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ANGLING AND TROUT POPULATIONS ON THE NORTH BRANCH OF THE AU SABLE RIVER, CRAWFORD AND OTSEGO COUNTIES, MICHIGAN, UNDER SPECIAL AND NORMAL REGULATIONS, 1958-1963[1]

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History of fishing regulations on the North Branch

Special angling regulations, specifying a minimum size limit greater than 7 inches and restrictions on the lure, have been in effect on the North Branch of the Au Sable River during certain periods since the early 1900's. Reports of the former Michigan Fish Commission indicate that between 1911 and 1931 there were 11 years in which the size limit was increased to 8 inches, and 3 years in which the lure was restricted to artificial fly. A state-wide daily creel limit of 50 was imposed in 1903, the limit was lowered to 15 trout in 1927, and finally, in 1952, the present limit for streams of 10 trout per day was put in force. Today, a 5-trout limit is in force on lakes and on a few "special regulation" streams.

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1 Contribution from Dingell-Johnson Project F-27-R, Michigan.

There are few adequate data from which one can compare the relative angling quality of the past and the present. W. B. Mershon, a well-known Saginaw sportsman, recorded in his diary (kindly made available to the senior author in 1935) the annual trout catch for the North Branch of the Au Sable River for the seasons 1909-1913. He estimated the catch to vary between 15, 269 and 31, 061 for the 24.6 miles of river between Dam 2 and the main stream of the Au Sable (621 to 1, 263 trout per mile). No record of angling pressure was given. The relatively few points of access to the river in those days may have limited angling pressure; his estimates are judged to be reasonably correct.

Between 1937 and 1940 an intensive creel census was carried out on 4.6 miles of the North Branch between the county line and the town of Lovells by Civilian Conservation Corps enrollees, supervised by the Michigan Department of Conservation. This census indicated annual catches ranging between 2, 095 and 3, 143 trout (455 to 683 trout per mile). Angling pressure varied from 1, 154 to 1, 446 man-hours per mile.

Estimates of total annual catch obtained from a stratified random creel census for 19.8 miles of stream between Dam 2 and Kellogg Bridge during the past 6 years have varied from 3, 062 to 20, 668 (155 to 1, 044 trout per mile). Fishing pressures ranged from a low of 1, 201 hours per mile to a high of 2, 037 hours per mile.

In 1949, following the research of Cooper (1951, 1952) on brook trout growth in Michigan trout streams, the Conservation Commission imposed a 10-inch minimum size limit on brook trout for the County Line-Lovells section of the North Branch. In 1950 the Commission extended the section with special regulations downstream to Eaman's (making a total distance of 6.9 miles), and at the request of the local sportsmen's club, lures were limited to flies. At this time the daily creel limit was reduced to 10 trout, 5 of which might be brook trout. In 1955 the daily limit was reduced to 5 trout. During the period 1956-1960, the section of the stream within Crawford County was fished under a set of regulations allowing only flies, a 9-inch minimum size limit, and a 5-trout daily limit.

Between 1950 and 1957 the effects of these regulations on angling were measured by a partial creel census which yielded valid data only on the catch per hour per angler. Population changes were followed by "index" runs with electrofishing gear (Shetter, Whalls and Corbett, 1954; Cooper, Shetter and Hayne, 1959). There was some indication that the catch of brook trout 10 inches and larger increased in the restricted water between 1950 and 1954, but declined thereafter to levels typical of the older regulations; these fluctuations were also suggested by electrofishing results.

By the fall of 1957 it was evident that better data were needed to evaluate angling and trout populations changes on the North Branch. The creel census was re-designed so that it would provide estimates of

the total angling pressure and total catch for specific parts of the river. Instead of index runs, population estimates were made on sample areas within each of three experimental stream sections each fall, 1957 through 1963.

Recent investigations

The North Branch of the Au Sable is located about 225 miles north of Detroit in Michigan's Lower Peninsula, in Crawford and Otsego counties. The headwaters lie a short distance east of Otsego Lake at an elevation of approximately 1,275 feet above sea level. In the 33 miles from its headwaters to its junction with the main stream of the Au Sable it drops about 200 feet. Above an old lumber dam (cf. Dam 2, Figure 1) it receives the outlet streams from a number of warm-water lakes, and is marginal trout water. More details of the width, depth, bank cover and native fish species are given by Shetter (1937).

The sections of the stream studied to evaluate regulations are shown in Figure 1. From 1958 to 1960 the Dam 2-County Line area (hereafter referred to as the upper section) was fished under normal Michigan trout stream angling rules (7-inch minimum size limit, 10-fish daily creel limit, any lure). During the same period the County Line-Eaman's section (middle section) and the Eaman's-Kellogg Bridge portion (lower section) were fished under special regulations, which were, a 9-inch minimum size limit, a 5-fish daily creel limit, and artificial flies only.

From 1961 to 1963, the lower section remained under the special regulations and served as a control; the middle section reverted to normal

trout stream regulations, and the upper section was placed under the special regulations. The reason for the regulation reversal was to eliminate the possibility that the differences observed between these two sections were not related in some way to habitat differences. If the more stringent regulations had an effect upon angling quality and upon the trout population, then the fishing and trout populations should have decreased in the middle area. Fishing should have improved and populations should have increased in the upper area from 1961 to 1963.

Creel census methods

Starting in 1958, the creel census was operated under a stratified random sampling plan which provided estimates of total fishing and total catch for the three sections of stream under study. In 1958 and 1959 the census work was done by one clerk. The stream was divided into 18 sub-sections, each slightly longer than 1 mile. The clerk walked sample sub-sections, counting anglers that were fishing. Beginning in 1960, one of two census clerks employed counted anglers by canoeing the entire stream section. These randomly selected instantaneous counts of anglers were the basis for estimating total hours of fishing.

The trout season was stratified into four periods because angling pressure and the response of the fish to various lures differs during the season. Angling pressure varies between weekends (and holidays) and weekdays. It is generally much heavier on weekends. Thus, 50 percent of the samples were taken on weekends and holidays. Each day was

divided into three 5-hour sampling periods when anglers were counted and contacted (8 a.m.-1 p.m., 1 p.m.-6 p.m., 6 p.m.-11 p.m.). The period when a given section was to be sampled was determined from a table of random numbers.

The total of angling hours was computed by multiplying the average instantaneous angler counts within a particular stratum by the total hours within that stratum. The sum of the estimated hours for various strata yield total hours of angling for the season. Clerks interviewed as many anglers as possible at the completion of their trips. Each angler was asked how long he had fished. His creeled trout were counted, measured, and scale-sampled. From these data the average catch per hour per angler was computed, and species composition and size frequency of trout were determined. Each angler was also asked how many sublegal trout he had caught and released. The catch was computed by multiplying total hours of fishing by average catch per hour.

Populations study methods

The fish populations of sample sections of stream 700 to 1,300 feet long were estimated by the Petersen mark-and-recapture method. Details of the method used are given by Shetter (1957). Direct-current electrofishing gear was used to capture the fish. Although many minnows and rough fish are present, only trout were included in the estimates. In 1957 and 1958 one sample section was investigated within each of the three stream sections being tested; during 1959-1962 two sample sections were utilized; beginning in the fall of 1962, the number of sample sections

within each test section was increased to three. The last six of the nine sample sections were chosen at random.

Results

Creel census

The creel census data (Table 1) give the average yearly estimates of angling hours, average estimated numbers of 7.0- to 8.9-inch trout, and trout larger than 9.0 inches captured, for the two 3-year periods. Trout refers to the combined catch of brook trout and brown trout. The data are expressed on a per-mile basis to facilitate comparison. The estimates of the numbers of 7.0- to 8.9-inch trout caught and returned in the special regulation waters were made by applying the factor 0.273 to the reported numbers of sublegal fish returned. The factor was determined from experimental fishing by four anglers from the Department of Conservation who caught and measured several hundred trout from the upper and middle waters of the North Branch during the 1959 season. Their data indicated that 27.3 percent of the trout smaller than 9.0 inches were between 7.0 and 8.9 inches in total length.

The angling data summarized for the lower section, where special regulations remained in force during the two 3-year periods, demonstrate clearly that angling pressure and catch were relatively constant during the two 3-year test periods. The differences between the averages for the two periods were subjected to the *t* test, and were not found to be statistically significant.

Under special regulations, average angling pressure on the upper section was lower (541 hours per mile) than during 1958-1960 when normal angling rules prevailed (1,007 hours per mile). The probability that this difference is significant is about 81 percent.

The average annual estimated catches of both 7.0- to 8.9-inch and 9.0-inch and larger trout were not greatly different in either period, although considerable variation was noted between the two time periods. The probability of the existence of a significant difference was less than 50 percent for both size groups.

Under normal regulations (1958-1960) in the upper section, when all trout larger than 7.0 inches were creeled, the catch averaged 541 trout per mile; under special regulations (1961-1963) the catch of fish larger than 9.0 inches was estimated to be 116 trout per mile. The difference in the average numbers creeled per year during the two periods is significant at the 89 percent level of probability.

The angling results in the upper section may be summarized as follows: For practical purposes, the angling yield per mile of fish over 9.0 inches was about the same under both types of regulation, but the estimated total number of trout creeled was about four times greater under normal regulations. Substantially greater angling effort was expended by the fishermen during years when normal regulations were in effect.

A greater response to the reversal of the angling regulations occurred in the middle section of the North Branch. Under special

regulations (1958-1960) this stream area was fished at an average annual rate of 1,939 hours per mile; during the three seasons of normal regulations fishing was at the rate of 3,427 hours per mile. The difference is significant at the 99.5 percent level of probability; it is clear that angling pressure increased about 82 percent over that noted for the 1958-1960 period.

The average annual catch under special rules was estimated to be 1,056 trout per mile of fish 7.0-8.9 inches long and 277 trout per mile of fish larger than 9.0 inches (the latter group creeled, the former released), or a total of 1,333 trout per mile. On reversal to normal regulations in 1961-1963 the average annual angling yield (all creeled) was 1,121 trout per mile of the 7.0- to 8.9-inch fish and 421 trout per mile larger than 9.0 inches, for a total estimated creel of 1,542 trout per mile. The differences between the mean estimated catches of the two size groups is not significant statistically (P less than 50 percent). On the other hand, the difference between the total fish creeled per mile is significant at the 92 percent level.

Average length of angler-caught trout

The average total lengths of angler-caught trout measured by the creel census clerks are listed in Table 2. The only size groups directly comparable are those categories larger than 9.0 inches, inasmuch as 7.0- to 8.9-inch trout could not be possessed legally in the lower section at any time, and only for 3-year periods in the other two areas.

In the lower section, under special regulations for both periods, the average total length of both brook trout and brown trout 9.0 inches and larger was slightly longer during 1958-1960 than between 1961-1963. In the middle section, despite an increased harvest during 1961-1963, the average lengths of trout 9.0 inches and larger were not significantly different from average lengths in 1958-1960 when this section was fished under the more stringent rules. Trout caught in the upper section were slightly, but significantly, longer during the years when normal angling laws prevailed (1958-1960) than under special regulations (1961-1963). It is doubtful if individual anglers, fishing any of these sections in both time periods, would have noticed a difference in the average size of trout creeled that were larger than 9 inches. However some of these differences are of statistical significance.

The length-frequency distribution of trout caught in the two types of water was examined by grouping the brook trout and brown trout larger than 9.0 inches into 1-inch size groups. Data for all years were combined. The results are given in Table 3. Brown trout from normal- and special-regulation sections were further grouped into 9.0- to 11.9-inch, 12.0- to 15.9-inch, and 16.0- to 21.9-inch size groups. A Chi-square test on the relative numbers of fish creeled from each water type in these groupings proved nonsignificant (Chi-square = 5.316, 4 df, P = 74 percent). The same was true for angler-caught brook trout from both waters grouped into 9.0- to 10.9-inch and 11.0- to 12.9-inch classes (Chi-square = 0.824, 1 df, P = 61 percent). In addition to the

fact that numerous 7.0- to 8.9-inch trout were creeled on waters under normal regulations, the catch of trout over 9 inches in normal waters was not significantly different from the number caught in waters under special regulations.

Angling quality

Angling quality under special regulations and normal regulations has been determined by calculation of the simple catch per hour (estimated numbers of fish per mile divided by estimated number of hours per mile) for the various years and sections. Means and standard errors were derived from the basic yearly estimates. Averages for the two 3-year periods are given in Table 4.

In the lower section, under continuous special regulations, the catch per hour was stable in both periods. In the upper section, catch per hour was significantly better for 7.0- to 8.9-inch trout, and for 9.0-inch and larger trout during 1961-1963 when special regulations were in force. However, angling quality for trout larger than 7.0 inches was significantly better under normal regulations than was the catch per hour for 9.0-inch and larger trout under special regulations.

In the middle section, the catch per hour of 7.0- to 8.9-inch trout was better under special rules, but there was little difference in the catch per hour of trout larger than 9.0 inches in either period. Again, a measurably higher catch per hour of trout larger than 7.0 inches was noted under normal trout stream regulations than of trout larger than 9.0 inches under special regulations.

Population studies

The average fall populations, of brook trout and brown trout combined, are listed in Table 4. All data are given on a per-mile basis. In all three experimental sections the 0- to 6.9-inch and the 7.0- to 8.9-inch groups were predominantly brook trout, while the great majority of trout larger than 9.0 inches were brown trout.

Inspection of Table 5 reveals that the average fall trout population for the two time periods varied only slightly in the lower section where special regulations prevailed during both periods.

In the upper section, the special regulations (higher minimum size limit, lower creel limit, lure restricted to artificial fly) increased the fall population of 7.0- to 8.9-inch trout from 305 trout per mile to 786 trout per mile (P = 99 percent). The changes noted in the other size groups were of relatively small magnitude and were not statistically significant.

Despite the higher fall populations of trout larger than 7 inches during 1961-1963, the estimated yield per mile to the angler did not increase (see Table 1). In part, the reason was noticeably lower angling pressure, but probably more important was the overwinter loss of fish to predators such as American mergansers, brown trout, otter, mink, and blue herons.

Comparison of the 1958-1960 averages for the middle section with those of 1961-1963 indicates that reversal of regulations from special to normal brought about a decrease in the fall standing crop. In

the two smaller size groups the decreases were not significant. Among trout larger than 9.0 inches, however, there were significantly larger numbers of this size group present during 1958-1960 than in 1961-1963 (P = 88 percent). As in the upper section, despite higher fall trout populations during the period of special regulations, anglers harvested fewer trout than when it was fished under normal Michigan trout stream rules.

The average numbers of trout, 6.9 inches and smaller, in the fall populations did not differ by statistically significant degrees after regulation reversal in the upper and middle sections, even though there were noticeable changes in the numbers of adult fish present in the fall. Since the majority of this size group is made up of young-of-the-year trout, this suggests that abundance of young is determined by factors other than large numbers of adult fish. Latta (1964) found no relationship between the numbers of adult brook trout present in the Pigeon River (Michigan) in the fall of one year and the numbers of young produced by these adults that are present the following fall.

Discussion

The special trout stream angling restrictions on the North Branch obviously reduced angling pressure and total yield to the creel. Reduced rod pressure, higher minimum size limits, and lower daily creel limits combined to produce somewhat higher residual trout populations in the fall. Not all of the observed increases were of

significant proportions. In the light of findings elsewhere (Shetter and Alexander, 1962), it is doubtful that reduced hooking mortality due to restriction of lure to artificial fly influences the fall trout populations in streams like the North Branch of the Au Sable.

The increases noted in catch per hour for both size groups of trout under special regulations are somewhat misleading because of the great differences in angling pressure under the two types of regulation. For example, if 1,000 trout per mile are available and captured by 500 fishermen in 500 hours of special-regulation fishing, the catch per hour is 2.0; but if the same number of fish are captured in 1,000 hours of normal-regulation angling by 1,000 sportsmen, the catch per hour is only 1.0; however, the total yield is exactly the same. The anglers fishing under special regulations may at times enjoy significantly greater individual success, but substantially greater numbers of fishermen can be accommodated on an equal amount of water with the same stock of fish if the stream is managed under normal Michigan trout stream rules.

The findings described here suggest that in our present state of knowledge, Michigan trout streams with adequate natural reproduction can provide the most sport for the most anglers under normal trout stream regulations. The quality of angling in the North Branch has been best in the middle portion of the river regardless of the regulation in force, because this part of the stream has the best all-around trout habitat.

Until predation on the trout population can be reduced, losses from hooking and the differences between special and normal bag limits will not influence the total creel significantly.

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Table 1.--Summary of angling statistics, North Branch Au Sable River, 1958-1963

Stream section and length	Period	Regulations	Angling pressure (hours per mile)		Catch (trout per mile)					
					7.0-8.9 inches		9.0+ inches		Total (legal fish)	
			Mean	Standard error	Mean	Standard error	Mean	Standard error	Mean	Standard error
Dam 2--County line, (upper) 4.2 miles	1958-1960	Normal	1,007[1]	276	419	164	123	33	541[1]	196
	1961-1963	Special	541[1]	113	337[2]	99	116	36	116[1]	36
County line-Eaman's (middle) 6.9 miles	1958-1960	Special	1,939[3]	27	1,056[2]	130	277	82	277[4]	82
	1961-1963	Normal	3,427[3]	241	1,121	346	421	178	1,542[4]	521
Eaman's-Kellogg Bridge (lower) 8.7 miles	1958-1960	Special	1,052	116	515[2]	95	141	45	141	45
	1961-1963	Special	1,145	79	581[2]	105	131	63	131	63

[1] Difference between means of the two periods is significant at the 80 percent level of probability.

[2] Estimated from angler reports of undersized fish caught and released.

[3] Difference between means of the two periods is significant at the 99 percent level of probability.

[4] Difference between means of the two periods is significant at the 90 percent level of probability.

Table 2.--Average lengths of angler-caught trout, North Branch Au Sable River, 1958-1963

Period and species	Size range (inches)	Dam 2-County line: Number of fish	Dam 2-County line: Total length (inches) Mean	Dam 2-County line: Total length (inches) Standard error	County line-Eaman's: Number of fish	County line-Eaman's: Total length (inches) Mean	County line-Eaman's: Total length (inches) Standard error	Eaman's-Kellogg Bridge: Number of fish	Eaman's-Kellogg Bridge: Total length (inches) Mean	Eaman's-Kellogg Bridge: Total length (inches) Standard error
1958-1960 Regulations		Normal			Special			Special		
Brook	7.0-8.9	145	7.71	0.05	...	...	...	...	...	...
Brook	9.0+	16	9.42	0.16	36	9.57	0.29	22	9.45	0.11*
Brown	7.0-8.9	17	7.72	0.11	...	...	...	...	...	...
Brown	9.0+	44	11.61	0.10	46	11.40	0.25	50	11.61	0.36*
All trout	9.0+	60	11.03	0.27*	82	10.60	0.18	72	10.95	0.28
1961-1963 Regulations		Special			Normal			Special		
Brook	7.0-8.9	...	...	...	373	7.75	0.03	...	...	...
Brook	9.0+	28	9.55	0.12	48	9.60	0.10	8	9.07	0.08*
Brown	7.0-8.9	...	...	...	36	8.02	0.09	...	...	...
Brown	9.0+	28	10.91	0.32	119	11.63	0.23	60	10.50	0.08*
All trout	9.0+	56	10.23	0.19*	167	11.04	0.18	68	10.33	0.23

* Difference between period means significant at the 95 percent level.

Table 3.--Length-frequency of angler-caught trout larger than 9.0 inches from normal and special regulation sections, all years combined

Inch-groups	Normal regulations		Special regulations	
	Brook	Brown	Brook	Brown
9.0- 9.9	51	38	77	55
10.0-10.9	10	43	16	52
11.0-11.9	2	34	..	40
12.0-12.9	1	15	1	13
13.0-13.9	..	5	..	6
14.0-14.9	..	5	..	8
15.0-15.9	..	8	..	1
16.0-16.9	..	9	..	1
17.0-17.9	..	3	..	5
18.0-18.9	..	1	..	1
19.0-19.9	..	1	..	2
20.0-20.9	..	..	..	..
21.0-21.9	..	1	..	..
Total	64	163	94	184

Table 4.--Catch per hour on special regulation sections and normal regulation sections, 1958-1963

Data from Table 1

Stream section	Period	Regulations	Catch per hour of trout					
			7.0-8.9 inches		9.0+ inches		Legal	
			Mean	Standard error	Mean	Standard error	Mean	Standard error
Upper	1958-1960	Normal	0.39[1]	0.06	0.12[2]	0.00+	0.51[3]	0.06
	1961-1963	Special	0.60[1]	0.06	0.20[2]	0.03	0.20[3]	0.03
Middle	1958-1960	Special	0.55[1]	0.07	0.14	0.04	0.14[1]	0.04
	1961-1963	Normal	0.32[1]	0.07	0.12	0.04	0.43[1]	0.12
Lower	1958-1960	Special	0.48	0.05	0.13	0.03	0.13	0.03
	1961-1963	Special	0.50	0.06	0.11	0.05	0.11	0.05

[1] Difference between period means significant at 90 percent level.

[2] Difference between period means significant at 95 percent level.

[3] Difference between period means significant at 99 percent level.

Table 5.--Average fall trout populations (brook trout and brown trout combined), under normal and special trout stream regulations

Stream section and length	Period	Regulations	Number of trout per mile					
			0-6.9 inches		7.0-8.9 inches		9.0+ inches	
			Mean	Standard error	Mean	Standard error	Mean	Standard error
Dam 2-County line 4.2 miles	1958-1960	Normal	6,659	420	305[1]	31	262	47
	1961-1963	Special	7,738	1,611	786[1]	91	347	61
County line-Eaman's 6.9 miles	1958-1960	Special	13,312	3,034	1,292	139	840[2]	97
	1961-1963	Normal	10,300	948	1,094	194	513[2]	128
Eaman's-Kellogg Bridge 8.7 miles	1958-1960	Special	16,055	1,569	1,363	58	439	90
	1961-1963	Special	15,181	266	1,494	182	469	81

[1] Difference between period means statistically significant at the 99 percent level of probability.

[2] Difference between period means statistically significant at the 88 percent level of probability.

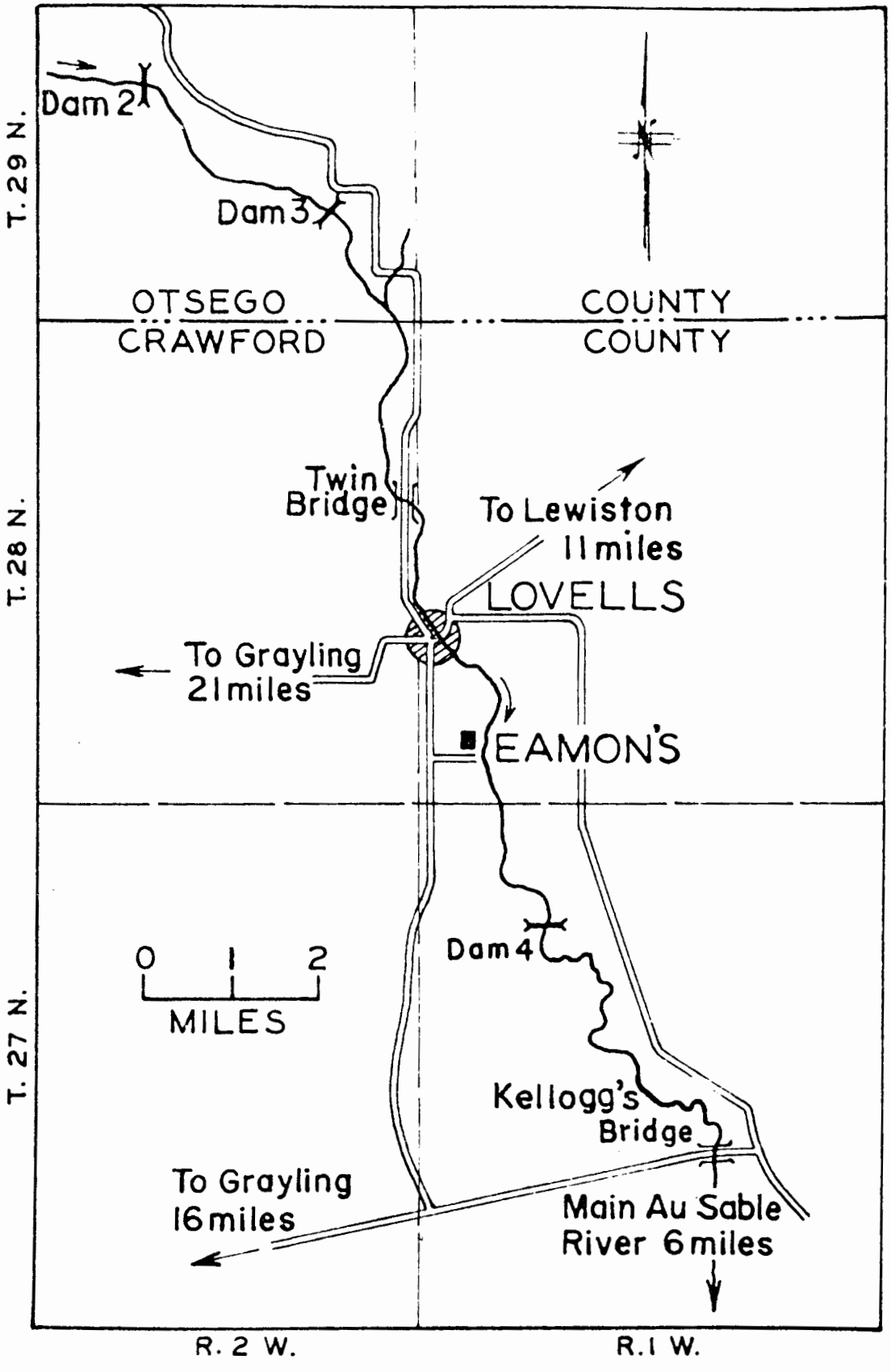

Figure 1.--A portion of the North Branch Au Sable River in Otsego and Crawford counties, where tests on special trout-fishing regulations were conducted.