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TROUT POPULATIONS AND PREDATOR STUDIES, NORTH BRANCH AU SABLE RIVER, 1960-1962

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Introduction

The North Branch of the Au Sable River located in Crawford and Otsego counties, Michigan, is noted for its fine trout fishing, both present and past. During the past decade much controversy has existed as to whether or not restrictive lure regulations (flies-only) could improve the trout fishermen's prospects on this stream. Research suggests that even though the lure restrictions save some small trout from being killed by hooking, the over-all effect on the annual mortality is slight. It appears that in some streams lure restrictions coupled with high size limits and low bag limits (9 inch minimum size, and 5 trout per day) can increase the standing crop of fish present in the fall of the year. However, natural mortality between trout seasons removes the trout anyway and the effects of the restrictions are nullified.

This report deals with trout population dynamics in a 19.8-mile sector of the North Branch from Dam 2 in Otsego County to Kellogg Bridge in Crawford County, and with the possible effect of predators on trout mortality. Trout species present were brook and brown.

Methods

The experimental water was divided into three sections as follows: Upper (4.2 miles), Middle (6.9 miles) and Lower (8.7 miles). The sections were separated on the basis of present and past angling regulations.

Measurements of the trout population densities have been made semi-annually (fall and spring), on six sub-sections (two in each experimental section) 700-1,300 feet long, since the fall of 1960. Estimates were made by the mark-and-recapture method as described by Shetter (1957). Differences between fall and spring populations gave estimates of the loss of trout between trout seasons.

Another measure of between-season (over-winter) mortality of trout over 7.0 inches long was obtained from a tagging program conducted in the fall and spring. Recaptures of tagged trout were reported by anglers, and other recaptures were made by electrofishing during population estimates. An inquiry into the causes of between-season trout mortality was begun during the winter of 1961-62. With the cooperation of Game, Field Administration, Forestry and Fish Division personnel, 21 airplane flights to count mergansers, goldeneyes, herons, and other potential predators were made over the experimental water of the North Branch between January 1, 1962 and April 18, 1962. These counts permitted an estimate of the number of days of feeding by these birds. Shotguns were used to collect 24 American mergansers, 21 American goldeneyes and 1 hooded merganser for analysis of their diets on this stream.

Results

Fall and spring estimates of trout population, and computed over-winter mortality in 1960-61 are shown in Table 1. The numerical mortality rates were highly uniform (71 to 97 percent) in spite of the large variation in population size between stream sections and size groups.

Fall and spring estimates of trout population, and computed over-winter mortality in 1961-62 are shown in Table 2. The mortality rates over the winter of 1961-62 varied considerably compared to the rates found between 1960 and 1961. Again mortality rates were high in all sections and among trout of all sizes, except among trout longer than 9 inches in the Middle section where the population actually increased from 286 in the fall of 1962 to 493 in the spring of 1962. Presumably a part of the increase resulted from growth, as well as a higher rate of survival.

Comparing mortality in 1960-61 to 1961-62 reveals that the mortality rate (percentage lost) changed little in the Upper water although the actual loss was greater by 2,704 trout per mile. The Lower water had a 63 percent loss rate in 1961-62 compared with 71 percent in 1960-61, whereas the numerical loss was 1,055 trout per mile fewer than in 1960-61. A big change in mortality occurred in the Middle water. It changed from 82 percent in 1960-61 to 38 percent in 1961-62. The numerical loss was 9,647 trout per mile fewer than during the winter of 1960-61. The reasons for this change in mortality are not clear. The standing crop of trout (81,386) entering the winter of 1961-62 was considerably lower than in 1960-61

Table 1.--Estimated populations of trout, and computed mortality, North Branch Au Sable River, Fall 1960, and Spring 1961

Length (inches)	Per mile estimates							
	Fall		Spring		Mortality		Percentage mortality	
	Number	Weight (pounds)	Number	Weight (pounds)	Number	Weight (pounds)	Number	Weight (pounds)
Upper Section (4.2 miles)								
0-6.9	7,361	188	1,318	49	6,043	139	-82	-74
7-8.9	273	59	9	2	264	57	-97	-97
9+	369	251	63	74	306	177	-83	-71
Total	8,003	498	1,390	125	6,613	373	-83	-75
Totals for Section	33,613	2,092	5,838	525	-27,775	-1,567		
Middle Section (6.9 miles)								
0-6.9	15,344	401	2,747	105	12,597	296	-82	-74
7-8.9	1,026	225	108	23	918	202	-89	-90
9+	768	521	183	198	585	323	-76	-62
Total	17,138	1,147	3,038	326	14,100	821	-82	-72
Totals for Section	118,252	7,914	20,962	2,249	-97,290	-5,665		
Lower Section (8.7 miles)								
0-6.9	17,139	471	5,047	173	12,092	298	-71	-63
7-8.9	1,155	240	269	55	886	185	-77	-77
9+	598	388	164	112	434	276	-73	-71
Total	18,892	1,099	5,480	340	13,412	759	-71	-69
Totals for Section	164,360	9,561	47,676	2,958	-116,684	-6,603		
Grand totals, all sections (19.8 miles)	316,225	19,567	74,476	5,732	-241,749	-13,835		

Table 2.--Estimated populations of trout and computed mortality, North Branch Au Sable River, Fall 1961, and Spring 1962

Length (inches)	Per mile estimates: Fall Number	Fall Weight (pounds)	Spring Number	Spring Weight (pounds)	Mortality Number	Mortality Weight (pounds)	Percentage mortality Number	Percentage mortality Weight (pounds)
Upper Section (4.2 miles)								
0-6.9	10,180	215	1,674	66	8,506	149	-84	-69
7-8.9	624	131	38	9	586	122	-94	-93
9+	305	159	80	78	225	81	-74	-51
Total	11,109	505	1,792	153	9,317	352	-84	-70
Totals for Section	46,658	2,121	7,526	643	-39,132	-1,478		
Middle Section (6.9 miles)								
0-6.9	10,793	273	6,865	254	3,928	19	-36	-7
7-8.9	716	147	398	83	318	64	-44	-44
9+	286	196	493	298	+207	+102	+72	+52
Total	11,795	616	7,756	635	4,453	+19	-38	+3
Totals for Section	81,386	4,250	53,516	4,382	-27,870	+132		
Lower Section (8.7 miles)								
0-6.9	18,242	463	6,983	224	11,259	239	-62	-52
7-8.9	1,144	234	254	51	890	183	-78	-78
9+	358	278	150	131	208	147	-58	-53
Total	19,744	975	7,387	406	12,357	569	-63	-58
Totals for Section	171,773	8,483	64,267	3,532	-107,506	-4,951		
Grand totals, all sections (19.8 miles)	299,817	14,854	125,309	8,557	-174,508	-6,297		

(118, 252), and perhaps this decrease was partly responsible. Conversely, the population density in the Lower section was greater in 1961-62 than in 1960-61 and this section also had a reduced mortality rate. Also, the population density in the Upper section was higher in the fall of 1961 than in the fall of 1960 and there was little change in mortality rate. Our activities in collecting predatory birds during the winter of 1961-62 may have caused the reduced mortality in the Middle section. Because of deep snow we had to do most of our collecting in the Middle section until mid-February. About one half of our time (44 hours/mile) was spent in the Middle section, 27 hours per mile in the Upper and 22 hours per mile in the Lower section.

Recapture percentages of trout tagged in the fall or in the spring yielded estimates of over-winter survival and these data are given in Table 3. Survival estimates were derived from the ratio of the percent of fall-tagged trout recaptured to the percent of spring-tagged trout recaptured, expressed as a percentage. To November 1, 1962, 30 of 849 trout marked in the fall of 1960 were recovered by angling for a 3.53 percent return. In addition 53 (6.24 percent) were recovered during the population estimates in the fall of 1961, the spring of 1962, and fall of 1962. In the spring of 1961, 181 trout were tagged and anglers have reported catching 16 (8.84 percent). An additional 22 (12.15 percent) were recaptured with the shocker. The angler return ratio of 3.53 to 8.84 yields an estimate of the over-winter survival of 40 percent. The electrofishing recapture ratio of 6.24 to 12.15 indicates a 51 percent survival during the winter of 1960-61.

Table 3.--Number of trout tagged in 1960-1962 and numbers and percentage of recaptures by anglers and by electrofishing to November 1, 1962, North Branch Au Sable River

Year and section	Number tagged	Angler recovery			D-C recovery		
		Number	Percentage	Survival percentage[1]	Number	Percentage	Survival percentage[1]
Fall 1960							
Upper	127	3	2.36	12	6	4.72	12
Middle	486	21	4.32	55	24	4.94	53
Lower	196	6	3.06	34	23	11.73	94
Total	849	30	3.53	40	53	6.24	51
Spring 1961							
Upper	5	1	20.00	..	2	40.00	..
Middle	64	5	7.81	..	6	9.38	..
Lower	112	10	8.93	..	14	12.50	..
Total	181	16	8.84	..	22	12.15	..
Fall 1961							
Upper	125	2	1.60	9	7	5.60	43
Middle	190	20	10.53	57	20	10.53	268
Lower	22	2	9.09	350	2	9.09	44
Total	337	24	7.12	49	29	8.61	101
Spring 1962							
Upper	23	4	17.39	..	3	13.04	..
Middle	229	42	18.34	..	9	3.93	..
Lower	77	2	2.60	..	16	20.78	..
Total	329	48	14.59	..	28	8.51	..

[1] The ratio of the percentages of recapture, dividing percentage fall recapture by percentage (following) spring recapture.

In the fall of 1961, 337 trout were tagged and 329 were tagged during the spring of 1962. Anglers have reported 7.12 percent of the fall-marked trout and 14.59 percent of the spring-marked trout and the ratio indicates an over-winter survival of 49 percent. The electrofishing ratio of 8.61 to 8.51 indicates a 101 percent survival during the winter of 1961-62.

Analysis of tag recoveries from the Upper, Middle, and Lower sections for differences in survival between stream areas indicated that in general survival was much poorer in the Upper, and slightly better in the Lower than in the Middle section.

In the Upper section, over-winter mortality estimates of trout over 7 inches long, computed from population estimates and recaptures of tagged trout (mean ratio of angler and electrofishing recoveries), were in fairly close agreement in 1960-61. Population estimates indicated a survival rate of 9 percent and tags 12 percent. In 1961-62, population estimates indicated a survival rate of 12 percent and tags of 26 percent.

In the Middle section in 1960-61 data from population estimates indicated a survival of 16 percent and tags a survival of 54 percent. For 1961-62 the survival rates were 89 and 163 percent respectively.

In the Lower section survival rates were 19 and 64 percent in 1960-61 and 27 and 197 percent in 1961-62.

The discrepancies between the methods of estimating mortality, or its complement, survival, between the various sections are probably

due to tagging and recovering too few trout to eliminate the variation due to chance. However, the combined data from population estimates for all three sections are in fair agreement.

Possible causes of mortality

To determine the factors causing these high losses of trout between seasons (over-winter) a study of the potential predators was conducted during the winter of 1961-62. Airplane flights indicated that on the average 14.3 American mergansers were present in the entire 19.8 miles of experimental water (Table 4). Judging from sightings in nearby lakes, these ducks arrived about November 15 and departed about April 15 (as determined by streamside observations). Thus they were present for about 150 days during the winter season. From the literature (White, 1937 and 1957; Salyer and Lagler, 1940; Elson, 1962; and Leonard and Shetter, 1937) it is well documented that American mergansers on trout streams feed extensively on trout. To determine the percentage of trout in their diet, 24 American mergansers were shot on the North Branch Au Sable from January to April 1962. Based upon the 20 birds that contained food, and calculating the mean percentage of trout, their diet consisted of 70 percent trout by weight. According to White (1937), the American merganser eats about 1 pound of food per day during the winter period. Using White's ration of 1 pound per day and our data that indicates a 70 percent trout diet, it was estimated that each merganser on the North Branch Au Sable ate 0.7 pound of trout per day, or 105 pounds of trout

Table 4.--Instantaneous airplane counts of ducks

North Branch Au Sable River, winter 1961-62

Species	Area	Mean count	Standard error
American merganser	Upper	2.14	0.70
	Middle	7.14	2.19
	Lower	5.00	0.95
	Total	14.28	2.48
American goldeneye	Upper	9.67	2.51
	Middle	60.41	12.18
	Lower	32.80	8.51
	Total	102.88	15.07
Mallards and Blacks	Upper	3.91	1.43
	Middle	2.19	0.79
	Lower	1.20	0.47
	Total	7.30	1.70

during the 150 days; thus the total consumption of trout by the 14.3 mergansers (average) was 1,500 pounds in the 19.8 miles of stream. According to the fall and spring population estimates of 1961-62, we lost about 174,508 trout weighing 6,297 pounds from the entire 19.8 miles of experimental water. Further computations indicate that the mergansers accounted for 11,400 trout (7 percent) of the loss in numbers and about 24 percent of the poundage lost. It is believed that these estimates are minimal figures on merganser-caused mortality. Reasons for believing the estimates are minimal are as follows:

The airplane counts of ducks were probably low because birds resting on shore or concealed in log jams or streamside brush were invisible. Perhaps more accurate counts could be made by using a helicopter. Several accounts in the literature (White, 1957) describe "killing sprees" by mergansers when food in excess of their daily need is available. This killing for fun may occur under natural conditions in streams with high trout populations. White noted that mergansers disgorge food upon being startled. This would necessitate killing fish beyond their daily food requirement. On two occasions we observed freshly killed trout after mergansers were startled by us or by deer. Another factor that could have caused a lower count of bird days of feeding than actually existed is the possibility that birds resting in the Main Au Sable River fly out to feed on the North Branch. If this occurs to any extent it would also result in low counts. As many as 1,000 to 5,000 goldeneyes were observed at dusk during

February and March, 1962, in the area below the Mio Dam on the Main Au Sable. In the morning these birds fly to feeding areas. Some mergansers were also present in these flocks.

Merganser diet

As already stated merganser stomachs contained 70 percent ± 18 percent trout by weight. (This estimate is the mean percentage composition of trout in each of the 20 birds that contained food.) The total combined weight of all food found in all merganser stomachs was 84.7 percent trout (67.0 brown, 17.7 brook) (Table 5). By number, trout make up 38.7 percent of the food. Numerically, creek chubs, muddlers, and blacknose dace accounted for 16.3, 15.3 and 10.2 percent of the food. Shiners, darters, suckers, sticklebacks, perch, rock bass, crayfish, and insects accounted for the remaining food.

Figure 1 compares the size-frequency distribution of the trout found in the merganser stomachs with the size distribution of the trout in the fall and spring population estimates. The figure shows that mergansers eat the larger-than-average size trout. The merganser stomachs contained trout 3.5 to 11.8 inches long. In addition, ten jaw tags were recovered from the merganser stomachs and gizzards. One of these jaw-tagged trout was 13.3 inches when tagged during the fall of 1960. This trout was probably longer than 14 inches when the bird ate it. Tags on fish fed to a captive merganser at the Oden Hatchery in Michigan were retained for fewer than 8 days. One merganser contained tags from trout marked at three of the

Table 5.--Contents of 24 American merganser stomachs (4 empty) collected from the North Branch Au Sable River, winter 1961-62

	Birds containing food item	Food item		Percentage		Average length of fish in stomachs (inches)
		Number	Weight (pounds)	Number	Weight (pounds)	
Brown trout	13	22	3.01	16.3	67.0	6.7
Brook trout	11	16	0.80	22.4	17.7	5.4
Muddler	7	15	0.07	15.3	1.6	2.3
Creek chub	7	16	0.11	16.3	2.5	2.3
Blacknose dace	6	10	0.07	10.2	1.5	2.5
Shiner	4	5	0.03	5.1	0.7	2.3
Darters	3	6	0.01	6.1	0.2	1.4
Sucker	1	1	0.33	1.0	7.4	10.0
Other fish	4	4	0.06	4.3	1.3	2.7
Crayfish	1	2	0.01	1.0	0.1	...
Insect	1	1	...	2.0	...	...
Total	..	98	4.50	100.0	100.0	...

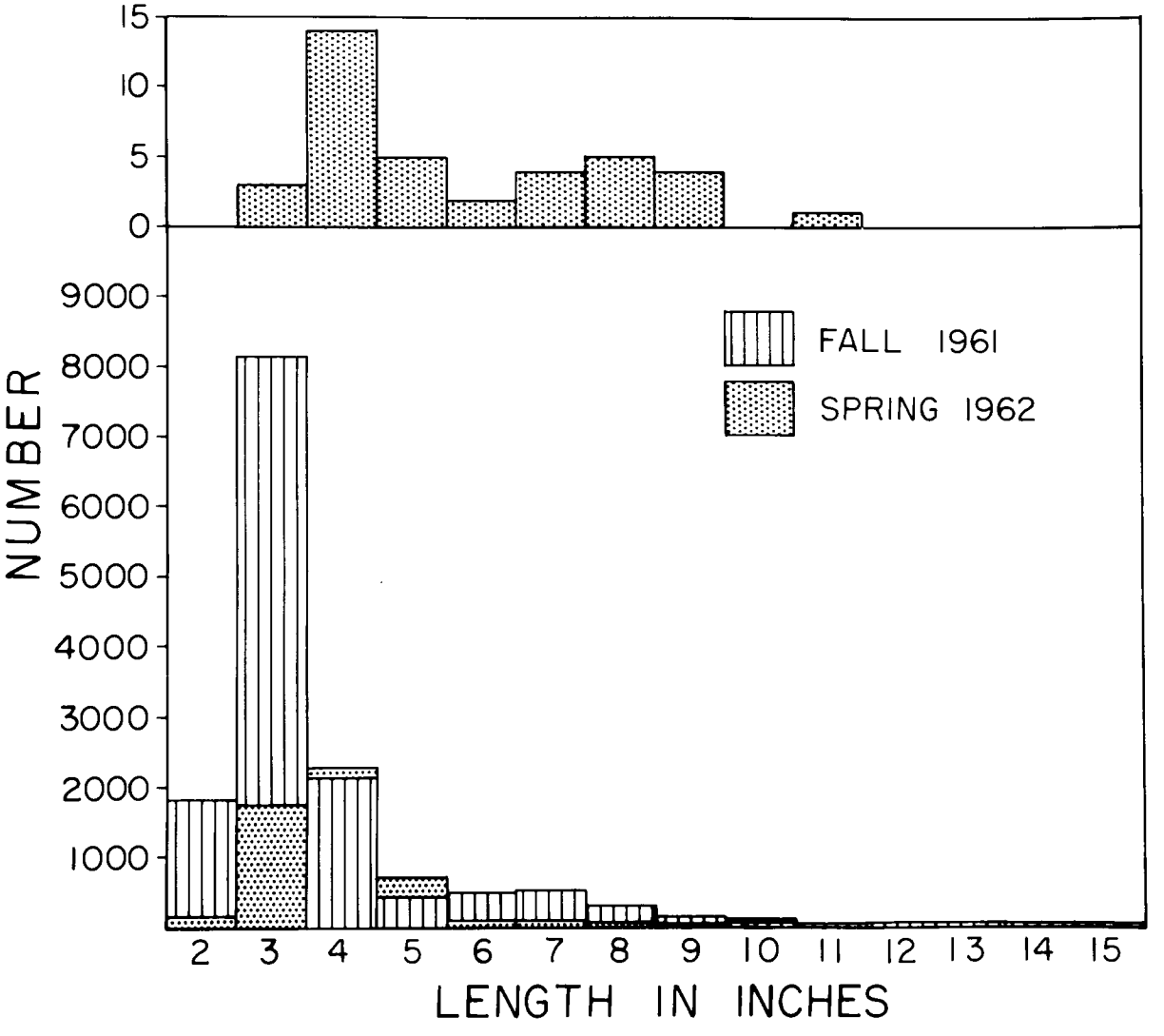

Figure 1

Upper: Size distribution of trout found in merganser stomachs, winter 1961-62.

Lower: Size distribution of trout found in fall and spring population estimates (per mile), 1961-62.

six sub-sections. The sub-sections were distributed over about 15 miles of stream, so individual birds may forage over an extensive area. The size-frequency distribution of trout in the merganser stomachs differed from that of the trout used in the population estimates; apparently mergansers feed selectively. Merganser stomachs contained no trout smaller than 3.5 inches, although other species of fish as small as 1.0 inch were found and fish of 2.0 inches were common. Possibly if we had been able to collect mergansers in late fall and early winter we would have found smaller trout in them. Two- and 3-inch trout suffer a 93.5 percent loss over winter. Some of this apparent mortality is due to fish growing into the next larger size group but at least 50 percent of the loss is unexplained; it cannot, at present, be attributed to mergansers.

Goldeneyes

None of the 21 goldeneyes collected for stomach analysis from the North Branch contained trout although some goldeneyes collected by R. F. Sharkey at Oden Hatchery had eaten trout. Their diet consisted of immature aquatic insects, crustaceans, and plant roots. The airplane counts indicated that on the average 102 goldeneyes were present each day. Assuming that these birds eat about one-third of their body weight per day, then the goldeneye population consumed 10,339 pounds of food over winter. A similar calculation of food consumed by black ducks and mallards (although none were collected) indicates that an average population of 7.3 ducks ate another 1,095 pounds of food from the North Branch

Au Sable. The effect of this feeding on trout stream food forms and the resultant effect on the trout population is not known.

An appraisal of the number and possible role of other predators is difficult at this time. Herons were present as late as January, 1962, and reappeared again in late March. The number of heron days for the river is not known. Some kingfisher were present all winter throughout the entire length of stream. Mink and otter were also present (as determined from observation of tracks and scats) but the number of animals could not be estimated with any accuracy.

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