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Periodicity of mortality of brook trout during first summer of life[1]

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Abstract

Little is known about the periodicity of mortality of brook trout (Salvelinus fontinalis) between the egg stage at mid-winter to fingerling stage the following fall. In a 300-yard section (0.77 acre) of the Pigeon River, Otsego County, Michigan, the rate of loss of young brook trout was computed to be 87.6 per day from emergence in March to June 26, 6.1 per day from June 26 to July 24, and 3.6 per day from July 24 to September 19.

The study area was part of Section E of the experimental water at the Pigeon River Trout Research Station. Section E is good trout habitat and usually has a fall standing crop of about 24 pounds per acre of brook trout and brown trout (Salmo trutta). One quarter to one third of the poundage was composed of brown trout. Other abundant species are the white sucker (Catostomus commersoni), blacknose dace (Rhinichthys atratulus) and creek chub (Semotilus atromaculatus).

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[1] Contribution from Dingell-Johnson Project F-17-R, Michigan.

A direct-current electric shocker was used to collect trout for population estimates. Estimates were made on June 26 (976 young-of-the-year trout), July 26 (804 trout) and September 19 (598 trout). A potential egg production of 11,480 eggs was calculated from the number of brook trout 5 inches or longer estimated to be present in the study area in September, 1960. From the literature, available information on mortality from egg to emergence as fry was used to estimate a survival of 9,035 fry in the study area in March, 1961, from the potential 1960 egg production. The mortality rates per day of brook trout during the first summer of life were calculated from these population figures. The causes of mortality were unknown.

Introduction

Shetter (1961) made a detailed study of survival of brook trout (Salvelinus fontinalis) from the egg stage at mid-winter to fingerling stage the following fall, but little is known about the periodicity of mortality between these times. The present study was made during 1961 on a 300-yard section of the Pigeon River, Otsego County, Michigan. The rate of loss of young brook trout in this section of stream was computed to be 87.6 per day from emergence in March to June 26, 6.1 per day from June 26 to July 24, and 3.6 per day from July 24 to September 19.

The study area was part of Section E of the experimental water at the Pigeon River Trout Research Station. Section E is the upstream section of the 6 miles of stream under the control of the Station. It is 1.2 miles in length, has an average width of 40 feet and an area of 5.7 acres. It is good trout habitat and usually has a fall standing crop of about 24 pounds per acre of brook trout and brown trout (Salmo trutta). One quarter to one third of the poundage was composed of brown trout. Other abundant species are the white sucker (Catostomus commersoni), blacknose dace (Rhinichthys atratulus) and creek chub (Semotilus atromaculatus). There is a dam which forms a 70-acre impoundment at the upper end, and 4.8 miles of experimental stream below the lower end of Section E.

The study area selected was approximately 300 yards in length (0.77 acre), 500 yards upstream from the lower end of Section E. It was selected as typical habitat for the section. Fingerling trout are common each fall and spawning occurs here.

Methods

A direct-current electric shocker (9.3 amperes, 230 volts) was used to collect trout for population estimates. Estimates were made on June 26, July 24 and September 19. In the first two estimates, the procedure included immobilization of fish with tricaine methanesulfonate, and marking by clipping a combination of fins.

Because of the small size of the trout in June, a check was made to determine whether experimental techniques would be a cause of mortality. On June 12, prior to the estimates, a sample of brook trout fingerlings (2.2 inches in length) was taken with the shocker from below the study area. Twenty-five of these were placed directly in a screened crate; and 26 were anesthetized, fin clipped (top of the caudal fin) and placed in another crate.

The crates were anchored in the stream. At the end of 9 days, none of the 25 trout in the first crate had died, and only 2 of the 26 in the second crate had died. A Chi-square test of independence indicated that this difference in mortality among the two lots of fish was not statistically significant.

For the June 26 population estimate, a shocker run was made through the 300 yards of the study area, and the dorsal and left pectoral fins were clipped from all brook trout captured. After all trout had recovered from the anesthetic, they were distributed back through the area from which they had been removed. The size distribution was such that there was no trouble in distinguishing young-of-the-year from yearlings. The average total length of the young fish was 2.2 inches (24 fish, range 1.5-2.9 inches). The "recapture run" was made the following day. The trout were again redistributed through the area from which they had been collected.

For the July 24 estimate, the trout were marked by clipping the dorsal and left pelvic fins. The "recapture run" was made the following day. The average total length of young trout was 2.8 inches (25 fish, range 2.0-3.8 inches). At this time, there was some question whether the larger trout were young-of-the-year or older. Scale samples from six of the larger trout revealed that they were young fish.

The third and final population estimate for the 300-yard study area was made as part of the annual fall estimate for the whole 6 miles of experimental water. The first run through Section E was made on September 19, the second run on September 26. Fish of all sizes were captured, no anesthetic was used and the trout were marked by removing the tip of the caudal fin. Records were kept for each 100-yard segment of Section E, so that an estimate of the population in the 300-yard study area was possible. The average total length of young-of-the-year trout in Section E (including the study area) was 3.4 inches. Scale samples, taken from each 1-inch group of trout, indicated that 94 percent of the 4-inch fish were in 0 age group. The estimates were adjusted accordingly.

Population estimates

The Petersen method (simple proportion) was used to calculate population size. Clopper and Pearson's (1934) chart was used to calculate the 95 percent confidence limits. The numbers of young-of-the-year brook trout estimated to be present in the study area on June 26, July 24 and September 19, 1961 are given in Table 1. Because of the care taken in techniques and in the redistribution of the fingerlings through the area after handling, and because of the short time between marking and recapture (especially the first two estimates), the population estimates are believed to be very precise.

The potential egg production in the 300-yard study area was calculated from the number of spawning trout estimated to be present in September, 1960. The annual fall estimate in 1960 indicated 85 brook trout, 5 inches or longer, to be present. Using Cooper's (1953) data for the percentage of mature females, and for the average number of eggs for brook trout of each inch group in Michigan, the egg production for the study area was calculated to be 11,480 eggs in 1960.

Shetter (1961) summarized the available information on mortality from egg to emergence as fry. He used Brasch's (1949) figure of 21.3 percent mortality as typical. I apply the mortality figure of 21.3 percent to the figure on egg production (11,480) and estimate that 9,035 fry survived in the study area in March, 1961.

In Michigan, most brook trout fry emerge from redds during March (Shetter, 1961). In order to have a definite time period for calculation of mortality rates after emergence, I arbitrarily chose March 26 as the date by which most of the fry would have emerged.

Mortality

During the September population estimate for the 6 miles of experimental water, a record was kept of all recaptures of young trout which had been fin-clipped and released in the 300-yard study area. None of those clipped during June and July were taken outside of Section E. Of those clipped in July, only 2 (of the 39 "recaptures") were taken outside the study area; these 2 fish were so close to the study area that movement for this group can be considered nil. However, of those clipped in June, 9 (of 26 "recaptures") were outside of the study area; 2 were downstream (the farthest was 300 yards) and 7 were upstream (the farthest was 1,200 yards). If an adjustment is attempted for a 35-percent (9 out of 26) movement from the study area between June 26 and July 24, the June 26 estimate of 976 is reduced to 634 on July 24, whereas the July 24 estimate was 804. Thus, if 35 percent of the population (342 trout) did leave, there was some (170 trout) immigration to offset this loss. The total number of fish involved was small, so that the 35 percent figure is a rough estimate (95 percent confidence that the proportion of marked fish outside the study area could range from 4 out of 26 to 15 of 26). Undoubtedly some emigration took place but it is presumed that all or most of it was compensated for by immigration and that the difference between the two estimates (172 trout) was mortality.

My calculations for mortality rates during separate portions of the period from March to September (Table 2) are based on the estimate of 9,035 fry in March and the shocker estimates for young-of-the-year on June 26, July 24 and September 19. The bulk of the mortality occurred during the first three months, from March to June; the population of young trout declined from 9,035 to 976, at a rate of 87.6 trout per day or an instantaneous mortality rate of 0.02419 trout per day. During the next month, the rate was only 6.1 trout per day (instantaneous rate of 0.00691); and during the following two months the mortality rate dropped to 3.6 trout per day (instantaneous rate of 0.00519). The decline in number of brook trout during the first summer of life in the 300-yard study area is shown in Figure 1. Allen (1951) and Ricker and Foerster (1948) found mortality of about the same magnitude for brown trout and sockeye salmon, respectively, during their first months of life.

The percentage survival from eggs to fall fingerlings in the present study is computed at 5.2 percent. This is slightly higher than Cooper's (1953) figures (3.3 to 5.1 percent) for brook trout in the Pigeon River but well within the range of survival (2.7 to 8.8 percent) given by Shetter

(1961). For the whole of Section E, the survival was computed at 3.3 percent (calculated as described above for the 300-yard study area).

The causes of mortality are unknown. Certainly at the size (less than 2.2 inches) at which most of the loss takes place, the brook trout are extremely vulnerable to predation. Kingfishers and great blue herons are common along this section of stream and there are many brook and brown trout of a size to be effective predators. The physical environment may play a part, e.g., amount of ground water seepage (Benson, 1953). The problem of identifying factors influencing survival remains to be solved.

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Table 1.--Number of young-of-the-year brook trout estimated to be present in a 300-yard segment of Pigeon River, in June, July and September, 1961

Time of estimate	Number of trout marked	Number of unmarked trout recovered	Number of marked trout recovered	Population estimate	
				Number of trout	95 percent confidence limits
June 26	179	178	40	976	723 - 1,394
July 24	238	195	82	804	659 - 955
Sept. 19	131	132	37	598	434 - 820

Table 2.--Mortality per day of brook trout in the 300-yard study area during the first summer of life

Time of estimate	Number of trout in population	Number of days between estimates	Total mortality: Trout per day	Total mortality: Instantaneous rate per day
March 26	9,035	..	...	...
	...	92	87.6	0.02419
June 26	976	..	...	...
	...	28	6.1	0.00691
July 24	804	..	...	...
	...	57	3.6	0.00519
Sept. 19	598	..	...	...

Figure 1.--Decline in number of brook trout during the first summer of life in a 300-yard study area of Pigeon River, 1961.

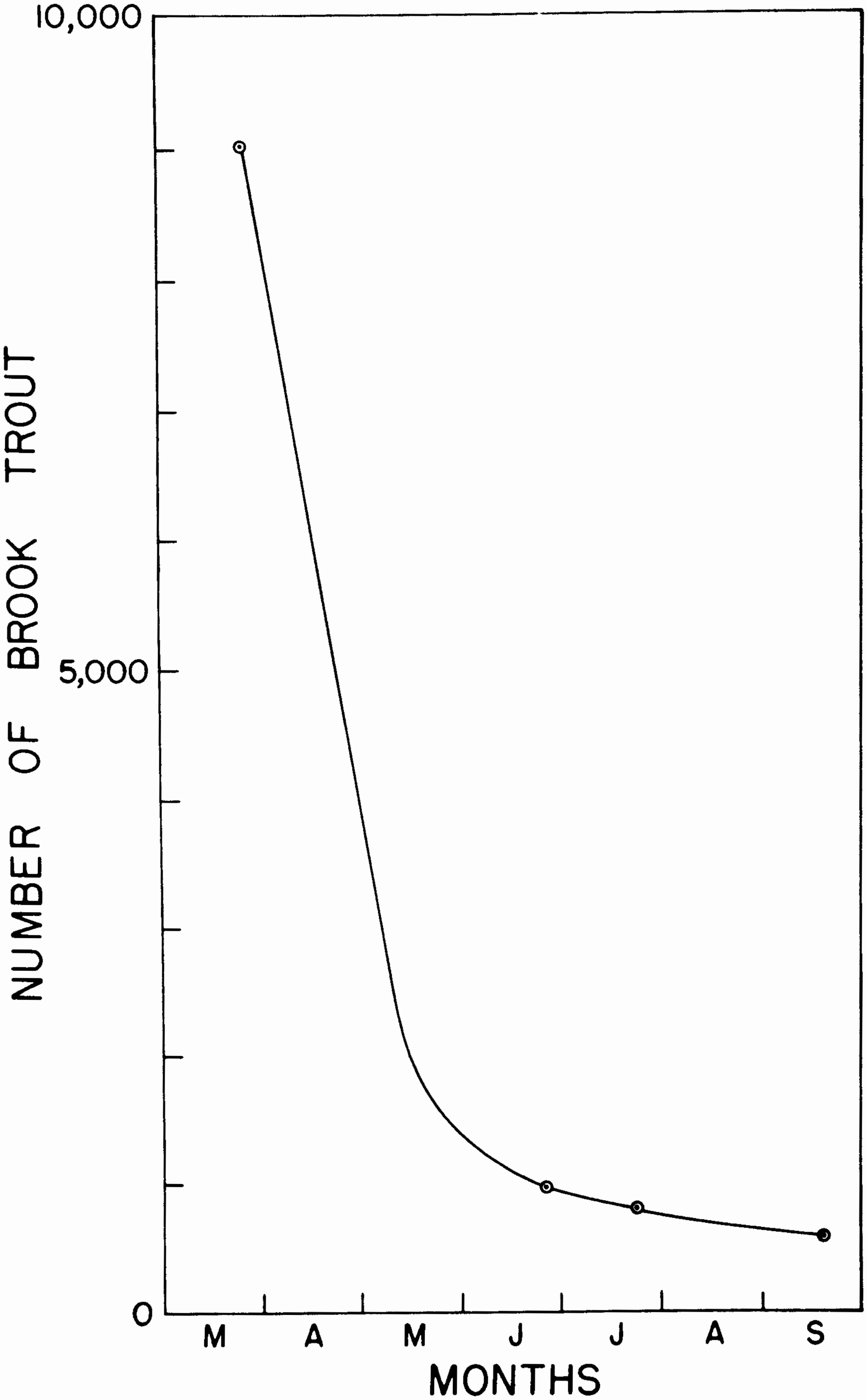

Figure 1