped and unclipped fish.

It is hoped to obtain records of numerous recoveries of these marked fish as they come into the commercial catches and a reward of $2 per marked fish is offered for the return of each fin-clip scar with complete data on

the fish. It will probably be 1949 before very many marked fish are recovered, judging from our inadequate knowledge of the growth rate of the species. For the marking and control experiments planned for September, 1946, the left pectoral fin will be used.

SEA LAMPREY INVESTIGATIONS

This parasite on commercial species of fish in the Great Lakes has continued to increase during the past two years. Its chief victim appears to be the lake trout. In 1944, the cooperative experimental work in the Ocqueoc River in Presque Isle County, sponsored by the East Presque Isle County Sportsmens' Association and the Conservation Department, captured and destroyed 3,366 lampreys on their spawning migration.

The trap on the Ocqueoc was reinstalled in 1945. That year, more detailed records were kept, and some additional observations were made on the life history of the spawning adults. The trap was in place about one month earlier than in 1944, and captured a total of 4,608 lampreys, about 90 percent of which were estimated to be sea lampreys. It was found that the peak run at the trap occurred when the water temperature ranged between 50 and 60 degrees F. The great majority of the lampreys moved into the trap between the hours of midnight and noon. The size of the lampreys captured ranged from 14.1 to 30 inches, and the average size was estimated to be close to 20 inches. Because of faults inherent in the construction of the traps and blocking arms, many mature sea lampreys escaped to the spawning grounds below Ocqueoc Falls each year the trap was operated.

The weir and trap method of eliminating the sea lamprey would prove to be extremely costly if the proper type of weir were built on each known spawning stream. Before any large-scale attempts at sea lamprey control are initiated, a careful study of the number of fish found damaged in the commercial catches should be made, as well as a study on the price differential on scarred and unscarred fish.

CREEL CENSUS

The general creel census was taken by Conservation Officers as a part of their regular duties. This census was started in 1927 and has been expanded and developed so that it is believed to represent a random sampling of the fishing in the entire State of Michigan. During this biennium the data from trout waters, non-trout lakes and streams, the Great Lakes, and the connecting waters of the Great Lakes have been considered separately for the first time. The reason for this separate consideration of the data is to obtain a better indication of the quality and fishing intensity in the six general types of water administered by the state. In 1944, the officers interviewed 46,100 anglers who had fished 152,196.5 hours on all types of waters throughout the state, and who had taken 177,262 legal-size fish at a rate of 1.16 fish per hour. In 1945, the officers contacted 42,283 fishermen who fished a total of 143,913.9 hours and who took 161,015 legal-sized fish, a catch of 1.12 fish per hour.

The fishing quality as indicated by the catch per hour was highest in the Great Lakes and connecting waters. Yellow perch made up the bulk of the total catch for Great Lakes waters, 72.2 percent in 1944 and 86.5 percent in 1945. As in past years, the fish most abundant in the catch was the bluegill; this species constituted 44.2 percent (1944) and 48.0 percent (1945) of the catch in non-trout waters. The yellow perch was second in abundance. The bluegill and perch, together, made up more than 65 percent of the catch in non-trout waters during this biennium.

Brook trout constituted the bulk of the trout catch. In 1944 there were 18,830 trout reported, of which 15,478 (82.2 percent) were brook trout, 2,038 (10.8 percent) were rainbow trout, and 1,314 (7.0 percent) were brown trout. In 1945, of the 20,989 trout, 16,110 (76.8 percent) were brook trout, 2,478

(11.8 percent) were rainbow trout, and 2,401 (11.4 percent) were brown trout.

In order to determine the amount of use and the fishing value of the special-regulation trout ponds in southern Michigan, a simple census form has been placed in boxes at these ponds (one pond in 1944, three ponds in 1945, and six in 1946). Fishermen using these ponds are required to register their catches and the time spent fishing. Further information on these experimental trout ponds is given in the section on Fish Management.

When the state secured title to the Rifle River Area it was realized that a continued record of the fish catch, game kill and fur take would provide an answer to the question frequently raised as to the effect of such uses on the annual crop. This area had been in private ownership for about twenty years and had been little used since 1933. It therefore might be properly assumed to have reverted to a condition of maximum fish and game population. Just what the crop would be when heavily used by the public and how well the annual take would hold up under such use was an intriguing problem. Because of the road pattern and complete blocking and enclosure of the area, accurate checks on the kill are available. Permits to enter and use the area are issued free of charge at the checking station and the catch or kill are registered when visitors leave.

From April 28 (when the area was first opened) to December 31, 1945, a total of 16,370 persons registered for sightseeing, fishing, hunting or trapping. There were 4,084 fisherman days spent on the Area with a combined catch of 6,638 fish which had a total estimated weight of 2,469 pounds. Trout fishermen numbered 1,476 with a total catch of 388 trout. The catch was mostly bluegills, sunfish and perch but some trout (mostly brown trout), northern pike and bass were also taken, including several exceptionally large brown trout and pike from DeVoe Lake.

From April 27 (the opening day) to June 30, 1946 the Area was used by 3,441 visitors of which 1,246 registered for fishing. Of the latter number, 956 were trout fishermen who removed 630 trout and 72 other fish. It will be noted that trout fishing was much better during the second year the Area was opened; the catch to June 30 exceeding greatly the total catch for the season of the preceding year. Better fishing conditions (clear, normal-level water) during the early part of the period is believed to account for this better trout fishing. No fish have been planted in the Area, so this is not a factor in the catch.

For the purpose of the experiment it will be essential that no stocking or any radical change in the fish environment be made for several years. After the average production of these waters has been established they will be used for a number of experiments in fish management.

A plan for a volunteer creel census of the various streams in the Au Sable River drainage was drawn up in the spring of 1945 and the cooperation of numerous fishermen, guides, and resort operators and cabin owners was enlisted. The objective was to obtain some idea of the quality of the fishing through the voluntary recording of the minimum amount of data necessary to determine the catch per hour. Any information obtained, it was felt, would be an improvement over the previous situation wherein we had no data on fishing quality (except for a short portion of the North Branch of the AuSable).

Mimeographed record sheets were distributed to 40 individuals, and data were kept on the entire season's fishing by 15 of these parties, with scattered records being turned in by the remainder. On the entire drainage, a total of 1,644 angling days was reported, during which time 7,208.25 hours of fishing were expended. The total catch during this time was reported to be 3,353 brook trout, 4,004 brown trout and 452 rainbow trout, or a total of

7,809 legal trout, or 1.08 legal trout per hour of fishing. Brown trout were most numerous in the catches reported from the Main Stream and the South Branch, while brook trout dominated the catches from the North Branch and its tributaries. Fishing quality was best on the North Branch (1.34 legal trout per hour). A larger group of cabin owners, guides, and resort operators are keeping records for the 1946 angling season on the AuSable. It is to be hoped that this will become an annual cooperative affair between the Department and those interested in the AuSable River.

Since many anglers and even departmental employees still fail to appreciate the important part played by natural reproduction in furnishing a rather large portion of the trout fisherman's catch, it was decided to mark all legal-sized trout before release in three drainages during the 1946 trout season. This was done by clipping the right pectoral fin from all legal-sized trout planted in the AuSable and Fox River drainages, and the left pelvic fin from all legal-sized trout planted in the Rifle drainage. Anyone fishing in the Fox River drainage of the Upper Peninsula, or in the Rifle or AuSable drainages of the Lower Peninsula, could tell at a glance whether his trout were of hatchery origin by looking for these particular fins. If all fins were present, the trout was a survivor of natural reproduction, or possibly from previous fingerling plantings. Since the best survival to the creel in experiments in planting fingerling trout in streams has been approximately 3 percent, the latter possibility is very remote.

This demonstration project entailed the fin-clipping of approximately 70,000 legal fish before release, and was carried out by cooperation between Institute and hatchery personnel. To speed up the fin-clipping operations, the fish were anesthetized with ether, and clipped with stout-bladed surgical shears on which the cutting edges were corrugated.

The three drainages were checked each Sunday of the trout season by

members of the Department who contacted as many anglers as possible. Catches were inspected and the numbers of marked and unmarked fish observed were recorded. It is planned to extend this marking work to include all legal fish planted during 1947 and 1948.

FISH MANAGEMENT

The fish population of Deep Lake, Oakland County, Michigan[1] was killed by poisoning with chemicals on September 12, 1941. A total of 27,329 fish weighing 562.7 pounds, was recovered, or 38.0 pounds per acre. Bluegills were the most abundant species. Legal game fish made up 3.2 percent of the number and 56.1 percent of the weight of all fish recovered. Of all of the species of fish present in Deep Lake, the rock bass and the largemouth bass were the only species possessing a better than average growth rate.

After poisoning, Deep Lake was restocked with legal rainbow trout, smallmouth bass fingerlings and 100 adult bluegills. At the end of the fourth complete year since poisoning, the following items of interest can be noted here: (1) Bluegills. Excellent conditions existed for bluegills in Deep Lake in 1942. Extensive spawning was noted, and all fish made good growth, although stunted at time of planting. Conditions remained excellent for the bluegills during most of the 1943 growing season. However, by the end of the 1943 growing season, the peak of the carrying capacity appears to have been reached and passed. The growth rate of all age groups of bluegills declined abruptly in 1944 and remained very poor through 1945. The lake is now heavily overpopulated with stunted bluegills. (2) Smallmouth bass. The first planting of smallmouth bass was not successful and very few, if any,

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[1] Carbine, W. F. and Vernon C. Applegate. The fish population of Deep Lake, Michigan. Trans. Am. Fish. Soc., Vol. 75. In press.

survived. Therefore, another planting was made in 1943. Fish of the 1943 planting spawned in 1945 and 1946, but survival is questionable. (3) Rainbow trout. Rainbow trout are growing at a fairly good rate in Deep Lake. This growth would undoubtedly be much better if the stunted bluegill population were not present. Stomach examinations reveal that about 25 percent of the trout feed on bluegills.

Future management experiments for Deep Lake include control of the stunted bluegill population.

To determine if ciscoes could be removed from a lake by gill nets with little or no detrimental effect to other species present, especially trout, an experimental management project was instigated in the fall of 1944 on Birch Lake, Cass County, Michigan. The plan, to be operated for three consecutive years, consisted of removing a given number of ciscoes each year from the lake under certain regulations. Participants of the harvest were required to obtain a daily permit at a checking station operated by Institute personnel, entitling them (Act 247, P.A. 1919) to set a gill net between the hours of 5:00 p.m. and 11:00 p.m. in water depths restricted to the 8- to 25-foot range. At the close of each daily period, fishermen were required to take their catch to the checking station for inspection. Netters were further obligated to mark their sets by visible white floats bearing their respective names and addresses.

During the fall of 1944 (November 25 to December 10, inclusive) a total of 19,044 fish, including 18,738 ciscoes, was removed from the lake. These ciscoes, having a combined weight of 10,540 pounds, represented a removal of 32.9 pounds of fish per acre. A total of 582 net days were involved in the harvest. Fish other than ciscoes, consisting of perch, trout, bass and panfish captured in the nets during the harvest, were of a negligible quantity, amounting to only 1.62 percent of the total.

In 1945 (November 25 to December 10 inclusive) a total of 11,718 fish, including 11,256 ciscoes, was removed from the lake. The approximate total weight of the ciscoes amounted to 7,339 pounds, representing a removal of 23.8 pounds per acre. A total of 753 net days were involved in the operation. Fish other than ciscoes, consisting of perch, trout, bass and panfish captured during the harvest, amounted to less than 4.0 percent of the total.

In order to secure some basic data on lake fish management, 38 hatchery ponds, having a total area of 162 acres, are being used for the following experiments on warm-water fish:

1. Control of stunted bluegills.
2. Maximum carrying capacity for various combinations of fish species.
3. To determine whether fast growing fish have an early mortality.
4. To determine the effect of more liberal fishing regulations on a known fish population.

The effects upon lake fish production by controlling the number of suckers is being tested in Big Bear Lake, Otsego County. This has involved creel census, population estimates, and study of growth rate and feeding habits of the fish, for three years prior to reduction of the sucker population (in the spring of 1943) and for a three year period thereafter. In the population study made in the spring of 1946, the lake was found to be supporting good numbers of game fish of the following species: largemouth bass, smallmouth bass, bluegills, pumpkinseed sunfish, rock bass, and perch, but there has been no appreciable change in the numbers of game fish following the removal of the suckers. The greatly improved perch fishing in Big Bear Lake since 1943 coincides with the sucker removal, but we do not have sufficient information to say that the improved perch fishing was caused by

the removal of the suckers. Present information indicates that we could harvest a substantial crop of suckers, which are not now being utilized, from many of our inland lakes without affecting the game fish populations. Netting of suckers is most easily accomplished in the spring during their spawning season.

Evidence from research raises questions as to the value of many of the present laws regulating fishing, such as size limits and closed seasons on panfish (bluegills, sunfish, perch, etc.). In order to test the effect of relaxing certain laws, the Legislature in 1945 granted full regulatory authority to the Conservation Commission on not more than 20 lakes, and not more than 10 streams (not mor than one of either in a county) for a five-year period.

Studies have been initiated on the effect of more liberal fishing regulations on 13 lakes[1/] located in the southern half of the Lower Peninsula, and in one northern lake and stream. The following regulations were set by the Commission: Six lakes south of highway M-46 are open throughout the year to fishing for species not protected by statutory closed seasons, thus allowing more fishing for perch, crappies, pike, walleyes and some other species. On four lakes the closed season on bluegills and sunfishes is discontinued, and additional fishing for all fish except bass is allowed. On three lakes the size limit on bluegills and other panfishes is discarded. On one lake the opening day of the fishing season is advanced from June 25 to May 15, primarily to determine if the longer spring season would increase the take of planted rainbow trout. The regulations became effective in 1946, and will extend for periods of from three to five years on most of the lakes. A program of creel census was begun on these lakes starting with the spring of

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1/ See Michigan Conservation for June, 1946, Vol. 15, No. 5, pp. 5, 13-14.

1946 and it is planned to continue the census during the duration of the special regulations. It is anticipated that the creel census data will show the effect of the change in regulations on the fishing. Studies on the growth rate of the fish are being made concurrently with the creel census to provide supplementary evidence.

To increase trout fishing in southern Michigan, ponds originally built for rearing bass and bluegills but no longer needed for this purpose have been stocked with trout and opened to fishing during the regular trout season under the following special regulations:

1. Artificial flies only.
2. Daily limit of two trout.
3. Eight inch size limit.
4. Fishing hours: One hour before sunrise to one hour after sunset.
5. Fishing from boats prohibited.
6. Record of fish catch required.

In 1945, three ponds (Bates in Barry County, Portage Creek Pond in Jackson County, and Wilder Creek Pond in Calhoun County) were in operation. These ponds were stocked in the fall of 1944 with the following trout: 326 marked rainbow, 301 marked brown, and 246 marked brook trout in Portage Creek Pond; 175 unmarked trout of each of the three species in Bates Pond, and 500 unmarked trout of each of the three species in Wilder Creek Pond.

Anglers fishing the ponds were required to fill out a creel census form after finishing their fishing. No doubt some anglers failed to comply with the regulation; therefore, the data from the voluntary census can be considered the very minimum figures. In 1945, Portage Creek Pond was fished by 741 anglers of whom 684 submitted complete data. They fished 1,884 hours to catch 718 legal trout (of this number, 294 trout were released) for a catch of

0.38 legal trout per hour. Bates Pond in 1945 was fished by 192 fishermen of whom 147 turned in complete data. These anglers fished 250 hours and caught 75 legal trout (of this number, 7 were released), a catch per hour of 0.30. In 1945, 331 anglers tried their luck on Wilder Creek Pond, and of these anglers 305 submitted complete census forms. During 783 hours of fishing these anglers caught 394 legal trout (98 trout were released) for a catch of 0.50 legal trout per hour.

In the fall of 1945, the ponds were restocked with legal fish; this is necessary since there is little natural propagation of trout in ponds. Portage Creek Pond was restocked with 450 marked brown and 450 marked rainbow trout of legal size. Bates Pond was planted with 83 marked browns, 153 marked rainbows and 172 marked brooks. Wilder Creek Pond was stocked with 499 marked brook trout, 413 marked rainbow trout and 364 marked brown trout.

In 1946, the number of special trout ponds was increased to six. In addition to the three in operation the previous year, Cook Pond in Barry County, Hillsdale Pond #2 in Hillsdale County, and Sylvan Ponds in Washtenaw County were added. The addition of these ponds was due to interest shown by anglers. The new trout ponds were stocked with unmarked legal trout in the spring of 1946. Cook Pond was planted with 100 trout of each of the three species. Sylvan Ponds were stocked with 150 rainbows. Hillsdale Pond #2 was stocked with 75 trout of each of the three species. Most of the fishing on these ponds is done during April, May and early June by anglers residing within 25 miles of the ponds.

The Guiley Pond project is a cooperative demonstration and research project which has been continued through the efforts of the Conservation Department and the Sportsmen's Improvement Association of Saginaw. It was established in 1940 to learn more about the life history of the rainbow

trout and the value and effect of confining for angling purposes the spawners which run this stream from Lake Huron. The pond, which is located on Guiley Creek, a tributary of the East Branch of the AuGres, is stocked by transferring adult rainbow trout over the small power dam as they make their spawning run each spring. The fish are held in the pond, after they spawn above Guiley Pond, by 1 1/2 inch bar screens which with an effective fish ladder, allow free movement in either direction for the smaller rainbow trout and brook trout.

Fishing is open to the public under special regulations which include: artificial flies only, an 8-inch size limit, and a possession limit of not more than 10 fish, or 5 pounds of fish, nor more than one fish of four pounds or larger.

Intensive creel census records kept at the pond demonstrate that the big rainbows present are a drawing card for numerous anglers. Despite the war and its handicaps of tackle shortages and transportation difficulties, 2,176.25 hours were spent on this 1 3/4-acre pond in 1944 and 2,046.50 hours of fishing took place there in 1945.

The 1944 catch consisted of 158 rainbow trout which averaged 2.6 pounds in weight, and 215 brook trout averaging 0.26 pound in weight, or a total removal of 419 pounds. In 1945, 189 rainbow trout (average weight 2.2 pounds) and 234 brook trout (average weight 0.26 pound) weighed a total of 475.5 pounds. Over 70 percent of the spawning fish confined each year were captured by angling. The 1946 angling up until July 1 has not been up to the quality of the previous years, presumably because a smaller number of spawners came to the pond this past spring. Of considerable interest were two recoveries of immature rainbow trout tagged at Guiley Pond and recovered in Lake Huron on the Michigan and Ontario shores, respectively.

COOPERATIVE INVESTIGATIONS

Cooperation with the University of Michigan has continued to the mutual advantage of both organizations. Generous provision of office and laboratory space, access to libraries and museums, and the advice furnished by the various departments of the University is gratefully acknowledged. In return, the Institute has contributed specimens and data to various collections and has loaned equipment to workers. The fellowship arrangement, necessarily curtailed during the war, has been resumed. This gives advanced students in fisheries some financial support and valuable practical experience in research on problems of interest to the Institute.

Studies of fish predators, initiated during the first years of the Institute's existence, were combined in cooperation with the University of Michigan. Food analyses of garter snakes collected on natural waters showed it to feed mostly on frogs, toads, and earthworms, whereas specimens from fish rearing stations ate mostly fishes, frogs and toads.[1] Watersnake food studies showed that this snake eats mostly trout about trout hatcheries and rearing stations, but that in normal trout streams only about 6 percent of the watersnakes contain trout. Details of the sizes of game fishes were studied as well as the habits of the snake in general. Control of both the watersnake and the garter snake at fish hatcheries is warranted, but such measures do not seem justifiable elsewhere in Michigan.[2, 3]

Data on the feeding habits of the kingfisher, referred to in the biennial report for 1943-44, are being prepared for publication.

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[1] Karl F. Lagler and J. Clark Salyer, II 1945. Influence of availability on the feeding habits of the common garter snake. Copeia, 1945 (3): 159-162.

[2] Karl F. Lagler 1945. Watersnake food. Mich. Cons., 14 (2) 9.

[3] Karl F. Lagler and J. Clark Salyer, II. Food and habits of the watersnake, Natrix s. sipedon, in Michigan. In press. Papers Mich. Acad. Sci. Arts and Letters.

Certain equipment for rearing fish was made available to The Laboratory of Vertebrate Biology at the University of Michigan for studies of hybridization in fishes and of the effects of temperature on development.

Assistance, primarily help in illustration, was given to the authors of "Fishes of the Great Lakes Region" to be published late this year or early next by Cranbrook Institute of Science.[1]

Field work on the distribution of the many fishes of Michigan was sponsored jointly by the Fish Division, the Rackham School of Graduate Studies, and the Department of Zoology of the University of Michigan. Particular attention during the last two summers was given to learning about the kinds of fishes inhabiting the waters on and about the islands of Michigan in the upper Great Lakes.

Cooperation with the Agricultural Experiment Station of Michigan State College has been continued on studies involving the use of fish as food. The comparative palatability of hatchery-reared versus wild brook trout has been evaluated by a panel of six judges at the experiment station. Trout from the Grayling and Harrietta state hatcheries, and wild trout from Hunt Creek and the East Branch of the AuSable River were handled and prepared, as far as possible, in a like manner. Scoring the fish (unidentified to the judges as to source) on characteristics of aroma, flavor, texture, and moisture, the judges rated the wild trout quite consistently higher on all four bases, but they also rated all of the hatchery trout as "acceptable" in eating quality. The results of these organoleptic tests on hatchery versus wild trout are summarized as a report[2] which should be soon in print. The

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[1] Carl L. Hubbs and Karl F. Lagler. Fishes of the Great Lakes Region. In press. Cranbrook Inst. of Sci., Bloomfield Hills, Mich.

[2] Baeder, Helen A., Peter I. Tack and Albert S. Hazzard. The comparison of palatability of hatchery-reared and wild brook trout. (To be published in near future.)

Fish Division is also cooperating with the Agriculture Experiment Station in studies[1] on methods of preparing for table use some of our species of coarse fishes which are taken commercially from the Great Lakes, by supplying these fish to the experiment station.

Since some of our fisheries problems are similar to those in the neighboring lake states, and of concern to both state and federal agencies, several cooperative agreements and research programs have been set up involving these states and federal agencies. Reference has been made above to the Lake Trout Committee. This includes representatives from Minnesota, Wisconsin, Illinois, Indiana, Michigan, the United States Fish and Wildlife Service, and the Province of Ontario Department of Lands and Forests. This committee is coordinating a cooperative research study on the value of hatchery-reared lake trout plantings to the trout fishery of Lakes Michigan and Superior. A certain percentage of the lake trout fingerlings being planted in Lake Michigan are marked, and returns of these fish in the catch of commercial fishermen will show the extent to which they contribute to the take.

The great concern over the spread of the sea lamprey into the Great Lakes (above Lake Ontario), its present abundance, and its reputed damage to lake trout and other commercial species has resulted in plans for cooperative action by the states and federal agencies. The United States Fish and Wildlife Service has been authorized to undertake a program of research and control on the sea lamprey in the Great Lakes, and it is expected that the states concerned will participate in the program. A committee (similar to the Lake Trout Committee) of representatives from the several lake states, the United States Fish and Wildlife Service, and the Province of Ontario will

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[1] Smoking and cooking lake herring, suckers, carp. Michigan Agricultural Experiment Station, Folder 3, Oct., 1944.

coordinate the activities of the several agencies in this program of research and control of the sea lamprey.

Another problem of mutual concern to states and federal agencies is the presumed increasing scarcity of the natural supply of bait minnows and the consequent difficulty of bait dealers in keeping up with the demand. A committee of representatives from Minnesota, Wisconsin, Michigan and the United States Fish and Wildlife Service is functioning in an exchange of information on bait minnow problems, an apportionment of projects on needed research on life histories and propagation of bait minnows, and in the preparation of a bait-culturists' manual for distribution in the three states.

Report typed by Mary M. Loux

CAPTIONS FOR SUGGESTED PHOTOGRAPHS

FOR BIENNIAL REPORT

Fig. 1. Checking station for creel census clerk at Hillsdale Rearing Pond Experiment.

Fig. 2. Fin clipping for population study.

Fig. 3. Weighing fish.

Fig. 4. Measuring fish.

Fig. 5. Burrowing mayfly nymph, commonly called "wigglers." They are excellent fish bait.

Fig. 6. Lake inventory map.

Fig. 7. Poster used along Fox, Au Sable and Pirle River systems to call fishermen's attention to the marked-fish experiment.

Insert after line 4 on page 23 of

Institute for Fisheries Research Report No. 1073--

Biennial Report for 1944-1945

The possible value of brush shelters as lake-improvement devices was first brought to the attention of Institute personnel on October 25, 1931 at Crystal Lake in Oceana County. A small pile of brush had been installed on an otherwise barren shoal, and 6,491 fish, mostly young and half-grown game fish, were found to be occupying this shelter.[1] This was followed in the early thirties by a limited experimental program of brush shelter installation by the Institute and an extensive program of shelter installation by the C.C.C. Some testing of the effectiveness of brush shelters was done during this period,[2] and this research program was intensified from 1937 to 1944, especially by studies at Douglas Lake in cooperation with the University of Michigan summer biological station.[3,4,5,6]

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[1] Hubbs, Carl L. and R. W. Eschmeyer. 1938. The improvement of lakes for fishing. Bull. No. 2, Institute for Fisheries Research, Michigan Department of Conservation. 233 pp. (See p. 204).

[2] Tarzwell, Clarence M. 1936. Lake and stream improvement in Michigan. Proc. First North Amer. Wildlife Conf., 1936: 429-434.

[3] Rodeheffer, Immanuel A. 1939. Experiments in the use of brush shelters by fish in Michigan lakes. Pap. Mich. Acad. Sci., Arts, and Letters, 24, 2 (1938): 183-193.

[4] Rodeheffer, Immanuel A. 1940. The use of brush shelters by fish in Douglas Lake, Michigan. Pap. Mich. Acad. Sci., Arts, and Letters, 25 (1939): 357-366.

[5] Rodeheffer, Immanuel A. 1941. The movements of marked fish in Douglas Lake, Michigan. Pap. Mich. Acad. Sci., Arts, and Letters, 26 (1940): 265-280.

[6] Rodeheffer, Immanuel A. 1945. Fish populations in and around brush shelters of different sizes placed at varying depths and distances apart in Douglas Lake, Michigan. Pap. Mich. Acad. Sci., Arts, and Letters, 30 (1944): 321-345.

In 1944 a recheck was made of many of the shelters which were installed in 1933 and following years by the C.C.C.[1]

It has been amply demonstrated by the studies at Douglas Lake that brush shelters attract large numbers of fish, especially the young and juvenile, from adjacent areas with relatively less cover. There is some evidence that larger shelters attract more of the larger fish. Some species (examples: rock bass, largemouth bass, pumpkinseed and bluegill) concentrate in the shelters in much larger numbers than do others (example: northern pike). There was found a marked difference in occupancy of the shelters relative to day and night, with more rock bass and sunfish in the daytime and more perch at night; and a marked difference relative to water depth, with more fish (especially perch) in shelters at 10 to 15 feet than in shelters at 5 feet (preferred by largemouth bass). When shelters were temporarily displaced and their fish occupants removed, nearly equal numbers of other fish moved in to replace them. The recheck during 1944 on 30 lakes revealed that many of the brush shelters installed by the C.C.C. up to 10 years previously were still in good shape and affording cover for fish.

It is not to be inferred that the installation of brush shelters is a worthwhile practice for all lakes. Where the principal function is to harbor and presumably favor the survival of young fish, brush shelters would be needed only in lakes where insufficient numbers of young fish survive. Many lakes have an over-abundance of small fish, judging from the numerous instances of stunting; and in such waters an increase in the rate of survival is considered to be detrimental rather than beneficial.

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[1] Rodeheffer, Emanuel A. 1945. Brush shelter investigations, summer 1944. Report No. 1019, Institute for Fisheries Research. (Unpublished)

Among lakes which have very little natural cover, it is assumed that there may be numerous instances where an increase in the rate of survival would be expected to result in a material increase in the number of adult fish. Experiments are needed to demonstrate whether brush shelters actually increase adult fish production in lakes. Shelters installed on open shoals of large lakes may contribute to fishing by concentrating legal fish so that they can be taken more readily by anglers. But we still need to evaluate the effect of such a procedure on yield and quality of fishing on a long-time basis.