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A Population Study of a Limited Area in a Michigan Trout Stream [1]

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[1] Contribution from the Michigan Institute for Fisheries Research

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The comparative scarcity of published studies of trout stream populations leads the authors to hope that the data here presented may be of interest to fishery biologists concerned with trout stream problems. The entire fish population of a short stretch of stream was available for examination. There follows a description of the physical conditions and methods which made the study possible, together with an analysis of the fish population made from various standpoints, including that of age and growth, apparent mortality between age-groups, and difficulty of capture.

In the Hunt Creek Experimental Area, located in southern Montmorency County, Michigan, various parts of Hunt Creek have been given special designations, on an ecological basis, to aid in evaluating intensive creel

census results. Other research requirements made it desirable to construct a series of by-pass channels, which could be screened and controlled, near the middle of a 3,970-foot-long stretch of stream designated "Section C." [2]

[2] Surface area, 1.07 acres, as determined from a plane table map drawn to a scale of 1 inch = 20 feet.

After the new channels were excavated, the entire flow of the stream was diverted through them, so that concrete bulkheads could be placed across the original channel. The diversion of the water presented an excellent opportunity to study the entire fish population of the section of stream thus cut off, in a manner similar to that described by Embody (1929). Seining and treatment with rotenone were employed, in addition to water diversion, to insure a complete count of all fish present in the delimited area.

The delimited area consisted of two contiguous, arbitrarily designated sections which, to conserve space, will be referred to hereafter as II-A and III-A. Together, these sections comprised 580.5 feet of stream with a total surface area of 0.131 acre. Individually, III-A, the upper of the two sections, has a length of 298 feet, an average width of 9.2 feet, and a surface area of 0.063 acre; II-A has a length of 282.5 feet, an average width of 10.5 feet, and a surface area of 0.063 acre. Stream flow, at the time of the study, was approximately 6,500 gallons per minute at a surface velocity varying, throughout the area, from 1 to 2.5 feet per second, as determined with a Bentzel velocity tube. The water supply is almost wholly of spring origin. In the sections concerned, dissolved oxygen is usually present at the rate of 10.5 p.p.m.; dissolved carbon dioxide has never been found in excess of 2 p.p.m. and is usually absent; methyl-orange alkalinity is about 175 p.p.m., and the pH varies from 7.8 to 8.0

as determined with a Hellige pocket comparator. Throughout both sections the stream bottom is gravelly, composed of smoothly rounded glacial drift material ranging in size from that of a pea to that of a man's two fists, the average about the size of a hen's egg. Very little sand is exposed in the bottom, except for occasional bars formed behind natural obstructions.

Bottom fauna investigations indicate that in both II-A and III-A the average square foot of bottom yields about 0.750 cubic centimeters of bottom organisms during September. Larvae and pupae of caddisflies, especially those of Mystrophora americana, surpass both mayflies and aquatic Diptera in number and volume. Common mayfly nymphs are those of Baetis vagans and B. brunneicolor, Paraleptophlebia praepedita and P. mollis, and Ephemerella invaria. Among stoneflies, only nymphs of Isogenus frontalis are often significant volumetrically, although nymphs of Capnia manitoba, Allocapnia torontoensis, Leuctra sp. and Nemoura spp. are numerically abundant.

The stream banks, which are seldom over one or two feet high, support a mixed open stand of alder (Alnus incana), tamarack (Larix laricina), white cedar (Thuja occidentalis), and aspen (Populus tremuloides). Aquatic vegetation is of negligible amount in the sections here considered. There are a few small beds of speedwell (Veronica comata); and algae (Vaucheria sp.) form mats over the infrequent sandy areas.

Procedure

On September 25, 1940, at 7:30 A.M., blocking seines of 3/8-inch bar measure were doubled and placed across the stream simultaneously at points X and Y (Figure 1), and at the same time the flow was diverted into the bypass channel by means of a tight sandbag dam at point Z. The lead lines of the blocking seines were held tightly to the stream bottom and the

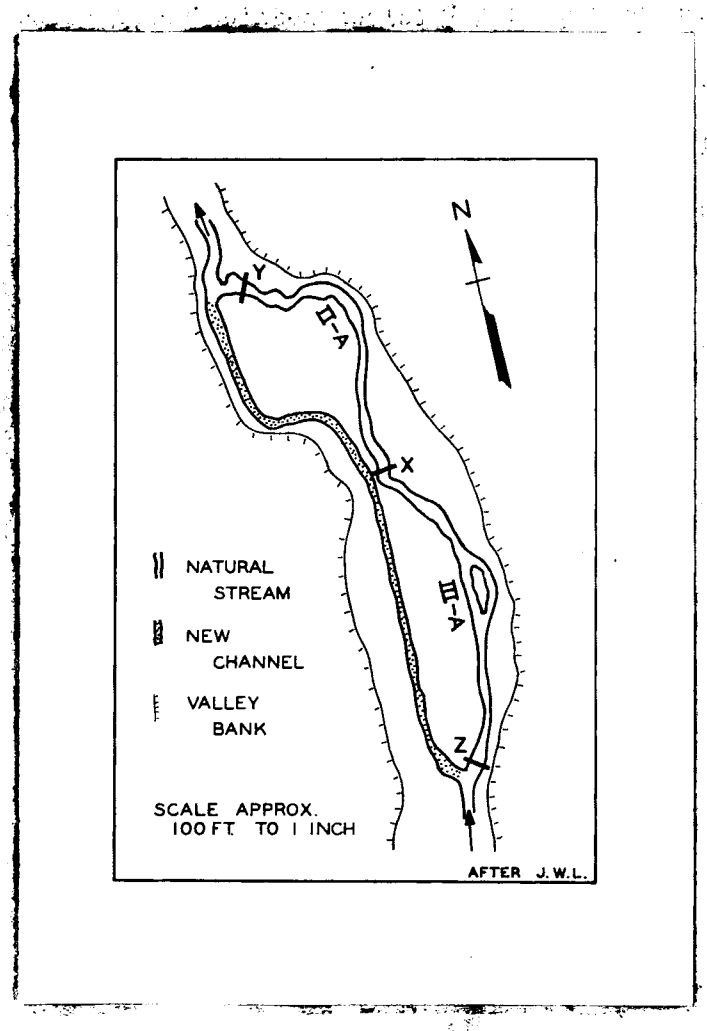

Figure 1.— Map of stream area of Section C of Hunt Creek, Montmorency County, Michigan, on which the population study was made.

intersections with the bank by a continuous row of large stones placed on each lead line. The entire fish population in II-A and III-A was thereby trapped. In about 45 minutes most of the normal water content had drained out of the area cut off, and the fish present were concentrated in 20 to 30 small and more or less isolated pools.

At this time seining was begun; a 4-by-4-foot common-sense minnow seine was used. All water areas were thoroughly netted, and most of the fish were taken in this way. Of the few fish taken by hand or with scap nets, a majority were muddlers (Cottus b. bairdii). The only trout in the area were eastern brook trout (Salvelinus f. fontinalis). All fish captured were transferred to a tub of fresh water, and later were counted and weighed by species. Trout of legal size (7 inches or more in length) were weighed and measured individually; measurements and scale samples were taken from a representative series of the smaller trout. All fish taken by seining were released alive below the lower blocking net after being weighed and measured. The entire day of September 25 was devoted to capturing and recording the fish taken by seining.

Although nearly six hours of intensive seining effort had been expended on less than 600 feet of stream, a small but noticeable number of trout and muddlers remained in the blocked-off area of stream. It was decided to leave the blocking seines in place over night, and to treat the pools with poison on the following morning. Accordingly, on September 26, at 7:15 A.M., with the air temperature at 38°F. and that of the water at 44°F., 200 grams of powdered derris root (5 per cent rotenone content) were mixed with 5 quarts of water, and a small portion of the mixture was sprinkled over the surface of each pool in III-A, the upper of the two sections. After about ten minutes, trout and muddlers remaining in the area began to die, and were collected by hand or with scap nets.

Because of spring seepage from the banks and bottom of the stream, the isolated pools gradually spilled over, and the poisoned water from III-A was slowly forced into II-A, where its concentration proved sufficient to kill fish that had escaped capture by seining there. To prevent possible mortality of trout below the area under observation, a sand-and-gravel dike was thrown across the stream below the blocking net at point Y (Figure 1), and the poisoned water pumped out of the lower end of II-A by means of an engine-driven diaphragm pump having a capacity of 100 gallons per minute. Operation of the pump for a four-hour period removed most of the poisoned water. A small notch was then cut in the dike and the remaining water allowed to drain slowly from the isolated area. A careful inspection of Hunt Creek on the following day indicated that no mortality occurred below the isolated area.

Fish population of the drained areas

Only two species of fish were present in II-A and III-A: eastern brook trout (Salvelinus f. fontinalis), and muddlers (Cottus b. bairdii). From III-A, with a length of 298 feet, an average width of 9.2 feet, and a surface area of 0.063 acre, a total of 345 trout and 90 muddlers was recovered. From II-A, the lower section, with a length of 282.5 feet, an average width of 10.5 feet, and a surface area of 0.068 acre, 260 trout and 98 muddlers were taken. Combining results, it may be seen that 605 trout and 188 muddlers were removed from 580.5 feet of stream having a surface area of 0.130 acre. A further analysis is shown in Table 1. On the basis of measurements of the area and the total number of fish recovered, it was found that this section of the experimental stream was supporting fish at the rate of 4,619 brook trout and 1,435 muddlers per acre, or, in terms of weight, 94.4 pounds per acre of trout and 9.68 pounds per acre of muddlers.

It should be mentioned that an unknown but probably small number of legal trout may have been removed from the restricted study area during the angling season which closed on September 4, 1940.

Table 1.--Data on actual and calculated fish population of Diversions II-A and III-A of Section C of Hunt Creek, Montmorency County, Michigan, on September 25, 26, 1940

Item	Number captured	Total weight (pounds)	Calculated number per acre	Calculated pounds per acre
Diversion II-A, area 0.068 acre				
Brook (7 inches or longer	10	1.64	147	24.08
(4-6 7/8 inches	79	3.52	1,162	51.76
trout (less than 4 inches	171	1.43	2,514	21.06
Muddlers	98	0.64	1,441	9.43
Totals	358	7.23	5,264	106.33
Diversion III-A, area--0.063 acre				
Brook (7 inches or longer	4	0.75	63	11.97
(4-6 7/8 inches	58	2.55	921	40.44
trout (less than 4 inches	283	2.47	4,492	39.22
Muddlers	90	0.63	1,429	9.94
Totals	435	6.40	6,905	101.57
Total area censused, 0.131 acre				
Brook (7 inches or longer	14	2.39	107	18.26
(4-6 7/8 inches	137	6.07	1,046	46.33
trout (less than 4 inches	454	3.90	3,466	29.81
Muddlers	188	1.27	1,435	9.68
Totals	793	13.63	6,054	104.08

[1] The average total length of the 14 legal brook trout was 7.81 inches; the average total length of the sublegal brook trout was 5.12 inches (137 specimens measured); the average total length of the fingerling brook trout was 2.83 inches (51 specimens measured).

Of the 605 trout captured, 40 were marked fingerlings of hatchery origin. Thirty-nine of these were released in Section C in August, 1940; one was from a planting of hatchery-reared fingerlings made in the section in October, 1939. The hatchery-reared trout made up 6.7 per cent of the total trout population; all were less than legal length (7 inches) at the time of the study. By weight, hatchery trout made up 2.7 per cent of the calculated total weight of trout per acre. Since all the trout planted in Hunt Creek since 1938 have been marked, all unmarked trout are presumably of natural origin.

Size distribution of the trout population

Data from all specimens obtained from II-A and III-A were combined to draw up a size-frequency table (Table 2 and Figure 2). The table and the figure show that a great majority of the trout present were fingerlings (less than 4 inches total length). Of the 605 trout captured, 2.3 per cent (14) were 7 inches or more in length; 22.0 per cent (133) were between 4 and 6 7/8 inches in length and were classed as sublegal; and 75.7 per cent (458) were fingerlings. By weight, legal trout made up 19.4 per cent, sublegals 48 per cent, and fingerlings 32.6 per cent of the total weight of the trout captured.

Comparison of the populations of the two areas

The populations of II-A and III-A have been calculated separately to determine what differences existed in the components of the total population. The lower section, II-A, was slightly the larger, had more and larger pools, and better underwater cover. In II-A the pools were 1.2 feet in average depth while those of III-A averaged 1.0 foot. In II-A was found the largest number of legal-length trout (10 as compared with 4), and also the larger

Table 2.--Length-frequency distribution of brook trout found in Diversions II-A and III-A, Section C, Hunt Creek, September 25, 26, 1940

(Includes 40 marked hatchery trout)

Range in total length, (millimeters)	Number of specimens in group	Range in total length, (millimeters)	Number of specimens in group
55- 59	10	155-159	6
60- 64	37	160-164	4
65- 69	71	165-169	4
70- 74	60	170-174	3
75- 79	100	175-179	4
80- 84	100	180-184	2
85- 89	37	185-189	1
90- 94	34	190-194	1
[1] 95- 99	9	195-199	1
100-104	3	200-204	1
105-109	11	205-209	...
110-114	9	210-214	...
115-119	26	215-219	4
120-124	13	220-224	...
125-129	8	225-229	...
130-134	13	230-234	...
135-139	13	235-239	...
140-144	10	240-244	1
145-149	3		
150-154	6	Total	605

[1] The length-frequency distribution of brook trout less than 100 millimeters total length was determined from a sample of 174 fish from Section C measured on September 24, 1940. The percentages of fish in each size range of the latter sample was applied to the total number of fish classed as "fingerlings" in the population count. This procedure was followed because of lack of time to measure all trout captured.

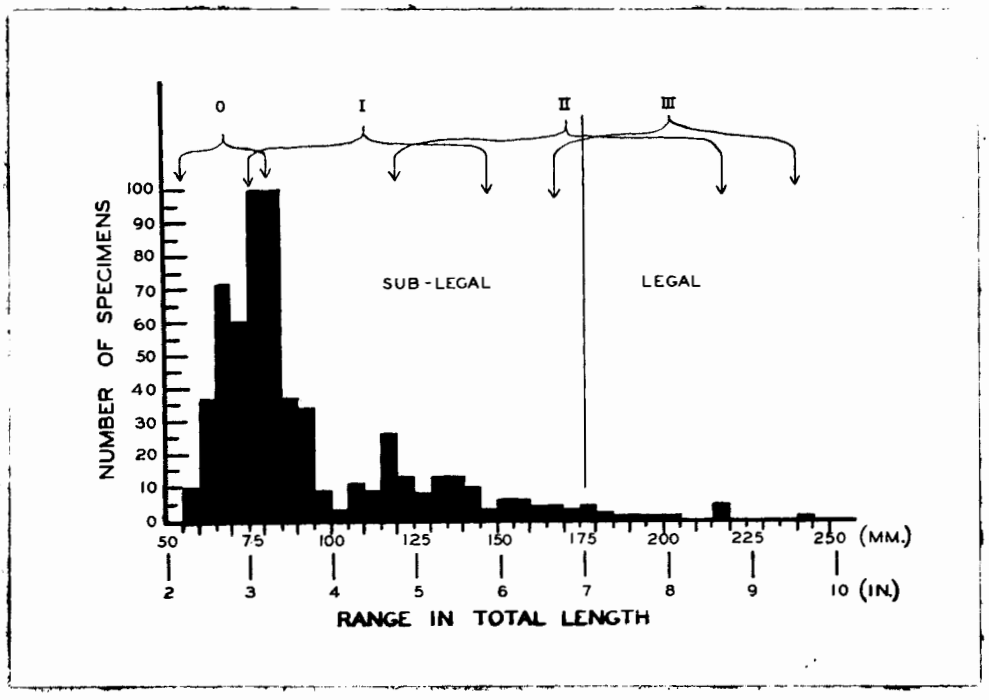

Figure 2.--The length-frequency distribution of the entire brook trout population of II-A plus III-A, September, 1940

number of sublegals (79 as compared with 58). The number of fingerlings, however, was considerably less (171 as compared with 283) than in the smaller and slightly shallower upper section. Corresponding calculations on numbers and pounds per acre were on a similar scale. The total poundage of fish removed from III-A was at the rate of 101.57 pounds per acre as compared with 106.33 pounds per acre for II-A. (Table 1.)

An analysis of difficulty of capture

Of some interest was the degree of difficulty with which the trout and muddlers of various sizes were captured. Seining activities were initiated as soon as the water level had dropped to a point where there was little flow between pools, and continued on the following day for about 3.5 hours in the morning. By that time it was thought that more than half of the fish present had been removed. In both diversions, exactly 50 per cent of the legal brook trout were taken in the morning seining, roughly one-half of the sublegal trout, and approximately 63 per cent of the fingerlings. Capture of the muddlers varied considerably; in III-A about 41 per cent were taken in the morning seining, while in II-A only 3.1 per cent were taken at that time (Tables 3 and 4).

In III-A, the percentage of trout removed by seining (both afternoon and morning) was 91.9 while poison accounted for 8.1 per cent (27 fingerlings and one sublegal trout). The percentage of all fish removed by seining, trout and muddlers combined, was 81.4 per cent, by poison 18.6 per cent. The rotenone was especially helpful in recovering small muddlers, which often escape a net by burrowing in the gravel and rubble of the bottom.

In II-A, the percentage of trout taken by seining was 86.2, by poison 13.8 (24 fingerlings, 12 sublegal trout). The percentage of all fish taken by seining was 72.6, by poison 27.4.

Table 3.--Analysis of difficulty of capture of fish population of Diversion III-A, September 25, 26, 1940

Date, 1940	Item	Total number	Total weight (grams)	Percentage of Total number	Percentage of Total weight
September 25	Brook trout				
	Over 7 inches	2	143	50.0	41.8
A.M. seining	4-6 7/8 inches	33	716	56.8	61.9
	Less than 4 inches	184	706	65.0	62.9
	Cottus	37	157	41.2	55.2
September 25	Brook trout				
	Over 7 inches	2	199	50.0	58.2
P.M. seining	4-6 7/8 inches	24	429	41.5	37.1
	Less than 4 inches	72	327	25.4	29.1
	Cottus	...	...	0.0	0.0
September 26	Brook trout				
	Over 7 inches	...	...	0.0	0.0
poisoning	4-6 7/8 inches	1	11	1.7	1.0
	Less than 4 inches	27	88	9.6	8.0
	Cottus	53	127	58.8	44.8
Total fish	Brook trout				
removed by	Over 7 inches	4	342	100.0	100.0
all methods	4-6 7/8 inches	58	1,156	100.0	100.0
September 25, 26	Less than 4 inches	283	1,121	100.0	100.0
	Cottus	90	284	100.0	100.0
Totals		435	2,903	100.0	100.0
Brook trout removed by seining		317	2,520	91.9	96.2
Brook trout removed by poisoning		28	99	8.1	3.8
All fish removed by seining		354	2,677	81.4	92.8
All fish removed by poisoning		81	226	18.6	7.8

Table 4.--Analysis of difficulty of capture of the fish population of Diversion II-A, September 25, 26, 1940

Date, 1940	Item	Total number	Total weight (grams)	Percentage of	
				Total number	Total weight
September 25	Brook trout				
	Over 7 inches	5	387	50.0	52.0
A.M. seining	4-6 7/8 inches	35	713	44.3	44.6
	Less than 4 inches	102	395	59.6	60.7
	Cottus	3	17	3.1	5.8
September 25	Brook trout				
	Over 7 inches	5	356	50.0	48.0
P.M. seining	4-6 7/8 inches	32	662	40.5	41.5
	Less than 4 inches	45	174	26.3	26.8
	Cottus	23	63	23.4	21.7
September 26	Brook trout				
	Over 7 inches	...	...	0.0	0.0
poisoning	4-6 7/8 inches	12	222	15.5	13.9
	Less than 4 inches	24	81	14.1	12.5
	Cottus	72	211	73.5	72.5
Total fish	Brook trout				
removed by	Over 7 inches	10	743	100.0	100.0
all methods	4-6 7/8 inches	79	1,597	100.0	100.0
September 25, 26	Less than 4 inches	171	650	100.0	100.0
	Cottus	98	291	100.0	100.0
Totals		358	3,281	100.0	100.0
Brook trout removed by seining		224	2,687	86.2	89.9
Brook trout removed by poisoning		36	303	13.8	10.1
All fish removed by seining		260	2,767	72.6	84.3
All fish removed by poisoning		98	514	27.4	15.7

To demonstrate further how much error would be introduced by considering results obtained by seining only, the percentage of the weights removed from the two sections by seining and by poisoning are shown in Tables 3 and 4. For example, seining alone accounted for only 84.3 per cent of the total weight of fish taken from II-A. Seining appears to have been more efficient in III-A, where nearly 93 per cent of the total weight of fish captured was taken by this method.

On the basis of the percentage of trout removed by seining, II-A might be classed as "moderately difficult to seine," and III-A as "easy to seine," if data obtained by Trippensee (1937) on New Hampshire trout streams are applicable to Michigan trout waters.

The discrepancies that can be noted in Tables 3 and 4 between the populations found by seining, and those found by seining plus poisoning, present further proof that seining alone cannot remove all the fish from even a small area of stream unless conditions are extremely favorable; and these conditions (such as gently sloping shore, smooth bottom with no rocks or snags, gentle current, etc.) seldom occur in normal trout streams. It should be remembered, too, that the seining discussed here was conducted with a water level so low as to almost isolate the deeper pools, and with no interference in the seining operations from the effects of water currents. Had the water level and current been of normal proportions, we probably could not have taken as many fish by seining as are shown in the tables.

Age and growth

From the 605 brook trout enumerated in the total population of the two blocked-off areas, a more or less random series of scale samples from 95 individuals were studied. This series was augmented further by a study of the scales of 27 brook trout collected from the same general stream area in the course of the September seining of the experimental stream for

marked brook trout. The growth history of the brook trout in Section C was determined from body-length measurements and scale measurements from 71 wild fish of the 122 fish whose ages were determined. All scales (except for 33 small trout of the 0 age-group and 19 from the I age-group) were mounted on microscope slides in glycerin-gelatin and studied on the microprojection machine under a magnification of 90X. Scales of the fish noted in the exception were in water mounts viewed under a binocular microscope or on the microprojector, and were examined to determine as closely as possible the upper and lower limits of the size ranges of the 0 and I age-groups respectively.

The data relating to age and growth suggest that the brook trout on the upper reaches of Hunt Creek are relatively slow-growing. From Table 5 and Figure 3 it will be noted that the average calculated total length of brook trout in this stream does not reach the legal size of 7 inches until sometime during the fourth summer of life (age-group III). According to the length measurements and growth calculations from scale measurements, the average total length of the wild brook trout in Section C at the end of one year is slightly more than 3 inches; at the end of two years, 5 inches; at the end of three years, just under 6 7/8 inches; at the end of 3 3/4 years, 8 inches. (The average total length of 9 fish showing three annuli at the time of the population study was 8 inches.)

The average total length of the "young-of-the-year" (spawned the previous fall and showing no annuli on their scales) was 68 millimeters (about 2 5/8 inches). The size range of the fish in the 0 age-group was from 57 to 81 millimeters (about 2 1/4-3 1/4 inches total length). An overlap in the size ranges of the several age groups was noted (Table 5 and Figure 3). Brook trout in age-group I ranged in size from 2 3/4 to

Table 5.—Actual and calculated total lengths (in inches) of wild brook trout in Section C of Hunt Creek, September 24-26, 1940

Age-group	Number of scales studied	Average total length (measured)	Average calculated total length of fish at annulus			Range in measured total lengths
			1	2	3	
I	44	4.06	25 3.03	...	...	2.80 - 5.83
II	37	6.34	3.07	5.08	...	4.72 - 8.58
III	9	7.99	2.87	4.76	6.81	6.61 - 9.45
Totals or averages	90	...	3.03	5.00	6.81	2.80 - 9.45

25 Indicates number of scales on which measurements were made.

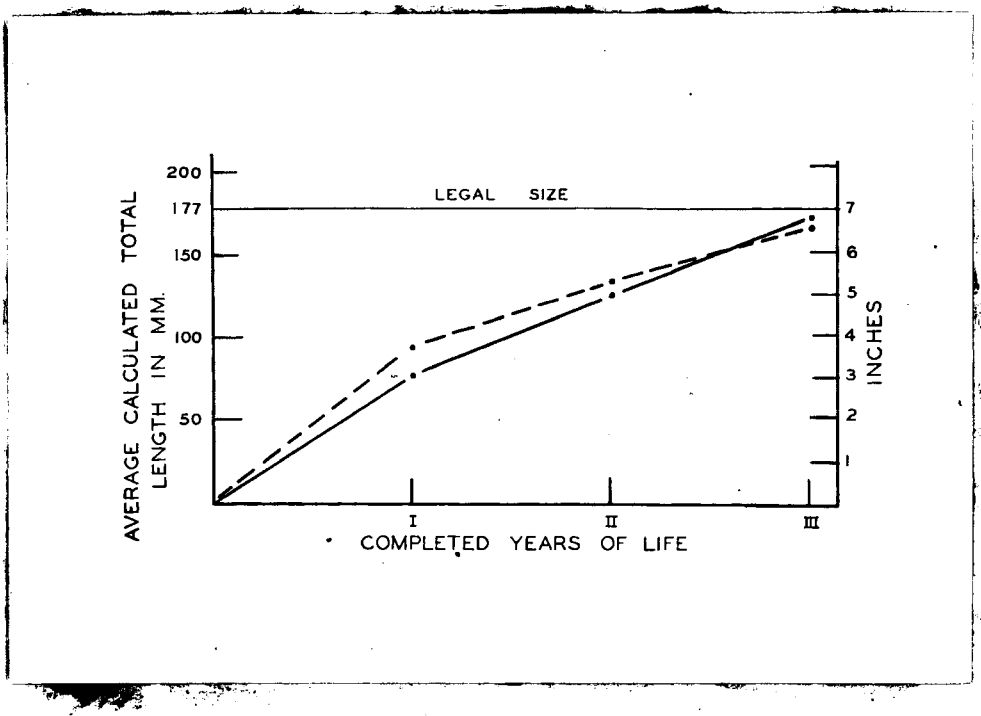

Figure 3.--Average calculated total lengths of Hunt Creek brook trout (solid line), and New York State brook trout (broken line) at the end of various years of life

5 7/8 inches; those in age-group II were found to vary in size from 4 3/4 to 8 5/8 inches; and fish in the oldest age-group, III, were found to range in size from 6 5/8 inches to 9 1/2 inches. Such an overlap in the size ranges of the various age-groups makes it impossible to predict the ages of the various elements of the brook trout population from their total lengths.

Although the growth curve drawn up from the average calculated total lengths at the end of the various years of life indicates that the brook trout from this part of Hunt Creek do not reach legal size until sometime during their fourth summer of life, actually a small portion of the population does exceed the size of 7 inches total length during the third summer (age-group II). At the same time it should be pointed out that not all of the fish found to be in their fourth summer of life (age-group III) were of legal size. Since the population study was conducted shortly after the close of the 1940 trout season, it is very possible that the anglers' catch reduced the number and the average size of the brook trout recorded in age-groups II and III, as the law permits the angler to keep only those fish taken by hook and line which are 7 inches or longer.

Some comparative data on the age and growth of brook trout in 13 trout streams in New York state are given by Hazzard (1932). In this study it was found that the average calculated total length at the first annulus was slightly less than 3 3/4 inches; at the second annulus, slightly less than 5 3/8 inches; at the third annulus, 6 5/8 inches. Apparently the brook trout in these New York streams grew at a slightly faster rate during the first two years of life than do the brook trout of Hunt Creek, but exhibited a diminished rate of growth during the third year. The growth curve for the New York fish is presented also on Figure 3.

Comparisons were also made of the average total length of brook trout of various ages from three other Michigan brook trout waters (unpublished data) and with the data presented by Ricker (1932) for the growth of Ontario brook trout. Without going into detail here it may be said that the Hunt Creek brook trout grow the slowest of brook trout in any of the waters on which data are available. The comparative data suggest that the length of 7 inches is reached in the other streams for which comparative data are available during the third instead of in the fourth summer of life.

Distribution of the brook trout population among age-groups

The distribution of the brook trout population among the various age-groups is of considerable interest. If it is assumed that the sample of fish which was studied for ages is representative, the percentage of the total population of wild brook trout of the two diversions in the various age-groups may be calculated from the percentages obtained from a study of the scale samples.

Table 6 presents the number and percentage of fish found in the various size ranges (7 inches or larger, 4.0-6.9 inches, 2.1-3.9 inches) of the series of scales which were studied for age. The percentages obtained were then applied to the known length-frequency distribution (Table 2) to calculate the total number of wild fish of the several ages in the various size ranges (Table 7).

Where fish of the same age occurred in more than one size range, the sum was determined. The percentage of the total population of wild fish (565) in the age-groups was found by dividing the number in each age-group by 565. According to this latter calculation, 46.7 per cent of the wild brook trout population were "young-of-the-year" (no annulus on the scale), 30.8 per cent were two summers old (one annulus), 19.8 per cent were three summers old (two annuli), and 2.7 per cent were four summers old (three annuli).

Table 6.--Age and size distribution among 95 wild brook trout from Diversions II-A and III-A, Section C, Hunt Creek, September 25, 26, 1940

Size range (inches)	Number of wild brook trout from II-A and III-A whose ages were determined	Number (and percentage) of brook trout in sample in each size group			
		0	I	II	III
2.1 - 3.9	52	33 (63.5)	19 (36.5)	...	...
4.0 - 6.9	29	...	5 (17.0)	23 (79.0)	1 (4.0)
7.0 - 9.5	14	...	...	5 (35.7)	9 (64.3)

Table 7.--Distribution among the various age-groups of the wild brook trout population of Diversions II-A and III-A, Section C, of Hunt Creek (as determined from the data presented in Table 6)

Size range (inches)	Actual number of wild brook trout in II-A and III-A in size range	Calculated number of wild brook trout in age-group				Totals
		0	I	II	III	
2.1 - 3.9	415	264	151	...	...	415
4.0 - 6.9	136	...	23	107	6	136
7.0 - 9.5	14	...	...	5	9	14
Totals	565	264	174	112	15	565
Calculated percentage of wild brook trout in II-A and III-A in each age-group		46.7	30.8	19.8	2.7	100.0

If it is assumed that the population count in II-A plus III-A is representative of Section C of Hunt Creek, the age composition of the wild brook trout population of Section C in September, 1940, would be as follows: age-group 0--2,155 fish; age-group I--1,421 fish; age-group II--914 fish; age-group III--125 fish; total population of wild brook trout--4,615 fish (Table 8). The above figures were determined by applying the percentages obtained in Table 8 to the calculated number of wild fish per acre as shown in Table 1, and then multiplying the results by 1.07, the measured water acreage of Section C of Hunt Creek.

It is of interest to note that if the calculated population of wild fish of legal size (114) is correct, the 1940 anglers' catch was approximately 50 per cent of the standing crop of legal brook trout, since the intensive creel census records for Section C in 1940 show a catch of 113 legal brook trout.

Table 8.--Calculated age and size distribution of the wild brook trout in the total estimated wild brook trout population of Section C (area 1.07 acres) of Hunt Creek, September 25, 26, 1940, with an estimate of the percentage of survival from age-group to age-group. (Figures in parentheses indicate the percentage of each age-group in each size range)

Item	Age-group				Totals
	0	I	II	III	
Calculated number of wild brook trout in size range 2.1 - 3.9 inches	2,155 (100.0)	1,233 (86.8)	...	...	3,388 (73.4)
Calculated number of wild brook trout in size range 4.0 - 6.9 inches	...	188 (13.2)	875 (95.7)	46 (36.9)	1,109 (24.0)
Calculated number of wild brook trout in size range 7.0 - 9.5 inches	...	...	39 (4.3)	79 (63.1)	118 (2.6)
Distribution of calculated total brook trout population of Section C among the age-groups	2,155 (100.0)	1,421 (100.0)	914 (100.0)	125 (100.0)	4,615 (100.0)
Percentage of wild brook trout surviving from previous age-group	100.0	65.9	64.3	13.7	...
Calculated survival from 1,000 young-of-the-year brook trout	1,000	659	424	58	...

Percentage of fish surviving from one age-group to the next

From the data available through the calculations demonstrated in Tables 6, 7, and 8, the percentage of the calculated total population of Section C in the various size ranges and age-groups may be estimated. The number of fish surviving from one age-group to the next may be regarded as an index of mortality from year to year, if it is assumed that the factors causing mortality between the several age-groups are the same from year to year. A survival of 65.9 per cent was found to exist between the first and second summers; between the second and third summers, 64.3 per cent; between the third and fourth summers, 13.7 per cent (Table 8). The number of fish surviving to the end of the second, third, and fourth summers from 1,000 young-of-the-year would then be 659, 424 (of which 18, or 4.3 per cent, would be of legal size), and 58 (of which 36, or 63.1 per cent, would be of legal size). In other words in Section C of Hunt Creek only 54 (36 plus 18) brook trout out of 1,000 fingerlings reach the legal size of 7 inches total length by the end of the fourth summer of life, or 5.4 per cent. If the creel census figures for Section C for the 1940 season indicate the true situation, the angler takes only about 50 per cent of the legal trout present and the return to him per 1,000 fingerlings would be in the neighborhood of 2.7 per cent, or approximately 27 legal fish out of every 1,000 young-of-the-year brook trout available in the late summer. Probably the most important function of the Hunt Creek Fisheries Experiment Station will be to determine what happens to the other 97.3 per cent and whether a greater return to the angler can be effected in any practicable way.

Coefficient of condition of the brook trout in Section C, Hunt Creek

Knowledge concerning the condition of the brook trout, that is, whether the fish are heavy or light for their respective lengths, is of interest

in connection with their rate of growth. Since measurements and weights were available from 144 specimens of the population, the coefficient of condition (K) was calculated for these fish. This series of coefficients is almost entirely for brook trout exceeding 100 millimeters total length (approximately 4 inches). Neither time nor facilities for the accurate weighing of fingerling fish were available during the population study.

The coefficient of condition (K) was calculated from the formula

$$K = \frac{\text{weight in grams} \times 10{,}000}{\text{standard length in millimeters}^3}$$

The average K for the 144 specimens (size range 98-240 millimeters total length) was found to be 1.469, and the K's ranged from 0.970 to 2.029 (Table 9).

The brook trout for which coefficients of condition were determined were separated into 10-millimeter size groupings starting at 90 millimeters and running to 249 millimeters. The average K for each group was determined and plotted against the average total length (Table 9 and Figure 4). The table and chart appear to demonstrate that the larger fish were in better condition (were heavier for their lengths) than were the smaller fish. The larger brook trout, particularly those above 150 millimeters total length (approximately 6 inches) were approaching sexual maturity, or were sexually mature and preparing for the spawning season, which may partially explain the somewhat higher average values obtained for the larger fish.

The average values of K found for the Hunt Creek brook trout are somewhat higher than the values of K published by Hazzard (1932) for 18 New York trout streams, and by Klak (1941) for three West Virginia trout streams. Since live weights were taken in this study and dead weights (after several hours in the creel) were used by these other workers, this may at least partially explain the higher average condition of trout in Hunt Creek.

Table 9.--Summary of coefficient of condition of wild brook trout population of Diversions II-A and III-A, Section C, Hunt Creek, September 25, 26, 1940

Size range in total length (millimeters)	Number of specimens	Range in coefficient of condition	Average K
90 - 99	1	1.270	1.270
100 - 109	14	1.135 - 1.729	1.340
110 - 119	33	1.205 - 1.686	1.413
120 - 129	21	0.970 - 1.700	1.410
130 - 139	24	1.158 - 2.029	1.471
140 - 149	13	1.206 - 1.826	1.479
150 - 159	12	1.331 - 1.806	1.566
160 - 169	8	1.385 - 1.891	1.679
170 - 179	7	1.285 - 1.799	1.547
180 - 189	3	1.480 - 1.731	1.564
190 - 199	2	1.497 - 1.593	1.545
200 - 209	1	1.771	1.771
210 - 219	4	1.577 - 1.726	1.643
220 - 229	...	...	...
230 - 239	...	...	...
240 - 249	1	1.672	1.672
Totals or averages	144	0.970 - 2.029	1.469

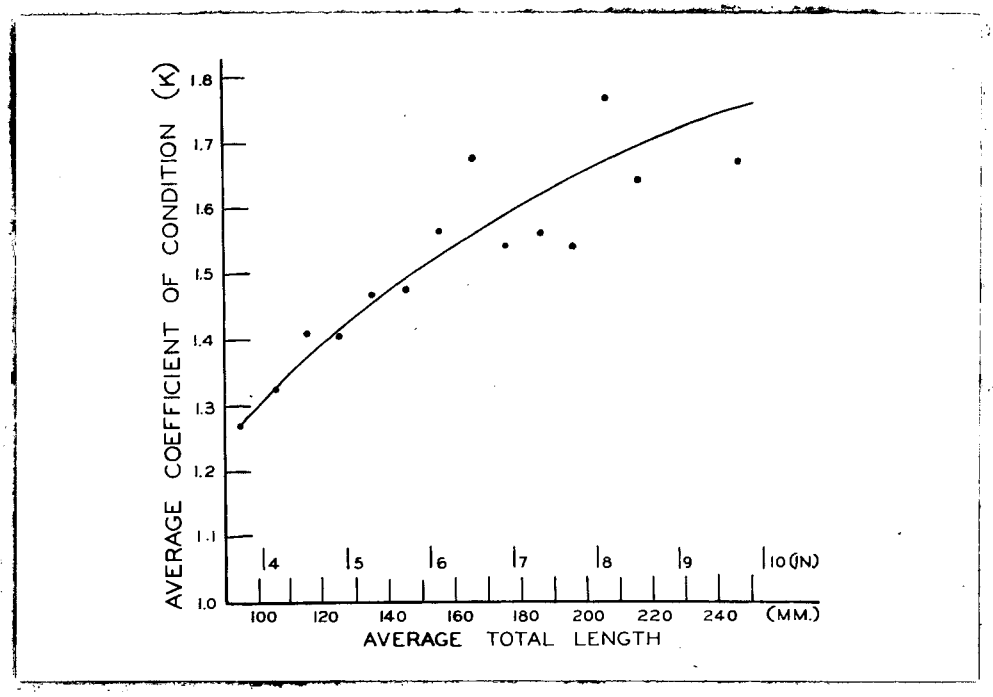

Figure 4.--Relationship between average total length and average coefficient of condition of brook trout in II-A and III-A, Section C, Hunt Creek, Montmorency County, Michigan, September, 1940

Summary

1. The conditions which made possible the study and the methods used to make an exact population count of 580.5 feet of Section C of Hunt Creek in Montmorency County, Michigan, were described. To the best of our knowledge, the figures obtained represent a 100 per cent capture of the fish present in the blocked-off area.

2. A total population of 605 brook trout and 188 muddlers was found. The calculated number of trout and muddlers per acre of stream was determined to be 4,619 and 1,435 respectively, or, expressed in pounds per acre, 94.40 pounds of trout and 9.68 pounds of muddlers. Hatchery-reared trout, recognizable by the fin combinations which had been clipped on their release, made up 6.7 per cent of the actual trout population and 2.7 per cent of the calculated total weight of trout per acre.

3. Of the total number of trout captured (605), some 2.3 per cent were of legal size, 22.0 per cent were from 4 to 6 7/8 inches in size, and 75.7 per cent ranged in size from 2 1/8 to 4 inches total length.

4. More legal trout and trout of sublegal size were taken from II-A where the pools were slightly deeper than from III-A, which was relatively shallow. However, more small trout were found in III-A than in II-A.

5. An analysis of the difficulty with which fish were captured from the blocked-off areas indicates that population studies conducted with the use of the seine as the sole method of capture cannot be expected to be more than 80 per cent accurate, even under the most favorable conditions.

6. Age determinations on a series of scale samples from brook trout in the population demonstrate that the brook trout of Section C do not reach the legal length of 7 inches until their third summer, when about

4.4 per cent of the fish of that age are longer than 7 inches, total length. About 63 per cent of the four-summer-old brook trout will have reached the legal size of 7 inches, total length.

7. The calculated percentage distribution of the brook trout population of Section C of Hunt Creek among the various age-groups was as follows:

0	I	II	III
46.7	30.8	19.8	2.7

8. Data on the coefficient of condition (K) for the brook trout of Section C of Hunt Creek demonstrate that the fish were rather heavy for their length, since the average values obtained were somewhat higher than K's published by other authors for brook trout. The high values obtained may have been somewhat influenced by the approach of the spawning season or may have been high because they were based on live weights.

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