MICHIGAN DEPARTMENT OF NATURAL RESOURCES

FISHERIES DIVISION

Fisheries Research Report No. 1807

November 20, 1973

THE EFFECTS OF A FLIES-ONLY FISHING REGULATION UPON TROUT IN THE PIGEON RIVER, OTSEGO COUNTY, MICHIGAN[1]

By W. C. Latta

ABSTRACT

The effects of a flies-only fishing regulation on the catch and standing crop of brook (Salvelinus fontinalis) and brown (Salmo trutta) trout were measured in experimental sections C and D (2.3 miles) of the Pigeon River in 1958-64. During these years the minimum legal size was 9 inches total length and the creel limit was 5 trout. For the years 1951-57, before the flies-only regulation, any lure was permitted, and the creel limit was 2 trout in 1951-54 and 5 trout in 1955-57. The size limit was also 9 inches throughout the period 1951-57. Because of environmental variability, a ratio was used to relate experimental sections C and D to control section B, the river section immediately downstream. In Section B (1.2 miles in length) the regulations were a minimum length of 7 inches, a creel limit of 5 trout, and no restriction as to lure used for the test years 1951-64. Of the various aspects of the catch and standing crop analyzed, only the catch of brook trout (in numbers and pounds) and the number of young-of-the-year brook trout were statistically significant. None of the brown trout parameters was significant. For the brook trout, fewer fish were caught during the years of flies-only, 1958-64, than during the before years, 1955-57 (or the combined years, 1951-57), probably as a result of the decreased fishing pressure. The young trout were fewer in number during the years of flies-only, 1958-64, and during the years 1951-54 (under a 2-trout limit, any lure), than during the years 1955-57 (under a 5-trout limit, any lure); there is no obvious explanation.

Fishing pressure in hours in sections C and D declined 44% under the flies-only regulation from 1955-57 to 1958-64. The slight increase in the catch per hour per trip, from 0.06 to 0.07 trout, was not statistically significant. The increase in the creel limit from 2 trout to 5 did not increase the total catch nor significantly decrease the percentage of successful anglers.

---

[1] Contribution fron Dingell-Johnson Project F-27-R Michigan.

Introduction

In 1955, Shetter and Allison published a comparison of mortality between fly-hooked and worm-hooked trout in Michigan streams which quantified a debate that had been going on for several decades among trout anglers and fisheries managers. The question of how many undersized trout does the angler fishing with worms kill in comparison with the number killed by hooking with flies was satisfactorily answered when they showed that hooking mortality using worms was 42% for brook trout (Salvelinus fontinalis) and 20% for brown trout (Salmo trutta) while only 3 and 0%, respectively for fish caught on flies. Shetter and Allison also extrapolated the brook trout hooking mortality to the creel census figures of Hunt Creek and estimated that worm hooking would be responsible for a 17 to 32% reduction in the fall population of 4.0- to 6.9-inch brook trout (minimum legal size was 7.0 inches). A few years prior to this, Edwin L. Cooper's doctoral research had resulted in a suggestion that a minimum legal size of 10.0 inches rather than 7.0 inches would be beneficial to some fast-growing brook trout populations (Shetter, Whalls and Corbett, 1954). These two studies generated in many trout anglers an enthusiasm for higher minimum size limits and the restriction of the lure to artificial flies only. In Michigan and elsewhere in the nation these regulations have been imposed together on trout streams and in many cases the creel limit also has been substantially reduced. Under these conditions it becomes impossible for the fisheries investigator to separate out the results of higher size limit, from a restriction of lure used, from a reduction in the number of trout that may legally be kept. This was the situation in Michigan where Shetter and Alexander (1966) compared catches and standing crops of trout under a 7-inch minimum size limit, 10-fish daily creel limit, any lure, with a 9-inch minimum size limit, 5-fish creel limit and artificial flies only. In only two studies have artificial flies been evaluated alone without a concurring change in size limit and creel limit. Shetter and Alexander (1962) tested flies-only on

the population of brook trout in Hunt Creek, Michigan, and Hunt (1964, 1970) did likewise (but without any before years of study) on a population of brook trout in Lawrence Creek, Wisconsin. In Hunt Creek the minimum size was 7 inches and the creel limit 10 fish; in Lawrence Creek the minimum size was 8 inches and the creel limit 5 fish. In the present study the flies-only regulation was evaluated under a minimum size of 9 inches total length and a creel limit of 5 fish, but it differs also from the previous experiments in that the fish population was composed of brook and brown trout. Before the present experiment there also was the opportunity to test changes in the catch as a result of an increase in the creel limit from 2 trout to 5 trout.

Methods

From 1949 through 1965, 6 miles of the Pigeon River, divided into five almost equal experimental sections, were under the control of the Pigeon River Trout Research Station of the Michigan Department of Conservation (now Natural Resources). Cooper (1952) and Benson (1953) gave descriptions of the area and the watershed. The experimental sections were identified as A through E, with Section A at the downstream end. The physical features of the stream sections which are part of this study, are given in Table 1. Section B was designated as the control water in this experiment. The fishing regulations in Section B from 1951 through 1964 remained a 7-inch minimum size limit, 5-fish creel limit, and any lure. In C and D, the experimental sections immediately upstream from B, the minimum size limit was 9 inches for the entire period 1951 through 1964; the creel limit was only 2 fish for 1951-54 and then became 5 fish for the remaining years, and the lure was restricted to artificial flies from 1958 through 1964 (Table 2).

The variations through the years in the catch and the standing crop were such that a control for environmental variability was essential (Figs. 1, 2 and 3). A comparison of the before years, 1955-57, of any lure with the after years, 1958-64, of flies only, for the standing crop

of brook trout in Section C plus D suggests that with the change to flies only there was a doubling in the mean standing crop (Fig. 3). In reality, there was a similar increase in the adjoining Section B and the increase was apparently unrelated to the change in regulation. Therefore the ratio of Section B to Section C plus D was used in the analyses of variance of the catch and standing crop.

In 1951, sections B and C were planted with hatchery trout as part of another study (Cooper, 1953). In succeeding years no hatchery trout were planted and in the present study only wild trout are considered. The planting of fish, however, led to very high fishing pressure and a low catch per hour in sections B and C in 1951 (Figs. 4 and 5).

Fishing in the experimental sections of the river was allowed only by a daily permit. All anglers were required to report their catch, at the end of each trip to each section, which guaranteed a nearly complete record of the catch. Each fishing season extended from the last Saturday in April through the second Sunday in September.

The mark-and-recapture method (Ricker, 1958) was used to calculate the number of trout present each fall, immediately after the close of the fishing season, in each experimental section. Two trips were made through each section using an electric shocker to take samples of trout (one trip to mark trout and the second to recapture, with an interval of a week between trips). The number of fish in each 1-inch size group of each species for each section was calculated. In 1953, and 1956 through 1964, about 15 scale samples were taken from each 1-inch size group of each species in each section, in order to delimit age groups. Age-group 0 (young-of-the-year) and age-group I (yearlings) were found to overlap in the 4- and 5-inch size groups. Average percentage of overlap of 0 and I age groups from the years 1953 and 1956-60 was used to delimit age groups in the years in which no scale samples were taken (Latta, 1965). Actually the age groups could be separated mostly on the basis of size alone; all trout 4 inches and less

in length could be considered young-of-the-year. Examples of 95% confidence limits for the trout populations are given in Latta, 1965.

In order to compute pounds of trout in the estimated populations, the average weight of each 1-inch group of each species was determined from the calculated weight at each 0.1 inch. The calculations were based on the length-weight relationship of Pigeon River trout as described by Cooper and Benson (1951).

Results

From the creel census and the annual fall population estimates, it was possible to compile various aspects of the catch and standing crop. The analysis of catch included both numbers (Table 3) and pounds (Table 4) of brook trout and brown trout taken by anglers in sections B, and C plus D, 1951 through 1964. Although Section B had a 7-inch minimum size limit, only trout 9 inches and larger were compiled for Tables 3 and 4 in order to make the comparison with Section C plus D more pertinent. Of the population parameters, standing crop in pounds is a basic measurement in fisheries evaluations (Table 5). The summation of fall standing crop with the catch in pounds for the year is a reasonable index to production (Table 6). This measurement needs only the estimate of pounds of trout lost to natural causes less the standing crop at the beginning of the year to equal annual production. Age-I and older trout in the fall population plus the number caught should be an excellent measurement in numbers of the effect of changing fishing regulations (Table 7). Young-of-the-year trout are the key to recruitment to the population (Table 8), but in the Pigeon River recruitment is largely controlled by environmental factors (Latta, 1965). Presumably, their deletion from the total population numbers would leave the remaining part of the population (age group I and older) as a more sensitive reflector of experimental change. The numbers of age-I and older trout in the fall population are presented in Table 9. Likewise the numbers of trout 7 inches and larger (the statewide minimum size) and 9 inches and larger

(the experimental minimum size) in the fall population would be expected to respond to a reduction in hooking mortality (Tables 10 and 11).

The compilation is complete with the presentation of total fishing pressure (Table 12), number of trout caught per hour per trip (Table 13), and the percentage of anglers who caught at least one trout in the study sections (Table 14).

The means of the ratios for Section B to Section C plus D for the trout population statistics, with the results of the analyses of variance for the periods of experimental fishing regulations, are given in Table 15. In each analysis of variance, differences were sought first between treatments--that is between a 2-trout creel limit, a 5-trout limit and the restriction to artificial flies only. Then a detailed comparison was made between the 2-trout (1951-54) and 5-trout (1955-57) creel limit. If there was no difference, a comparison was then made between the combined years, 1951-57 and the flies-only years, 1958-64. Finally a comparison was made between the years 1955-57 under the 5-fish limit and the years 1958-64 under a 5-fish limit and the flies-only restriction. During all of the years, 1951-64, the minimum size limit in sections C and D was 9 inches.

For the brook trout the analysis of variance was significant (at the 5% level) only for the catch in numbers and pounds, and the young-of-the-year trout.

For the catch there was significant difference in both numbers and weight between the any-lure years, 1955-57, and the flies-only years, 1958-64 (Table 15). There was no difference in catch between a 2-fish (1951-54) and 5-fish limit (1955-57); the combined years, 1951-57, under any lure were different from the flies-only years. The catch of brook trout decreased during the years of the flies-only regulation. The young-of-the-year trout appeared to increase during the years 1955-57 under the 5-fish, any-lure regulation.

Although there was no statistical significance, the ratios for number of trout in the fall population 9 inches and larger suggest that there were more fish present in Section C plus D under a 2-fish limit,

any lure; and a 5-fish limit, flies-only; than under the 5-fish limit, any-lure regulation.

For the brown trout there was no statistical difference between treatments for either the catch or any aspect of the standing crop (Table 15). However, the mean ratios suggest that fewer fish and less weight of fish may have been caught under a 2-fish limit (1951-54) and the flies-only regulation (1958-64), as was observed for the brook trout.

The mean values for the catch and fall population of brook and brown trout under the various fishing regulations in sections B, and C plus D, are given in Table 16. The mean values complement the mean ratios, and the interpretations are similar.

The mean ratios for Section B to Section C plus D for hours of fishing, catch per hour per trip and percentage successful anglers with the analyses of variance are given in Table 17. The mean values for these parameters of fishing are presented in Table 18. There was no statistically significant difference between periods of experimental fishing regulations for catch per hour per trip or percentage successful anglers but there was a difference (at the 0.1% level) for the hours of fishing (Table 17). The fishing pressure under the 5-fish limit, any-lure regulation was considerably greater than during the 2-fish limit, any lure, or the 5-fish limit, flies-only regulation.

Discussion

Flies-only fishing regulation

The primary objective of a flies-only regulation is to reduce hooking mortality of trout smaller than the legal minimum size and thus through increased recruitment, increase the future catch. The secondary objective is to increase the number of undersize fish available to be caught and released during the fishing season. This did not happen in Section C plus D at the Pigeon River. There was no statistically significant increase in any aspect of the standing crop for either brook or brown trout, with the exception of the young-of-the-year brook trout

(Table 15). In this case there was no statistical difference between treatments, but in the detailed comparisons the period 1955-57 proved to be different from earlier and later years. There does not appear to be any obvious biological or environmental reason to explain this comparative increase in young during 1955-57. The trend for the mean ratios suggests that there were fewer brook trout of spawning size present during this period. The ratios, particularly for fish 9 inches and larger, but also for the category 7 inches and larger, imply that there were more fish present in 1958-64 during the flies-only regulation than during 1955-57, the years under any lure. However the same trend is apparent in the comparison of the years 1951-54 under a 2-fish creel limit, with the years 1955-57 under a 5-fish limit. With both periods having an any-lure regulation, the earlier years appeared to have more fish present than the years 1955-57. None of this has statistical significance because of the variability of the data, but if the trends are meaningful, the apparent increase in the standing crop of larger fish in the two time periods 1951-54 and 1958-64 can probably be attributed to changes in fishing pressure (Table 17). The mean ratios for hours of fishing indicate statistically significant decreases for the periods 1951-54 and 1958-64. The reduction in fishing pressure presumably led to some increase in standing crop of larger brook trout.

The mean ratios for the catch, both in numbers and weights, indicate a statistically significant decrease in the years 1958-64 under the flies-only regulation (Table 15). Again this can probably be attributed to the decrease in fishing pressure.

The flies-only regulation had no statistically significant effect on the catch or standing crop of brown trout (Table 15). The mean ratios suggest (in contrast to the brook trout) that there were more young-of-the-year brown trout during the periods 1951-54 and 1958-64 than during the years 1955-57, but there is no obvious explanation for this response. The other aspects of the standing crop showed no trends. The mean ratios for catch, although not statistically valid,

showed the same pattern as the brook trout. The catch in both numbers and weight appeared to be greater during the period 1955-57 under the creel limit of 5 fish and the any-lure regulation.

Under the flies-only regulation the catch per hour per trip (brook plus brown trout) and the percentage of successful anglers remained the same as under the any-lure regulation (Tables 17 and 18). Although the fishing pressure in Section C plus D decreased 44% from 2,111.8 hours in 1955-57 to 1,077.7 hours in 1958-64, the catch per hour per trip increased only from 0.06 to 0.07 trout (Table 18). Shetter and Alexander (1962) and Hunt (1964) found a significant increase in catch per hour per trip with a decrease in fishing pressure, in their evaluations of flies-only in brook trout populations. In my study the fishing pressure and the catch decreased significantly, whereas the increase in catch per hour per trip was not significant.

Creel limits

Limits to the number of fish that an angler may have in his possession (or creel) are imposed (1) to distribute the catch more equally among the anglers; and (2) to limit the total catch. In the present study neither of these objectives was attained in changing the creel limit from 2 fish to 5 fish. From 1951 through 1954, the creel limit in sections C and D was 2 fish and in 1955 through 1957, it was 5 fish. During these years the legal minimum size was 9 inches, and any lure could be used to catch fish. The percentage of successful anglers in C plus D decreased from 15.2 to 12.2 during the periods involved, which suggests a slightly better distribution of fish among anglers (Table 18). However, when C plus D was related to B, the ratios were not significantly different (Table 17). Likewise, the total catch in numbers or pounds was not increased by increasing the creel limit (Tables 15 and 16).

Factors affecting interpretation

The flies-only regulation under present fishing pressure does not increase the standing crop of trout. Apparently hooking mortality is compensated for by a decrease in mortality from other sources. However it is not known whether an increase in fishing pressure in the future might reach the point where losses from hooking would exceed the normal natural mortality and a flies-only regulation would be justified. In the present case the average fishing pressure under any-lure regulation was 195 hours per acre each year (Fig. 4). At Hunt Creek, Michigan, the comparable fishing pressure was 292 hours per acre (Shetter and Alexander, 1962), and at Lawrence Creek the fishing pressure in experimental sections of the stream above the flies-only section was 173 hours per acre (Hunt, 1964). Because of the inverse density-dependent relationship of brook trout angling where a greater percentage of small populations are cropped than of larger populations (McFadden, 1961), it would appear that a flies-only regulation, if needed, would be more effective in an unproductive stream or one with low reproduction (Shetter, 1969).

Movement of trout between sections of the stream could bias the results. In order to check this possibility, in the fall of 1959 all of the trout taken during the first run with the direct-current shocker through the experimental sections of the river were given a fin clip distinctive for each section. Also, in the fall of 1961, all trout less than 4 inches long (mostly young-of-the-year) taken during the first run with the shocker were given a fin clip distinctive for each section. Marked fish were identified in the creel census and in the fall population estimates the year following the marking. Numbers of fish marked and recovered are given in a separate report (Latta, 1972).

In general, there was considerable movement of trout between sections. In 1960, sections C (especially) and D lost more fish, both brook and brown trout, than they gained, while Section B gained some

brook trout and neither lost nor gained brown trout. In 1962, in sections C and D the losses equalled the gains, whereas Section B lost fish (both brook and brown). It is not possible, with the variable information available, to adjust for the movements during the years of the experiments. It is assumed that during the course of the study, gains compensated for losses in the stream sections involved, but in any future studies movement should be either controlled or continually monitored.

To date it has not been demonstrated in this study, or in others, that protecting trout less than 7 inches, 8 inches or 9 inches long from hooking losses leads to an increase in the standing crop of fish. In all three experiments the most obvious change, with imposition of the flies-only regulation, was a dramatic decrease in fishing pressure. It appears that at the present time the flies-only regulation is operating in a sociological manner to create a limited entry fishery. No biological gain has yet been demonstrated. Some alternative angling methods are only slightly more damaging to trout than is flies-only. Shetter and Allison (1958), after the tests in 1955 comparing mortality between fly-hooked and worm-hooked trout, compared deaths caused by artificial lures with those caused by flies. In this experiment the four hardware lures used killed 4.6% of the trout, which was only slightly greater than the 1.3% killed with flies. Hunsaker, Marnell and Sharpe (1970) and Stringer (1967) reported similar results. Mason and Hunt (1967) have shown that approximately two-thirds of deeply hooked rainbow trout would survive if anglers would cut their lines and release the trout with the hook still in them. In spite of the evidence, the flies-only regulation is regarded by many anglers as a key to unlimited trout populations. Of necessity, fishery managers practice a great deal of sociology, but they should acknowledge and not ignore the underlying biology.

Table 1.--Morphometry of experimental stream sections, Pigeon River Trout Research Station

Section	Length (miles)	Average width (feet)	Area* (acres)
B	1.19	41	5.90
C	1.13	40	5.39
D	1.18	40	5.65

* Computed from data on length and width which were more precise than the figures in this table.

Table 2.--Experimental fishing regulations in sections of the Pigeon River, 1951-1964

Years	Stream sections			
	B		C + D	
	Creel limit (trout per day)	Minimum legal length (inches)	Creel limit (trout per day)	Minimum legal length (inches)
1951-1954	5	7	2	9
1955-1957	5	7	5	9
1958-1964	5	7	5	9[a]

[a] Lure was restricted to artificial flies only in sections C and D in 1958-1964.

Table 3.--Numbers of brook and brown trout of 9-inch minimum size or larger taken by anglers in sections B, and C plus D, Pigeon River, 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	10	38		49	34	
1952	6	45		22	27	
1953	21	49		26	39	
1954	23	77	0.28	75	138	0.87
1955	19	55		29	91	
1956	6	44		53	77	
1957	14	44	0.27	20	26	0.59
1958	23	61		29	27	
1959	10	20		7	7	
1960	18	33		28	33	
1961	11	53		42	33	
1962	47	92		20	33	
1963	25	34		16	23	
1964	20	33	0.50	21	23	0.92

Table 4.--Pounds of brook and brown trout of 9-inch minimum size or larger taken by anglers in sections B, and C plus D, Pigeon River 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	4.8	12.8		17.0	13.3	
1952	2.3	14.4		9.4	11.0	
1953	7.9	16.3		11.7	21.0	
1954	7.5	25.9	0.33	32.9	63.7	0.80
1955	6.4	18.1		17.0	58.2	
1956	2.1	14.4		22.5	38.0	
1957	5.7	18.0	0.27	14.5	16.3	0.59
1958	7.5	18.5		15.1	12.5	
1959	3.4	6.3		4.4	2.5	
1960	6.4	12.2		14.9	14.1	
1961	4.2	17.3		21.6	21.7	
1962	15.8	34.4		17.8	28.5	
1963	8.8	11.6		6.0	15.8	
1964	6.8	10.5	0.51	21.7	12.4	1.11

Table 5.--Standing crop in pounds of brook and brown trout of all sizes in sections B, and C plus D, Pigeon River, after the fishing season in 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	53.6	347.2		67.8	188.6	
1952	58.3	301.0		93.8	175.4	
1953	76.2	315.1		102.6	282.9	
1954	96.3	317.2	0.22	108.4	275.4	0.41
1955	39.0	163.9		90.4	204.2	
1956	29.6	132.2		56.9	117.3	
1957	26.2	201.3	0.20	47.9	88.9	0.49
1958	35.3	258.7		63.5	145.9	
1959	53.0	195.6		66.7	155.8	
1960	53.8	232.4		60.9	118.3	
1961	69.5	370.0		55.3	157.1	
1962	90.7	397.9		65.6	168.4	
1963	90.1	379.0		42.8	120.8	
1964	95.7	343.7	0.22	80.6	131.2	0.44

Table 6.--Fall standing crop and anglers' catch in pounds of brook and brown trout in sections B (minimum size 7 inches) and C plus D (minimum size 9 inches), Pigeon River, 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	90.5	360.0		103.3	201.9	
1952	94.4	315.4		111.8	186.4	
1953	107.5	331.4		119.7	303.9	
1954	142.6	343.1	0.32	149.9	643.0	0.44
1955	69.4	182.0		110.1	262.4	
1956	47.0	146.6		83.9	155.3	
1957	54.0	219.3	0.32	67.1	105.2	0.53
1958	70.3	277.2		82.1	158.4	
1959	69.9	201.9		72.7	158.3	
1960	80.9	244.6		77.5	132.4	
1961	105.8	387.3		79.2	178.8	
1962	134.9	432.3		85.0	196.9	
1963	122.9	390.6		50.0	136.6	
1964	127.2	354.2	0.31	105.0	143.6	0.50

Table 7.--Numbers of brook and brown trout, age I and older, in the river after the fishing season, plus the anglers' catch, in sections B (minimum size 7 inches) and C plus D (minimum size 9 inches), Pigeon River, 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	508	2,345		424	828	
1952	467	1,804		291	388	
1953	753	2,735		453	949	
1954	979	2,396	0.29	409	664	0.59
1955	512	1,508		417	762	
1956	313	855		191	443	
1957	254	1,087	0.31	140	181	0.58
1958	406	2,111		219	339	
1959	609	2,062		377	867	
1960	507	1,714		229	311	
1961	566	2,397		199	323	
1962	851	3,339		219	433	
1963	1,072	3,864		172	293	
1964	736	2,664	0.26	204	344	0.59

Table 8.--Numbers of young-of-the-year brook and brown trout in sections B, and C plus D, Pigeon River, after the fishing season in 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	1,653	6,865		410	369	
1952	2,559	8,037		965	1,640	
1953	2,202	5,203		343	667	
1954	2,651	6,249	0.35	438	882	0.65
1955	796	3,275		635	1,057	
1956	694	3,965		381	409	
1957	860	3,975	0.21	915	552	1.06
1958	1,242	4,736		1,308	3,045	
1959	1,318	4,801		767	481	
1960	1,469	4,396		350	555	
1961	3,091	9,117		815	1,024	
1962	3,003	8,121		472	747	
1963	1,954	5,863		412	530	
1964	4,401	8,453	0.35	860	1,075	0.81

Table 9.--Numbers of age-I and older brook and brown trout in sections B, and C plus D, Pigeon River, after the fishing season in 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	281	2,307		262	794	
1952	233	1,759		219	361	
1953	587	2,686		392	910	
1954	696	2,319	0.19	287	526	0.48
1955	343	1,453		369	671	
1956	210	811		112	366	
1957	107	1,043	0.20	94	155	0.49
1958	210	2,050		171	312	
1959	520	2,042		359	860	
1960	362	1,681		190	278	
1961	358	2,344		144	290	
1962	640	3,247		189	400	
1963	902	3,830		148	270	
1964	571	2,631	0.20	169	321	0.53

Table 10.--Numbers of brook and brown trout, 7 inches and larger, in sections B, and C plus D, after the fishing season in 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	57	630		206	645	
1952	33	446		202	331	
1953	60	357		227	747	
1954	94	497	0.13	237	511	0.42
1955	66	188		206	500	
1956	30	137		96	301	
1957	34	468	0.21	80	147	0.42
1958	25	460		129	227	
1959	48	252		214	366	
1960	44	361		162	232	
1961	66	667		105	256	
1962	61	494		127	294	
1963	65	462		103	202	
1964	56	554	0.12	137	266	0.53

Table 11.--Numbers of brook and brown trout, 9 inches and larger, in sections B, and C plus D, after the fishing season in 1951-64

Years	Brook trout			Brown trout		
	Section		Mean ratio	Section		Mean ratio
	B	C+D	B:C+D	B	C+D	B:C+D
1951	2	54		42	172	
1952	1	76		74	140	
1953	9	71		68	190	
1954	8	56	0.08	111	299	0.38
1955	2	27		82	125	
1956	6	11		28	78	
1957	4	47	0.24	26	87	0.44
1958	3	69		19	74	
1959	6	39		22	50	
1960	6	65		47	117	
1961	2	84		40	99	
1962	6	73		34	79	
1963	10	76		37	89	
1964	10	90	0.09	61	83	0.44

Table 12.--Total fishing pressure in angler hours in sections B, and C plus D, Pigeon River, 1951-64

Years	Section B	Section C+D	Mean ratio B:C+D
1951	3,148.0	2,977.5	
1952	1,563.0	1,734.5	
1953	1,535.0	1,784.0	
1954	1,756.0	2,239.0	0.90
1955	1,125.0	2,475.5	
1956	1,046.5	2,230.0	
1957	931.5	1,630.0	0.50
1958	1,308.5	1,050.0	
1959	894.5	703.5	
1960	891.0	805.5	
1961	1,165.0	1,228.0	
1962	1,110.0	1,377.0	
1963	1,169.5	1,161.0	
1964	1,073.5	1,219.0	1.04

Table 13.--Catch per hour per trip (number of trout, species combined) in sections B, and C plus D, Pigeon River, 1951-64

Years	Section B	Section C+D	Mean ratio B:C+D
1951	0.12	0.03	
1952	0.20	0.07	
1953	0.16	0.06	
1954	0.26	0.15	2.81
1955	0.18	0.07	
1956	0.17	0.06	
1957	0.19	0.05	3.07
1958	0.18	0.08	
1959	0.10	0.04	
1960	0.18	0.08	
1961	0.22	0.08	
1962	0.21	0.09	
1963	0.15	0.04	
1964	0.17	0.05	2.75

Table 14.--Percentage of anglers who caught at least one trout in sections B, and C plus D, Pigeon River, 1951-64

Years	Section B	Section C+D	Mean ratio B:C+D
1951	19.9	6.1	
1952	30.1	14.0	
1953	24.3	15.9	
1954	29.0	24.7	2.03
1955	27.9	12.9	
1956	23.2	13.9	
1957	23.9	9.9	2.08
1958	26.7	15.5	
1959	14.2	7.5	
1960	24.7	15.5	
1961	28.4	14.8	
1962	25.2	16.8	
1963	23.4	10.2	
1964	21.4	9.3	1.89

Table 15.--Means of ratios, for Section B to sections C plus D, of annual trout population statistics from Pigeon River, 1951-64, and Analysis of Variance for differences between periods of experimental fishing regulations

Year	Trout 9 inches and larger, in catch		Fall standing crop (lbs)	Fall standing crop plus catch (lbs)	Age-I and older plus catch (numbers)	Number of trout in fall population			
	Number	Pounds				Young of year	Age-I and older	7 inches and larger	9 inches and larger
BROOK TROUT									
1951-54	0.28	0.33	0.22	0.32	0.29	0.35	0.19	0.13	0.08
1955-57	0.27	0.27	0.20	0.32	0.31	0.21	0.20	0.21	0.24
1958-64	0.50	0.51	0.22	0.31	0.26	0.35	0.20	0.12	0.09
Levels of significance for analysis of variance (* at 5%; 0 at > 5%)									
Between treatments	*	0	0	0	0	0	0	0	0
1951-54 vs 1955-57	0	0	--	--	--	*	--	--	0
1951-57 vs 1958-64	*	*	--	--	--	--	--	--	--
1955-57 vs 1958-64	*	*	--	--	--	*	--	--	0
BROWN TROUT									
1951-54	0.87	0.80	0.41	0.44	0.59	0.65	0.48	0.42	0.38
1955-57	0.59	0.59	0.49	0.53	0.58	1.06	0.49	0.42	0.44
1958-64	0.92	1.11	0.44	0.50	0.59	0.81	0.53	0.53	0.44
Levels of significance for analysis of variance (* at 5%; 0 at > 5%)									
Between treatments	0	0	0	0	0	0	0	0	0
1951-54 vs 1955-57	0	0	--	--	--	0	--	--	--
1951-57 vs 1958-64	0	0	--	--	--	--	--	--	--
1955-57 vs 1958-64	0	0	--	--	--	0	--	--	--

Table 16.--Mean values for the catch and fall population of brook and brown trout for the periods of experimental fishing regulations, Pigeon River 1951-64

Species and years	Trout 9 inches and larger, in catch		Fall standing crop (lbs)	Fall standing crop plus catch (lbs)	Age-I and older plus catch (numbers)	Number of trout in fall population			
	Number	Pounds				Young of year	Age-I and older	7 inches and larger	9 inches and larger
SECTION B									
Brook trout									
1951-54	15	5.6	71.1	108.8	677	2,266	449	61	5
1955-57	13	4.7	31.6	56.8	360	783	220	43	4
1958-64	22	7.6	69.7	101.7	678	2,354	509	52	6
Brown trout									
1951-54	43	17.8	93.2	121.2	394	539	290	218	74
1955-57	34	18.0	65.1	87.0	249	644	192	127	45
1958-64	23	14.5	62.2	78.8	231	712	196	140	37
SECTION C + D									
Brook trout									
1951-54	52	17.4	320.1	337.5	2,320	6,588	2,268	482	64
1955-57	48	16.8	165.8	182.6	1,150	3,738	1,102	264	28
1958-64	47	15.8	311.0	326.9	2,593	6,498	2,546	464	71
Brown trout									
1951-54	60	27.2	230.6	333.8	707	890	648	558	200
1955-57	65	37.5	136.8	174.3	462	673	397	316	97
1958-64	26	15.4	142.5	157.9	416	1,065	390	263	84

Table 17.--Means of ratios for Section B to sections C plus D, for hours of fishing, catch per hour per trip, and percentage successful anglers, with Analysis of Variance for the periods of experimental fishing regulations, Pigeon River, 1951-64

Year	Hours of fishing	Catch per hour per trip	Percentage successful anglers
1951-54	0.90	2.81	2.03
1955-57	0.50	3.07	2.08
1958-64	1.04	2.75	1.89
Levels of significance for analyses of variance (*** at 0.1%; ** at 1%; * at 5%; 0 at > 5%)			
Between treatments	***	0	0
1951-54 vs 1955-57	**	---	---
1951-57 vs 1958-64	**	---	---
1955-57 vs 1958-64	***	---	0

Table 18.--Mean values for hours of fishing, catch per hour per trip and percentage successful anglers for the periods of experimental fishing regulations, Pigeon River, 1951-64

Section and years	Hours of fishing	Catch per hour per trip	Percentage successful anglers
SECTION B			
1951-54	2,000.5	0.18	25.8
1955-57	1,034.3	0.18	25.0
1958-64	1,087.4	0.17	23.4
SECTION C + D			
1951-54	2,183.8	0.08	15.2
1955-57	2,111.8	0.06	12.2
1958-64	1,077.7	0.07	12.8

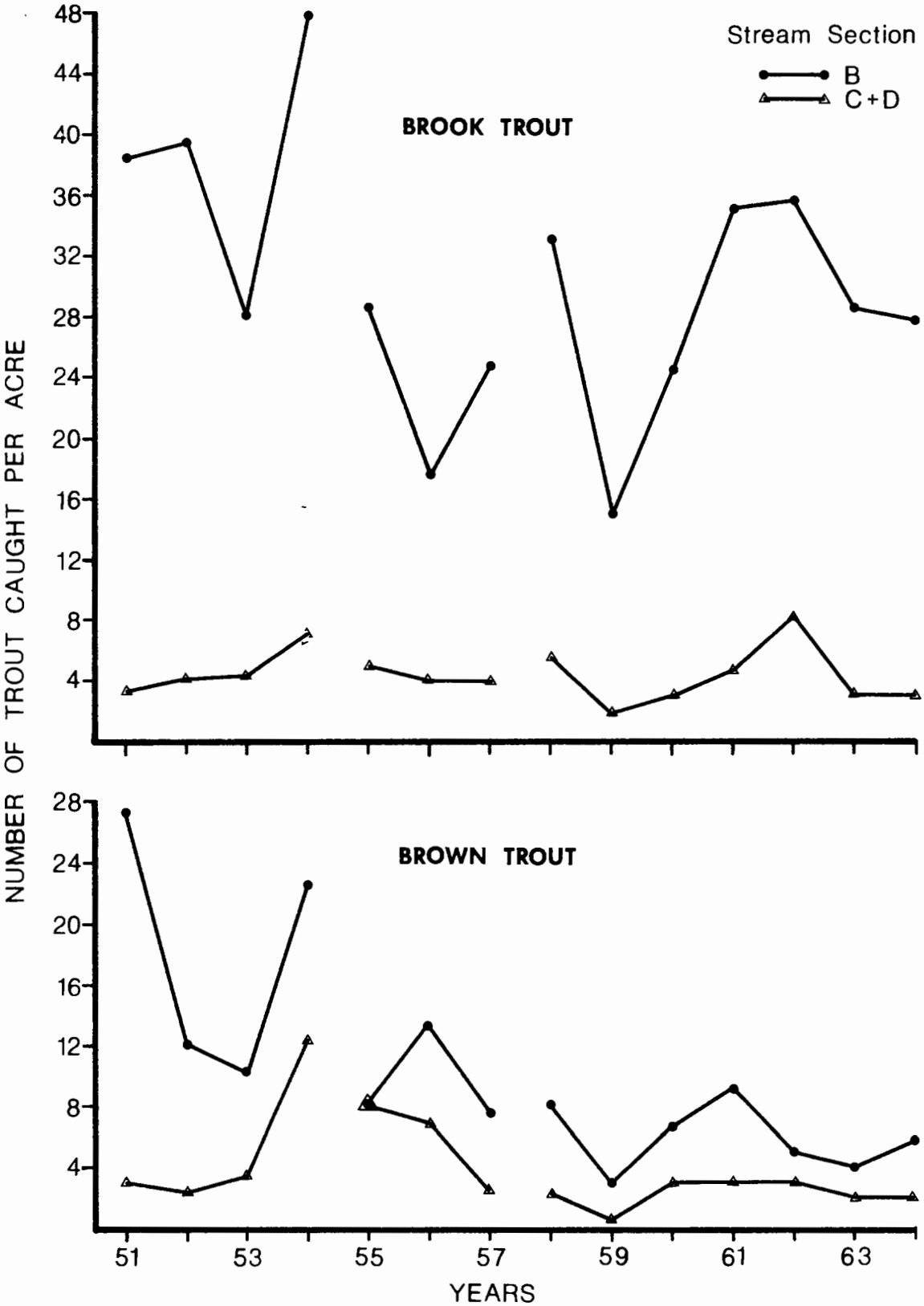

Figure 1.--Numbers of brook and brown trout caught per acre in sections B and C plus D, under experimental fishing regulations, Pigeon River, 1951-64.

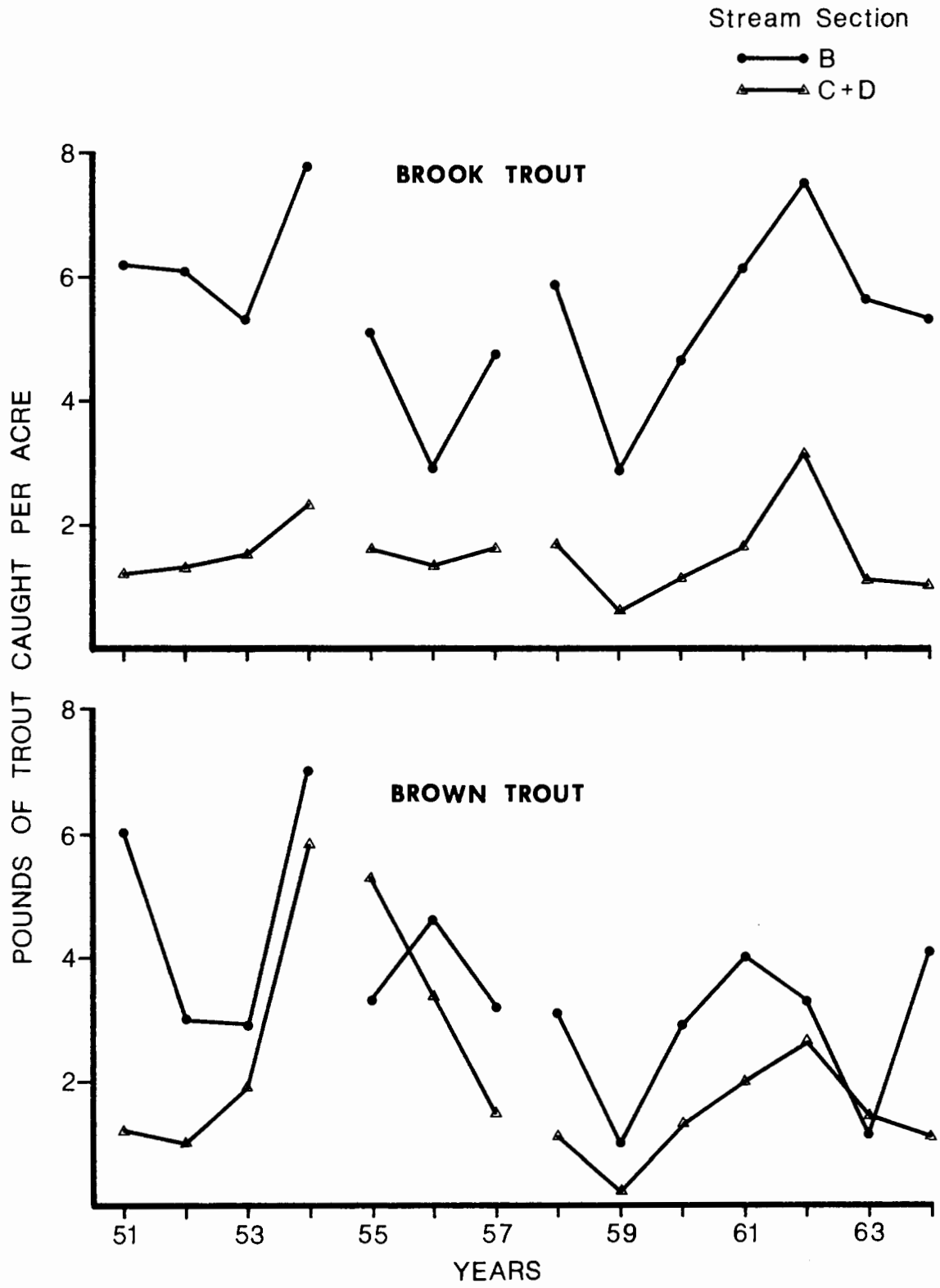

Figure 2.--Pounds of brook and brown trout caught per acre in sections B, and C plus D, under experimental fishing regulations, Pigeon River, 1951-64.

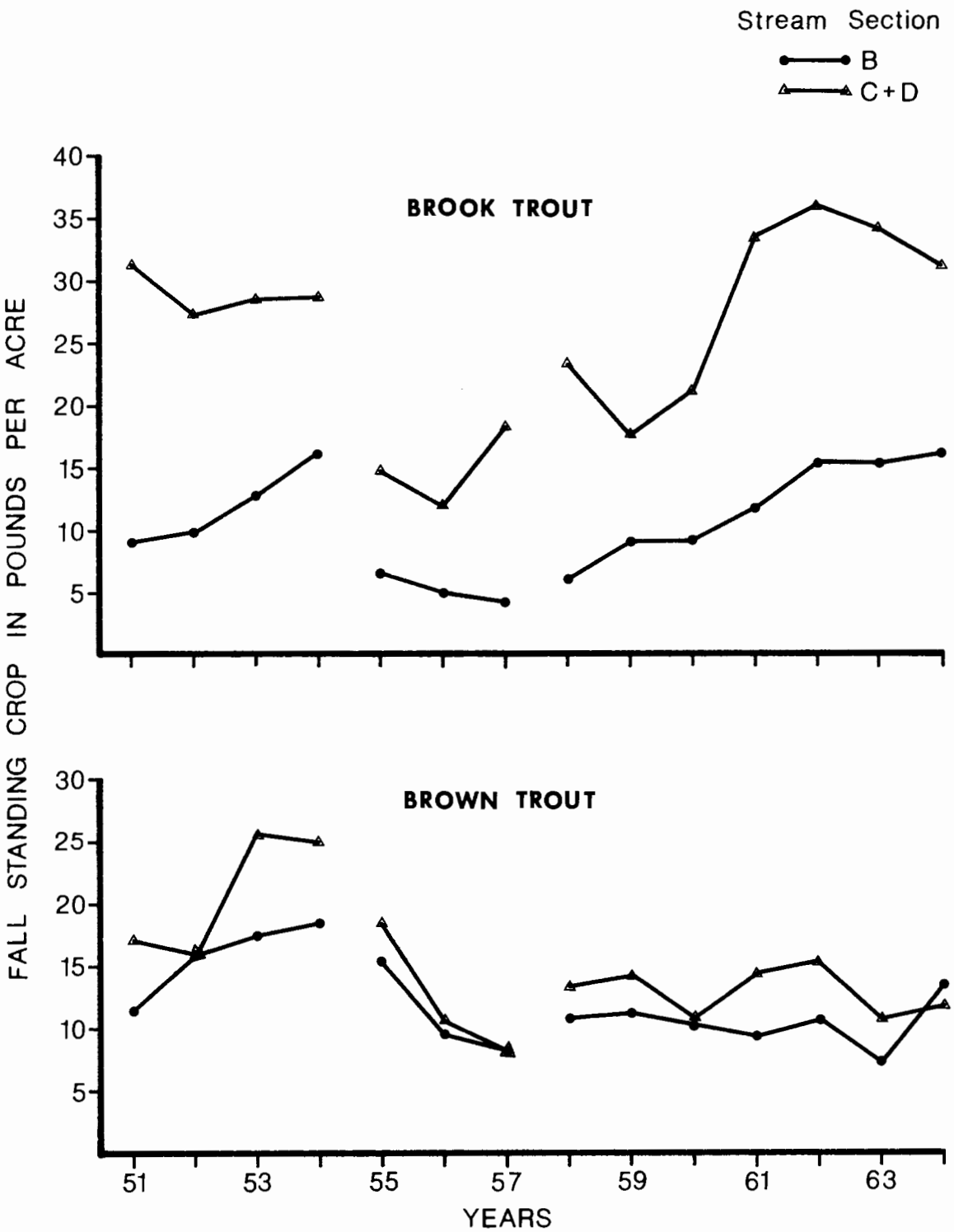

Figure 3.--Fall standing crop in pounds per acre of brook and brown trout in sections B, and C plus D, under experimental fishing regulations, Pigeon River, 1951-64.

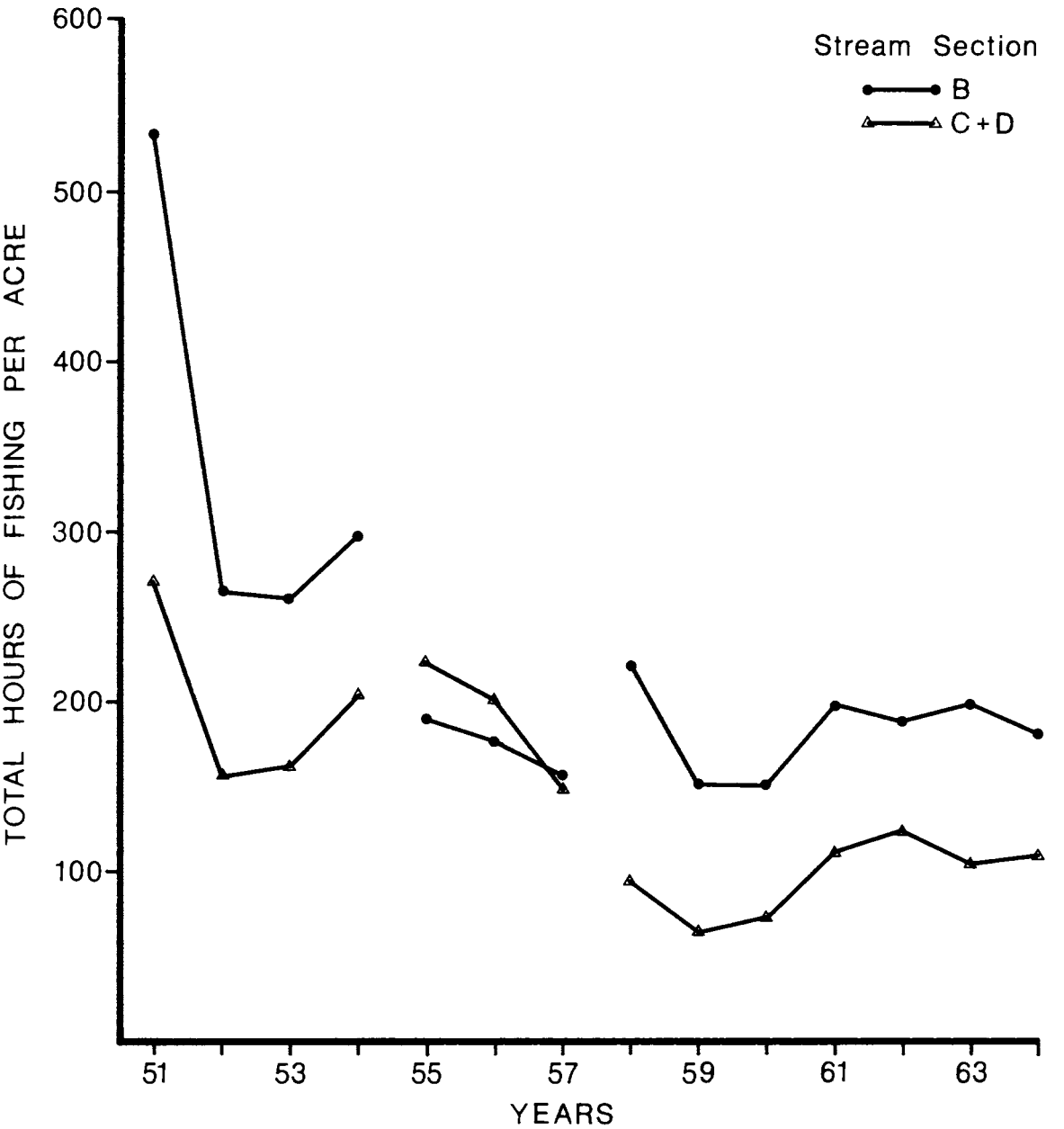

Figure 4.--Total hours of fishing per acre in sections B, and C plus D, under experimental fishing regulations, Pigeon River, 1951-64.

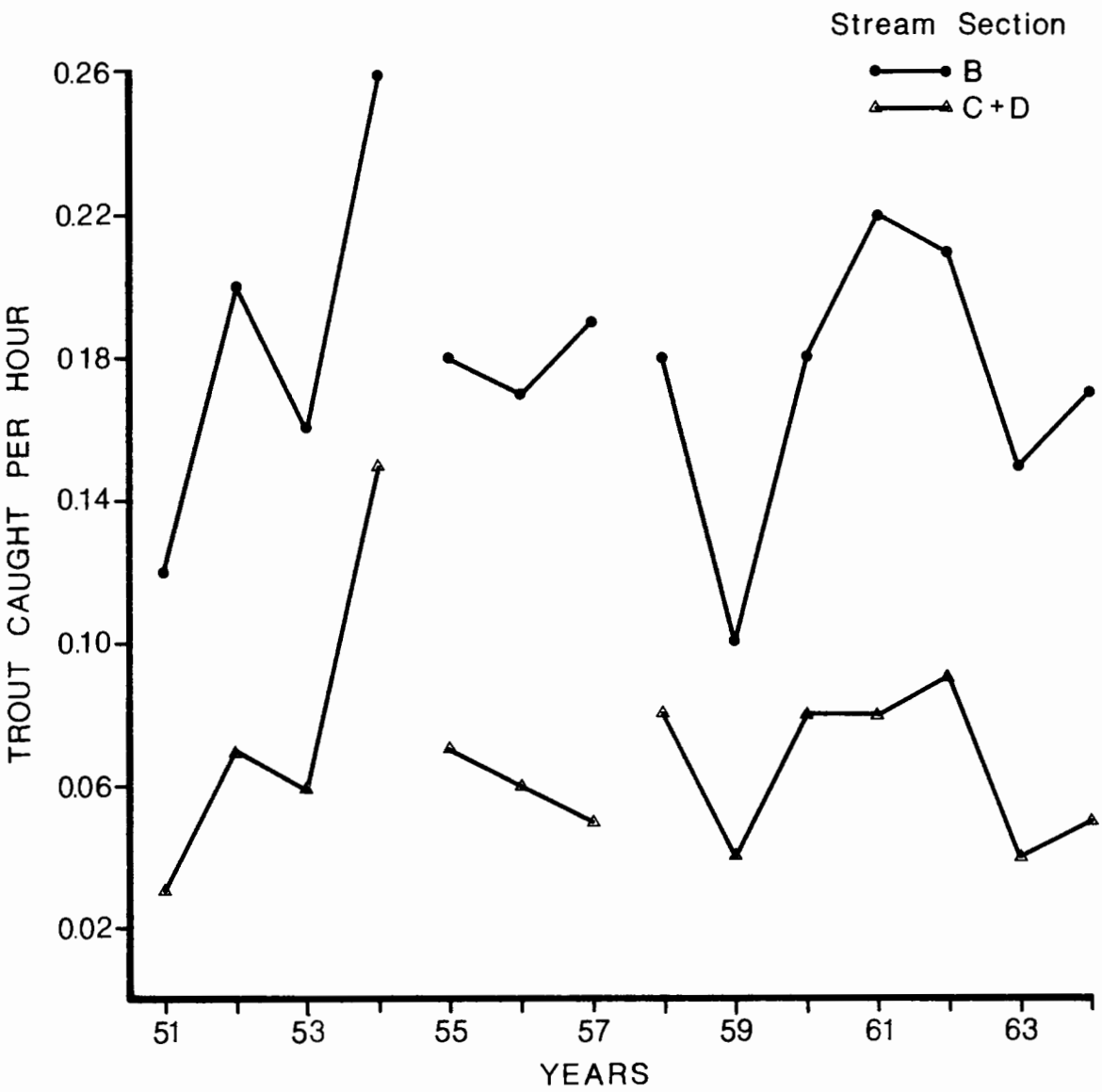

Figure 5.--Number of trout (brook and brown) caught per hour in sections B, and C plus D, under experimental fishing regulations, Pigeon River, 1951-64.

Literature cited

Benson, Norman G. 1953. The importance of ground water to trout populations in the Pigeon River, Michigan. Trans. N. Amer. Wildl. Conf., 18: 268-281.

Cooper, Edwin L. 1952. Rate of exploitation of wild eastern brook trout and brown trout populations in the Pigeon River, Otsego County, Michigan. Trans. Amer. Fish. Soc., 81(1951): 224-234.

Cooper, Edwin L. 1953. Returns from plantings of legal-sized brook, brown and rainbow trout in the Pigeon River, Otsego County, Michigan. Trans. Amer. Fish. Soc., 82(1952): 265-280.

Cooper, Edwin L., and Norman G. Benson. 1951. The coefficient of condition of brook, brown and rainbow trout in the Pigeon River, Otsego County, Michigan. Prog. Fish-Cult., 13: 181-192.

Hunsaker, Don II, Leo F. Marnell, and F. Phillip Sharpe. 1970. Hooking mortality of Yellowstone cutthroat trout. Prog. Fish-Cult., 32: 231-235.

Hunt, Robert L. 1964. Evaluation of fly-fishing-only at Lawrence Creek (a three-year progress report). Wisc. Cons. Dep., Misc. Res. Rep. No. 10 (Fisheries), 14 pp.

Hunt, Robert L. 1970. A compendium of research on angling regulations for brook trout conducted at Lawrence Creek, Wisconsin. Wisc. Dep. Nat. Res., Res. Rep. 54, 37 pp.

Latta, William C. 1965. Relationship of young-of-the-year trout to mature trout and ground water. Trans. Amer. Fish. Soc., 94: 32-39.

Latta, W. C. 1972. The effects of stream improvement upon the anglers' catch and standing crop of trout in the Pigeon River, Otsego County, Michigan. Mich. Dep. Nat. Res., Research Develop. Rep. No. 265, 57 pp.

Mason, John W., and Robert L. Hunt. 1967. Mortality rates of deeply hooked rainbow trout. Prog. Fish-Cult., 29: 87-91.

McFadden, James T. 1961. A population study of the brook trout, Salvelinus fontinalis. Wildl. Monogr., No. 7, 73 pp.

Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Fish. Res. Bd. Canada, Bull. No. 119, 300 pp.

Shetter, David S. 1969. The effects of certain angling regulations on stream trout populations. Symposium on Salmon and Trout in Streams. H. R. MacMillan Lectures in Fisheries, 1968, Univ. British Columbia, Vancouver, Canada, pp. 333-353.

Shetter, David S., and Gaylord R. Alexander. 1962. Effects of a flies-only restriction on angling and on fall trout populations in Hunt Creek, Montmorency County, Michigan. Trans. Amer. Fish. Soc., 91: 295-302.

Shetter, David S., and Gaylord R. Alexander. 1966. Angling and trout populations on the North Branch of the Au Sable River, Crawford and Otsego counties, Michigan, under special and normal regulations, 1958-63. Trans. Amer. Fish. Soc., 95: 85-91.

Shetter, David S., and Leonard N. Allison. 1955. Comparison of mortality between fly-hooked and worm-hooked trout in Michigan streams. Mich. Dep. Cons., Inst. Fish. Res., Misc. Publ. No. 9, 44 pp.

Shetter, David S., and Leonard N. Allison. 1958. Mortality of trout caused by hooking with artificial lures in Michigan waters 1956-1957. Mich. Dep. Cons., Inst. Fish. Res., Misc. Publ. No. 12, 15 pp.

Shetter, David S., Marvin J. Whalls, and O. M. Corbett. 1954. The effect of changed angling regulations on a trout population of the Au Sable River. Trans. N. Amer. Wildl. Conf., 19: 222-238.

Stringer, G. E. 1967. Comparative hooking mortality using three types of terminal gear on rainbow trout from Pennask Lake, British Columbia. Canad. Fish Cult., 39: 17-21.

Report approved by G. P. Cooper

Typed by M. S. McClure