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SOME CHARACTERISTICS OF A POPULATION OF STUNTED PERCH

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An inventory of the pot-hole lakes in the Pigeon River State Forest, Otsego and Cheboygan Counties, made by the Institute for Fisheries Research in 1932 showed that several of these small lakes contained an abundance of yellow perch (Perca flavescens); several others contained only minnows, or minnows and brook trout where the latter had been planted. In 1933 most of these lakes were stocked with trout. Subsequent study indicated that the survival and growth of the trout was good in those lakes which did not contain perch but was poor in those lakes in which perch were abundant. It was apparent also that the perch were in poor condition; most of those netted were small and thin. The lakes which contained perch were fished very little; those with only trout (and minnows) produced excellent fishing.

It was decided, in 1934, that an effort be made to remove the fish from one of these perch lakes by poisoning and to stock the lake later with trout. South Twin Lake, T. 32 N., R. 1 W., Section 10, was selected for the experiment. This lake, according to the Institute's 1932 survey, has an area of 4.3 acres, a maximum depth of 12.7 meters, a relatively circular outline, and a bowl-shaped basin with limited shoal area. The study indicates that in summer the water is definitely stratified with the thermocline at a depth of 4 to 7 meters. The bottom soil at the margin is sand; it is organic (pulpy peat) in deeper water. The water is relatively clear (disc reading 7.5 meters) and is alkaline (surface pH 8.7). This small land-locked lake has high, steep, sandy banks and a very small drainage area.

This lake was netted several weeks before the poisoning and five sticks of dynamite were discharged at the time of the netting. The perch obtained by these two methods were placed in one lot (lot 4); they are included in this study. The net used was made of meshes of various sizes.

On the morning of September 20th, 1934, an Institute party consisting of Milton B. Trautman and the writer distributed about 48 pounds of powdered Derris Root (5% rotonone content) over the surface of the lake. The poison had been previously mixed with water. An outboard motor was used to disseminate the mixture. During the process the motor ceased to function with the result that a portion of the mixture had to be broadcast by hand. About 8 hours after the poison was distributed 100 sticks of 40% dynamite were discharged in deep water (in three lots of approximately 25, 25 and 50 sticks) in order to assure a thorough circulation of the poison throughout the lake.

The poison had killed a considerable number of fish before the dynamite was used; many of these were collected and are included by lot 1. Another lot (lot 2) was collected on the same day after the dynamiting; lot 3 was collected on the following day. Most of the fish which floated or which sank in shallow water were recovered. A gill net with meshes of various sizes was set in the lake overnight several weeks later, but took no fish. A live perch was seen, however, at the time of netting. Not all of the perch were killed and not all of those killed were recovered.

The perch in all four lots were preserved in (approximately) 10% formaldehyde and were later transferred to alcohol. All studies of the perch were made from preserved specimens. Some of the fish were heavily parasitized with Strigeid larvae, others were parasitized but little, some were apparently not infested. It is anticipated that a study of the effect of parasitism on the growth of these perch will be made later. In addition to the perch, a few trout were taken by netting and two were recovered after poisoning; no other species were taken or known to have been present. The trout are not included in this study.

The purpose of this paper is to indicate some of the characteristics of this population of stunted perch, based on the collection recovered by the several methods

indicated above. Unfortunately the entire population could not be collected for study. The fish tended to come to the surface, when dying, and wave action tended to wash the dead fish toward the shoals where they continued to float or sank in shallow water. Although any estimate of the percentage of the total population recovered would be little more than a guess, it is possible that a relatively large percentage (well over 50%) of the population was collected.

Total Population

The four lots included a total of 3615 perch. In addition 503 perch were counted lying on the bottom after the last lot had been recovered. A total of 4118 fish were therefore definitely known to have been present in the lake. This number represents 955 perch per acre, provided the area of the lake was correctly determined. The total population was probably well in excess of 1000 fish per acre; the actual population could not, of course, be determined since not all of the fish were seen or recovered.

The 3615 perch had a total weight of 49,590.6 grams (109.3 pounds). This represents a weight of 25.4 pounds per acre. If the 503 perch which were seen but not collected were of average weight they represented a total of 15.2 pounds, increasing the total weight per acre to about 29 pounds. The weight of the entire population was probably well in excess of 30 pounds per acre.

Size and Age Distribution

All of the recovered fish were measured to the nearest millimeter; both standard and total lengths were recorded. They were weighed on a Welch balance which was calibrated to tenths of grams. The small fish were weighed in groups of about 2 to 90 fish per group; all fish older than the II group were weighed individually. The size distribution irrespective of age or sex is shown in Table 1 where the fish are grouped in 10 millimeter classes. The table suggests that most of the fish probably belong to one age group (primarily in the 79.5-89.5 m.m. group), also that another age group (primarily in the 109.5-119.5 m.m. group) is present; it does not indicate, definitely, more than the two groups, consequently, sorting of this stunted population fails to show the actual distribution of the fishes in the various age groups.

Table 1

Size distribution of all perch, irrespective of age and sex, by 10 m.m. classes (standard length)

Size Class	Number	Per cent of Total
49.5 - 59.5	3	0.1
59.5 - 69.5	0	0.0
69.5 - 79.5	144	4.0
79.5 - 89.5	2270	62.8
89.5 - 99.5	345	9.5
99.5 - 109.5	112	3.1
109.5 - 119.5	357	9.9
119.5 - 129.5	222	6.1
129.5 - 139.5	93	2.5
139.5 - 149.5	32	0.9
149.5 - 159.5	18	0.5
159.5 - 169.5	7	0.2
169.5 - 179.5	3	0.1
179.5 - 189.5	3	0.1
189.5 - 199.5	0	0.0
199.5 - 209.5	0	0.0
209.5 - 219.5	2	0.1
259.5 - 269.5	1	0.0
269.5 - 279.5	1	0.0
279.5 - 289.5	1	0.0
289.5 - 299.5	1	0.0
Total	3615	99.9

All of the 3615 fish were used for age determination. The scales were studied under a bionocular microscope. The annuli were located easily in the young fish (I and II groups) but were difficult to locate in the scales from some of the older fish, especially from those in poor condition, since many of these emaciated individuals had apparently partially resorbed portions of their scales (See Fig. —). On some specimens 50 or more scales were examined before the age could be determined with any degree of certainity; even though the scales were carefully studied it is possible that the age determinations on some of the older fish were incorrect. The distribution of the perch, by sexes, in the several age groups is shown in Table 2. The ages indicate the number of winter marks (annuli); since most of the fish were taken in mid-September (20th), the fish were actually almost one growing season older than the figures indicate.

Table 2

Number of female and male perch in each year group,

and average length and weight of fish in each group

	0	I	II	III	IV	V	VI?	Over VI
Females (1530)								
Lot 1	2	27	607	24	66	13	...	2
Lot 2	...	...	284	4	31	3	...	...
Lot 3	...	...	320	6	31	2	1	...
Lot 4	...	1	27	65	13	...	...	1
Total	2	28	1238	99	141	18	1	3
Males (2085)								
Lot 1	1	45	638	132	11	...	...	...
Lot 2	...	3	497	59	32	...	...	...
Lot 3	...	10	361	108	42	...	...	...
Lot 4	...	13	40	84	9	...	...	...
Total	1	71	1536	383	94	...	...	...
Total (both sexes)	3	99	2774	482	235	18	1	3
Per cent of total collection	0.1	2.7	76.7	13.3	6.5	0.5	0.0	.1
Ave. standard length in m.m.								
Females	44	80.4	87.1	125.0	134.2	169.1	274.0	282.0
Males	43	89.0 1/	84.4	116.0	121.1	...	...	...
Ave. weight in grams								
Females	2.7	7.7	9.6	30.2	35.3	76.5	445.3	443.3
Males	2.7	11.3 1/	9.7	21.7	21.7	...	...	...
Ave. (approximate) total length in inches								
Females	2.1	3.8	4.1	5.9	6.3	7.88	12.49	13.83
Males	2.0	4.2	4.0	5.5	5.7	...	...	...
Ave. weight in ounces								
Females	.09	.27	.34	1.07	1.25	2.70	15.73	15.65
Males	.08	.40	.37	.77	.89	...	...	...

1/ A number of the males in the I group showed exceptionally rapid growth compared with the other fish.

Over three-fourths of the fish (76.7%) were in one year group (II); fish in III and IV groups were more abundant than those in the 0 and I groups. The dominance of a single age group is in agreement with the observation of Jobes (1933) on the perch of Lake Erie.

The fish with five or more annuli were all females; in the IV group the females predominated; in the I, II and III groups the males were decidedly more abundant than the females. Apparently the females definitely lived longer than the males, a condition which is not uncommon among fishes and some other forms of animal life. Geiser, (1924) held that females are inherently better fitted than males to survive adverse environmental conditions.

The perch, in general, grew quite slowly. In the I group the males averaged longer and heavier than the females, in the II group both sexes were of about equal length and weight; in the fish older than II the females were decidedly the longer and heavier, exhibiting a much greater growth than the males. Schneberger (1935) in his study of perch in three northern Wisconsin lakes found that the females grew much faster than the males in Silver Lake, the lake with the slowest growing population. This is in accord with the writer's findings. In the two Wisconsin lakes where the fish grew more rapidly the difference in growth rate of the two sexes was much less pronounced. A few of the female perch reached a large size; the single perch in the VI? group weighed more than 45 perch in the II group; it weighed about as much as 16 average male perch from the oldest group of males (IV). The dominant group (II) averaged only slightly over four inches in total length, and only a little over a third of an ounce in weight.

Some of the males in the I group grew very rapidly, compared with the other fish, and decidedly raised the average length and weight for this group. Such unusual growth was present also in a few of the II group but was not observed in the older fish. Schneberger (1935), in his study of perch from several Wisconsin lakes noted a similar rapid growth in some of the young fish. He states that "In the younger fish (age-groups II and III) cases are found where the annulus is far from the focus, indicating an extremely rapid growth. However, this type is rarely found in the older fish, suggesting that the rapid growers are shorter-lived." Hile, (MS.) in his study of

cisco from lakes in Vilas County, Wisconsin, discusses growth ~~compensation~~ at considerable length.

The approximate number of legal-sized fish was determined. All the perch were measured after they were preserved so it is impossible to indicate exactly the number of fish of a given length because the amount of shrinkage is not know. Van Oosten (1929) found, for the lake herring, that the shrinkage factor was 1.016. This same factor was used by the writer on the perch. The legal length on this species in Michigan is 6 inches (152.4 m.m.); all perch with a length of 150 m.m. or more (after preservation) are here considered to be of legal length. The number, age and length of all perch 150 m.m. or more in length are shown in Table 3.

Table 3

Number, age and sex of all perch

with total length of 150 m.m. or more

Year Class	II		III		IV		V	VI?	Over VI	Total		
Sex	Male	Female	Male	Female	Male	Female	Female	Female	Female	Male	Female	Both sexes
Number	4	1	31	50	19	126	18	1	3	54	199	253
Per cent of all fish (of same sex) in year class	0.3	0.1	8.1	50.1	20.2	89.4	100	100	100	2.6	13.0	7.0

If it be assumed that the allowance for shrinkage was correct, seven per cent of the fish collected or approximately 60 fish per acre were of legal length and the ratio of legal females to legal males was approximately 4 to 1 (199 to 54). Since some of these fish had very large heads and were in poor condition, and since some were parasitized rather heavily, the percentage of desirable legal-sized fish in the total population was very small, apparently less than five per cent.

For comparison of growth of the South Twin Lake perch with perch from other waters the lengths of this species in the several year groups found by Jobes (1933), Harkness (1922), Schneberger (1935) and Hile (1931) are recorded in Table 4. In all of these

studies the lengths given are actual lengths and all fish were taken in the summer or fall. It will be noted that, in general, the perch from South Twin Lake grew more slowly than those from the other lakes. The Lake Erie perch (Jobes) had attained an average size in the II group greater than that of the South Twin Lake perch in the V group.

Table 4

Average standard length in millimeters of perch in various year classes from several lakes (adapted from several authors)

Investigator	Lake	I	II	III	IV	V
Eschmeyer	South Twin	87	86	118	129	169
Jobes[1]	Lake Erie	161	178	196	213	250
Harkness	Lake Erie	...	144	168	187	217
Schneberger[2]	Nebish (Wis.)	124	157	173	209	245
Schneberger[3]	Weber (Wis.)	95	130	158	174	191
Schneberger[4]	Silver (Wis.)	77	109	120	145	173
Hile[5]	Wawasee (Ind.)	86	129	167	198	220

1/ Data for 1927 and 1928 combined
2/ Data for 1930, '31, '32 combined
3/ Data for 1928, '30, '31, '32 combined
4/ Data for 1928, '30, '31 combined
5/ Data for 1926, '27, '28 combined

Sex Ratio

As was shown in Table 1, the sex ratio differed decidedly in the different age groups. For the entire population the sex ratio was 74 females per 100 males, approximately a 3 to 4 ratio. The ratios for each lot were:

Lot 1. 89 females per 100 males
Lot 2. 54 females per 100 males
Lot 3. 69 females per 100 males
Lot 4. 74 females per 100 males

The ratios vary considerably; incidentally lot 4, the smallest lot, showed a proportion of females to males identical with the proportion of the two sexes for all lots combined. It is possible that the poisoning was selective, that one sex floated

more readily than the other after being killed. If the poisoning was no more selective than netting or other methods used to take fish, the study suggests that the taking of a random sample of a perch population involves certain difficulties. It is possible that these fish school in separate sexes, at least at certain times of the year; it also appears that the larger fish tend to be predominantly females. The latter tendency appears not only in the South Twin Lake perch, but in Schneberger's (1935, Table III) study as well. In the South Twin Lake collection males predominated the population as a whole even though the large fish were mostly females. Schneberger (1935) in his study of perch in three lakes in norther Wisconsin found that "In Nebish Lake the males are slightly more abundant than the females . . . . In Weber and Silver Lakes the reverse is true, as there are more females than males." The ratio of females to males in Nebish was 1:1.26, the ratio of males to females in Weber was 1:1.21, and in Silver 1:1.40. The conclusions are based on 355, 407 and 392 fish respectively. Silver Lake, with the greatest concentration of perch and with the slowest growing perch had the greatest proportion of females (58% females). It is possible that this sex ratio would have been decidedly different had he been able to check a large percentage of the total population in the lakes. The fact that the perch in South Twin Lake were dominantly young fish (primarily II's) probably had a bearing on the sex ratio found for the fish in that lake. Hile (MS.) shows that in the cisco from four northern Wisconsin lakes, there is a preponderance of females in his collections from three of them. He states also that, "with the exception of the irregular data of Silver Lake the females tend to become relatively more abundant as age increases." This suggests further that in taking a random sample the age groups must be given consideration.

Condition of Perch[1]

All perch in the collection were measured and weighed and the condition factor or "degree of fatness" of the individual fish was determined. The formula $K = \frac{W\ 100,000}{L^3}$ was used where W = weight in grams and L = standard length in millimeters.

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[1] Discussions of coeficient of condition and length-weight relationship are found in papers by Clark, Van Oosten, Hile, Schneberger, and others.

Since perch in the 0, I and II groups were weighed in groups, the value for K for fish in these classes is only approximate; all older fish were weighed individually. Table 5 shows the value of K, for each, for each year class.

Table 5

Value of K of all perch in each year class[1]

Year Class[2]	I	II	III	IV	V	VI?	Over VI	Average
Females	1.49	1.46	1.51	1.42	1.46	2.17	1.97	1.46
Males	1.49	1.51	1.41	1.41	...	...	...	...
Both sexes	1.49	1.49	1.43	1.42	1.46	2.17	1.97	1.46

[1] Number of perch in each group is shown in Table 1

[2] 0 class not included in this table

K for males and females in the I group was identical; in the II group the males were in slightly better condition; in the groups older than II the condition of the females was better than that of the males. The fish as a whole were in poorest condition in the III and IV groups. For comparison, the condition of perch in other waters as determined by Schneberger and Hile are listed in Table 6.

Table 6

Value of K for Perch in three Wisconsin lakes and one Indiana lake compared with value of K for South Twin Lake

Investigator	Lake	I	II	III	IV	V
Eschmeyer	South Twin	1.49	1.49	1.43	1.42	1.46
Schneberger[3]	Nebish (Wis.)	1.67	1.64	1.63	1.72	1.75
Schneberger[3]	Weber (Wis.)	1.65	1.44	1.54	1.61	1.65
Schneberger[3]	Silver (Wis.)	...	1.57	1.60	1.61	1.65
Hile[4]	Wawasee (Ind.)	1.51	1.63	1.60	1.77	1.70

[3] Combined for 1930, '31 and '32.

[4] Combined for 1926, '27, '28 and '29

It will be noted that the condition of perch from South Twin Lake was poorer than the condition of perch in the other four lakes. The fish from all the lakes were collected

in summer and fall, and actual lengths (rather than calculated lengths) were used for all fish. The studies differed in one respect, on all except the South Twin lake fish the measurements were taken on fresh (unpreserved) specimens. This difference may be a significant one; Hile (MS.) in his study on the cisco in several Wisconsin lakes shows the shrinkage factor for weight of cisco in one lake (Muskellunge) to be 1.181, in another lake (Clear) to be 1.144.

For fish older than the II group the individuals were grouped (by age and sex) in classes to indicate the range in condition, in Table 7. For most groups the distribution curve would approach a normal curve. The distribution for the V group (all females) suggests a tendency toward a bimodal curve; unfortunately the number of fish in this group is quite small. The species in general had a wide range of condition varying from less than 1.0 to more than 2.0.

Table 7

Distribution of perch (III class and older) according to condition (percentage, to nearest one per cent, of year class)

Classes	♀ III	♂	♀ IV	♂	♀V	♀VI	♀Over VI
0.9 - 1.0	1	1	1	...			
1.0 - 1.1	...	4	4	2			
1.1 - 1.2	2	9	9	6	6		
1.2 - 1.3	8	13	13	14	17		
1.3 - 1.4	19	24	20	29	6		
1.4 - 1.5	19	25	22	21	28		
1.5 - 1.6	22	12	11	11	33		33
1.6 - 1.7	13	9	9	10	6		
1.7 - 1.8	8	3	7	4	6		33
1.8 - 1.9	3	1	2	2			
1.9 - 2.0	2	...	...	1			
2.0 - 2.1	2	...	1	...			
2.1 - 2.2				...		100	33
2.2 - 2.3			1	...			
Total	99	101	100	100	102	100	99

It appears that, in normally growing fresh water fishes the head grows more slowly, in proportion, than the body. Hubbs (1930) gives separate head lengths for the young and adults of certain Catostomid species. His figures indicate that the head in the young is decidedly larger, in proportion, than the head in adults. Table 8 indicates that, in the South Twin Lake perch, the head grew faster, in proportion, than the body.

Table 8

Head length (B/H). Extreme head length in standard length

	I	II	III	IV	V	VI?	Over VI
Females							
Number	1	28	76	78	18	1	3
B/H	3.20	3.09	2.84	2.86	2.96	2.95	3.06
Males							
Number	13	42	121	5			
B/H	3.11	3.10	2.90	2.78			

A comparison of Tables 5 and 8 suggests a correlation between condition of fish and size of head; that the fish in poor condition have relatively larger heads. According to Jordan the head in length (standard) for perch is $3\frac{1}{4}$. The III, IV and V groups from South Twin Lake had an average head length of less than 3.

Ninety-one specimens of the III group were divided into three classes of condition: 0.9 - 1.3, 1.3 - 1.6 and 1.6 - 1.9. These classes contained 28, 48 and 15 specimens respectively. The average length of head (in body) for the three groups was 2.91, 2.92 and 2.86 respectively. This failed to show a close correlation between condition and size of head but the number of specimens used was probably inadequate. A further study of this point appears desirable. A study of the head length for ~~128~~ 153 specimens of the III group indicates that the head length varies little with differences in growth although there is a suggestion that the head is larger in the fast growing fish (130 - 150 m.m.). Because of the small number of specimens used the data may not be significant. The average size of head is shown below:

Size Class	Number of Specimens	Head in Body
105 - 109.5	6	2.90
109.5 - 114.5	33	2.87
114.5 - 119.5	67	2.86
119.5 - 124.5	25	2.85
124.5 - 129.5	10	2.88
129.5 - 134.5	7	3.11
134.5 - 139.5	2	2.93
139.5 - 144.5	3	2.97

Food

No study was made of the abundance of food organisms in the lake but a rather brief and unpretentious examination of the stomach contents was made. A number of the larger fish, almost all of them females, had been previously examined. A considerable proportion of these fish contained perch in the stomachs, most of the perch being undigested. It is probable that the smaller perch were incapacitated by the poison before the large fish were effected and were therefore easily captured by the large fish. Although the proportion of perch in the stomachs was probably much higher than normal, the small perch obviously are an important food item for the large fish. It

is possible that the excellent condition of the larger females (some of the IV class and older) is attributable to the presence of the abundant population of small perch (primarily II class).

A stomach analysis of 34 of the I group indicates that insects and small Crustacea constituted almost the entire food supply, Chironomids and Cladocera being the most common organisms. The insects included also Diptera other than Chironomidae, and Ephemerida, Trichoptera, Coleoptera and Odonata. Although the stomachs generally contained relatively little food only one of the 34 was completely empty. The examination indicated that the individual stomachs contained either insects or Crustaceans; none were found to contain both forms.

Analysis of stomachs of the II class (50 specimens) suggests that the food of this group is essentially the same as that used by the I group except a greater proportion of the stomachs contained Crustacians. The insects included primarily Diptera and Ephemeridae, a few Trichoptera were also eaten. The Crustacea were primarily Cladocera.

Stomachs of 40 fish of the III class (all males) were examined. The bulk of the food consisted of Diptera, with Chironomidae and Corethera predominating. Small snails and small clams were eaten to a limited extent along with leeches, algae, Tricoptera, Hemiptera and Hymenoptera. Six of the stomachs were empty.

The food in the stomachs of 40 fish in the IV class was essentially similar to that of the III group, consisting primarily of Diptera, Corethera predominating. Other forms, snails clams, Odonata, Orthoptera, Coleoptera, Ephemerida, Trichoptera, leeches and crayfish, were taken in very limited amounts.

It appears that, at the time the perch were taken, Diptera constituted the chief food supply with Chironomids apparently constituting the bulk of the food. The fact that many (perhaps most) of the Chironomids were changing from the larval to the pupal stage may have contributed to their being eaten so extensively at the time. In general the stomachs were very small and contained little food; however, only 13 of the 164 stomachs were entirely empty.

The study suggests that food organisms, of suitable size, in sufficient abundance to produce a reasonably fast growth after the first summer may be lacking, that most of the fish cannot subsist on the small organisms and that, therefore, they may die of starvation.

General Characteristics of the Population

It has been indicated that the fish in South Twin Lake, Otsego County, were netted, poisoned and dynamited to reduce in numbers (if possible, to remove entirely) the perch population. Those perch which floated or which sank in shallow water were recovered and were studied by the writer. The study shows that of those recovered, (1) over three-fourths were of one age group, (2) all fish over four winters old were females, (3) the proportion of females to males was 74 to 100, (4) the young fish were dominantly males, the older ones dominantly females, (5) a total of 955 perch per acre, weighing 29 pounds per acre were definitely accounted for, the actual number and weight were of course greater than the number accounted for, (6) the fish grew quite slowly, (7) seven per cent were legalfish (54 males, 199 females), (8) in general the fish were in poor condition, (9) the fish had unusually large heads, (10) the fish covered a wide range of condition, (11) Diptera constituted the primary food item of the fish.

Various studies have been made on the effect of crowding of fish; to what extent the concentration of the fish in South Twin Lake affected their growth and condition could not, of course, be determined.

A number of factors suggest that a majority of the fish normally died of starvation. The lake was fished very little and predators of the larger fish were few or none; few fish were normally removed by man or by predators. Factors already mentioned which might suggest starvation of a considerable portion of the population are: (1) a decrease in condition in the III and IV group, (2) the poor condition of the population in general, (3) an unsually large head, especially in the groups in poorest condition, (4) size of the food organisms in the stomachs, with an apparent scarcity of organisms of a size intermediate between Diptera and perch of the II group, (5) small amount of food in the stomachs (regurgitation may have taken place when the fish were poisoned), (6) apparent

resorption of portions of the scales in many of the poorer individuals. Although not studied in detail a casual examination of the sex organs in the emaciated individuals indicated that these were very small. Although it cannot be definitely proven that many of the fish normally died of starvation, the evidence, collectively, strongly suggests that starvation was responsible for the mortality.

There is reason to believe, although it cannot be definitely proven, that a definite cycle normally occurrs in such a population. When the fish were killed over three-fourths were of the II group; 0 and I groups were very poorly represented. It is possible that, with a paucity of available food the II group subsisted on the eggs or young when these were available. Had the fish not been poisoned most of the II group would possibly have died of starvation in the following year.. Enough adult fish would have survived to assure adequate reproduction. With most of the predators removed by starvation, a large crop of young fish would again have resulted. In such a cycle one age group would be very abundant, would keep down the following two age groups by eating the eggs or young, would largely die of starvation in its third year, and, in dying, would make possible the survival of another group with too few predators remaining to seriously deplete the numbers of the new group. The dominant age group in South Twin Lake for the ten years starting in 1934 might have been (successively): II, 0, I, II, 0, I, II, 0, I, II provided the cycle was uniform. The dominant group would invariably have been under legal size (6 inches). In reply to a letter addressed to Mr. William Horsell, Superintendent of the Pigeon River State, Mr. Horsell indicated that in the last eleven years the perch in South Twin Lake had always been small, six inches or less.

The population in another lake (Section 4 Lake) was poisoned in 1935. A study of this population may give more information on the possibility of a cycle in the perch populations.

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