

Brook

Great Smoky Mountains National Park
Gatlinburg, Tennessee 37738

Systematics of the Brook Trout,
Salvelinus fontinalis (Mitchell)
in Great Smoky Mountains National Park

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A Research Proposal
submitted to the
National Park Service, Atlanta, Georgia
by the
Tennessee Cooperative Fishery Research Unit
Cookeville, Tennessee
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Abstract

The southern form of the eastern brook trout, Salvelinus fontinalis (Mitchell) has become dramatically reduced in its range. A systematic study of this fish is proposed to substantiate it as a distinct taxa. Classical morphometric and meristic in addition to electrophoretic techniques will be employed to determine the current taxonomic status of this geographic isolate. If uniqueness is verified then recommendations can be offered for a management plan to protect, propagate, and eventually restore this fish in its range.

Duration of Contract and Method of Presentation of Results:

The contract will run for a period of two years from inception. Data will be made available to the Park Service ultimately in the form of a final report. Interim results will be presented semi-annually prior to completion of the contract.

Statement of Problem:

The brook trout, Salvelinus fontinalis (Mitchell) is the only salmonid native to the southern Appalachian Mountains in the eastern United States. Cursorial studies by biologists and the general opinion of fishermen agree that this form is perhaps an "Appalachian strain" of the species. Allopatric location in the extreme southern limits of the range of the species lends support to this contention, however, no specific detailed studies into the problem have been conducted and no published evidence exists.

The brook trout has become drastically reduced in its range within the Park as a result of extensive logging, overfishing, and introduction of the exotic rainbow trout (King, 1937). It presently persists only in extreme headwater situations under adverse environmental stresses of anchor ice; rapid water temperature fluctuations, flooding, low pH and water hardness, reduced water volume, and high stream gradient. Despite lack of fishing pressure due to inaccessibility in such remote areas, these harsh conditions coupled with continued upward aggressive advance of the rainbow may ultimately extirpate this form of the brook trout. Already in 1966 Peterson alluded to the necessity of inclusion of this fish under endangered status.

Fishermen highly prize "specs" (Stupka, 1962) and repeated attempts by the Park Service have been made to preserve this fish. Re-establishment

of reduced populations has been approached through stocking of the northern brook trout, but has failed in most instances. The converse, or transplanting of this "strain" in refugia outside the Park have also been unsuccessful. On the other hand, stocking the "Appalachian strain" in suitable waters within the Park has met with success. It therefore appears this fish is a different form and can only survive within the southern Appalachian region. Its uniqueness needs immediate study and documentation. If verified, steps should be taken to: 1) protect its present distribution within Great Smoky Mountains National Park, 2) propagate and maintain brood stock in hatcheries, and 3) eventually restore its former range in Park waters.

Research Objectives and Management Implications:

Specimens of brook trout will be collected from streams in all major watersheds within the park. Creeks in which the northern form of brook trout have been stocked also will be sampled and specimens collected. A series of fishes will be removed at each locality. In addition to morphometric and meristic characters, a subgroup of each series will be subjected to electrophoretic analysis of selected enzymes and eye lens and muscle proteins. Several series of specimens from the northern portion of the species' range (Maine; New England strain) and from areas of Georgia and North Carolina in the South will be acquired and treated in like manner. Taxonomic decisions as to uniqueness of the form within the Park when compared to that of the northern form will be based upon the combination of morphometric, meristic, and electrophoretic (genetic) data. Repetative stocking of the New England strain in the past (Holloway, 1945) will require a decision as to if this northern form or its genes persist in the Park. That is, the purity of the

"Appalachian strain" geographically within the Park needs to be determined.

In the event of the established uniqueness of the brook trout presently inhabiting the Park, positive steps can be taken to both maintain its present distribution and restore its former range. Certain high elevation streams containing brook trout habitat are now devoid of this fish. It would be undesirable if intergrades (i.e. northern X southern forms) were stocked in these pristine, upper elevation reaches of stream and allowed to "swamp" the existing pure gene pool. On the other hand, pure southern Appalachian fishes may yet exist and can be restocked in reaches lacking fishes. Steps also can be taken for their propagation to permit more extensive stocking throughout the Park as has been attempted with the northern form in the past.

Further protection may be afforded through listing the southern form as a threatened subspecific entity and defining its "critical habitat" on the basis of altitudinal criteria. Programs directed at removal of the highly competitive rainbow in selected streams would then conceivably have a firm basis in Park management schemes.

Conversely, the purity of the native brook trout gene pool may be non-existent and/or its uniqueness may not be established. This would then provide the Park Service with an alternative management plan with less emphasis on preserving and restoring this "native form" in wake of the advancing exotic rainbow and its thriving fishery.

Previous Related Research:

The only research directed toward the systematics of the brook trout in the Great Smoky Mountains National Park was cursorial in nature (Lennon,

1967). He compared number of spots and adjusted means of ten body parts to those recorded by Wilder (1952) for the northern form of brook trout in Nova Scotia. Spotting patterns were different but analysis of covariance indicated a significant difference in only four of the ten adjusted morphometric measurements. These four measurements are therefore viable and should be employed in the proposed study in addition to proportional measurements (to be determined later, e.g., head width/body depth, eye diameter/head length) not calculated by Lennon.

Although electrophoresis has been used for over 30 years to distinguish multiple fractions of proteins, it has only been since 1970 that techniques have been discussed and considered as a valuable systematic tool (Avisé, 1974). Enzymes, blood serum, and muscle proteins have been extensively studied and utilized in electrophoretic work with brook trout (Morrison and Wright, 1966; Wright and Atherton, 1970; Wuntch and Goldberg, 1970; Nyman and Shaw, 1971). Other research (Bouck and Ball, 1968) has implicated eye lens proteins as both easier to utilize and more discriminative than above components. This has been confirmed by Eckroat and Wright (1969). More recently, Eckroat (1971) has shown that lens proteins variations will distinguish both hatchery and wild (natural) populations of brook trout.

Snieszko (1957) suggested that disease resistance justified classification of the Appalachian form as a subspecies. Low fecundity of the Park brook trout also may indicate it is a different strain. Both genetic (McFadden, 1961) and environmental (Rounsefell, 1957) factors have been pointed out as causative agents in differing fecundities of brook trout populations. The southern form has been recorded to have both more rows (Holloway, 1945) and smaller size (Bridges, 1958) of spots. Local study and testimony combined with more broad geographic information imply the uniqueness of the

native brook trout inhabiting the waters of the Park. However, a detailed systematic analysis of the present populations is necessary before future management programs can be implemented.

Methods and Analyses:

Field - A series (minimum of 25 fishes) of brook trout will be collected by electrofishing at each sampling site. Localities within all major drainages of the Park will be sampled. Arrangements will be made to obtain additional series of southern brook trout from North Carolina, Georgia and of the northern New England form for comparisons.

Specimens collected will be preserved in formalin for later laboratory examination and measurements. Number of rows of red spots on fresh fishes will be recorded for each series collected. A subgroup of each sample will be kept fresh with ice until blood, liver, heart, skeletal muscle, vitreous humor and eye lens can be removed and preserved by freezing for later lab analysis.

Laboratory - Measurements which have been employed to distinguish the northern and southern forms of brook trout (Lennon, 1967) will be made based on Wilder (1952) and methods listed in Hubbs and Lagler (1958). Other viable characters for separation of the two forms of brook trout will be sought.

All previous electrophoretic work is based upon the northern form of the brook trout. For sake of comparison, electrophoresis will be performed on all or a combination of blood, enzymes, muscle and eye proteins.

Both starch and acrylamide gel techniques will be employed in examination of enzymes, blood and tissues. Methodology will be based upon recent literature on brook trout electrophoretic work (see previous related research section) and that developed and workable in the laboratory at Tennessee Technological University on rainbow trout and shad (McCarty, 1974; Byrne, 1976).

Statistical - Electrophoretic banding patterns (zymograms) and morphometric and meristic data will be compared by observation. Chi square, analysis of variance, group comparison tests, and regression analysis will be used to define trends in and significance of different banding patterns. Taxonomic decisions will be based on degree of similarity or difference as shown by a combination of characters. Agreement of banding patterns with morphometric and meristic data from both northern and southern populations will be interpreted as strong evidence that the form inhabiting waters of the Smokies is indeed a separate entity (subspecies, race) of the brook trout. Similarity or intermediacy of banding patterns of Park fish to those shown by proposed research and patterns in the literature will be viewed as evidence that the southern form is a non-distinct gene pool and/or has been swamped out by genes from past introductions (stocking) of the northern brook trout.

Budget

Personnel

Graduate student assistant

\$298/month for 12 months	3,576.00
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\$325/month for 12 months	3,786.00
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Hourly help, 120 hours @\$2.25/hour	270.00
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Tuition and fees for 5 quarters

@ \$417/qtr	2,085.00
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Indirect costs (38.5%)	2,938.32
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Travel and subsistence	1,500.00
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Shipping of specimens	300.00
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Communication and reports	400.00
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Expendible supplies (gels, dyes,

misc. lab materials)	350.00
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Total estimated budget \$15,205.32

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