Factors Influencing Beaver Lodge-site Selection on a Prairie River
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Notes and Discussion

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ABSTRACT.—Physical and vegetative habitat characteristics were evaluated at 33 beaver (*Castor canadensis*) lodges during 1986 along the Big Sioux River in eastern South Dakota. Slope of the riverbank was the most important physical factor and horizontal vegetation cover was the most important vegetative factor influencing lodge-site selection. Beaver preferred the habitat quality of ungrazed areas for lodge sites. Although 60% of the study area was grazed, only six (18%) of 33 beaver lodges were located there.

INTRODUCTION

The beaver's ability to cut trees enables it to build elaborate lodges made of sticks and mud. A lodge serves as a residence for a beaver colony, which typically consists of 4–8 related individuals (Bradt, 1938; Bergerud and Miller, 1977). Lodge sites may be used by a family unit for several years, although juvenile beaver disperse at age 2 to form new colonies (Bradt, 1938). Lodge-site selection is influenced by population levels, territoriality (Aleksiuk, 1968), and habitat quality (Slough and Sadleir, 1977). Factors such as water conditions, bank configuration and vegetative composition directly adjacent to shore may also influence lodge-site selection.

In South Dakota, beaver are dependent on riparian habitat for both food and shelter. Beaver thrive along the floodplain forest of the Big Sioux River, one of the few naturally wooded areas of eastern South Dakota. However, livestock grazing has curbed forest regeneration (Smith and Flake, 1983), thereby altering available beaver habitat. The objectives of this research were to determine: (1) factors beaver may use in selecting an adequate lodge site, and (2) the effects of cattle grazing on lodge-site selection by beaver.

STUDY AREA

The study was conducted during the summer of 1986 along 45 km of the Big Sioux River in Brookings and Moody counties, South Dakota. The Big Sioux River is the primary drainage for the Coteau des Prairies geologic region. It is a meandering river with a highly variable flow due to frequent flooding. Width of the river channel varies from 15–40 m and river depth ranges from 0.3–1.7 m. The 1–2% stream gradient of the Big Sioux River is ideally suited for beaver habitation (Ruthorford, 1964).

Riparian tree and large shrub species commonly found in the study area are green ash (*Fraxinus pennsylvanica*), boxelder (*Acer negundo*), peachleaf and sandbar willow (*Salix amygdaloides* and *S. exigua*) and American elm (*Ulmus americana*). Species found occasionally throughout the area are hawthorn (*Crataegus mollis*), hackberry (*Celtis occidentalis*), Tartarian honeysuckle (*Lonicera tatarica*), American plum (*Prunus americana*) and cottonwood (*Populus deltoides*).

Agricultural land use along the Big Sioux River includes cultivation of row crops and grazing of livestock, especially cattle. Negative impacts of cattle activity such as trampling of trees and riverbanks are evident in grazed areas. In our study area, 60% of the habitat was grazed. Ungrazed areas along the Big Sioux River have a much higher tree density and stem density than grazed areas (Dieter, 1987).

METHODS AND MATERIALS

Beaver lodges were located from a boat along approximately 45 km of the Big Sioux River. Only those lodges with evidence of recent beaver activity, such as new wood cuttings or fresh scent mounds, were included in the sample. Due to the variable flow rate and volume of the river, an effort was made to collect data during a period of stable water levels. Beavers generally constructed lodges when there was little fluctuation in water levels such as during late summer. Therefore, to avoid unusual variability due to rising or falling water levels, and to best approximate the conditions when beavers select lodge sites, all measurements were taken during August 1986.

Numerous studies have identified key factors affecting beaver lodge-site selection, such as tree species

TABLE 1.—Means of variables used in analysis of 33 beaver lodge sites and an equal number of random sites

Variable	Site	Mean	SE	t-test	df
Horizontal cover 1 m above ground at 10 m (%)	Lodge	89.3	1.7	3.13**	64
	Random	78.3	3.0		
Horizontal cover 1 m above ground at 15 m (%)	Lodge	53.0	4.8	4.16**	64
	Random	28.2	3.5		
Horizontal cover 2 m above ground at 10 m (%)	Lodge	94.6	1.3	2.70**	64
	Random	86.0	2.9		
Horizontal cover 2 m above ground at 15 m (%)	Lodge	68.0	4.3	3.13**	64
	Random	47.8	4.8		
Overhead cover (%)	Lodge	41.2	4.3	2.52*	64
	Random	26.4	4.0		
Depth of river (cm)	Lodge	75.5	4.8	4.00**	64
	Random	49.4	4.5		
Width of river (m)	Lodge	19.9	0.9	0.06	64
	Random	20.0	0.9		
Slope of riverbank (degree of angle)	Lodge	40.7	2.1	5.32**	64
	Random	26.7	1.6		

* Significant at the 0.05 level
** Significant at the 0.01 level

composition, stem diameter, and proximity to water. However, few authors have addressed physical and vegetational conditions in the immediate area of lodge sites. Therefore, we selected several parameters that we considered of possible importance which could also be measured easily. We investigated lodge-site selection by comparing habitat characteristics among active lodge sites and an equal number of randomly selected sites.

Vegetation characteristics that were evaluated included percent of overhead cover, which was measured with a spherical densiometer (Lemmon, 1957). Readings were taken 3 m from the lodge or the center of a random site in three directions. One reading was taken perpendicular to the river, and two readings were taken parallel to the river, one upstream and one downstream. Percent of understory cover at 1- and 2-m heights at each site was measured with a vegetation profile board (Nudds, 1977) placed at distances of 10 m and 15 m from the center of lodge or random sites. Physical characteristics measured included width of the river and its depth 1 m from shore. A clinometer was used to measure the slope of the riverbank nearest to lodges or random sites. We also recorded lodges by land-use category, either grazed or ungrazed.

Means of individual variables at lodge sites were compared to those at random sites using a t-test. The relative importance of variables in classifying sites as lodge sites vs. random sites was assessed using stepwise discriminant analysis. A chi-square goodness-of-fit test was used to determine if grazed or ungrazed habitat was used in proportion to availability ($P \leq 0.05$). If use was disproportionate, confidence intervals were constructed around the proportion of observed use of the habitat type to determine selection or avoidance (Neu *et al.,* 1974; Byers and Steinhorst, 1984).

RESULTS

There were 33 active beaver lodges in the study area. Of these, only two were surrounded by water and the rest were built into riverbanks. *Percent canopy cover* ($P \leq 0.05$) and all four understory cover measurements ($P \leq 0.01$) were significantly greater at lodge sites than at random sites (Table 1). Analysis of physical variables showed that both riverbank *slope* and *water depth* were significantly greater ($P \leq 0.01$) at lodge sites than at random sites, but there was no significant difference in stream

TABLE 2.—Selection or avoidance of land-use types by beaver for lodge sites

Land use	Proportion of study area	Proportion expected	Proportion observed	95% CI on proportion observed
Grazed	0.60	19.8	6 (0.182)[a]	$0.034 < P1 < 0.330$
Ungrazed	0.40	13.2	27 (0.818)[s]	$0.670 < P2 < 0.966$

Chi-square value = 23.9**; significant at 0.01 level

[a] = avoidance (proportion of study area > upper confidence limit); [s] = selection (proportion of study area < lower confidence limit)

width. Stepwise discriminant analysis of all habitat variables indicated that slope of the riverbank and understory cover density 2 m above ground (at 10 m) were significant discriminating variables which accounted for 51% of the variation among site types. Using the discriminating ability of these two variables, 79% of the lodge sites and 88% of the random sites were correctly classified.

Chi-square tests for habitat use indicated a significant difference ($P \leq 0.01$) between the *number of lodges* in *grazed* and *ungrazed* areas. Only six lodges were located in grazed areas even though approximately 60% of the study area was grazed. Ungrazed areas were selected by beaver for lodge sites, while grazed areas were avoided (Table 2).

DISCUSSION

The importance of vegetative cover to beavers is shown by the fact that lodge-site locations were in areas of significantly greater ground cover than random sites. Although ground-cover measurements were statistically different, it is difficult to determine what was biologically significant to beavers. Beaver may have selected the "thickest" cover available as a survival instinct to reduce exposure to predators, even though few, if any, natural predators reside along the river. Vegetation in areas directly adjacent to lodges was generally left unharvested by beavers. This indicates that ground cover consisting of small trees and brush as well as overhead cover for concealment may be important factors in lodge-site selection.

Slope of the riverbank was the most important variable for selection of lodge sites. The fact that lodges built into riverbanks were more common than lodges surrounded by water along the Big Sioux River may have influenced the selection of steep banks. Because lodges generally have two or more underwater entrances, steep banks provide sufficient depth to conceal more than one entrance to the lodge and allow the construction of large chambers above water level. There was evidence that some beaver colonies built two lodges in close proximity. One was accessible at normal water levels, and an adjacent lodge built higher up the bank was probably used when the river was at flood stage.

Although portions of the Big Sioux River forest still provide excellent beaver habitat, grazing appears to have affected lodge-site selection, and consequently beaver distribution. Preference for ungrazed areas probably reflects the quality of available habitat. In ungrazed areas, dense thickets of willow, numerous small trees, and a variety of aquatic plants provide a diverse and reliable year-round food source and plenty of building materials (Dieter, 1987).

Munther (1981) stated that heavy livestock grazing eliminates the food supplies available to beaver and can hinder colonization. Grazed sections of riverbank, which contain few stems or small trees, usually lack appropriate building materials and sufficient food supplies for lodge construction. Large trees, which were the only available resource for beaver, require much effort to cut, and are usually cut only when small trees are unavailable (Johnson, 1983).

Physical conditions along the river in grazed areas did not differ greatly from those in ungrazed areas. Beaver have the ability to alter the physical conditions near lodge sites for their benefit through the use of dams or canals. Avoidance of grazed areas for lodge sites was influenced more by the lack of sufficient resources for building and food than by physical factors.

We believe that beavers are beneficial in a large prairie river system. Beaver are not increasing habitat damage along the Big Sioux River (Dieter, 1987), and supply important income and recreation to trappers. Thus, practical management of riparian areas for beaver is necessary, and involves (1) protection of the physical environment from land-use practices which can degrade the land base for beaver production, and (2) management of the food supply (Slough and Sadleir, 1977).

Munther (1981) stated that livestock can rapidly modify riparian vegetation by reducing forage, wildlife and fisheries habitat, and watershed values, whereas beaver add to the productivity of riparian areas. This productivity can be seen along the Big Sioux, where beaver dams on small feeder streams create habitat for nesting wood ducks (*Aix sponsa*) and loafing areas for migrating waterfowl. This habitat is important for other fur-bearers and big game animals such as whitetail deer (*Odocoileus virginianus*).

Since beaver along the Big Sioux River tend to select ungrazed areas with dense cover, elimination of livestock grazing would likely provide for more desirable lodge sites. However, most land along the Big Sioux is privately owned and voluntary protection of habitat from cattle grazing is unlikely. We suggest that the state of South Dakota restrict livestock grazing along the river or implement a program to lease or buy riparian habitat. A return to a natural riparian ecosystem would enhance beaver distribution and production. Additional benefits would be reduced soil erosion, increased wildlife habitat, and greater aesthetic value.

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