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RESULTS OF STUDIES ON MICHIGAN TROUT WATERS WITH SPECIAL ANGLING RESTRICTIONS (TYPE OF LURE, SIZE LIMIT, CREEL LIMIT), 1949-1959

By

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Special regulations on trout fishing--lures limited to flies only and/or a higher size limit of 9 or 10 inches (rather than 7 inches) and a lower creel limit of 5 trout (instead of 10)--are in effect on sections of eight Michigan streams (total, 62 miles) and one small lake. A list of these waters and the years during which the special restrictions have been in effect are shown in Table 1. The general location of the various test waters is shown in Figure 1.

The current series of special regulations on trout fishing was begun in the North Branch of the Au Sable in 1949, when a 10-inch size limit was imposed on a 4.6-mile section of the stream. This experimental regulation followed the observations that growth of brook trout in the North Branch was very rapid and that anglers legally removed a large share of the female brook trout (under a 7-inch size limit) before they had spawned once (Cooper, 1951, 1952). The regulation was adopted in order to determine whether the population of brook trout would increase with this added protection to the spawning stock. In 1950 the experimental section was extended to a total of 6.9 ~~inches~~ miles and a flies-only restriction was added at the request of the local hunting and fishing club. It was the club's contention that bait fishermen were killing a large number of fish less than the legal size limit and might be jeopardizing the success of the experiment. Similar restrictive regulations were extended to the Pigeon River in 1951, the South Branch of the Au Sable in 1952, and to other waters in 1955 (see Table 1).

Table 1.--List of trout waters with special regulations: Flies only and/or higher size limits

(State-wide regulations on streams, 1952 to date: 7" size, 10 trout in creel)

Stream	Miles affected[1]	Stream section under special order	Years in effect	Restrictions on trout
N. Br. Au Sable	4.6	Crawford-Otsego line to Lovells Bridge	1949	10" on brook trout
" " " "	6.9	" " " " Eaman's	1950-54	Flies, 10", 10 trout (5 brooks)
" " " "	13.4	" " " " " plus Kellogg Br. to mouth	1955	Flies, 10", 5 trout
" " " "	20.0	All of the stream in Crawford County	1956-60	Flies, 9", 5 trout
S. Br. Au Sable	12.0	300' below Steckert Br. (25N, 2W, S.29) to Smith Br.	1952-54	Flies, 10"
" " " "	4.4	Smith Bridge to mouth	1952-54	10"
" " " "	16.4	300' below Steckert Br. to mouth	1955-59	Flies, 10", 5 trout
Main Au Sable	8.0	Burton's Landing to Wakeley Bridge	1955-59	Flies, 10", 5 trout
Little S. Br. P.M.	5.5	Carlson Br. (16N,12W,S.9-16) to Oxbow Br. (17N,12W,S.31)	1955-56	Flies, 10", 5 trout
" " " "	5.0	" " to county line (in Newaygo County)	1957-59	Flies, 10", 5 trout
Boardman	4.4	Forks Forest Camp (26N, 9W, S.4) to Scheck's Br. (26N, 9W, S.18)	1955-59	Flies, 10", 5 trout
E. Br. Fox	5.0	Trout Rearing Sta. (47N, 13W, S.16) to Robinson's (46N, 13W, S.9)	1955-59	Flies, 9", 5 trout
Hunt Cr.	1.0	Experimental sections Z and A	1955-59	Flies only
Pigeon	2.3	Experimental sections C and D	1951-54	9", 2 trout
"	2.3	" " " " "	1955-57	9", 5 trout
"	2.3	" " " " "	1958-59	Flies, 9", 5 trout
Ford Lake	10.7 acres	(Located in Pigeon River Area)	1955-59	Flies

[1] Total of 62 miles of stream under flies-only regulation during 1959.

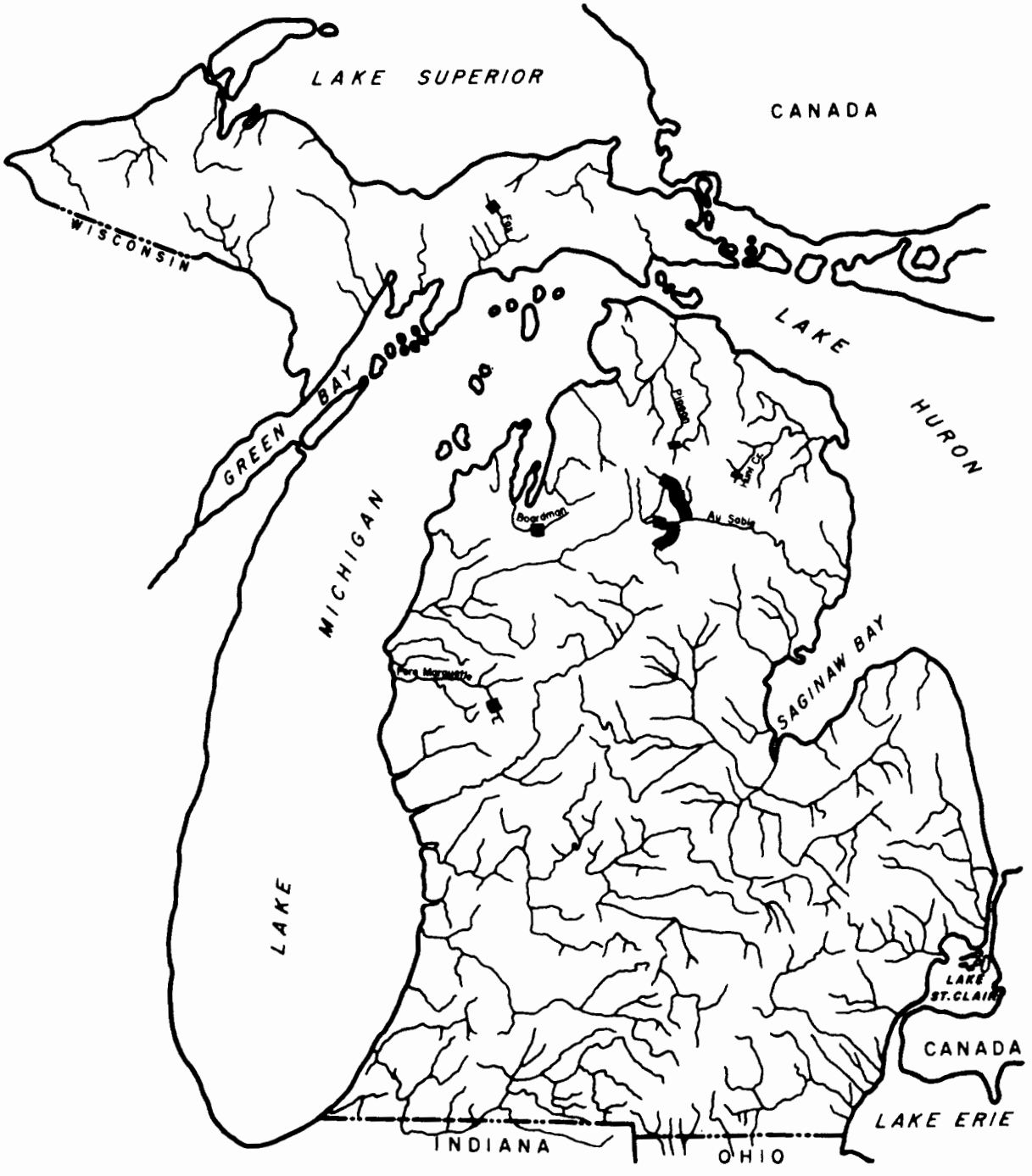

Figure 1.--Locations of Michigan trout waters which were under special fishing regulations in 1959.

Although the special regulations on the main stream of the Au Sable are considered (briefly) here, the regulations on this stream were established on a management basis, and the main stream was not included in the research program on this subject. Sampling with an electric shocker was done on the main stream in 1957, and repeated in 1959, because of considerable interest in this water.

The special-regulation trout waters have been the subject of two progress reports to the Conservation Commission (Cooper, Shetter and Hayne, 1958; 1959); a series of reports from the Institute for Fisheries Research to the Fish Division, relating to the effects of the regulations in certain waters (Hazzard and Christensen, 1953; Schultz, 1955a, 1955b, 1955c, 1956, 1957a, 1957b; Shetter, 1952, 1953, 1954, 1957a, 1957b; Shetter, Whalls and Corbett, 1954); and two studies concerning hooking mortality (Shetter and Allison, 1955; 1958), the results of which may be applicable to problems concerned with special-regulation waters.

The present report includes all relevant data collected on the various waters prior to August 1, 1959. The special regulations have been in effect on most of the waters for about five years or more and (except for the North Branch of the Au Sable) expire at the close of the 1959 season. The material has been summarized at this time to permit review by the Commission and Department personnel prior to the September 4 meeting of the Commission, when fishing regulations for 1960 will be drawn up.

The studies on the various test waters have been by several approaches. At Hunt Creek, the Pigeon River, and Ford Lake on the Pigeon River Area, a complete creel census of angling is obtained at checking stations where fishermen must report the results of each fishing trip. On the North Branch of the Au Sable, an estimate of total fishing effort and total catch is obtained by a census based on stratified sampling. For the other waters, creel census data are not available. For Hunt Creek, the Pigeon River, and the North Branch of

the Au Sable River, estimates of the total number of trout, by species and by size groups, present at the end of the fishing season in the fall are obtained by sampling with an electric shocker and estimating the population by the procedure of mark-and-recapture. For the Boardman, Fox, Little South Branch of the Pere Marquette, South Branch of the Au Sable, and the main stream of the Au Sable, the only information available consists of index figures on abundance of trout; these index figures are numbers of trout collected per hour with an electric shocker, during the summer on some streams, during the fall on other streams. For these index samples, a 3-man shocker crew took samples at several stations (typically three) in the flies-only water, and samples at stations in the "normal" water above and below the experimental sections, and this sampling was repeated year after year at the same stations. The theory behind this index type of sampling has been that, if the special regulations have the effect of increasing the population of trout spawners and therefore increasing within a year or two the population of young trout, the index sampling would be sufficient to detect any appreciable increase in the population. Control sites for this index sampling are considered essential, since the trout populations in the streams might change as a result of factors other than the special regulations. If the populations changed in the waters with special regulations, to a greater degree than in the control waters, the conclusion would be that the changes resulted from the special regulations. Unfortunately the data collected in several of the streams were inherently so variable that they did not provide a useful means of detecting changes in fish populations which might have resulted from changes in regulations. (This limitation is discussed later.)

Although the present regulations on the North Branch of the Au Sable remain in effect through 1960 (which means that the future for this stream need not be decided in 1959), the North Branch is one of the three streams on which our research effort has been most extensive, and the effect of the flies-only

regulation and the higher size limit on the quality of fishing in this stream should be pertinent in a decision of what might be expected on other waters. For that reason, our results on the North Branch of the Au Sable are summarized here in some detail. Results for other waters are discussed in the order in which they are listed in Table 1.

North Branch Au Sable River

[Current regulations: flies only, 9 inches, 5 trout]

The portion of the North Branch of the Au Sable River which is currently under special trout regulations is shown in Figure 2. A 10-inch size limit on brook trout was in effect from the Otsego-Crawford County line downstream to Lovell's Bridge (including the Twin-Bridge Area) in 1949; this size limit (plus flies only) was extended further downstream to Eaman's Landing in 1950-1954; a separate stream section, from Kellogg's Bridge to the mouth, was added in 1955; and the entire portion of the stream from the County line to the mouth was placed under the current special regulations in 1956. (The stream section added in 1956, from Eaman's to Kellogg's, is here termed the "new" fly water, whereas the remainder of the North Branch currently under special regulations is called the "old" fly water.)

Index runs with an A-C shocker were made at the Twin Bridges each fall, in 1948-1958. According to these index figures, the population of brook trout increased during the period from 1948 to about 1952, but subsequently declined (Table 2). The transitory population increase occurred among both young and adult brook trout. The population of adult trout declined back to about the 1948 level, but the population of young leveled off (the shocker index figures

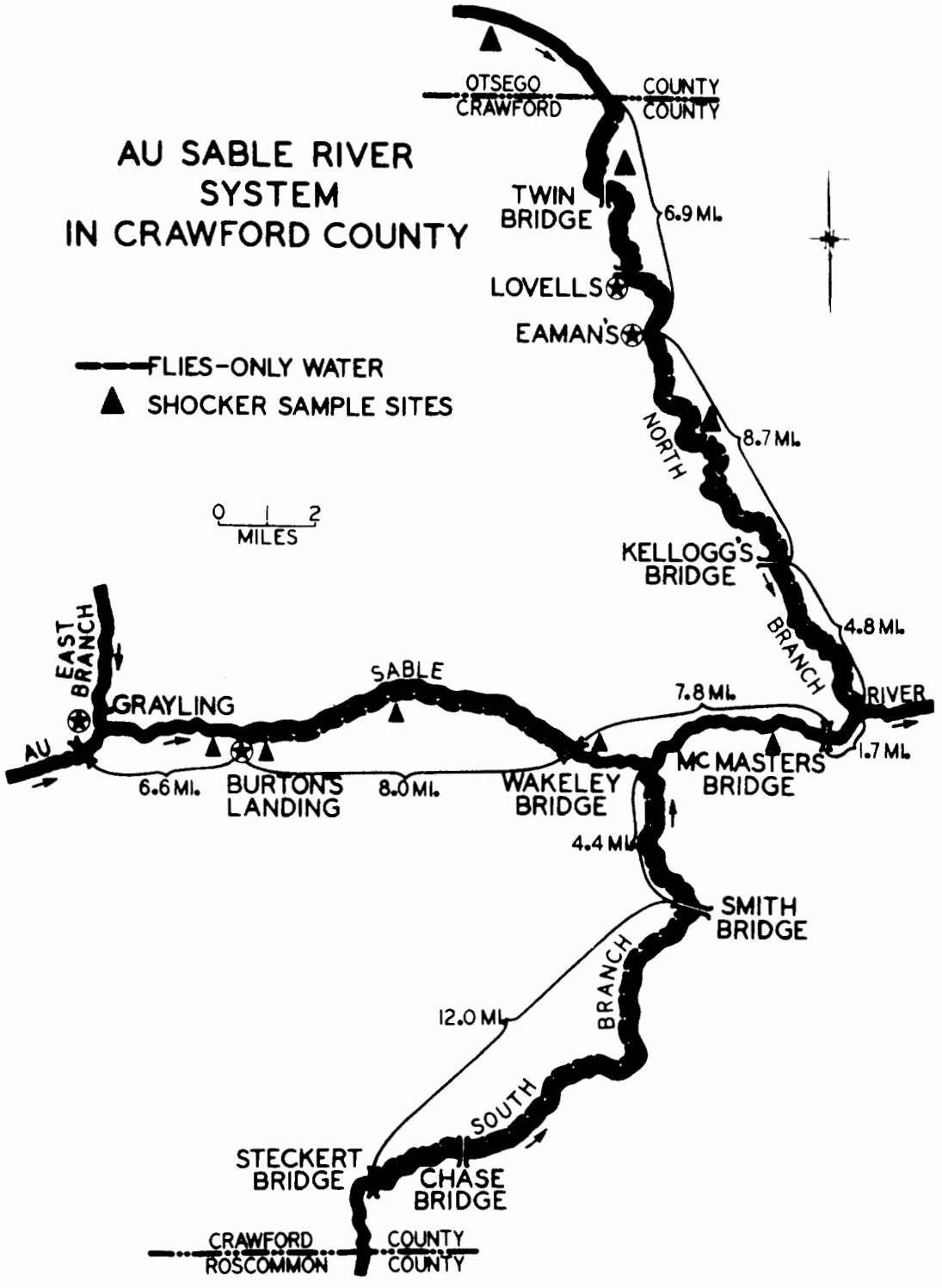

Figure 2.--The Au Sable River System in Crawford County, showing sections of the stream which are under special trout-fishing regulations, and localities of special interest in this study.

Table 2.--Catch of trout per hour in fall sampling with an A-C shocker, Twin Bridge area of North Branch Au Sable River, 1948-1958

[Regulations: 10-inch size limit in 1949; 10-inch, flies only, 1950-1955; 9-inch, flies only, 1956-1958]

Species of trout	Length (inches)	Year, and minutes shocked										
		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
		120	40	44	23	38	36	37	39	49	57	40
Brook	0.0-4.9	67	81	89	...*	...*	215	109	205	151	112	135
	5.0-7.9	44	83	77	110	148	112	24	55	36	42	48
	8.0-13.9	4	72	52	227	116	81	34	18	18	40	27
Brown	0.0-5.9	...*	...*	...*	...*	...*	0	10	40	17	27	44
	6.0-11.9	...*	...*	...*	...*	...*	5	18	20	27	25	21
	12.0-16.9	...*	...*	...*	...*	...*	5	8	6	7	6	3
	17.0-21.9	...*	...*	...*	...*	...*	0	0	2	2	2	1

*Not recorded.

were consistent) at about twice the abundance of the 1948-1950 period. A non-random creel census conducted prior to 1955 showed a considerable increase in the catch of brook trout per hour up to a peak in about 1953, which tends to confirm the shocker index figures obtained at the Twin Bridges. Since about 1953 or 1954 there has been some decline in the anglers' success in taking legal brook trout in the flies-only water, but there was an increase when the size limit was dropped from 10 inches to 9 inches in 1956. (The average catches of trout per hour by anglers in the three experimental sections of the North Branch in 1950-1958, based on interviews of a sample of anglers in each section of the stream in each year, are shown in Figure 3.)

Another check on the effect of special regulations on the North Branch trout populations is found in the A-C shocker indices collected annually since 1953 in the autumn, in the Eaman's Landing-Kellogg Bridge stream area. As mentioned above, this stream section was fished under an any-lure, 7-inch, 10-trout regulation until 1956, when it was placed under a flies-only, 9-inch, 5-trout-daily regulation. For comparison, we have A-C shocker indices for the stream in Otsego County, which has been fished under the any-lure, 7-inch, 10-trout regulation since 1949, and which can be regarded as a control.

The average number of trout caught per hour with an A-C shocker in the experimental water and in the control water is shown in Table 3. The averages were determined from the total catch and total minutes of shocking at three sampling sites in the experimental water and two sites in the control water. These data were divided into indices for three different size groups of brook trout and four different size groups of brown trout.

If the special regulations on the Eaman's-Kellogg Bridge section of the North Branch had a direct favorable effect on the trout populations there, we would expect a significant increase in the indices for young-of-the-year trout

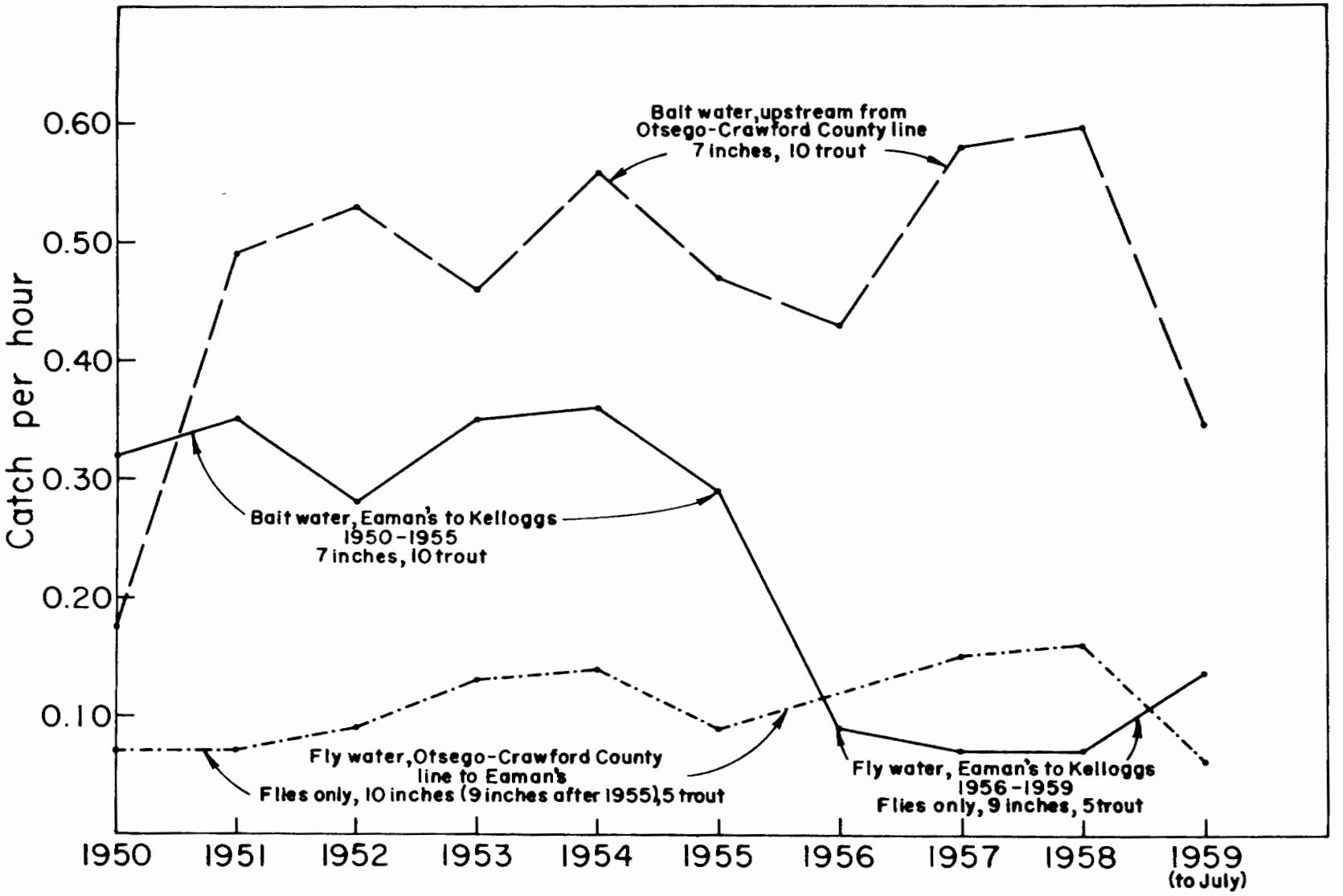

Figure 3.--The average catch of trout per hour by anglers in the North Branch Au Sable River, 1950-1959

Table 3.--Average number of trout collected per hour with an A-C shocker, before and after regulation changes on the Eaman's-Kellogg Bridge area of North Branch Au Sable River, fall, 1953-1958

Species of trout	Type of water*	Length (inches)	Regulations and years: Any lure, 7-inch 1953	1954	1955	Flies only, 9-inch 1956	1957	1958	Average number collected: Before change in regulation	After change in regulation
Brook	Experimental	0.0- 4.9	78	92	59	88	122	125	76	112
		5.0- 7.9	22	12	6	20	19	20	13	20
		8.0-13.9	1	1	1	6	4	8	1	6
	Control	0.0- 4.9	49	50	60	70	80	53	53	68
		5.0- 7.9	30	20	28	53	20	5	26	26
		8.0-13.9	2	3	1	4	3	2	2	3
Brown	Experimental	0.0- 5.9	69	72	66	61	58	70	69	63
		6.0-11.9	37	30	26	47	39	29	31	38
		12.0-16.9	9	5	3	4	7	6	6	6
		17.0-21.9	0	0	tr	tr	0	0	tr	tr
	Control	0.0- 5.9	14	18	21	41	28	25	17	31
		6.0-11.9	38	10	18	57	36	17	22	36
		12.0-16.9	16	11	3	10	7	2	10	6
		17.0-21.9	0	0	1	0	0	tr	tr	tr

* Data were obtained from A-C shocker collections at three stations in the experimental water: (Eaman's downstream, Dam 4, and Kantagree Club) and at two stations in the control water (Dam 2 and Boutell's Ford).

after 1957 and 1958, and probably immediately in 1956 for larger trout. Similar increases should not occur in the control water if the effects are to be ascribed to the special regulations.

There was a moderate relative increase in index values for brook trout in the Eaman's-Kellogg section following the flies-only order (Table 3). However, when the data on which this table is based were subjected to a partial analysis of variance, after logarithmic transformation of the catch per hour values, no increases of statistical significance could be demonstrated for any of the length groups among the two species. It is concluded that any effect of the special regulations on the fall standing crop of trout in the Eaman's-Kellogg Bridge stream area during the period 1956-1958 was too small to be detected by the present index sampling. From an analysis of index-sampling data (see below), the method is now judged to be less precise than anticipated.

Mark-and-recapture estimates of the actual trout populations present in the fly water and bait water of the North Branch are available for the fall of 1957 and the fall of 1958; and the randomized creel census (started in 1958) gave estimates of total angling and catch during 1958, and up to July 31, 1959. Such data have been considered separately for the bait water in Otsego County, the new fly water and the old fly water.

During the years 1957 and 1958, there were 4,000 to 12,000 young brook trout per mile in various sections of the North Branch, of which 78 to 94 percent disappeared during the course of their second summer (Table 4). In the bait, 7-inch water, these second-summer brook trout contributed 65 percent of the anglers' catch, even though 90 percent of them were lost to other mortality. Brook trout three years of age or older made up one percent or less of the population in the bait water, and 1 to 4 percent of the population in the fly water. In the respective fall populations there were 3 to 7 times as many brook trout over 7 inches per mile in the fly water as in the bait water (Table 5). With

Table 4 --Estimated numbers of trout of different ages (per mile of stream) in fall populations, total mortality, and angling mortality, North Branch Au Sable River, 1957-1958

[Angling mortality is based on computed total angling harvest. In the fall, trout in the 1st year of life are in age-group 0 (young of the year--one growing season completed); 2nd year--age-group I; etc.]

Brook trout						Brown trout					
Fall population						Fall population					
1957		1958		Total mortality (percentage)	Angling mortality (percentage)	1957		1958		Total mortality (percentage)	Angling mortality (percentage)
Year of life	Number of fish	Year of life	Number of fish			Year of life	Number of fish	Year of life	Number of fish		
Bait water											
		1st	4,122					1st	2,152		
1st	10,540	2nd	678	93.6	3.6	1st	3,278	2nd	183	94.4	2.9
2nd	410	3rd	24 →	94.4	46.7	2nd	483	3rd	146		
3rd	16					3rd	97	4th	32 →	69.9	17.0
						4th	20	5th	4		
						5th	4				
Old fly water											
		1st	12,550					1st	3,782		
1st	8,932	2nd	1,927	78.4	0.04	1st	3,332	2nd	644	80.6	0.4
2nd	2,861	3rd	303	90.9	3.6	2nd	703	3rd	412		
3rd	484	4th	4 →			3rd	227	4th	84 →	47.1	16.9
4th	17					4th	63	5th	29		
						5th	25	6th	17		
						6th	21	7th	8		
New fly water											
		1st	12,784					1st	4,261		
1st	11,694	2nd	2,384	79.6	0.01	1st	5,082	2nd	879	82.7	0.08
2nd	2,240	3rd	136 →	94.2	1.2	2nd	1,213	3rd	148		
3rd	82					3rd	148	4th	29 →	86.7	3.6
						4th	25	5th	8		
						5th	8				

Table 5.--Estimated numbers of trout of different length groups (per mile of stream) in fall populations, 1957-1958, and numbers caught in 1958, North Branch Au Sable River

Length (inches)	Brook trout			Brown trout		
	Fall population		1958	Fall population		1958
	1957	1958	harvest	1957	1958	harvest
			Bait water			
0.0-6.9	10,775	4,557	...	3,318	2,157	...
7.0-8.9	191	256	525	317	110	96
9.0 and over	0	12	57	248	252	102
Total	10,966	4,825	582	3,883	2,518	198
			Old fly water			
0.0-6.9	10,231	13,400	...	3,361	3,837	...
7.0-8.9	1,885	1,350	...	509	143	...
9.0 and over	177	34	124	501	997	188
Total	12,293	14,784	124	4,371	4,977	188
			New fly water			
0.0-6.9	13,439	14,326	...	5,213	4,285	...
7.0-8.9	561	945	...	908	524	...
9.0 and over	16	33	28	355	516	50
Total	14,017	15,304	28	6,476	5,325	50

considerably more brook trout in the fly water, angler harvest in the bait water was 4 to 20 times the number of brook trout taken in the fly water (582 fish over 7 inches [per mile of stream] in the bait water; 124 fish over 9 inches in the old fly water, and 28 fish over 9 inches in the new fly water). Anglers took 57 brook trout over 9 inches long per mile of stream in the bait water, as compared to 124 brook trout over 9 inches in the old fly water and 28 in the new fly water.

During 1957 and 1958, there were 2,000 to 4,000 young brown trout per mile in various sections of the North Branch, of which 81 to 94 percent disappeared during the course of their second year (Table 4). In the bait water the second-summer brown trout contributed about 50 percent to the anglers' catch of brown trout, even though 90 percent of them were lost to other mortality. Brown trout three years of age and older made up 3 to 7 percent of the population in the bait water, and 3 to 11 percent in the fly water. In the fall there were 2 to 4 times as many brown trout over 7 inches per mile in the fly water as in the bait water (Table 5). With considerably more brown trout per mile in the fly water, angler harvest in the bait water was 1 to 4 times that in the fly water (198 fish over 7 inches [per mile of stream] in the bait water; 188 over 9 inches in the old fly water; and 50 over 9 inches in the new fly water). In the angler harvest from bait water, 102 of the 198 brown trout were over 9 inches.

In 1958, the catch of brook trout and of brown trout (per mile of stream) by anglers was 102 and 92 pounds, respectively, in the bait water, 41 and 111 pounds in the old fly water and 10 and 28 pounds in the new fly water (Table 6).

In addition to fish in the creel, anglers on the flies-only water on the North Branch caught and liberated a considerable number of fish in the length range of 7.0 to 8.9 inches. The census clerk on the North Branch, in interviewing a sample of all anglers, asked each one how many sublegal fish he caught and released, from which it was computed that anglers caught and released 2,200 fish under 9 inches in length per mile of stream in the old fly water, and 1,200 per

Table 6.--Estimated total fishing pressure, catch per hour, and catch per mile of stream (brook and brown trout considered separately), North Branch Au Sable River, 1958 and first half of 1959

[Legal sizes: 7" in bait water, 9" in fly water]

Season, species, and type of water	Hours of fishing per mile of stream	Legal-size fish caught per hour	Total legal fish caught per mile	Average weight of fish (pound)	Total weight of fish caught per mile (pounds)	Pounds of fish per acre	Number of fish 9" or over	Catch per hour of fish 9" or over
Entire 1958 season								
Brook trout								
Bait water	1,311	.444	582	.17	101.6	10.0	57	.043
Old fly water	1,885	.066	124	.33	41.0	3.0	124	.066
New fly water	1,143	.024	28	.34	9.5	3.0	28	.024
Brown trout								
Bait water	1,311	.151	198	.46	91.6	9.0	102	.078
Old fly water	1,885	.100	188	.59	111.1	8.1	188	.100
New fly water	1,143	.044	50	.56	27.8	8.1	50	.044
First half of 1959 season*								
Brook trout								
Bait water	458	.238	109	.19	20.8	2.0	35	.076
Old fly water	1,503	.036	54	.32	17.1	1.2	54	.036
New fly water	464	.116	54	.33	17.6	1.5	54	.116
Brown trout								
Bait water	458	.098	45	.43	19.4	1.9	35	.076
Old fly water	1,503	.028	42	.57	24.0	1.8	42	.028
New fly water	464	.043	20	.56	11.1	0.9	20	.043

* April 25-July 3, 1959

mile in the new fly water (Table 7). These figures included both fish from 7 to 8.9 inches and fish under 7 inches. In order to estimate what proportion of these fish might have been in the 7.0-8.9-inch size range, test fishing was done by four employees of the Conservation Department during 1959 on different sections of the North Branch. In this test fishing, the four anglers fished a total of 144 hours, and caught 461 trout; of the trout less than 9 inches which they caught, 1/4 were in the size range of 7.0-8.9 inches, and 3/4 were under 7 inches (Tables 8 and 9). If we apply this fraction of 1/4 to the figures obtained by the creel census clerk, we estimate that public anglers on the flies-only water of the North Branch took 300 to 500 7.0-8.9-inch trout per mile--which they released. These estimates are considered to be maximum figures, because the test fishermen took consistently larger fish than the public. The figures on estimated numbers of trout (brook and brown combined) of different sizes taken by anglers, per mile of stream, in different types of water on the North Branch are given in the following text table. The two figures which are underlined represent the "sublegal" fish which had to be released in the fly water, but could have been kept in the creel under a 7-inch limit.

Length of trout, inches	Water		
	Bait	Old fly	New fly
Less than 7"	2,700	1,700	900
7"-8.9"	621	<u>500</u>	<u>300</u>
Over 9"	159	312	78

In the test fishing done during 1959 by four Department employees on the North Branch, their catch per hour of trout over 9 inches by fly fishing in the old fly water was 0.22, and their catch per hour of trout over 7 inches by fishing with both bait and fly in the bait water was 0.58 (Table 8); this is in close agreement with the finding from the creel census that public anglers caught

Table 7.--Creel census summary, showing estimated total fishing pressure, catch per hour, and catch per mile of stream (brook and brown trout combined), North Branch Au Sable River, 1958 and first half of 1959

[Legal sizes: 7" in bait water, 9" in fly water]

Season, and type of water	Hours of fishing per mile of stream	Legal-size fish caught per hour	Total legal fish caught per mile	Average weight of fish (pound)	Total weight of fish caught per mile (pounds)	Pounds of fish per acre	Number of fish 9" or over	Catch per hour of fish 9" or over	Sublegal fish caught per hour	Total sublegal fish caught per mile	Number of sublegal fish caught per legal
Entire 1958 season											
Bait water	1,311±28%	.595	780±33%	.25	193.2	18.9	159	.121	2.10*	2,755*	3.5*
Old fly water	1,885±21%	.166	312±33%	.48	152.1	11.1	312	.166	1.20*	2,253*	7.2*
New fly water	1,143±31%	.068	78±40%	.48	37.4	3.1	78	.068	1.06*	1,211*	15.5*
First half of 1959 season**											
Bait water	458±28%	.336	154±36%	.26	40.2	3.9	70	.153	1.50	689	4.5
Old fly water	1,503±20%	.064	96±40%	.43	41.1	3.0	96	.064	1.80	2,707	28.2
New fly water	464±25%	.159	74±53%	.39	28.7	2.4	74	.159	1.64	763	10.3

* Assuming rate of capture of sublegal fish for first quarter of season to equal that during second quarter (no information on catch of sublegal fish during first quarter).

**April 25-July 3, 1959.

Table 8.--Comparison of catch of trout per hour by four test fishermen with catch per hour by the general public, in the bait water and the old fly water, North Branch Au Sable River

[Results for test fishermen in fly water refer here only to fly fishing]

Item	Fly water		Bait water	
	Test fishermen	General public	Test fishermen	General public
Legal fish	0.22	0.06	0.58	0.34
Fish 9" and over	0.22	0.06	0.07	0.15
Sublegal fish	4.41	1.80	1.65	1.50
Fish under 7"	3.58	....	1.65	1.50
Fish 7"-8.9"	0.83	....	0.51	....
Number of sublegals per legal	16.1	28.2	2.8	4.5

Table 9.--Catch of trout per hour by four test fishermen in the bait water and "old" fly water of the North Branch Au Sable River, 1959

[Catch includes brook and brown trout, combined. Each test fisherman fished for 9 hours with each lure in each water, for a total of 36 hours per man and 144 hours for the four; 461 trout were caught and returned to the stream]

Water	Lure	Length of trout (inches)		
		Less than 7	7.0-8.9	9.0 and over
Fly	Worms	2.11	1.94	0.47
	Flies	3.58	0.83	0.22
Bait	Worms	1.33	0.56	0.08
	Flies	1.97	0.47	0.06

(per hour) about 2 1/2 times as many trout over 7 inches in the bait water as they caught trout over 9 inches in the old fly water. The four test fishermen obviously were more expert as trout fishermen than the general public on the North Branch; public anglers interviewed on the North Branch had an average catch per hour of trout over 9 inches in the fly water of 0.06 and a catch per hour of trout over 7 inches in the bait water of 0.34.

South Branch Au Sable River

[Current regulations: flies only, 10 inches, 5 trout]

The portion of the South Branch of the Au Sable River under special trout fishing regulations extends from a point 300 feet below Steckert's Bridge to the confluence of the South Branch and the main stream (Figure 2). The section from near Steckert Bridge to Smith Bridge has had a flies-only, 10-inch regulation since 1952; the section from Smith Bridge to the mouth has also been under a 10-inch size regulation since 1952, but the flies-only restriction was not imposed until 1955.

The fall shocker indices showed a possible increase in the population of young and sublegal trout in 1955-1956 as compared to 1952-1953, the first two years of the special order (Table 10). (There was no index sampling prior to the order.) Index figures obtained by shocker during the summer of 1959 were much lower than figures for the fall of 1955 and 1956, possibly due mostly to seasonal factors affecting the operation of the shocker. Persons who have done the collecting are strongly of the opinion that trout are much more active at midsummer temperatures in the 70's, and therefore more difficult to collect by electrofishing, than at the lower water temperatures when collecting is done in

Table 10.--Average number of fish collected per hour with a D-C shocker at various stations on the South Branch Au Sable River, fall 1952-1956 and summer, 1959

Year	Stream section*	Number of stations	Brook trout Length (inches) 0-6.9	7.0-9.9	10.0 or over	Brown trout Length (inches) 0-6.9	7.0-9.9	10.0 or over	All trout
1952	Upper (normal)	4	0	0	0	9	10	11	30
	Flies only, 10"	13	39	1	0	70	18	40	169
	Lower (10")	4	37	7	0	67	15	11	137
1953	Upper (normal)	3	0	0	0	0	15	16	31
	Flies only, 10"	10	20	1	0	21	32	29	101
	Lower (10")	4	35	1	<1	30	19	19	105
1954	Upper (normal)	2	8	0	0	5	0	10	22
	Flies only, 10"	9	38	7	0	18	9	22	94
	Lower (10")	3	109	4	0	53	9	15	142
1955	Upper (normal)	3	6	1	0	55	17	22	101
	Flies only, 10"	12	76	12	4	89	19	67	267
	Lower (flies only, 10")	4	57	2	0	64	44	42	208
1956	Upper (normal)	0	...	..	..	..	..	.	...
	Flies only, 10"	7	100	20	10	74	35	2	240
	Lower (flies only, 10")	3	65	4	1	66	41	61	238
1959	Upper (normal)	1	0	0	0	12	12	6	30
	Flies only, 10"	5	26	37	0	35	19	22	139
	Lower (flies only, 10")	0	...	..	..	..	..	..	...

*Upper stream section refers to stream above Steckert Bridge, under state-wide ("normal") fishing regulations; flies only, 10" refers to the stream between a point near Steckert Bridge and Smith Bridge (flies only, 10" limit since 1952); and lower refers to portion of stream between Smith Bridge and the mouth.

the fall (in late September or early October). Therefore, we are not inclined to change our previous conclusion (Cooper, Shetter and Hayne, 1958) that there are now more trout in the flies-only section than there were during the first two years of the special order.

A population estimate in a 970-foot section of stream near Failing's Landing (located about 3 miles downstream from Chase Bridge) in midsummer, 1959 suggested a brook trout population density in this area of 3,125 (3,000 under 7 inches in length) per mile of stream and a brown trout population of 2,430 (2,054 under 7 inches; 174 between 7.0 and 9.9 inches; and 202 over 9.9 inches) per mile. These values are derived from a projection of the values given in Table 11. The population estimate at this station offers an opportunity to evaluate future changes in the trout population more accurately than would be possible with index stations alone (where catch per hour with a shocker is recorded).

Main Au Sable River

[Current regulations: flies only, 10 inches, 5 trout]

The section of the main stream of the Au Sable which is under special regulations extends from Burton's Landing downstream to Wakeley Bridge (Fig. 2). The regulations were passed as a management measure in 1955 and this stream has not been regarded as a part of the research project. No population data are available for the years prior to the regulation but, because of special interest in this section of stream, index figures were obtained by electrofishing in the fall of 1957 and midsummer 1959 (Table 12) and a population study was made in two sections of the stream (one in the flies-only water; one in the bait water, upstream) in 1959 (Table 13).

Table 11.--Numbers of trout collected with a D-C shocker, and population estimates (pop. est.) in fly water at Failing's Landing (T. 25N., R. 2W., Sec. 13), South Branch Au Sable River, midsummer, 1959

[Two "runs" were made with the shocker. Fish taken in the first run were fin-clipped and liberated. Fish collected during second run included a number of recaptures of fish marked in first run.]

Locality data	Species and run*	Length (inches)		
		0-6.9	7.0-9.9	10.0 or over
Length of stream: 970 feet	Brook trout			
	First run	19	9	0
	Second run	29	10	0
	Recaptures	1	4	0
	Pop. est.	551	23	0
Average width: 53 feet				
	Brown trout			
	First run	51	15	14
	Second run	37	17	8
Dates: July 27, 28	Recaptures	5	8	3
	Pop. est.	377	32	37

*Only one rainbow trout was collected in the two runs.

Failing's Landing is located about 3 miles downstream from Chase Bridge, near the middle of the flies-only section.

Table 12.--Number of trout collected per hour with a D-C shocker, main Au Sable River, fall, 1957 and midsummer, 1959

Location	Species of trout	Length (inches)							
		0-6.9		7.0-9.9		10.0 or over		Total	
		1957	1959	1957	1959	1957	1959	1957	1959
Burton's (upstream)	Brook	20	11	1	2	0	0	21	13
	Brown	57	27	91	38	80	20	229	85
	Rainbow	2	0	0	0	0	0	1	0
	Total	79	38	92	40	80	20	251	98
Burton's* (downstream)	Brook	52	136	1	11	0	1	53	148
	Brown	109	72	99	18	83	21	291	111
	Rainbow	7	0	0	0	0	0	7	0
	Total	168	208	100	29	83	22	351	259
Stephan's* (downstream)	Brook	48	134	6	1	0	0	54	135
	Brown	300	175	178	63	152	46	630	284
	Rainbow	48	52	6	0	0	0	54	52
	Total	396	361	190	64	152	46	738	471
Wakeley's (downstream)	Brook	9	5	0	0	0	0	9	5
	Brown	223	199	92	41	47	17	362	257
	Rainbow	0	0	0	0	0	0	0	0
	Total	232	204	92	41	47	17	371	262
Connor's** (upstream)	Brook	4	0	0	0	0	0	4	0
	Brown	12	6	0	2	4	0	16	8
	Rainbow	0	0	0	0	0	0	0	0
	Total	16	6	0	2	4	0	20	8

*Restricted waters: flies-only, 10-inch size limit.

**Shocker very inefficient because of deep water.

For location of Burton's Landing and Wakeley's Bridge, see Figure 2. Stephan's Bridge is about midway between Burton's and Wakeley's Bridge. Connor's Flat is about midway between the mouths of the North and South branches of the Au Sable River.

Table 13.--Numbers of trout collected with a D-C shocker, and population estimates (pop. est.) in Main Au Sable River, midsummer, 1959

[Two "runs" were made with the shocker. Fish were fin-clipped and liberated on the first run. Fish taken during second run included a number of recaptures of fish liberated in first run]

Section	Species,* and run	Length (inches) 0-6.9	7.0-9.9	10.0 or over
Bait water, above Burton's	Brook trout			
	First run	11	2	0
	Second run	8	1	0
Length of stream: 790 feet	Recaptures	0	0	0
	Pop. est.	(No estimate possible)		
Average width: 70 feet				
	Brown trout			
Dates:	First run	27	37	18
July 21, 22	Second run	38	36	12
	Recaptures	2	8	7
	Pop. est.	513	166	31
Fly water, at Stephan's	Brook trout			
	First run	134	1	0
	Second run	148	1	0
Length of stream: 715 feet	Recaptures	25	1	0
	Pop. est.	793	1	...
Average width: 87 feet				
	Brown trout			
Dates:	First run	175	63	44
July 23, 24	Second run	151	75	58
	Recaptures	26	20	21
	Pop. est.	1,016	236	122
	Rainbow trout			
	First run	50	0	0
	Second run	132	1	0
	Recaptures	6	0	0
	Pop. est.	1,102	1,108 6	...

* No rainbow trout were taken in the bait water.

The index figures obtained in both 1957 and 1959 tend to show that there are many more trout (especially brook trout) in the flies-only section than in the stream immediately above (Burton's Landing) or below (downstream from Wakeley Bridge and Connor's Flats). This is also shown by a comparison of the 1959 population estimates for the bait water above Burton's Landing, as compared to the fly water near Stephan's Bridge (Table 13). Since there are no index figures for the stream prior to the special order, we have no evidence that the greater population in the flies-only section is due to the special order. The flies-only section of this stream may be better trout habitat, which could account for the difference. Index figures obtained during midsummer of 1959 were relatively low compared to figures for the fall of 1957. Again (as for the South Branch) this is not regarded as good evidence of a change in trout population, but is probably attributable to the higher water temperatures in 1959 (see comments under South Branch of Au Sable, above).

Little South Branch Pere Marquette River

[Current regulations: flies only, 10-inches, 5 trout]

Boardman River

[Current regulations: flies only, 10 inches, 5 trout]

East Branch Fox River

[Current regulations: flies only, 9 inches, 5 trout]

The sections of the above three streams which are under special regulation, and the stations at which midsummer index samples have been obtained with a D-C shocker every year since 1954 (one year before the special order went into effect) are shown in Figures 4, 5, and 6.

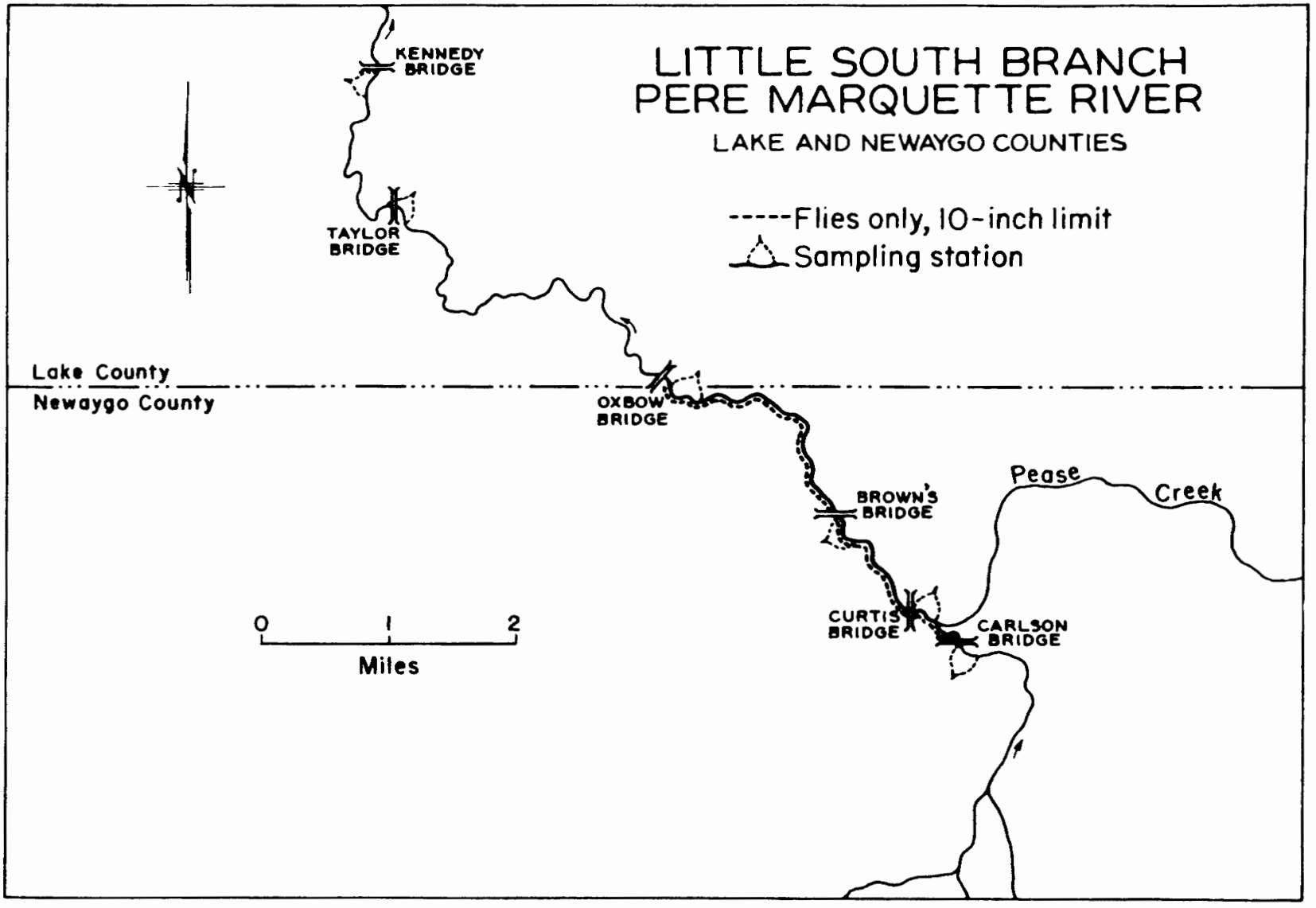

Figure 4.--A portion of the Little South Branch of the Pere Marquette River, showing the extent of flies-only water and the locations of sampling stations.

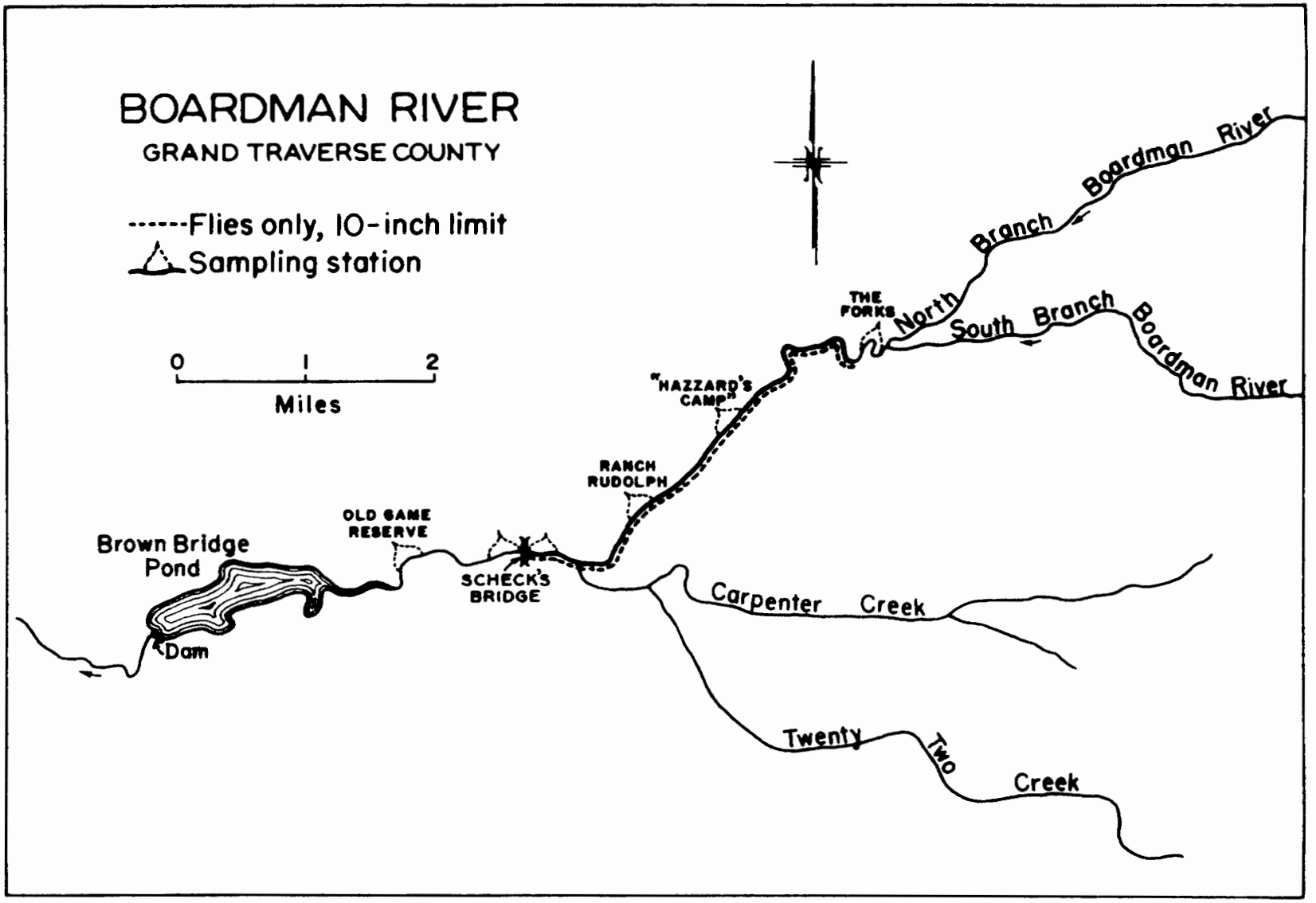

Figure 5.--A portion of the Boardman River, showing the extent of the flies-only water and the locations of sampling stations.

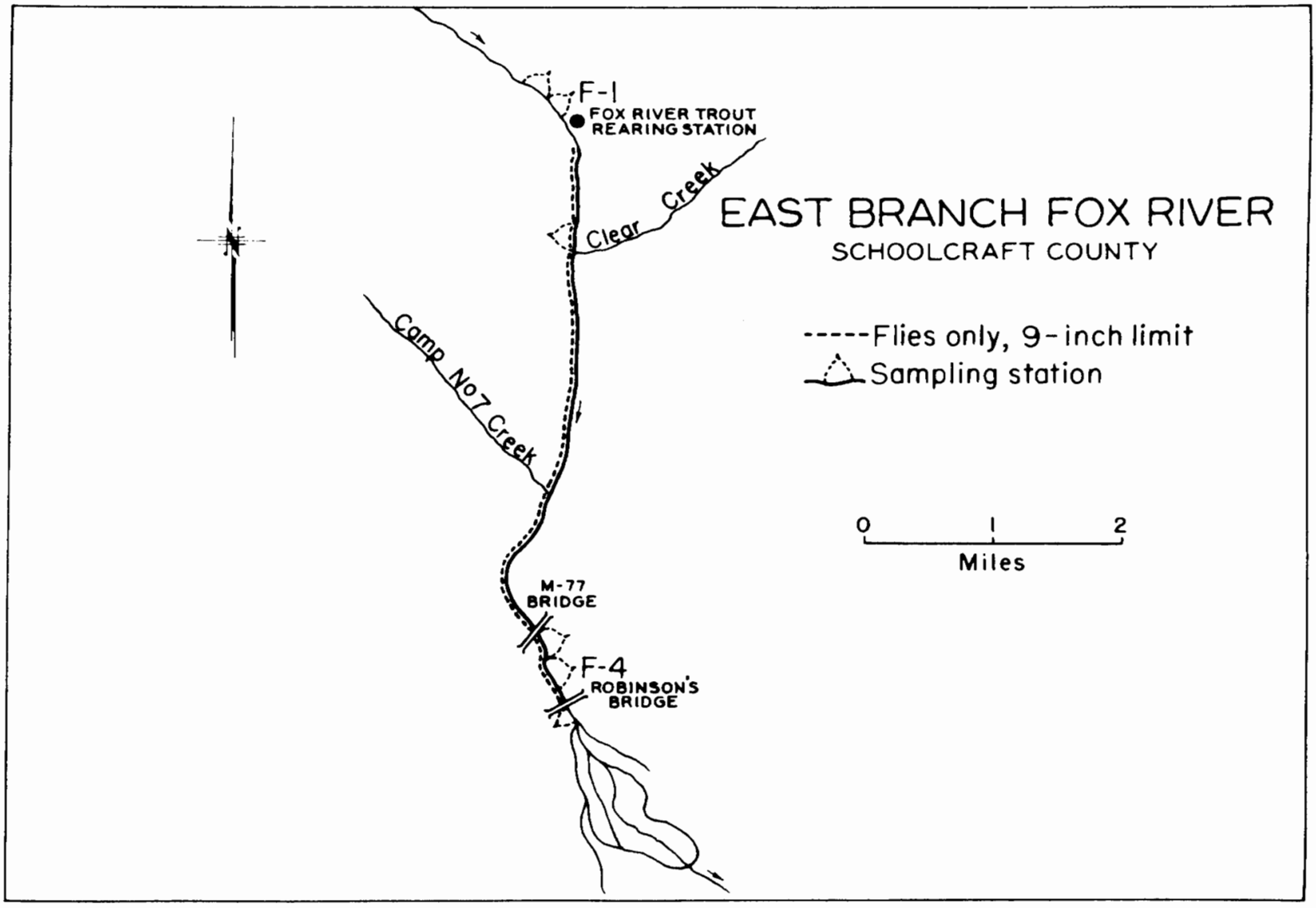

Figure 6.--A portion of the East Branch of the Fox River, showing the extent of the flies-only water and the locations of sampling stations.

On each of the three streams, samples were collected from three stations in the flies-only water and from three stations above or below the special-regulation section. The shocker was operated for about one hour along 100 to 200 yards of stream at each station, and all fish caught were measured and returned to the stream. The annual indices of abundance (number of trout collected per hour with the shocker) for each stream, given as averages for all experimental and all control stations are listed for different length groups of fish, in Tables 14, 15, and 16.

As mentioned earlier in this report, a primary hypothesis in these flies-only experiments was that heavy fishing pressure was keeping the population of trout spawners at so low a level that natural reproduction was not stocking the water to its maximum carrying capacity; from this it would follow that a higher size limit, plus a flies-only regulation to avoid killing many sublegal trout, might rear more spawners and result in a greater population of young.

The detection of any large increase in the population of young trout, and in the population of spawners is the only question being investigated in these streams. Since streams differ from year to year both in population levels of trout, and in certain physical characteristics which affect shocking efficiency, we may expect shocker indices to vary from year to year; what we must look for in the experimental waters is a consistent increase in the indices after the regulation as compared to before, at least an increase compared to the trend in the bait water. In other words, were the changes in the fly water after the regulation in a positive direction as compared to the changes in the bait water during the same period? If they were, and if this trend is fairly consistent over all stations, then we have evidence for deciding that the special regulations were effective.

This fairly complex statistical question has been attacked by an analysis of variance for each species-stream-length subclass where sufficient fish were

Table 14.--Number of trout collected per hour with a D-C shocker, Little South Branch Pere Marquette River, midsummer, 1954-1959

[Data combined for three stations in bait water and three stations in fly water]

Species of trout	Year	Length of trout (inches), and type of water							
		0-4.9		5.0-6.9		7.0-9.9		10.0 and over	
		Bait	Fly	Bait	Fly	Bait	Fly	Bait	Fly
Brook	1954	0	0	0	0	0	0	0	0
	1955	1	0	0	0	1	0	0	0
	1956	0	0	0	0	0	0	0	0
	1957	0	0	0	0	0	0	0	0
	1958	1	1	0	0	0	0	0	0
	1959	0	0	0	0	0	0	0	0
Brown	1954	39	15	5	7	10	10	9	9
	1955	64	55	8	17	60	81	16	44
	1956	25	21	7	7	41	45	18	49
	1957	36	40	5	4	17	18	18	33
	1958	119	181	10	4	62	51	19	44
	1959	22	72	56	54	42	33	23	36
Rainbow	1954	10	3	3	3	0	4	0	0
	1955	49	54	5	5	5	13	0	1
	1956	19	18	5	2	6	13	0	0
	1957	9	9	5	1	5	4	0	0
	1958	125	70	4	2	8	15	0	0
	1959	35	14	29	21	5	3	0	0

Table 15.--Number of trout collected per hour with a D-C shocker, Boardman River, midsummer, 1954-1959

[Data combined for three stations in bait water and three stations in fly water]

Species of trout	Year	Length of trout (inches), and type of water							
		0-4.5		4.6-6.9		7.0-9.9		10.0 and over	
		Bait	Fly	Bait	Fly	Bait	Fly	Bait	Fly
Brook	1954	13	9	10	6	0	1	0	0
	1955	11	16	3	8	0	2	0	0
	1956	43	39	4	5	0	1	0	0
	1957	25	34	5	9	0	2	0	0
	1958	69	46	8	11	1	3	0	0
	1959	72	56	9	11	1	1	0	0
Brown	1954	67	43	28	22	17	16	7	7
	1955	77	70	35	26	52	63	11	14
	1956	100	80	37	36	39	47	9	15
	1957	98	91	34	36	26	34	8	12
	1958	176	110	65	49	71	61	10	13
	1959	83	62	75	62	29	22	7	5

Table 16.--Number of trout collected per hour with a D-C shocker, East Branch Fox River, midsummer, 1954-1959

[Data combined for three stations in bait water and three stations in fly water]

Species of trout	Year	Length of trout (inches) and type of water							
		0-4.4		4.5-6.9		7.0-8.9		9.0 and over	
		Bait	Fly	Bait	Fly	Bait	Fly	Bait	Fly
Brook	1954	23	13	19	8	5	5	0	0
	1955	20	20	30	4	3	1	0	1
	1956	4	0	3	0	1	0	0	0
	1957	40	31	16	17	3	5	1	1
	1958	146	65	30	17	6	11	2	2
	1959	83	80	11	22	2	4	1	2
Brown	1954	1	3	0	1	0	0	0	0
	1955	0	11	0	0	0	1	0	0
	1956	0	0	0	0	0	0	0	0
	1957	0	0	1	1	0	0	0	0
	1958	0	0	0	0	0	0	1	0
	1959	0	2	0	0	0	0	0	0

taken. Analyses were carried out for 18 of these subclasses. In the form in which the data were analyzed, the apparent relative change in the fly water was negative compared to the bait water in 7 instances, a virtual tie in two cases and positive for 8 sets of data, as shown in Table 17, where a positive change is represented by a value greater than one. The positive effect is expected if the regulation is effective. But in only one instance was the relative change consistent enough among the separate stations to be trustworthy; in all the others the average differences are within the range expected from the variable data. The one statistically significant difference was for brown trout over 10 inches in length, on the Little South Branch of the Pere Marquette River, where the increase in the fly water averaged about 2.2 times that recorded in the bait water.

The shocker indices collected in this manner are known not to constitute a very sensitive method for detecting relative changes within a trout stream. It is possible to compute for each of these three streams the discriminating ability of the method in terms of the smallest difference which likely could be detected as a statistically significant difference; such values are shown in Table 17. This discriminating ability varies with the consistency of the responses of the individual experimental and control stations. For example, if all three stations in the fly water vary in the same pattern from year to year, and if the three control stations also agree among themselves in their own trend, then the method will be sensitive on that stream, i.e., small changes in the fly water relative to the bait water will be easily detected. But if the year-to-year changes among the experimental and among the control stations are inconsistent, then only large changes may be detected. In this last situation, which includes many of the sets of data of this study, rather large changes could take place without being detected on the stream.

Table 17.--Discriminating ability of the test of effect of special regulations in parts of the Pere Marquette, Boardman, and Fox rivers, as measured by shocker index values,[1] 1954-1959

[Discriminating ability is shown as the relative change in the fly water as compared to the bait water which would be reasonably (75%) sure of being detected, using statistical significance at the 5% level. The observed changes are noted in parentheses. Values less than 1.0 indicate a relative decrease in the fly water as compared to the bait water.]

River, and species of trout	Length (inches)			
	Fingerlings	Fingerlings to 6.9 inches	6.9-9.9 inches[2]	10 inches and over[3]
Little South Branch, Pere Marquette River:				
Brown	4.2 (1.9)	300.0 (0.3)	6.3 (0.9)	2.6 (2.2)*
Rainbow	33.7 (0.6)	20.4 (1.1)	63.2 (0.1)	... ...
Boardman River:				
Brook	6.4 (1.6)	74.7 (1.2)	44.4 (2.0)	... ...
Brown	2.4 (0.9)	3.4 (1.0)	4.3 (2.6)	5.5 (1.3)
East Branch of Fox River:				
Brook	38.2 (0.7)	2.8 (1.0)	57.8 (0.9)	65.0 (1.9)

[1] For rainbow trout in the Boardman, brown and rainbow trout in the E. Br. Fox, and brook trout in the Pere Marquette, relatively few fish were collected and the data are inadequate for the present comparison.

[2] 6.9-8.9 inches in East Branch of Fox River.

[3] Over 9.0 inches in East Branch of Fox River.

* Observed difference significant at 5 percent level.

While the shocker index method was known to yield variable results when this series of observations was planned, the present quantitative information was not then available. Looking back on the work done, however, we see that in only a handful of the various comparisons was there any chance at all of our detecting such population changes as might reasonably be expected to happen with a change in regulations. Thus while there were enough data to make a comparison in 18 instances, in only 6 of these did we have any fairly good chance of detecting a change in the flies-only water of about four times the change in the bait water (and in only 3 a change of less than 3-fold); in the remaining 12 comparisons one could hardly expect the change in regulations to produce a population effect great enough to be detected (Table 17). In appraising this work, therefore, it is more accurate to speak of one significant difference out of 6, or perhaps only 3, good tests, rather than one out of 18.

This analysis of experience with the shocker-index method reveals that results are generally highly variable. While populations change from year to year at any one point in a stream and thus may be partly to blame for the high variability of the method, still the shocker index itself is now known to be quite variable. Evidence for this is found in Table 18 which shows the ratio of population estimate to shocker index for those instances where both have been determined. From this experience, it seems that if one were to try to judge what the population estimate would be from the shocker index figure and an average multiplying factor, then only half the population estimate values might be expected to be within a plus or minus 50 percent. While some of this variability may be associated with the population estimates themselves, most of it is thought to be due to variable stream characteristics which influence shocker efficiency.

In order to obtain more reliable information on the trout populations than that provided by shocker indices, detailed population studies were run in representative sections of the bait water and the fly water in each of the three streams

Table 18.--Variability of trout shocker indices as illustrated by ratio: estimated population per acre divided by shocker index (average number of trout collected per hour)

Locality	Species of trout	Length (inches) 0-6.9	7.0-9.9*	10.0 and over**
D-C shocker, 1959:				
South Branch, Au Sable River, Failing's	Brook	24.6	2.2	...
	Brown	6.2	1.8	2.2
Main Stream, Au Sable River, Burton's	Brook	...	...	...
	Brown	15.0	3.5	1.3
Main Stream, Au Sable River, Stephan's	Brook	4.1	0.7	...
	Brown	4.1	2.6	1.9
Boardman River, Scheck's	Brook	5.5	...	...
	Brown	7.6	1.9	...
Boardman River, Rudolph's	Brook	7.8	...	...
	Brown	7.8	...	...
East Branch, Fox River: Station 1	Brook	21.7	...	...
Station 4	Brook	14.0	...	...
Pere Marquette River: Taylor's	Brown	...	3.5	1.7
Brown's	Brown	...	2.2	1.6
A-C shocker - all from North Branch, Au Sable River:				
Dam 2, 1957	Brook	6.3	4.8	...
	Brown	6.8	1.7	2.4
Dam 2, 1958	Brook	4.4	5.3	...
	Brown	6.7	3.4	1.6
Twin Bridge, 1957	Brook	6.2	2.3	3.0
	Brown	8.6	3.2	1.8
Twin Bridge, 1958	Brook	6.2	2.1	0.7
	Brown	6.5	3.3	3.2
Dam 4, 1957	Brook	6.0	1.7	...
	Brown	8.8	4.6	2.2
Dam 4, 1958	Brook	9.5	2.1	0.8
	Brown	9.2	2.8	2.7
Over-all average for size range		8.9	2.8	1.9
Range calculated to include 50% of values		5.5-12.2	2.0-3.6	1.4-2.5

*7.0-8.9 inches for the E. Branch Fox River and North Branch Au Sable.

**9.0 inches and over for the East Branch Fox River and North Branch Au Sable.

here concerned. No marked differences were observed, however, in favor of the fly water as compared to the bait water. In the Pere Marquette River, fingerling brown and rainbow trout were more abundant in the fly water than in the bait water, but estimated numbers of brown trout over 7 inches in length were nearly identical in the two sections, and 7.0-9.9-inch rainbow trout were more abundant in the bait water than in the fly water (Table 19). In the Boardman River fingerling brook and brown trout were more abundant in the bait water than in the fly water, but more brown trout (by far the most important species in this stream) over 7 inches in length were taken in the fly water than in the bait water (Table 20). In the Fox River, which is primarily a brook-trout stream, the estimated numbers of fingerlings were approximately equal in the two stream sections studied, but the population of larger trout was greater in the bait water than in the fly water (Table 21). Water conditions were poor for electrofishing in the Fox, however, and the population estimates cannot be regarded as being highly reliable.

Hunt Creek

[Current regulations, Sections Z + A: flies only, 7 inches, 10 fish]

Hunt Creek, Montmorency County, was the only stream where a flies-only order was invoked but the size limit was not raised and the creel limit was not reduced. On Hunt Creek the flies-only order had the effect of greatly reducing fishing pressure; at the same time the catch per hour on the fly water increased to the extent that the total angler harvest was about the same as before the flies-only order went into effect (Figure 7). There has not been a significant relative increase in the numbers of trout remaining in the stream at the end of the season after the flies-only order went into effect (Table 22).

Table 19.--Number of trout collected with a D-C shocker and population estimates (pop. est.), Little South Branch Pere Marquette River, midsummer, 1959

[Two "runs" were made with the shocker. Fish were fin-clipped and liberated on the first run. Fish taken during the second run included a number of recaptures of fish marked in first run.]

Type of water, dimensions and date	Species, and run	Length (inches)			
		0-4.9	5.0-6.9	7.0-9.9	10.0 or over
Bait water, at Taylors	Brown trout				
	First run	29	24	41	28
	Second run	19	12	25	21
Length of stream: 1,550 feet	Recaptures	3	4	8	14
	Pop. est.	184	72	128	42
Average width: 25 feet					
	Rainbow trout				
Dates:	First run	3	29	12	0
July 13, 14	Second run	8	12	10	0
	Recaptures	1	3	2	0
	Pop. est.	24	116	60	0
Fly water, at Brown's	Brown trout				
	First run	173	79	49	26
	Second run	103	50	33	32
Length of stream: 1,350 feet	Recaptures	18	21	14	17
	Pop. est.	990	188	116	49
Average width: 35 feet					
	Rainbow trout				
Dates:	First run	29	38	1	0
July 14, 15	Second run	14	34	2	0
	Recaptures	0	12	0	0
	Pop. est.	103	173	283 7	0

Table 20.--Numbers of trout collected with a D-C shocker and population estimates (pop. est.) in Boardman River, midsummer, 1959

[Two "runs" were made with the shocker. Fish were fin-clipped and liberated on the first run. Fish taken during the second run included a number of recaptures of fish marked in first run.]

Type of water, dimensions and date	Species and run	Length (inches) 1.0-4.5	4.6-6.9	7.0-9.9	10.0 or over
Bait water, below Scheck's Br.	Brook trout				
	First run	66	10	1	0
	Second run	61	6	0	0
Length of stream 1,320 feet	Recaptures	7	2	0	0
				33	
Average width: 45 feet	Pop. est.	575	31	2	0
Dates: July 6, 7	Brown trout				
	First run	57	73	31	5
	Second run	77	78	36	2
	Recaptures	2	13	14	0
					98
	Pop. est.	2,194	438	89	9
Fly water Rudolph's	Brook trout				
	First run	42	7	1	0
	Second run	33	3	0	0
Length of stream: 1,010 feet	Recaptures	6	0	0	0
				300	
Average width: 33 feet	Pop. est.	262	35	3	0
	Brown trout				
Dates: July 2, 3	First run	15	48	24	5
	Second run	16	40	19	7
	Recaptures	0	8	5	0
			441		151
	Pop. est.	115	326	118	33

Table 21.--Numbers of trout collected with a D-C shocker and population estimates (pop. est.), East Branch Fox River, midsummer, 1959

[Two "runs" were made with the shocker. Fish were fin-clipped and liberated on the first run. Fish taken during the second run included a number of recaptures of fish marked in first run.]

Type of water, dimensions, and date	Species,* and run	Length (inches)			
		0-4.4	4.5-6.9	7.0-8.9	9.0 or over
Bait water (F-1)	Brook trout				
	First run	82	11	3	1
Length of stream:	Second run	163	19	8	1
1,920 feet; average	Recaptures	9	1	0	0
width: 18 feet				420	
Dates:					
June 29, 30	Pop. est.	1,485	293	107	20
Fly water (F-4)	Brook trout				
	First run	83	7	0	1
Length of stream:	Second run	46	0	0	0
2,650 feet; average	Recaptures	2	0	0	0
width: 27 feet				2,093	
Dates:					
June 25, 30**	Pop. est.	1,971	107	0	15

*No brown trout were caught in the bait water, and only 5 in the fly water.

**Rain on June 30.

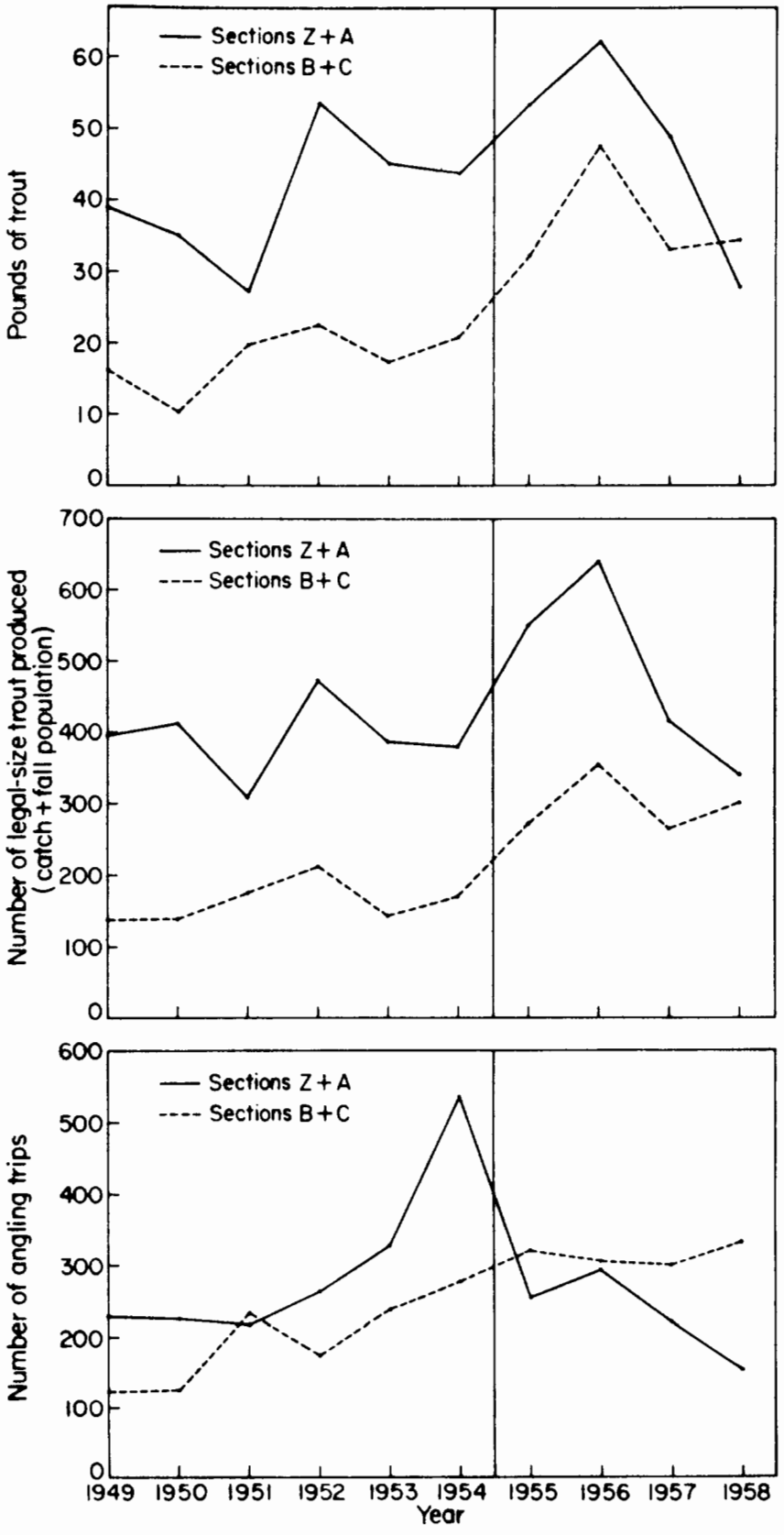

Figure 7.--A comparison of the total pounds of trout caught by anglers (top graph), total number of legal-size trout produced (middle), and total numbers of fishing trips (bottom) in Sections Z + A (lures restricted to flies only, 1955-1958) and Sections B + C (no lure restriction) of Hunt Creek, Montmorency County.

Table 22.--Numbers of sublegal and legal-size brook trout in fall populations, number of fishing trips, and total catch by anglers, Hunt Creek, 1949-1958

Year	Fall population of wild brook trout				Stream section, and number of fishing trips		Stream section, and total number of brook trout caught	
	Sections Z+A		Sections B+C					
	Under 7"	7" or over	Under 7"	7" or over	Z+A	B+C	Z+A	B+C
No lure restriction								
1949	3,569	136	2,477	34	229	124	259	102
1950	3,676	158	2,582	70	226	125	254	69
1951	3,150	112	3,055	57	216	232	196	128
1952	3,602	119	3,235	49	261	174	353	162
1953	4,598	77	2,462	35	326	238	309	109
1954	4,748	87	3,735	36	535	277	293	134
Flies-only in Z+A								
1955	3,839	193	2,785	74	254	320	357	199
1956	3,307	267	3,215	59	293	305	371	295
1957	4,542	135	3,889	66	220	298	282	200
1958	4,264	149	3,645	74	154	331	192	227

Pigeon River, Sections C + D

[Current regulations: flies only, 9 inches, 5 trout]

In the Pigeon River at the Pigeon River Fisheries Research Station (Otsego County) the trout population is about two-thirds brook trout and one-third brown trout. Estimates of numbers of trout present were made each fall with a D-C shocker, and a compulsory permit system insured a complete census of fishing. Of the five sections (total of 6 miles) of stream under control of the Station, two (C + D) were placed under special regulations (9 inches, and 2 or 5 trout, 1951-1957, and flies only, 9 inches, 5 trout in 1958) and the other sections (including B) were retained under state-wide regulations (no lure restriction, 7 inches, 10 trout). Data on fall populations of trout, total catch, angling quality and fishing pressure are summarized in Tables 23 and 24 and Figure 8.

During the period of study, the numbers of trout in the entire six miles of stream increased through the mid-1950's and decreased in more recent years. This was reflected in both the fall population estimates and the catch. In order to evaluate the change of regulations in Sections C and D in relation to this general fluctuation in the trout population, Section B was used as a control. The ratio of the number of fish in the fall population in Sections C and D to the number in Section B for each year are given in Table 23. The total catch of fish nine inches and larger were treated similarly (Table 24).

A statistical analysis of these ratios did not demonstrate any significant change in the number of fish in Sections C and D under the changes in regulation. The catch, too, was relatively unaffected. The fishing success as measured by the catch of trout per hour, 9 inches long and larger, increased with the increase in size limit and the reduction in catch limit, but the fishing success also varied similarly in Section B, where the regulations did not change. There was no statistical difference in the ratios.

Table 23.--Estimated numbers of brook and brown trout of different sizes in fall populations, Sections C + D, Pigeon River, and ratios of numbers of fish in Sections C + D to numbers in Section B, 1949-1958

Species of trout	Length (inches)	Regulations, and year: 7 inches, 15 fish		9 inches, 2 fish				9 inches, 5 fish			9 inches, 5 fish, flies only
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
		Population estimates									
Brook	0.0-3.9	2,462	2,624	5,981	7,080	4,636	5,202	3,100	3,751	3,391	4,606
	4.0-6.9	1,773	3,463	2,569	2,252	2,939	2,793	1,484	1,040	1,127	1,733
	7.0 and over	249	196	634	474	419	496	193	139	461	452
Brown	0.0-3.9	428	316	299	1,032	268	480	706	317	420	2,667
	4.0-6.9	151	319	251	632	504	447	513	157	137	441
	7.0 and over	317	384	569	358	771	505	496	328	148	221
		Ratios of numbers of fish in Section C + D to Section B									
Brook	0.0-3.9	7.0	4.3	4.6	3.1	2.3	2.2	4.3	6.5	4.9	4.0
	4.0-6.9	3.3	6.9	7.3	4.5	4.6	3.2	4.5	4.1	5.2	1.6
	7.0 and over	11.3	2.1	10.2	14.8	4.3	5.2	6.0	4.6	17.1	16.1
Brown	0.0-3.9	0.5	0.5	1.8	1.5	1.1	1.3	14.4	0.9	0.5	2.4
	4.0-6.9	1.4	2.0	0.9	2.1	1.9	3.6	1.9	3.2	2.1	1.8
	7.0 and over	1.6	2.5	3.7	1.8	3.1	2.1	2.1	3.3	2.1	1.7

Table 24.--Catch per hour by anglers and total catch of trout 9 inches long or longer in Sections C + D, Pigeon River, and ratios of numbers of fish caught in Sections C + D to numbers caught in Section B, 1949-1959

Regulations, and year	Brook trout				Brown trout				Total hours
	Number caught	Ratio C + D / B	Catch per hour	Ratio C + D / B	Number caught	Ratio C + D / B	Catch per hour	Ratio C + D / B	
7 inches, 15 fish									
1949	25	2.3	0.008	1.5	39	1.4	0.012	0.9	3,166.5
1950	33	2.8	0.009	1.8	47	1.7	0.013	1.2	3,571.0
9 inches, 2 fish									
1951	38	3.8	0.013	4.0	34	0.7	0.011	0.7	2,977.5
1952	45	7.5	0.026	6.8	27	1.2	0.016	1.1	1,734.5
1953	49	2.3	0.028	2.0	39	1.5	0.022	1.3	1,784.0
1954	77	3.3	0.034	2.6	138	1.8	0.062	1.4	2,239.0
9 inches, 5 fish									
1955	55	2.9	0.022	1.3	91	3.1	0.037	1.4	2,475.5
1956	44	7.3	0.020	3.5	77	1.5	0.034	0.7	2,230.0
1957	44	3.1	0.027	1.8	26	1.3	0.016	0.7	1,630.0
9 inches, 5 fish flies only									
1958	61	2.7	0.058	3.3	27	0.9	0.026	1.2	1,050.0
1959*	18	1.8	0.037	2.6	4	0.7	0.008	1.0	487.5

*April 25-August 1, 1959.

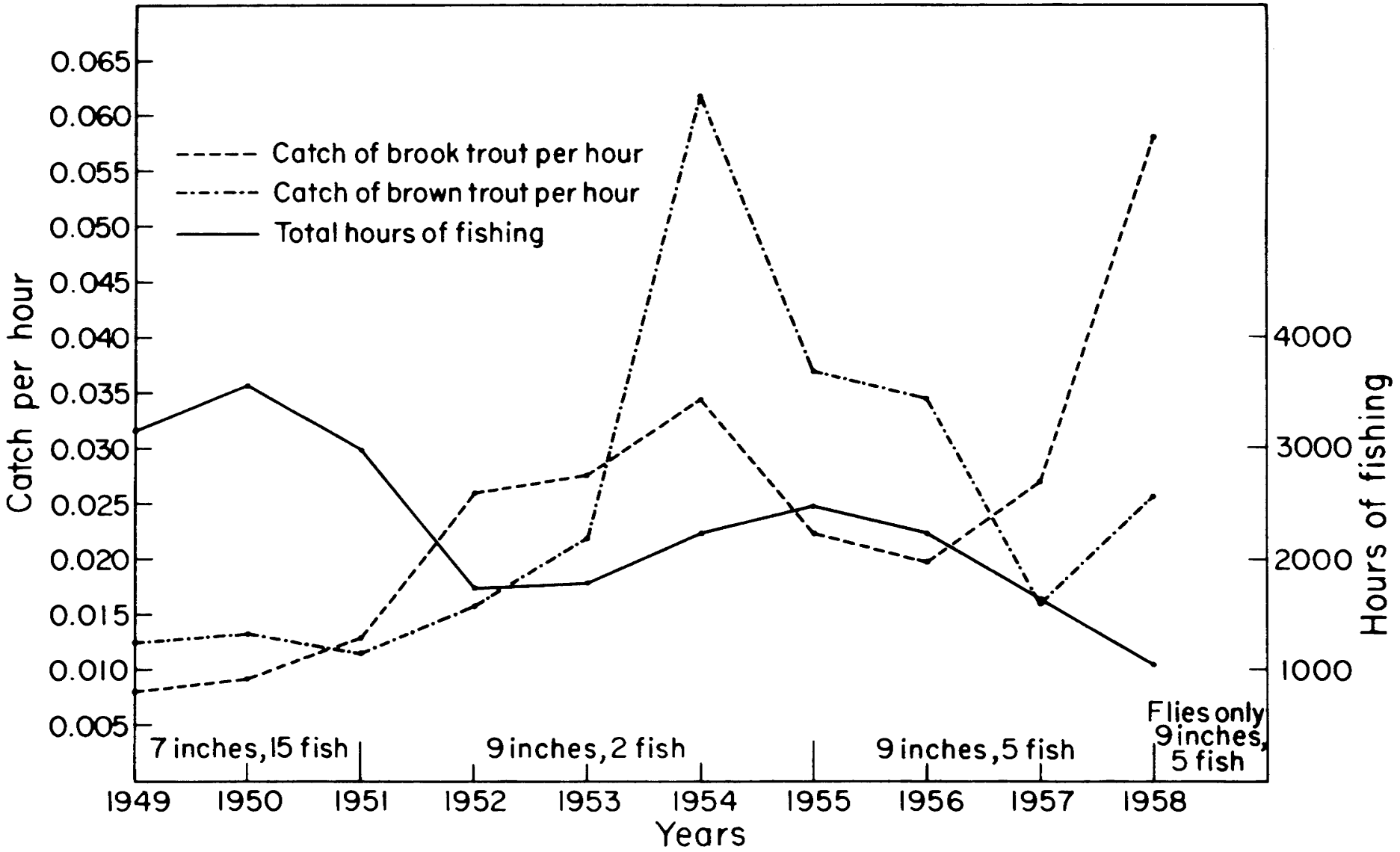

Figure 8.--Catch of brook trout and brown trout per hour by anglers, and total fishing pressure, in Sections C and D of Pigeon River, 1949-1958

The major effect of the 9-inch length restriction was to markedly decrease the fishing pressure (Table 24).

The catch of brook trout per hour varied inversely with the fishing pressure (total hours). When the fishing pressure decreased, the catch per hour increased. This effect was not as apparent for brown trout.

The conclusion is that no significant change in the trout population can be shown under the changes in regulation--a 9-inch size limit since 1951 plus a flies-only restriction since 1958.

Ford Lake

[Current regulations: flies only, 7 inches, 10 trout]

During the five years while the flies-only order has been in effect on this lake, changes have been made in the program of stocking brook trout fingerlings. The size of fingerling trout available from the hatcheries for stocking has increased, and there has been a corresponding adjustment made in the number of trout planted per acre. An improvement in catch of trout per hour in the lake, and an increase in percentage return of hatchery fish to the angler (Table 25), might have been due mostly to the change in size and number of fish planted. The results to date on this lake are inconclusive, in so far as evaluating the flies-only order is concerned.

Summary

It appears from our records that invoking a higher size limit or a flies-only order had the effect of greatly reducing fishing pressure. This occurred on the

Table 25.--Numbers of brook trout stocked, total catch, number of planted fingerlings caught, and fishing pressure, Ford Lake, Otsego County, 1952-1959

Year	Brook trout stocked*				Total catch	Catch from fingerling plants		Total hours fished
	Fingerlings		Legal-size fish			Total number	Catch per hour	
	Number	Average length (inches)	Number	Average length (inches)				
1952	2,650	4.0	265	8.1	...	...	....	.....
1953	5,850	3.5	650	8.1	613	269	0.39	694.5
1954	5,850	4.2	600	7.0	981	447	0.38	1,176.0
1955	5,850	4.3	300	6.7	327	243	0.49	494.0
1956	5,850	5.7	...	...	310	243	0.42	576.0
1957	1,170	5.6	...	...	202	202	0.48	417.5
1958	1,170	5.6	...	...	289	289	0.80	360.0
1959**	.....	...	...	...	547	547	1.19	460.5

*All fingerlings were planted in the fall; legal-size fish were planted in the fall in 1952 and 1953, and in the spring in 1954 and 1955.

**April 25-August 1.

two waters (Hunt Creek and Pigeon River) where complete creel census data were available before and after the special orders went into effect. The fact that the highest fishing pressure on the North Branch of the Au Sable occurs on the old fly water probably reflects the fact that this section is especially accessible and includes the Village of Lovells where trout fishermen tend to concentrate.

On the North Branch of the Au Sable, anglers are harvesting many more trout over 9 inches from the old fly water and many less in the new fly water, than in the bait water, and with the special regulations they are giving up about 2/3 of the numerical catch and 1/3 the weight of trout in the creel. If only the old fly water section of the North Branch were involved, the general picture would be much more favorable for the flies-only regulation.

For all three branches of the Au Sable system (North Branch, South Branch, and main stream) our records indicate that there are more trout present in the flies-only waters, than there are in adjacent waters which are under the bait regulation.

For the Boardman, Fox and Little South Branch of the Pere Marquette, we have no evidence that the flies-only regulation and higher size limit have had a significant effect on the trout populations in the stream, except for large brown trout in the Pere Marquette.

On all of the test streams except Hunt Creek, the special regulations include a 5-fish creel limit (rather than the state-wide 10-fish limit). Thus, on most of the streams, we are testing the combined effect of restrictions on lure, size limit and creel limit. We judge that the reduced creel limit is of less importance than the other two restrictions, because only a small percentage of anglers catch more than 5 trout in a given day's trip.

Need for future research

A continuation of the study on the North Branch of the Au Sable and Sections C and D of the Pigeon River offers the best opportunity of detecting in the near future, any benefit of the flies-only regulation and a higher size limit. So far, the results are not very conclusive. The old fly section of the North Branch holds some promise of showing an improvement in fishing as a result of the special regulations, but there is still the question of whether the greater population of trout in the old fly water, as compared to that in the adjoining bait water in Otsego County, is the result of the special regulations, or whether it might be attributable to the old fly water being the best trout habitat in the North Branch. We believe it is highly desirable to continue the present experimental regulations on the North Branch of the Au Sable through 1960 (as per Commission order now in effect), and starting with 1961 the regulations on the North Branch might well be reversed, with the present old fly water above Eaman's changed to bait, 7-inch water, and the present bait water in Otsego County changed to flies-only, 9-inch-limit water.

It is recommended that the flies-only regulation and the 9-inch size limit be continued on Sections C and D of the Pigeon River through 1962, and that the flies-only order on Ford Lake (no change in size limit) also be continued through 1962. The flies-only order has been in effect on the Pigeon River for only two years which is not long enough to provide a good test. An extension of three years on Ford Lake is needed to allow for changes in the stocking program for this lake.

The five-year record for Sections Z and A of Hunt Creek under the flies-only regulation is sufficient to judge the quality of fishing under this order. It is suggested that the flies-only order be dropped starting in 1960. Subsequent records will provide a further evaluation of the flies-only order.

For the Boardman, Fox, and Little South Branch of the Pere Marquette, there is little point in continuing the flies-only regulation and the higher size limits for the purpose of further research, unless a great deal more effort is put into the study of these streams than has been possible in the past, and for which there is no provision in the Institute's research program at the present time.

There is perhaps some logic in a continuation of the flies-only order and the higher size limit on the South Branch of the Au Sable, since this is one of the streams where our shocker sampling indices were consistent with an increase in the trout population after these orders went into effect. However, there is no provision in the present research budget for greatly intensifying a study of this stream, in the form of a creel census and population estimates.

Acknowledgments

Many present and former Institute employees at the Hunt Creek and Pigeon River stations collected creel census data and made trout population estimates in this study. Drs. A. S. Hazzard and E. L. Cooper were especially concerned with the study, before they left the Institute. Mr. O. M. Corbett conducted the creel census on the North Branch of the Au Sable. Mr. E. E. Schultz supervised much of the index shocker sampling. Other Fish Division employees have contributed. Those who gave much assistance in the preparation of this report are Drs. P. H. Eschmeyer and W. C. Latta, and Messrs. G. R. Alexander, J. D. Ryckman and W. L. Cristanelli.

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Some recent information on flies-only trout streams:

1. Trout populations and anglers' catch in North Branch Au Sable River.

2. Trout populations in Main Stream Au Sable River.

3. Anglers' catch on Little South Branch Pere Marquette River.

Compiled by

Institute for Fisheries Research

September 6, 1960

To supplement Institute Report No. 1577

North Branch Au Sable River

Fall trout population (1957-1959) and anglers' catch (1958-1960).
All figures on per-mile-of-stream basis.

Water	Year	Fall (October) population											
		Brook trout				Brown trout				Brook plus brown			
		0-4.9"	5-6.9"	7-8.9"	9"+	0-4.9"	5-6.9"	7-8.9"	9"+	0-4.9"	5-6.9"	7-8.9"	9"+
Bait water													
Dam 2	1957	10,361	410	191	0	3,243	73	317	248	13,604	483	508	248
1300 ft.	1958	4,235	321	256	12	2,127	28	110	252	6,362	349	366	264
2.50 acres	1959	4,226	463	171	0	3,309	12	65	106	7,535	475	236	106
Dam 3	1959	2,425	114	202	0	1,191	76	135	253	3,616	190	337	253
1253 ft.													
2.14 acres													
Old fly water													
Twin Bridge	1957	9,275	964	1,886	177	3,216	147	509	501	12,491	1,111	2,395	678
1255 ft.	1958	12,853	556	1,351	34	3,520	320	143	998	16,373	876	1,494	1,032
3.25 acres	1959	8,302	703	2,076	76	1,844	72	429	488	10,146	775	2,505	564
Black Hole	1959	1,809	105	120	40	1,426	427	85	828	3,235	532	205	868
1051 ft.													
2.06 acres													
New fly water													
Dam 4	1957	11,878	1,578	562	17	4,952	268	909	347	16,830	1,846	1,471	364
1280 ft.	1958	12,774	1,569	946	33	4,237	54	525	516	17,011	1,623	1,471	549
2.94 acres	1959	11,180	2,759	487	8	2,573	1,338	958	359	13,753	4,097	1,445	367
Mary Ann	1959	5,399	1,503	734	6	1,370	312	514	150	6,769	1,815	1,248	156
913 ft.													
1.59 acres													

Fishing pressure in hours, and anglers' catch (brook and brown trout combined); figures for 1960 are for first 3/4 of the season, to August 12.

	Year	Hours of fishing	Length of trout			
			5-6.9"	7-8.9"	9"+	
Bait water	1958	1,311	2,884	621	159	Legal fish are underlined
Dam 2 to County	1959	608	923	170	72	
line	1960(3/4)	447	314	97	47	
Old fly water	1958	1,885	3,377	1,266	312	
County line to	1959	1,972	2,891	1,084	121	
Eaman's	1960(3/4)	1,686	2,035	763	375	
New fly water	1958	1,143	1,680	630	78	
Eaman's to	1959	821	825	309	117	
Kellogg's	1960(3/4)	947	1,258	472	207	

Figures on sublegals caught by anglers are based on angler reports, and for fly water the reported sublegals are apportioned to 5-6.9 and 7-8.9 classes on the basis of results of test fishing.

Main Stream Au Sable River

Trout population estimates, by mark-and-recapture, November, 1959

Fish caught by shocker, fin-clipped and released. Pop. = population estimate.
N_1 = fish caught first run. N_2 = fish caught second run.
N_{12} = marked fish caught second run.

Type of water	Length group, inches	Brook trout				Brown trout				~~Brook plus brown~~ Rainbow			
		N_1	N_2	N_{12}	Pop.	N_1	N_2	N_{12}	Pop.	N_1	N_2	N_{12}	Pop.
Bait water	2	..	..	..	..	..	..	..	..	..	..	..	..
At Allison's,	3	..	1	..	1	2	1	..	3	..	..	..	..
Sec. 8 of 26 N,	4	..	..	..	..	8	11	2	44	..	..	..	..
3 W.	5	..	..	..	..	1	..	..	1	..	..	..	..
Nov. 2-3.	6	1	1	..	2	..	..	..	..	..	..	..	..
1053 ft. stream	7	..	..	..	..	5	4	1	20	..	..	..	..
2.37 acres	8	..	..	..	..	4	4	1	16	2	..	..	2
	9	..	..	..	..	3	2	1	6	..	..	..	..
	10	..	..	..	..	3	1	..	4	..	..	..	..
	11	..	..	..	..	3	1	1	3	..	..	..	..
	12	..	..	..	..	5	2	2	5	..	..	..	..
	13	..	..	..	..	4	1	..	5	..	..	..	..
	14	..	..	..	..	1	1	..	2	..	..	..	..
	15	..	..	..	..	1	1	..	2	..	..	..	..
	16+	..	..	..	..	1	..	..	1	..	..	..	..
Fly water	2	4	10	..	14	1	1	1	1	..	..	..	..
At Wa Wa Sum	3	48	68	13	251	25	25	4	156	1	1	..	2
Secs. 12 and 7	4	28	44	10	123	56	45	20	126	2	1	1	2
of 26 N, 2 and	5	19	22	5	84	11	8	4	22	..	2	..	2
3 W.	6	19	19	7	52	20	19	9	42	..	..	..	..
Nov. 9-10	7	12	13	4	39	45	36	21	77	..	..	..	..
773 ft. stream	8	11	7	5	15	40	28	12	93	..	..	..	..
1.75 acres	9	3	..	..	3	34	21	9	79	..	2	..	2
	10	..	2	..	2	23	21	7	69	1	..	..	1
	11	..	..	..	..	10	10	4	25	..	..	..	..
	12	..	..	..	..	7	10	2	35	..	..	..	..
	13	..	..	..	..	4	5	3	7	..	..	..	..
	14	..	..	..	..	6	5	2	15	..	..	..	..
	15	..	..	..	..	4	2	1	8	..	..	..	..
	16+	..	..	..	..	3	1	1	3	..	..	..	..

Summation for population estimates:

Length group, inches	Bait water (2.37 acres)			Fly water (1.75 acres)		
	Brook	Brown	Rainbow	Brook	Brown	Rainbow
2-4	1	47	..	388	283	4
5-6	2	1	..	136	64	2
7-9	..	42	2	57	249	2
10-12	..	12	..	2	129	1
13-14	..	7	..	..	22	..
15+	..	3	..	..	11	..
Totals	3	112	2	583	758	9

Little South Branch Pere Marquette River

Fishing pressure and trout in creel during first three quarters of 1960 season.

First quarter: Apr. 30-June 3. Second quarter: June 4-July 8.
Third quarter: July 9-Aug. 12. Computed from creel census.

Type of water	Quarter of season	Pressure in hours	Trout in creel (all species) Number	Pounds	Average length, inches	Average weight, pound
Bait water* 7" limit 5 miles of stream	First	2,252	1,174	434	9.8	0.37
	Second	1,000	636	184	9.0	0.29
	Third	795	166	42	8.5	0.25
	Total	4,047	1,976	660	9.4	0.33
Fly water 10" limit 5 miles of stream	First	362	137	96	12.1	0.70
	Second	1,025	431	297	12.0	0.69
	Third	656	201	133	11.8	0.66
	Total	2,043	769	526	12.0	0.68

*Slight revisions for some of the figures, from earlier compilation.

Fish in creel were mostly brown trout plus some brook trout and a few rainbow trout.

During the period April 13 to June 27, 1960, 5,000 legal-size brown trout and 2,500 legal-size brook trout were planted (from hatcheries) in the 5-mile stretch of bait water, but no trout were planted in the fly water. Wild and hatchery trout were not differentiated in the census; in other words some (but an unknown number) of the trout creeled in the bait water were hatchery fish.

North Branch Au Sable River

Fishing pressure in hours, and anglers' catch (brook and brown trout combined); figures for 1960 are complete for the entire trout fishing season.

Type of water	Year	Hours of fishing	Anglers' catch 5"-6.9"	7"-8.9"	9"+
Bait water	1958	1,311	2,884	621	159
Dam 2 to County	1959	608	923	170	72
line	1960	619	413	265	78
Old fly water	1958	1,885	3,377	1,266	312
County line to	1959	1,972	2,891	1,084	121
Eaman's	1960	1,950	2,186	819	399
New fly water	1958	1,143	1,680	630	78
Eaman's to	1959	821	825	309	117
Kellogg's	1960	1,191	1,613	605	228

Legal fish are underlined

Figures on sublegals caught by anglers are based on angler reports, and for fly water the reported sublegals are apportioned to 5-6.9 and 7-8.9 classes on the basis of results of test fishing.

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Little South Branch Pere Marquette River

Fishing pressure and trout in creel during each of four quarters of 1960 season. Computed from creel census.

First quarter: Apr. 30-June 3. Second quarter: June 4-July 8.
Third quarter: July 9-Aug. 12. Fourth quarter: Aug. 13-Sept. 11.

Type of water	Quarter of season	Hours of fishing	Trout in creel (all species) Number	Pounds	Av. length, inches	Av. weight, pound
Bait water	First	2,252	1,174	434	9.8	0.37
7" limit	Second	1,000	636	184	9.0	0.29
5 miles of	Third	795	166	42	8.5	0.25
stream	Fourth	617	287	100	9.5	0.35
	Total	4,664	2,263	760	9.4	0.34
Fly water	First	362	137	96	12.1	0.70
10" limit	Second	1,025	431	297	12.0	0.69
5 miles of	Third	656	201	133	11.8	0.66
stream	Fourth	483	265	125	10.8	0.47
	Total	2,526	1,034	651	11.7	0.63

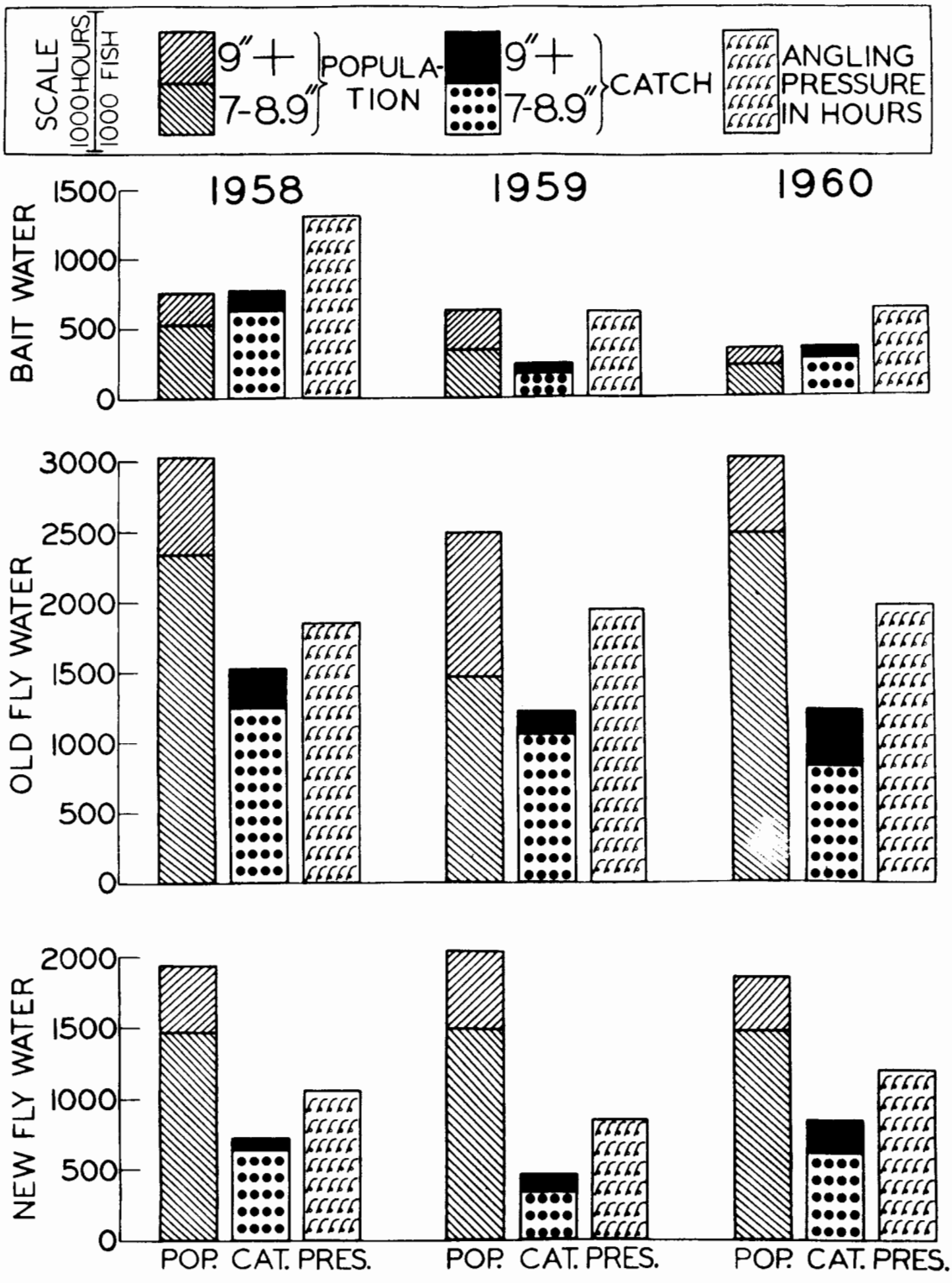
Fish in creel were mostly brown trout plus some brook trout and a few rainbow trout.

During the period April 13 to June 27, 1960, 5,000 legal-size brown trout and 2,500 legal-size brook trout were planted (from hatcheries) in the 5-mile stretch of bait water, but no trout were planted in the fly water. Wild and hatchery trout were not differentiated in the census; in other words some (but an unknown number) of the trout creeled in the bait water were hatchery fish.

Compiled by
INSTITUTE FOR FISHERIES RESEARCH
September 28, 1960
To supplement Institute Report No. 1577

NORTH BRANCH AU SABLE RIVER

FISHING PRESSURE, ANGLER CATCH, AND TROUT POPULATION
PREVIOUS FALL, PER MILE OF STREAM



PROGRESS REPORT ON RECENT DATA FOR TROUT STREAMS WITH SPECIAL REGULATIONS

(Flies only, 5-fish creel limit, and 9-inch or 10-inch minimum size limit)

By

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Gaylord R. Alexander

Second supplement to Report No. 1577

of Institute for Fisheries Research

Compiled August 10, 1961

Special regulations on trout fishing (lures limited to artificial flies, higher minimum size limits of 9 or 10 inches, and a 5-trout creel limit) are currently in effect on sections of seven Michigan trout streams (55.5 miles) and one trout lake (10.7 acres). A list of the waters and the present restrictions are given in Table 1. Studies on special regulations as a trout management tool began in 1949, when a 10-inch minimum size limit for brook trout was imposed on a 4.6-mile section of the North Branch Au Sable River in Crawford County, following studies which indicated that, under a 7-inch size limit, anglers removed a high fraction of the brook trout before they spawned once. The flies-only regulation on this same stretch of water was added in 1950, with the idea that no benefit from the higher size limit would accrue unless sublegal trout were protected from hooking mortality when caught with worms. Additional waters, both for testing the effects of special regulations, and as a "management" procedure, have been added since 1951. At present, creel census, population estimates, and related studies are being made on all of these test waters, except for very limited data at More Trout, Inc.

Results of studies on special regulation trout streams up to September, 1959 were reviewed in I. F. R. Report No. 1577, and results to September, 1960 were reviewed in a supplement (dated Sept. 6, 1960) to that report.

During the earlier years of this study most of our information on abundance of trout in the streams was in the form of indices of relative abundance--the number of trout taken per hour by electric shocker. During later years we have, for more streams, data on the actual number of fish present--from the mark-and-recapture method, using an electric shocker.

Starting with 1960, research effort on this study was increased considerably by the employment of three additional men, and the transfer of a fourth, to conduct creel census and trout population estimates on the Little South Branch of the Pere Marquette, the Boardman, the Main Au Sable, and the South Branch of the Au Sable. The creel census and population estimates on the North Branch of the Au Sable and the Pigeon River have been continued.

Through 1959, the general conclusions have been: (1) Fishing pressure has declined on stream sections with the special regulations. This has been especially apparent on streams such as Hunt Creek and the Pigeon where special and normal waters are equally accessible. On the Au Sable system fishing pressure on the fly water has been relatively heavy, at least partly because of long-time popularity and easy accessibility of the special water. (2) On most streams the anglers' take of trout in the creel has been smaller, both numerically and by weight, in the fly water than in the any-lure water. But on some streams the weight of trout creeled on the fly water compared favorably with that of trout creeled on the any-lure water; this was true for the North Branch Au Sable and the Little South Branch of Pere Marquette during 1960. (3) Both the shocker indices of trout abundance and the population

Table 1. --Trout waters under special fishing regulations, 1961

Stream	Flies-only, 5-fish limit*			Control water State-wide regulations	
	Section	Miles	Size limit	Section	Miles
N. Br. Au Sable					
	Dam 2 - County line	4.2	9"	Co. line - Eaman's	6.9
	Eaman's - mouth	14.9	9"		
S. Br. Au Sable					
	Deerheart Valley Rd. - mouth	16.1	10"	None	
Main Au Sable					
	Burton's - Wakeley	8.7	10"	Grayling - Burton's	5.6
L. S. Br. Pere Marquette					
	Carlson's Br. - County line	4.7	10"	Co. line - Taylor Br.	5.2
Boardman					
	Forks Forest Camp - Scheck's Br.	3.9	10"	Forks upstream Scheck's downstream	0.4 1.7
Pigeon					
	Sections C and D	2.3	9"	Sections A and B	2.5
E. Br. Au Gres					
	At More Trout, Inc.	0.7	7"	None	
Ford Lake (at Pigeon River Area)		10.7 acres	7"	Other Pigeon R. lakes	

* 10-fish creel limit at More Trout, Inc. pond.

Total of 55.5 miles of stream under special regulations during 1961.

estimates have shown that the flies-only sections of the Au Sable drainage contain larger fall populations of trout than do adjacent any-lure waters. On the other hand, shocker indices on the Boardman, Fox, and Little South Branch Pere Marquette did not show a greater population of trout in the flies-only water, except for trout larger than 10 inches in the Little South Branch Pere Marquette. (4) The streams are highly variable in trout populations and fishing pressure; sections of the same stream differ widely; and the effects of the special regulations might be expected to differ among the several streams. Only in the Au Sable system, so far, has there been some indication of a favorable result from the special regulations, but with the three test streams in this system there is still the question of whether the high population levels and large numbers of trout in the creel are due to the special regulations or are the result of the flies-only waters being the best trout habitats.

In October of 1960 the Commission approved a continuation of the special regulations on the Little South Branch of the Pere Marquette, and also approved a reversal of regulations on two sections of the North Branch of the Au Sable. The section of stream in Otsego County, from Dam 2 to the county line, was put under special regulations for the first time; whereas the special regulations were discontinued on the "old fly water" from the Otsego-Crawford County line to Eaman's Landing in Crawford County. This "reversal" was regarded as necessary for a better evaluation of the special regulations.

Methods during 1960 and 1961

On the Au Sable drainage, the special waters and the companion normal waters (except for the South Branch of the Au Sable, which is all fly water downstream from Deerheart Valley Road) are subjected to a planned random sampling to obtain estimates of total hours of angling and total catch. Angler counts are made by one man from a canoe on predetermined dates and at randomly selected hours and stream sections. The second man of the 2-man team contacts anglers to obtain information on as many angling trips as possible, and picks up the first member who has made the counting trip. On the Boardman and Little South Branch of the Pere Marquette, similar censuses are made by the census clerk walking predetermined mile sections at randomly drawn dates and hours.

Fall population estimates for both special and normal (control) waters are made with a DC shocker. Estimates are made on two 700-foot to 1300-foot stream sections within each type of water to obtain an average for that type of water. In addition, spring (pre-season) population estimates on the three parts of the North Branch of the Au Sable were begun in the spring of 1961.

At the Pigeon River Trout Research Station, complete angling records are collected on the special regulation water (Sections C and D) as well as on the "control" water (Sections A and B). Fall population data for the total area of all sections are available for each year since 1949, and spring population estimates have been made since 1960. Dr. W. C. Latta provided the data for the Pigeon River.

Recent Results

Results of a 5-year (1955-1959) study of a flies-only regulation on Hunt Creek have been written up in a separate Institute report which will be available in the Fish Division in the near future. In this study at Hunt Creek, lures were restricted to flies only, but the 7-inch size limit and the 10-fish creel limit were retained. The flies-only regulation at Hunt Creek did not result in an increase in the catch or an increase in the trout population in the stream.

For streams other than Hunt Creek, the accompanying tables give annual summaries of creel census and trout populations for the years 1957 to 1961 (see especially Table 2). For 1961 the creel census data are for only the first half of the trout season.

Other information of interest and rather directly connected with the research are tabulations of the population trends on the North Branch of the Au Sable (Table 3), and data on migration of brown trout and brook trout in the North Branch of the Au Sable (Table 4).

In Table 2, data on fall trout populations and on angling pressure and catch in the creel are all given on a per-mile-of-stream basis. Note especially that catch figures for 1961 are for the first half of the trout season only; there has not been time (to date) to compile the catch figures for the second half. From past experience we judge that the total catch for 1961 will be about double that for the first half. The figures on population are averages for two sample sections in each type of water. The figures on pressure and catch are based on a census of the entire stream section. The figures are given for trout of two size ranges: above and below 9 inches for streams with a 9-inch size limit, and above and below 10 inches for streams with a 10-inch limit.

Among the streams listed in Table 2, the Little South Branch Pere Marquette has mostly brown trout; the Main Au Sable has both brook and brown trout in considerable numbers plus planted rainbow trout in the any-lure section; the South Branch Au Sable has "wild" brook and brown trout plus planted trout of all three species; and the remaining streams have both brook and brown trout in considerable numbers.

North Branch Au Sable River

This stream has been under a sampling type of creel census since 1958. The normal water has had about 1/2 as much angling pressure as observed on the "old" fly water (County Line to Eaman's Landing), but about the same angling pressure as the "new" fly water (Eaman's Landing to Kellogg Bridge). Total catches (in the creel) were largest in the normal water; but the most fish larger than 9 inches have been harvested from the "old" fly water, and the "new" fly water was only slightly better than the normal water in catch of fish over 9

Table 2.--Fall populations, fishing pressure, and anglers' catch on six test streams, 1957 (58) through the first half of 1961. All figures are fish per mile and hours per mile of stream. Under regulation, N = any-lure or normal water, S = special regulation

Stream, section and mileage	Regulation	Number of fish in fall population [3] Year	7.0" to 8.9"	9"+	Angling pressure in hours and number of trout caught Year	Hrs. per mile	7.0" to 8.9"	9"+	Total legal catch
N. Br. Au Sable R.	N	1957	508	248	1958	1,561	739	189	928
Dam 2-Co. line	N	1958	366	264	1959	724	202	86	288
4.2 miles	N	1959	286	185	1960	737	315	93	408
	S[2]	1960	263	338	1/2-1961	250	427	47	47
Co. line-Eaman's	S	1957	2,395	678	1958	1,885	1,266	312	312
6.9 miles	S	1958	1,494	1,032	1959	1,972	1,084	121	121
	S	1959	1,355	716	1960	1,960	819	399	399
	N	1960	1,026	772	1/2-1961	2,054	247	192	439
Eaman's-Kellogg Br.	S	1957	1,471	364	1958	1,143	630	78	78
8.7 miles	S	1958	1,471	549	1959	821	309	117	117
	S	1959	1,346	261	1960	1,191	605	228	228
	S	1960	1,273	506	1/2-1961	604	792	43	43
Pigeon River [1]	N	1957	75	32	1958	928	133	35	168
Sections A B	N	1958	125	23	1959	506	51	10	61
2.50 miles	N	1959	107	19	1960	562	91	32	123
	N	1960	115	39	1/2-1961	406	96	29	125
Sections C D	S	1957	208	58	1958	454	...	38	38
2.31 miles	S	1958	235	62	1959	262	...	11	11
	S	1959	228	39	1960	348	...	28	28
	S	1960	178	78	1/2-1961	325	...	26	26

(Continued on next page)

Table 2, concluded.

Stream, section and mileage	Regulation	Number of fish in fall population[3] Year	7.0" to 9.9"	10.0"+	Angling pressure in hours, and number of trout caught Year	Hrs. per mile	7.0" to 9.9"	10.0"+	Total legal catch
L. S. Br. P. Marquette	N	1959	...	...	1960	897	307	126	433
Co. line-Taylor Br. 5.2 miles	N	1960	217	185	1/2-1961	913	74	157	231
Carlson Br.-Co. line	S	1959	...	...	1960	537	...	181	181
4.2 miles	S	1960	608	394	1/2-1961	290	...	71	71
Boardman R.	N	1959	...	...	1960	1,563	372	66	438
Control water 2.1 miles	N	1960	751	203	1/2-1961	867	319	30	349
Forks-Scheck's Br.	S	1959	...	...	1960	496	...	37	37
3.9 miles	S	1960	1,225	106	1/2-1961	228	...	18	18
Main Au Sable R.	N	1959	220	110	1960	6,446	699	444	1,143
Grayling-Burton's 5.6 miles	N	1960	365	82	1/2-1961	1,318	281	115	396
Burton's-Wakeley Br.	S	1959	2,104	1,127	1960	6,010	...	664	664
8.7 miles	S	1960	2,870	1,512	1/2-1961	3,493	...	552	552
S. Br. Au Sable R.	S	1959	...	...	1960	2,074	...	253	253
Deerheart Rd.-Downey's 7.1 miles	S	1960	278	208	1/2-1961	842	...	108	108
Downey's-Mouth	S	1959	...	...	1960	1,622	...	340	340
9.0 miles	S	1960	291	175	1/2-1961	808	...	110	110

[1] Data from Pigeon River are derived from complete creel census records and population studies on the entire stream mileage indicated.

[2] On North Branch Au Sable special regulation waters, the catch of 7.0"-8.9" trout was estimated from data collected by experimental fishing during the 1959 trout season.

[3] For 1959 and 1960 on the North Branch, and starting with 1960 on all other streams (Pigeon River excepted), the fall population data are averages for two sample sections in each type of water (each section 700 to 1300 feet in length).

inches. Fall populations of trout have consistently been higher in the "old" fly water, next best in the "new" fly water, lowest in the any-lure water from Dam 2 to the county line.

As evident in Table 2, the reversal of the regulations on the North Branch, starting in 1961, has caused a change in fishing pressure and catch, as was to be expected. Pressure has about doubled on the "old" fly water which was changed from flies-only, 9-inch to any-lure and 7-inch limit; and pressure has declined in the Otsego County water which was changed from any-lure to flies-only. There have been comparable changes in anglers' catch, except that there has not been the large creel harvest of 7"-9" trout in the "old" fly water (from the county line to Eaman's) which was anticipated. In the Eaman's to Kellogg Bridge section, where no regulation changes were made, and where the special regulations continue to apply, 1961 angling and catch appear to be running at the previously observed rates.

Little South Branch Pere Marquette River

Starting with 1960, about twice as much angling has been done on the normal water as on the special water. The anglers' catch of trout over 10 inches has been about the same in the two types of water. Fall populations of trout over 7 inches in this stream were about 2 1/2 times greater per mile in the special regulation water. Angler access is available chiefly at bridges for both waters, three in the special water, two in the normal water.

Boardman River

About three times as much fishing is done in the normal water as in the special regulation water. The catches have been significantly better in the normal water. The fall population of trout is highest in the normal water for fish larger than 10 inches, but better in the special water for 7"-9.9" trout. There is good access for anglers on both types of water.

South Branch Au Sable River

All the stream studied here is special water. Fishing pressure is about the same as on the special water of the North Branch (about 1,800 hours/mile/year). The catch appears to be slightly larger than in the North Branch, although the fall populations of trout larger than 10 inches are smaller than what we find in the North Branch. There is good angler access on the South Branch, except from Smith Bridge to the mouth.

Main Au Sable River

During 1960, the normal water on the Main Stream was fished at a slightly higher rate than the special water; the catch of trout over 10 inches was 50 percent higher on the special water which was enough to compensate

for the creel harvest of 7"-9.9" trout in the any-lure water. During the first half of 1961, anglers creeled many more fish, and a much greater weight, from the special water. Fall population estimates indicate that the special water has approximately 10 times more trout per mile than are found in the normal water. Angler access is best in the special water for wading and bank angling. Much of the fishing in both waters is done from canoes and longboats.

Pigeon River

Special regulations, corresponding to those on the North Branch of the Au Sable River, have been in force on Sections C and D since 1958. Sections A and B (regulations: any lure, 7 inches, 5 trout) are studied as controls. Angler access is equally good for the four sections. Complete creel census and fall population data are available for each section. Fishing pressure is considerably less on the special water. The catch of trout over 9 inches is no better on the special water than on the any-lure water, and the total angler harvest in the creel is much less in the special water.

In the fall populations there are about twice as many trout present in the special water as in the any-lure water.

Population Trends, North Branch Au Sable River

Population estimates on the North Branch have been made during the fall since 1957 and spring estimates were started in 1961 (see Table 3). Dam 2 and Dam 3 are sample sites for the stream in Otsego County; Black Hole and Twin Bridges are sample sites in the County Line-Eaman's Landing section ("old" fly water) in Crawford County; and Mary Ann and Dam 4 are sites in the Eaman's Landing-Kellogg Bridge sector. The data for each of the six sites are presented in Table 3 to show the great variation in populations within each of the three "types" of water, and the great variations from year to year at each site.

In previous reports on flies-only waters, it has been noted that there is a high rate of natural mortality of legal-size trout in the North Branch, in addition to the harvest of trout by anglers. The population estimates during the fall of 1960 and the spring of 1961, at the six sites on the North Branch, give further proof of this high natural mortality and show that much of it might regularly occur during winter (i.e., between October and April). The data suggest that for trout larger than 7.0 inches, the loss amounted to 95 percent for the Dam 2-County Line section, 88 percent for the County Line-Eaman's section, and 85 percent between Eaman's Landing and Kellogg Bridge. Fall and spring population estimates will be continued for the next two or three years to see if this heavy over-winter mortality is normal.

Information available (but not detailed here) from spring population studies on the Pigeon River, Hunt Creek, and Rifle River indicate that over-winter (October to April) mortality ranges from 40 to 80 percent on brook trout and brown trout in these streams.

Table 3. --Number of trout per mile at six sites on the North Branch Au Sable, from population estimates, fall of 1957 through April of 1961

Site and length	Year	Season	Brook trout (size range in inches)				Brown trout (size range in inches)				Totals (size range in inches)			
			0-4.9	5.0-6.9	7.0-8.9	9.0+	0-4.9	5.0-6.9	7.0-8.9	9.0+	0-4.9	5.0-6.9	7.0-8.9	9.0+
Dam 2	1957	Fall	10,361	410	191	0	3,243	73	317	248	13,604	483	508	248
1,300'	1958	Fall	4,235	321	256	12	2,127	28	110	252	6,362	349	366	264
	1959	Fall	4,226	463	171	0	3,309	12	65	106	7,535	475	236	106
	1960	Fall	6,691	244	235	8	1,514	8	73	264	8,205	252	308	272
	1961	Spring	1,226	162	4	0	73	16	0	0	1,299	178	4	0
Dam 3	1959	Fall	2,425	114	202	0	1,191	76	135	235	3,616	190	337	253
1,253'	1960	Fall	3,865	345	147	25	1,920	135	72	379	5,785	480	219	404
	1961	Spring	543	189	8	0	261	164	4	46	804	353	12	46
Black Hole	1959	Fall	1,809	105	120	40	1,426	427	85	828	3,235	532	205	868
1,051'	1960	Fall	1,566	286	191	35	2,535	472	110	532	4,101	758	301	567
	1961	Spring	351	156	0	5	397	135	0	85	748	291	0	90
Twin Bridge	1957	Fall	9,275	964	1,886	177	3,216	147	509	501	12,491	1,111	2,395	678
1,255'	1958	Fall	12,853	556	1,351	34	3,520	320	143	998	16,373	876	1,494	1,032
	1959	Fall	8,302	703	2,076	76	1,844	72	429	488	10,146	775	2,505	564
	1960	Fall	22,498	897	1,436	177	2,349	84	316	800	24,847	981	1,752	977
	1961	Spring	3,296	678	202	42	299	181	13	101	3,595	859	215	143
Mary Ann	1959	Fall	5,399	1,503	734	6	1,370	312	514	150	6,769	1,815	1,248	156
913'	1960	Fall	6,601	815	295	116	2,324	156	1,609	410	8,925	971	1,904	526
	1961	Spring	1,526	353	52	0	636	237	29	40	2,162	590	81	40
Dam 4	1957	Fall	11,878	1,578	562	17	4,952	268	909	347	16,830	1,846	1,471	364
1,280'	1958	Fall	12,774	1,569	946	33	4,237	54	525	516	17,011	1,623	1,471	549
	1959	Fall	11,180	2,759	487	8	2,573	1,338	958	359	13,753	4,097	1,445	367
	1960	Fall	15,298	2,320	1,112	74	4,907	210	531	412	20,205	2,530	1,643	486
	1961	Spring	4,326	688	255	58	1,978	350	148	87	6,304	1,038	403	145

Trout Movements in North Branch Au Sable River

Between the fall of 1958 and April, 1961, a total of 1,628 brown trout and 503 brook trout were tagged and released in the North Branch during the population studies. Anglers have reported recapture of 87 tagged brown trout and 19 tagged brook trout (Table 4). From information on locality of recovery furnished by the anglers, 75 percent of the brown trout were retaken at or within five miles of the site of tagging, and 88 percent of the brook trout were retaken at or within one mile of the site of tagging. Of the 106 recoveries reported by anglers, only 5 fish were from outside the confines of the stream covered by creel census: one from Crapo Creek, one from Big Creek, one below Kellogg Bridge, and two from the Main Stream of the Au Sable.

During shocking for population studies in years following the original tagging, 94 of 95 recaptures were at the original site of tagging one or more years later.

These records show that the amount of migration of trout out of the North Branch is far too small to account for the great over-winter decline of trout in the stream.

Discussion

Present special regulations on the Little South Branch Pere Marquette were set at the Commission meeting in October of 1960 with the stipulation that the need for a continuation of the order be reviewed annually. We believe that it is highly desirable that the present order be continued on this stream. On the various streams which have had special regulations in effect since 1949 (or part of that time), the results have not yet been generally conclusive. On some streams where we have good records (Pigeon River and Hunt Creek), the regulations have not produced better trout fishing. However, particularly on the Au Sable system, there is a possibility that the higher size limit combined with the flies-only regulation has resulted in an increase in the trout population and better trout fishing in terms of a sufficiently greater catch of large trout to compensate for the non-harvest of smaller trout.

From the intensive studies on the Little South Branch Pere Marquette during 1960 and 1961, it is judged that this stream will continue to provide significant information on anglers' catch and trout population for a test of the regulations.

The "reversal" of regulations order on the North Branch Au Sable is due for review next year. So far there has not been the anticipated high harvest of 7"-8.9" trout in the "old" fly water; such a harvest during the first part of the 1961 season was expected, based on the large number of 7"-8.9" trout present during the 1960 fall population estimate. Rather, it now appears, from the population estimates for the fall of 1960 and the spring of 1961, that an over-winter mortality took a large share of the fall population at the expense of angling during the first half of the 1961 season. The problem we now face is to see if the over-winter loss can be prevented, and, if so, this might enhance any positive effects of the special regulations.

Judging from the literature on mortality of trout, our best guess is that the high over-winter mortality of trout in the North Branch is due to predation--probably mostly by the merganser, but also the otter, mink and heron. During

Table 4. --Recovery by anglers and by electric shocker, of brook trout and brown trout tagged and released in the North Branch Au Sable, 1958-1961

Numbers in parentheses are recoveries made two or more years after tagging

Year tagged	Season	Number tagged	Number recovered by anglers, miles from tagging site					Recoveries by DC shocker	
			0-0.9 mi.	1-4.9 mi.	5+ mi.	? mi.	Total	At site	Away from site
Brown trout									
1958	Fall	490	14(2)	6(1)	3	1	27	17(6)	0
1959	Fall	476	28(3)	5(1)	2(1)	4	44	50(2)	1
1960	Fall	591	7	4	2	..	13	19	0
1961	Spring	71	2	1	..	..	3	..	..
Total		1,628	49(5)	16(2)	7(1)	5	87	86(8)	1
Brook trout									
1958	Fall	105	2	1	..	..	3	0	0
1959	Fall	52	3	..	..	1	4	0	0
1960	Fall	236	6	..	..	..	6	0	0
1961	Spring	110	6	..	..	..	6	..	..
Total		503	17	1	..	1	19	0	0

the shocking for population estimates in April of 1961 many trout were taken which had wounds and scars. During winter and early spring of certain years, mergansers are present on the North Branch in large numbers. It is possible that if some form of control on fish predators was exercised, a higher population of trout would be available for the anglers in the spring.

A winter census of fish predators, and a continuation of fall and spring trout population estimates on the North Branch, are planned for the next year or two, as a preliminary to experimental predator control on this stream; and similar studies will be made on the Pigeon River. Some experimental control work on predators is planned for East Fish Lake at the Hunt Creek Station where blue herons may cause a heavy mortality of planted brook trout.