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RESEARCH IN AQUATIC HABITATS AT THE SOUTHEASTERN STATION

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Abstract.--Research is urgently needed to provide technology necessary to restore, maintain, or improve approximately 20,000 miles of trout stream in the southern Appalachian Mountains. Studies at the Coweeta Hydrologic Laboratory in western North Carolina have shown that man's activities change the quantity, quality, and stability of water flowing from forest land, and that land management practices which affect these parameters also affect the stream biota. A new program of aquatic habitat research has been started at the Southeastern Forest Experiment Station. Intensive research is needed to meet demands of trout fishermen.

Additional keywords: Trout, research program, research approaches.

Each year, millions of Americans visit the Appalachians, where they camp, picnic, fish, or just relax and enjoy the soothing qualities of flowing water. Approximately 900,000 sportsmen fish some 20,000 miles of trout water in the southern Appalachians. The popularity of sport fishing continues to grow, and mountain streams in our national forests are currently receiving increasing pressure from some 10 million sport fishermen who live within driving distance of this region. Despite this large and growing public interest, the management of trout fisheries has not received the attention on public lands that managers extend to wildlife. Most land managers appreciate the recreational aspects of sport fishing and the importance of protecting watersheds and water quality. But they have limited knowledge about trout stream management or the ecology of aquatic resources in general.

There are three elements involved in managing a trout stream for sport fishing: the environment, the fish, and the angler. From the management or research point of view, these elements are not mutually exclusive. The environment and fish are parts of an intricate ecosystem upon which the angler is superimposed as an external predator. We know most about managing trout. Population structure and arrangement, territoriality, physiological functioning, attributes of different species of trout, etc., have all been studied in detail. We know considerably less about the angler and what motivates him to seek certain experiences in conjunction with his pursuit. For the most part, confirmed trout fishermen seem to be independent, intolerant, and demanding when it comes to land management activities that might influence their sport. Questions outnumber answers about managing or improving stream environments, because such environments reflect complex patterns of local geology, climate, and vegetation. Such patterns determine the chemical, physical, and biological features of streams, and these features, in turn, determine the condition of the habitat for trout. Research is needed to define those characteristics of trout habitat in the Appalachians which are subject to management and intentional and unintentional modification. Such knowledge will provide a sound basis for management decisions that will protect and possibly enhance the trout resource for future generations of fishermen.

Our program for aquatic research is new; we are emphasizing trout habitat, recognizing that other aquatic habitats are also involved and equally important. This paper indicates the relevancy of past research by the U.S. Forest Service and describes trout habitat research that is proposed or currently underway at the Southeastern Station.

PAST RESEARCH

Research over the past 40 years at the Coweeta Hydrologic Laboratory in western North Carolina has shown that water is a most sensitive indicator of watershed activities. Early experiments at Coweeta documented the effects of mountain farming, logging, and grazing practices on water quality and yield (Lieberman and Hoover, 1948; Greene, 1950; Dils, 1952; Johnson, 1952). Later studies verified that water yield and timing can be changed substantially by drastically altering forest cover (Hewlett and Hibbert, 1961; Hibbert, 1966; Swank and Miner, 1968). Other studies examined road design, construction, and location with respect to erosion and water quality and pointed out the importance of minimizing soil movement during timber harvest (Hursh, 1935; Lieberman and Hoover, 1948; Jones, 1955).

Some of the first documented evidence of the detrimental effects of logging on stream biology was collected at Coweeta by the North Carolina Wildlife Resources Commission in the early fifties. This investigation established relative values for invertebrate biomass, measured effects of siltation and stream zone clearing on bottom organisms and temperatures, and established feeding preferences of rainbow, brook, and brown trout (Tebo, 1955; 1957). Later studies showed that stream temperatures could be increased, decreased, or left unchanged depending on the type of cutting practice employed (Swift and Messer, 1971), and that temperature increases caused by clearcutting could be moderated by streamside buffer strips (Swift and Baker, 1973).

In conjunction with the IBP Program, the processing structure of several small streams was partially revealed by toxonomic and trophic investigations. Studies showed that the benthic fauna in woodland streams can be altered by cutting treatment and forest-land conversion (Woodall and Wallace, 1972) and revealed nutrient pathways and the capacity of small streams to alter and process various kinds of material (Woodall, 1972).

Many excellent studies have been conducted at Coweeta on small watershed streams. Investigations clearly show that man can and does change the quantity, quality, and stability of water flow from forest land, and that practices which affect these parameters also affect the stream biota. These findings provide a valuable beginning for the biologist concerned with the trout resource in the Appalachians.

CURRENT RESEARCH

The Program

Streams are biological units which process and utilize organic and inorganic materials of terrestrial origin. Such units are sensitive to change, and activities on the land which disrupt or change the material balance between the stream and the watershed are potentially harmful to certain portions of the stream biota. Trout are very sensitive to chemical, physical, and biological changes in their habitat. While such sensitivity has eliminated trout from many miles of once productive water, it simplifies the research problem. The fish themselves are excellent response variables which can be used to determine how changes in habitat affect them.

Our research program is designed to develop the technology needed to protect and enhance the aquatic environment and the trout fishery in the Appalachian Mountains while maintaining and enhancing other resource values. We hope to (1) determine how variations in water quality, food cover, and fishing pressure influence trout production; (2) establish environmental standards for logging, road construction, land clearing, and mining to prevent adverse impacts on trout; and (3) provide methods and technology for restoring and maintaining productive capacities of trout streams.

Research Approaches

Our approaches, when possible, are designed to predict the influences of land management practicies on stream biology. Effects of timber harvesting, roading, construction, and other forms of disturbance can be evaluated through land-use impact studies. This approach is readily applicable to management situations which could not be duplicated experimentally. The disadvantage of this approach is that it does not fully explain the reason for observed changes, and the results may not be directly applicable to other environmental situations.

Another approach, and the one we will emphasize, is habitat analysis. This is a basic approach which relates population characteristics of trout and other organisms to the stream environment. When possible, observations will be made over a range of stream types, rather than one as in conventional case history studies. This technique adds realism to our models by considering the ofttimes overlooked dimension of natural variation and its effects on results.

Current Studies

We recently began research to determine reasons for the wide disparity among population densities, size of fish, and composition of trout in our mountain streams. One facet of this work compares the growth rate of different fish stocks with the relative abundance of the food and of the fish population. Another facet relates population density to the physical and chemical characteristics of streams. By measuring trout density, species composition, and growth characteristics and relating these factors to the availability of food and cover, water chemistry, and stream morphology, we will begin assembling fundamental data needed to formulate suitable management practices.

In one opportunistic study, we measured the effects of a severe flood on protective cover for a large known density of trout. The flood significantly reduced quantities of logs, undercut banks, and brush, cover units used by large fish in study sections. These losses were offset by increases in the cover-affording capacity of stream-bottom material. The size of cover units available to fish after the flood was disproportionately reduced, however. As a result, study sections now primarily support a larger density of smaller size trout.

We are also studying the effects of a small waste treatment facility on a trout stream. Results from this study will show what effects nutrients have on the biology of relatively sterile receiving waters.

We are planning several important new studies. One will investigate the effects of cable logging on the aquatic resource. Such logging systems may greatly reduce formation and transport of erosion products which frequently damage streams during and after conventional timber-harvest operations. Another study will evaluate forest fertilization and its effects on stream biology. Fertilization may benefit trout by increasing overall stream productivity.

Future Direction

Our proposed program will require a team of researchers including specialists in fisheries management, aquatic ecology, and entomology. We will enlarge the overall research effort through cooperative programs with neighboring universities, State and Federal agencies, and interested conservation groups.

We must closely examine existing food chains and webs available to trout. Efforts must be made to relate productivity of food organisms to water chemistry, food availability, and physical habitat. We must determine how the invertebrate biota is affected by land management and how the distribution, composition, and abundance of key invertebrates vary seasonally.

We must begin to intensively evaluate the effectiveness of current guidelines for roading and logging practices as protectors of the aquatic environment. We must identify geologic, moisture, and soil conditions for which modified or new criteria are needed.

In light of current demands for both trout fishing and forest products, we must also consider permissible ranges of alterations to the stream biota. Some alterations may benefit the fishery by, for instance, increasing the supply of available food or even cover without stressing other portions of the habitat. Perhaps the careful and limited removal of streamside vegetation could increase the growth of periphytic plants sufficiently to appreciably raise production of grazing aquatic organisms. Or, perhaps, changing the structure or species composition of streambank vegetation could provide additional cover and more nutritious or decomposable material to the stream biota.

These are some questions we hope to answer. Studies which deal with various facets of protection and those which have immediate management potential will receive priority in our research program.

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