Original: Fish Division
cc: Education-Game
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INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

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August 25, 1952

Report No. 1348

BIENNIAL REPORT OF THE INSTITUTE FOR FISHERIES RESEARCH

FOR JULY 1, 1950 TO JUNE 30, 1952

The Institute, established in 1930, is the research branch of the Fish Division. The main office, provided with laboratory space, is located at Ann Arbor. There also are several field stations with laboratory facilities in the northern part of the state.

Investigation of sport fishery problems is the chief function of this organization. Research is directed toward the maintenance and best utilization of fish resources. This field presents a large number of varied problems that offer a great challenge for effective solution. During the past two years progress has continued in collection of data and their interpretation.

During the biennium, 77 formal reports were prepared that cover this research. A number of these reports have been published in technical journals or in MICHIGAN CONSERVATION.

Lake Mapping and Surveys

Work has continued on preparation of lake maps that show shoreline features, water depths, and bottom boil types. The field work has proceeded mostly during the season of ice cover, although some was done also in summer. Four parties (12 men) during the winters of 1950-51 and 1951-52 charted 120 lakes. Other Fish Division personnel and summer survey

crews produced a number of additional maps. Counties in which mapping has been done the past two years are Alger, Allegan, Baraga, Barry, Branch, Calhoun, Chippewa, Dickinson, Genesee, Gladwin, Grand Traverse, Houghton, Ingham, Jackson, Kalamazoo, Kent, Livingston, Lenawee, Luce, Mackinac, Marquette, Midland, Missaukee, Newaygo, Oakland, Otsego, and Washtenaw.

Lake inventories of fish populations, fish growth, aquatic vegetation, water chemistry, etc., were made by three field parties during the summers of 1951 and 1952. These parties also mapped a number of the lakes prior to inventory. Emphasis was placed on investigating those lakes where some specific problem had been reported. Attention was also given to finding lakes that are suitable for trout, and several lakes were studied particularly to learn the success of trout introductions. Some of the larger waters that were inventoried are Hodenpyle Reservoir (Wexford and Manistee counties), Secord Lake (Gladwin County), Wixom Lake (Gladwin and Midland counties), and Sanford Lake (Midland County). Fish collections for growth studies were taken from such major lakes as Big Manistique (Mackinac and Luce counties), Brevoort (Mackinac County), and Indian (Schoolcraft County).

Stream Surveys

In the summer of 1951, intensive surveys of streams were continued after an interval of several years. These investigations have involved entire stream systems. The work included fish collecting (done mainly with electric shocking machines) at designated sampling stations, notation of physical data (stream widths and depths, bottom soil types, current velocities, types and abundance of cover available for fish, character of the bordering terrain, etc.), and obtaining large numbers of water temperature readings during warm periods. Scale samples were taken from

game fishes for growth analysis, and samples of forage species were preserved for certain identification at a later time in the laboratory. The main purpose of this project has been to gain basic information on stream systems that have been considered for habitat improvement. The data obtained will be used to evaluate the effects of improvement. Also, these studies add to the general knowledge of requirements and limitations for fish life in streams. Two 3-man crews have been engaged in this work during the summer and early fall seasons. Stream systems covered during 1951 were the Chocolay River (Marquette County), Carp River (Mackinac County), Pine River (Alcona and Iosco counties), and Pine River (Osceola, Lake, Wexford, and Manistee counties). Some additional work was to be done on these trout waters in 1952 , and the following stream systems were added to the 1952 schedule: Pine River (Chippewa and Mackinac counties), White River (Newaygo, Oceana, and Muskegon counties), and North and South branches of the Kalamazoo River (Calhoun, Jackson, and Hillsdale counties). The last-named system is primarily of the warm-water type.

In the fall of 1950, fish collecting with an alternating-current shocker was done at certain stations on the Rifle River (Ogemaw County) and on several of the headwater tributaries. The work was continued in 1951 and 1952. This study is aimed at learning the fish population makeup and growth rates of trout in waters affected by the Rifle River Watershed Development Program, and should provide very worthwhile basic data for evaluating the effects of improvement.

Age and Growth of Fishes

Research begun in 1950 to develop a satisfactory method of aging fish of the pike family (Esocidae) has continued. Scales were collected at regular intervals from tagged, known-age fish in hatchery ponds and natural

waters. Fin rays, opercles, vertebral, and other bones were also taken from known-age pike as material that may prove useful to show age and rate of growth. Difficulty encountered in artificially raising muskellunge to provide a source of known-age fish has hampered research on this species. However, 1,300 muskellunge fry were hatched in the spring of 1952, and fish from this lot will be mainly used for age and growth study.

A detailed study was made of the growth rates of wild brook and brown trout of the Pigeon River.[1] [2] Both species were found to be growing at an average rate of about 4 inches each year. Brown trout showed a somewhat higher life expectancy due to their lower rate of exploitation by anglers, a few fish living to be 6 years old. Brook trout over 3 years old were rare.

Study of growth and seasonal change in condition of trout in three streams (North Branch of the Au Sable, Hunt Creek, and Pigeon River) revealed that rapid rate of growth is related to a high condition factor.[3] [4]

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[1] Cooper, Edwin L. 1952. Body-scale relationship of brook trout, Salvelinus fontinalis, in Michigan. Copeia, No. 1, pp. 1-4.

[2] Cooper, Edwin L. Rate of growth of brook and brown trout from the Pigeon River, Otsego County, Michigan. Mich. Acad. Sci., Arts, & Ltrs. In Press.

[3] Cooper, Edwin L. and Norman G. Benson. 1951. The coefficient of condition of brook, brown and rainbow trout in the Pigeon River, Otsego County, Michigan. Prog. Fish. Cult., Oct., 1951, pp. 181-192.

[4] Cooper, Edwin L. Periodicity of growth and change in condition of brook trout (Salvelinus fontinalis) in three Michigan trout streams. Copeia. In Press.

In all three streams, rapid growth began during the last week in April or first week in May. It remained rapid during May and June, slowed up considerably from July through October, and practically ceased from November through March. The condition of the brook trout was uniformly low in the three streams during late March and early April, 1951. It rose rapidly during late April and May, reached a peak usually about the first week in June, and declined thereafter to the winter low condition.

Routine age and growth studies have continued in connection with lake and stream survey work, and with lakes suspected of containing stunted fish and that provide poor fishing. Impression of scales on plastic with a 20-ton hydraulic press has greatly speeded up preparation of scales for age and growth assessment, and a large portion of the backlog of unmounted scales on hand have been prepared for convenient examination. Addition of a roller press has increased efficiency even more.

Fish Mortalities and Disease

The fish pathology laboratory is located at the Grayling Hatchery. During the biennium, the pathologist continued studies of fish diseases in lakes and streams and at hatcheries. Also, he has worked with experiments aimed toward increasing efficiency of hatchery operations, and has participated in in-service training programs, outlining new methods for control of diseases and reviewing current methods. A pamphlet on fish parasites and diseases was issued for general distribution.[5]

In 1951, rainbow trout coming into the Au Gres River from Lake Huron were found affected with furunculosis, a bacterial disease usually restricted

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[5] Allison, L. N. 1952. Fish parasites and diseases. Fish Div. Pamph., No. 1, 4 pp. (Mimeographed).

to brook and brown trout. Further study of this phenomenon is planned to determine the origin and extent of the disease, which is fatal to fish but not harmful to man.

The pond-method of treating fish for disease has largely replaced the dip-method in Michigan trout hatcheries. Until recently, no new means of applying chemicals to the ponds had been developed to keep pace with the modern method. In 1952, a small power sprayer was employed successfully to introduce the chemicals into the ponds. Use of the sprayer increased efficiency through greater ease of application and a saving of man-hours of labor, and a proper dilution of chemical was obtained within a short time. The machine can also be used as a sprayer for weed-killing solutions, thereby serving a multiple purpose.

Due to the high cost of suitable diets for trout in hatcheries, search for a diet of moderate cost continues. In 1952, six different diets were tested at the Marquette Hatchery, and two diets at the Thompson, Oden, Grayling, Harrietta, and Paris hatcheries. The results of these tests, although not conclusive as yet, promise to effect a moderate saving in expenditure for fish food.

A significant reduction in the annual post-spawning mortality of brood stock brown trout was effected, at the Paris Hatchery, by the use of ether to anesthetize the fish while spawn was being taken.

Preliminary experiments with the use of oxygen in transporting various sizes and species of trout indicate that this method has certain advantages over the recirculation system which is now generally employed. Use of oxygen is especially adaptable to transport of fish across the Straits of Mackinac because gasoline engines that power the recirculation system must be stopped on state ferries. Further tests are to be made to determine the feasibility of general use of oxygen in transporting fish.

Development of sulfa-resistance in Bacterium salmonicida, the causative organism of furunculosis, led to tests with terramycin as a means of contol of this fatal disease in hatcheries. The antibiotic reduced losses drastically, but current high cost of terramycin limits its general use. An attempt to develop a stock of trout resistant to the disease will be made through selective breeding.

Sea Lamprey Investigations

While the state continues to take an active part in sea lamprey research and control, the major share of the work now is in the hands of the U. S. Fish and Wildlife Service whose facilities have been greatly expanded to deal with this fish parasite. Michigan's participation in the program during 1951-52 has included studies of the lamprey afforded by a dam and traps installed on the Black River (Mackinac County). The barrier dam was provided with a curved over-flow lip. This special type construction was intended to prevent lampreys from reaching spawning sites during their immigration upstream from Lake Michigan while permitting rainbow trout to surmount the barrier on their run from the lake. If found effective, similar structures may be installed elsewhere for sea lamprey control. To date, the dam has been found fairly adequate, both for obstructing lamprey movement and allowing trout to reach their spawning grounds. A few lampreys have negotiated this obstruction at times of high water, and some further refinements in construction may be necessary.

Intensive checks were begun in 1952 to learn if the sea lamprey has become established in some of the inland lakes of the state. In a number of these lakes no evidence of this parasite has been found. Native parasitic lampreys, that are relatively harmless, are often mistaken for the much larger sea lamprey.

The Conservation Commission in 1952 delegated the Department to cooperate with the U. S. Fish and Wildlife Service in providing access for barrier devices on streams tributary to Lake Superior that are used by sea lampreys for spawning. Preventing the parasite from reaching suitable spawning sites appears to be the most practicable method of control.

Hunt Creek Fisheries Experiment Station

The Hunt Creek station is located 9 miles southeast of Lewiston in Montmorency County. In the past biennium the main research activity here consisted of: (1) continuation of intensive creel census of the experimental trout waters for the 12th and 13th consecutive seasons; (2) post-season population estimates of the blocked-off experimental sections (Z, A, B, C) of Hunt Creek, of Fuller Creek Pond, and East Fish Lake; (3) collection of scale samples for age and growth analysis from all angler-caught brook trout and from a representative series of trout in the fall population studies; and (4) hooking experiments with both hatchery-reared and wild brook trout for information on relative mortality occurring among these fish hooked with fly and with various sizes of hooks baited with worms.

Collection of creel census data from the experimental waters under the daily permit system has been accepted graciously by the angling public. There have been very few violations of the Conservation Commission order under which this system has operated since 1949. Following are the census data on Hunt Creek for legal (7-inch and above) brook trout for the 1950 and 1951 seasons.

Season	Fishing trips	Hours fished	Trout caught	Pounds	Trout per hour	Pound per hour
1950 ...	533	1,388	578	96	0.42	0.070
1951 ...	681	1,388	555	94	0.40	0.068

The additional removal of 166 brook trout 6 to 7 inches in length from Sections C and D (1950 was the last year in which 6-inch brook trout were legal in Sections C and D and Fuller Creek west of the rotary screen), and 29 sub-legal trout from various other sections, brought the total weight of brook trout removed in 1950 to 114.38 pounds or 16.29 pounds per acre. Seven sub-legal trout creeled in 1951 brought the total poundage for that season to 94.56 pounds or 13.47 pounds per acre. The average size for legal brook trout taken in 1950 and 1951 was 7.8 inches both seasons; the average weight was also identical--0.17 pound.

On the basis of post-season population studies made with an electric shocker, it was estimated that anglers in 1950 took 56.6 percent of the legal trout available in the blocked-off sections of stream, and that 37.7 percent remained for spawning. Observed mortality accounted for 1.5 percent; the remainder had emigrated during the season. After the 1951 season, a similar study on the fate of legal brook trout between October, 1950, and October, 1951, indicated that 46.7 percent had been taken by angling, 27.9 percent survived to spawn, 21.6 percent were unaccounted mortalities, 1.9 percent were known mortalities, and 1.9 percent were emigrants.

The re-established Fuller Creek Pond provided considerable fishing in 1950 under a 6-inch minimum size limit and a 15-fish daily creel limit. A total of 347 legal brook trout were taken in 429.75 hours of fishing. Average size of the fish was 9.3 inches and 0.32 pound. In 1951, the limits were set at 5 fish daily and 10-inch minimum size, while use of live minnows as bait was prohibited. These regulations sharply reduced the angling pressure and catch. In 165.25 hours of fishing, 22 legal trout were caught. The average size was 11.0 inches and 0.53 pound

No great difference in results followed a change in regulation on 16-acre East Fish Lake. A 5-fish creel limit and a minimum size limit of 7 inches were in force here on brook trout in 1950. In 1951, minimum size was increased to 10 inches. Average sizes of the fish in 1950 and 1951 were 12.3 inches, 0.82 pound and 11.4 inches, 0.64 pound, respectively. Other records for the lake follow.

Season	Fishing trips	Hours fished	Trout caught	Pounds	Trout per hour	Pound per hour
1950 ...	218	613.25	47	38	0.08	0.063
1951 ...	200	732.00	56	36	0.08	0.049

In 1950, white suckers appeared in the catch in appreciable numbers from East Fish Lake for the first time since 1941 when the lake was poisoned. Anglers took 17 suckers in 1950, and 9 in 1951. An experiment in rough fish control was begun on the lake in 1952. Between April 24 and June 23, hoop nets and trap nets took 916 suckers and 458 creek chubs having a total weight of 506.6 pounds. Netting will continue annually to determine if the sucker and chub populations can be controlled and the trout population favorably affected.

A controlled hooking experiment that was begun in 1950 was continued in 1951 and 1952. Baited hooks of various sizes have killed considerably more brook trout than a No. 12 fly. Plans are to expand the experiment to include rainbow and brown trout.

An artificial feeding experiment was initiated in 1952 on Section 2 of Hunt Creek. A commercial fish food in the form of dried meat pellets is being fed. Comparison of data afforded by creel census, population studies, and growth analysis should afford an evaluation of direct feeding as a tool in trout stream management.

Pigeon River Trout Research Area

The Pigeon River Trout Research Area is situated 13 miles east of Vanderbilt in Otsego County. It contains 4.8 miles of trout stream, averaging about 40 feet wide, and several trout lakes. A complete census of fishing is accomplished by means of a compulsory permit system.

One of the principal investigations conducted at the station was concerned with returns from planting of legal-sized trout.[6][7] The experimental sections of the Pigeon River for three years (1949, 1950, 1951) have averaged 2,414 daily fishing trips per year, equivalent to 278 hours of fishing effort per acre of water per year. Sections planted with hatchery trout attracted about three times as much fishing as did the unplanted sections. Fishing quality was generally poor for native trout, averaging less than 1 fish for 5 hours of effort. Hatchery fish made up about 70 percent of the total catch for the three years. Scatter planting did not prove to be more advantageous than spot planting. Although 4,500 legal-sized trout were planted each year, about half the fishing trips were unsuccessful. Limiting the daily catch to 5 trout instead of 15, did very little to reduce the percentage of unsuccessful anglers. Further reduction to 2 fish per day lowered unsuccessful trips to 36 percent. Plantings of rainbow trout and brook trout gave much higher returns to fishermen than did equal numbers of brown trout. Rainbow and brown trout survival over winter to successive seasons was less than 10 percent, while

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[6] Cooper, Edwin L. 1951. Pigeon River trout studies. Mich. Cons., May-June Issue, pp. 3-6.

[7] Cooper, Edwin L. Returns from plantings of legal-sized brook, brown, and rainbow trout in the Pigeon River, Otsego County, Michigan. Trans. Am. Fish. Soc. In Press.

for brook trout it was less than 3 percent. Planted brook, rainbow, and brown trout contributed to the catch for a relatively short time. Brook trout were exploited most readily--only 4 percent of the recoveries were taken after 40 days of liberty. For brown trout and rainbow trout this value was 26 percent and 22 percent, respectively. In all of the plantings there was considerable unexplained loss, and this loss was greatest when poor conditions for exploitation by anglers prevailed over the initial 20 to 40 days following planting.

Rate of exploitation of wild brook trout has been revealed to be much higher than that for wild brown trout, based on creel census data and estimates of fish remaining at the close of the season.[8] Anglers took 3 brook trout for each one of legal length remaining at the close of the season, while for brown trout only 0.4 fish was caught for each one remaining.

The Pigeon River station's staff has pursued an investigation on the effects of more restrictive angling regulations on brook trout. Scene of this study is the North Branch of the Au Sable River.[9,10] In 1949, the minimum size limit here was raised from 7 to 10 inches, and the daily catch limit reduced to 5 brook trout. In 1950, fishing was further restricted to artificial flies only. Electro-fishing population counts and creel census data show that there has been a tremendous increase in the standing

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[8] Cooper, Edwin L. Rate of exploitation of wild eastern brook trout and brown trout populations in the Pigeon River, Otsego County, Michigan. Trans. Am. Fish. Soc. In Press.

[9] Cooper, Edwin L. 1951. Every trout a trophy. Mich. Cons., March-April Issue, pp. 14-18.

[10] Cooper, Edwin L. 1952. The North Branch story. Mich. Cons., March-April Issue, pp. 8-11.

trout population in this experimental portion of the stream. It seems obvious that the brook trout population present in 1948 was in a depleted state principally due to over-exploitation of the spawning stock.

Studies of various aspects of the life history of brook and brown trout have been in progress at the station. An interesting sidelight to more detailed investigations was a study of the relationship between fishing quality and such factors as barometric pressure changes, fishing calendars based on lunar periods, and water temperatures.[11] Little or no effect of atmospheric pressure changes or phase of the moon could be demonstrated on fishing quality based on fishing records of more than 7,000 individual trips. However, water temperatures do affect trout fishing; very cold and warm temperatures inhibit trout feeding.

Rifle River Area

The Rifle River Area is the former Harry M. Jewett estate that the Department of Conservation acquired in 1945. It is located 4 miles east of Rose City in Ogemaw County. This tract has 10 lakes (8 of which are used for fishing) and 9.17 miles of trout streams, including the headwater of Rifle River.

A complete year-round creel census has been taken on the Area waters since 1945. The catch from streams has consisted mainly of brown trout. A few brook trout are taken, and in 1950 and 1951 a considerable number of rainbows were caught following plantings of hatchery rainbow trout. The trout streams were fished more intensively in 1951 than in any previous year. Census data for the streams are summarized in the following table.

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[11] Cooper, Edwin L. Time to fish for trout. Weatherwise. In Press.

Season	Fishing trips	Hours fished	Trout caught			Other fish caught	Pounds, trout	Pounds, others	Trout per hour
			Brown	Brook	Rainbow				
1950...	2,615	6,921.5	633	7	407	51	368	29.38	0.15
1951...	2,847	7,326.0	711	9	534	248	507	196.00	0.17

The catch of lake fishes on the Area has been dominated by bluegills, yellow perch, and pumpkinseed sunfish. Other species taken include brown and rainbow trout, northern pike, largemouth and smallmouth bass, rock bass, black crappies, bullheads, and white suckers. Lake fishing during 1950 was the best that has been recorded to date for this area. The fishing on Loon Lake was outstanding--2.99 fish per hour in 1950 and 3.18 in 1951. Except for 42 trout from Devoe and North lakes, all lake fish taken in 1950 and 1951 were of natural origin. Census figures for the lake follow.

Season	Fishing trips	Hours fished	Fish caught	Pounds	Fish per hour
1950...	2,427	7,577.0	8,200	2,116	1.08
1951...	1,657	5,348.5	6,465	1,390	1.21

In addition to creel census, scale samples have been collected and examined for information on growth. A summary report on these data and others that have accumulated since 1945 is in preparation. Facilities on the Rifle River Area are being expanded to carry on more intensive research here, especially on the lakes. In 1952, experiments got under way in encouraging plant growth in a marl-bottom lake and studying the effects of fertilization of another marl lake. These tests are aimed toward finding means of improving fishing in lakes of this type. Besides affording excellent opportunities for fishery research, the area also is used by the Game Division for research. Many people (12,454 in 1950 and 13,074 in 1951) visit the grounds just to view the scenery.

Studies of Fish Food Organisms

During the biennium, field work undertaken to provide material for a bulletin on trout stream insects was completed. Publication of this bulletin has been delayed by difficulties in obtaining services of an artist to complete certain necessary illustrations.

At the Hunt Creek Experiment Station, feeding experiments were conducted in an effort to determine possible differences in acceptability and nutritional value of various food organisms to trout. These preliminary tests should be carried further because, as knowledge of ecological requirements of such organisms increases, environmental control work may be refined to increase production of those species which prove to be most nutritious and most readily available to fish.

An investigation of possible changes in quantity and composition of fish food insect populations in a tributary of the Rifle River was undertaken as one of a number of projects designed to measure the efficacy of the watershed control program now in operation in this drainage. Bottom samples are being taken for quantitative studies, and qualitative checks are also in progress.

A specialist in aquatic Diptera, working on a seasonal basis, has just initiated a long overdue study of the midges of trout streams. These insects (members of the families Tendipedidae and Heleidae) are of great importance in fish nutrition, but have remained comparatively little known. Information on their taxonomy, life histories, and ecological requirements will be most helpful to improved trout stream management.

Fingerling Lake Trout Planting Experiments

During a five-year period (1944-1948), large numbers (total of 485,284) of fin-clipped lake trout fingerlings were released in Lakes

Michigan and Huron as part of a cooperative program initiated by the Great Lakes Lake Trout Committee. Each year a different fin or fin combination was removed, so that the year of origin might be determined. Until 1951, a $2.00 reward was paid fishermen for each undersized lake trout with a missing or deformed fin or lake trout fin scars, and proper information on the fish if they were of legal size. The reward for legal trout turned in was increased to $4.00 in 1951 to keep pace with their increased value on the open market, while the reward for undersized fish remained at $2.00.

Recoveries by commercial fishermen to date (August 15, 1952) have been as follows:

	Legal	Undersize
1944	4	31
1945	112	959
1946	22	235
1947	None	None
1948	None	None

In addition to these fairly certain recoveries, rewards have been paid for trout, or fin scars and information, from 236 fish which appear to be doubtful recoveries. Considered as to the years when the reliable recoveries from each planting have been made, the following table is quite revealing.

Year marked	Total number recovered each year					
	1947	1948	1949	1950	1951	1952
1944	8	10	17	None	None	None
1945	32	207	570	252	10	None
1946	None	9	59	167	22	None
1947	None	None	None	None	None	None
1948	None	None	None	None	None	None

Results of controlled experiments at the Marquette Hatchery on fin-regeneration and mortality of samples of marked lake trout have been published.[12] The essential points of the results were given in the Fifteenth Biennial Report.

Two experiments at the Marquette Hatchery on effects of predator fish on lake trout fingerlings were concluded.[13] Losses of marked trout to the predator fish were no greater than those of unmarked trout, nor was there any significant difference in rate of growth between marked and unmarked lake trout.

General Creel Census

The general creel census is a random sample of sport fishing conditions over the entire state. Conservation officers secure records of anglers' catches from most of the principal waters and these records are compiled and analyzed by the Institute. This census was initiated in 1927 and has been continuous. During 1950, the officers interviewed 53,844 anglers who had fished 130,298.6 hours and caught 209,661 fish at a rate of 1.6 fish per hour. In 1951, the officers contacted 50,845 fishermen who had fished 123,003.4 hours, and took 168,913 fish, a catch of 1.4 fish per hour.

Of a total of 17,588 trout reported in 1950, 11,389 (64.8 percent) were brook trout, 2,803 (15.9 percent) were rainbow trout, and 3,396 (19.3 percent) were brown trout. In 1951, of 23,240 trout, 16,208 (69.7 percent) were brook trout, 3,337 (14.4 percent) were rainbow trout, and 3,695 (15.9 percent) were brown trout.

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[12] Shetter, David S. 1951. The effect of fin removal on fingerling lake trout (Cristivomer namaycush). Trans. Am. Fish. Soc., Vol. 80, 1950, pp. 260-277.

[13] Shetter, David S. The comparative mortality and growth of marked and unmarked lake trout (Cristivomer n. namaycush [Walbaum]) fingerlings in the presence of predators. Trans. Am. Fish. Soc., Vol. 81. 1951. In Press.

The bluegill was the species caught in greatest numbers in non-trout waters, where it constituted 43.5 percent (1950) and 41.6 percent (1951) of the total catch in non-trout waters. Bluegills and yellow perch, combined, made up 72.6 percent in 1950 and 75.1 percent in 1951 of the catch in non-trout waters. In the Great Lakes and connecting waters, yellow perch made up the bulk of the total catch--96.2 percent in 1950 and 94.3 percent in 1951.

Liberalized Fishing Experiment

Intensive creel census was continued on 12 experimental lakes chosen with legislative authority in 1946, although Craig Lake (Branch County) was dropped from the program in December, 1951. Bear Lake (Manistee County) was added the same year. Many of the data collected during the first five years of this study have been analyzed.[14][15] A census has also been taken since 1950 on Devils Lake (Lenawee County) where year-round fishing has been permitted for all species except black bass, pike and walleye, and where any number of pan fish less than 6 inches in length may be kept. Otsego Lake (Otsego County) was put on the census list in the spring of 1952.

Rainbow Trout Studies

Studies on migratory rainbow trout were made at specially built dams on the Black River (Mackinac County) and on the East Branch of the Au Gres River (Iosco County). The dam on Black River was designed for

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[14] Cooper, Gerald P. and Kenneth E. Christensen. 1951. Testing new fishing regulations. Mich. Cons., May-June Issue, pp. 15, 18, 19, 20.

[15] Westerman, F. A. 1952. Spring bluegill fishing. Mich. Cons., July-Aug. Issue, pp. 8-9.

obstructing sea lamprey runs and permitting rainbows to surmount the barrier. Various improvements have been made on the structure since its installation in 1950. It has been found quite effective for the purposes it was intended to serve. Creel census and tagging of rainbow trout have been carried on in connection with observations on the dam, and should produce valuable information on this migratory species.

A barrier dam of concrete and steel grates was installed on the East Branch of the Au Gres River in the spring of 1950 to permit marking of rainbow trout on their upstream run from Lake Huron. A creel census has been conducted on the stream each season. This investigation also should provide a worthwhile contribution of knowledge on the rainbow.

Trout Planting Experiment

To supplement findings from a study on survival of planted brown trout, begun on the Au Sable River in 1947, plantings of equal numbers of marked, hatchery-raised brown and rainbow trout were made in the fall of 1951 and spring of 1952 in four streams. These streams are Manistee River (Crawford and Kalkaska counties), Sturgeon River (Cheboygan County), Escanaba River (Delta County), and Dead River (Marquette County). A random creel census was conducted in 1952 on the sections of stream stocked with these fish. The main objectives of this study were to get more information on the best time to plant and to determine the relative value of hatchery-reared adult brown and rainbow trout in furnishing sport to the angler. The resultant data should provide additional facts needed for sound trout stream management.

Lake Fish Population Studies

Fish population studies on Sugarloaf Lake (Washtenaw County) in 1948, 1949, and 1950, and Fife Lake (Grand Traverse County) in 1950,

This check has shown that in 1950 a total of 1,920 anglers made 3,736 trips to the East Branch of the AuGres and caught 872 fish; in 1951, there were 1,161 anglers who made 3,160 trips and took 742 fish. Peak fishing pressures in 1950 prevailed between May 20-July 7 and October 14-November 5; in 1951, high fishing pressures fell between April 28-July 7 and September 29-November 11.

Fish traps were added to the dam in 1951 in an effort to determine the total numbers of fish appearing at the dam during spring and fall migrations and to investigate rainbow trout movement. The traps were only partially successful since they were ineffective during times of high water. A total of 670 rainbows was fin-clipped and released from the upstream trap, and 684 rainbows were taken later on from the downstream trap. The largest rainbow trapped weighed 12 pounds.

were summarized in a report prepared this past biennium.[16] Estimates on the size of the populations present were based on trap-net catches and the Peterson mark-and-recapture procedure. A primary objective of this investigation was to test the adequacy of the methods on good sized lakes and to make whatever refinements in procedure that appeared necessary. The waters studied were particularly suited for this purpose since intensive creel census figures on them were available for comparison with population counts.

These studies were continued in 1951 on Sugarloaf Lake and on a ¾-acre pond at the Wolf Lake Hatchery. All findings to date on Sugarloaf Lake were summarized.[17] Additional information on warm-water fish populations was made available by a report on work done in previous years on Big Bear Lake (Otsego County).[18]

Cooperative Projects with Michigan State College

A number of investigations have been carried on by graduate students at Michigan State College under joint supervision of faculty specialists and senior Institute staff members, with financial support provided by

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[16] Cooper, Gerald P. Estimating fish populations in Michigan lakes. Trans. Am. Fish. Soc. In Press.

[17] Cooper, Gerald P. Population estimates of fish in Sugarloaf Lake, Washtenaw County, Michigan, and their exploitation by anglers. Mich. Acad. Sci., Arts, and Ltrs. In Press

[18] Crowe, Walter R. An analysis of the fish population of Big Bear Lake, Otsego County, Michigan. Mich. Acad. Sci., Arts, and Ltrs. In Press.

Members of the faculty have also made some contributions. the Department. / Experiments on aquatic weed control in lakes were concluded.[19] Also completed was a study relating to farm fish ponds.[20] A research project on interrelations between fish and food organisms was carried out.[21] Investigations on bait fish production and harvest were in progress,[22,23] and a report of a survey of live-bait dealers was completed.[24] Several additional studies are presently underway under the cooperative arrangement between the College and the Institute. One of these is a study of the biological changes produced by artificial circulation of the bottom water of West Lost Lake, a small lake within the Pigeon River Trout Research Area.

Terminated within the biennium was a long-term program to determine the effects of fertilizing natural lakes.[25] Early experiments had shown that while the enrichment of lakes does produce better fish growth and more fish, over-enrichment will create winterkill conditions, resulting in complete destruction of the fish population present. The expense of a fertilization program cannot be justified except where fishermen harvest a large percentage of the additional fish produced.

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[19] Levardsen, Norman O. 1951. Studies on chemical methods of aquatic plant control in freshwater lakes and ponds. Ph.D. thesis.

[20] Ball, Robert C. and Tait, Howard D. 1951. Production of bass and bluegills in Michigan ponds. M.S. thesis.

[21] Wilkins, Lloyd P. 1952. Relationships of a fish population to the invertebrate fauna in two small ponds. M.S. thesis.

[22] Hedges, Sheldon B. 1951. Harvesting and production of bait fishes in ponds. M.S. thesis.

[23] Shull, David L. 1952. Experimental propagation and production of bait fishes in Michigan ponds. M.S. thesis.

[24] Lauf, George H. 1951. A survey of live-bait dealers in Michigan. M.S. thesis.

[25] Tanner, Howard A. 1952. Fertilization of trout lakes in Michigan. Ph.D. thesis.

Economic values of fish from farm ponds and methods of processing were studied.[25] Results of an investigation of certain factors that influence production of fish were published.[26] A study of the biological and chemical relationships of phosphorus in production of aquatic organisms was carried out on a group of trout lakes.[27]

[25] Ford, John R. 1951. Weight loss on dressing and methods of processing game fish. Mich. Agr. Exp. Sta. Quart. Bull., Vol. 34, No. 1, pp. 65-74.

[26] Ball, Robert C. and Don W. Hayne, 1952. Effects of the removal of the fish population on the fish-food organisms of a lake. Ecology, Vol. 33, No. 1 pp. 41-48.

[27] Barrett, Paul. 1952. Effects of alkalinity on absorption and regeneration of phosphorus in natural lakes. Ph. D. thesis, Michigan State College.

With this information as a basis, further investigations were begun in 1948 on the experimental trout lakes of the Pigeon River Trout Research Area. Smaller applications of fertilizer were made to reduce the expense and the danger of winterkill. Results of these experiments indicate that, by using smaller applications, considerable increase in fish food organisms, fish growth, and numbers of trout can still be achieved. A corresponding increase in angling success was noted. Reduction in the amount of fertilizer used decreased the danger of winterkill. It was noted further that conditions for winterkill are accumulative, that is, each succeeding year that fertilizer is applied to a lake, the danger of winterkill becomes successively greater. There were some indications that artificial enrichment may permanently alter the lake so as to make it less suitable for trout. Because of these and possibly other long-term effects not yet apparent, use of fertilizer on natural lakes presently is not on the state's fish management program.

Cooperative Projects with University of Michigan

The Institute also cooperates closely with the University of Michigan in the training of advanced students in fisheries and in work on fisheries problems. Senior members of the staff have honorary faculty status and serve on doctoral committees of a number of men working on problems involving sport fisheries. Graduate fellowships are also offered for qualified individuals willing to undertake special investigations of concern to the Department. During this past biennium, four fellowships have been occupied at the University. The subjects covered by these appointments, the first two of which are nearly completed, are: 1. Beaver-trout relationships. 2. Effect of ecological factors on the density of trout

populations. 3. Statistical aspects of creel census methods. 4. Effects of stream improvement on insect populations. The last-named project has been mentioned elsewhere in this report; reports on the other projects will follow.

By special arrangement with one of the University's faculty members, a publication was prepared on the description, methods of capture, and utilization of turtles.[6]

Beaver-Trout Investigation

Field work on this investigation was concluded during the biennium despite disastrous washouts of dams on two study streams, and the investigator is now writing his final report. Some physico-chemical elements were pinned down during the final season of field work, including a test on the temperature tolerance of brook trout in a marginal stream. Determinations of biochemical oxygen demand demonstrated a substantial loss of oxygen at local centers of decomposition. A series of tests at regular intervals over a 24-hour period showed a peak of oxygen late in the afternoon on the edge of an aquatic plant bed, and a low at dawn by an old dam which was under water, reflecting the effects of two opposite forces in the flowage--photosynthesis and organic decay.

Yield to the angler was of paramount importance in this study. In two years of creel census in Gogebic County, fishermen on a large Morrison Creek Beaver pond and on the Middle Branch of the Ontonagon River took 0.5 trout per hour, but from Section D of Hunt Creek, Montmorency County, the return was significantly better when beaver were present. Decline in angling may be brought about by excess fishing pressure, competition from rough fish such as suckers and creek chubs, low spawning success in ponds, and barrier effects of beaver dams. An intensive effort to learn

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[6] Lagler, Karl F. Michigan Turtles, their habits, culture and use. Mich. Cons., In Press.

more about the last item was inconclusive, but from recoveries of marked fish it appears that one of the structures under observation was a definite block to brook trout moving upstream in the fall, while the other was not.

The direct current fish shocker did not function in beaver ponds so well as expected, although it was used satisfactorily for a population study in one pond. Hook-and-line fishing definitely took the faster growing trout from the large Morrison Creek flowage, in which the growth rate held up well. In Section D of Hunt Creek, growth rate fell off rapidly after one year. There was little difference between the condition factors of fish from the former pond and natural stretches of the Middle Branch of the Ontonagon River.

The bottom fauna of the areas under study included an abundance of chironomids, a fair number of dragon flies, plus a few mayflies and caddis flies. Stomachs from trout in these ponds contained these forms, plus numerous corixids, and some other insects. Terrestrial insects, especially grasshoppers, were taken at the height of seasonal abundance. Importance of leeches and vertebrates (frogs, tadpoles, sticklebacks, and minnows) as trout food increased over what it is in natural streams. The year-to-year changes in organisms and brook trout feeding habits were overshadowed by the seasonal changes.

Effect of Ecological Factors on Trout Populations

The purpose of this investigation was to determine what environmental factors are responsible for variance in numbers of wild brook trout and brown trout in different sections of the Pigeon River. The results will provide knowledge of value in (1) surveys of trout streams, (2) formulation of stocking policies, and (3) improvement of trout environment. Detailed chemical, physical, and biological data were collected throughout the year in four study areas that differed greatly in numbers of trout present.

The results indicate that ground water seepage is by far the most important controlling factor of trout populations in the Pigeon River. Because neither brook nor brown trout migrate much during their entire lifetime in this stream, their numbers are controlled directly by the amount of local spawning that occurs. Brook and brown trout will not spawn where there is a complete lack of ground water seepage. Cover possibly influences trout populations by increasing the survival and/or growth rates, but is useless unless spawning facilities are present. The numbers of stream insects in various sections of this river showed little relationship to the numbers of trout. Winter ice cover was found to be an accurate index of trout abundance in this stream. Portions of the river that froze over completely for long periods of time lacked ground water seepage and had few trout. The complete results of this study are now being compiled.

Creel Census Statistics

The major objective of this study is to develop sampling procedures which will give reliable estimates of fishing pressure and the catch of fish from lakes and streams. Complete census records that have been collected on several lakes are being analyzed and subjected to systematic sampling with computing machines to determine the most efficient census methods. Some of the more theoretical aspects of the problem include: 1. Study of distributions of census statistics. 2. Selection of appropriate significance tests for evaluation of census data. 3. Study of the effect of differential skill of anglers.

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