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EFFECTS OF REMOVAL OF INSTREAM DEBRIS ON TROUT POPULATIONS

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Abstract: In Poplar Creek and South Fork Mills River, North Carolina, the occurrence of debris as cover for brown trout (*Salmo trutta*) and rainbow trout (*Salmo gairdneri*) was directly correlated with fish numbers and biomass. Cover was the limiting factor for larger fish. The limiting factor for small fish was a variable associated with flow or substrate size. The decision on whether to remove debris should be based on the identification of limiting factors and a clear formulation of the intended outcome. If the management objective is to maintain the number of large fish, debris removal should be discouraged.

Key Words: trout; fish management; *Salmo trutta*; *Salmo gairdneri.*

INTRODUCTION

Cover is an important component in the habitat requirements of trout, and the addition of cover has been correlated with increases in fish numbers and biomass (Tarzwell, 1937; Shetter et al., 1949; Boussu, 1954; Gard, 1961; Lewis, 1969; Hunt, 1971). In a general way, decreases in cover have been correlated also with decreased fish numbers and biomass (Boussu, 1954).

Instream debris normally provides cover for trout (Hartman, 1965; Bustard and Narver, 1975). In many streams, however, instream debris builds up in jams or piles against downed trees, rocks, or bends in the creek bed. In extreme cases these piles of debris block trout spawning runs (Bishop and Shapely, 1962; Narver, 1971), and in other instances debris piles may become a hydrological hazard to the stream bed or surrounding structures. The manager must then decide whether the debris should or should not be removed.

The knowledge of the significance of debris cover to fish, the conflict of debris with sound hydrology, and economic considerations that dictate debris removal, pose a difficult problem for the fisheries manager. The tradeoffs inherent in this situation can be made intelligently only if information is available pertaining to the effects of debris removal on fish populations.

METHODS

The study was conducted on Poplar Creek and the South Fork Mills River in Transylvania County, North Carolina, within the Pisgah National Forest. The two streams originate on the east side of the Blue Ridge Mountain in a geological

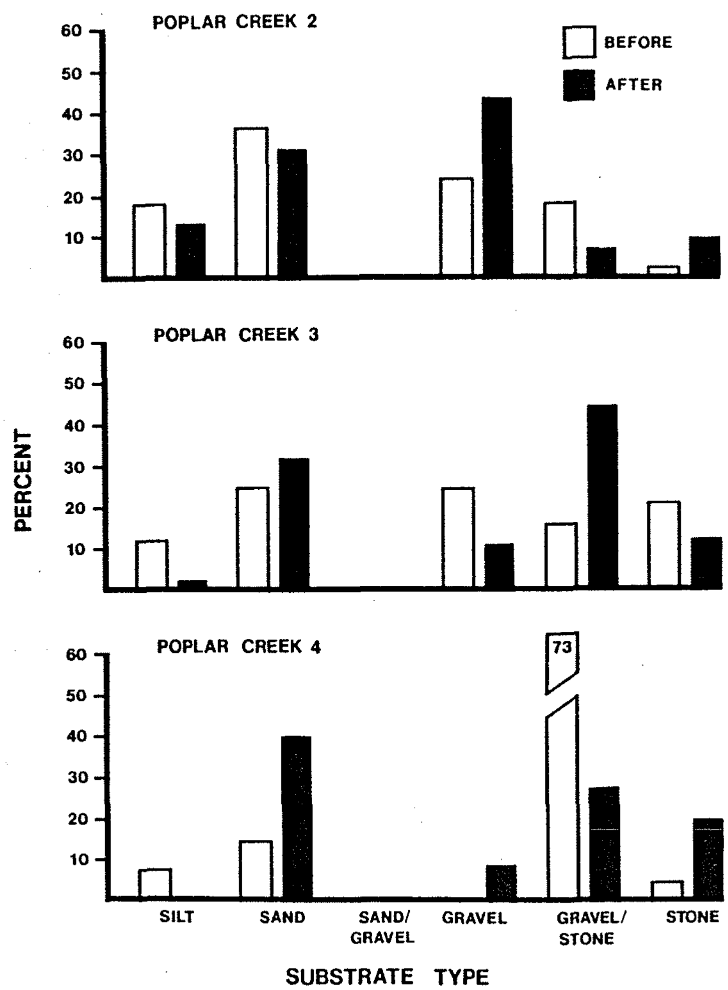

FIG. 1. Substrate composition (percentages) in the three Poplar Creek experimental sites before and after treatment. Data from non-debris control and debris-containing control are not shown.

area known as the Pink Beds at about 975 m (3,200 ft). Both streams have generally low gradients (<7 m mile), are of medium size (3–5 m wide, 0.5–1.0 m deep in summer) and are relatively unproductive (alkalinity, 4–5 ppm; hardness, 6–8 ppm). The streams contain both brown trout (*Salmo trutta*) and rainbow trout (*Salmo gairdneri*) and the "fish" or trout that we refer to here represent the sum of both varieties, without distinction.

Four stream sections, 30–40 m long, that contained debris accumulations, and one section that contained no debris were selected on each stream as experimental areas. The physical characteristics of each section were mapped in May 1975. Fish 10 cm long or longer were weighed and measured. Fish were taken by blocking upper and lower ends of the section with nets and conducting electrofishing depletion estimates in each section in August 1975, before the experiment began, to provide baseline information on fish populations.

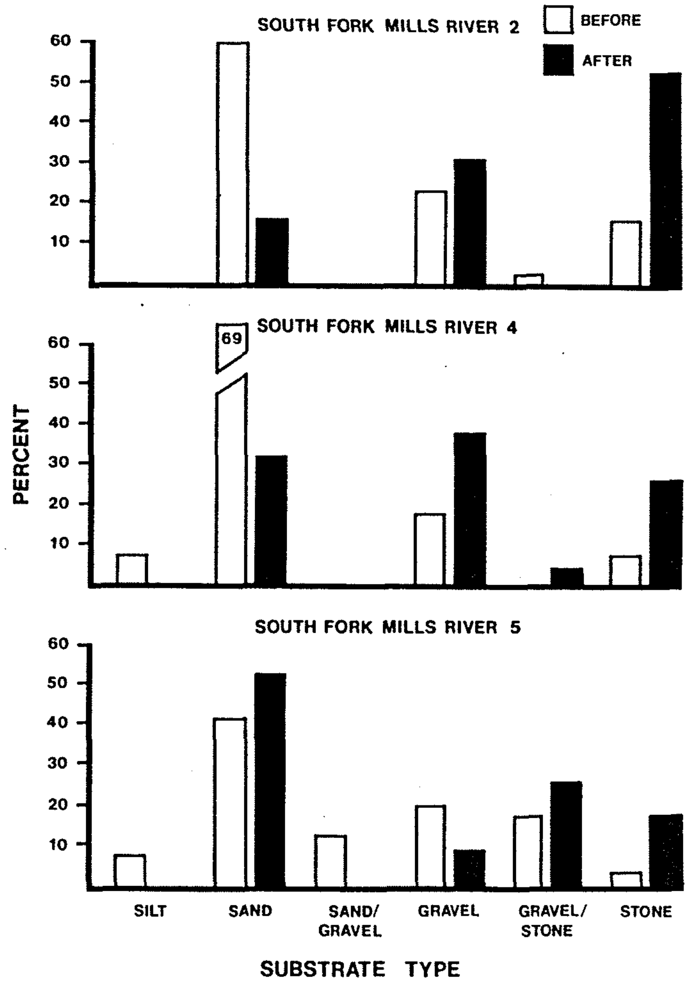

FIG. 2. Substrate composition (percentages) in the three South Fork Mills River experimental sites before and after treatment. Data from non-debris control and debris-containing control are not shown.

In mapping we used the particle size categories of Whitworth et al. (1968) to map the substrate and obtained a quantitative measure of the cover. Cover was defined as overhanging banks (including vegetation), instream debris, and overstream debris and vegetation, and was considered to extend 0.3 m outward from the actual structure. Therefore, structures within 0.6 m of each other were counted as one cover unit.

After physical and biological conditions in the sections had been documented, we removed the debris from three sections. Debris removal required several weeks. When debris removal was completed, we repeated the fish and substrate sampling and mapping. Samples were collected in September 1975, and April and June 1976.

Populations of trout were compared within sections and among sampling dates in terms of numbers, average weight, average lengths, and biomass. Biomass was

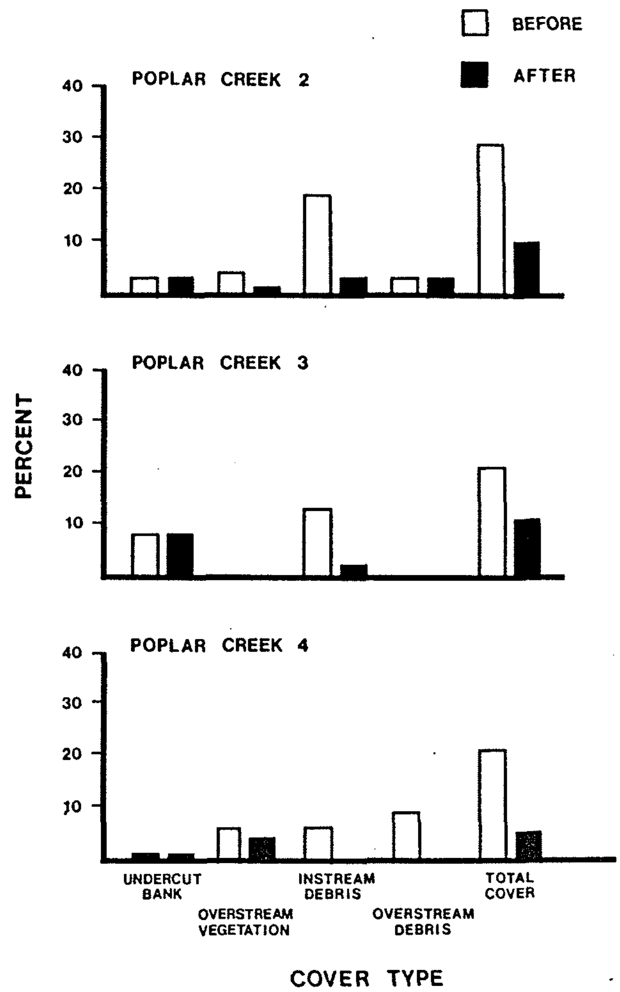

FIG. 3. Cover types (percentages) in the three Poplar Creek experimental sites before and after treatment. Data from control sites are not shown.

defined as the average weight of fish taken times the estimated number of fish present as determined from depletion population estimates. These factors were then regressed on physical factors to identify those that were important. To test the hypothesis that large and small fish might respond differently to debris removal and thereby confound results, we tested the data with a Wilcoxon distribution free rank sums test to determine if fish living in sections containing debris were larger than those with no debris.

RESULTS

In general debris removal resulted in decreases in the amount of silt but had variable effects on the percentages of most other substrate sizes, with a predominate increase in stone (Figs. 1 and 2). Removal of debris did not generally affect

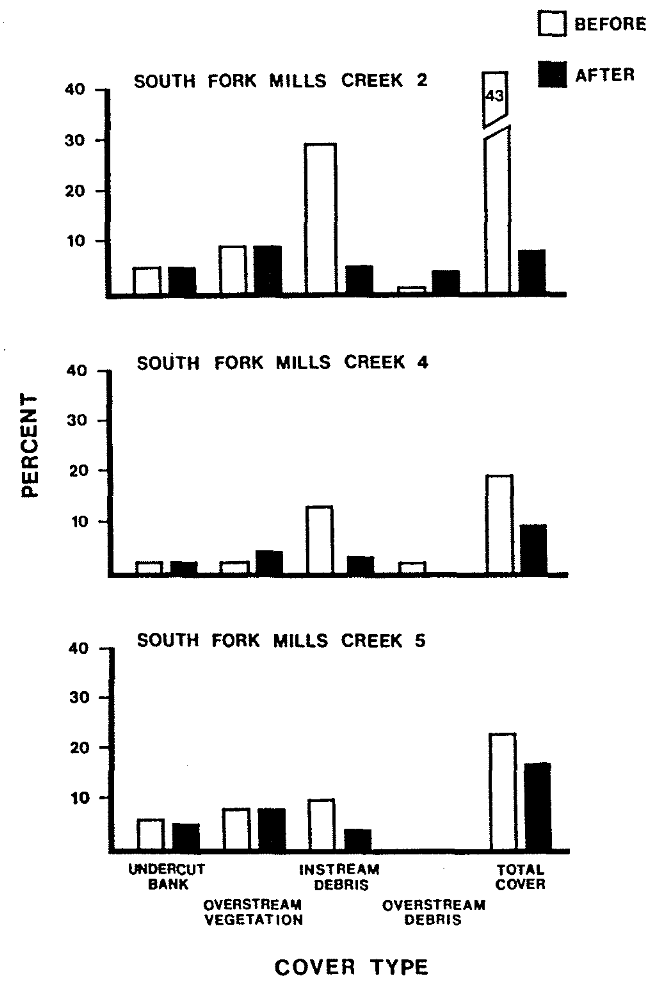

FIG. 4. Cover types (percentages) in the three South Fork Mills River experimental sites before and after treatment. Data from control sites are not shown.

the amount of cover in other cover categories but did cause a decrease in the total cover available (Figs. 3 and 4).

Total numbers of trout showed no consistent trends immediately after debris removal, generally increasing on Poplar Creek and decreasing on South Fork Mills River (Fig. 5). Biomass generally decreased after debris removal in the South Fork Mills River (Fig. 6). The Poplar Creek study areas showed slight increases in biomass.

Regression analysis indicated that only instream debris and substrate size, among the variables tested, were important in determining trout biomass ($R^2 = 0.58$) and numbers ($R^2 = 0.73$). However, fish in the debris-containing areas were larger than those in non-debris areas [$W^* \gg$ (0.08)].

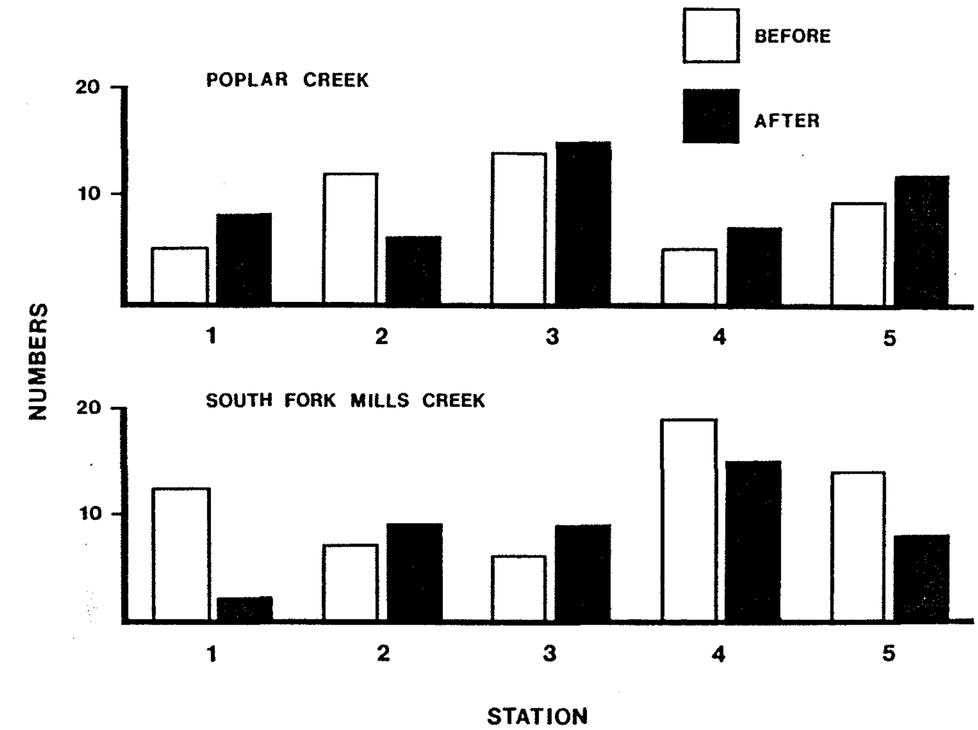

FIG. 5. Pre and posttreatment numbers of trout in the ten study sections. Sites 1 and 3 on South Fork Mills River and sites 1 and 5 on Poplar Creek were not treated.

DISCUSSION

At first glance the data do not appear to support the hypothesis that removal of debris would result in decreases in numbers and biomass of trout. Such an explanation is reasonable if cover is not the limiting factor for fish in these streams. Closer evaluation of the data, however, shows that, although numbers either increased or decreased after debris removal, overall treatment biomass decreased. This information, in addition to the fact that debris-containing sections were inhabited by larger fish than sections containing no debris, led us to conclude that larger fish moved out of areas from which debris had been removed. Thus cover was probably limiting for larger fish in our study sections.

The variable results in fish numbers remain to be explained. Previous workers have emphasized the importance of current among the habitat requirements of trout—especially of small ones (Baldes and Vincent, 1969; Lewis, 1969). It can be argued that substrate size is a better biological measure of flow characteristics than actual point measurements of flow because of the difficulty in extrapolating point measurements to the entire area; hence, the larger the substrate size the greater the rate of flow. If this hypothesis is accepted the numbers of fish generally increased where flow increased after debris removal; and where flow decreased, the numbers of fish either decreased or remained about the same. We therefore

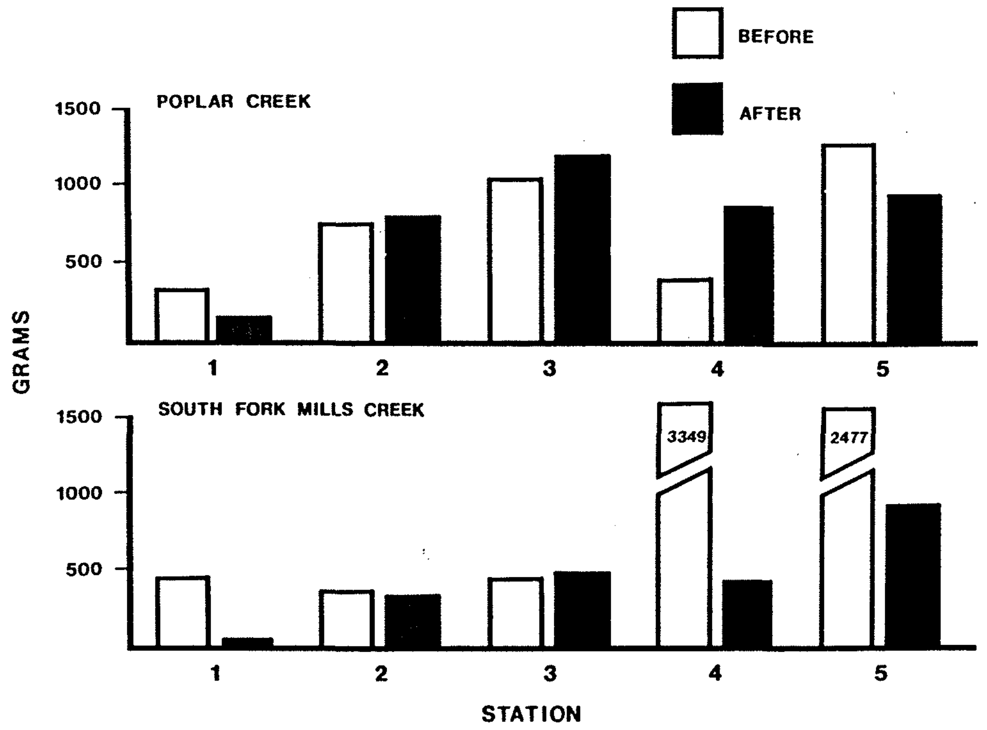

FIG. 6. Pre and posttreatment biomass of trout in the ten study sections. Sites 1 and 3 on South Fork Mills River and sites 1 and 5 on Poplar Creek were not treated.

concluded that the limiting factor for small fish was a variable associated with flow or substrate size.

This study showed that management depends on correctly identifying the limiting factor for the segment of the population to be measured and on clearly formulating management objectives. If the management objective is to maintain the number of large fish, debris removal should be discouraged; but if the objective is to increase numbers regardless of size, debris removal should be encouraged—especially in areas where the hydrological result is increased flow. The correct management decision is based on the proper identification of limiting factors and a clear formulation of the management objective.

LITERATURE CITED

BALDES, R. J., AND R. E. VINCENT. 1969. Physical parameters of microhabitats occupied by brown trout in an experimental flume. Trans. Am. Fish. Soc. 98:230–238.

BISHOP, D. M., AND S. P. SHAPELY. 1962. Effects of log-debris jams on southeast Alaska salmon streams. Proc. Alaska Science Conf. 1962:90.

BOUSSU, M. F. 1954. Relationships between trout populations and cover on a small stream. J. Wildl. Mgmt. 19:229–239.

BUSTARD, D. R., AND D. W. NARVER. 1975. Aspects of the winter ecology of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). J. Fish. Research Board of Canada 32:667–680.

GARD, R. 1961. Creation of trout habitat by constructing small dams. J. Wildl. Mgmt. 25:384–390.

HARTMAN, G. F. 1965. The role of behavior in the ecology and interaction of underyearling coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). J. Fish. Research Board of Canada 22:1035–1081.

HUNT, R. L. 1971. Responses of a brook trout population to habitat development in Lawrence Creek. Wisconsin Dept. of Nat. Resources Tech. Bull. 48. 35 pp.

LEWIS, S. L. 1969. Physical factors influencing fish populations in pools of a trout stream. Trans. Am. Fish. Soc. 98:14–19.

NARVER, D. W. 1971. Effects of logging debris on fish production. Pp. 100–111 *in* J. T. Krygier and J. D. Hall, eds., Forest Land Uses and Stream Environment. Continuing Education Publications, Oregon State Univ., Corvallis.

SHETTER, D. S., O. H. CLARK, AND A. S. HAZZARD. 1949. The effects of deflectors in a section of a Michigan trout stream. Trans. Amer. Fish. Soc. 76:248–278.

TARZWELL, C. M. 1937. Experimental evidence on the value of trout stream improvement in Michigan. Trans. Amer. Fish. Soc. 66:177–187.

WITHWORTH, W. R., P. L. BERRIEN, AND W. T. KELLER. 1968. Freshwater fishes of Connecticut. State Geol. and Nat. Hist. Survey, Connecticut, Div. of Dept. of Agric. Nat. Resources Bull. 101. 134 pp.

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