IMPORTANCE AND EVALUATION OF INSTREAM AND
RIPARIAN COVER IN SMALLER TROUT STREAMS

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In

Riparian Ecosystems and Their Management:
Reconciling Conflicting Uses
First North American Conference
Tucson, AZ

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Importance and Evaluation of Instream and Riparian Cover in Smaller Trout Streams[1]

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Cover is an important trout habitat component result-
ing from the geomorphological characteristics of a stream
channel, the streambank interface with the riparian
community, and the streamflow. This paper quantitatively
describes the significance of the riparian contribution to
overall stream cover as related to brown trout population
size.

INTRODUCTION

Cover is an important trout habitat component
resulting from the geomorphological characteris-
tics of a stream channel, the streambank interface
with the riparian community, and the streamflow.
In recent years, numerous habitat models have
included cover measurement as part of the overall
evaluation process. These models include the
Habitat Quality Index (Binns, 1982), the Instream
Flow Incremental Methodology (Bovee, 1982), the
Habitat Suitability Index Models for brown trout
(Raleigh, Zuckerman and Nelson, 1984), the Bureau
of Land Management Stream Habitat Survey (Duff and
Cooper, 1976) and the General Aquatic Wildlife
System of the U.S. Forest Service, Region 4 (Duff,
1981).

Trout cover in smaller streams has been
described by Wesche (1973, 1974 and 1980) as
consisting of three primary components: 1)
instream rubble and boulder areas having a
substrate particle diameter of 7.6 cm or greater
in association with water depth of at least 15 cm;
2) overhead bank cover, including undercut banks,
overhanging vegetation, logs and debris jams,
having effective widths of 9 cm or greater in
association with water depths of at least 15 cm;
and, 3) deep pool areas having water depths of at
least 45 cm. These components were identified
based upon the escape cover preferences of
approximately 2,300 trout (62% brown trout)
sampled by electrofishing. Combining these
components into unitless, additive equations and
incorporating weighing factors based upon trout

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preferences for different cover types, two models
for cover evaluation were developed and tested
against trout standing crops (Wesche, 1980).

The objective of this paper will be to
summarize the application and evaluation of these
two Cover Rating Models, stressing the important
contribution of riparian vegetation to the
availability of cover in small trout streams.

DESCRIPTION OF STUDY AREAS

The results presented in this paper are based
upon field investigations made at 27 study sites
in 11 reaches of 8 montane and foothills streams
located in the North Platte River Basin of south-
east Wyoming. Brown trout (Salmo trutta) was the
predominant game fish species present at all
study sites, comprising 61% to 100% of the total
trout populations, on a numbers basis. Lesser
numbers of brook (Salvelinus fontinalis) and
rainbow trout (Salmo gairdneri) were collected at
certain of the sites. Trout standing crops were
found to range from 8.0 to 210.6 Kg/Ha.

Mean elevations of the study sites ranged from
1615 to 2835 m above mean sea level, while average
discharges through the reaches varied from approx-
imately 0.3 to 4.5 m³/sec. Site lengths averaged
140 m (range of 73 to 253 m). Study reaches, the
combination of several adjacent sites, had a mean
length of 340 m with a range from 134 to 629 m.
Stream widths varied from 2 to 23 m.

More detailed descriptions of the study
streams can be found in Wesche (1973, 1974 and
1980).

METHODS

Trout standing crop estimates were made at
each study site by means of electrofishing using
the three-pass removal method described by Zippin
(1958). Block nets were placed at the upper and
lower ends of each site prior to sampling to
prevent fish migration.

Available trout cover was measured at each study site using the Cover Rating Method described by Wesche (1973, 1974 and 1980). The equation for Model I of this method is of the form:

$$CR = \frac{L_{obc}}{T}(PF_{obc}) + \frac{A_{r-b}}{SA}(PF_{r-b})$$

where L_{obc} = length of overhead bank cover in the study section having a water depth of at least 15 cm and an effective width of 9 cm or greater;

T = length of the thalweg line through the section;

$\frac{L_{obc}}{T}$ = percent overhead bank cover;

PF_{obc} = preference factor of brown trout for overhead bank cover;

A_{r-b} = surface area of the study section having water depths greater than 15 cm and substrate size 7.6 cm in diameter or greater (i.e., rubble and boulder) or a substrate covered with aquatic vegetation;

SA = total surface area of the study section;

$\frac{A_{r-b}}{SA}$ = percent rubble-boulder area;

PF_{r-b} = preference factor of brown trout for instream rubble-boulder-aquatic vegetation areas; and

CR = cover rating value for the study section at the discharge worked.

While Model I was developed for use primarily on smaller streams (average discharge less than 2.75 m³/sec), a deep water component was included in Model II to increase the applicability of the method to larger habitats. The equation for Model II is as follows:

$$CR = \frac{L_{obc}}{T}(PF_{obc}) + \frac{A_{r-b}}{SA}(PF_{r-b}) + \frac{Ad}{SA}$$

where CR, L_{obc}, T, PF_{obc}, A_{r-b}, SA, and PF_{r-b} are exactly the same as defined above for Model I, and

Ad = surface area of the study section having a water depth of 45 cm or greater regardless of substrate or adjacent bankside cover.

Ad/SA = percent deep water area.

Step-by-step procedures for applying the two models are provided in Wesche (1980).

Simple and multiple regression analysis of the relationships between the two cover models and the three individual cover components (independent variables) and trout standing crops (dependent variable) were performed using the ABSTAT package on the Wyoming Water Research Center's CompuPro computer system.

RESULTS

The results of the regression analysis testing the relationships between the independent cover variables (Cover Rating Model I, Cover Rating Model II, percent rubble-boulder cover area, percent overhead bank cover, and percent deep-water cover) and the dependent variable, Kg/Ha of trout, are presented in Table 1 for the site data. The analysis by study reach is provided in Table 2.

Three cover variables (Model I, Model II and percent overhead bank cover), were found to have a statistically significant positive linear relationship with trout standing crop when considered on a site basis. Of the three, percent overhead bank cover was found to explain the greatest amount of variation among the trout populations sampled, 39 percent. Also, the regression using this cover variable had the smallest standard error, 42.5 percent.

The results of the analysis on a study reach basis (Table 2) indicate that two of the cover variables, Model I and percent overhead bank cover, were found to have statistically significant positive correlation coefficients when regressed against trout standing crop. As with the site analysis, percent overhead bank cover was the independent variable found to explain the greatest amount of variation among the trout populations sampled, 63 percent. Also, the standard error of the estimate using percent overhead bank cover was again the lowest, 25.4 percent.

Multiple regression analysis on a study site basis using percent rubble-boulder area (% A_{r-b}), percent overhead bank cover (% OBC) and percent deep water cover (% Ad) as the independent variables yielded the following equation:

$$Y(Kg/Ha) = 38.31 - 32.45\ (\%\ A_{r-b})$$
$$+ 108.31\ (\%\ OBC) + 46.93\ (\%\ Ad)$$

This relationship explained 40 percent of the variation in trout standing crops with a 44.2 percent standard error of estimate, only slightly improved over the simple regression relationship found when using just percent OBC.

Similar results were obtained with multiple regression analysis on a reach basis. The equation developed was:

$$Y(Kg/Ha) = 0.67 - 5.16\ (\%\ A_{r-b}) + 192.58$$
$$(\%\ OBC) + 74.72\ (\%\ Ad)$$

Table 1. Regression statistics for brown trout streams, by sites, using trout biomass (Kg/Ha) as the dependent variable.

Independent Variable	n	$\bar{X}$	$\bar{Y}$ (KG/Ha)	a	b	r	R^2	F	T	Standard Error of Estimates
Cover Rating (Model I)	27	0.30	68.4	-5.60	235.46	0.56**	0.31	11.22**	3.35**	45.1
Cover Rating (Model II)	25	0.47	72.2	19.46	112.20	0.51**	0.26	8.18**	2.86**	47.0
% Rubble-Boulder Cover Area	26	0.30	70.2	104.84	-117.02	-0.37	0.14	3.92	-1.98	50.6
% Overhead Bank Cover	26	0.33	70.2	24.14	137.91	0.63**	0.39	15.54**	3.94**	42.5
% Deep Water Cover	25	0.15	72.2	51.86	136.93	0.38	0.14	3.89	1.97	50.6

*Statistically significant at   = .05

**Statistically significant at   = .01

Table 2. Regression statistics for brown trout streams, by reach, using trout biomass (Kg/Ha) as the dependent variable.

Independent Variable	n	$\bar{X}$	$\bar{Y}$ (KG/Ha)	a	b	r	R^2	F	T	Standard Error of Estimates
Cover Rating (Model I)	11	0.32	76.3	-28.21	330.33	0.62*	0.39	5.72*	2.39*	32.7
Cover Rating (Model II)	11	0.47	76.3	12.53	136.73	0.54	0.29	3.71	1.93	35.2
% Rubble-Boulder Cover Area	11	0.28	76.3	113.77	-132.15	-0.53	0.28	3.51	-1.87	35.5
% Overhead Bank Cover	11	0.34	76.3	6.78	202.81	0.79**	0.63	15.43**	3.93**	25.4
% Deep Water Cover	11	0.15	76.3	61.36	100.66	0.32	0.10	1.04	1.02	39.6

*Statistically significant at   = .05

**Statistically significant at   = .01

While this equation explained 69 percent of the variation in trout standing crop with a standard error of 26.5 percent, these results were only slightly improved over the simple regression equation developed using only percent OBC.

CONCLUSIONS

1) Based upon the results presented, it is evident that riparian vegetation contributes significantly to the amount of cover available in smaller trout streams and to the brown trout carrying capacity of these streams. Not only does the vegetation directly provide cover by creating quiet, shaded resting areas where it comes in contact with the water surface (overhanging vegetation) and by contributing material to debris jams, but also the roots of these plants are critical to the development and maintenance of undercut banks. Without this stabilizing influence and natural means of sediment control, trout cover would also be lost through the filling of pools and the embedding of larger substrate particles.

2) While the cover variables percent deep-water cover, percent rubble-boulder area, and Cover Rating Models I and II were not as strongly correlated with brown trout standing crop as was percent OBC, Wesche (1980) and Eifert and Wesche (1982) found these variables to be significant when dealing with larger brown trout streams and with brook trout streams. Thus, given the diversity of cover within stream systems, the investigators feel these variables can be useful for trout cover evaluations.

3. While the cover variables measured in this study are unitless and can be applied to any length of stream section, the data tend to indicate that the longer the reach investigated, the more reliable and meaningful will be the results. Additional study is needed in this area.

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1985

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Reconciling Conflicting uses

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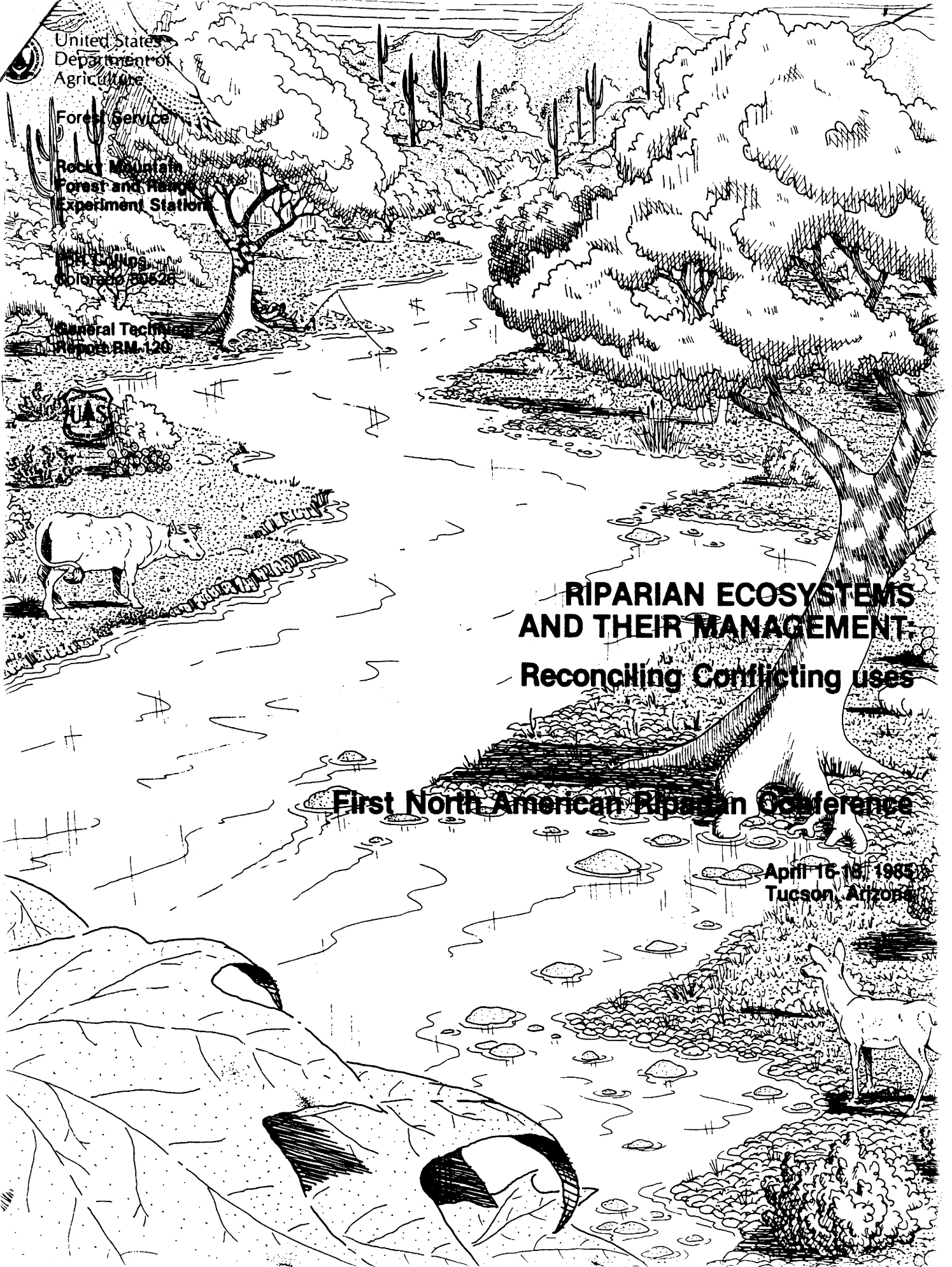Experiment Station

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Acknowledgments

Any meeting of this size and scope owes its success to a large number of individuals and organizations. First, we thank the sponsoring organizations (listed on the Title Page) whose financial support and encouragement helped make the conference a reality. The 360 registrants and approximately 100 additional persons who attended selected sessions demonstrated a sizable constituency for enlightened riparian management.

We are especially grateful to those who presided over the many concurrent sessions, or who donated their time on the technical and publications committees. Members of the University of Arizona Student Chapter of the Wildlife Society provided invaluable support both during and before the conference, as did personnel of the National Park Service Cooperative Resources Studies Unit at the University.

Two outstanding individuals, both with advanced degrees in science and law, contributed to the success of the conference—-Bruce Babbitt, Governor of Arizona, and Dr. Jon Kusler, Chairman, The Association of State Wetland Managers, Inc. Governor Babbitt took time from a busy schedule to present a conference address demonstrating his understanding of riparian ecosystems both as a scientist and as a politician. Dr. Kusler spent many hours meeting with study groups, contributing both his scientific and legal expertise to aid in the formulation of model draft riparian legislation (see Proceedings Appendix, p. 515) and to address other riparian concerns.

Finally, we thank the speakers at the conference for preparing their papers in camera-ready form to expedite publications of the proceedings. Each contributor is responsible for the accuracy and style of his or her paper. Statements by contributors do not necessarily reflect the policy of the USDA Forest Service or other conference sponsors.

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