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Contribution of Riparian Vegetation to Trout Cover in Small Streams

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Abstract.—Cover is an important trout habitat component resulting from the geomorphologic characteristics of a stream channel, the stream-bank interface with the riparian community, and the stream flow. By means of regression analysis, this study quantitatively describes the relative importance of three cover parameters (overhead bank cover, rubble–boulder–aquatic vegetation areas, and deepwater areas) and two cover models as indicators of trout standing stock in eight small streams in southeast Wyoming. Results indicated that overhead bank cover, provided primarily by riparian vegetation, is the cover parameter that explains the greatest amount of variation in trout population size.

The contribution of riparian vegetation to the structure and function of aquatic habitats has received increasing attention from fisheries managers and researchers in recent years. Platts (1983) and Moring et al. (1985) reviewed the role of streamside vegetation from the perspective of fisheries habitat and described five important riparian functions. These functions include: (1) regulation of stream temperatures; (2) provision of stream-bank stability; (3) input of nutrients to the system by allochthonous material; (4) direct input of invertebrates as fish food; and (5) provision of fish cover.

Cover, herein defined as those instream areas that provide quiet resting places and protection from predation, is an important fish habitat component resulting from the geomorphologic characteristics of a stream channel, the stream-bank interface with the riparian community, and the stream flow. Boussu (1954) and Hunt (1976) found that, as cover was reduced, trout abundance declined, and numbers likewise increased as cover was increased. In recent years, numerous habitat-assessment methods have included cover measurement as part of the overall evaluation process. These methods include the habitat quality index (Binns and Eiserman 1979), the instream flow incremental methodology (Bovee 1982), the habitat suitability index models for brown trout (*Salmo trutta*) (Raleigh et al. 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 small streams has been described by Wesche (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 sampled by electrofishing. By combining these components into unitless, additive equations and incorporating weighting factors based upon trout 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 is to quantitatively describe the relative importance of the three cover components and two cover models described by Wesche (1980) in relation to trout standing stock in small Wyoming streams, stressing the contribution of riparian vegetation to cover availability.

Study Areas

The results presented in this paper are based upon field investigations made at 27 study sites on eight montane and foothills streams located in the North Platte River Basin of southeast Wyoming. Brown trout was the predominant gamefish species present at all study sites, comprising 61–100% of the total trout populations, on a number basis. Lesser numbers of brook trout (*Salvelinus fontinalis*) and rainbow trout (*Salmo gairdneri*) were collected at many of the sites. Trout standing crops ranged from 8 to 211 kg/hectare. Mean elevations of the study sites ranged from 1,615 to 2,835 m above mean sea level, while

TABLE 1.—Regression equations relating the dependent variable trout standing crop to cover parameters (sample size = 27).

Independent variable (X)	Regression equation (Y = kg trout/hectare)	Correlation coefficient[a]
Trout cover rating, model I (*TCRI*)	$Y = 2.70 + 2.04X$	0.50**
Trout cover rating, model II (*TCRII*)	$Y = 22.10 + 1.04X$	0.48*
% overhead bank cover (% *OBC*)	$Y = 29.40 + 1.16X$	0.56**
% rubble–boulder cover area (% *ARB*)	$Y = 105.70 - 1.15X$	−0.37
% deep water cover (% *AD*)	$Y = 52.58 + 1.31X$	0.36

[a] Asterisks indicate significance at $P_\alpha = 0.05$* and $P_\alpha = 0.01$**.

average discharges through the reaches varied from 0.3 to 4.5 m^3/s. Site lengths averaged 140 m (range, 73–253 m), while average stream widths varied from 3.8 to 17.7 m. More detailed descriptions of the study streams can be found in Wesche (1980).

Methods

Trout standing crop estimates were made at each study site by means of electrofishing according to 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 site using the trout cover rating (TCR) methods described by Wesche (1980). The equation for model I of this method is:

$$TCRI = (\%OBC)(PFOBC) + (\%ARB)(PFRB);$$

- $TCRI$ = cover rating for the study section based on model I;
- $\%OBC$ = (length of overhead bank cover in the study section having a water depth of ≥15 cm and an effective width ≥9 cm/length of the thalweg line through the section) × 100;
- $PFOBC$ = preference factor of trout for overhead bank cover (0.75 for fish ≥15 cm total length [TL] and 0.50 for fish <15 cm TL);
- $\%ARB$ = (surface area of the study section having water depths >15 cm and substrate sizes ≥7.6 cm diameter, i.e., rubble and boulder, or a substrate covered with aquatic vegetation/total surface area of the study section) ×100;
- $PFRB$ = preference factor of trout for instream rubble–boulder–aquatic vegetation areas (0.25 for fish ≥15 cm TL and 0.50 for fish <15 cm TL).

Model I was developed primarily for use on small streams (average discharge less than 2.75 m^3/s), but a deep-water component was included in model II to increase the applicability of the method to somewhat larger habitats. The equation for model II is:

$$TCRII = (\%OBC)(PFOBC) + (\%ARB)(PFRB) + \%AD;$$

- $TCRII$ = cover rating for the study section based on model II;
- $\%AD$ = (surface area of the study section having a water depth ≥45 cm regardless of substrate or adjacent bankside cover/total surface area of the study section) × 100.

The TCRI and TCRII were calculated for each study site for fish <15 cm TL and for fish ≥15 cm TL. The mean TCR values were then used as independent variables in the regression analysis. Step-by-step procedures for applying the models are provided in Wesche (1980).

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 with the ABSTAT package on the Wyoming Water Research Center's CompuPro computer system.

Results and Discussion

Results of the regression analysis testing the relationships between the independent cover variables (TCRI, TCRII, %OBC, %ARB, and %AD) and the dependent variable (kg trout/hectare) showed that three cover variables (TCRI, TCRII, and %OBC) had a statistically significant, positive linear relationship with trout standing crop (Table 1). Of the three, %OBC was found to explain the greatest amount of variation among the trout populations sampled: 31%. Neither %AD nor %ARB were significantly related to standing crop when regressed alone.

Platts (1983) stated that the banks bordering small streams provide the habitat edges or niches needed to maintain high fish populations. The findings of our study quantitatively verify this conclusion. It is evident from the results presented that, of the various cover variables tested, the amount of overhead bank cover available in small streams predominated by brown trout exerts the strongest influence on trout carrying capacity. The riparian system is the dominant factor controlling this cover type. 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 for the formation of debris and log dams, but also the roots of these plants are critical to the development and maintenance of undercut banks (Li and Shen 1973).

The relationships of two cover variables, %AD and %ARB, to trout standing stock were not found to be statistically significant. However, Eifert and Wesche (1982) found %ARB to be a significant habitat variable in streams predominated by brook trout, and Wesche (1980) reported %AD to be important as cover in brown trout streams having average discharges greater than 2.75 m^3/s. Therefore, given the diversity of cover types that occur in stream systems and the variation in cover preferences which different salmonid species and size classes can exhibit (Wesche 1980; Binns 1982; Hickman and Raleigh 1982; Raleigh 1982; Raleigh et al. 1984), we feel these variables can be of use for describing cover in certain stream situations.

Results of this study can be directly applicable to both terrestrial and aquatic management situations. The cover models presented can be used to assess the influence of various land uses, such as grazing strategies, on aquatic and riparian habitats. Many stream habitat restoration projects are designed to increase carrying capacity through addition of cover. The models could be applied during the planning process to weigh restoration alternatives from the perspective of potential carrying capacity increase in relation to economic considerations. Such a cost–benefit approach could aid the manager not only for project planning but also in postrestoration analysis.

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