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CHARACTERIZATION OF BROOK TROUT HABITAT IN
GREAT SMOKY MOUNTAINS NATIONAL PARK

A PRELIMINARY REPORT

INTRODUCTION

The brook trout, Salvelinus fontinalis, is the only salmonid native to the Southern Appalachian Mountains and the Great Smoky Mountains National Park (GRSM). In this region, the fish are at the southern extreme of their range. They are smaller in size and have more spots than their northern counterparts. Morphological and electrophoretic data suggest that the Appalachian brook trout represents a unique gene pool and possibly an undescribed subspecies (Lennon 1967, Brussard and Nelson 1976, Stoneking et al. 1981). Unfortunately, this distinction is not always clearcut, and the taxonomic status of the fish is still uncertain (Harris et al. 1978). Determining the exact taxonomic relationship of the Appalachian brook trout has been complicated by stocking the northern strain in GRSM and surrounding areas. Regardless of its taxonomic status, the brook trout is a native species with a unique gene pool that should have refuge in GRSM. However, even within this protected area, the range of the brook trout appears to have declined over the past 50 years (King 1937, Lennon 1967, Kelly et al. 1980). Before the establishment of the park in 1934, brook trout populations were severely reduced by logging and the subsequent rise in stream temperature and silt loads. Continued reduction of brook trout range is generally attributed to competitive interaction with the introduced rainbow trout (Salmo gairdneri) (Kelly et al. 1980).

Within GRSM, several attempts have been made to reclaim lost brook trout range by removing rainbow trout. These attempts have been only partially successful, with the renovated streams showing an increase in brook trout population size but an incomplete removal of rainbow trout (Moore et al. 1981, 1983, 1984; Whitworth 1979). The effectiveness of such reclamation efforts could be increased by concentrating on those streams most suited for brook trout growth and reproduction. This paper reports on the initial findings of a study designed to describe the best brook trout habitats in GRSM.

Although several papers have been published on methods for rating trout trout habitat, only one habitat index has been developed for brook trout (Binns and Eiserman 1979, Duff and Cooper 1978, Mohn and Bugas 1979, Platts 1979, Bonner 1982, Raleigh 1982, Oswood and Barber 1982). Most of these

studies have relied on previously published reports of trout habitat requirements as baseline data. Only two of the studies use multivariate regression techniques on a set of measured stream parameters to evaluate habitat suitability. Since almost all of the streams in GRSM are good trout habitat, we need a finer resolution of habitat analysis than the above studies provide.

METHODS

Sample sites were chosen so that a range of brook trout population sizes would be sampled. Using historical data provided by King (1937), Lennon (1967), and Kelly et al. (1980), six streams were chosen to be sampled. Anthony Creek and the section of Big Creek between Walnut Bottoms and Yellow Creek were chosen to represent areas that had lost most of their brook trout population. Meigs Post and Cosby Creek were chosen to represent areas that held mixed populations of brook and rainbow trout. Enloe Creek and Bunches Creek represent areas of pure undisturbed brook trout. To ensure that samples were not biased by changes due to elevation, each stream was divided into thirds. Each third was subdivided into 100 m sections. Ten percent of the sections from each stream third were randomly selected for study.

In the field, the section was located by using a 1:2400 USGS topographic map. Once located, the section was measured and the length of each pool and riffle was recorded. A visual estimate was made of the type of bank cover, the percentage of canopy cover, and the major vegetation types. In-stream measures of dissolved oxygen and water temperature were taken using a YSI Model 54A oxygen meter. Field pH measurements were obtained using an Orion ionalyzer 407A. A mid-stream mid-depth one-liter water sample was taken for laboratory analysis. The parameters measured and the methods used for measurement are listed in Table 1.

Within each 100-m section, four pools and four riffle areas were selected to represent the section. At each of these eight sites, visual estimates of substrate composition and the type and amount of cover for fish were made. Three riffles and one pool in each section were sampled for benthic macroinvertebrates using a square foot Surber sampler. Each of the sample pools was classified by its size and depth. Table 2 presents the classification systems used in this study.

Fish population size was estimated by using a gasoline powered backpack electroshocker generating approximately 650 volts. Each stream section was selected so that a natural obstruction such as a riffle or small waterfall was present at each end of the section. Such obstructions appear to prevent or at least reduce fish movements out of the section without the use of heavy, bulky

block nets. Each section was electrofished three times, with an hour or more between successive samples. This timing provides for the best depletion estimate (Peterson and Cedarholm 1984). The method of Carle and Strub (1978) was used to estimate population size from depletion data.

Information on fish population structure and growth rates was obtained by taking individual lengths, weights, and scale samples from all trout. Total weights and maximum and minimum lengths were recorded for all other species. Scale samples were taken anterior to the dorsal fin above the lateral line on the left side of the fish. A combination of length frequency data and scale annuli counts were used to age the fish.

RESULTS

Each stream parameter measured was individually plotted against brook trout population size. After examining these plots, 14 variables were selected for further analysis by multivariate regression. The number of variables included in the multivariate analysis was limited because the statistical procedure used (R-square in SAS) generated spurious results when more variables are considered. All possible regression combinations were run on the 14 selected variables. These variables were rainbow trout population size, percent of boulders, percent of large rubble, percent of small rubble, percent of coarse gravel, percent of organic debris, percent of log cover, elevation, gradient, percent of turbulence cover, channel width, stream width, and total cover. The best six variables are gradient, elevation, rainbow trout population size, and the percent of small rubble, coarse gravel, and organic debris. They provide an R^2 value of 0.875, which indicates that 87 percent of the variance in brook trout population size can be explained by these six variables. Thus the best brook trout habitat consists of high elevation, low gradient streams with no rainbow trout, with medium sized substrate particles and lots of organic debris.

DISCUSSION

The analysis performed thus far is only preliminary and may not properly take into account the effort of interaction between variables. Some variables, including water chemistry, macroinvertebrate biomass, and disturbance history were not included in this preliminary analysis. Additional samples are needed to strengthen the model and to test its predictive power. However, the variables indicated are consistent with published information on brook trout life history and distribution and can be used immediately to help rate GRSM streams as to their potential for supporting brook trout.

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Table 1. Chemical parameters measured and methods used to obtain them.

<u>Parameter</u>	<u>Method</u>
Conductivity	Altex conductivity bridge
Hardness	As CaCO_3 using an Orion Ionalyzer 407A and a Calc probe and standards
Nitrate	N/N using Orion Ionalyzer 407A and N probe and standards Orion low level measurement
Turbidity	Nephelometer
Alkalinity	Tritation with .2N H_2SO_4 as described in Standard Methods, p. 278-281

Table 2. Listing and description of classification variables used in characterizing stream habitats.

Category	SUBSTRATE VARIABLES	
	Description	
Silt	Gray	
Sand	Particles smaller than 0.1 inch	
Muck	Black mud composed of decomposed organic material	
Clay	Compact and sticky mud	
Debris	Undecomposed woody or herbaceous material	
Fine gravel	0.1 - 1 inch in diameter	
Coarse gravel	1 - 3 inches in diameter	
Small rubble	3 - 6 " " "	
Coarse rubble	6 - 12 " " "	
Boulder	12 inches in diameter	
Bedrock	Large solid mass	

COVER VARIABLES

Ledge
Vegetation
Rock
Turbulence
Depth
Undercut banks

POOL CLASSIFICATION

- 1 Maximum pool diameter (MPD) > average stream width (ASW) and depth (d) > .5 m
- 2 MPD > ASW; d < .5 m
- 3 MPD 1 > 1/2 x ASW; d > .5
- 4 MPD 1 > 1/2 x ASW; d < .5
- 5 MPD < 1/2 ASW