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RESULTS OF PREDATOR REDUCTION ON BROOK TROUT AND BROWN TROUT IN 4.2 MILES OF THE NORTH BRANCH OF THE AU SABLE RIVER [1]

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Abstract

During the autumns of 1964, 1965 and 1966, brown trout 12.0-25.1 inches in length were removed from 4.2 miles of the North Branch of the Au Sable River (Dam 2-County Line), and American mergansers were harassed in the same area each winter as time permitted. The objective was to decrease losses among the smaller salmonids which would otherwise be eaten by the large trout and mergansers. Secondarily the objective was to provide angling opportunities over a numerically larger population of trout. Effects of control efforts were assayed by comparison of 1965-1967 angling results and population estimates with similar data accumulated on the test section and two other stream sections of the North Branch during 1961-1964 when predator manipulation was not carried on.

In 1964, 561 large brown trout (12.0-25.9 inches) were removed; the estimated population of large brown trout was 848, thus 66% of the

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estimated total population was removed. In 1965 and 1966, the actual removals were 346 of an estimated 546 and 104 of an estimated 261, or 63 and 40% removals respectively. The only major change noted was an increase during 1965, 1966, and 1967 in numbers of brook trout larger than 9 inches in the population estimates. However, this population increase did not affect the anglers' catches of brook trout during 1965-1967. No significant changes in the catch or population of brown trout could be demonstrated.

Average lengths of the age groups of both brook trout and brown trout, before and after predator manipulation, were investigated. No significant differences which might be ascribed to predator manipulation were found. It was concluded that predator reduction would have to be conducted at a considerably higher level of intensity to induce major changes in trout populations and the subsequent anglers' catch.

Introduction

Studies by Elson (1962), White (1937, 1957), Leonard and Shetter (1937), Salyer and Lagler (1940), and Alexander and Shetter (1962) have established that the winter diet of American mergansers (Mergus merganser) consists largely of smaller salmonids when this bird is present on natural trout waters. Stomach analyses on brown trout (Salmo trutta) larger than 12 inches, taken from the Au Sable, have demonstrated a high proportion of small trout in their diet (unpublished). Furthermore, population estimates on trout in the

North Branch of the Au Sable River, calculated from data collected in the fall after close of the trout season, and again during the following spring, show an over-winter loss, the magnitude of which can be ascribed mainly to these two fish-eating forms which are usually present in the winter.

It was hypothesized that, if the between-season losses of trout were reduced by reduction of these two predators, substantial increases in the populations of small salmonids might result, and the anglers' catch should subsequently increase.

To test this general hypothesis we removed numerous large brown trout from the Dam 2-County Line section of the North Branch (4.2 miles) each fall during 1964, 1965 and 1966. Efforts were made each winter to harass American mergansers noted on the same water, with the expectation that fewer small trout would be eaten by these birds.

Location and methods

The experimental area (Upper section, 4.2 miles) is indicated on the map (Fig. 1). Creel census operations and population studies were carried on here, as well as on the Middle section (County Line-Eaman's, 6.9 miles) and the Lower section (Eaman's-Kellogg Bridge, 8.9 miles). Creel census data for 1961-1967 on all sections of the stream were obtained by methods already described by Shetter and Alexander (1966). Population estimates for the Middle and Lower sections are averages of estimates of two or three sub-sections during

1961-1967. Population estimates for the Upper section were obtained in a similar fashion 1961-1965. Starting with the 1966 spring estimate, the data were derived from two complete runs over the entire 4.2 miles of stream. Trout were captured by d-c electrofishing gear, and Petersen-type estimates of numbers in each inch-group were made, as described by Shetter (1957).

Numbers of American mergansers were determined by periodic counts during flights of a Department of Natural Resources airplane between December 15 and April 15 each winter during 1961-1967. Pilot Peter VanValin and various observers made the counts, which numbered 13 to 21 per winter.

The physical removal of brown trout larger than 12 inches was done during the falls of 1964, 1965 and 1966. This activity, plus limited harassment of mergansers, should have benefitted the anglers' catch and trout populations during 1965, 1966 and 1967. Thus we compared angling and population data for 1961-1964 (prior to predator manipulation) with corresponding averages for 1965-1967 (during and following predator manipulation). Mean differences tested by student *t* were considered significant at the 0.05 level.

Results

American mergansers

Counts of mergansers on the North Branch are summarized in Table 1. The data were reduced to birds seen per flight per mile

of stream in the respective sections, and averages for three winters prior to predator manipulation were compared with three winters during and following predator manipulation (1964-65, 1965-66, and 1966-67). No statistically significant differences can be demonstrated for any of the experimental sections or between the two time periods. There were fewer American mergansers present in the Upper section during 1964-1967 than during 1961-1964 (0.11 per flight per mile as against 0.30 per flight per mile). However, variation within periods was so great that a statistically significant difference between these means could not be demonstrated.

Removal of brown trout larger than 12.0 inches

Brown trout larger than 12 inches, which prey on smaller trout to a considerable degree during the winter months, were removed during each fall in 1964, 1965 and 1966. During 28 October-3 November 1964, a total of 561 large brown trout were removed from the waters under study (transferred to Shupac Lake, Crawford County). These fish ranged from 12.0 to 23.9 inches, total length. Removal was accomplished by nine men using two d-c electrofishing units and a floating live crate.

A similar operation conducted 27-29 October 1965, removed 346 brown trout (size range 12.0-25.1 inches); these fish were transferred to Pickerel and Town Corner lakes, Otsego County.

In 1966, two complete trips were made in late October over the 4.2 miles of the Upper section, and all large brown trout caught on the second trip (104) were removed (size range 12.0-21.2 inches); these fish were transferred to the Hunt Creek diversions for research on digestion rates.

During the three falls a total of 1,011 brown trout, 12.0-25.1 inches in length, were removed from the Upper section (561 in 1964; 346 in 1965; and 104 in 1966). Based on known numbers of marked fish present in the Upper section just prior to the annual removal operations, in combination with the marked/unmarked ratio of large brown trout removed, it is estimated that the total population of brown trout larger than 12.0 inches in the respective years was 848, 546, and 261 in the 4.2 miles of the Upper section.

The population calculations were as follows:

1964: 65 fish marked, 43 recaptures in 561 removals;

$$\frac{43}{65} = \frac{561}{x}, \quad \text{or } x = 848.$$

1965: 60 fish marked, 38 recaptures in 346 removals;

$$\frac{38}{60} = \frac{346}{x}, \quad \text{or } x = 546.$$

1966: 128 fish marked, 51 recaptures in 104 removals;

$$\frac{51}{128} = \frac{104}{x}, \quad \text{or } x = 261.$$

Thus we removed 66, 63 and 40%, by number, of the large brown trout in the respective years.

The size distribution and age distribution of the brown trout removed are shown in Table 2 and Figure 2. All fish removed were measured individually. The estimated age distribution of brown trout removed was determined from 164, 101 and 127 scale samples and measurements collected at random from large brown trout removed and encountered during population study operations each year. At the conclusion of the removal operations in 1966, the estimated population of brown trout 12.0-25.0 inches was only 19% as large as that estimated in 1964 (157 as compared with 848).

Let us examine the effects of the removal operations on subsequent angling, trout populations and average length of the trout.

Angling results

Estimates of angling pressure and catch of trout, both given on a per mile basis, are shown in Table 3 for all sections for 1961-1967. The brook trout ranged in size from 9.0 to 12.9 inches. Brown trout catches were divided into sizes 9.0 to 11.9 inches, and those larger than 12.0 inches. Total trout larger than 9.0 inches are shown for all sections, and total trout in the 7.0- to 8.9-inch size range are shown for the Middle section where the size limit was 7 inches, rather than 9 inches.

The Upper section had the lowest angling pressure (327 to 711 hours per mile). In this section fishing pressure averaged 556 hours per mile per year during 1961-1964, and, after removal of brown trout

was started, it averaged 568 hours (during 1965-1967); the difference is not statistically significant.

The annual catch of brook trout from the Upper section varied between 34 and 228 fish per mile. Before brown trout removal, the average catch per mile per season was 114. After brown trout removal and harassment of mergansers, the average catch per mile was 129. The difference between these means is not significant ($t = 0.33$, 5 d.f., $P > 0.50$); further, if the catch in the Upper section is related to catch in the Lower section, the means of ratios are not significant ($t = 0.026$, 5 d.f., $P > 0.50$).

Similarly, the average annual catch of brown trout prior to the removal operations was not significantly different from the catch after removal (before, 60 fish per mile; after, 58 fish per mile). Also a comparison of the Upper/Lower ratios for brown trout creeled before and after predator manipulation proved the difference to be non-significant.

In summary, the annual catch by anglers did not show a statistically significant increase from the pre-removal years (1961-1964) to the period 1965-1967.

Estimated populations

Spring and fall population estimates per mile during 1961-1967 are given for brook trout in Table 4, and for brown trout in Table 5. The statistical tests on the mean numbers present of the various size groups during the 1961-1964 period, as compared with 1965-1967, are

tabulated in Table 6 (brook trout) and Table 7 (brown trout). The estimates are for three size groups of trout: 0-6.9 inches, 7.0-8.9 inches, and over 9.0 inches (9.0-12.9 for brook trout; 9.0-25.1 for brown trout). Also given are standard errors, and the probability that the "before" and "after" means of annual populations differ by a significant amount. The means were compared directly by the student t test; also, the means of population ratios between the Upper and Middle sections, and the Upper to Lower sections, are calculated and compared to provide an experimental control for time periods.

Among brook trout of 0-6.9 inches, spring population estimates increased in the Upper section after brown trout removal; while in "control" sections, they increased in the Middle section and declined in the Lower section. Fall populations (of small brook trout) declined in all stream sections after brown trout removal. Only in the Lower section, where a decline among the 0- to 6.9-inch brook trout was reflected in both spring and fall estimates, were the differences statistically significant ($P < 0.05$); as a reminder, this Lower section is an experimental control area, not the treatment area where brown trout were removed. The tests of ratios between Upper and Middle sections for both spring and fall populations proved non-significant, as did the Upper/Lower test for the fall estimate. The test of Upper/Lower ratios for spring populations gave statistical significance for an increase in the Upper section after brown trout removal; this result was due more to the large decline in the control (Lower) section than to the small increase in the Upper section. The interpretation here

is made especially difficult because the significant increase as indicated by ratios of spring populations was not accompanied by a corresponding increase in ratios of fall populations. One would expect that an accumulating excess which is present in successive spring seasons would also be present during previous fall seasons.

Changes in 7.0- to 8.9-inch brook trout populations, spring or fall, were relatively small in all stream sections, and were not statistically significant. One of the ratio tests (Upper/Lower, fall) suggests some increase of this size group in the Upper section after brown trout removal; here again, the (nearly) significant statistic probably results from a modest decline in the control section combined with a modest increase in the treatment section.

Among 9.0- to 12.9-inch brook trout, both fall and spring population estimates demonstrated significant increases in the Upper section ($P < 0.05$) after the removal of brown trout (in 1964-1966). Population levels in the Middle and Lower stream sections, both in fall and spring, showed only minor and non-significant changes between time periods. Since the increases in the Upper section were large (8-fold in spring, 2-fold in fall), it follows that the ratio tests would be significant. Three such ratio tests were significant ($P < 0.05$); the other (Upper/Lower, spring) was "suggestive" ($0.05 < P < 0.10$). The increase in the population of brook trout larger than 9.0 inches in the Upper section is believed to have resulted from reduced competition to this particular size group of brook trout by removal of large brown trout, and not from any lessening of direct predation.

Brown trout populations are given for comparison in Table 7. Brown trout of 0-6.9 inches decreased in the Upper and Lower sections and increased in the Middle section following predator manipulation. However, only the decrease in the Upper section (spring) was statistically significant ($0.025 < P < 0.05$); the differences noted in the Middle and Lower sections were not. With a decline in the treatment area and moderate increases in the control areas, the Upper/Middle and Upper/Lower population ratios mostly show significant decreases (three out of four comparisons--see Table 7). Both spring and fall tests for Upper/Middle ratios were statistically significant ($0.025 < P < 0.05$), along with one of two tests among Upper/Lower ratios. The general conclusion is that there were fewer small (0- to 6.9-inch) brown trout present in the Upper section in the years following removal of large brown trout from that part of the stream.

Among brown trout of 7.0-8.9 inches and 9.0-25.1 inches, population differences between the two time periods were of relatively small magnitude for all stream sections and for both spring and fall estimates. This prevailed, even though about 80 large brown trout per mile per season were removed from the Upper section in 1964-1966. Non-significant differences were found both in comparing populations in the Upper section and in comparing ratios of Upper/Middle and Upper/Lower sections.

Based on the foregoing analysis of the brook trout and brown trout populations for the 1961-1964 period versus the 1965-1967 period, we conclude that the removal of large brown trout and harassment of

mergansers from the Upper section were accompanied by a significant increase of 9.0- to 12.9-inch brook trout, and a significant decrease in 0- to 6.9-inch brown trout in the Upper section.

Average length of age groups

The data concerning average total lengths of the various age groups of brook trout and brown trout were examined in a manner similar to that already described for populations. The results of the statistical tests indicated that the post-removal average lengths of the age groups of both species in the Upper section were not affected to any practical degree of significance. Average lengths of the trout in the various age groups are given in Table 8.

In general, significant differences in angling pressure and catch, which can be found in Table 3, were associated with differences in angling regulations, already described by Shetter and Alexander (1966). The addition of four more years of data after 1963, for the various experimental stream sections of the river, showed the same trends noted in the earlier publication, and reinforced the earlier conclusions.

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Table 1. --Numbers of American mergansers observed from plane flights over the three study sections of the North Branch Au Sable River during the winters (January-March) of 1961-1967

Winter	Number of flights	Mergansers seen			Mergansers per flight mile		
		Upper	Middle	Lower	Upper	Middle	Lower
1961-1962	21	46	150	100	0.52	1.03	0.55
1962-1963	20	24	73	70	0.29	0.52	0.40
1963-1964	15	6	10	12	0.10	0.10	0.09
1964-1965	13	0	27	34	0.00	0.30	0.30
1965-1966	11	3	25	40	0.07	0.33	0.41
1966-1967	12	13	29	46	0.26	0.35	0.44

Table 2.--Length and estimated age distribution of large predatory brown trout removed from the North Branch Au Sable River (Upper section) during the falls of 1964-1966

Year	Length class, in inches				Totals
	12.0-13.9	14.0-15.9	16.0-17.9	18.0-25.9	
1964	437	86	22	16	561
1965	230	85	20	11	346
1966	79	18	5	2	104

	Age group				Totals
	II	III	IV	V-VII	
1964	235	276	43	7	561
1965	122	187	25	12	346
1966	30	61	10	3	104

Table 3. --Angling pressure and catch of trout per mile in the North Branch Au Sable River, 1961-1967, estimated from a randomized creel census

Stream section, angling regulation, [a] and year	Angling hours	Brook trout catch 9.0-12.9 inches	Brown trout catch 9.0-11.9 inches	Brown trout catch 12.0+ inches	Total trout larger than 9.0 inches	Total trout catch 7.0-8.9 inches [b]
Upper--S						
1961	327	34	12	3	49	-
1962	583	81	39	9	129	-
1963	711	114	50	11	175	-
1964	603	228	97	22	347	-
1965	459	132	50	11	193	-
1966	667	94	45	10	149	-
1967	579	161	47	10	218	-
Middle--N						
1961	3,126	59	156	61	276	608
1962	3,251	78	208	82	368	802
1963	3,905	166	487	192	845	1,726
1964	3,504	101	353	139	593	1,076
1965	3,107	59	180	71	310	611
1966	4,025	109	359	141	609	1,148
1967	3,825	97	305	120	522	1,010
Lower--S						
1961	990	5	35	9	49	-
1962	1,248	10	64	17	91	-
1963	1,197	26	181	47	254	-
1964	1,349	28	176	46	250	-
1965	1,033	18	130	33	181	-
1966	1,611	22	151	39	212	-
1967	1,426	18	130	34	182	-

[a] S = Special fishing regulations: flies only, 9-inch minimum size limit, 5-fish daily creel limit.

N = Normal regulations: any natural or artificial lure, 7-inch minimum size limit, 10-fish daily creel limit.

[b] See footnote (a) for regulations.

Table 4. --Number of brook trout of different length categories (inches) per mile in the North Branch of the Au Sable River, spring and fall population estimates, 1961-1967

Stream section and year	Spring (April) 0-6.9	7.0-8.9	9.0-12.9	Total	Fall (Sept.-Oct.) 0-6.9	7.0-8.9	9.0-12.9	Total
Upper								
1961	1,059	6	0	1,065	8,271	431	20	8,722
1962	2,047	37	2	2,086	6,218	501	36	6,755
1963	2,742	216	27	2,985	4,079	499	23	4,601
1964	2,104	1,364	70	3,538	3,644	736	97	4,477
1965	2,240	418	262	2,920	4,749	792	148	5,689
1966	2,891	719	321	3,931	4,254	691	122	5,067
1967	1,941	321	61	2,323	2,505	609	93	3,207
Middle								
1961	2,239	100	23	2,362	8,421	430	4	8,855
1962	4,954	317	27	5,298	9,873	593	37	10,503
1963	5,509	724	38	6,271	7,774	617	21	8,412
1964	2,999	1,175	67	4,241	7,176	781	47	8,004
1965	3,979	686	35	4,700	9,778	444	14	10,236
1966	5,073	348	65	5,486	8,034	497	13	8,544
1967	3,007	820	31	3,858	5,580	725	19	6,324
Lower								
1961	3,494	176	49	3,719	12,619	563	37	13,219
1962	5,095	161	0	5,256	10,282	557	30	10,869
1963	5,101	455	9	5,565	9,324	921	26	10,271
1964	4,525	786	35	5,346	9,627	687	72	10,386
1965	3,232	369	28	3,629	8,593	522	56	9,171
1966	3,429	190	18	3,637	7,148	464	25	7,637
1967	2,076	209	17	2,302	7,045	636	22	7,703

Table 5.--Number of brown trout of different length categories (inches) per mile in the North Branch of the Au Sable River, spring and fall population estimates, 1961-1967

Stream section and year	Spring (April) 0-6.9	7.0-8.9	9.0-25.1	Total	Fall (Sept.-Oct.) 0-6.9	7.0-8.9	9.0-25.1	Total
Upper								
1961	259	2	36	297	1,907	193	214	2,314
1962	281	0	72	353	1,914	384	428	2,726
1963	499	16	141	656	617	321	247	1,185
1964	260	78	297	635	182	168	516	866
1965	140	35	98	273	419	133	473	1,025
1966	66	13	340	419	1,128	283	141	1,552
1967	194	21	158	373	434	412	237	1,083
Middle								
1961	507	6	120	633	2,371	286	288	2,945
1962	1,909	83	599	2,591	1,769	614	504	2,887
1963	1,340	293	596	2,229	691	741	727	2,159
1964	846	147	900	1,893	1,576	390	1,090	3,056
1965	1,487	117	866	2,470	2,224	508	727	3,459
1966	1,627	153	649	2,429	3,788	761	661	5,210
1967	1,315	673	1,078	3,066	1,917	780	823	3,520
Lower								
1961	1,650	93	112	1,855	5,650	583	438	6,671
1962	1,893	94	62	2,049	4,627	1,076	398	6,101
1963	1,591	484	291	2,366	3,460	821	590	4,871
1964	1,681	912	731	3,324	4,601	1,132	735	6,468
1965	1,659	197	294	2,150	4,043	802	797	5,642
1966	1,105	331	370	1,806	8,220	686	505	9,411
1967	1,325	248	478	2,051	5,374	794	509	6,677

Table 6.--Comparison [a] of brook trout populations before and after predator manipulation in Upper section, North Branch Au Sable River. The analysis involves both the actual populations in the Upper section from year to year and the ratios of populations in the Upper section to population in the Middle (or Lower) control section.

Season, size group (inches), and time period	Average of estimated annual populations						Upper/Middle		Upper/Lower	
	Upper	Std. error	Middle	Std. error	Lower	Std. error	Ratio	Std. error	Ratio	Std. error
Spring, 0-6.9										
1961-1964	1,988	347	3,925	778	4,554	378	0.52	0.06	0.43	0.05
1965-1967	2,357	275	4,020	597	2,912**	422	0.59	0.03	0.82**	0.07
Fall, 0-6.9										
1961-1964	5,553	1,066	8,311	579	10,463	746	0.66	0.11	0.66	0.07
1965-1967	3,836	681	7,797	1,217	7,595**	500	0.49	0.02	0.50	0.07
Spring, 7.0-8.9										
1961-1964	406	323	579	237	526	147	0.41	0.26	0.62	0.38
1965-1967	486	120	618	140	256	57	1.02	0.53	2.15	0.83
Fall, 7.0-8.9										
1961-1964	542	67	605	72	682	85	0.90	0.04	0.82	0.11
1965-1967	697	53	555	86	541	50	1.34	0.27	1.32*	0.18
Spring, 9.0-12.9										
1961-1964	25	16	39	10	23	7	0.47	0.25	1.75	0.62
1965-1967	215*	79	44	11	21	4	4.80**	1.59	10.26*	4.14
Fall, 9.0-12.9										
1961-1964	44	18	27	9	41	10	2.28	0.93	0.99	0.18
1965-1967	121**	16	15	2	34	11	8.28**	1.73	3.92**	0.66

[a] Where a population mean, or a ratio mean, for years "after" predation removal (1965-1967) is statistically different from the corresponding "before" mean, the "after" mean is marked by * for $0.05 < P < 0.10$, or by ** for $P < 0.05$.

Table 7.--Comparison [a] of brown trout populations before and after predator manipulation in Upper section, North Branch Au Sable River. The analysis involves both the actual populations in the Upper section from year to year and the ratios of populations in the Upper section to population in the Middle (or Lower) control section.

Season, size group (inches), and time period	Average of estimated annual populations						Upper/Middle		Upper/Lower	
	Upper	Std. error	Middle	Std. error	Lower	Std. error	Ratio	Std. error	Ratio	Std. error
Spring, 0-6.9										
1961-1964	325	58	1,150	305	1,704	177	0.35	0.07	0.02	0.04
1965-1967	133**	37	1,476	90	1,363	161	0.09**	0.03	0.10**	0.03
Fall, 0-6.9										
1961-1964	1,155	445	1,602	348	4,584	447	0.72	0.21	0.24	0.08
1965-1967	660	234	2,643	579	5,879	1,232	0.24**	0.03	0.11	0.02
Spring, 7.0-8.9										
1961-1964	24	18	132	61	396	195	0.23	0.02	0.04	0.02
1965-1967	23	6	314	125	259	39	0.14	0.08	0.10	0.04
Fall, 7.0-8.9										
1961-1964	266	52	508	328	903	126	0.54	0.07	0.31	0.05
1965-1967	232	122	683	88	761	38	0.39	0.08	0.37	0.10
Spring, 9.0-25.9										
1961-1964	136	58	554	161	299	152	0.25	0.05	0.59	0.19
1965-1967	199	73	864	124	381	53	0.26	0.13	0.53	0.19
Fall, 9.0-25.9										
1961-1964	351	72	652	145	540	77	0.60	0.12	0.67	0.15
1965-1967	284	99	737	47	604	97	0.38	0.13	0.45	0.09

[a] Where a population mean, or a ratio mean, for years "after" predator removal (1965-1967) is statistically different from the corresponding "before" mean, the "after" mean is marked by * for $0.05<P<0.10$, or by ** for $P<0.05$.

Table 8.--Average total length in inches of brook trout in fall population estimates, before and after predator manipulation, North Branch Au Sable River, 1961-1967

Species, stream section and time period	Age group 0 Mean	0 Std. error	I Mean	I Std. error	II Mean	II Std. error	III Mean	III Std. error	IV Mean	IV Std. error
Brook trout										
Upper 1961-1964	3.5	0.02	6.7	0.09	8.4	0.01	9.7	0.27	-	-
1965-1967	3.5	1.91	6.9	0.04	8.7**	0.05	10.2	0.03	-	-
Middle 1961-1964	3.5	0.01	6.8	0.09	9.3	1.31	10.5	0.00	-	-
1965-1967	3.4	0.17	6.7	0.01	8.4	0.33	10.5	0.00	-	-
Lower 1961-1964	3.4	0.04	6.3	0.08	8.2	0.06	10.1	0.35	-	-
1965-1967	3.4	0.10	6.3	0.05	8.2	0.04	9.7	0.12	-	-
Brown trout										
Upper 1961-1964	3.7	0.05	8.5	0.11	11.5	0.26	13.5	0.17	16.8	0.32
1965-1967	3.6	0.21	8.3	0.26	11.7	0.09	13.5	0.08	16.7	0.13
Middle 1961-1964	4.0	0.04	8.3	0.09	11.5	0.20	14.1	0.28	16.6	0.14
1965-1967	3.7	0.20	8.2	0.16	11.8	0.15	14.3	0.09	16.5	0.08
Lower 1961-1964	3.8	0.03	7.6	0.11	10.5	0.15	13.2	0.37	15.2	0.60
1965-1967	3.7	0.09	7.7	0.10	10.7	0.07	13.1	0.04	15.3	0.33

** This mean is significantly greater than the corresponding value for 1961-1964; $P < 0.05$.

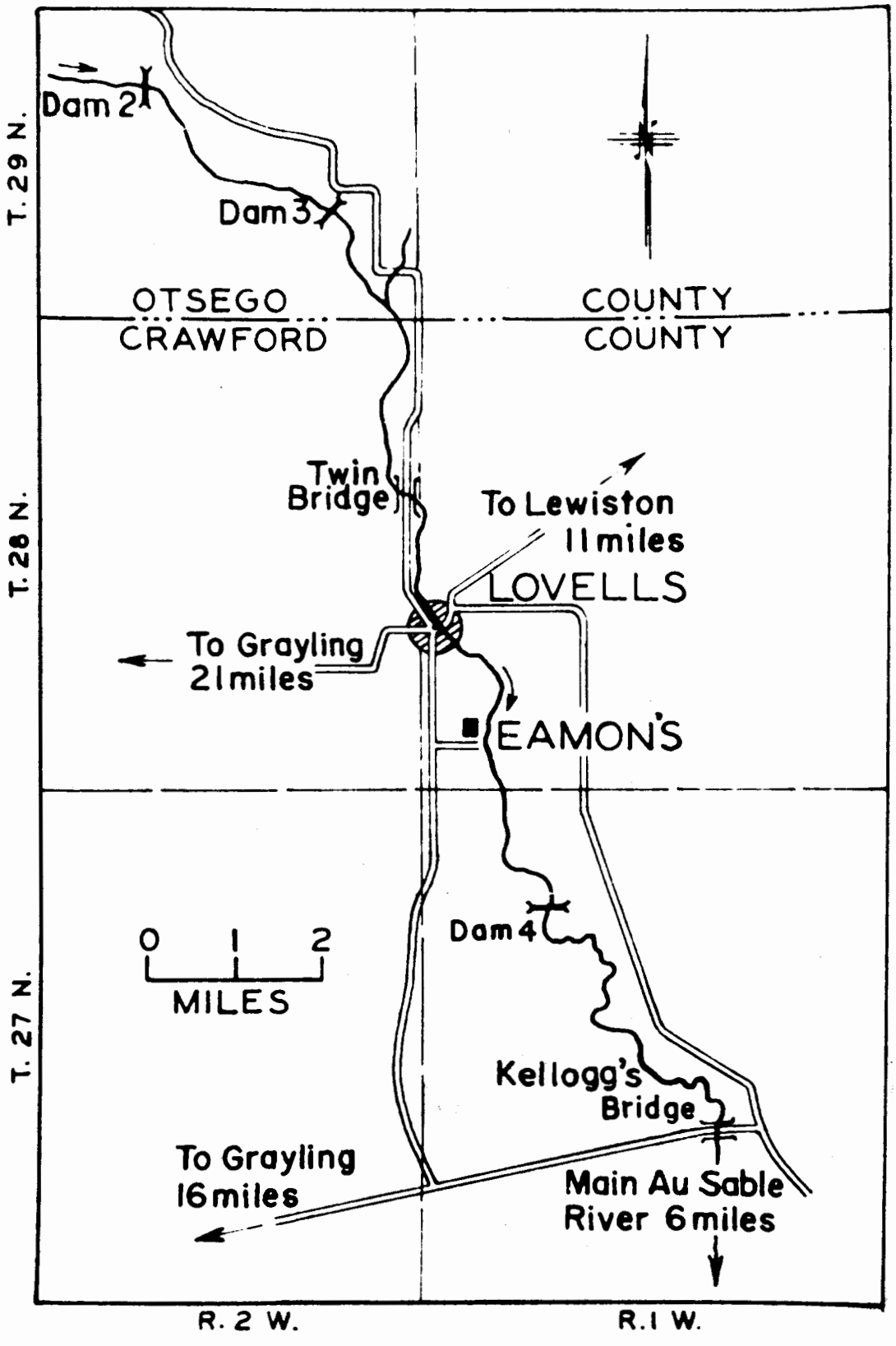

Figure 1.--North Branch Au Sable River, Otsego and Crawford counties, Michigan, showing experimental areas discussed in text.

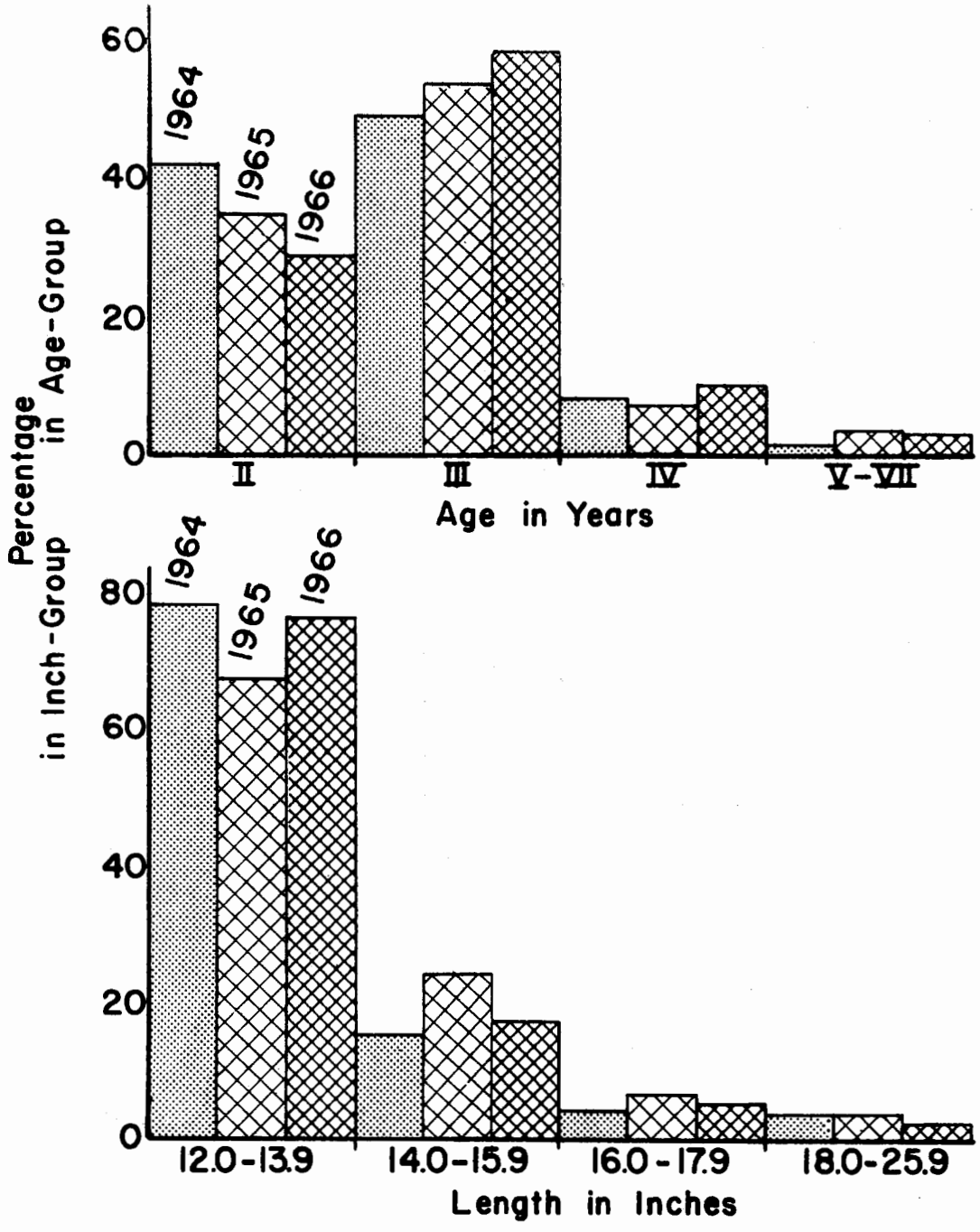

Figure 2.--Length and age distribution of brown trout removed during 1964-1966 from Upper section, North Branch Au Sable River.