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MERGANSEER PREDATION ON BROOK TROUT IN LAKES<sup>1</sup>

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Introduction

Causes of natural mortality of trout stocked in lakes have not been definitely determined (Johnson and Hasler, 1954; Alexander and Shetter, 1961; Eipper, 1961; Hatch and Webster, 1961; Latta, 1963). The American Merganser (Mergus merganser americanus) becomes a likely suspect as a major source of mortality in lakes following the studies of Salyer and Lagler, 1940; White, 1957; and Elson, 1962, on merganser predation on salmonids in streams and, particularly, when mergansers are commonly seen on the lakes (Johnson and Hasler, 1954; Hatch and Webster, 1961).

The objective of this study was to measure the effects of predation by American Mergansers on population structure and angling success for brook trout (Salvelinus fontinalis) in lakes.

Four lakes at the Pigeon River Trout Research Station, Vanderbilt, Michigan, were used in the experiment. These lakes are considered by geologists to be limestone sinks; i. e., they were formed

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through the solution of underlying limestone by ground water, accompanied by a settling of the surface layer of sand and gravel which produced a cone-shaped pothole. The water surface is 40 to 60 feet below the surrounding terrain. Tanner (1960) gave a physical and chemical description of each lake. In the early 1950's a toxicant was used to remove all fish from the lakes and since then trout have been planted annually. Trout do not spawn successfully in these lakes. In 1957-63 the lakes received about 100 brook trout per acre each November. North Twin Lake was stocked with 550 trout, South Twin with 430, West Lost with 400, and Lost with 460. Brook trout 5 to 6 inches long (average total length about 5.5 inches) were selected for each planting. Each year class was identified by a distinctive fin clip.

Regulations for trout fishing in the lakes were: minimum size, 7.0 inches; creel limit, 5 fish; no restriction as to lure or bait, except that minnows could not be used. The fishing season extended from the last Saturday in April through the second Sunday in September. A permit-type creel census required anglers to report their catch after each trip to each lake, which guaranteed a nearly complete record of the harvest.

#### Methods

The six American Mergansers used in the experiment were captured at the State Fish Hatchery, Oden, Michigan. Three were caught after they were wounded with a shotgun, and three were caught

in Bailey traps. They were held captive in cement fish tanks for 49 to 69 days to learn something about their feeding behavior (Latta and Sharkey, 1966). The largest one (51 ounces) was a male; the others were females.

Three birds were released on each of two lakes (North Twin and South Twin) on April 17, 1963, after the primary feathers of one wing were clipped. West Lost and Lost lakes served as controls. Five of the birds were removed (shot) 19 days later on May 6. One of the mergansers on South Twin Lake was killed on May 5, apparently by some predator, and consumed on May 6; thus it was on the lake for only 18 days. The weight in ounces of each merganser before its release on a lake and after its removal was as follows: North Twin, before--51.0, 43.2, 35.0, after--51.0, 49.0, 34.5; South Twin, before--36.0, 33.5, 33.0, after--38.0, 35.0. Final weight was not obtained for the bird killed by a predator.

When the mergansers were sacrificed on May 6, their stomachs contained the following food: from South Twin, one merganser contained a trout about 7 inches long, a crayfish, and a frog; the other merganser also contained a trout of the same size, a crayfish, and several aquatic insects--mostly Odonata larvae. From North Twin, one merganser contained a trout about 6 inches long, a frog, frog eggs, and an Odonata larva; the other two mergansers had eaten frogs, frog eggs, crayfish, and an Odonata larva, but no trout. The frogs apparently were Rana pipiens, and the crayfish, Orconectes virilis.

The size of the brook trout population in each lake was estimated three times in 1963: during March, before the fishing season started and the mergansers were released; in May, after the mergansers were removed from the lakes; and in October, after the fishing season had ended (Table 1). For the first estimate, trout were captured through the ice in March by fishing with hook and line, and recaptured in April after the ice had left the lakes by electrofishing at night (Latta and Myers, 1961). In May both samples of trout were taken by electrofishing. In October trout were captured by angling and recaptured by electrofishing. The estimates were calculated by Bailey's formula, a modification of the Petersen method described by Ricker (1958); the 95% confidence limits were calculated by use of Clopper and Pearson's (1934) chart. The mean total length (inches) and weight (pounds) of the trout in each year class for each lake was obtained from the angling samples taken in March and October (Table 2).

#### Effects of merganser predation on trout populations

Salyer and Lagler (1940) estimated from observations and stomach samples that an adult American Merganser consumed from 1 to 1 1/2 pounds of fish daily or "one-third to one-half its body weight." White (1957) fed a tame immature male American Merganser for 19 days. Its daily consumption averaged 15.8 ounces or 38.5% of its body weight. While held in captivity, the mergansers used in this experiment daily ate a quantity of fish equivalent to 17.9%-19.8% of their mean body

weight (Latta and Sharkey, 1966). Assuming that the mergansers would consume daily a minimum of fish that amounted to one fifth of their body weight, and a maximum of one half, the mergansers (total weight, 129.2 ounces) on North Twin could consume 30 to 77 pounds of trout in 19 days. On South Twin, the mergansers (102.5 ounces) could consume 24 to 61 pounds of trout.

The weight of the trout present in March in each lake was calculated from the population estimates and mean weights (Table 3). North Twin had a standing crop of 166.6 pounds of brook trout; South Twin, 80.6 pounds. This was more than enough for the expected requirements if all the trout were available as food. However, Latta and Sharkey (1966) found that when equal numbers of 4- to 8-inch trout were presented to captive mergansers, the birds consumed the smaller fish first, and that girth of the trout and size of the merganser determined the maximum size of trout eaten. From these observations it is doubtful that the experimental mergansers could consume many trout 10 inches long or larger. By this assumption the 1960 year class and most of the 1961 year class in North Twin Lake would be eliminated as potential prey (Table 2). In South Twin most of the 1961 year class would be potentially available, but not the 1959 and 1960 year classes (Table 2). Trout of the 1962 year class would be expected to provide most of the prey in both lakes because they were the smallest and most numerous. On the basis of this reasoning there would be about 54 pounds (1962 year class) of trout available in North Twin and about 71 pounds (1961 and

1962 year classes) in South Twin. This would be more than enough fish for the maximum requirements of the mergansers on South Twin (61 pounds needed, 71 pounds available) but not enough for those on North Twin (77 pounds needed, 54 pounds available).

After the mergansers were removed from the lakes, an attempt was made to estimate the number of trout that remained (Table 1). The samples for both marking and recapturing were taken by electrofishing at night, May 6-17. Unfortunately, not enough trout of the 1959-61 year classes were taken in any of the lakes to provide reliable estimates of these groups. The fishing season had been open for three weeks (April 27-May 17) before the electrofishing was completed. Conceivably many of these fish could have been removed by angling which would account for lack of fish in the samples. However, anglers caught only 19 trout from North Twin, 1 from South Twin, 27 from West Lost, and 39 from Lost Lake during the three weeks. Almost all of these fish were from the 1959-61 year classes. Only eight were from the 1962 year class. Very few of the 1962 year class had reached the legal size of 7.0 inches (Table 2).

The May estimates of the 1962 year class in each lake apparently were smaller than the actual numbers. For both North Twin and South Twin, this estimate is less than the summation of the anglers' catch plus the October estimate (Tables 1 and 6). Nevertheless, by utilizing the population estimates for May and the average weights for March, the pounds of trout in the 1962 year class remaining in each lake were calculated (Table 3). These calculations show that the 1962 year

class decreased by 36.0 pounds in North Twin and 14.8 pounds in South Twin. The 1962 year class also declined in the control lakes. In West Lost Lake the loss amounted to 9.9 pounds, and in Lost Lake it was 16.2 pounds. The loss among the other year classes cannot even be roughly estimated; therefore a comparison cannot be made between expected and estimated consumption by the mergansers.

In October, following the 1963 fishing season, the population estimate and the average weight of trout for each year class in each lake provided figures on standing crops (Table 3). The standing crop for March 1963, minus the 1962 year class (planted in November), should be comparable to an estimate of the standing crop for the fall of 1962. (Latta, 1963, found that natural mortality of brook trout in two similar lakes in the area was low from October to April.) A comparison of the standing crop for March 1963, minus the 1962 year class, with the standing crop for October 1963, indicates little change in either the lakes with mergansers or those without them. In North Twin Lake the standing crop was 23.5 pounds per acre in March 1963 and 24.6 pounds per acre in October 1963; in South Twin the respective crops were 14.9 and 18.0 pounds; in Lost 4.6 and 6.6; and in West Lost, 11.0 and 17.0. The estimate of 11.0 pounds for West Lost Lake is low. During the winter of 1962-63, 45 trout that weighed 14.2 pounds were removed from this lake for another study. Inclusion of these fish brings the standing crop for March 1963 to 15.1 pounds per acre. The standing crop, from March to October, 1963, increased in North Twin 5%, in South Twin 21%, in Lost 43% and in West Lost 13%. The foregoing comparisons gave no indication

that merganser predation appreciably influenced the size of the October 1963 standing crop of trout in North and South Twin lakes.

The estimates for October 1963, indicated there were 44.8 trout per acre in North Twin, 37.2 in South Twin, 46.9 in West Lost, and 35.1 in Lost Lake (Table 4). The estimates of the 1962 year class indicated about equal numbers in the three lakes: 34.2 trout per acre in North Twin, 35.4 in West Lost, and 35.1 in Lost. South Twin had only 22.8 trout per acre. Again there was no indication that the fall populations were appreciably influenced by the merganser predation.

The natural mortality from March to October is shown in Table 4. For the lakes with mergansers, this mortality was 91.1 trout per acre in North Twin and 84.7 in South Twin. Natural mortality in the lakes without mergansers was only 49.1 trout per acre in West Lost, but in Lost it was 83.6 trout per acre--almost as high as in North and South Twin lakes.

#### Effects of merganser predation on angling

According to the first estimates made in 1963, all of the lakes had approximately the same number of trout per acre (139 to 149) in March (Table 4). The May estimates indicated that about twice as many trout of the 1962 year class were present in the control lakes, West Lost and Lost, than in North and South Twin. The total angler catch per acre was 13.5 trout on North Twin and 22.7 on South Twin. The catch on Lost Lake was 25.4 trout per acre, only slightly higher



than South Twin Lake. West Lost produced the highest catch per acre, 42.9 trout. The 1962 year class, presumed to be the most susceptible to merganser predation, contributed only 5.0 and 7.7 fish per acre to the catch in North Twin and South Twin, respectively, as compared to 26.0 and 13.2 per acre in West Lost and Lost lakes.

Data on fishing pressure and angling quality for 1962 (the year before mergansers were placed on the lakes) and 1963 (when mergansers were present) are presented in Table 5. Comparison of 1962 data with those of 1963 shows that the largest change (decrease) in fishing pressure occurred on North Twin Lake. Likewise, the quality of the angling was poorest on this lake. An increase in fishing pressure occurred on South Twin Lake but the quality remained about the same. On West Lost Lake there was little change in fishing pressure and quality between 1962 and 1963. On Lost Lake the pressure decreased and angling quality increased moderately.

The number and weight of trout caught from each year class in 1962 and 1963 from the four lakes are given in Table 6. Numerically, from 1962 to 1963, the catch decreased about two thirds in North Twin, increased about a third in South Twin, and remained essentially the same in West Lost and Lost lakes. In weight, the catch decreased about one half in North Twin, almost doubled in South Twin, decreased about one sixth in West Lost and remained the same in Lost Lake.

### Discussion

It would appear that the mergansers reduced considerably the number of trout in the 1962 year class (presumed to be most vulnerable to predation). Although the estimates made in May are not very reliable, they do suggest that there were approximately twice as many trout of the 1962 year class present in the control lakes as in the experimental lakes (Table 4). The catch per acre of the 1962 year class by anglers indicates about a two and a half to one ratio for the control to experimental lakes which substantiates the population estimates.

The October estimates indicated there were approximately equal numbers (34 per acre) in three of the lakes but only 23 per acre in South Twin (Table 4). The catch in North Twin and South Twin lakes more than accounts for the decrease in population size between May and October but the decrease in West Lost and Lost lakes cannot be completely accounted for by a catch two and a half times greater than in North and South Twin lakes. The implication here, as in a previous study (Latta, 1963), is that the natural (or compensatory) mortality increases with population density.

With regard to the total catch (1962 plus other year classes) and fishing quality on North Twin both were considerably reduced, but on South Twin the catch increased and there was normal fishing quality. The explanation for the South Twin catch lies in the fishing record of one couple. This extremely efficient angling team caught 63 of the 89 trout harvested here. Their rate of catch was 0.83 trout per hour,

whereas the average for all the anglers was 0.13. They compiled this record in only 22 fishing trips among the total of 221 trips. Although they also fished North Twin and West Lost lakes successfully, they concentrated on South Twin and exerted the most influence on the catch from this lake.

Considerable natural mortality occurred in West Lost and Lost lakes in the absence of mergansers. Natural losses amounted to 91.1 trout per acre in North Twin, 84.7 in South Twin, 49.1 in West Lost and 83.6 in Lost (Table 4). I have no explanation for the high loss of trout from the control lakes. Daily observations were made on each lake but no predators were seen. Apparently many of the causes of natural mortality among brook trout in these lakes are still unidentified.

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INSTITUTE FOR FISHERIES RESEARCH

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Table 1.--Estimated number of brook trout, by year class, present in lakes in March, May and October, 1963 with 95% confidence limits for estimates

Lake and year class	March estimate		May estimate <sup>a</sup>		October estimate	
	Num-ber	95% confi- dence limits	Num-ber	95% confi- dence limits	Num-ber	95% confi- dence limits
North Twin						
1960	20	...	...	...	1 <sup>b</sup>	...
1961	219	158-407	...	...	50	30-150
1962	478	390-633	159	101-318	164	119-262
Total	717	...	159	...	215	...
South Twin						
1959	4 <sup>b</sup>	...	...	...	3	...
1960	19	...	...	...	1 <sup>b</sup>	...
1961	208	150-340	...	...	52	36- 91
1962	333	290-406	112	65-391	89	69-134
Total	564	...	112	...	145	...
West Lost						
1959	2 <sup>b</sup>	...	...	...	...	...
1960	15 <sup>b</sup>	...	...	...	3 <sup>b</sup>	...
1961	120	96-192	...	...	37	27- 75
1962	349	295-463	224	140-559	124	93-186
Total	486	...	224	...	164	...
Lost Lake						
1960	1 <sup>b</sup>	...	...	...	...	...
1961	91	70-158	...	...	3 <sup>b</sup>	...
1962	441	383-534	227	182-341	127	105-167
Total	533	...	227	...	130	...

<sup>a</sup> Only the size of the 1962 year class could be estimated.

<sup>b</sup> Minimum estimate; number handled.

Table 2. --Mean length and weight by year class of brook trout caught by angling, March and October, 1963

Lake	Year class	Number in sample	Total length (inches)		Weight (pound)	
			Mean	Standard deviation	Mean	Standard deviation
<u>MARCH 1963</u>						
North Twin	1960	10	12.1	1.5	0.594	0.270
	1961	74	10.9	0.8	0.460	0.115
	1962	74, 75 <sup>a</sup>	6.8	0.5	0.113	0.015
South Twin	1959	3	11.8	0.9	0.488	0.124
	1960	13	10.7	0.8	0.392	0.116
	1961	73	9.2	0.8	0.235	0.070
	1962	108	6.1	0.3	0.067	0.003
West Lost	1960	12	11.7	0.7	0.543	0.155
	1961	55	9.2	0.7	0.244	0.072
	1962	94	6.2	0.4	0.079	0.018
Lost	1961	44	8.4	0.7	0.183	0.050
	1962	130	6.3	0.3	0.076	0.012
<u>OCTOBER 1963</u>						
North Twin	1961	15	12.5	1.0	0.801	0.214
	1962	48	10.3	0.7	0.472	0.098
South Twin	1959	3	12.2	1.5	0.698	0.262
	1961	22	11.4	0.9	0.625	0.180
	1962	37	9.8	0.6	0.395	0.075
West Lost	1961	15, 17 <sup>a</sup>	10.6	0.9	0.502	0.131
	1962	36, 43 <sup>a</sup>	9.1	0.8	0.319	0.084
Lost	1962	63	8.0	0.5	0.187	0.037

<sup>a</sup> First number indicates number weighed; second, number measured.

Table 3. --Estimated pounds of brook trout, by year classes, present in lakes in March, May and October, and in catch for April-September, 1963

Year class	March estimate		May estimate		April-September catch by anglers		October estimate	
	Total	Per acre	Total	Per acre	Total	Per acre	Total	Per acre
North Twin Lake (4.8 acres)								
1960+	11.9	2.5	...	...	2.7	0.6	0.8	0.2
1961	100.7	21.0	...	...	24.8	5.2	40.0	8.3
1962	54.0	11.2	18.0	3.8	6.8	1.4	77.4	16.1
Total	166.6	34.7	...	...	34.3	7.2	118.2	24.6
South Twin Lake (3.9 acres)								
1960+	9.4	2.4	...	...	3.8	1.0	2.8	0.7
1961	48.9	12.5	...	...	25.1	6.4	32.5	8.3
1962	22.3	5.7	7.5	1.9	9.3	2.4	35.2	9.0
Total	80.6	20.6	...	...	38.2	9.8	70.5	18.0
West Lost Lake (3.5 acres)								
1960+	9.2	2.6	...	...	5.5	1.6	1.5	0.4
1961	29.3	8.4	...	...	16.6	4.7	18.6	5.3
1962	27.6	7.9	17.7	5.1	18.6	5.3	39.6	11.3
Total	66.1	18.9	...	...	40.7	11.6	59.7	17.0
Lost Lake (3.7 acres)								
1960+	0.2	0.1	...	...	...	...	...	...
1961	16.7	4.5	...	...	8.4	2.3	0.6	0.2
1962	33.5	9.1	17.3	4.7	6.8	1.8	23.7	6.4
Total	50.4	13.7	...	...	15.2	4.1	24.3	6.6



Table 4. --Estimated number of brook trout present in lakes in March, May and October, catch for April-September, and natural mortality for March-October, 1963

[ All values expressed as number per acre for each year class]

Year class	March estimate	May estimate <sup>a</sup>	April-September catch by anglers	October estimate	March-October natural mortality
North Twin Lake (4.8 acres)					
1960	4.2	...	0.6	0.2	3.4
1961	45.6	...	7.9	10.4	27.3
1962	99.6	33.1	5.0	34.2	60.4
Total	149.4	...	13.5	44.8	91.1
South Twin Lake (3.9 acres)					
1959	1.0	...	0.2	0.8	0.0
1960	4.9	...	1.5	0.3	3.1
1961	53.3	...	13.3	13.3	26.7
1962	85.4	28.7	7.7	22.8	54.9
Total	144.6	...	22.7	37.2	84.7
West Lost Lake (3.5 acres)					
1959	0.6	...	0.3 <sup>b</sup>	...	0.3
1960	4.3	...	2.6	0.9	0.8
1961	34.3	...	14.0	10.6	9.7
1962	99.7	64.0	26.0	35.4	38.3
Total	138.9	...	42.9	46.9	49.1
Lost Lake (3.7 acres)					
1960	0.3	...	...	...	0.3
1961	24.6	...	12.2	0.8	11.6
1962	119.2	61.4	13.2	34.3	71.7
Total	144.1	...	25.4	35.1	83.6

<sup>a</sup> Only the size of the 1962 year class could be estimated.

<sup>b</sup> Includes 21 trout caught with gill nets July, 1963. The number in each year class was as follows: 1960--1, 1961--3, 1962--17.

Table 5. --Measurements of fishing pressure and quality for lakes  
in 1962 and 1963

Year	Lake			
	North Twin	South Twin	West Lost	Lost
<u>Fishing pressure in hours</u>				
1962	824.5	415.0	689.5	441.0
1963	492.5	460.5	705.0	348.0
Percentage change	-40.3	+11.0	+2.2	-21.1
<u>Number of fishing trips</u>				
1962	288	191	274	172
1963	190	221	264	129
Percentage change	-34.0	+15.7	-3.6	-25.0
<u>Percentage of successful anglers</u>				
1962	30.2	17.3	22.6	27.3
1963	16.3	15.8	25.0	35.7
Difference	-13.9	-1.5	+2.4	+8.4
<u>Average number of fish caught per hour per angler</u>				
1962	0.18	0.12	0.18	0.18
1963	0.12	0.13	0.17	0.20
Difference	-0.06	+0.01	-0.01	+0.02

Table 6. --Number and weight of brook trout caught from lakes,  
1962 and 1963

Year class	Year of capture			
	1962		1963	
	Number	Weight (pounds)	Number	Weight (pounds)
North Twin Lake				
1959	5	4.1	...	...
1960	73	34.1	3	2.7
1961	102	30.2	38	24.8
1962	...	...	24	6.8
Total	180	68.4	65	34.3
South Twin Lake				
1959	4	2.1	1	0.5
1960	25	9.0	6	3.3
1961	32	9.4	52	25.1
1962	...	...	30	9.3
Total	61	20.5	89	38.2
West Lost Lake				
1959	7	6.2	1 <sup>a</sup>	0.8
1960	79	36.5	8	4.7
1961	67	15.2	46	16.6
1962	...	...	74	18.6
Total	153	57.9	129	40.7
Lost Lake				
1959	...	...	...	...
1960	13	5.1	...	...
1961	73	9.9	45	8.4
1962	...	...	49	6.8
Total	86	15.0	94	15.2

<sup>a</sup> In July 1963, 21 trout were caught with gill nets for another study. The number and weight by year classes were: 1960--1, 0.9; 1961--3, 1.5; 1962--17, 4.2. Angling and netting together removed 150 trout that weighed 47.3 pounds.