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BEAVER-TROUT INVESTIGATIONS IN MICHIGAN[1/]

By

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Abstract

A review of previous work on the beaver-trout problem in Michigan is presented, and reasons for the selection of various areas for intensive study are outlined with special reference to Hunt Creek, Montmorency County, and the Middle Branch of the Ontonagon River, Gogebic County. The dams and ponds under observation along these waters are regarded as representative examples of the diversified fish and wildlife habitats created by beaver impoundments.

Physico-chemical data obtained during the summer of 1948 are presented. The figures do not show a noticeable warming of the water during its passage through the three Hunt Creek beaver ponds. The warmest maximum-minimum thermometer readings at the inlet of the uppermost pond fluctuated over a 15° range with a maximum of 66° F., while those below the last of the three dams varied over a 14° range with a maximum of 68° F. Evidently at no time during the course of the summer (June 18-September 9) did these beaver ponds go above 70° F. in temperature, although air readings varied from 102° F. to 34° F.

1/ Paper No. 32 presented at Tenth Midwest Wildlife Conference, Ann Arbor, Michigan, December 11, 1948.

It appears that beaver dams in their first two years on the Middle Branch of the Ontonagon River may raise the temperature of the water above the theoretical 70° F. maximum tolerance of brook trout during periods of extreme heat such as that which occurred late in August of 1948. For the most part oxygen content of the water is not decreased unduly. However, in cases of intense decomposition of organic matter such as takes place in the beaver pond under observation on McGinty Creek, dissolved oxygen does at times drop below 5.0 p.p.m., the minimum consentration theoretically necessary for brook trout survival.

At the Hunt Creek Fisheries Experiment Station, the portion of the stream (Section D) on which the beaver dams are located is included in the area currently managed under an experimental regulation which permits anglers to take 6-inch brook trout for the creel in contrast to the statewide size limit of 7 inches. The catch during the summer of 1948 was the largest recorded in management history of Section D, though heavier angling pressure was recorded in both 1941 and 1942; the take of adult brook trout per hour (0.84) equaled the previous high of 1939.

The most abundant fish predators around the ponds under observation in the Upper Peninsula of Michigan were kingfishers, bitterns, and great blue herons, in that order. Waterfowl, particularly black ducks, were fairly numerous also, though their numbers in the general vicinity of Watersmeet were somewhat reduced from those of 1947. American mergansers were common, and some mallards and wood ducks also were seen during the course of this investigation.

Various sportsmen and conservation administrators are often outspoken either in favor of beaver dams on trout streams or in opposition to them on such waters. The two lines of thought are well presented by Leonard (1938). Arguments advanced in support of the beavers hold that their activities favor: (1) production of a good supply of fish food behind the dam for two to four or more years; (2) development of better shelter for trout; (3) maintenance of water flow in temporary streams, and checking of torrential run-offs; and (4) augmentation of trout habitat by an increased water supply in spring runs.

Opponents of beaver dams maintain that: (1) in four or five years the ponds become "sour," a source of minor pollution, and at the same time increase the number of parasites in trout; (2) the dams constitute a barrier to spawning migrations, and the silt accumulating behind beaver dams covers spawning beds and chokes springs; (3) trout in these impoundments are concentrated for the angler and the predator, who are likely to overfish the area and deplete the trout stock; and (4) the oxygen content of dammed streams is so reduced and the water temperature raised so high that the fish population is dominated by chubs rather than the favored trout.

The generalizations mentioned above obviously are not entirely applicable to every beaver pond, the effects of a dam being different according to the type of stream on which it is located. In most instances Michigan's beaver dams seem detrimental on slow streams, whereas on faster waters they may be a decided aid in trout production.

The problems in game and fisheries management brought about by the presence of beaver dams on Michigan trout streams were first investigated

in detail by J. C. Salyer in 1933 and 1934. When he left to take a position with the Federal Government, a program of correction based on the results of his field work was initiated by G. W. Bradt of the Game Division and J. W. Leonard of the Fish Division's Institute for Fisheries Research.

There were several objections, particularly on the Upper Peninsula, to the procedure of dam removal and so-called "stream-cleaning." In 1944, Dr. Bradt and W. F. Carbine, the latter then employed by the fisheries research branch of the Michigan Department of Conservation, made a survey to locate critical beaver-trout areas, and to learn sportsmen's views. They noted conflicting opinions both among club members and between clubs in the same locality, but formulated a departmental policy which held until the end of the war, when it was hoped the problem could be further investigated.

In the fall of 1947 another project for the study of beaver-trout relations, scheduled to run for three years, was set up by the Institute for Fisheries Research as a fellowship at the University of Michigan. This work is being carried on by myself under the direction of J. W. Leonard and K. F. Lagler.

Since Salyer's research had been in the nature of an extensive study of this problem over the whole state, it was decided that the present undertaking should be intensive in scope, and that it should follow a few selected streams over a period of years to learn in detail the effects of beaver dams on some representative Michigan trout waters. It was further decided that emphasis should be placed on streams in one drainage area rather than on small tributaries of several larger river systems.

There were several factors to be borne in mind in the selection of study areas. Variations in beaver ponds regarding size, type, frequency, and the character of the streams themselves were apparent. Ponds sufficiently accessible to be visited twice a week were selected for observation, and a balance was reached between roadside reconnaissance and the transportation of field equipment for considerable distances through the brush.

Cooperation was solicited from other Department employees who might be available for part-time help. The aid of various men in the Field Administration, Fish, and Game divisions fortunately has been forthcoming when needed, and is gratefully acknowledged.

Salyer's recommendations (1935) as administered were mostly applicable to the streams of lower Michigan, and in the main were not favorably received by the trout fishermen of the Upper Peninsula. Although current field observations are being carried on most intensively in the latter portion of the state, close contact is being maintained with three beaver ponds at the Hunt Creek Fisheries Experiment Station, Montmorency County, in lower Michigan. These dams were constructed in the summer of 1947, and have been followed subsequently by myself and the resident staff of the station.

Of these dams and ponds on Hunt Creek, the one furthest downstream, of uncertain age, was built around an old stream improvement structure installed in 1935. The second, built in 1947, is active at present, retaining about four feet of water, and the third (1944?) is still traversed by beaver, though it is not being maintained solidly. This stream remains cold most of the summer. At Hunt Creek, an intensive creel census is taken from every angler fishing in the experimental area. With

a resident staff, singularly valuable information can be obtained the year round, some of which will be presented later in this report.

In the spring of 1948 a reconnaissance trip was made through the Upper Peninsula, during which areas occupied by beaver were observed from ground and air. Controversy among sportsmen on the beaver-trout problem seemed to be hottest in the vicinity of Negaunee, Ishpeming, and Marquette. Since it was felt that chances of obtaining definitive biological information would be greatest in a district where interested sportsmen were in disagreement, it was decided that a popular stream familiar to anglers in this area should be the focal point of the study.

A number of well-known trout streams were excluded from consideration as potential study areas for reasons which are discussed below. Conservationists have long recognized that the streams of the Keweenaw Peninsula and the region between Ontonagon and the Porcupine Mountains constitute a special problem in themselves, and, therefore, these areas were not considered for investigation on a large scale at this time.

The Yellow Dog River in Marquette County is in a remote region from which virgin timber is now being cut, and most of the beaver dams are evidently on its headwaters far from the beaten track. The Escanaba River watershed, lying largely in Marquette and Dickinson counties, is a vast one; accessibility and a convenient base for year-round operations were again lacking. A large part of the Paint River system is marginal trout water, and most of the beaver dams seen there were, like those on the Escanaba, of questionable age.

There were several factors responsible for the selection of the Middle Branch of the Ontonagon River in Gogebic County as the stream on

which the field work of this project is to be concentrated. Having worked in this general area during 1947 as assistant to the District Fisheries Biologist, the investigator was familiar with several of the streams tributary to the river itself. The State Fish Hatchery at Watersmeet provides a convenient base of operations, and there are several noted beaver pond fishermen in the town itself.

The pond under observation on the Middle Branch of the Ontonagon River is about as far downstream as a beaver dam will hold during the heavy spring run-off. It is at least two years old, and is subject to some fishing pressure; the dam holds more than three feet of water, and there is an extensive flooded meadow upstream.

Morrison Creek, a tributary of the Middle Branch, has a series of 14 dams on it, of which two, those furthest upstream and downstream, are active at present. The former is a new one discovered under construction during August, 1948; the lower pond was formed a year earlier. There is much dead alder behind a dam which was maintained by beaver during the summer of 1947, and then abandoned by them in favor of the area just downstream.

McGinty Creek has not been cruised from its headwaters to the confluence with the Middle Branch, but the area has probably been "beavered" many times in the past. The current pond itself is divided into two parts, a meadow, and the pond proper, by an old dam presumably blown out by a CCC crew in the '30's.

The East Branch of Bluff Creek just over the line in Ontonagon County has two series of beaver ponds which received some attention during the

summer of 1948. A convenient study area chosen was that on Stager Creek in Iron County, where a beaver pond is divided by a fill on U. S. Highway Number 2 where it crosses the creek south of Crystal Falls. Whether or not the accessibility in this instance is worth more than the prospect of human interference remains to be seen.

As an alternative watershed for study, in case the observations on the Middle Branch of the Ontonagon River should be nullified by unforeseen events, the Paint River system might be used. Stager Creek mentioned above is one of its tributaries, and in June, 1948, one of the forestry students from the University of Michigan's camp on Golden Lake discovered a new beaver dam less than a foot high on Cook's Run, another tributary. This structure retained a 2.5-foot head of water when last visited in September.

In addition to streams selected for intensive investigation, an extensive survey of "problem" areas and others called to the attention of the investigator on streams throughout the state is to be made during the course of the work on this project. A special form for beaver pond appraisal has been devised, and several of these have been filled in to date. The cards will ultimately be included in the file of Lake and Stream Survey records at the Institute for Fisheries Research, and other offices of the Fish Division.

One of the major phases of any ecological study is the mapping of the areas under investigation. Cartography is being done jointly by the writer and William Lawrence, a graduate student in the Forestry School, University of Michigan, who is studying beaver management in the Ottawa National Forest and shares some study areas with myself.

Two sets of air photos are available, one taken in 1947 using infrared and an earlier one photographed with panchromatic film. These photos are valuable as a source of base maps, from which interpretations can be checked readily in the field. Besides maps of this sort, plane table maps of the ponds and surrounding terrain are being prepared, though the hazards of flooded alder swamps make this an exceptionally difficult task. However, the beaver ponds are constantly changing in depth, shore line, and in other ways, and may become either more or less accessible with the passage of time.

In the collection of data on this project, we have borne in mind 17 pertinent questions, first formulated by Salyer, many of which have not been answered by subsequent investigators. Though this is not essentially a fair-weather biological problem, nevertheless most of the field work is being concentrated in the summer months, during which effects of beaver activities are likely to be most critical for trout, and for which a check-list of operations has been formulated. The collection of data was divided into two major categories, physico-chemical and biological.

Among the physico-chemical observations, records are being kept of temperature of air and water, with maximum-minimum thermometers where possible; of chemical characteristics of the water as shown weekly by standard water analysis methods; and of other physical properties such as color and turbidity. Chemical water analyses may be performed at intervals throughout the year, although the difficulties with these procedures in winter remain to be seen.

Biological aspects of the work are concerned chiefly with the fauna rather than the flora, though an attempt is being made through periodic

plant collections to learn more about the ecological succession of plants in and around beaver ponds. These are being made in the late summer and early fall when seeds are available as an aid in the identification of the plants.

The main zoological aspects of this investigation concern the fish population, either directly or indirectly. Attempts to do some seining were prevented, in most ponds, by the presence of numerous snags. Creel census notes were taken at every opportunity, and attempts were made also to obtain both trout scales and stomach samples for future analysis.

The bottom fauna was sampled at monthly intervals to note changes, and for later correlation with the contents of fish stomachs. Record was made of all wildlife seen in the vicinity of beaver ponds, and also of distinctive signs, particularly for the beaver themselves, fish predators, and various game species, especially the waterfowl found utilizing beaver pond habitat. The ponds were visited once or twice a week, and notes were taken on 5 x 8-inch sheets, including the standard stream survey forms of the Fish Division.

The above program for the summer is being supplemented by efforts at other times of year. An attempt is being made to photograph the dams and ponds from established locations during all four seasons to show the changes which occur with time. For such a pictorial review it has been found that color film is much more satisfactory than black and white. Miscellaneous ecological notes are being taken on the effects of spring break-ups, ice action, and other winter phenomena in the ponds under observation.

Changes in bottom fauna and the fish population are to be investigated in seasons other than summer. Creel census in the Upper Peninsula is to be

intensified during the opening weeks of trout season; efforts will be made in connection with this activity to secure samples of scales and stomachs, and also to note carefully evidence of parasitized fish.

Problems concerning fish population studies in beaver ponds will be mentioned later in this discussion. Some attempts have already been made in this direction at Hunt Creek, where the resident staff has also been collecting information regarding trout movements and spawning in the beaver ponds themselves and in adjacent waters.

Interpretation of the results of the 1948 summer's field work is not yet complete, but some of the noteworthy physico-chemical and biological material may be presented at this time.

At the Hunt Creek Fisheries Experiment Station, in the "beavered" portion (Section D), eight maximum-minimum thermometers were put in the water for the summer at strategic locations, and one was left in the air near the middle unit of the three dams. These stations were established on June 18, and an attempt was made to read the instruments daily through September 9.

The figures for the summer of 1948 (Table 1) do not show a noticeable warming of the water during its passage through these three beaver ponds; however, this section of the stream is fed by a few springs of its own, and the one sizeable tributary did not show any significant difference in temperature from the waters of Hunt Creek proper. The highest thermometer readings at the inlet of Pond III fluctuated over a 15° range with a maximum of 66° F., while those below the last of the three dams varied over 14° with a maximum of 68° F. At no time during the course of the summer were water temperatures above 70° F. observed in these ponds, though air readings reached a high of 102° F.

Table 1--Maximum Temperature Readings in Degrees Fahrenheit, Hunt Creek, Section D, Summer of 1948

Period	Inlet of Pond III	Pond III	Outlet of Pond III (Inlet of Pond II)	Pond II	Air east of Dam II	Tributary entering Pond II	Outlet of Pond II (Inlet of Pond I)	Pond I	Outlet of Pond I
June 18-19	66°	66°	65°	60°	66°	62°	57°	62°	...
June 20-26	62°	64°	65°	65°	88°	61°	65°	65°	65°
June 27-July 3	63°	64°	63°	63°	84°	60°	64°	65°	64°
July 4-10	63°	66°	67°	67°	99°	63°	68°	68°	67°
July 11-17	64°	64°	67°	66°	92°	61°	67°	67°	68°
July 18-24	64°	63°	65°	64°	90°	63°	65°	65°	63°
July 25-31	63°	65°	64°	67°	88°	67°	67°	67°	67°
Aug. 1-7	62°	64°	65°	63°	86°	65°	65°	65°	64°
Aug. 8-14	62°	63°	63°	60°	86°	61°	64°	62°	61°
Aug. 15-21	60°	60°	64°	62°	94°	64°	63°	62°	62°
Aug. 22-28	63°	66°	66°	67°	102°	64°	68°	68°	67°
Aug. 29-Sept. 4	64°	65°	66°	65°	96°	64°	65°	65°	64°
Sept. 5-9	58°	61°	63°	62°	99°	60°	63°	63°	62°

Chemical analyses of the water were made four times during 1948. In the winter (February 20), with the air temperature varying from 10° to 14° F., dissolved oxygen was present in Ponds I and III at a rate of 13.7 and 13.0 p.p.m. respectively, the pH in each instance being 7.8 in the 34° F. water.

In the early summer (June 18), with air temperatures of 56°-59° F. and water 45°-50° F., oxygen content in the three ponds progressing upstream was, respectively, 10.0, 11.0, and 11.6 p.p.m., with questionable pH readings of 8.4. Later in the summer (August 21 and 23) the oxygen content ranged from 7.4 p.p.m. in Pond III (a surface determination made after a period of showers), to 10.1 p.p.m. at the surface in Pond II and 9.9 p.p.m. at the surface of Pond III, pH values varying over a narrow margin—7.6 to 7.8.

The late summer (September 11) determinations of oxygen progressing upstream through the ponds were 8.9, 9.8, and 10.7 p.p.m. respectively, with pH readings ranging from 7.4 to 7.6.

The lowest oxygen reading obtained, 7.4 p.p.m., is still well above the minimum of 5.0 p.p.m. theoretically necessary for good survival of brook trout. In the first year these beaver pond waters did not show physico-chemical conditions detrimental to their supporting a good trout population.

The weather of the spring and summer of 1948 in the western end of the Upper Peninsula was unusual in that the former was an extremely dry season, stream levels throughout the region being 1 or 2 feet below the normal and lake levels 2 or 3 feet below the average conditions throughout the summer. The last two weeks of June were spent in the final selection of study areas, intensive field observations commencing in

early July. Periods of extreme heat were the week following July 4, and the nationwide wave late in August, which hit the vicinity of Watersmeet from the 23rd through the 26th of that month.

Oxygen samples during the Upper Peninsula phase of this study were all taken at the uniform depth of 2 feet. Morning and afternoon temperature records are shown on the two figures appended.

Temperatures in the upper end of the beaver pond on the Middle Branch of the Ontonagon River itself during the period June 24-September 8 (Table 2) fluctuated at the surface over a 17° range, the highest figure (73° F.) being noted on August 27. The outlet reached a high of 70° F., and the water at the dam itself (depth of two feet) was also as warm on one occasion.

The eight sets of chemical water analysis data show that the oxygen content was reduced from the upper end of the pond to the dam itself in all but one case, there being no difference between the two 5.6 p.p.m. readings on August 20. The greatest loss was from 8.2 to 6.3 p.p.m. on August 6, and on the 27th of this month the two stations each showed their minima for the summer of 4.3 and 4.1 p.p.m. respectively. It may be repeated that 5.0 p.p.m. is considered as the minimum oxygen concentration required by trout. During this period the pH readings ranged from 6.6 to neutral.

The water in the upper end of the active pond on McGinty Creek (Table 3) ranged in temperature from 71° to 50° F. during the summer at the surface, and from 64° to 49° F. at a depth of 2 feet; in this period the water near the dam itself varied from 72° F. to 54° F. at the surface, and from 66° F. to 54° F. at a depth of 2 feet. At no time was the outlet above 70° F.; it is believed that there are some springs still flowing into the lower reaches of this pond which on occasion tend to counteract the sun's warming effect on the water.

Table 2—Temperatures in degrees Fahrenheit in an Active Beaver Pond, Middle Branch of Ontonagon River, Gogebic County, Michigan, Summer, 1948

Date	Morning			Date	Afternoon		
	Air	Inlet	Outlet		Air	Inlet	Outlet
				June 24	81°	64°	64°
				July 12	75°	69°	69°
				July 15	69°	61°	63°
				July 20	67°	67°	65°
July 23	59°	56°	56°				
July 27	60°	60°	60°				
July 30	60°	60°	60°				
				August 3	62°	59°	59°
				August 6	70°	56°	56°
August 11	68°	61°	60°				
				August 14	78°	63°	59°
August 20	70°	60°	62°				
				August 27	76°	73°	70°
				Sept. 4	80°	66°	65°
Sept. 8	...	60°	60°				

Table 3--Temperatures in degrees Fahrenheit in an Active Beaver Pond, McGinty Creek, Gogebic County, Michigan, Summer, 1948

Date	Morning			Date	Afternoon		
	Air	Inlet	Outlet		Air	Inlet	Outlet
June 26	74°	56°	56°				
July 7	62°	60°	61°				
July 10	76°	71°	70°				
				July 12	72°	61°	66°
				July 19	67°	70°	64°
July 22	54°	52°	55°				
July 26	66°	53°	57°				
August 2	65°	50°	57°				
				August 5	66°	62°	60°
				August 7	74°	60°	59°
				August 9	72°	62°	59°
August 13	66°	50°	55°				
				August 18	71°	61°	60°
				August 23	82°	67°	66°
August 27	75°	67°	70°				
Sept. 3	72°	60°	61°	Sept. 3	78°	66°	66°

The seven upstream oxygen determinations ranged from 9.9 to 3.7 p.p.m., and those immediately above the dam from 3.6 to 5.0 p.p.m. However, the oxygen content downstream shows a recovery from the low value noted at the dam itself. The pH in this pond varied from a questionable reading of 6.2 (acid) to neutral.

From cruising Morrison Creek in the summer of 1947, it is known that several springs underlie the currently active pond, which, judging from temperature observations, were flowing at a good rate during the past season. Of 15 sets of readings during 1948 (Table 4), the water at the surface of the active dam was on eight occasions cooler than that flowing into the pond over an old dam upstream. Temperatures at the latter location varied from 79° to 53° F., the larger figure being registered on August 25. Recordings at the newly-built structure ranged over 22° to a maximum of 80° F., the high figure being noted on the same day as above, when the outlet itself was 76° F. However, the thermometer showed a temperature of but 72° F. at a depth of 2 feet.

Oxygen content in this pond was unusually high--7.0 to a questionable 12.5 p.p.m., while at the next dam upstream it varied between 8.4 and 10.5 p.p.m., each of the minimum readings being recorded on August 25 when maximum temperatures were also noted.

From the above figures it appears that beaver dams in their first two years on the Middle Branch of the Ontonagon River do raise the temperature of the water above the theoretical 70° F. tolerance of brook trout during periods of extreme heat such as that which occurred late in August of 1948. For the most part oxygen content of the water is not decreased unduly except in cases of intense decomposition such as takes place in the beaver pond under observation on McGinty Creek.

Table 4--Temperatures in degrees Fahrenheit in an Active Beaver Pond, Morrison Creek, Gogebic County, Michigan, Summer, 1948

Date	Morning Air	Morning Inlet	Morning Outlet	Date	Afternoon Air	Afternoon Inlet	Afternoon Outlet
June 24	69°	59°	60°				
July 6	68°	56°	66°				
July 12	60°	56°	60°				
July 16	66°	57°	60°				
				July 20	78°	64°	66°
				July 22	55°	53°	54°
				July 26	64°	64°	61°
				July 30	64°	64°	60°
August 3	64°	52°	57°				
				August 5	68°	70°	57°
				August 13	70°	66°	63°
				August 19	75°	67°	60°
				August 25	82°	79°	76°
				Sept. 1	72°	62°	61°
				Sept. 3	80°	72°	68°

Turning now to some of the biological material, that portion not analyzed to date includes scale samples, fish stomachs, bottom samples, and aquatic plants collected during the course of the summer's investigation. The intensive creel census conducted on Hunt Creek has been tabulated by the resident staff there. The portion of this stream on which the beaver dams are located is included in an area now being managed under an experimental regulation which permits anglers to take 6-inch brook trout for the creel. This reduced size restriction may be an added attraction to fishermen who try their luck in the beaver ponds, for the catch on Section D during the past summer was the largest recorded in the history of the Hunt Creek Fisheries Experiment Station for that portion of the stream. Heavier angling pressure was recorded in both 1941 and 1942 than in 1948, yet the catch of adult brook trout per hour for 1948 (0.84) equaled the previous high of 1939.

There are several handicaps to intensive creel census on the Upper Peninsula streams under observation, there being neither a conservation officer nor a biologist currently on duty at Watersmeet to aid in this phase of the study. Several reports have been found among the general creel census returns for Iron and Gogebic counties which will be useful in this investigation, and efforts along this line are to be increased during future trout seasons. A special designation for beaver ponds on the general creel census blanks is being considered for the years to come.

In passing, the noteworthy angling of a Watersmeet resident is well worth mentioning. This man is a confirmed beaver pond fisherman, who carries his hook and line with him and cuts a "government stick" on location at the pond of his choice. During the past summer Mr. Herman Tirpe, an employee of the Watersmeet Hatchery, took a total

of 408 brook trout, only two of which were hatchery fish, in 154 hours of angling, for an average catch rate of 2.65 fish per hour. This high catch brings to mind one of the question's raised by Salyer, viz., whether such yields are due primarily to the increased productivity of beaver ponds per se, or to a concentration of stream fish in comparatively open, unprotected areas where they can be easily harvested by angler and predator alike.

In late September and early October, a fish population study of the beaver ponds on Hunt Creek was conducted under Dr. Shetter's direction. Both electric shocker and trap nets were used in the lowest pond, but the former apparatus could not be employed in the upper two. Some difficulty was experienced with the beavers themselves, plus muskrats, in the active pond, and the nets had to be mended extensively, not to forget the removal of one 40- or 50-pound individual.

The fish populations of the lower two ponds were determined to be as follows:

		Shocker	Trap-net
Pond I	7" and up	19	15
	6"-7"	18	18
	sub-legal	51	51
	fingerlings	446	451
Pond II	7" and up	...	109-110
	6"-7"	...	52
	sub-legal	...	174-191
	fingerlings	...	67-92

The fish in the uppermost pond were free to move both upstream in the creek proper, and downstream over that pond's impoundment (Dam III).

Some fish previously tagged in the population study of Pond II were recovered in the third pond, indicating that the third dam was not a barrier to upstream movements. This movement also reflects on the accuracy of the estimate made for the population of the second pond.[2/]

Throughout the summer in the Upper Peninsula, records were kept of the wildlife observed around the beaver ponds under investigation, and similar notes were made by the staff at Hunt Creek. Among the game birds seen, woodcock, supposedly not too plentiful on the western end of the Upper Peninsula (Mendall and Aldous, 1943), favored the lowland alders near the beaver ponds, and several ruffed grouse were noted also, plus three jacksnipe during their autumn migration and an equal number of rails during the summer. Red-winged blackbirds were abundant in late June and early July, but were not often seen thereafter.

The predominant fish predators during the day and in the evening were kingfishers (37), bitterns (19), and great blue herons (12). The records for these individuals may be computed on the basis of hours spent in the field on various beaver ponds under observation, though this may not be an accurate index of their actual numbers. Again there is a need for comparison with numbers of such birds seen on other streams providing different sorts of trout habitat. Ospreys were noted over the Middle Branch of the Ontonagon River, but not over the beaver ponds, and a marsh hawk nest containing two young was found in the tall grass of the old beaver meadow on McGinty Creek. Few snapping turtles, and no sign of either water snakes or otters, were seen. Regarding the mammalian predator just mentioned, the above observations include only summer field work, and otter sign may well be found around these beaver ponds during the winter.

2/ A detailed report of the study at Hunt Creek to date is to be prepared by Dr. Shetter and myself during the spring of 1949.

Waterfowl, particularly black ducks, were fairly abundant around these beaver ponds, though their numbers in the general vicinity of Watersmeet were somewhat reduced from those of 1947. On one occasion, during an extensive cruise of the beaver pond on the Middle Branch of the Ontonagon River, a total of 11 blacks was flushed; these birds had evidently been either loafing or feeding on animal matter or the seeds of vegetation in the flooded area. American mergansers were common, and some mallards and wood ducks were also seen during the course of this investigation.

Several significant questions were raised during the first summer's field work. One of these concerns the possibilities of developing methods for maintaining a beaver pond at its most productive stage as a management measure to benefit the most desirable forms of fish and wildlife in such a community.

A second concerns the wisdom of heavy stocking of beaver ponds with legal-size hatchery trout. During the course of the summer of 1948 several instances of liberal plantings of trout in these impoundments were brought to the author's attention. These plantings apparently were made in response to pressure from Upper Peninsula sportsmen who wanted good fishing maintained in their favorate beaver ponds. It may be questioned if this practice is consonant with the goal of distributing hatchery products among the widest number of anglers.

The matter of using an electric shocker in such waters is still being considered, even though trap-nets were used to good advantage at Hunt Creek during the fall of 1948. Dr. Shetter and Mr. Pratt each have some ideas about the adaptations of conventional equipment for such work, which may be available for testing next season.

Regarding the physico-chemical aspects of this study, some of the questions brought to the author's attention thus far, either directly through field work or by others concerned with this project, include the following:

a. What is the depth of the warm-water surface layer, and how does this vary with air temperature?

b. What are the best locations for maximum-minimum thermometers to gain a true picture of temperature conditions?

c. On the hottest days, for how long does the temperature remain high and the oxygen content low, and for how long are brook trout able to endure under such adverse conditions?

d. Do old ponds eventually reach a state of "equilibrium," with less decomposition and decrease in oxygen content than shown previously in the course of their evolution?

e. When, if ever, in the process of beaver pond succession, does rapid decay of organic matter cease?

f. Are there significant variations in oxygen depletion related to the terrain and type of vegetation flooded?

g. Are there satisfactory methods for determination of hydrogen sulfide, methane, nitrogen, and phosphorous content of such waters in the field.

A matter of considerable import in any ecological study of beaver ponds is the accurate aging of the dams themselves. No strictly dependable method has been devised by previous workers in this field, although several valuable suggestions have been made by various persons concerned with Michigan beaver ecology; to date these methods appear to be largely theoretical and academic in nature and untested by actual trials in the field.

The program for this project may include several related studies on the side, these being made largely for comparisons of various sorts. In this category is a summary of the studies conducted on the Gladwin Game Refuge during the past 15 years by Salyer, Bradt, and others. The long-term effects of beaver occupancy of this area could be evaluated from information collected to date, and certainly the ecological succession could be traced here in ponds of known age. However, the abnormal conditions of this location, an over-population of beaver combined with waters marginal for trout, must be borne in mind.

An experimental determination of the minimum, optimum, and maximum physical and chemical conditions for wild Michigan brook trout has long been deemed desirable by several workers in the state's Fish Division. Instances of adaptability of brook trout and their survival in waters of low oxygen content have recently been recorded in New Hampshire (Siegler, 1948, and Jahoda, 1947), indicating that further research along this line is necessary to provide information basic to the formulation of stocking policies and other fish management techniques.

The overall biological productivity of "beavered" streams should be compared with that found on others nearby where beaver dams do not exist. An evaluation of trout stream carrying capacity, considering beaver ponds on one hand and man-made improvement structures on the other, has not been conducted to date. The work of a stream improvement crew during the past summer on the Middle Branch of the Ontonagon River west of Watersmeet may provide a suitable study area for the latter aspect of such a comparison.

A survey of the time of recovery of a stream from its abandonment by beaver to the regaining of its original trout-carrying properties is

being currently undertaken as part of a Pittman-Robertson project in West Virginia, and is being followed with interest by those concerned with the beaver-trout investigation in Michigan.

There is still a possibility of joint support of a project by the Michigan Department of Conservation and the National Park Service, relating to the beaver problem on Isle Royale, but specific plans did not materialize during the first year's work.

A detailed population study of fish above, within, and below beaver ponds, with differential marking of the individuals in each of the three locations, might be used to gain more information about fish movements in a much-beavered stream.

Besides gaining an estimate of the size of beaver colonies from field observations alone, a live-trapping effort to compare the productivity of the animals on trout streams with the figure at which Bradt arrived for the whole state might be made.

There are undoubtedly many other angles worthy of investigation, and the limiting of this problem to the time and manpower resources available has been difficult. However, the Michigan Department of Conservation is making an earnest effort to learn more of the answers to the beaver-trout controversy and to put this information to use in its management of these important resources of the North Country.

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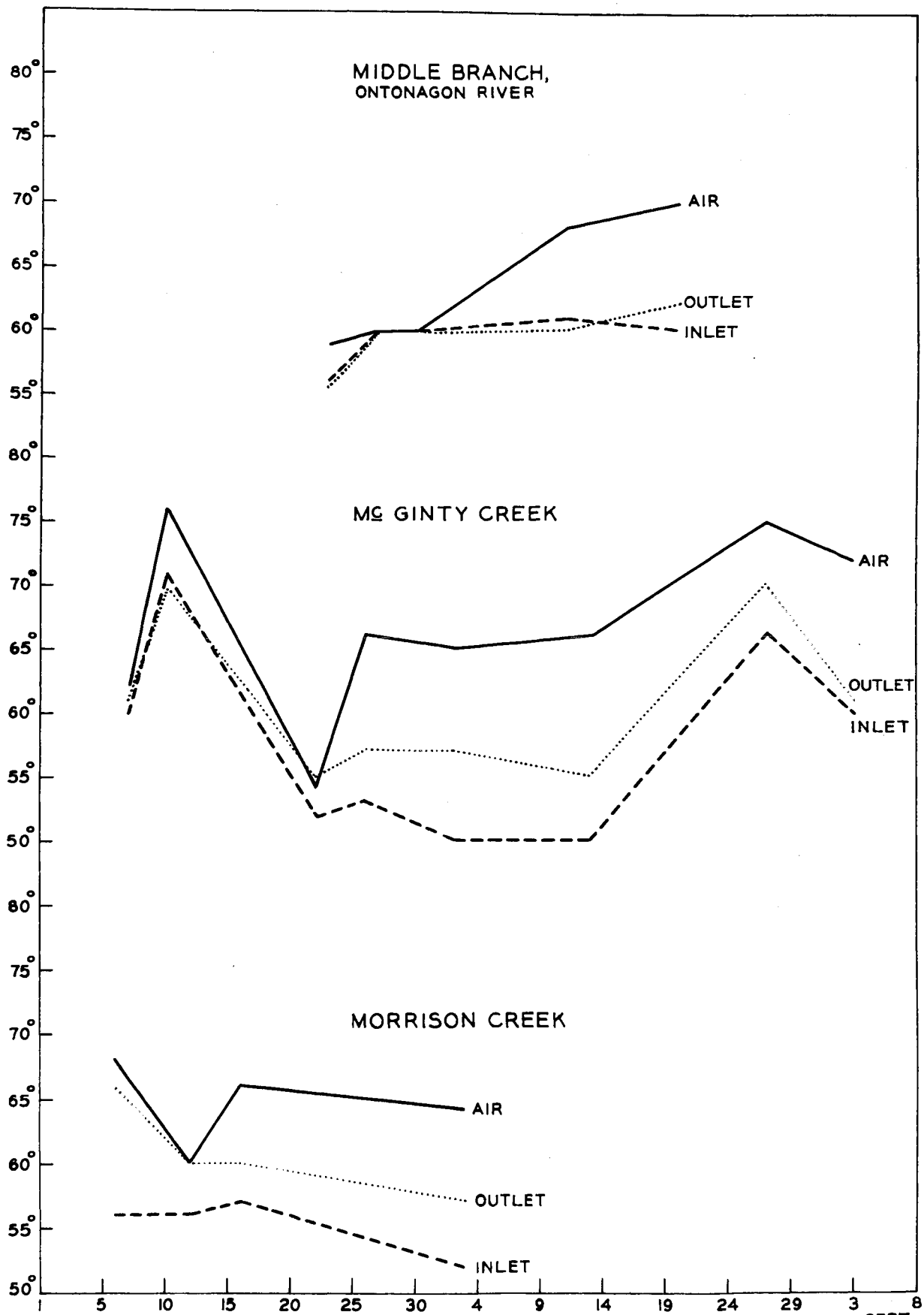
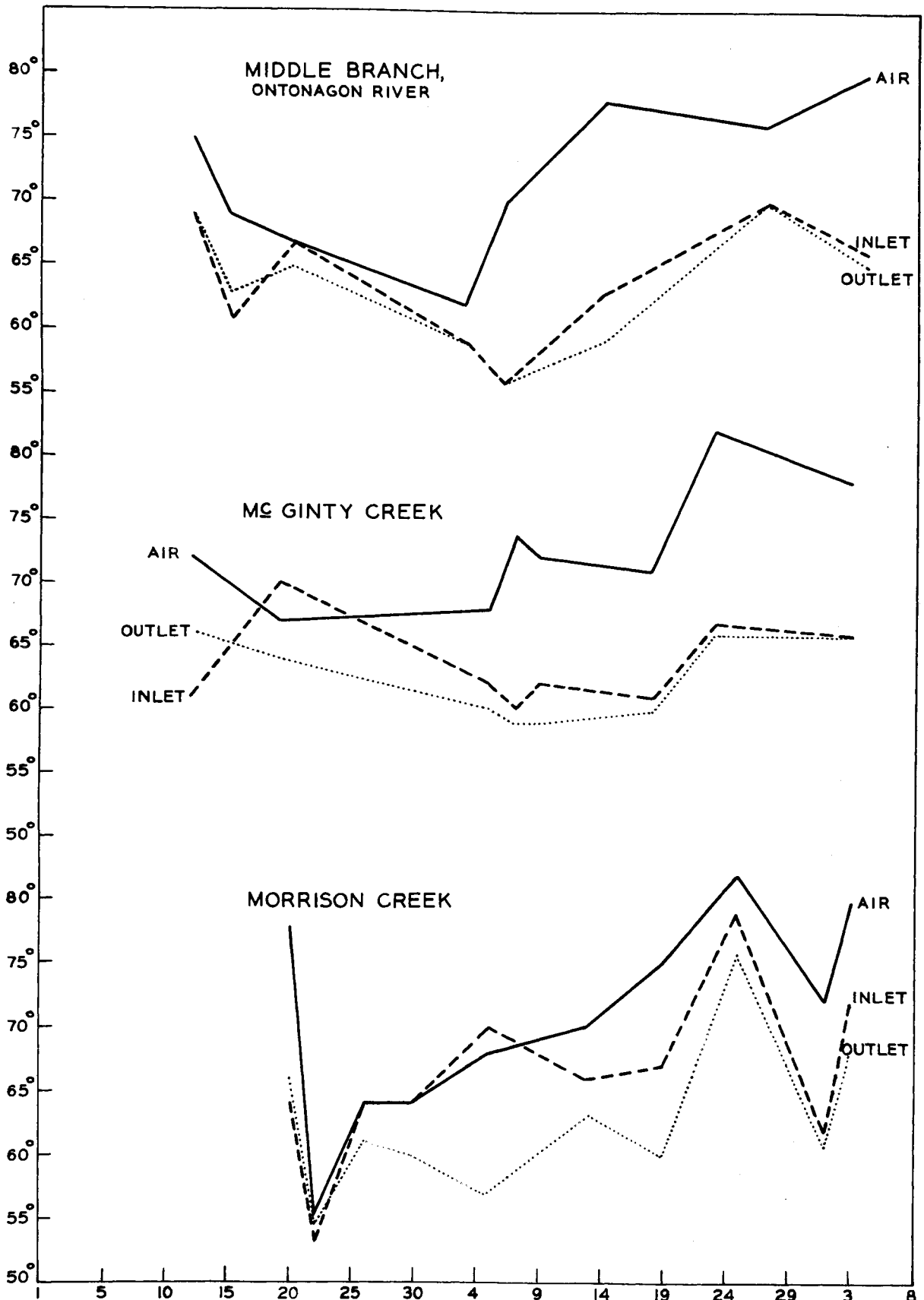
Figure 1



MORNING TEMPERATURE RECORDS, SUMMER, 1948

Figure 2



AFTERNOON TEMPERATURE RECORDS, SUMMER, 1948