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BIENNIAL REPORT OF THE INSTITUTE FOR FISHERIES RESEARCH  
FOR JULY 1, 1954 TO JUNE 30, 1956

The research branch of this Division has headquarters in Ann Arbor with six field stations in various parts of the state. Problems associated with the sport fishery are its main concern. The chief material expansion of this branch during the biennium was the addition of a field station for warm-water fish investigations. This station is located at Hastings in what formerly was the Hastings State Fish Hatchery. A building that will house storage space and work room was under construction at the Waterloo Recreation Area headquarters near Chelsea.

Dr. Albert S. Hazzard left his position as director of the Institute in November of 1955 to accept employment with another state. Dr. Hazzard had been in charge of research under the Fish Division since 1935. Dr. Gerald P. Cooper, associated with the Institute as assistant director since 1945, became director.

Lake Mapping and Surveys

Lake mapping was done during the open-water seasons as well as in winter. One crew mapped on open water with an echo sounder in 1955 and 1956. A sounder purchased in 1956 that gives more accurate readings for shallower depths (less than 5 feet) than the instruments formerly used,

promises to increase appreciably the efficiency of this method of mapping.

Two winter crews in 1954-55, three in 1955-56, and the one crew that used the echo sounder in 1954 and 1955 mapped 108 lakes. Men from Department of Corrections work camps assisted with mapping during the winter seasons.

Lake inventories were made by three field parties in both 1955 and 1956. These inventories included studies on the composition of fish populations, fish growth, aquatic vegetation, temperatures and water chemistry. The larger lakes investigated in 1955 were Burt, Cheboygan County; Paradise, Cheboygan and Emmet counties; Manistee, Kalkaska County; and Houghton, Roscommon County.

Large lakes listed for inventory in 1956 were Cedar, Alcona and Iosco counties; Elk, Antrim and Grand Traverse counties; Mullett, Cheboygan County; and Mona, Muskegon County.

Inventory and mapping of lakes were financed chiefly with Dingell-Johnson funds.

#### Stream Surveys

Apart from studies carried out in connection with sea lamprey investigations, one three-man crew was concerned with routine stream surveys in 1955 and 1956. In 1955 an intensive survey was made of the upper part of the Big Cedar River drainage system (Menominee County) and an intensive survey of the Ford River system (also in the Upper Peninsula) was completed. Work on these projects consisted of fish collecting (with electric shocker), recording of temperatures, notation of physical data, and growth analysis of game fishes.

This stream survey crew spent a major share of its time collecting data with which evaluations are being made of the effects of experimental regulations on fishing in sections of several trout streams. These streams are: East Branch of the Fox River, Schoolcraft County; Boardman River, Grand Traverse County; Little South Branch of the Pere Marquette River, Newaygo County; and Pine River, Lake County. In the lower Baldwin River (Lake County) survival rates of wild and hatchery-grown brown trout fingerlings are being compared.

Dingell-Johnson funds have largely financed these stream survey operations.

#### Age and Growth of Fishes

Research on methods of aging northern pike was completed in 1955. A beginning has been made on means of aging muskellunge with establishment of known-age populations of this species.

Routine age and growth determinations on other species of fish are of value in determining the course of management programs. Inmates from Department of Corrections work camps have prepared the impressions of scales on plastic material.

Compilation of state-wide growth-rate averages for several species of warm-water game fish, the growth rates of which had not been established before, was completed during the biennium.

#### Fish Mortality and Disease

Kidney disease, a disease of trout heretofore unreported from midwestern United States, was discovered at several Michigan hatcheries. Losses from the malady have not been extremely high but various new treatments were attempted in an effort to control this disease. An attempt is also being made to develop a stock of brood fish resistant

to infection. Since no information is available on the effect of the disease after the trout have been planted, studies are in progress to determine whether the infection persists and is transmitted to other trout in natural waters.

In an attempt to develop stocks of brook and brown trout resistant to furunculosis, eggs were taken from these species in a stream known to contain infected fish.

Experiments with pyridylmercuric acetate, a chemical employed to control gill disease in trout, revealed that the product varied in composition; the higher concentrations proved toxic to rainbow trout fingerlings. Studies are under way to find an antidote for over-dose of this chemical. As a substitute for pyridylmercuric acetate, roccal was tested and found effective for treatment of gill disease in rainbow trout.

The marking of trout by injection of colored liquid latex beneath the skin was tested. The fish are being held in aquaria to determine permanency of the marks.

#### Sea Lamprey Investigations

The experimental sea lamprey barrier on the Black River, Mackinac County, continued in operation. It proved to be a completely effective obstacle to sea lampreys migrating upstream in 1955; in 1956, only one lamprey was known to have surmounted it. Rainbow trout can negotiate this barrier, but smelt and suckers are blocked.

Operation of a weir and investigations were continued on Carp Lake River in Emmet County to obtain additional data relevant to the ammocoete (larval) stage in the life cycle of the sea lamprey. The results of these investigations have cast considerable doubt on the

early theory that the ammocoete stage lasts four years. The recent data suggest that this stage may last seven or more years.

Owing to the promise of a new larvicide under development for control of sea lampreys, a program was begun in 1955 to locate points of concentration of ammocoetes in streams for treatment with the poison. As part of this program, 16 stream systems were surveyed in 1955. cursory examination of the data obtained suggested that sea lamprey ammocoetes were most often found in mainstream waters or streams with flow volumes of over 30 c.f.s., and which had temperatures that ranged between 70° and 79° F.

#### Rainbow Trout Studies

Investigations of various phases of the life history of the migrating rainbow trout continued on the Black River in Mackinac County. Objectives were as follows: (1) To ascertain if the special spring and fall fishing seasons have special effect on the population. (2) To determine the relationship (if any) between successful spawning of a parent run and the subsequent run of adults. (3) To learn the age and growth rate of migratory rainbows. (4) To determine migratory and feeding habits.

In brief, the life history of migratory trout that frequent Black River was found to be as follows: (1) After hatching, they spend one to three years in the stream, during which time they attain a length of six to nine inches; (2) they then migrate into Lake Michigan; (3) while living in Lake Michigan they grow rapidly (as much as eight inches in five months); (4) they return to the stream to spawn for the first time at the age of three or four years. ✓

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✓ Stauffer, Thomas M. 1955. He's still a rainbow by any other name.

Mich. Cons., May-June Issue, pp. 19-21.

In the spring of 1955, a large-scale investigation was begun to determine if hatchery-reared rainbow trout will supplement natural runs of rainbows from the Great Lakes. Approximately 29,000 marked two-year-old hatchery rainbows were planted at or near the mouths of 14 streams during May and June of 1955. As of December 15, 1955, tag returns indicated that 1.6% were caught shortly after planting, while 0.6% were caught three or more months after planting. Fish that had been at liberty for three months or longer increased in length an average of 5.9 inches. The investigation continued in 1956.

#### Pike and Muskellunge Investigations

A fish population study was begun on Fletcher Floodwater (Alpena and Montmorency counties) in April of 1956 especially because of the interest in the northern pike of this impoundment. The effect here of spearing pike during the winter is the matter of particular concern. Pike and largemouth bass captured in trap nets were marked by fin-clipping. An intensive creel census was resumed in 1955 and 1956. The resulting records should indicate what management procedure is to be followed on this highly popular fishing water.

Research on muskellunge continued at Lake St. Clair. Composition of anglers' catches was determined during the May-June spawning period, other creel census data were recorded, and materials were collected for age and growth studies.

A creel census was conducted on Gun and Thornapple lakes (Barry County) during the winter of 1955-56 to accumulate basic data in connection with muskellunge investigations.

Three lakes were stocked with fingerling northern muskellunge on an introduction basis during 1955, and follow-up checks showed survival in all. Plans called for the planting of fingerlings in one lake in 1956.

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## Walleye Investigations

Investigation of the value of planting walleye fingerlings, initiated in 1951, is a continuing program. Fingerlings have been introduced into 18 lakes, and 23 lakes are being stocked on a maintenance basis at four-year intervals. Results of both introductory and maintenance plantings from several lakes have been encouraging. Success of the program is being followed through test netting and creel census. It is yet too early to evaluate completely this stocking program, but fairly conclusive results should appear within the next two or three years.

Research on the walleye in the Inland Waterway (Cheboygan and Presque Isle counties) was continued in 1955 and 1956, with particular emphasis on Black Lake. Tagging results indicate that the walleyes of Black Lake do not leave the lake, and that no extensive migration occurs like the spawning migrations out of Burt and Mullett lakes. Black Lake walleyes apparently spawn in Black Lake. Tagging done here has also produced evidence that exploitation of walleyes by anglers is not intensive. Population checks at Black Lake with trap nets indicated that the walleye population there probably is proportionately smaller than the populations in Burt and Mullett lakes.

Detailed records are maintained on recoveries of walleyes that have been tagged on various waters. A report, based on tag returns and transfer operations, has been prepared on walleyes that spawn in the Muskegon River. <sup>2</sup>✓

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<sup>2</sup>✓Crowe, Walter R. 1955. Numerical abundance and use of a spawning run of walleyes in the Muskegon River, Michigan. Trans. Amer. Fish. Soc., Vol. 84, 1954, pp. 125-136.

Hunt Creek Fisheries Experiment Station

The staff of the Hunt Creek Fisheries Experiment Station in Montmorency County worked on the following projects: (1) Intensive creel census on experimental brook trout waters for the 16th and 17th consecutive seasons. (2) Post-season population studies on these waters to determine exploitation by angling. (3) Fall sampling of trout populations in experimental sections of the North and South branches of the Au Sable River to obtain population indices and scale samples. (4) Further hooking mortality experiments, under both hatchery and natural conditions, that involved artificial lures. (5) Cooperation with other workers in several studies, such as the experimental work done by Psychological Research Services, Inc. and with officers of More Trout, Inc. on management of rainbow trout in impoundments. (6) Development of new research techniques and equipment.

A practical test of the effect of a "flies only" regulation, with all other regulations unchanged, was begun in sections A and Z of Hunt Creek in 1955. Results to date are encouraging.

Creel census data for experimental sections of Hunt Creek follow:

Season	Fishing trips	Hours fished	Wild brook	Hatchery brook	Hatchery rainbow	Pounds	Trout per hour
1954....	1,111	2,486	626	255	185	186	0.43
1955....	841	1,815	706	276	12	166	0.55

Attempts to control coarse fish in East Fish Lake by netting were continued in the springs of 1954 and 1955. This netting, however, failed to reduce substantially the white suckers and creek chubs. Some 229 pounds of these fish were taken in 1954, and 167 pounds in 1955, from

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this 16-acre trout lake. East Fish Lake, and Fuller Creek Pond, which is also plagued with coarse fish, were to be poisoned in the latter part of 1956.

Following are creel census records for East Fish Lake:

Season	Fishing trips	Hours fished	Wild brook	Hatchery brook	Pounds	Trout per hour
1954....	264	940	39	62	45	0.11
1955....	230	902	29	10	24	0.04

These creel census records were collected on Fuller Creek Pond:

Season	Fishing trips	Hours fished	Wild brook	Hatchery brook	Pounds	Trout per hour
1954....	67	182	15	1	10	0.09
1955....	37	143	13	...	7	0.09

Data collected by partial creel census and an alternating-current electric shocker on the North Branch of the Au Sable River again indicated presence of good to excellent brook and brown trout populations. Angler success was lower during 1954 and 1955 than before for brook trout, but was good on brown trout. Scale studies of angler-caught and shocker-collected fish provided evidence that the minimum size could safely be lowered to nine inches, and this limit was in effect for the 1956 trout season.

Investigation with a direct-current shocker on the special regulation waters of the South Branch of the Au Sable River during the fall in 1954 and 1955 indicated a stable brown trout population and an improved population of brook trout. Anglers' comments suggest that fishing has been satisfactory under the regulations in force. These

regulations provide for fly fishing only, a minimum size of 10 inches, and a daily catch limit of five trout. Scale studies show that here, as on the North Branch, the minimum size could safely be reduced to nine inches.

The Hunt Creek staff continued to assist in periodic checks on survival experiments initiated by Psychological Research Services, Inc. The staff aided in marking large numbers of trained and untrained fingerling trout that were released in various experimental waters in the fall of 1954. Detailed tabulations are being made of the catch of these fish, survivors of which have begun to appear in anglers' catches.

In cooperation with the officers of More Trout, Inc., creel census, tagging, and recovery data on the impoundment on the East Branch of the Au Gres River in Iosco County were collected during 1955 for analysis. The 1955 spring spawning run of 755 rainbow trout was lifted over the dam through united effort of the corporation, the Region II staff of the Fish Division, and members of the Hunt Creek and Rifle River Area staffs. Many scale samples collected at the time of the transfer and from subsequent recoveries were aged.

The Hunt Creek staff developed coding systems for utilization of punch cards on which to record tag recoveries, leading to easier and more rapid sorting. Creel census tabulations also were done on IBM machines.

A new type of fish trap was built, tested, and a description published. <sup>3/</sup> A simpler and sturdier modification of the inclined-

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<sup>3/</sup> Whalls, Marvin J., Karl E. Proshek and David S. Shetter. 1955.

A new two-way fish trap for streams. Prog. Fish. Cult., Vol. 17, No. 3, pp. 103-109.

screen trap was developed and several were built. A simpler and less costly self-cleaning rotary screen was constructed and tested, and is ready for production. A water gate that opens and closes automatically with changes in water level was developed for use with the rotary screens.

Additional office space was provided on the second floor of the laboratory-office building.

#### Pigeon River Trout Research Area

Experimental waters of the Pigeon River Trout Research Area include about six miles of Pigeon River in Otsego County (from the Lansing Club Dam to Elk Point) and seven small trout lakes. Complete angling records from these waters are obtained by a compulsory fishing permit system which allows collection of scale samples for age and growth analysis, and examination for marks on fish from experimental plantings.

Creel census data on the Pigeon River, plus information collected during annual fall population studies, have aided in the evaluation of the following projects: (1) Survival of spring-planted sub-legal trout. (2) Survival of fall-planted fingerling trout in situations where only spawning facilities are lacking. (3) Comparison of survival between psychologically trained and untrained hatchery brook trout fingerlings. (4) Effect of channel deepening on a fish population. (5) Effect of stream improvement structures on angling and the trout population of Section A.

The creel census data for the experimental water of Pigeon River are presented in the table that follows. The decline in fishing pressure and catch, both in the stream and in the lakes from 1954 to 1955, resulted from extremely warm weather during the 1955 trout season.

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Season	Fishing trips	Hours fished	Trout caught	Trout per hour
1954....	2,427	6,581	2,445	0.37
1955....	2,039	5,775	1,376	0.24

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Creel census information from the experimental lakes have been of importance in the evaluation of these projects: (1) Survival of brook trout planted as fry. (2) Survival of brook trout fingerlings released at various sizes. (3) Yield to anglers of a brook trout lake fished under a "flies only" regulation. (4) Survival and change in health of brook trout infected with kidney disease.

Following are the creel census data for the lakes:

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Season	Fishing trips	Hours fished	Trout caught	Trout per hour
1954....	1,688	4,530	3,853	0.63
1955....	1,388	3,597	1,865	0.52

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The staff did considerable improvement and maintenance work on the buildings during the past two years. The housing facilities received an increased amount of use by graduate students and special investigators working on Department problems on and in the vicinity of the area.

Addition of a research biologist to the staff of the Pigeon River station toward the end of the biennium will aid in the analysis and publication of much data that have accumulated from studies carried out here in past years.

Rifle River Area

The Rifle River Area in Ogemaw County provides hunting and fishing opportunities for the public as well as means for research in fish and game management. A complete year-round creel census has been taken on the waters since 1945, the year this 4,318-acre tract was acquired by the Department of Conservation.

More than 2,000 anglers fished the lakes of the area in each 1954 and 1955 but, with the exception of Dollar Lake and South Pond in 1954, fishing pressure was relatively light. Among the 13 species of fish that appeared in the lake catches in 1954 and 1955, bluegills and perch were taken in greatest numbers. Bass fishermen on Loon and Dollar lakes enjoyed better success over this two-year period than in 1952-1953. Crappie fishing was also excellent on these two lakes in 1954. Spring Lake provided good perch fishing in 1955, but no fish were caught in 1954, presumably because of winter-kill. Angling on the two largest lakes--Devoe and North--was relatively poor both years. Rainbow trout have been stocked in Devoe Lake, but the catches for 1954 and 1955 were considerably below the catch for 1953, which was a peak year. Also, there was a pronounced drop in the catch of smallmouth bass from both lakes.

A brief creel census summary for lake fishing follows:

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Season	Fishing trips	Hours fished	Fish caught	Pounds	Fish per hour
1954....	2,513	8,763	6,308	1,353	0.72
1955....	2,296	7,013	4,283	1,359	0.61

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Angling pressure on the streams in the area continued to increase during 1954 and 1955. Improvement in the catch per hour of trout during

1955 was influenced primarily by experimental plantings of hatchery fish. Brown trout from fingerling plantings made in the fall of 1953 and the spring of 1954 began to enter the catch during 1955. Sub-legal and legal-length rainbow trout planted in Rifle River resulted in an increase in catch of this species in 1955. Rainbows of legal length stocked in Devoe Lake in the fall of 1954 also effected an increase in the take from the streams, particularly Rifle River.

Creel census data for the streams are summarized as follows:

Season	Fish- ing trips	Hours fished	Trout caught			Other fish caught	Pounds, trout	Pounds, other	Trout per hour
			Brown	Brook	Rain- bow				
1954....	3,501	10,393	17	1,135	462	308	662	240	0.16
1955....	3,828	10,725	29	1,661	995	104	893	81	0.25

Weirs in Gamble Creek were operated during the spring and fall of 1954 and 1955 to determine the recruitment of brown trout into Rifle River and also to determine the size of the spawning runs of brown trout and sea lampreys out of Devoe Lake.

Weirs were installed in North Lake outlet in the spring of 1955 to check on the movement of hatchery rainbow trout and to trap northern pike for removal to another lake.

Fish sampling was conducted throughout the Rifle River drainage system during the fall of 1955 to obtain additional data for evaluation of the watershed improvement program.

#### Marquette Fisheries Research Station

The Marquette Fisheries Research Station moved from temporary quarters on the campus of Northern Michigan College of Education to the

Marquette State Fish Hatchery in September, 1955, where laboratory facilities were completed in May, 1956.

The main research activities at this station consisted of: (1) A creel census on three experimental trout lakes to determine which size of hatchery brook trout (fingerling, sub-legal, or legal) gives the best return to fishermen. (2) Use of diving equipment in conjunction with lake surveys and other studies in fish management and research. (3) Rainbow trout studies. (4) Sea lamprey control investigations.

Moccasin, Swanzy, and Airport lakes in Marquette County are the sites where brook trout planting procedure is being evaluated by creel census. Results of the experiments are as yet inconclusive.

Diving equipment (self contained underwater breathing apparatus or SCUBA) was used during the summers of 1955 and 1956 in conjunction with lake survey work. It was of particular value in observations on effectiveness and condition of brush shelters, and on results of lake poisoning. For example, underwater examination showed that brush shelters as old as 16 years were intact and used by fish. Counts made with the aid of SCUBA in a lake that had been treated with a toxicant revealed that approximately 50% more fish were dead on the bottom than were observed on the surface or along the shoreline.

Summaries of the investigations on rainbow trout and sea lamprey appear elsewhere in this report.

#### Hastings Fisheries Research Station

Administration of the Hastings State Fish Hatchery was transferred from the Fish Division's fish cultural section to the Institute in July, 1956. The station was occupied for research purposes in September of 1955. The research here will be on problems in warm-water fish management.

Basic research presently concerns interrelationships between predator fish and their prey, especially pan fish. Currently under way is an evaluation of reduction of excessive numbers of bluegills in several lakes in the southern part of the state.

An extensive remodeling program for the station's buildings, grounds, and water supply is planned for the near future.

#### Studies on Fish Food Organisms

A long-term study continued on production of fish-food organisms in six southern Michigan warm-water lakes. A paper was published on chemical conditions and morphometry of these and other southern Michigan lakes. ✓ This study demonstrated that lakes which contain an abundance of lime tend to have basins with abrupt slopes and sparse stands of aquatic plants. A report was also prepared on production of plankton in these waters. ✓

An intensive study of bottom organisms in Sugarloaf Lake, Washtenaw County, has continued, and was the subject of a preliminary report. ✓ Results to date have shown large year-to-year fluctuations in abundance of key fish-food organisms. The aim is to determine whether these fluctuations appreciably influence survival of fish.

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✓ Hooper, Frank F. 1956. Some chemical and morphometric characteristics of Michigan lakes. Pap. Mich. Acad. Sci., Arts, and Litrs., Vol. 39, pp. 109-130.

✓ Hooper, Frank F. Some characteristics of the phytoplankton of eight southern Michigan lakes. Ms.

✓ Anderson, Richard O. and Frank F. Hooper. Seasonal abundance and production of littoral bottom fauna in a southern Michigan lake. Trans. Amer. Fish. Soc. In Press.



Identifications and volumetric measurements have been made on organisms found in bottom samples collected from several trout streams in the northern part of the Lower Peninsula. A report was prepared on one insect species that occurred in these samples. ✓

#### General Creel Census

Conservation officers have obtained catch records of sport fishing since 1927. These records are sent to the Institute for tabulation and analysis. The census shows how the various species contribute to the harvest and provides an index to fishing quality in the state. In 1954, the officers interviewed 70,109 anglers who fished 169,243 hours and caught 251,953 legal-size fish, at the rate of 1.5 fish per hour. During 1955, the officers contacted 62,382 fishermen who fished 146,557 hours and took 215,660 fish, or 1.5 fish per hour.

As in past years, brook trout constituted the bulk of the catch from trout waters. In 1954, of 18,465 trout reported from these waters, 12,720 (68.9%) were brook trout, 3,736 (20.2%) were rainbow trout, and 2,009 (10.9%) were brown trout. In 1955, of 19,265 trout, 10,877 (56.5%) were brooks, 5,546 (28.8%) were rainbows, and 2,842 (14.7%) were browns. The catch per hour was 0.79 trout in both 1954 and 1955.

The bluegill was caught in greatest numbers in non-trout inland waters. This species constituted 36.6% of the catch in 1954, and 35.2% in 1955. Bluegills and yellow perch combined made up 67.5% and 67.2% of the take in these waters in 1954 and 1955, respectively.

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✓Curry, LaVerne L. Notes on the ecology and Taxonomy of Tendipes (Tendipes) staegeri (Lunbeck). Ms.

Perch composed 89.5% of the catch from the Great Lakes and connecting waters in 1954, and 91.2% in 1955. On the basis of catch per hour, fishing quality was best in these waters—3.3 in 1954 and 2.8 in 1955.

#### Creel Census on Experimental Lakes

Of particular interest during the past two years in the creel census on experimental lakes where fishing regulations are being tested were results from special rules on size limits and seasons for largemouth and smallmouth bass, northern pike, and walleyes. The following provisions went into effect in the spring of 1954 and will continue at least through the winter of 1958-59:

There are no size limits on bass, pike, and walleyes on three lakes: Big Portage, Jackson County; Duck, Calhoun County; Fine, Barry County.

Larger size limits (largemouth and smallmouth bass, 16 inches; northern pike, 24 inches) are in effect on three other lakes: Fife, Grand Traverse and Kalkaska counties; Minnewaukon, St. Joseph County; Sugarloaf, Washtenaw County.

A year-round open season for all species of fish is in effect on the following three lakes: Bear, Manistee County; Pontiac, Oakland County; Whitmore, Washtenaw and Livingston counties.

To date, bass populations show no abnormal reduction from year-round fishing. A noteworthy fact is the large number of bass less than 10 inches in length that anglers keep (as high as 56% of the bass catch for one summer on one of the three test lakes). Further study will determine whether this cropping of small bass will affect future fishing quality.

Anglers have taken a favorable view of the larger size limits. Creel census data show that the number of bass over 16 inches and pike over 24 inches taken by anglers has resulted in approximately a 50%

increase above the number of fish of these sizes caught from the lakes formerly under the state-wide limits of 10 inches and 14 inches.

The experimental lakes on which a creel census is being taken include Birch in Cass County and Otsego in Otsego County in addition to the nine already mentioned. Study of the effect of a rainbow trout stocking program under which plantings are to be made at four-year intervals is the main objective of the fishing inventory of Birch Lake. The year-to-year status of the northern pike fishery is a prime point of interest in the Otsego Lake census.

Beginning in the winter of 1954-55, a creel census has been under way on Corey Lake, St. Joseph County. Corey Lake has been considered for an experiment in which fishing for rainbow trout during the winter season would be permitted. A census was deemed advisable to provide basic records in the event this liberalization on trout fishing becomes effective.

#### Lake Fish Population Studies

Population estimates for several of the experimental regulation lakes were made by the mark-and-recapture method on fish caught by trap nets. These lakes are Whitmore, Sugarloaf, Big Portage, Fine, and Fife. Such studies, along with creel census, are a basis for evaluating experimental regulations which are in effect on these waters.

Suckers were removed from Big Bear Lake, Otsego County, in the spring of 1955. Trap-netting was repeated in the spring of 1956 to catch suckers that had grown to maturity during 1955. The purpose of this program is to investigate the effects on game fish of reducing competition for food.

## Fish Toxicants

Studies were undertaken to determine whether the insecticide toxaphene can be used safely as a fish toxicant. This chemical costs much less than toxicants that contain rotenone, and its use is more likely to result in complete eradication. Its chief disadvantage is that toxicity may persist for a long time. Conditions necessary to bring about detoxification were investigated in the laboratory, and a detoxifying mechanism was discovered.<sup>8</sup> Techniques based on the laboratory results have been used in field trials. Six lakes have been treated with toxaphene, and fish have been completely eliminated in all of them. The lakes were toxic from 2 to 11 months.

A pamphlet was prepared on the use of rotenone products for killing fish.<sup>9</sup>

## Aquatic Plant Control

Further tests have been made on the effectiveness of new algaecides. Experiments at the Hillsdale Rearing Ponds and at the Drayton Plains Hatchery have shown that "Delrad" is highly effective against green algae and musk grass (Chara). However, treatment of ponds with the organic copper algaecide "Cutrine" have not been successful.

A study was begun on the value of aquatic weed control as a tool in maintaining favorable balance in fish populations of warm-water lakes.

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<sup>8</sup>Hooper, Frank F. and Alfred R. Grzenda. The use of toxaphene as a fish poison. Trans. Amer. Fish. Soc. In Press.

<sup>9</sup>Hooper, Frank F. 1955. Eradication of fish by chemical treatment. Fish Div. Pamph., No. 19, 6 pp. (Mimeographed).

Minnewanna Lake in Lapeer County and one of the rearing ponds at Hillsdale are being used for the experiments.

A pamphlet on methods of using sodium arsenite for control of aquatic weeds was prepared to fill requests for information on weed eradication.<sup>10/</sup>

#### Cooperative Projects with Michigan State University

In continuation of previous policy, research was conducted by graduate students at Michigan State University. Faculty members and senior members of the Institute staff jointly supervised the various projects. The state Department of Conservation gave financial support. Faculty members also contributed research effort.

Fertilization Experiments. A study on treatment of acid bog lakes with lime and the effects upon the numbers of fish-food organisms and growth of fish was completed.<sup>11/</sup> The procedure shows promise for application in fishery management.

Preliminary reports were prepared on the results of introducing inorganic fertilizer into a marl lake which is the source of a trout stream.<sup>12,13/</sup> The investigation is being continued. Such fertilization shows promise as a management procedure to increase growth of fish in marl lakes and cold-water streams.

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<sup>10/</sup>Hooper, Frank F. and A. B. Cook, Jr. 1955. Chemical control of submerged water weeds with sodium arsenite. Fish Div. Pamph., No. 16, 6 pp. (Mimeographed).

<sup>11/</sup>Waters, Thomas F. 1956. Chemical and biological effects of lime application to bog lakes in northern Michigan. Ph.D. thesis.

<sup>12/</sup>Alexander, Gaylord R. 1956. The fertilization of a marl lake. M.S. thesis.

<sup>13/</sup>Grzenda, Alfred R. 1956. The biological response of a trout stream to headwater fertilization. M.S. thesis.

Improvement of Marl Lakes. A study has continued for discovery of the chemical, physical, and biological factors responsible for poor fishing quality in marl lakes and for remedial techniques that will increase biological productivity and provide more fish. Various lake improvement techniques were tested. Fertilizers were introduced into the waters, the marl substrate was altered by addition of various forms of organic matter, and aquatic vegetation was planted. Fourteen species of plants were employed in the research aimed at finding means of establishing vegetation in marl lakes. The criteria for measuring the success of each experiment were based on statistical enumeration of the organisms present on the experimental area before and after each method was tried.

The biological responses to certain of the improvement methods employed were significant. Fish tended to congregate in the experimental areas where plants had been established, and used them effectively for spawning. In some cases the production of aquatic vegetation was increased 90-fold, and fish-food organisms, 11-fold.

Effects of Pollution on Fish Production. An investigation is under way to evaluate the effects of domestic and industrial pollution on the game fish population of a warm-water stream. A preliminary report on this project was written. <sup>11/</sup>

Hybridization Studies. Hybridization experiments in search for a pond fish that is less prolific than our native species and that will have desirable growth and sport characteristics have yielded several good possibilities.

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<sup>11/</sup>Brehmer, Morris L. 1956. A biological and chemical survey of the Red Cedar River in the vicinity of Williamston, Michigan. M.S. thesis.

Predation on Fish Foods. An experiment was conducted to determine the relationships between the weight of fish that can be grown in a pond and the amount of natural foods present.<sup>15/</sup>

Improvement of Hatchery Diets. A study was concluded in search for satisfactory dry diets for hatchery trout.<sup>16/</sup> The goal was to develop pelleted mixtures that contain no meat other than fish meal (to reduce food costs) and which would produce healthy, legal-size fish in the shortest time possible. Rations were developed during the course of the experiments that are superior to raw meat diets in enough respects to warrant their use for full-scale hatchery feeding.

#### Cooperative Projects with University of Michigan

Close cooperation between the Institute and the University of Michigan has prevailed ever since the fisheries research unit was established in 1930. Students have done research work under graduate fellowships with Department support. Senior members of the Institute staff have honorary faculty status and serve on doctoral committees.

Age Determination of Northern Pike. A study was completed in which the validity of marks on the scales for use in aging northern pike was proved and in which criteria for determination of true annuli were established. Means of distinguishing false annuli were also determined.<sup>17/</sup>

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<sup>15/</sup>Hayne, Don and Robert C. Ball. Benthic productivity in relationship to fish production. Limnol. and Oceanog. In Press.

<sup>16/</sup>Grassl, Edward F. 1956. Pelleted dry rations versus standard meat rations for trout. Ph.D. thesis.

<sup>17/</sup>Williams, John E. 1955. Determination of age from the scales of northern pike (Esox lucius L.). Ph.D. thesis.

Food Habits of Burbot. An investigation was made on the kinds of food eaten by the burbot or lawyer in a trout stream.<sup>18/</sup> The feeding habits were found related to size of food and size of consumer. The sequence of forms most commonly consumed by burbot from small to large size was insects, small crustaceans, crayfish, and fish. Fish was the main food of burbot over 10 inches in length; blacknose dace and rainbow trout were eaten more frequently than other fish.

Fish Food Study. Quantitative and qualitative investigations of invertebrate populations in Houghton Creek (Ogemaw County) were continued. A check on the effects of the Rifle River watershed control program is one of the aims of this study. A study has been made on effects of small amounts of domestic sewage upon the trout population through the influence of the waste on the bottom fauna. A study is being made of the biology of the aquatic sow bug (Asellus intermedius) that lives in Houghton Creek. This organism is a preferred food of brown trout here, and is especially important in that it is abundant during the summer when the insect population in the stream is at low ebb. In addition, 22 species of adult stoneflies and about 75 species of adult caddis flies from Houghton Creek have been identified.

Smallmouth Bass Study. Investigation of the life history of the smallmouth bass of the Great Lakes has continued. The field work of this project, centering in the area off Waugoshance Point in northeastern Lake Michigan, was completed in 1955. Analysis of the data is in progress. Upon completion of this research, facts on the life

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<sup>18/</sup>Beaton, Alfred M. 1956. Food habits of the burbot (Lota lota lacustris) in the White River, a Michigan trout stream. >Copeia, No. 1, pp. 58-60.