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USING PHYSICAL, CHEMICAL AND BIOLOGICAL INDICATORS TO ASSESS WATER QUALITY ON THE OUACHITA NATIONAL FOREST UTILIZING BASIN AREA STREAM SURVEY METHODS

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ABSTRACT

The Ouachita National Forest (ONF) has developed a series of Best Management Practices (BMP's) designed to protect water quality and associated beneficial uses (fisheries, municipal water supplies, etc.). A monitoring program is necessary to document the effectiveness of that protection. The Basin Area Stream Survey (BASS) methodology provides a monitoring link from BMP's to the aquatic ecosystems. The goal of BASS is to identify the physical, chemical and biological characteristics of a stream in a format that will allow comparisons with other streams, and indicate when a stream is being impacted. Six index streams within two ecoregions were selected and inventoried in 1990, 1991, and 1992, to serve as baseline data sources. The South Fork of Alum Creek and Bread Creek represent the upper Ouachita Mountain Ecoregion, Caney Creek and Brushy Creek represent the lower Ouachita Mountain Ecoregion, and Jack Creek and Dry Creek represent the Arkansas River Valley Ecoregion.

INTRODUCTION

The National Forest Management Act (PL 94-588) requires the Forest Service to maintain or enhance water quality and soil productivity. The Clean Water Act of 1972 (PL 92-500) further requires the protection of beneficial uses and designates the State as the responsible agency. The Environmental Protection Agency has determined that the development and utilization of BMP's are the methods to meet state water goals for nonpoint pollution.

In conjunction with the States of Oklahoma and Arkansas, the ONF has developed a series of BMP's (USDA Forest Service, Ouachita National Forest, 1990). These practices, when properly implemented, should protect water quality and associated beneficial uses. While it is assumed that the BMP's are fully protecting beneficial uses, a monitoring program is necessary to document the effectiveness of that protection. One of the shortfalls of BMP's is that they are not directly tied to beneficial uses. BASS provides the monitoring link from BMP's to the aquatic ecosystem and beneficial uses.

Pfankuck (1975), Bisson *et al.* (1981), Hanken (1984) and Ebert *et al.* (1989) have developed criteria in the form of stream inventories to describe the physical, chemical and biological characteristics of streams. This study applied a paired-basin technique to use stream inventories in assessing the effects of forest management (Ponce *et al.*, 1982).

OBJECTIVE

The objective of BASS is to identify the physical, chemical and biological characteristics of a stream in a format that will allow comparisons with other streams, and may identify trends concerning stream health and impairment of beneficial uses.

METHOD AND MATERIALS

The first criteria was the recognition of ecoregions. The ONF used the Arkansas Department of Pollution Control and Ecology's ecoregion concept (Bennett, *et al.*, 1987) with modification of the Ouachita Mountain Ecoregion. The Ouachita Mountain Ecoregion was separated into an upper and lower subdivision.

Within each ecoregion or subdivision, two watersheds were selected based on past management activities, comparable size, ownership, and proximity. Watersheds containing little or no timber harvesting activities served as control basins, while watersheds with harvesting activities typical of the ONF represented managed basins. Candidate watersheds were large enough to support a resident fishery, with primarily Forest Service ownership, and proximal to the other watershed in the ecoregion (Table 1).

Table 1. Stream inventory information.

Stream	Kilometers Inventoried	Ecoregion	Control/ Managed
S. Alum Fork	7.7	upper Ouachita Mtn	C
Bread Creek	8.5	upper Ouachita Mtn	M
Caney Creek	13.5	lower Ouachita Mtn	C
Brushy Creek	8.8	lower Ouachita Mtn	M
Dry Creek	9.1	AR River Valley	C
Jacks Fork	7.0	AR River Valley	M

PHYSICAL

Physical inventories began at the downstream or lower end of the watershed. Moving upstream, habitat types (or reaches) were consecutively numbered beginning with one. The minimum reach identified was ten meters in length. Individual stream reaches were flagged and labeled with the reach number and habitat type. Habitat types were coded according to McCain *et al.*, (1990). The length and width of each reach were measured to the nearest tenth of a meter. Mean bankfull width was visually estimated to the nearest meter.

A transect of depths was measured to the nearest centimeter. The transect measurements occurred at the waters edges, one quarter, half and three quarters of the width. In addition, the depth at the thalweg was measured to the nearest centimeter. All widths and depths were measured at the midpoint of the reach or habitat type. For example, if a reach was 12 meters long, the width was measured at six meters.

Substrate material was expressed as a percentage of the entire area of the reach. Substrates were classified into bedrock, boulder (>30cm), cobble (8-30 cm), gravel (8-1 cm), sand (1 cm-0.5 cm) and fines (<1 mm), according to a modified Wentworth scale (Bovee and Cochnauer, 1977). Embeddedness was estimated as the average percent of cobble-sized substrate surrounded by fines.

Cover factor for fisheries was estimated as a percent of the habitat area. Categories included undercut banks, large woody debris (d>0.15 m, logs and rootwads), small woody debris (d<0.15 m), terrestrial vegetation overhanging stream (h<0.3 m), white water, boulder (d>30cm), bedrock ledges, clinging vegetation on substrate and rooted vegetation in the stream substrate (Platts *et al.*, 1987).

Each stream bank angle was measured in degrees with a clinometer. For example, vertical banks were 90 degrees, undercut banks were less than 90 degrees (Platts et al., 1987). Bank stability was estimated for each bank, as a percent of the bank intact and/or non-erodible. Terrestrial vegetation was classified as brush, grass, forest or barren. Canopy closure was recorded as the percent of vegetation closure and measured using a spherical densiometer while facing upstream in the middle of the reach.

BIOLOGICAL

The biological inventory was based on a 10% sample of all stream reaches typed. For example, if 27 main channel pools were identified within a stream then three main channel pools were sampled. Sample areas were stratified along the length of the stream.

For fish collections, the habitat reach was isolated with block nets. Collections were made using the multiple-depletion, maximum likelihood estimation method of Van Deventor and Platts (1985). This involved at least two and preferably three or more electroshocking passes through the sample area. These passes covered the entire reach in an upstream progression with consistent effort on all passes. The downstream block net was surveyed for fish after every pass and captured fish were included with that pass. Each pass comprised a sample and was placed in separate containers. Fish were preserved in 10% formalin and labeled. Game species, endangered, threatened, or sensitive species were measured and weighed in the field and returned to the stream.

Aquatic macroinvertebrates were collected with a five-minute kick-net sample, utilizing the same reaches sampled for fisheries. Reaches were sampled as the collector shuffled or kicked the substrate with the dip net positioned directly downstream. All microhabitats (woody debris, leaf packs, etc.) within the reach were included in the sample. At the completion of the five-minute kick sample, an additional five-minute sample from washed substrate was taken. The dip net was placed downstream and individual cobbles were scrubbed with a soft bristle brush into the dip net. That sample was combined with the kick-net sample. Large organic debris and leaves were washed and removed from the sample. Aquatic macroinvertebrate samples were preserved in 70% ethanol and labeled (Merritt and Cummins, 1984).

CHEMICAL

Water chemistry and flow data were collected in the same areas sampled for biological characteristics. Volume flow, dissolved oxygen, turbidity and temperature were measured in the field. Water samples were collected and preserved for analysis. Water analysis included suspended sediment, turbidity, conductivity, pH, bromide, nitrate, boron, silicon, zinc, phosphorous, iron, copper, manganese, magnesium, sodium, cobalt, aluminum, nickel, calcium, titanium, chromium, lead, sulfate, acidity and chloride.

DISCUSSION

The Basin Area Stream Survey is a method for the systematic and comprehensive collection of data in lotic aquatic ecosystems.

Following the analysis of the data, the frequency and characteristics of habitat types in a given stream and ecoregion may be compared and contrasted. Within habitat types, physical characteristics, biological criteria and chemical parameters may also be evaluated.

After determining the variability within and between managed and control stream systems and ecoregions or subdivisions, trends in habitat composition and stream characteristics may be monitored. Additionally, the six streams become index streams for comparison to other streams within their respective ecoregions or subdivisions.

In conjunction with management history and sediment models, predictive models concerning beneficial uses may be developed based on management activities. This will allow resource managers to make more informed decisions regarding management practices and provide a link between Best Management Practices and effects on beneficial uses.

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LITERATURE CITED

BENNETT, C., J. GIESE, B. KEITH, M. MANER, R. MCDANIEL, B. SINGLETON. 1987. Physical, chemical, and biological characteristics of least-disturbed reference streams in Arkansas' ecoregions. State of Arkansas, Department of Pollution Control and Ecology, Little Rock, AR 72219. I-II.

BISSON, P.A., J.L. NIELSEN, R. PALMASON, and L.E. GROVE. 1981. A system of naming habitat types in small streams, with examples of habitat utilization by salmonids during low streams flow. In N.B. Armantrout [ed.] Acquisition and Utilization of Aquatic Habitat Inventory Information, Western Division, American Fisheries Society, Portland, OR 97208. 376 pp.

BOVEE, K.D. and T. COCHNAUER. 1977. Development and evaluation of weighted criteria, probability-of-use curves for instream flow assessments: fisheries. USDI Fish and Wildlife Service, Instream Flow Information Paper 3, FWS/OBS - 77/63, Fort Collins, CO 80526.

EBERT, D.J., S.P. FILIPEK, and R.D. PATTON. 1989. A basic habitat analysis guide for Arkansas streams. USDA Forest Service, Unpublished Report, Russelville, AR 72801.

HANKIN, D.G. 1984. Multistage sampling design in fisheries: applications in small streams. Canadian Journal of Fisheries and Aquatic Sciences. 41:1575-1591.

MCCAIN, M., D. FULLER, L. DECKER, and K. OVERTON. 1990. Stream habitat classification and inventory procedures for northern California. USDA Forest Service, Pacific Southwest Region, FHR Currents, San Francisco, CA 94111. 1:1-16.

MERRITT, R.W. and K.W. CUMMINS. 1984. An introduction to the aquatic insects of North America. Kendall/Hunt Publishing Co., Dubuque, IA. 722 pp.

PFANKUCK, D.J. 1975. Stream reach inventory and channel stability evaluation. USDA Forest Service, Northern Region Federal Building, R1-75-002, Missoula, MT 59807. 26 pp.

http://scholarworks.uark.edu/jaas/vol46/iss1/40

PLATTS, W. S., C. ARMOUR, G.D. BOOTH, M. BRYANT, J.L. BUFFORD, P. CUPLIN, S. JENSEN, G.W. LIENKAEMPER, G.W. MINSHALL, S.B. MONSEN, R.L. NELSON, J.R. SEDELL, J.S. TUHY. 1987. Methods for evaluating riparian habitats with applications to management. General Technical Report INT-221, USDA Forest Service, Intermountain Research Station, Ogden, UT 84401. 177 pp.

PONCE, S.L., D.W. SCHINDLER, and R.C. AVERTT. 1982. The use of the paired-basin technique in flow-related wildland water-quality studies. USDA Forest Service, Watershed Systems Development Group, WSDG-TP-00004, Fort Collins, CO 80526. 21 pp.

USDA FOREST SERVICE, OUACHITA NATIONAL FOREST. 1990. Amended land and resource management plan. USDA Forest Service, Ouachita National Forest, Hot Springs, AR 71902. 423 pp.

VAN DEVENTOR, J.S. and W.S. PLATTS. 1985. A computer software system for entering, managing, and analyzing fish capture data from streams. USDA Forest Service, Intermountain Research Station, Ogden, UT 84401. 12 pp.