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ASPECTS OF THE ECOLOGY OF AN ISOLATED POPULATION OF BROOK TROUT *(Salvelinus fontinalis)* IN FAIRFAX COUNTY, VIRGINIA[1]

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ABSTRACT

An isolated population of brook trout *(Salvelinus fontinalis)* appears to have survived in the headwaters of Difficult Run, Fairfax County, Virginia since at least 1899 when they were first reported. The presence of brook trout in Difficult Run is unusual for two reasons: 1) Difficult Run is the only stream in the area known to have been inhabitated by brook trout for so long, and 2) they are apparently the only potentially self-sustaining population of native trout in Virginia's Piedmont Province. Brook trout were sampled from 1979 to 1981 with electroshocking gear. The sex ratio was not significantly different from unity. Juveniles accounted for 38 percent of the sample. The modal size class was between 115-135 mm total length. Mean total length and weight of males and females was not significantly different. A multiplicative function suggests that weight increases at significantly less than the cube of total length, unlike most other brook trout populations. The population in a 410 meter section of stream was estimated at 65 fish. Gut contents consisted primarily of plecopterans and coleopterans. Movements of marked fish ranged from 20-150 meters between capture intervals of 7-128 days. Spawning probably occurs in November. The brook trout of Difficult Run may be a relic of a previously more widespread distribution of native trout.
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INTRODUCTION

In Virginia, the range of the native brook trout *(Salvelinus fontinalis)* is confined primarily to the Appalachian Mountains (Hendricks, 1980). However, Smith and Bean (1899) reported the existence of an isolated population in the Piedmont Physiographic Province of Fairfax County. They noted that, "In former years this fish inhabited Difficult Run on the Virginia side of the Potomac [River] below Great Falls, but was supposed to be long since exterminated. Recently, however, a few have been taken in this stream." McAtee and Weed (1915) observed that the upper course of Difficult Run was the only place in the area surrounding Washington, D.C. known to be inhabited by brook trout, and that their presence distinguished Difficult Run from all other streams in the area. As urbanization increased in Fairfax County, it was assumed that the brook trout population of Difficult Run was extirpated (Manville, 1968). In 1975 students and faculty of George Mason University collected brook trout in Difficult Run during an ichthyological survey of Fairfax County (Lovich, 1984). This discovery prompted an investigation of the distribution and abundance of brook trout in the headwaters of the stream. In this paper, I discuss selected aspects of the ecology of the brook trout population of Difficult Run.

MATERIALS AND METHODS

Difficult Run is the largest watershed entirely within Fairfax County, Virginia covering 149 square kilometers (Figure 1). The stream originates just west of Fairfax City near the intersection of Route 50 and Route 66 and flows northeasterly about 25.5 kilometers to its confluence with the Potomac River below Great Falls. Over its course there is a total drop in elevation of about 111 meters. The results of this study are based on sampling efforts conducted to the South Fork of Difficult Run near Fox Mill Road. Most work was confined to a section of stream extending about 200 meters above and below Fox Mill Road. The stream bed in this area was about 3 meters wide. Above Fox Mill Road the stream was bordered by forest. Dominant tree species included *Acer rubrum,* mesic *Quercus, Liriodendron,* and *Carpinus.* Housing developments encroached on the stream

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at several points. The area below the road was bordered on one side by pasture and on the opposite bank by forest for 160 meters. The area immediately below this was forested. The site was visited a total of 21 times from October, 1979 to April 1981.

Trout were collected primarily with a Coffelt backpack electroshocker using direct current. Stunned fish were captured with a hand-held dipnet. In addition, a 213x121 cm seine (0.63 cm mesh) was often used to prevent fish from escaping downstream. The study area was marked in 10 meter intervals so that movement patterns could be followed with each recapture. Trout were measured (total length), weighed, and sexed. Each specimen was marked for future identification by injecting small quantitites of India ink under the dorsal skin surface at various locations. Population size in the study area was calculated using the Bailey modification of the Petersen estimate (Begon, 1979). This particular estimate is well suited for small sample sizes of marked individuals. Other statistical techniques follow procedures outlined by Zar (1984).

RESULTS

A total of 41 observations were made on 31 individuals. Seven fish were captured twice, two were captured three times, and one individual was captured on four separate occasions. The sex ratio of 10 females and 9 males was not significantly different from 1:1 (X^2 corrected for continuity = 0.11, $P > 0.5$). Those fish that did not display secondary sexual characters were classified as juveniles and accounted for 38 percent (n = 12) of the sample. The total population was estimated to be 65 ± 29 fish. Using this figure the density of trout in the study area was estimated to be one individual per 6.3 linear meters. The modal size class was between 115-135 mm total length (Figure 2). The size frequency distribution was not significantly different from a normal distribution (X^2 Goodness-of-fit test: $X^2 = 0.43$, df = 1, P = 0.51). Mean male (196 mm ± SD 40.4) and female (184 mm ± SD 27.3) total lengths at first capture were not significantly different (Student's two-tailed t-test: t = 0.74, df = 17, P = 0.47). Mean weight at first capture was not significantly different between males (69 g ± SD 27.0) and females (77.5 g ± SD 22.2) even though the longest and heaviest fish in the sample was a male (Student's two-tailed t-test: t = -0.51, df = 7, P = 0.63). Mean total length and weight of juveniles at first capture was 114 mm ± SD 15.7 and 23 grams ± 6.7 respectively. The relationship between length and weight was modelled by the equation:

$$\text{Weight} = (\log_n -8.392)\ (\text{length}^{2.411})$$

for all captures (Figure 3). The model provides a good fit to the data, explaining 94.4 percent of the variance in the sample.

Most brook trout moved between captures. Minimum distances moved by seven individuals recaptured at relocation intervals of 7-128 days ranged from 20-150 meters. These distances and intervals suggest minimum rates of movement ranging from 0.18-12.86 meters/day, assuming constant movement rates and unidirectional movement.

The gut contents of an 81 mm brook trout caught in September were examined by dissection. The most abundant food items were plecopteran (stone fly) nymphs and terrestrial coleopterans (beetles). One brook trout regurgitated an earthworm when captured in May.

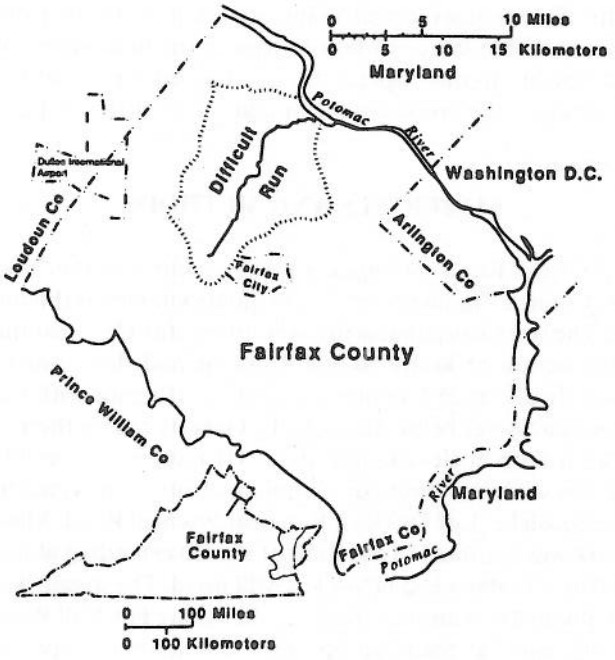

FIGURE 1. Map showing location of Difficult Run. The drainage basin is outlined with a hatched line.

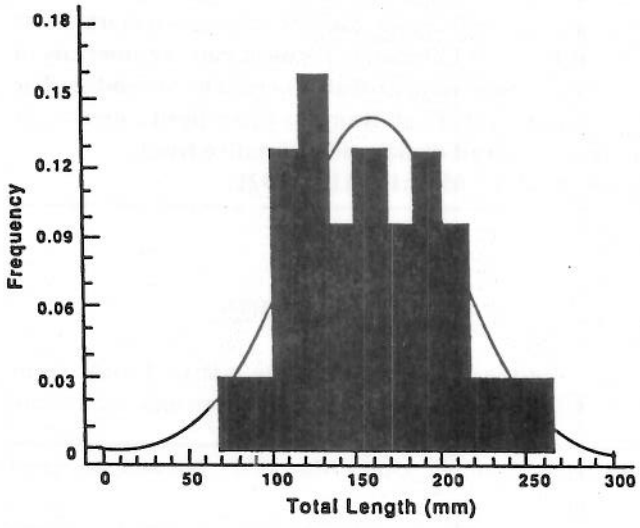

FIGURE 2. Size frequency distribution of Difficult Run brook trout at first capture (n = 31). The normal curve associated with the mean and standard deviation of total length is also shown.

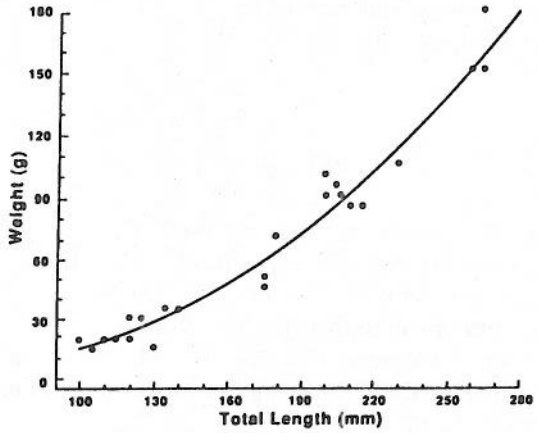

FIGURE 3. The relationship between total length and body weight at first capture of Difficult Run brook trout. Refer to text for details.

No direct evidence of spawning was observed, but males developed bright spawning colors immediately prior to the second week of November 1980. In the same year, native brook trout in nearby Madison County, Virginia (at a higher elevation) were observed spawning during the second week of October (personal observation).

DISCUSSION

The existence of an apparently self-sustaining, possibly native population of brook trout in the piedmont of northern Virginia is surprising. However, from an ecological perspective the brook trout of Difficult Run are much like other populations. The even adult sex ratio observed in this study is typical for brook trout (McAfee, 1966). However, females may predominate slightly in older age groups (McFadden, 1961). The size at which maturity is attained is highly variable among populations, even in the same area (Cooper and Scherer, 1967). Males tend to mature earlier and at a smaller size than females.

Detailed comparisons of the relationship between length and weight were presented by Carlander (1969) for 22 samples and populations of brook trout. He concluded that the relationship between these two variables varied more locally than by region or major habitat type. It is interesting to note that the majority of populations for which he presented data show weight increasing at slightly more than the cube of length. Brook trout at Difficult Run show increases in weight at length to the 2.41 power. The 95 percent confidence interval associated with this parameter estimate (2.16-2.66) does not include the value three, suggesting that brook trout at Difficult Run are lighter for their size than the populations examined by Carlander. The significance of this finding is difficult to determine. It is possible that the isolation of Difficult Run has resulted in morphological differentiation from other brook trout populations. Alternatively, the "lean condition" may be a result of resource limitation (Currens et al., 1989) or stress.

McAfee (1966) reviewed movements in freshwater populations of brook trout. Short upstream movements may occur during the spawning season with the reverse occurring during colder months. Although movements were recorded in Difficult Run, the data are insufficient to conclude that there was seasonal directionality.

Brook trout eat a variety of immature and adult aquatic and terrestrial invertebrates as well as zooplankton (Needham, 1930; Allen and Claussen, 1960; McAfee, 1966; Carlander, 1969). The most important aquatic foods are Trichoptera, Diptera and Ephemeroptera (McAfee, 1966). Coleoptera are a major terrestrial food source, and larger brook trout tend to eat larger Coleopterans (Allen and Claussen, 1960). Seasonal variation in diet is a reflection of food availability. For example, in Needham's (1930) study in New York, earthworms were only found in the stomachs of brook trout during the warmer months.

Spawning in brook trout occurs from August to January depending on latitude and water temperature (McAfee, 1966). Although direct evidence of spawning was not detected in brook trout at Difficult Run, three observations suggest that the population is naturally sustaining. First, trout have presumably existed in the stream continuously since before 1899 (Smith and Bean, 1899; McAtee and Weed, 1915; Lovich, 1984). The fact that brook trout rarely live longer than four years (McAfee, 1966), coupled with the fact that brook trout were collected every year during seven years of sampling, provides additional circumstantial support for the self-sustaining hypothesis. Second, during the expected spawning season in Virginia, male brook trout at Difficult Run developed nuptial colors, and females exhibited protruding genital papillae. Third, and finally, juveniles were collected. Suitable spawning areas consisting of gravelly, silt-free riffles (Greeley, 1933; Webster, 1962) were present at the study site.

Two important questions arise from this research. First, are the trout in Difficult Run native, as suggested by Jenkins (1979), or are they descendants of stocked fish? I have been unable to document any instances of brook trout stocking by state agencies. However, long-time local residents claim that trout were stocked in the 1950's. That some stocking (by state or private parties) took place is shown by the presence of brown trout (*Salmo trutta*), a native of Eurasia, in the Main Branch of Difficult Run. The presence of self-sustaining trout populations in other piedmont streams near Washington, D.C. confirms a widespread interest in stocking (Dietemann, 1974; Anon., 1980). Assuming that brook trout cannot sustain themselves from year to year in Difficult Run, then stocking would had to have started as early as 1899 when Smith and Bean reported the presence of the fish. However, neither Smith and Bean (1899) nor McAtee and Weed (1915) mentioned that the brook trout were stocked in Difficult Run. Smith and Bean suggested that at some time in the past brook trout probably occurred in the cooler tributaries of other area streams. McAtee and Weed felt that the brook trout of Difficult Run may have been established from individuals carried down the

Potomac River from their normal mountain home.

Whether the brook trout of Difficult Run are native or not, the second and perhaps more interesting question is, how does this species survive in a habitat that is generally considered to be suboptimal? Native brook trout populations in Virginia are presently confined to Blue Ridge Mountains, Mount Roger's area, and the Allegheny Highlands (Jenkins, 1979; Bugas and Mohn, 1981; Camuto, 1988). Streams in these areas are cold, clear, highly oxygenated, and rocky, unlike Difficult Run which is a fairly sluggish stream over most of its course. Brook trout do not thrive in streams where water temperatures exceed 20°C for long periods (McAfee, 1966). Yet, maximum water temperatures of 26°C were recorded in the South Fork of Difficult Run during July and August. Meisner (1990) analyzed the effect of climatic and geographic factors on the native distribution of brook trout. The southern distributional limit of this species is strongly influenced by summer air temperatures. However, groundwater temperatures may be more important because they maintain the low temperature in brook trout streams. Groundwater temperature varies as a function of altitude and latitude. Analysis of specific locality records of brook trout indicated that the minimum altitude of suitable habitat increased from about sea level at 39° 12'N to about 640 meters at 34° 40'N. Meisner concluded that the lower altitudinal margin of the range of brook trout was shaped by the 15°C groundwater isotherm. Difficult Run is located at about 39°N and ranges in elevation from about 130 meters at the source to about 30 meters at the confluence with the Potomac River. Estimated groundwater temperatures at the source and mouth of Difficult Run, calculated with Meisner's equation #1, are 13.84°C and 14.37°C, respectively. If his model is correct, Difficult Run would appear to be suitable for brook trout from a strictly geographic and climatic standpoint. However, the absence of records for brook trout in other area streams casts some doubt on the generality of the model.

In conclusion, it seems reasonable to assume that the brook trout of Difficult Run are a relic of a previously more widespread distribution. The factors that allowed them to survive until at least 1981 are presently unknown. Future studies will be required to determine if the trout continue to survive as a self-sustaining population, and if they do, emphasis should be placed on conservation of Fairfax County's only known brook trout population.

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