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BIENNIAL REPORT OF THE INSTITUTE FOR FISHERIES RESEARCH, 1959-1960

This section is the research unit of the Fish Division. Its main office is in Ann Arbor, where office facilities are provided by The University of Michigan, and six field stations are located in various parts of the state. Some of the Institute's work is done in cooperation with The University of Michigan, Michigan State University, and the U. S. Fish and Wildlife Service.

The major cost of several research projects is borne by federal funds made available by the Dingell-Johnson Act. Three projects (lake inventories, creel census on experimental lakes, and research activities at the Hastings station) continued under the Dingell-Johnson program this biennium; three other projects (sea lamprey studies, and research activities at the Pigeon River and Rifle River stations) were added in 1960.

Lake Mapping and Inventories

Thirty-nine lakes were mapped during the biennium. Two crews operated in the winter of 1958-59 and one in 1959-60, with assistance from inmates of Department of Corrections work camps. Four lakes on Beaver Island were mapped in the summer of 1959 with an echo sounder. The Institute was also responsible for drafting and printing the maps of 28 lakes which were surveyed by the Lake and Stream Improvement Section in the winter of 1959-60.

One field crew made general inventories of lakes in the summers of 1959 and 1960. The routine aspects of this work included collection of samples and data

on the composition of fish populations, fish growth, aquatic vegetation, temperatures, and water chemistry. Special studies in 1959 included evaluation of the results from experimental plantings of fingerling walleyes in several lakes, and, in 1960, determination of the basic productivity of lakes by use of radioactive carbon.

Stream Inventories

One crew conducted fisheries inventories of streams. A major portion of this work consisted of collecting fish with a direct-current electric shocker, to provide information on the kinds of fish present, population densities, suitability of the streams for various species, and efficacy of management practices. The program in 1959 concerned mainly sections of trout streams to which special fishing regulations applied (lures restricted to flies, 9- or 10-inch minimum size limit, and 5 trout per day). The streams involved were the East Branch of the Fox River (Schoolcraft County), Boardman River (Grand Traverse County), Au Sable River and South Branch of the Au Sable River (Crawford County), and the Little South Branch of the Pere Marquette River (Newaygo County). Most of the summer of 1960 was spent on inventory and fish population estimates in the lower portion of the Kalamazoo River system, where warm-water species predominate.

Fish Mortality and Disease

Research and routine investigations on fish diseases and parasites are conducted by the pathologist whose laboratory is located at the Grayling Hatchery.

Study of the distribution of the "red worm" (nematode: Philometra cylindracea) in perch in Lake Huron was continued. Records indicate that this parasite is less prevalent in northern waters than in those of the southern part of the lake.

Tests of new chemicals, drugs, and antibiotics were made as opportunity afforded. Various sulfa drugs were tested for control of kidney disease in trout; sulfamerazine and sulfaguanidine included in food pellets were found to be more effective for treatment of furunculosis than drugs mixed with meat diet; the antibiotics terramycin and oleandomycin were tested as a treatment for furunculosis; a new drug, furoxone, which reportedly does not encourage development of resistant strains of bacteria, is being tested on furunculosis among brown trout.

Experiments with yearling lake trout at the Marquette Hatchery and in aquaria at Grayling proved that erosion of the skin in the cranial region ("bald-headedness") was actually sunburn. The condition was developed in fish held in aquaria by exposure to ultra-violet light.

Cataract among hatchery lake trout three years old and older is being investigated at Marquette, Harrietta, and in aquaria at Grayling. The effects of 10 different diets have been studied during the past two years. Experiments now in progress involve the exposure of yearling and three-year-old fish to various intensities of light; also, a study will be made of the effects of injections of vitamins.

Preliminary experiments have been made to evaluate the branding of trout as a method of permanent marking to identify individual fish. If successful, this method may replace metal jaw-tags for certain purposes, as for identifying brood stock in hatcheries.

Further tests will be conducted to determine stamina limits of trout by holding a number of fish in flowing water of known velocity until they become exhausted. Further study is also planned on plastic bags for transportation of fish. These studies were temporarily discontinued during the biennium.

Hatcheries were visited periodically, at the request of superintendents, to investigate problems associated with disease; causes of fish mortalities in lakes and streams were investigated; and inquiries from fishermen regarding diseases and parasites of fish were answered.

Sea Lamprey Investigations

Surveys begun in 1955 to determine the distribution and abundance of sea lamprey ammocoetes in Michigan tributaries of the Upper Great Lakes were continued. (Other species of fish are also collected during the surveys.) The results of these investigations have provided guidance for the U. S. Bureau of Commercial Fisheries in its program of eradication of ammocoetes with larvacides. Thirteen streams of the Inland Waterway (which supports a limited population of sea lampreys) were surveyed in 1958. Tributaries of northern Lake Michigan surveyed for ammocoetes included 9 in the Upper Peninsula in 1959 and 21 in the Lower Peninsula in 1960. A report on distribution of sea lamprey ammocoetes in Upper Peninsula tributaries of Lake Michigan was prepared for publication.

Migration of sea lamprey ammocoetes, that were marked in 1958, was studied in Carp Lake River, Emmet County. Judging by the recapture of marked individuals in an inclined-plane trap situated near the mouth of the stream, 2.4 percent of the marked animals moved downstream as ammocoetes, and 4.0 percent as newly transformed adults during the 1958-59 migration season.

Estimates of sea lamprey ammocoete populations, made mostly in 1959, were as follows: (1) Carp Lake River, 167,000; (2) Ogontz River, Delta County, 137,000; (3) Ogontz Bay, Delta County, 30,000.* A study of the population of ammocoetes in East Bay, Alger County, is under way. A report on the ammocoete populations in Ogontz River and Ogontz Bay was written for publication.

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* Study made in 1958.

Studies of the effect of a barrier dam on the sea lamprey population in Black River, Mackinac County, were terminated in 1960. The dam had been removed in 1957 and an electrical barrier substituted.

Operation of two weirs, one at each end of the stream, continued in Carp Lake River to obtain further information on the duration of the larval stage of the sea lamprey. Results of the weir operation and of other studies indicated that the age of sea lamprey ammocoetes in this stream in 1960 was almost certainly not less than 6 years (1954 year class), probably at least 7 years, and may have been 11 years or older.

Less extensive research projects in 1959-1960 included: (1) perfection of methods for collecting and marking sea lamprey ammocoetes; (2) study of the seasonal progress of metamorphosis among transforming ammocoetes; (3) occurrence of sea lamprey ammocoetes in lentic environments (large populations were found in East Bay and Au Train Lake, Alger County); (4) observations of treatment of certain streams with larvicide to determine if ammocoetes which drift out of a stream into a lake during treatment are able to survive.

Rainbow Trout Studies

Field study of the life history of rainbow trout in the Black River, Mackinac County, was completed in 1959. An investigation begun in 1955 to determine if hatchery-reared rainbow trout will substantially supplement natural runs of this species from the Great Lakes was continued. In a related experiment, tagged, fin-clipped, and unmarked rainbow trout were held from 1957 through 1959 at the Thompson Hatchery to determine the effects of marking on the fish.

Detailed studies on rainbow trout commenced in three Upper Peninsula lakes in 1958 (Bass Lake in Dickinson County, Stager in Iron County, and Sporley in Marquette County). The first two waters also contain warm-water fishes, whereas the third has only trout. The aims of this project include determination of factors that contribute to the success or failure of rainbow trout in lakes;

causes of decline in populations that often follows a period of good survival rates and growth rate during the first several years of planting; and evaluation of various stocking rates. Plankton and bottom samples, fish stomachs, scales, and water temperature and chemistry data have been collected monthly from each lake during the summer.

Rainbow trout (of legal length) were planted in Bass and Stager lakes for the first time in the fall of 1958, and again in the fall of 1959 (at lesser rates than in 1958). Subsequent collections have shown good survival and growth rates in Stager Lake. Bass Lake has produced poorly and apparently is incapable of sustaining a sizeable population of rainbow trout.

Sporley Lake was treated with toxaphene in August 1955 to eliminate warm-water fishes prior to restocking with trout. The water remained toxic to fish at least into the summer of 1958. Because the toxicity had dissipated sufficiently by the following summer to allow survival of brook trout but not enough for rainbow trout, and also to provide some fishing, a small planting of brook trout was introduced in June 1959. Fingerling and legal-size rainbow trout were planted in the fall of 1959. Survival rates have been good and growth has been rapid.

A considerable number of lakes (202) were opened to angling for rainbow trout through the ice during the months of January, February, and December, 1960. Personnel from the Fish, Field Administration, and Parks divisions conducted a creel census on 72 of these lakes in January and February to evaluate the results of the special season. The Institute planned the census procedure and prepared a report on the outcome of the study. The results showed a wide variation in harvest among the lakes, and no excessively high catch from any of them.

Walleye Investigations

Investigation of the value of planting fingerling walleyes, begun in 1951, has continued. Fingerlings were planted in 11 of the 31 lakes which were scheduled for planting in 1959, and in 1 of 19 in 1960. Plans currently call for the annual release of about 200,000 fingerlings in about 20 lakes. Evaluation of results has been limited to brief checks by creel census and/or netting. Lakes where stocking has shown some promise have remained on the program, and lakes in which results have been negative have been dropped. Results to date are being summarized, and it is hoped that enough information has accumulated to permit some conclusions as to the value of the program.

A study of the walleye fishery in the Bay de Noc area began in 1957 in cooperation with the U. S. Fish and Wildlife Service. Objectives are to locate spawning areas and to determine growth rates, year class composition of the population, migration patterns, and extent of exploitation by sport and commercial fishermen. Evidence that competition between the sport and commercial fisheries is keen continues to accumulate. In this area, 4,690 walleyes have been tagged. To date (August 15, 1960), the recapture of 399 (8.5 percent) of these marked fish has been reported; 70 percent (278) of the recaptures were reported by anglers, and the rest (121), by commercial fishermen. Two types of tags, metal-jaw and "spaghetti-dart," are now being used, and they apparently are equally satisfactory.

The walleye population in the Bay de Noc area apparently is composed of numerous discreet sub-populations. These sub-populations utilize separate spawning areas, exhibit differences in growth rate, and quite possibly are subject to differing rates of exploitation.

Hunt Creek Trout Research Station

The Hunt Creek Trout Research Station, Montmorency County, was concerned with these projects: (1) Intensive creel census of the experimental brook trout waters of Hunt Creek for the 20th and 21st consecutive seasons; partial creel census of the North Branch of the Au Sable River for the 9th and 10th consecutive seasons. (2) Postseason population studies with electrofishing gear on these waters to investigate exploitation and survival rates. (3) Postseason sampling with a D. C. shocker on the main stream of the Au Sable to obtain population estimates and scale samples for growth studies. (4) Investigations on the relative effectiveness of salmon eggs and night crawlers as lures for rainbow trout in the Sturgeon River, Cheboygan County. (5) Detailed population studies of brook trout and rainbow trout in East Fish Lake and Fuller Creek Pond by periodical ice fishing and electrofishing between the fall planting and the opening of the trout seasons. (6) A controlled fishing experiment, carried on during the 1959 trout season in the experimental sections of the North Branch of the Au Sable River, to determine fishing quality with flies and worms in the special and general waters. (7) Drafting of sampling schedules and supervision of new creel census programs on experimental portions of the main stream and South Branch of the Au Sable, Little South Branch of the Pere Marquette, and Boardman rivers. These censuses began with the opening of the 1960 fishing season to provide more information about angling pressure and quality under special regulations (flies only, 10-inch minimum size, daily limit of 5 trout). (8) Completion of a test of a "flies only" regulation on about one mile of Hunt Creek with the end of the 1959 trout season.

The main features of the anglers' catch for the 1958 and 1959 seasons in the various waters being studied at the Hunt Creek station are given in the following table.

Water	Season	Fishing trips	Hours fished	Trout caught: Wild brook	Trout caught: Hatchery brook	Trout caught: Rainbow	Total pounds	Trout per hour
Hunt Creek*	1958	785	1,432	684	3	14	140	0.49
(Sections Z, A, B, C, D)	1959	727	1,257	551	0	6	80	0.44
Fuller Creek*	1958	159	332	71	15	0	14	0.26
	1959	134	234	70	1	0	11	0.30
Fuller Creek Pond**	1958	80	182	6	50	0	26	0.31
	1959	83	237	68	4	0	31	0.30
East Fish Lake**	1958	237	725	0	120	0	56	0.17
	1959	443	1,205	4	92	197	240	0.24

* General trout fishing regulations.

** Ten-inch minimum size, 5 trout daily, use of minnows for bait prohibited.

Population studies in Hunt Creek with D. C. electrofishing gear in the spring and fall have been continued to provide information on survival rates.

The investigation conducted on the Sturgeon River to compare the effectiveness of salmon eggs and angleworms as bait indicated that the eggs were about 3 1/2 times more efficient than worms for catching lake-run rainbow trout. A report on this study was prepared for publication.

The results of a comparison of hooking mortality rates between trout taken with flies and trout caught with hardware lures were published late in 1958. This investigation revealed that hardware lures are not generally more destructive to 7- to 10-inch trout than are artificial flies.

Pigeon River Trout Research Station

This station, located in Otsego County, has six miles of the Pigeon River and seven small lakes under experimental control. Complete records on angling are obtained by a compulsory fishing permit system.

Creel census records and information from population studies have been used in the evaluation of the following experiments: (1) An increased minimum size

limit and a flies-only regulation on trout in the Pigeon River. A 9-inch minimum was in effect on two experimental sections of the stream from 1951 through 1957, with no restriction as to bait. In 1958, a flies-only restriction was included. (2) Influence of stream improvement structures on quality of fishing and density of trout populations. This study, which began in 1953, was scheduled for completion in 1958, but because the results were indecisive by that time, it was extended through 1964. In 1959, all the man-made structures and natural cover were removed from the experimental section of river, and sand was used to fill the holes created by deflectors. The next evaluation will compare data for a five-year period when improvement structures were present with data for five years when structures were absent and natural cover was greatly reduced. (3) Planting of fingerling brook trout in lakes in the fall (begun in 1952). The objectives of this study are to determine the proper planting rate for the best recovery, the season of greatest mortality, and the causes of natural mortality. (4) A fly-fishing-only restriction on brook trout in Ford Lake (begun in 1955). (5) Growth and harvest of brook trout fry planted each spring in Section Four Lake (begun in 1952).

Creel census data for the experimental waters of the Pigeon River station are presented in the following tables.

Pigeon River

Season	Fishing trips	Hours fished	Trout caught	Trout per hour
1958	1,399	4,205	1,021	0.24
1959	1,206	2,760	342	0.12

Ford, Hemlock, Lost, West Lost, North Twin, South Twin, and Section 4 lakes

Season	Fishing trips	Hours fished	Trout caught	Trout per hour
1958	1,980	5,157	2,748	0.53
1959	2,071	5,144	1,949	0.39

The number of trout caught in the experimental sections of the Pigeon River in 1959 was the lowest on record. The cause of the small catch is as yet unknown, but sand brought into this part of the stream by the flood in 1957 possibly was a major contributing factor. (It is of interest to note that the trout catch from streams of the Rifle River Area was also appreciably smaller in 1959, and that the catch from Hunt Creek was somewhat less in 1959 than in 1958.)

Rifle River Fisheries Research Station

This station is located on the Rifle River Area, at the headwaters of the Rifle River in Ogemaw County. The Area consists of a 4,318-acre fenced tract of state-owned land within which are located six lakes, several ponds, and about 9.5 miles of trout streams. As there is only one entrance, complete records of fishing, hunting, trapping, and sightseeing are secured. Pertinent information has been recorded on all fish and game taken from the Area since 1945. Visitors numbered over 25,000 in both 1958 and 1959, of whom approximately two-thirds were sightseers.

The number of fishing trips on the lakes during this period declined 5.5 percent from 1956-1957. In 1958, the catch per hour (0.78) exceeded that of three of the previous four years; bluegills comprised slightly more than half the catch. In 1959, however, the quality of fishing was only half as good (0.39 fish per hour), and the total catch was the smallest recorded since the Area was opened

to public fishing. This overall decline resulted largely because of unusually poor fishing in Dollar and Loon lakes. Disappearance of a previous strong year class of bluegills, removal of slow-growing bluegills by seining, and decreased fishing pressure probably largely accounted for the low yield from Dollar Lake. The poor fishing on Loon Lake is ascribed to winterkill and reduction of an overabundant sunfish population by a light treatment with toxaphene. No fish were caught in Spring Lake because northern pike and crappies of the newly established population were still small.

A brief summary of the lake fishing follows:

Season	Fishing trips	Hours fished	Fish caught Number	Pounds	Fish per hour
1958	2,042	5,532	4,340	829	0.78
1959	2,085	6,150	2,416	790	0.39

There were 8 percent more fishing trips and 70 percent more trout caught in the Area's streams during 1958-1959 than in the preceding two years. The stocking of larger numbers of hatchery-reared trout influenced this increase in catch appreciably; fish of hatchery origin comprised 52 percent of the total catch of trout in 1959 (a generally poorer season than that of 1958). Meanwhile, the harvest of native trout fluctuated greatly. In 1958, when stream levels were abnormally low, the catch of native fish was comparatively large, and represented an 85 percent increase over the catch in 1957.

There were 17 percent fewer fishing trips and 66 percent fewer trout caught in the streams in 1959 than in 1958. A severe rain storm occurred on May 20, 1959, which caused extensive flooding but did little damage to stream improvement structures installed in 1950-1952. The flash flood appeared to have only a temporary

adverse effect on angling, as fishing quality and yield throughout this season were substantially less than in 1958.

Creel census data for the trout streams are summarized as follows:

Season	Fishing trips	Hours fished	Trout caught			Other fish caught	Pounds, trout	Pounds, other	Trout per hour
			Brook	Brown	Rainbow				
1958	3,631	9,444	27	2,380	156	118	1,006	72	0.27
1959	3,022	7,170	19	946	312	135	506	108	0.18

The principal activities in the station's research program during 1959-1960 were as follows: (1) Investigation of proposed methods for management of lakes subject to winterkill, which included an unsuccessful attempt to circulate Loon Lake with compressed air and test of a northern pike-black crappie-redbelly dace species combination in Spring Lake. (2) Bluegill population reduction by the use of a large seine was attempted in Dollar Lake. (3) Estimates of fish populations were made in several of the streams and in two of the lakes. (4) Introduction of redear sunfish into northern Michigan waters has been studied. (5) Collections of bottom-dwelling organisms were made in Houghton Creek as a follow-up to previous studies. (6) Lamprey ammocoetes were collected from Gamble Creek. (7) Analysis of creel census data obtained from the lakes and streams, including exploitation rates and age composition of the catches.

Winter office quarters in the checking station were enlarged and improved in the fall of 1959 by the construction of a 12 x 14-foot addition.

Marquette Fisheries Research Station

This station is housed in the main building of the Marquette Hatchery. A 6-year test of planting three grades of brook trout (fingerling, sublegal, and legal) in three Marquette County lakes (Airport, Moccasin, and Swanzy) to

determine which size is preferable for stocking lakes was completed in 1958. A creel census was carried on to enumerate recovery of the fish. The data have not been statistically analyzed as yet, but apparently the more distinctive features of the results are these: (1) Fingerling plantings gave the greatest return in poundage (1.75 pounds, average for six years) per pound of trout planted, despite the lowest percentage of numerical return (19.5%, average for six years). (2) Plantings of legal-size fish provided the largest average numerical return (54%). (3) The fishing quality was approximately equal (about 0.4 fish per hour) from sub-legal and legal plantings, and poorest from fingerling plantings (about 0.2 fish per hour). One advantage of planting fingerlings was that natural foods in the lakes contributed substantially to growth of the fish; trout of the larger grades did not stay in the lakes long enough to attain appreciable growth there.

The objective of a different investigation started on these waters in 1959 is to determine the effects on harvest of brook trout in lakes from later opening (May 15) and closing (October 15) of the fishing season. The special regulation applies to Airport and Swanzy lakes, while the general season is in effect on Moccasin Lake. All three lakes are being stocked with fingerling brook trout, and are being censused.

Studies on rainbow trout and the sea lamprey conducted from this station are described under separate headings.

Hastings Fisheries Research Station

This station, located in Barry County, is concerned mainly with research in the management of warm-water fishes. Progress has been made in the following projects (numbers 1 through 4 cooperatively with the Lake and Stream Improvement Section): (1) Preliminary investigations on five lakes to be renovated by removal of bluegills and/or carp. (2) Follow-up studies on 22 lakes treated since 1956 with either rotenone or copper sulfate, or seined, for reduction of bluegills and/or carp. (3) Evaluation of production of young northern pike at Townline Lake,

Montcalm County, and Otsego Lake, Otsego County, in marshes which were experimentally managed by various techniques, including planting of brood stock, installation of dams to serve as barriers to fish and as controls on water level, and fertilization. Maximum production occurred in 1960 at Otsego Lake where 30,000 fingerlings were produced. (4) Checking on the survival and growth of muskellunge introduced into seven lakes between 1955 and 1957, and advising on experimental "musky" spawning-area management at two of the more successful sites (Valley-Wildwood lakes, Oakland County; Budd Lake, Clare County). (5) Continuation of the census of spearing for muskellunge in winter at Gun Lake, Allegan and Barry counties, where a test of maintenance stocking of muskellunge is anticipated for the future. Fishermen's reports from this lake for the January-February spearing season have provided the following figures for the last five seasons (1956-1960) combined: total hours of spearing--5,978; total "muskies" speared--16; hours per "musky"--374. (6) Completion of reports that concern spearing of sturgeon during winter from 1956 through 1958, in lakes of the Inland Waterway, and collection of additional fins for age determinations. Estimates of the total fishing pressure and harvest follow:

Year	Hours of spearing	Sturgeon speared	Hours per sturgeon
1956	9,630	70	138
1957	10,685	17	628
1958	6,205	26	239

(7) Observations on the spawning habits, early life history, and growth rate of bowfins (dogfish). (8) Studies in lakes and aquaria on feeding habits of predatory fish, especially in regard to food preferences. (9) Determination of temperature and depth preferences of fish in lakes. (10) Continued preparation of a monograph on northern pike.

Data on experimental control of overly large populations of bluegills in some lakes of southern Michigan are being analyzed to provide an evaluation of this program. Since 1956, 13 lakes have been treated with rotenone to thin out bluegill populations, 6 were treated for complete removal of bluegills and/or carp, 2 were seined to reduce bluegill numbers, and copper sulfate was used in one lake to kill bluegill eggs and fry. Preliminary and follow-up seining on all of these waters has yielded data on the extent of reduction and on growth rates of surviving or introduced fish. Creel census on three of the lakes has provided information on the influence on angling success.

The goal of this project has been to remove from 50 to 100 percent of the bluegills and to increase the numbers of predatory fish, principally northern pike. Results to date indicate that benefits from eliminating less than 50 percent of the fish from crowded bluegill populations are of short duration; very intensive or complete elimination is apt to result in poor fishing for some time. In some instances, stocking of rainbow trout has compensated for the lack of warm-water species during the first year after drastic reduction.

In 1960 basic data were obtained by creel census, seining, and age and growth analysis in three lakes which are scheduled for future treatment to reduce populations. Plans have been made to expand research on the use of copper sulfate to control abundance of bluegills by killing their eggs and/or fry.

A considerable number of improvements were made during the biennium on the station's buildings and equipment. New equipment was devised for holding and transporting fish, and techniques for handling experimental fish were improved.

General Creel Census

Catch records of sport fishing have been obtained by conservation officers since 1927. These records are tabulated and analyzed at the Institute. This census provides a sample of sport fishing conditions over the entire state.

In 1958, officers interviewed 81,427 anglers who fished 194,527 hours and caught 240,858 fish, at a rate of 1.2 fish per hour. During 1959, the officers recorded 73,263 fishermen who caught 224,602 fish in 166,777 hours, or 1.3 fish per hour.

Brook trout comprised most of the catch from trout waters. In 1958, of 17,484 trout reported from these waters, 8,406 (48 percent) were brook trout, 6,704 (38 percent) were rainbow trout, and 2,374 (14 percent) were brown trout. Of 15,578 trout reported in 1959, the figures for the respective species were 8,933 (57 percent), 4,853 (31 percent), and 1,792 (12 percent). The catch per hour was 0.6 trout in both 1958 and 1959.

In non-trout inland waters, bluegills continued to be caught most frequently. This species constituted 40 percent of the catch in 1958, and 36 percent in 1959. Bluegills and yellow perch combined made up 69 percent and 64 percent of the non-trout catch in 1958 and 1959, respectively. The catch per hour of all species in these waters was 1.2 in both years.

Yellow perch composed 93 percent of the catch from the Great Lakes and connecting waters in 1958, and 92 percent in 1959. The catch per hour for these waters was 1.9 in 1958, and 2.9 in 1959.

Creel Census on Experimental Lakes

A preliminary draft of the report on tests of experimental regulations conducted during 1954-1958 has been completed. The conclusions drawn from this study were: (1) No deleterious effects resulted from removal of all size limits on fish; (2) ~~sampling~~ quality was unaffected by removal of all closed seasons. These statements apply specifically to the six lakes tested, but probably would also apply to most warm-water lakes in Michigan. The tests of a 16-inch minimum size limit on largemouth and smallmouth bass and a 24-inch limit on northern pike demonstrated that populations of these species can be increased

by this kind of management; however, a high rate of natural mortality among the older age classes rules out adoption of size limits that are so high.

Included in the current group of tests is a 14-inch minimum size limit on black bass and a closed season (March 1 to June 17, inclusive, in 1960) on northern pike, combined with a ban on spearing of pike. Year-round fishing for bass continues on three lakes, as does abolishment of all size limits on two lakes. These tests will terminate in the spring of 1964.

The creel census at Houghton Lake, Roscommon County, has been continued to obtain more data on effects of the 20-inch minimum size limit on northern pike.

Censuses have been carried over on two "combination" trout lakes, Birch in Cass County and Corey in St. Joseph County. Results from Birch Lake indicate that a program of stocking rainbow trout one year in three is a sound management practice for maintaining a good return of planted fish and angling quality, especially for lakes in which angling success for trout sharply deteriorates under an annual stocking program. Results from Corey Lake influenced the opening of more than 200 lakes to winter fishing for rainbow trout in 1960.

Creel census was resumed on Saddle Lake (Van Buren County) and Otsego Lake (Otsego County), and continued on Big Portage Lake (Jackson County). On Saddle Lake, results of complete removal of the fish population by a toxicant and restocking are being evaluated. Evaluation of reestablishment of a former high water level with a dam is the goal of the study on Big Portage Lake; the lake had a lower level for approximately 15 years. The census on Otsego Lake will afford a check on the success of managing a marsh for production of northern pike.

~~Dingell-Johnson funds have largely financed these creel census activities.~~

Lake Fish Population Studies

Lake fish population studies were carried out at several of the field stations, and are mentioned in the commentaries on the stations' activities.

Investigation of the effects on the fish population from a draw-down of Haymarsh Lake, Mecosta County, in 1958, has continued. This study was complicated by an extensive die-off of fish, due to oxygen depletion, in the winter of 1958-59. As determined by gill-netting and trap-netting, the population was significantly smaller in 1959 than in 1958. As the winterkill doubtless played a major role in the reduction, any improvement in growth rates and fishing quality that may occur here cannot be attributed strictly to effects from the draw-down.

Studies on Fish Food Organisms

The collection of bottom-dwelling organisms from Sugarloaf Lake, Washtenaw County, was concluded. Data on seven years of collecting are available for a third report on the bottom fauna of this lake.

An investigation of the effects of increasing the water level in Big Portage Lake, Jackson County, was continued. Collections were taken for two years before and for three years after the level was raised to evaluate its effects on chemical nutrients, bottom organisms, and fish growth. A study of the same relationships has been begun on the new Winnewana impoundment in Washtenaw County.

Data on bottom samples previously collected from Saginaw Bay in cooperation with the U. S. Fish and Wildlife Service are being analyzed, and a report on the results is in preparation.

Fish Toxicants

Some work with fish toxicants has continued during the last two years. Further tests have been made with the insecticide, toxaphene, to determine whether it can be used selectively to exterminate only fish of certain sizes.

Aquatic Plant Control

An experimental application of one new aquatic herbicide was made in 1960. In addition, observations were made on experimental applications by two other agencies of two new chemicals.

Cooperative Projects with Michigan State University

Graduate students and faculty members worked on several investigations with support from the Department.

Trout stream fertilization.--This project is supported jointly by the Institute for Fisheries Research, Michigan State University, and the Atomic Energy Commission. By use of radioisotopes, it has been possible to trace the movement of the nutrient element phosphorus down a trout stream (West Branch of the Sturgeon River). It has been found that phosphorus is used and reused by aquatic plants and animals in its downstream progression. The results suggest that streams may be fertilized more efficiently than lakes.

Nutrient transport, and effects of sediments and silts on fish.--The aims of this study, which began in 1960, are to determine the mechanisms of nutrient transport that operate in a warm-water stream, and to evaluate the effects that sedimentation, siltation, and nutrient levels exert on smallmouth bass in the Red Cedar River. Radioactive phosphorus will be used to find the primary factors which determine circulation of this element. Estimates of stream-bed erosion and siltation will be studied by the use of radio-treated drift pellets; effects of sediments and silts on benthic organisms and fish will be evaluated by sampling the populations.

Cooperative Projects with The University of Michigan

Several graduate students at The University of Michigan conducted studies with financial support from the Department. Senior members of the Institute's staff have honorary faculty status.

Enrichment of hard-water lakes.--This investigation has dealt with the nutritive requirements of planktonic algae in hard-water lakes. Much of the experimentation was done in Blind Lake, Washtenaw County. The field work of this doctoral study has been completed.

Iron was found to be an important limiting factor in the production of algae. Addition to the water of certain organic compounds, known as chelates, increased the availability of natural inorganic elements so as to appreciably increase production of algae, and the rate of production was greatly increased by a combination of commercial fertilizer (nitrogen, phosphorus, and potassium) with chelate. Results were evaluated with radioactive carbon.

Coarse fish removal.--The study of the effects of removing coarse and forage fishes from a trout stream, begun in 1958, was continued through 1960. The stream is Canada Creek in Montmorency County.

Coarse and forage species were removed from the study area by electrofishing and traps. Migrating fish were prevented from entering the area by screens at the two ends of the experimental section of stream. The effects of removal will be evaluated indirectly by measurement of the trout harvest by anglers, and directly by measurements of total production of trout, growth, and survival.

Chestnut lamprey investigation.--This study was begun in 1959 on the Manistee River, Crawford and Kalkaska counties. It is designed to identify

the factors responsible for the large population of chestnut lampreys in this stream, appraise the relationship between them and trout, and supply data on the life history and ecology of the three native lampreys of the watershed--the parasitic chestnut, and the nonparasitic northern brook and American brook lampreys.

INSTITUTE FOR FISHERIES RESEARCH

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