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INSTITUTE FOR FISHERIES RESEARCH

ANN ARBOR, MICHIGAN

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REPORT OF INSTITUTE FOR FISHERIES RESEARCH

During the period covered by this report, research in fisheries has been actively continued with major emphasis on field management problems. Progress is being made in de-centralising research by stationing biologists in various parts of the state so that problems may be attacked more promptly and so that the results of various management practices (which are still largely experimental) may be followed more closely. Savings in time and travel and the release of the Ann Arbor staff for fundamental research are advantages already apparent.

Approximately 250 reports presenting results of investigations have been submitted and several of these have been published in scientific journals. Plans to establish an Institute series have been interrupted by the war but curtailment of field work should provide an opportunity to complete a number of manuscripts for bulletins for printing when this may be again possible.

Cooperative Investigations

The University of Michigan has continued its active cooperation by providing adequate office and laboratory facilities in the Museum Annex. Only a few minor alterations were necessary in adapting space of the former Health Service to our needs.

Fish collections, records and photographs contributed by the Institute to the Museum of Zoology were utilized by University zoologists in the

preparation of an illustrated guide for the identification of the fishes of this region.[1] Keys are given by which commercial, game, and forage species may be identified. Included are ninety-nine photographs of common species. Also in cooperation with the University, tests are being made to determine the value of a new method developed by the Du Pont Company for treating cyanide wastes. This method appears to be a great improvement over those in use at present and should simplify and cheapen the cost of rendering non-toxic wastes from plants having cyanide effluents. Tests are also being conducted for the Dow Chemical Company to determine the toxicity of wastes resulting from a process for making synthetic rubber. The tests should show the dilutions necessary to render these wastes harmless to fish. The limits of tolerance for various species of fish and fish foods to certain brine and oil wastes from Michigan wells are being explored in order to find out what precautions must be taken to avoid damaging fish and fish environment by the exploitation of our oil resources.

With the cooperation of the University's Biological Station a project was started to investigate the rate and character of sediment deposition in Douglas Lake. This investigation was also aided by the American Association for the Advancement of Science through the Michigan Academy of Science, Arts, and Letters. The five-year study of the value of brush shelters for fish in Douglas Lake was completed during the past summer and a report is being prepared.

The investigations dealing with predation on fishes as related to the practical problems of fish yield have been continued with the cooperation of the University of Michigan and Michigan State College. Financial support

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[1] Hubbs, Carl L. and Karl F. Lagler. 1941. Guide to the fishes of the Great Lakes and tributary waters. Bull. Cranbrook Inst. Sci., 18:1-100, 118 figs.

was given to some of these studies by the American Wildlife Institute and by the Associated Fishing Tackle Manufacturers.

A summary of the results of the predator studies[2] since their active resumption in 1937 indicates that general extermination of predators would not greatly increase the numbers of fishes available to anglers. Local or seasonal control at fish hatcheries and, in some instances on natural waters, may be effective in increasing survival of preferred species.

Studies of predatory fishes[3,4,5] (gars and bowfin) show that most of their food is composed of game and pan fishes. The remainder is largely organisms that are valuable as food for sport fishes. Since angling pressure continually crops the larger predacious sport fishes such as bass and pike, survival of the obnoxious predatory forms is favored. Where gars and bowfin have become excessively abundant, it is recommended that sportsmen fish for these species to counterbalance the effects of an otherwise selective sport fishery. These fishes are good fighters when hooked, although they are of little value as food. The eggs of gars are poisonous and care should be taken not to feed them to chickens or other animals.

Nearing completion is the study of the kingfisher. More than half of

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[2] Hagler, Karl F. 1941. Predatory animals and game fish. Amer. Wildlife, 30(2):87-90, 8 figs.

[3] Hagler, Karl F., Carl B. Obrecht and George V. Harry. 1942. The food habits of gars (Lepisosteus spp.) considered in relation to fish management. In press. Investigations of Indiana Lakes and Streams.

[4] Hagler, Karl F. and Frances V. Hubbs. 1940. Food of the long-nosed gar (Lepisosteus osseus oxyurus) and the bowfin (Amia calva) in southern Michigan. Copeia, 1940(4):239-241.

[5] Hagler, Karl F. and Vernon C. Applegate. 1942. Further studies of the food of the bowfin (Amia calva) in southern Michigan with notes on the inadvisability of using trapped fish in food analyses. In press. Copeia, October, 1942.

the food of kingfishers at fish hatcheries is composed of the fishes being cultured. On trout streams, trout make up about thirty per cent of the food and on lakes game and pan species comprise about twenty-two per cent. More than two thousand kingfishers were examined during this work.

The experimental open seasons on otter in the northern part of the state in the springs of 1940 and 1941 yielded a number of specimens for study. Food in the digestive tracts of these otter showed that proportionately more game and pan fishes are eaten on non-trout waters than on trout waters.[6] Although most of the 439 otters trapped were from trout-water habitats, these animals are diffuse and not abundant in the trout-supporting parts of the state. It is concluded that the otter is in general not a predator of determinative importance in fish production on trout streams or other waters of Michigan.

The Institute assumed an advisory and cooperative role in the investigations of the northern pike as a predator of ducklings at the Seney National Wildlife Refuge of the United States Fish and Wildlife Service. A corollary of these investigations is the development of a plan which will permit maximum public fishing on the refuge area commensurate with the realization of the principal objectives of this federal unit.

Cooperation in fisheries research was also continued with Michigan State College by the support of a fellowship to explore the relation of various lake soils to the growth of aquatic vegetation known to be most important in fish production. This study resulted in an improved classification of water soils and a better understanding of the amounts and importance of plant nutrients.[7]

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[6] Lagler, Karl F. and Burton T. Ostenson, 1942. Early spring food of the otter in Michigan. Journal of Wildlife Management, 6(3):244-254. 3 figs.

[7] Roelofs, Eugene W. 1940. Available plant nutrients in lake soils. Mich. Agr. Exper. Sta., Quart. Bull., Vol. 22, No. 4. May 1940, pp. 247-254 6 tables.

An investigation was begun of the warm-water streams of Michigan to find out their present fish-producing capacities and what may need to be done to improve them. Work has been concentrated on the Red Cedar River on the College property where a number of experimental stream improvement structures have been installed and where detailed and continuous studies can be made of the changes which may result in fish population and fish food supply. Less intensive studies have also been started on the Huron, Grand, St. Joseph and Muskegon Rivers.

The Home Economics Department of the College has also furnished useful service by conducting organoleptic tests of fish said to have been tainted by pollution and of wild and hatchery brook trout. These tests are conducted by a trained group of people experienced in rating various agricultural products on the basis of numbered samples the source of which is unknown to those who are tasting or smelling the samples. The result is a scientific, unbiased rating most useful in answering complaints of fishermen and others who may be eating or marketing fish products.

A cooperative program is now being planned to explore the possibilities of developing better markets for suckers, carp, herring and other commercial species which are high in nutritive value but which are poorly received by the public because of prejudice or because sufficient effort has not been made to place them on the market in more attractive form. Various methods of preparing the fish both for market and for the table will be investigated. The possible use of the waste products of the fisheries in making fish meals for poultry or stock food or as a supplement to the diet of hatchery trout will also be considered. Whether harvesting a crop of suckers, carp, dogfish, etc., from our inland waters would improve sport fishing is still debatable but it is believed that little permanent harm would result to the game fish

if commercial fishing for such species became necessary during the shortage of fresh meat caused by the war.

Following are summaries of the major Institute activities.

Fisheries Surveys

The lake mapping program has been somewhat curtailed during the last two years due to the shrinkage of the CCC organization. A total of 133 lakes in 22 different counties were mapped, 5 by the CCC, the rest by Institute parties operating mostly in the Lower Peninsula.

Biological surveys were made of 56 lakes scattered over 32 counties. These included such lakes as Crystal, Hubbard, Macatawa, and Hamlin in the Lower Peninsula, and Brevort Lake in the Upper Peninsula.

In selecting the lakes for survey particular attention has been given to those thought to have trout possibilities. As a result of these surveys a number of lakes including several in southern Michigan have been found to be suitable for stocking with rainbow, brook or lake trout. Plantings with yearling or two-year-old trout late in the fall have given excellent results in several instances and have added considerably to the trout fishing. Lakes, to be suitable for such plantings, must have a considerable area of cold, well-oxygenated water throughout the summer. Since in many deep lakes the cold bottom waters lose their oxygen early in the summer due largely to decomposition of organic material, surveys are necessary to determine which ones have water capable of supporting trout. Few of these lakes possess the requirements for successful spawning of trout so that fishing must be maintained through plantings. However, growth and survival of trout in lakes is generally superior to that in streams and the stock is not so rapidly depleted by angling at least in the larger lakes. Because of rather uniformly high temperatures in

southern Michigan streams it is believed that the chances for increasing trout fishing in this part of the state are much better in lakes than in the majority of streams.[8] It appears that there may be a considerable number of such lakes in all parts of the state in which a certain amount of trout fishing can be produced by this procedure.

Maps of lakes surveyed have been drafted and copies are available to the public at cost. Outline and depth contour maps of 678 lakes have been completed. Maps of 409 other lakes reveal some of the findings of biological surveys in addition to outline and depths, i.e., type of bottom soil, location and density of weed beds and fish shelter, etc. In addition to these, the United States Forest Service has prepared maps of 454 lakes within the various national forests of Michigan showing outline, depths, bottom types and location of weed beds. A complete price list of all lake maps available may be obtained from the Conservation Department.

Stream survey activities have been confined to the Rifle River and its tributaries, which were completed during the summer of 1941. The report is now in progress.

Minnows

Experimental introductions of minnows have been made in a number of lakes during the past eight years. Plantings of lake emerald shiners in some of our larger inland lakes have apparently failed to establish these fish and no further stocking is advised in the future unless a temporary increase in the number of forage fish should prove desirable. Plantings of blunt-nosed minnows and golden shiners in a 37-acre lake in Osceola County having a large population of largemouth bass and perch have been successful

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[8] Hazzard, Albert S. Michigan Conservation, p. 3, 9--June, 1942.

in establishing these species. The effect upon the growth rate and yield of bass will be determined by continued sampling and creel census.

Some assistance has been given bait dealers and anglers concerning methods of culture, holding and transportation of minnows in an attempt to provide for the better utilization of our minnow resources and prevent depletion of the minnow stocks in our inland waters.[9] During the past two years a number of dealers have already started to raise their own minnows. Interviews of 65 bait dealers have provided definite information on the many problems connected with handling live baits, and have shown how the Department can assist them best. As a result of these interviews, a bait dealers' questionnaire has been prepared to secure further information essential to provide improved regulations for the collection, transporting, holding and marketing of bait.

Experiments in the use of forage fish in hatcheries in an effort to produce bass and walleyed pike of larger size before planting have been outlined by the Institute and carried out by the hatchery personnel. Several hatcheries have built up a brood stock of minnows and several minnow feeding experiments are now underway.

Fish Populations

A study[10] was made on Third Sister Lake where little fishing had been permitted during the past 5 years and where the fish population was presumably maximum. The complete removal of fish was attained by angling, netting and by the use of poison. Exclusive of some small fish not recovered, a total of 15,454 fish weighing 866.6 pounds were found to be present or approximately

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[9] Carbine, W. F. Minnows. Michigan Conservation, Vol. X, No. 9, August, 1941.

[10] Brown, C. J. D. and R. C. Ball, 1942. A fish population study of Third Sister Lake. Submitted for publication to American Fisheries Society, 1943.

87 pounds of all species per acre. About 70 per cent of the total weight of all fish were legal game fish. Coarse fish made up 16.3 per cent and forage fish 3.4 per cent of the weight of all fish. About 25 per cent of the total legal largemouth bass and bluegills in the lake were caught by 80 man-hours of angling in 22 days prior to poisoning. The catch per hour was 4.6 fish.

Population studies, as an adjunct to lake reclamation, have been continued during the past two years. Holland Lake in Luce County yielded a total of 3,130 game fish of which only two were of legal size. East Fish Lake in Montmorency County contained approximately 6,000 game fish of which less than 5 per cent were of legal size. The analyses of all such fish populations carried on in Michigan to date are in progress and will be reported later.

On other waters population estimates have been made by netting and marking. A check of the method on one lake which was poisoned immediately after the population study showed only a 3.5 per cent error.

During the past year electricity was employed in making counts of fish in trout streams. If used carefully fish can be stunned, examined and revived with small loss.

The "shocker" of the type developed by the New York State Conservation Department was used to obtain fish counts in five sample areas of Section B in Hunt Creek in Montmorency County in August, 1942. Tests with marked fish of all sizes demonstrated that the general method was 93 per cent efficient in obtaining the fish of those areas. The same areas had been sampled in 1941 in August by the block-and-seine technique. Comparison of the data obtained through several years will enable one to determine changes in the trout population following various management practices.

Lake Reclamation

During 1941, the fish populations of five Michigan lakes were removed in order that these lakes might be developed as trout waters. Close checks for the dissipation of chemical toxicity following the removal of the population showed the lakes to be safe for planting with trout within two months of the time of poisoning. All of the lakes were stocked successfully in the late autumn of 1941. At the opening of the trout season on April 25, 1942, a check of the fishermen's catches on four of these lakes showed the fishing to be exceptional on all of them. Trout taken showed considerable growth over the winter months and were generally in fine condition.

From Holland Lake, Luce County, anglers took 136 of the 200 brook trout planted the previous fall during the first day, a return of 68 per cent. At East Fish Lake, Montmorency County, 313 of the 499 brook trout were taken out by anglers during the first week. This constituted 62.7 per cent of the original stocking. The anglers at Kimes Lake, Newaygo County, caught 422 brook trout on the opening day. This was 42.2 per cent of the 1,000 fish stocked in November, 1941. In Twin Lake, Osceola County, where a dam was placed between the two basins to prevent the movements of fish back and forth, anglers, during the first two days of the trout season, took 390 of the 456 brook trout (83.3 per cent) planted in the North Basin following the removal of other fish, whereas they caught out 383 of the 590 brook trout (64.7 per cent) planted in the South Basin, from which the existing population had not been removed.

In accordance with Public Act 63?4, lakes which have been reclaimed for trout are now designated by the Commission as closed to the use of live minnows as bait. This action is necessary to prevent the accidental planting of such lakes with competitive fish which would ruin the lakes for trout. Present

indications are that trout do best in waters from which all other fish have been excluded.

The heavy rate of removal of trout from small lakes suggests that a reduction in the daily limit to 5 fish might be appropriate especially since trout in such lakes generally average much larger than those from streams. Although these small lakes are usually considered "fished out" early in the season, experience has shown that although the number of trout is sharply reduced in the first few days, the remaining fish grow very rapidly and afford good sport to persistent anglers whenever conditions are right for the trout to strike. In larger lakes trout are more difficult to catch out and plantings generally yield fair results throughout the season.

The need for additional information on the effect of the tropical poison used in such work on the fish and fish food organisms was partly met when Third Sister, a 10-acre lake on University of Michigan property was poisoned. This was first attempted in early May when the water was cold and was only effective down to 10 feet in depth. Consequently not all of the fish were killed. A second application was made in mid-August and was effective down to 25 feet. Oxygen was deficient below this level and all fish were killed. Experiments with treated lake water showed: that high temperatures increased toxicity, that certain species of fish are consistently more tolerant than others and that fish could not be revived by removal to untreated water after they showed distress.

Some food organisms were seriously reduced by the poison. The small microscopic food plants (phytoplankton) showed little or no change in numbers or kinds which could be attributed to the poison but the microscopic food animals (zooplankton) showed significant reduction in some kinds. The larger food organisms such as the phantom midge, leeches, certain dragonfly nymphs and tadpoles were also seriously reduced in numbers.

Creel Census

Three types of creel census have been continued on Michigan waters during the past two years. The general census, taken by the conservation officers as an adjunct to their other duties, represents a random sampling of the fishing in all counties of the state. The general census has been in continuous operation since 1927. A total of 253,720 general census cards have been turned in by the officers between 1927 and January 1, 1942. In 1940, 32,432 records were submitted for analysis. The average catch for all legal fish was 1.0 fish per hour, a drop of 0.1 fish per hour from that of 1939. During 1941, the officers turned in 34,299 records. The average catch per hour was 1.0 fish, the same as in 1940. The quality of fishing as indicated by the catch per hour was highest in the southern part of the state. The bluegill was the most abundant of fish in the catch in 1940 and 1941, making up 32.4 and 43.4 per cent of the catch respectively in the two years. The yellow perch was second in abundance in the catch and in each of the two years these two fishes made up more than 60 per cent of all warm-water fish reported in the census.

Again, as in previous years, the brook trout far outnumbered the rainbow and brown trout in the catches reported in the census. In 1940, there were 14,190 trout reported of which 9,804 were brook trout (69.1 per cent), 2,563 were rainbow trout (18.1 per cent) and 1,823 were brown trout (12.8 per cent). In 1941 there was a decided increase in the number of brook trout reported whereas fewer rainbow and brown trout were recorded; of the 18,096 trout, 14,092 (77.9 per cent) were brook trout, 2,278 (12.6 per cent) were rainbow trout and 1,726 (9.5 per cent) were brown trout. The accompanying graph has been derived from the general creel census records of the past 15 years and shows the annual fluctuation in the relative abundance of the

three different kinds of trout--brook, rainbow and brown--in the angler's catch.

During the summer of 1942 the general creel census was intensified on the connecting waters between Lake Huron and Lake Erie. The boat liverymen on these waters were asked to cooperate in this census. Members of the Institute staff visited the waters at regular intervals throughout the summer and worked with the conservation officers in obtaining data. An analysis of these data is now underway and will be reported later.

Trout stream creel censuses during the past biennium have been limited to the work done at the experimental waters at Hunt Creek in Montmorency County, and on Quiley Pond in Iosco County. In both instances creel census has been taken by departmental employees. Because of the lack of available CCC assistance, projects have not been operated on other streams.

The data secured by these intensive censuses (such as total hours of fishing, total number of legal trout removed, total weight of the legal catch, average length of fish), particularly at Hunt Creek, are valuable in measuring the quality of the fishing in relation to the angling pressure and to changes made in environmental conditions and the stocking of hatchery-reared trout. It has been interesting to note that in the three years of creel census on Hunt Creek (1939 to 1941 inclusive) on the experimental sections, the angling pressure (man-hours per acre of water per season) has increased from 180 to 390 hours, but that at the same time the pounds of trout removed per acre has also increased from 15.4 to 26.8 pounds, indicating that the stream is not yet overfished.

Complete records of fish catches at the Wingleton Club have again been made available to the Institute so that results from planting experiments in Kinne Creek, a private stream tributary of the Pere Marquette River in

Lake County, might be available for comparison with results from similar experiments on public waters.

Intensive creel censuses in which an attempt is made to contact all anglers were carried out on six Michigan lakes during the summer of 1941. During the winter of 1941-1942 an intensive creel census was operated on one lake and during the summer of 1942 on four lakes all by temporary employees of the Institute. The purpose of these censuses was to secure information on the winter fishing problems or as tests of the results of lake management procedures.

The Sucker Problem

Whether suckers are an asset or liability to game fish production in lakes and streams has been much debated. Big Bear Lake, Otsego County, was selected to yield the answer in at least one typical northern Michigan bass and bluegill lake. Census of the catch and population estimates through netting and marking have been carried on there for three years. The population studies have verified local anglers' reports of large numbers of suckers. This fall suckers are to be heavily netted by commercial fishermen operating under supervision of the Department. Creel census and population counts during the next few years should show the value or harm of the removal of suckers. Stomachs of game fish and of suckers have been taken at various seasons to determine the competition for food and possible predation by bass on young suckers and by suckers on game fish eggs. Scale samples are being taken also to determine any change in growth rate of the game fish after the number of suckers are reduced. Tentative results from the study to date indicate that suckers contribute little to the food of bass and while they do not consume the young of game fish they may limit the production of more desirable fish through competition for food.

Life Histories

Investigations started in 1939 on the northern pike in Houghton Lake have been continued. Observations have been made on feeding habits, growth of young and adults, the return of adults and young to the lake, and migration.[1] Capture of pike in weirs during the spawning run have shown that some tagged pike return to the same stream to spawn each year. Three pike tagged during the spawning run in 1939, returned to the same stream to spawn again in 1940 and 1942. Four pike similarly tagged in 1940 returned to spawn in the same stream in 1942. One northern pike grew 13.2 inches between the time of tagging until it was caught, 680 days later.

Some evidence has been obtained that may throw some light on the annual fluctuations in the catch of northern pike at Houghton Lake and other pike lakes. Due to the high lake level during the spring and early summer of 1942, many marshes and other pike spawning areas were available to adult spawners for the first time in a number of years. The increase in available spawning territory, and the assurance (because of the continued high water) that the young pike would have an above average chance to return to the lake, may result in the increased production of northern pike in the next few years.

Northern pike propagation experiments conducted in cooperation with fish culturists at the Drayton Plains Hatchery, indicate that northern pike eggs can be stripped by the ordinary trout method and hatched in regular hatchery jars. A very small percentage of the total number of pike fry stocked in a rearing pond survived one summer, despite the presence of an ample supply of food. The greatest mortality occurred soon after the pike

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[1] Carbine, W. F. Observations on the life history of the northern pike, Esox lucius L., at Houghton Lake, Michigan. Trans. Am. Fish. Soc., 1941, (1942), Vol. 71.

began to feed on fish. During the second summer the few northern pike which survived made excellent growth and the mortality was low. The growth during the third summer was good, but still less than either the first or second summers. The mortality during the third summer was relatively high.

Accurate knowledge of the number of eggs, fry and adults that result from natural reproduction is essential to successful fisheries management. A four-year study of Deep Lake, Oakland County, ended in September, 1941, when all of the fish in the lake were removed by poison.

Collection and aging of all fish which could be recovered indicate an extremely high mortality of the young of largemouth bass, rock bass, pumpkinseeds and bluegills during the first three months of life. A second period of heavy loss seems to occur during the next twelve months especially in the case of bluegills. Tentative review of the data, which are just now being studied, indicate that only from 30 to 300 of each million fry produced any year ever reach the age of four years at which time they are of legal size.

Data were assembled for publication[12] on egg counts made on 41 brown trout from Madison River, Montana. The average number of eggs was 1,285 for these fish which had an average total length of 15.72 inches and an average weight of 21.35 ounces. In this collection there was no relation between the size of the fish and the number of eggs produced, although a relationship would logically be expected.

Egg counts[13] from 9 ciscoes from Swains Lake, Jackson County, yielded an average of 30,328 eggs each. The fish had an average total length of 15.7 inches and an average weight of 1.7 pounds. There was no apparent relation between the size of the fish and the number of eggs.

[12] Brown, C. J. D. and Gertrude C. Kamp, 1941. Gonad measurements and egg counts of brown trout (Salmo trutta) from the Madison River, Montana. American Fisheries Society, Vol. 71, pp. 195-200.

[13] Brown, C. J. D. and J. W. Moffett, 1942. Observations on the number of eggs and feeding habits of cisco (Leucichthys artedi) in Swains Lake, Jackson County, Michigan. Copeia. In press.

Stomach examinations of 87 ciscoes showed that spawning fish apparently eat very little and that the usual diet of this species consists mostly of the small, free floating, microscopic animals known as zooplankton. The water flea (Daphnia) was the most conspicuous item in the diet.

Growth Rate

Growth rate studies have been continued to determine the average size of important Michigan game fish at each year of life. Tentative tables have been established and these data have been used as a standard by which the rate of growth of fish from lakes which are investigated are judged. Management recommendations are frequently based upon growth rate studies.

Reduction in the density of the fish population has been suggested in lakes where an overcrowded condition, with resultant stunting of fish, has occurred. An experiment has been conducted on one such lake with very promising results.[14] An increased growth rate, too great to be accounted for by any normal fluctuation, has occurred in all age groups of rock bass present in the lake. This increased rate of growth has been maintained for a period of 4 years. The "condition" of the fish also improved, that is they were fatter than before the number was reduced.

The study on the time of year at which the annulus or year-mark forms on the scales of the fishes has been completed.[15] This study enables the investigators to determine more accurately the ages of fish caught in the

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[14] Beckman, William C. 1942. Further studies on the increased growth rate of rock bass, Ambloplites rupestris (Rafinesque), following reduction in density of the population. Ms. prepared for Trans. Am. Fish. Soc., Vol. 72.

[15] - - - 1942. Annulus formation on the scales of certain Michigan game fishes. Mich. Acad. Sci., Arts, and Let. In press.

spring and early summer. The time of annulus formation was found to be as follows: southern one-third of the Lower Peninsula--annulus completed by middle of May; northern two-thirds of the Lower Peninsula, by the first part of June; and the Upper Peninsula by the middle of June. Variation from normal spring temperatures may bring about some difference in the date of formation of the year-mark but except in a very late spring season the annulus should form by the above dates. Without this information growth readings might be off one year in either direction.

A detailed study was completed on the growth of the bluegill.[16] It was learned that this important fish, on the average, reaches legal size (6 inches) in the fourth summer of life shortly after the formation of the 3rd year mark. The relationship between length and weight was determined and a chart prepared to make possible an accurate estimate of the weight or length when only one of these measurements was taken. The sex ratio was found to be 112 females per 100 males. Little difference was found between the numbers of each sex caught in summer and winter fishing. The largest bluegill caught in Michigan, of which we have a record, was 12 inches long, weighed 1 1/4 pounds and was XIII years old, or in its 14th year of life.

The growth of the smelt from Crystal Lake, Benzie County, was also studied.[17] In addition, data were taken on the relationship between length and weight. The smelt, it was found, grow most rapidly during the first 2 years of life, reaching 7 inches in that time, on the average. The sex ratio was determined to be 154 females to 100 males. This ratio was based on fish taken before and after spawning season since the "runs" may be

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[16] Beckman, William C. 1941. Meet Mr. Bluegill, Mich. Conservation, Vol. X No. 7, June, 1941, pp. 6-7, 11.

[17] - - - 1942. Length-weight relationship, age, sex ratio and food habits of the smelt (Osmerus mordax) from Crystal Lake, Benzie County, Michigan. Copeia, 1942, No. 2, July 10.

dominantly of either sex depending upon when the sample is taken.

In addition to the tables for length of fish at each age, data were compiled on the weight of the game fishes at various lengths. This enables the investigators to estimate quite accurately the pounds of fish taken each year by anglers through the use of the average size of fish caught as recorded in the creel census records. Comparisons of the "condition" may also be made between fish of different lakes. Fish in one lake may reach the same length in the same period of time as fish in another lake and yet be much heavier in weight. If these lakes were rated on the basis of growth in length alone they would be equal, but when rated on weight also, one lake would be superior. Thus through a study of the fish growth along with a detailed analysis of the environment in which the fish live, the requirements for good fish conditions may be set up, and through management plans better fishing may be obtained.

Work has been started on the study of the body-scale relationship. This study will enable the investigator to determine the growth history of individual fish for each year of its life by measuring the zones of growth on the scales and calculating the amount of growth made each year. This will enhance the value of the scale samples by increasing the numbers of length calculations available for each year of life. Instead of 70,000 length measurements which are now available from the scale samples at hand, over 300,000 lengths could be determined from the scale measurements. This would insure more reliable growth rate standards.

Fish Migrations

The migrations of Michigan game fishes are being studied through the recoveries obtained from both the wild and hatchery-reared fish as mentioned

elsewhere. Also, as noted in the last biennial report, fish-traps or weirs are used to a considerable extent to obtain more exact information on the time and extent of fish movements.

In November, 1941, a stout, sheet-piled, two-way fish trap was completed near the outlet of the Platte River in Benzie County, about 1⅛ miles upstream from Lake Michigan. This device was installed to determine the time of movement and the number of fish moving into and out of the Platte River to and from Lake Michigan. In addition to these primary objectives, all possible information on the life history of the rainbow trout was to be gathered.

The weir consists of two long blocking arms with the slats spaced 1½ inches apart, a trap for upstream migrants, a trap for downstream migrants, and a boat-slip with lifting gates to permit the passage of anglers' boats. A fisheries biologist is in constant attendance at the weir.

In addition to keeping a record of the number and species of fish taken in the traps, air and water temperatures are recorded several times each day, and also the water level. The mouth of the river is inspected frequently and depth measurements are taken there. All fish coming into the traps are counted by species, and a representative sample is measured and weighed and scale samples are taken to determine growth rate. All fish entering the weir are either tagged or fin-clipped before being sent on their way. During the spring spawning run of the rainbow (steelhead) trout, 709 fish were checked. These ranged from 2½ to 18 pounds in weight. One hundred seventy-two of these big fish were tagged and the remainder fin-clipped. By September first this year 23 tagged fish and 46 fin-clipped fish had been reported caught. Other fish running the Platte River were as follows: 1,950 suckers (both the common and fine-scaled), 39 yellow perch, 13 ciscoes, 217 smelt, 4 dogfish (all travelling downstream), and one each of walleyed pike, great northern pike,

and rock bass. The peak of the rainbow trout spawning run was between April 5 and April 30. The suckers and smelt ran at approximately the same time.

Guiley Pond Project

Since January 1, 1941, this pond on Guiley Creek, a tributary of the East Branch of the Au Gres River in Iosco County has been operated as a cooperative research and angling project by the Fish Division and the Sportsmen's Improvement Association of Saginaw. The policies and regulations have been agreed upon by the Sportsmen's Improvement Association and the Fish Division, and the supervision and materials for research have been provided through the Institute.

The pond, although privately owned, is open to public angling. The following local rules have been adopted by members of the Association:

1. Artificial flies only.
2. Eight-inch minimum size limit.
3. Possession limit not more than ten fish per day nor more than five pounds of fish per day, nor more than one fish of four pounds or larger.

Although these provisions are more strict than those in force on the nearby trout streams, there has been very little complaint or violation of the rules.

The chief attraction at Guiley Pond is the chance of catching a large rainbow trout. These fish are trapped below the dam in a small one-way fish trap, and are measured and weighed. In 1941 scale samples were also taken from all fish handled. The fish are tagged and released in the pond above the dam. The bar spacing in both the weir and in the retaining gates of the

dam is 1½ inches which confines or stops only the adult rainbow trout. Because of the spacing used, the great majority of the brook trout are able to move at will through the stream system. The mature rainbow trout proceed further up Guiley Creek where they spawn, and then drop back into the pond where they are retained by the screen. This practice gives the angler a chance to fish over large trout which ordinarily would have returned to Lake Huron, often before the opening of the trout season.

During the open trout season, creel census records have been kept of all fishing on Guiley Pond. The fish captured by the anglers under the foregoing provisions are weighed and measured immediately after capture, and are checked for tags. During the 1942 season, all trout taken by angling were sampled for scales, and all stomachs from the pond-caught trout have been preserved for laboratory examination.

The unusual situation here has yielded interesting data on the growth and movements of the rainbow trout in the Au Gres drainage. Two rainbow trout tagged at the size of 7½ and 8 inches and weighing about 2 ounces in January and February of 1941 were recovered along the Canadian shore of Lake Erie in June and July of 1942. The one that had moved the farthest was taken by a commercial fisherman off Long Point in Eastern Lake Erie at least 430 miles away from Guiley Pond where it was tagged, and had attained an estimated weight of 5 pounds. This is the record migration for rainbow trout tagged in Michigan waters. Another tagged at Guiley Pond was recovered in the St. Clair River by a sport fisherman. In addition to these long distance recoveries, of the 280 rainbow trout theoretically available at the end of the 1941 season, 71 tagged rainbow trout which had escaped from the pond in 1941 returned in the spawning run of 1942.

In 1941, a total of 333 rainbow trout were tagged and placed in Guiley Pond, and these fish weighed 1,031 pounds. Nine hundred and thirty-seven fisherman days were spent on the pond and 104 rainbow trout weighing 194 pounds and 299 brook trout weighing 69 pounds were removed at the rate of 0.16 fish (0.15 pounds) per hour. In 1942, 301 rainbows weighing 1,216 pounds were trapped and tagged when they reached Guiley Pond.

During the 1942 trout season, 195 rainbow trout weighing 491 pounds and 155 brook trout weighing 42 pounds were caught in 1,364 fisherman days at the rate of 0.09 fish (0.14) per hour.

Fish Planting Experiments

During the period from September, 1940, to September, 1942, experimental plantings of tagged legal-sized trout from state hatcheries have been continued. The streams where these marked hatchery-reared fish have been released are as follows:

Middle Branch of the Ontonagon River (Gogebic County)--300 brook trout, 300 rainbow.

West Branch of the Sturgeon River (Cheboygan County)--1,000 brook trout.

Main Au Sable River (Crawford County)--500 brown trout, 500 rainbow.

Baldwin Creek (Lake County)--500 brown trout, 500 rainbow.

Dowagiac Creek (Cass County)--500 rainbows, 100 browns.

Portage Creek (Kalamazoo County)--200 rainbows, 50 browns.

Lake St. Clair and the St. Clair River (St. Clair County)--173 rainbows.

Returns on the marked fish have been secured by the voluntary cooperation of interested anglers, and through the cooperation of the district fisheries supervisors and their personnel, and through the efforts of many of the staff of the Division of Field Administration. We wish to extend our sincere

thanks to the many anglers who have informed us of their captures of marked fish, and to express our appreciation to the hatchery personnel and the conservation officers who have aided us in securing information on marked fish captured by the sport fishermen.

In general, the results of the plantings in streams, which have been made in the spring or in the fall of the year, demonstrate that from two to six times as many trout reach the angler's creel from spring releases as from fall releases. If legal-sized trout are to be planted in streams, stocking in the spring of the year or during the open season will give the stream angler the most fishing for his license money. On the other hand, a limited number of tagging experiments involving the planting of legal-sized trout in lakes at the two seasons proved that in trout lakes where conditions were suitable for trout, fish of legal size can be released in the fall of the year with the expectancy that a fairly high percentage will survive to reach the angler's creel in succeeding seasons.[18]

In May, 1941, a total of 1,344 "juvenile" lake trout were either tagged or fin-clipped after measurement and released at two localities; one lot of 700 tagged fish was released off Munising, and one lot of 644, which were marked by clipping off the dorsal and adipose fins, were released off Presque Isle near Marquette. To date a total of six recoveries from these two plantings have been reported, one from as far away as Whitefish Point, 100 miles to the east.

An interesting recovery of a tagged lake trout was received from the vicinity of Two Harbors, Minnesota, concerning one of eight adult lake trout tagged in May, 1940, by E. Niemi for the Marquette Lake Trout Derby. This

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[18] Shetter, David S. and Albert S. Hazzard. 1942. When shall we plant "keeper" trout. Mich. Cons., April 1942, p. 3-5.

particular fish travelled about 236 miles and grew 1⅛ inches and 1½ pounds in 17 months. It was tagged at the weight of 6 pounds and a length of 26 inches. Although these recoveries are few in number they are of value in that they supply hitherto unknown facts concerning the movements and growth of this species in Lake Superior.

During the spring of 1942, commercial fishermen operating under a Department permit trapped several hundred walleyed pike near the mouth of the Cheboygan River. These fish were tagged and measured before transfer to various localities in the Inland Water Route. The locality of planting and the number of fish released at each place is as follows:

Crooked Lake (Emmet County)---------- 109 walleyes

Cheboygan River (Cheboygan County)-- 81 walleyes (1/4 mile above Paper Mill Dam).

-- 70 walleyes (4 miles south of Cheboygan).

Black Lake (Cheboygan)---------- 135 walleyes

Mullet Lake (Cheboygan)---------- 82 walleyes

Burt Lake (Cheboygan)---------- 80 walleyes

The object of this experiment is to learn what percentage of the fish transferred are later taken by the anglers, and also to determine their movements within the drainage system. Also as a part of this program the tagging of smallmouth black bass captured in Great Lakes waters under special permit by commercial fishermen was continued. The tagged bass were planted in various lakes suitable to the species, and recoveries by fishermen indicate that a fairly high percentage (up to 38 per cent) are later recovered

by anglers. They appear to grow fairly well in the inland waters after transfer, and in one instance were observed to be on the spawning beds during the spring following their release.

The lakes which were planted with tagged smallmouth black bass in the period 1939-1941 after transfer from Great Lakes waters were as follows:

Douglas Lake (Cheboygan County)	1,0¼	smallmouth black bass
Crooked Lake (Emmet County)	1¼	smallmouth black bass
Round Lake (Emmet County)	50	smallmouth black bass
Lake Nettie (Presque Isle County)	93	smallmouth black bass
East Twin Lake (Montmorency County)	5¼	smallmouth black bass
Big Bear Lake (Otsego County)	37¼	smallmouth black bass
Long Lake (Presque Isle, Alpena County)	200	smallmouth black bass

To enable fisheries investigators (and also anglers) to determine the success of certain plantings of rainbow trout and lake trout in several inland lakes, the entire plantings of hatchery-reared trout for several lakes have been marked before their release by clipping one or more fins. The lakes, and the species in question, are shown in the following table.

Crystal Lake	Benzie	Lake trout
Glen Lake	Leelenau	Lake trout
Higgins Lake	Roscommon	Lake trout
Lake Leelenau	Leelenau	Lake trout
Birch Lake	Cass	Lake trout, rainbow trout
Pickerel	Otsego	Rainbow trout
Section 4	Otsego	Rainbow trout
North Twin	Otsego	Rainbow trout
South Twin	Otsego	Rainbow trout
Hemlock	Cheboygan	Rainbow trout
East Fish	Montmorency	Brook trout
West Fish	Montmorency	Bluegills

Lake Sedimentation

Geologists tell us that all lakes are temporary features of the landscape and are being filled more or less rapidly in various ways. The rate at which our inland lakes are becoming filled with sediment and the nature and source of this material are of interest to anglers and all others using lakes for recreation. The nature of the sediment appears to have a marked influence on conditions for fish life; if made up of soft, shifting plant remains it cannot support aquatic plants or fish food organisms and furnishes poor spawning habitat for any fish; but if relatively firm as sand and gravel brought in by tributary streams, the environment for most fish may be improved at least temporarily by the filling process.

In the summer of 1941 a start was made on an investigation of this problem. Borings were taken to the bottom of the original basins of three small lakes on the Hunt Creek Experimental Area and the nature of the sediment

determined. These lakes represent three stages in development: East Fish Lake is deep, cold and capable of producing trout; West Fish is past the trout stage and is now suitable only for warm-water fish; Middle Fish is almost completely filled and only a few hardy minnows can survive. Analysis of the cores secured in the borings show that these lakes have passed through a number of stages of alkalinity and acidity during their development. Determination of the pollen present at various levels will give a measure of the rapidity of filling.

This study was transferred to Douglas Lake during the summer of 1942 in order to learn the nature of lake sedimentation in one of the larger lakes of the state. Another summer will be required to complete this investigation.

A possible practical application of the results of these studies may be the development of methods to halt the filling process where desirable or to remove the accumulated sediment by dredging operations. Obviously such removal will be made easier if the amount and character of the sediment is known in advance.

Hunt Creek Fisheries Experiment Station

During the biennium the combined residence and laboratory was brought to completion by a small addition comprising a bathroom and conference room for transient employees, an entrance hall, and an extension of the basement to provide extra storage space. The loose sand driveway was graded and surfaced with gravel and clay. The grounds were graded, and about 1,000 young trees and shrubs were planted in the vicinity of the headquarters. Two small cabins were built in the experimental area, largely from reclaimed lumber: a 3-room cabin near the raceways to house permanent assistants, and a 1-room structure near the lower end of the area to serve as quarters for part-time and seasonal employees.

A low, earth-fill dam was constructed at the outlet of East Fish Lake. Small, V-type, two-way fish counting weirs were installed in the East Fish Lake outlet and near the mouths of Tributaries 2 and 3. After considerable delay due to scarcity of materials, the old counting weir on Fuller Creek was replaced by a permanent structure incorporating, in its improved design, a self-cleaning rotary screen. A thermograph was installed at this site to supply continuous records of air and water temperatures.

It was mentioned in the Tenth Biennial Report (p. 40) that plans called for testing the value of stream improvement devices as soon as basic information on existing conditions was obtained. In accordance with this plan, more than 20 structures were installed during the fall of 1941, in Section B, an 1,800-foot stretch of the stream having few natural pools and but little cover. The effect of these devices on the stream bed and on the abundance and composition of the populations of trout and trout-food organisms is being closely followed.

Investigational activities at the station have been many and varied during the biennium; a number of these were participated in by members of the Ann Arbor staff of the Institute. During the fall of 1941, the population of undesirable fish in East Fish Lake was removed by treatment with poison, and the lake stocked with legal-length brook trout. Although many of these fish were removed during the 1942 angling season, samples of the remaining population show the trout to be in excellent condition, making rapid growth, and obviously well nourished. A chemical substance purported to be effective in controlling the aquatic stages of the annoying blackfly without killing fish was thoroughly tested and found to be more lethal to trout than to the insects. A widely-advertised electric fish screen was tested and found to be valueless under local conditions. The experimental area was the site of tests on new

and promising electrical seining apparatus being developed by staff members of the Institute and Michigan State College.

Operation of the experimental stream sections constructed in the fall of 1940 has been continuous, and has already led to several findings of practical value. Among these is the discovery that trout-food insects establish themselves rapidly in newly-created water areas, even in late fall,[19] a fact of much assistance in better evaluating the effects of stream improvement. Experiments are being conducted to compare the growth and survival rates, condition, and success in natural feeding, of brook trout of wild and hatchery origin. The first test, with fingerlings 3 to 6 inches in length, initiated in February, 1941, revealed that hatchery fingerlings required a period of several weeks to adjust themselves to natural feeding, and suffered a higher death rate, than the wild fish. A similar experiment using smaller wild and hatchery fingerlings, started in June, 1942, and still running, has so far revealed feeding success by hatchery fish as great as or greater than the wild fish, although the mortality of hatchery fish has again exceeded that of the wild. Further tests should be conducted to better evaluate the effects of time of planting, and size of fish, on the ultimate success of plantings.

Intensive study of trout feeding habits and of available food supplies has been continued. Well over 1,000 brook trout stomachs have been examined and their contents correlated with natural occurrence and abundance of food organisms. It has been found that food organisms do not occur in the same ratio in stomachs as in the stream bottom, a fact which points to the necessity for learning more about the habits and palatability of natural food organisms,

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[19] Leonard, J. W. 1942. Some observations on the winter feeding habits of brook trout fingerlings in relation to natural food organisms present. Trans. Amer. Fish. Soc. 71:219-227.

so that the more desirable varieties may be fostered and increased through stream improvement. A step toward the goal of assaying carrying capacities of trout streams was made with the finding that, in winter, average bottom fauna production would supply, per square foot, three meals for a 3½-inch brook trout fingerling able to utilize all the organisms occurring there. In summer, when nearly half the food is composed of terrestrial insects dropping into the stream, all of the food organisms from a single square foot of bottom would supply the aquatic portion of three meals for a legal-length trout.

An important phase of work at Hunt Creek has been the maintenance of a continuous record of the angler's trout catch in each section of the experimental stream and in East Fish Lake. Since the best measure of the value of planting, environmental improvement and other management practices is their effect on the catch, such an intensive creel census is vital. A discussion of the results of the census at Hunt Creek is included in the section entitled "Creel Census."

Fish counting weirs have been operated on five tributaries of Hunt Creek for varying periods during the biennium to learn the nature and extent of trout migrations, and to acquire data on the validity of the "nursery stream" theory, which has been the subject of much debate. Records of continuous operation covering at least 12 months indicate that in Tributaries 2 and 3, upstream and downstream trout movements very nearly balance over a 12-month period, with an excess of upstream movement in the fall and of downstream movement in the spring, and with but casual movements in summer and winter. In Tributary No. 4 (Fuller Creek) past records show that there, downstream movement in both fall and spring outweighed upstream movement in a ratio of about 25 to 1. Continued effort is being directed at improvement of weir design.

The problem of marking trout for subsequent recognition is being approached through development of methods to supplement the more common practices of tagging and fin-clipping. Hypodermic and intramuscular injections of colloidal mercury sulfide were found to leave a recognizable mark for a minimum of 4 months, but were considered unsuitable for long-term tests. Experiments involving injection with thorium dioxide are now being conducted cooperatively with the University of Wisconsin.

The periodic seinings of about 9,000 feet of the experimental stream have been continued during the past two years. This includes all the waters where a seine can be operated with any degree of efficiency. The seining has been conducted on the average of about every six weeks throughout the year. The number of seine hauls made are recorded; all brook trout are counted and examined for marks, and all fish above 4 inches in size are measured, as well as an adequate sample of those fish less than four inches in size. The primary object in this work has been to follow the fate of plantings of known numbers of fin-clipped wild and hatchery-reared brook trout fingerlings which were stocked in August, 1939, and August, 1940. Final tabulation has not been completed but it is already obvious that there is an extremely high mortality among both the wild and hatchery-reared fingerling brook trout between fall planting and the time that they reach the legal size of seven inches. The data demonstrate also that during the colder months of the year (December - March) the brook trout normally found in Sections A and B literally disappear but return to those sections again with the onset of milder weather.

In September, 1940, construction of the diversions in Section C of Hunt Creek presented an opportunity to census 580.5 feet of natural stream when it became necessary to by-pass the water to permit erection of bulkhead

forms.[20] From 0.131 acres of stream a total of 605 brook trout weighing 12.36 pounds, and 188 muddlers weighing 1.27 pounds were captured by means of seining, scap netting and poisoning. Of the brook trout, 14 fish were 7 inches or larger. Based on these data, Section C of Hunt Creek was supporting 94.40 pounds of trout per acre (of all sizes) and 9.68 pounds of muddlers per acre. Data on the rate of growth of the brook trout in Section C, as determined from the scale samples taken from the captured fish, indicate that the brook trout in this part of the stream do not reach the legal size of 7 inches until their third or fourth summer of life.

The facilities of the station were much used by transient workers. During 1941 alone, members of the Ann Arbor and Lansing staffs spent a total of 269 man-days here. In addition, the facilities were made available to a considerable number of professional visitors from the Universities of Michigan, Indiana, Ohio, and Wisconsin, Michigan State College, several state conservation departments, and the United States Fish and Wildlife Service.

Adjustment to wartime conditions has already brought about reduction and alteration of station personnel and postponement of certain scheduled construction projects. Further drastic changes may be expected.

Desirable construction includes installation of a rotary-screen counting weir near the lower end of Section A; and erection of a warehouse and workshop, and a separate superintendent's residence. The present reduced staff should be augmented by a permanent employee for maintenance, a trained technician, and a professional fishery biologist, to make full utilization of the station's facilities for investigation of practical fishery problems.

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[20] Shetter, D. S., and J. W. Leonard. A population study of a limited area in a Michigan trout stream. Trans. Amer. Fish. Soc., Vol. 72, in press.

District Biologists

The first District Fisheries Biologist was appointed in December, 1940. Such investigators are now located at the hatcheries in Districts 1, 2, 3, and 5. These districts cover the Upper Peninsula and a part of the northern half of the Lower Peninsula. The program has already demonstrated its value in the prompt handling of fisheries problems as they arise and in having trained men in the field to follow through on the many fish management experiments now under way. During this period of curtailed travel many problems have received attention which because of distance could not have been readily investigated from the Ann Arbor laboratory. The program is to be extended as funds permit and as personnel is available until a trained fisheries biologist is available in each district to investigate problems as they arise and to advise in the management of the waters.

Pathological Studies

The loss of fish through disease continues in natural waters and in hatcheries and rearing stations. The epidemics which occur in nature appear to result from over-population and may actually benefit fishing in the future. However, if such losses could be prevented by a heavier removal of fish by anglers a considerably greater fish crop might be harvested and production kept on a more uniform keel. The first step toward this goal must of course be a better understanding of the causes of "spring mortality" and other large mortalities. It is hoped that a pathologist may be made available in the near future to study this problem.

Losses at fish cultural stations, however, should be capable of reduction as the specific organisms responsible for epidemics are determined, control

techniques perfected and fish culturists trained in modern methods of prophylaxis and treatment. One of the district fisheries biologists recently appointed is a trained parasitologist. A small pathological laboratory has been equipped for his use at the Grayling Hatchery which is quite central to trout cultural operations. This biologist has been made available to all hatcheries in case of epidemics. A careful study of the history of fish losses at each cultural station is being made with the purpose of determining the common disease organisms responsible at each place. Analyses of the water supply and methods of handling fish which is a part of this study may show how the physical equipment can be improved to lessen the chances for inroads of disease.

The establishment of a fish-cultural experiment station mentioned in the last Biennial Report has been postponed for the duration of the war because of the impossibility of securing equipment and curtailment of construction. It would also be difficult or impossible to secure properly trained men to carry on the experiments in nutrition, disease control and selective breeding planned for this station.

New Projects

At the April, 1942, meeting of the Conservation Commission, the Institute was authorized to set up "an experimental lake or lakes" for intensive studies of the factors influencing the production of fish, particularly the warm-water fish of southern Michigan. A number of lakes have been investigated by the Institute but as yet a favorable site for the project has not been found. Complete ownership or control of the fishing rights is believed to be essential to the proper functioning of these investigations. Southern Michigan lakes where this is possible are not numerous. Lack of personnel and equipment,

and construction problems may necessitate deferment of this project.

A new project in keeping with the present meat shortage is just now being planned, namely investigation as to the possible sources of fresh fish which can be harvested with little or no damage to the sport fishing. Suckers and carp may be taken from some of our southern rivers and richer lakes to the possible benefit of the bass and bluegills and other choicer fish. The best methods of such harvesting, preparation and marketing are to be the subject of this investigation. It is felt that we have a potential food resource in these so-called "rough fish" not only in the Great Lakes but also in some of the inland waters and that some means of harvesting this crop and insuring its proper utilization should be worked out.

INSTITUTE FOR FISHERIES RESEARCH

A. S. Hazzard, Director

Typed by: R. Bauch

IDENTIFYING CAPTIONS FOR POSSIBLE ILLUSTRATIONS FOR

INSTITUTE FOR FISHERIES RESEARCH SECTION OF BIENNIAL REPORT

(Numbers in red on back of prints).

1. Hunt Creek Fisheries Experiment Station--(photo by Eb Warren).

2. V-type, two-way fish trap and water level control dam on East Fish Lake, Hunt Creek Experimental Area. (Photo by Lloyd C. Hulbert).

3. A recording thermometer keeps a constant record of air and water temperatures at the Hunt Creek Fisheries Experiment Station. (Photo by Hulbert).

4. Two-way fish trap with revolving screen operated by paddle wheel. Dr. J. W. Leonard netting fish from the upstream trap. (Photo by Hulbert).

5. Percentage by volume of the food in stomachs of 131 bowfins (dogfish). From American Wildlife.

6. Percentage composition by volume of food from 95 stomachs of otters taken in early spring on trout waters in Michigan, 1940 and 1941. From The Journal of Wildlife Management.

7. Percentage composition by volume of food from 40 stomachs of otters taken in early spring on non-trout waters in Michigan, 1940 and 1941. From The Journal of Wildlife Management.

8. Results from the restoration of Kimes Lake. Good brook trout fishing was made by removing all fish and restocking with trout.

9. Fish trap at the Quiley Pond Project.

10. The Platte River weir where fish migration is being studied.

11. (Title on chart).

12. Seining for a fish sample in a survey of the Rifle River.

13. Mapping the Middle Branch of the Ontonagon River below Bond Falls during investigation of the effect of various flows on conditions for trout.

14. Size range of northern pike from the Ortonville Rearing Pond at the end of the first summer. Three hundred and sixty-two fish from 150,000 fry varied from 3.3 to 17.6 inches total length.