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October 4, 1944

REPORT NO. 962

BIENNIAL REPORT OF THE INSTITUTE FOR FISHERIES RESEARCH

1942 - 1943

SCIENTIFIC

Institute for Fisheries Research

Ann Arbor, Michigan

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War man-power needs have greatly reduced the Institute staff particularly during the past biennium. Twenty-four full or part-time employees are now in military service. Biological training and research experience qualified a number of these men for vital work in malaria control or physiological research. The resignation of Dr. C. J. D. Brown, effective April 7, 1944 to become Chief of the Technical Section of the State of Washington Pollution

Commission, has also affected the output of the Institute. Dr. Brown was assistant director^{of} the Institute and supervised lake and stream survey work.

Few new projects could be undertaken during this biennium and a number of the regular projects, such as lake and stream surveys, creel census, population studies, etc., have been drastically curtailed or suspended for the duration of the war. Fortunately most of the long-time investigations, the results of which would be impaired by any missing data, have been continued by shifting the remaining personnel.

The district biologist plan, inaugurated in 1940 and suspended in 1943, operated long enough to demonstrate its value in furnishing prompt service to field administrators and made possible considerable reduction in travel by the Ann Arbor staff. It is planned to place biologists in all fisheries districts as soon as properly trained men are again available.

During the biennium a total of 140 reports and 31 memoranda containing the results of biological investigations have been submitted. Preparation of findings for publication has been hampered by the departure for military service of men who were responsible for the work.

FISHERIES SURVEYS

One hundred and eleven lakes, mostly in the southern part of the state, were mapped during the past two winters. Accurate maps showing outline, depth, bottom types and shore features are necessary for fisheries surveys and for any intelligent program to maintain or improve fishing. Inventory of the biological conditions affecting fish life which must be done in summer was of necessity limited to completing the fisheries survey of the Huron River and its impoundments and the lakes in the Waterloo Recreation Area.

As a result of fisheries surveys conducted since 1936, experimental management plans have been prepared for 255 lakes in various parts of the state. Of this number, change in designation to the "pike" or "trout" classification has been suggested for 23. In 71 per cent (181 lakes) the survey recommended no further stocking since the most desirable and suitable species were established and were reproducing satisfactorily. Evidence has been accumulating in Michigan and other states which leads to the conclusion that planting for the maintenance of warm-water fish such as bass and bluegills is unnecessary and actually harmful in some cases.¹

Experimental fish plantings were recommended for the following species: brook trout--22 lakes, rainbow trout--39, brown trout--1, lake trout--7, northern pike--7, pikeperch--5, smallmouth bass--2, largemouth bass--9, bluegills--2, and forage fish (minnows, cisco and smelt)--5. Environmental control, such as installation of brush shelters, improvement of spawning areas, water level dams, etc., was recommended for 103 lakes. (Note-- Frequently more than one planting or type of improvement has been suggested for a single lake so that the figures given will not balance.) Trout plantings (except lake trout) were mostly suggested for lakes having conditions suitable for trout except for lack of spawning areas. The relative value of fingerlings and legal-sized fish in maintaining this fishing is being tested on some. The purpose of all other plantings recommended was to establish desirable species in lakes now lacking them. Once established, natural reproduction should maintain the fishing.

In the preparation of post-war survey projects it became necessary to determine the number of miles of streams and the number and area of lakes by counties. The best available county maps were used and the data,

¹ Hazzard, Albert S. The place of stocking in fish management. Trans. Am. Fish. Soc., 1944 (in press).

though only approximate, should be of considerable value. ^{2,3} A total of 36,350 miles of stream of all sizes was found. Marquette County had the largest mileage--1,906; Bay County, the smallest--50. Lakes were found in all but two counties and totaled 11,037 for the entire state. This total includes standing water of any size whether natural or artificial.

MINNOWS

Advice has been given bait dealers on methods of culture, holding and transportation of minnows and other fish used for bait. ⁴ A bait dealers' questionnaire has been distributed to all bait dealers in the state. The information obtained from the questionnaire should enable the Department to be of more assistance to the bait dealers in the future through research on their problems and by providing improved regulations for the capture and sale of bait.

Experiments are being continued at hatcheries in the use of forage fish (fathead minnow and common sucker) in the culture of walleyed pike. The frequent failure to establish this desirable species through fry plantings has led to attempts to rear fingerlings. In a pond at the Wolf Lake hatchery an estimated 350,000 fatheaded minnows per acre were produced.

² Brown, C. J. D. 1944. Michigan streams--their lengths, distribution and drainage areas. Misc. Publ. No. 1, Institute for Fisheries Research, Michigan Department of Conservation.

³ Brown, C. J. D. 1943. How many lakes in Michigan? Mich. Conservation, Vol. XII, No. 5, June, 1943, pp. 6-7.

⁴ Carbine, W. F. The artificial propagation and growth of the common white sucker, Catostomus c. commersonii, and its value as a bait and forage fish. Copeia, 1943, No. 1.

Research on the culture of different species of minnows for bait (northern creek chub, northern pearl dace, and the fine-scaled dace) has been undertaken and the initial results indicate that at least two of these fish may offer possibilities of practical artificial propagation. Also, as a possible method of alleviating the existing bait minnow shortage, the use of the glass traps has been tested in certain trout streams containing large populations of desirable bait minnows. Tentative results suggest that glass traps are selective to certain species and that they may be used to secure bait from trout streams without taking any significant number of trout. Whether the removal of chubs, shiners and other bait minnows from trout streams destroys a potential food supply for trout or whether this is more than balanced by direct food and space competition will be the subject of future investigation. Our present knowledge indicates that a considerable proportion of the minnow population could be taken without harm to the trout.

PATHOLOGICAL STUDIES

The investigation of fish mortality in both natural and hatchery waters has been progressing though the lack of trained personnel recently has curtailed several projects. The 1942-1943 Great Lakes smelt mortality was followed closely but the causative agent was not determined. Similar unsolved smelt epidemics in eastern waters have been followed by recovery within a few years. Some improvement in the spawning runs in the spring of 1944 indicates that smelt will soon be abundant again in Michigan waters. Whether the numbers will approach those of peak years prior to the heavy mortalities is problematical.

Various types of fish hatchery diseases have been studied and the prescribed treatments administered with some success. The use of formalin as an external medicine in the control of certain ecto-parasites has proven to be highly effective. A method of disease control developed by

the Wisconsin Conservation Department and put in practice here recently is the complete sterilization of fish hatchery ponds and equipment by the use of chlorine. The hatcheries at Oden and Watersmeet have been treated in this manner but as yet it is too soon to determine the full value of the procedure.

Studies on the control of the bass tapeworm are continuing. Methods have been proposed to eliminate this infestation by the development of a clean brood stock and by providing water supplies free from infection.

CREEL CENSUS

The general creel census is now in its seventeenth year of operation. Conservation officers while on regular patrol secure records of fishermen's catches from most of the principal waters of the state. These catch records are taken at all seasons of the year and are believed to furnish a good random sample of fishing by the average individual. In 1942 the officers interviewed 46,174 fishermen who had fished a total of 151,317 hours and had caught 173,438 legal fish, a catch of 1.15 fish per hour.

The decline in fishing caused by the war is probably reflected in the report for 1943. In that year officers interviewed 34,476 anglers who had fished a total of 103,429 hours and had caught 119,596 legal-sized fish, a catch of 1.16 fish per hour.

The above figures for 1942 and 1943 indicate that fishing on all waters is improving after reaching a low in 1940 (catch per hour 0.99). The sixteen year average (records for 1927 were not complete) of 1.18 is approached closely by 1942 and 1943 but fishing as a whole was not as good as in 1934 when the all-time high of 1.73 fish per hour was attained. In analyzing the catch in trout waters only, very little fluctuation is found but 1942 was exactly average for the sixteen year period—0.89, and 1943 slightly above 0.90.

A breakdown of the figures by fisheries districts shows much greater variation from year to year than indicated for the state averages and suggests the conclusion that if cycles of good and poor fishing do occur they are not state-wide at least for trout waters. Intensive censuses on individual streams and lakes from which complete records of the fish catch are obtained by Department employees are demonstrating years of good fishing followed by years of poor fishing. The reasons for these cycles are not yet understood.

Because of a lack of help intensive creel censuses have been restricted during this biennium to four lakes and a portion of one stream system. It was necessary to continue these censuses in order to secure the results of experiments started prior to the war. The best test of the value of plantings, environmental improvements and other fish management practices is found in the number and size of the fish in the anglers creel.

In 1943 creel census was continued on the connecting waters between Lake Huron and Lake Erie. A number of the boat liverymen cooperated with conservation officers and members of the Institute staff in this census. Results of the 1942 study indicate that there were more than 750,000 fish which weighed over 400,000 pounds taken by hook-and-line fishermen from the Michigan waters between Lake Erie and Lake Huron. Nearly half of this weight of fish (199,926 pounds) was taken from the St. Clair River. These connecting waters afforded fishing for nearly 200,000 anglers and this estimate does not include dock and bank fishermen. The figures for 1943 have not yet been compiled.

Results of opening day checks by conservation officers and fish division employees on small trout lakes showed that the survivors of the previous fall plantings of legal-sized fish are caught much too rapidly for the benefit of later fishing. From 40 to 70 per cent of the number of trout planted prior to the season are removed in the first two days

of the season--most of them the first day. The catch on the opening weekend in two lakes where continuous records were available represents from 80 to 94 per cent of the total number of trout taken during the entire season. Previous studies of the rate of removal of hatchery plantings in streams also indicated that a reduction in the daily limit might be desirable for all trout waters. ⁵

To determine the value of restricted fishing for trout in southern Michigan the Conservation Commission, under authority of Act 230, opened the state-owned Portage Creek Pond in the Waterloo Recreation Area to fishing for trout 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.

The pond was stocked in October, 1943 with 300 each of brook, brown and rainbow trout of legal size. In addition to these it was discovered that a number of brown trout up to 20 inches in length were present in the stream above. The premises were posted with placards listing the special regulations and fishermen were requested to enter their fishing records at a creel census box at the pond. Conservation officers checked the pond frequently but found very little evidence of the violation of the rules.

Based on spot checks and the creel census record it was estimated that approximately 700 fisherman-days were spent on the pond. The majority of anglers came from Jackson and Ann Arbor but the pond was used by some

⁵ Hazzard, Albert S. 1943. Fish trout for fun--not for food. Mich.

from Detroit and other towns. The estimated total number of trout taken and kept (some fishermen returned all trout caught) was 433, of which brown and rainbow trout made up 82 per cent. The trout showed excellent growth over winter and during the season. The maximum size reported was 13 inches for brook trout, 15 inches for rainbow trout, and 21 inches for brown trout. While fishing was most successful early in the season because of more suitable surface temperatures, some trout were caught throughout the summer during cool periods.

It was evident that this project is of considerable value in providing some interesting fly fishing especially when travel is limited. Several other ponds having similar conditions are now being investigated and may be operated under these restrictions in the future.

LIFE HISTORIES

An investigation of the life history of the northern pike was begun in 1937. Data were assembled on the egg production, growth history of the developing ova and the percentage survival of eggs and young of the northern pike on the spawning grounds at Houghton Lake.⁶ The number of eggs per female northern pike averaged 32,200 (range 7,691 to 97,273). The estimated egg production at Peterson's Marsh at Houghton Lake was 4,025,000 in 1939, and 2,093,000 in 1940, and 1,803,000 in 1942. The mortality of eggs and young, to the time when the young left the marshes, was estimated to have been 99.82 per cent in 1939, 99.93 per cent in 1940, and 99.56 per cent in 1942. The increased yield in 1942 seems to have been correlated with a higher and more constant water level over the marshes.

⁶ Carbine, W. F. Egg production of the northern pike, Esox lucius L., and the percentage survival of eggs and young on the spawning grounds. Papers of the Michigan Academy of Science, Arts and Letters, 29, 1943 (1944): 123-137.

It has long been known that most fishes have an indeterminate type of growth, but it has only recently been appreciated that their potential rate of increase is much greater than the average growth in nature. Since fishes are subject to dwarfing under conditions of overpopulation, extreme competition and restricted space, it follows then that the variation of size at a given age may be enormous. It is also known that reduced growth in early life does not destroy the growth potential, for when placed under favorable conditions the dwarfed fish may grow at an unusually rapid rate. The results obtained from experiments on the growth of the northern pike⁷ bear out each of the growth tendencies mentioned above. A tremendous spread in length developed early in the season in northern pike reared in hatchery ponds and this divergence increased as the summer progressed. The largest fish at the end of the first summer had grown at an average rate of 0.1 inches per day. The smallest fish at the end of the first year became the fastest growing fish in succeeding years and vice versa, thus illustrating growth compensation. Reduction in the population of various species in lakes has been followed by increased growth. Several experiments in different lakes are being conducted in an attempt to reduce the density of the native fish population by the introduction and establishment of walleyed pike, northern pike, smallmouth and largemouth bass.

HUNT CREEK FISHERIES EXPERIMENT STATION

The Hunt Creek Fisheries Experiment Station was established in 1939 to serve as a field laboratory and testing area for the study of the factors controlling the production of brook trout and to determine how fishing for this important species may be best maintained or improved.

⁷ Carbine, W. F. Growth potential of the northern pike (Esox lucius).

Ms. submitted to Michigan Academy of Science, Arts and Letters, 1944.

A number of long-time experiments and investigations are now nearing completion. Others have been suspended for the duration of the war for lack of specialized personnel. Emphasis has been placed upon continuation of creel census and the collection of data at the weirs and at sample stations in order that there may be no gaps in the fundamental data. The installation of three stream gauging stations by the Geology Division at strategic points in the experimental area will supply data which may be of value in interpreting the results of certain investigations.

Complete records of the fishing and the catch of brook trout (the only game species present) have been kept for the experimental waters since this station was established. The effects of gasoline rationing, increased tempo of war work and withdrawals of men for military service were reflected in decline in the fishing pressure in 1943 and 1944. A decrease of 57 per cent in man-hours over the preceding year was shown in 1943 by stream records. The catch was 0.7 legal trout per hour, the best since the start of the project. However in 1944 some recovery occurred in the number of fishing hours (an increase of 17.6 per cent over 1943) but the catch per hour dropped to 0.56.

The number of man-hours of angling in 1943 on East Fish Lake declined 31 per cent from 1942 but in 1944 increased 227 per cent over 1943. The development of exceptional fishing for large brook trout (up to two pounds and over in weight), presumably as a result of a lower population (stocking has been discontinued there and all the trout taken in 1943 and 1944 were from natural reproduction), accounted for the increased use of the lake. The number of angling hours was more than double that of 1942, a year when a considerable number of legal-sized hatchery trout were planted both the preceding fall and in the early spring. This, together with data from Guiley Pond and the Portage Creek Pond (to be discussed later), indicates

that trout fishermen are willing to take fewer fish if there is a chance of catching a big one.

One of the most important experiments initiated on Hunt Creek and now nearing completion is a "before and after" test of the actual value of stream improvement. Complete records of the fish catch were kept for Section B of Hunt Creek for a period of three years after which a number of pool-forming deflectors were installed. A careful record of the labor required for construction and maintenance has been kept. Comparison of the catch before and after improvement shows a marked increase in the average catch per hour and in the total number of trout caught. The effect of structures upon the size and depth of pools, type of bottom, vegetation, food supply and fish population has also been followed and the results of these studies will soon be published. Preliminary examination of the data indicates that a considerable increase in the productivity of trout waters of the type represented by Hunt Creek can be effected through proper environmental control.

Two-way fish traps⁸ have been in almost continuous operation on the tributary streams of Hunt Creek in the experimental area since the station was established to learn more concerning the value of these "feeders" and the movements of trout in the stream system. Trout larger than four inches are jaw-tagged; those ^{smaller} are fin-clipped using a different fin for each tributary. Records at the traps indicate a definite tendency for trout of all sizes to move out of the tributaries into the main stream in the spring of the year, presumably in response to population pressure. How much the headwaters of Hunt Creek contribute to the more important fishing waters below is an important question which cannot be answered until weirs can be placed in the main stream. In Hunt Creek there is little evidence

⁸ Carbine, W. F., and David S. Shetter. Examples of the use of two-way fish weirs in Michigan. Trans. Am. Fish. Soc., Vol. 73, 1943 (in press).

that tributary streams are used as spawning grounds by fish from the main stream probably because suitable spawning conditions are found in Hunt Creek proper.

In one of the unfished, screened stream sections the population of trout is being studied each year to learn the natural ratio of size and age classes in such an area. Survival of the various size groups is being followed together with the survival rate of a number of hatchery fingerlings equal to that produced naturally. Results so far indicate a heavy annual mortality of all size groups. Survival of marked wild fingerlings is about four times as great as that of an equal number of June-planted fingerlings. In another unfished section of stream, which in contrast to the screened section described above is left open to migration, the population has been enumerated at intervals during the past two years. Considerable fluctuation is evident in the number of trout of various sizes which must be attributed to natural mortality, replacement by reproduction and migrations.

In 1943 studies were begun to determine the fecundity of brook trout, the total production of young and survival to the creel of the progeny of a known number of adult fish. Eventually it is planned to learn the extent of reproduction in the Hunt Creek system and the importance of the headwaters in supplying the stock for the rest of the stream.

The ultimate objective of most of the studies at the experiment station is to discover at what stage or stages the greatest mortality occurs in the life history of brook trout. If the reasons for such mortalities can be determined the ways to increase production will then be made clear. From the results of various experiments and observations it does not appear that production is limited by a scarcity of young trout, rather the reverse may be true.

In addition to the regular investigations reported above, tests were begun to determine the toxicity to fish and fish foods (including blackfly

larvae) of the recently publicized insecticide Dichloro-diphenol-trichloro-ethane more commonly known as D.D.T. Since this chemical will undoubtedly come into wide use after the war in the control of blackflies and mosquitoes and since treatment of public waters will be proposed, it was considered desirable to test its effects upon fish and important fish foods. The Geigy Company, makers and distributors of various types of dusts and suspensions of D.D.T., is cooperating in the investigation by supplying the necessary quantities of the chemical.

PLATTE RIVER WEIR

To determine the number and size of fish entering the Platte River from Lake Michigan and whether the sand bar which forms periodically at the mouth of the river prevents fish movement a two-way fish trap was installed in the lower part of the river. This weir was in operation continually from November 1, 1941 to June 20, 1943 and again during the spring run of rainbow trout in 1944. The attendant counted all fish of the various species entering the traps and passed them in the direction they were traveling except in 1944 when the rainbows were held above the weir until June 20 to provide fishing in the stream above.

As a result of this study it was proved that the sand bar at the mouth does not block fish movement. The depth of the channel varied from 17 to 36 inches during this period. Fourteen different species of fish were taken in the weir. A total of 5,936 fish were handled in the traps, the great majority running upstream. The surprisingly small number of rainbow trout entering the river from Lake Michigan suggests that many of the trout caught in the Platte River above come from Platte and Round lakes or are permanent residents of the river.

GUILEY POND PROJECT

The Conservation Department has continued its cooperation with the Sportsman's Improvement Association of Saginaw in the operation of the Guiley Pond. This research and demonstration project is for the purpose of learning more about the life history of the rainbow trout and the value and effect of holding up the run of spawning rainbows which enter the trap below the dam. Fish larger than 13 inches are transferred to the pond and held there by screens. Free movement of smaller fish is possible through the screens and the fish ladder. A number of the fish are tagged or fin-clipped to learn more of their migrations and growth rate. Fishing is open to the public under special restrictions imposed by the Association: artificial flies, an 8-inch size limit and a possession limit of not more than ten fish nor more than five pounds nor more than one fish four pounds or larger.

The results to date do not indicate that the operation of Guiley Pond adversely affects the fishing for either brook or rainbow trout in the Au Gres River system. Runs to the pond are not decreasing and the size of the fish trapped has not diminished. From 41 to 63 per cent of the rainbows placed above the dam have been caught by anglers. Aside from these dying due to spawning activities, the remainder are released at the close of the fishing season to return to Lake Huron. Trout up to 9 pounds 11 ounces have been taken in the pond and fish of 4 or 5 pounds are fairly common. Compared with trout fishing elsewhere in the state, the catch per hour at Guiley Pond is very low, varying from 0.09 to 0.21 from 1942 to 1944. In spite of this, the fishing pressure has been extremely heavy. The number of man-hours per acre of water varied from 1,180 to 3,071 during these three years. The known presence of large trout accounts for the popularity of ^{this} the type of fishing and for the exceptionally heavy use the pond has received.

COOPERATIVE INVESTIGATIONS

The University of Michigan continued to provide the office and laboratory facilities of the Institute. In addition, much advice and help has been furnished by various University departments, especially the Museum of Zoology and the Zoology Department.

The war has brought with it many new pollution problems and has aggravated the ordinary problems of disposal of industrial waste and sewage. The Institute has continued its cooperation with the Michigan Stream Control Commission by examining specimens of fish killed and by advising on proposed methods for controlling certain wastes.

In cooperation with the University of Michigan, studies have been conducted on the toxicity to fish of several industrial wastes and products. The polysulfide treatment of cyanide wastes (proposed by the DuPont Company) was found to reduce the toxic effect of cyanide compounds to fishes approximately 600 times. Under certain conditions cyanide wastes may be rendered non-toxic to fish life at a much lower cost than by older and less efficient methods. Fish toleration tests were also conducted on wastes resulting from the manufacture of synthetic rubber. The Dow Chemical Company (synthetic rubber manufacturers) requested the help of the Institute in determining the toxicity to fish life of the five separate wastes, four of which were found to be toxic to the species tested. Necessary dilutions of these wastes for safe disposal were determined. The effect of oil well brines upon certain common Michigan fishes was also studied. Toleration tests revealed that warm-water fishes (bass, bluegills, etc.) were two to four times more susceptible to brines than were cold-water species (trout). The approximate lethal brine concentrations were determined for seven different species of Michigan fishes. Another series of fish toleration experiments was conducted on two compounds, Dinitro-O-Cyclohexylphenol and Phenothiazine, proposed chemicals as a possible substitute for pyrethrum

(well known larvacide) in the control of midge larvae whose presence in sewage treatment plants were found to interfere with the proper disposal methods. The approximate lethal dosage of these two compounds for nine species of Michigan fishes was determined and the limitations in the use of these chemicals proposed.

Studies of the natural enemies of fishes were continued as a cooperative project with the University of Michigan and the U. S. Fish and Wildlife Service. A first report on the kingfisher in relation to fisheries in the state was completed and is now being readied for publication.^{9/} It shows this bird to be a damaging visitor to fish rearing stations where most of its food (80 per cent) by volume is made up of the fish species being propagated. Trout stream kingfishers contained an average of one small trout for every two birds but have most of the bulk of the food composed of forage fishes and crayfishes. Similarly, on non-trout streams, forage fishes are eaten by more individuals and in greater numbers than are game and pan kinds. On lakes, kingfishers eat mostly forage fishes and only a few small fishes of value for sport. Whereas it is true that the kingfisher does not appear to consume significant numbers of preferred fish on natural waters, the exact effects of its food habits are undecipherable as yet. The problems of predation, as exemplified by findings on this bird, are very complicated.

Otter carcasses saved for study by the Field Administration and Game Divisions from the 1942 open season are being studied for food contents of stomachs. This will provide additional data on the otter-trout relationship and carried forward investigations described in the last biennial report.

^{9/} Salyer, J. Clark and Karl F. Lagler. The eastern belted kingfisher, Megaceryle alcyon alcyon (Linnaeus), in relation to fish management. Unpublished manuscript.

Further study was made of the northern pike in relation to waterfowl on the Seney Refuge. During the summers of 1942 and 1943 the Refuge was opened to controlled public fishing. Creel census returns show the northern pike to be abundant in the area and stomach content analyses demonstrate that less than one per cent of the pike "meals" include young waterfowl. Angling pressure is shown to be a reasonably satisfactory means of controlling the pike population. ¹⁰

Further field and laboratory work was done on the common watersnake and a report of the findings on this predator is nearing completion.

An analysis of the summer food habits of mergansers (fish ducks) was begun and will give a basis for extending evaluation of the effects of winter feeding of this bird on trout streams. Further work on wintering birds of this kind is planned.

The technical report on turtle food habits, ¹¹ abstracted in the previous biennial report, was published as was also a detailed account of methods for collecting turtles. ¹² The utilization of turtles as food including directions for trapping, dressing, and cooking was encouraged. ¹³ Means for computing the weight of snapping turtles when the length alone is

¹⁰ Lagler, Karl F. The northern pike in relation to water fowl in the Seney Marshes, Michigan. Unpublished manuscript.

¹¹ Lagler, Karl F. Food habits and economic relations of the turtles of Michigan with special reference to fish management. Amer. Mid. Nat., 29 (2): 257-312, figs. 1-9.

¹² Lagler, Karl F. Methods of collecting freshwater turtles. Copeia, 1943 (1): 21-25, 1 fig.

¹³ Lagler, Karl F. Turtle: an unrationed ration. Michigan Conservation, 12 (3): 6-7, illus.

known was prepared ^{11/} as a part of a study to illustrate the minimum lengths at which turtles should be taken by commercial trappers.

At a conference on December 8, 1943 at Madison sponsored by the Wisconsin Conservation Department, plans were made for a joint investigation of the value of planting lake trout in Lake Michigan. The states fronting on this lake and the state of Minnesota which is interested in this problem in Lake Superior and the U. S. Fish and Wildlife Service were represented. The plan as outlined calls for three years of fry and fingerling planting, as many as possible of the fingerlings to be marked by fin-clipping, followed by an equal period of no planting. The value of planting should be apparent from a statistical study of the commercial catch records in future years. The subsequent recovery of marked fish will check growth rate studies from scales, otoliths, and length-frequency and will indicate when plantings of any given year should affect the catch. Biologists representing the several states and the U. S. Fish and Wildlife Service compose a technical committee which will plan and carry out the details of the joint investigation.

The Food and Nutrition and Zoology Sections of Michigan State College, Agricultural Experiment Station have carried on organoleptic (taste tests) on the yellow pikeperch of Saginaw Bay to determine whether or not these fish are tainted by the pollution entering the water. This study is completed and it was found that the judges were able to detect the presence of disagreeable odor-flavors in certain fish from the southeast or inner end of the bay at some seasons of the year. The disagreeable odor-flavor was present in some individual fishes and lacking in others. This odor-flavor was especially pronounced at about the time the ice breaks up in the spring, but was detected in some fishes for a period of four to six weeks following the breaking up of the ice. It has also been detected in

^{11/} Lagler, Karl F. and Vernon C. Applegate, Relationship between the length and the weight in the snapping turtle (Chelydra serpentina Linnaeus). Amer. Nat., 77: 476-478, 1 fig.

the fall (October) as the water becomes cold. The odor-flavor can best be described as a medicinal odor or flavor. Its exact nature could not be determined organoleptically. This same substance was found in carp, suckers, and yellow perch, which were tested incidentally to the work on yellow pikeperch.

Brook trout from the Pilgrim River were tested organoleptically for the presence of tainting. The fish from the Pilgrim River were said to have an undesirable flavor as a result of pollution from a milk plant situated on the stream. Brook trout and rainbow trout taken from above the source of pollution and from below were tested. Three separate tests were conducted, the first on November 2, 1942, the second on June 18, 1943 and the third on August 23, 1943. There was no indication of off flavor due to milk plant pollution.

A comparison of palatability of hatchery reared and wild brook trout was made by testing both of them organoleptically. In these tests there was a distinct difference between the hatchery reared and wild fish. The wild trout were distinctly superior to the hatchery reared fish in flavor, aroma, and texture.

The cooperative study of utilization of fish and fishery products with special emphasis on the less popular varieties has gone forward rapidly. The aims and objectives of this work are outlined in a paper given before the Eighth North American Wildlife Conference. ¹⁵

This study has resulted in the publication of three recipe folders. ^{16,17}

¹⁵ Westerman, F. A., Tack, P. I., and Hazzard, A.S., 1943. Michigan's program to encourage wider utilization of the less popular varieties of fish. Trans. Eighth North American Wildlife Conference, pp. 251-259, 1943.

¹⁶ Experiment Station Folder 1, 1943. Fish Recipes - Carp. Michigan State College Agricultural Experiment Station Sections of Food and Nutrition and Zoology. A preview of Experiment Station Folder 2, 1943. Michigan State College Agriculture Experiment Station Sections of Foods and Nutrition and Zoology.

¹⁷ Experiment Station Folder 2, 1944. Fish Recipes - Lake Herring. Michigan State College Agricultural Experiment Station Sections of Foods and Nutrition and Zoology.

These folders are being distributed by the Michigan State College Bulletin room and by the Fish Division of the Michigan Department of Conservation. Similar folders are being prepared on suckers and on smoking fish.

In addition to developing recipes, studies on vitamin potency have been carried out by staff members of the Foods and Nutrition Section of the Agricultural Experiment Station. Two manuscripts are being prepared on this work. One manuscript covers the nicotinic acid (niacin). The nicotinic acid of lake herring was found to be comparable to that of lean meat or chicken while that of carp and suckers averaged slightly lower. Another manuscript deals with the vitamin D potency of fish oils. These oils were derived from the offal of lake herring, suckers, and carp and from the liver of the burbot. The burbot liver oil was about twice as potent in vitamin D as standard cod liver oil. The body oil of the lake herring was about equal to cod liver oil, while the body oils of suckers and carp were somewhat lower than cod liver oil in vitamin D potency.

In preparing the fish for vitamin analysis and recipe development careful records were kept of the waste in the various steps of preparation. This permitted the calculation of the yield of fishery products in the various standard stages adopted. ¹⁸ The expected yield of edible portion or fillet as a percentage of the total weight was determined for carp, suckers, and lake herring. The fillet weight or edible portion including the skin is thirty-eight, forty-two, and sixty-three per cent of the total or round weight of the carp, sucker and lake herring respectively.

INSTITUTE FOR FISHERIES RESEARCH

Report typed by V. Andres

A. S. Hazzard, Director

¹⁸ Tack, P. I. Weight loss in dressing fish. Submitted for publication to Experiment Station, Quarterly Bulletin.

SUGGESTED CAPTIONS FOR ILLUSTRATIONS FOR BIENNIAL REPORT - FISH DIVISION

(Please return these prints to the Institute for Fisheries Research)

1. Spawning habitat of the northern pike--marsh and drainage ditches on north bay, Houghton Lake.
2. Opening day on Pickerel Lake, Otsego County. Trout lakes are popular with fishermen early in the season. Photo by C. R. Goodrich.
3. Limit catches from Pickerel Lake. Rainbow trout are easily caught but are in poor condition the last Saturday in April. Photo by C. R. Goodrich.
4. Checking the trout population after improvement--Section B, Hunt Creek.
5. Using the portable electric "shocker" in a fish population count. Fish caught between the electrodes are stunned and can be readily picked up for measurement. Recovery is immediate once removed from the effects of the current.
6. Portage Creek Pond proved that fly fishermen appreciate close-to-home trout fishing even though the limit was two. Photo by Ann Arbor Daily News.
7. Fin-clipping a northern pike for population studies in the Seney Area. Photo by Rintimaki.
8. A limit catch for three men of pike from the Seney Area. Photo by Rintimaki.