Habitat Selection and Sexual Segregation of Elk in Northern Wyoming

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Abstract

We examined spring and summer habitat use patterns of adult male and female elk (*Cervus elaphus*) on the Bighorn National Forest in north-central Wyoming. Radio-collared elk were located twice in each of three sampling periods during June and July of 1995 and 1996. Habitat selection was examined at three spatial scales (13 ha, 52 ha, 112 ha) using a geographic information system (GIS). Selection ratios developed from use-availability data were used to detect habitat selection. Selection patterns of male and female elk significantly differed in both spring and summer. Males preferred forested habitats with larger patch sizes and less diversity, whereas females selected for smaller, more diverse foraging areas in open habitats. Our results indicated the value of large, contiguous timber stands for mature male elk are not limited to hunting seasons and also should be considered on spring and summer ranges.

Key words: *Cervus elaphus*, elk, habitat selection, security cover, sexual segregation.

Introduction

Sexual segregation during the non-breeding period has been documented in a variety of polygynous ungulates, including mule deer *(Odocoileus hemionus)* (King and Smith 1980, Ordway and Krausman 1986, Weckerly 1993), white-tailed deer *(Odocoileus virginianus)* (McCullough et al. 1989), moose *(Alces alces)* (Miquelle et al. 1992), reindeer *(Rangifer sp.)* (Skogland 1989), caribou *(Rangifer sp.)* (Jakimchuk et al. 1987), red deer *(Cervus elaphus)* (Clutton-Brock et al. 1982), bighorn sheep *(Ovis canadensis)* (Geist and Petocz 1977, Bleich et al. 1997), and elk (Geist 1982). Spatial separation of male and female elk may be a result of different habitat requirements or preferences. Because of the important role females play in population dynamics, most ungulate research and management is directed towards this segment of the population. However, knowledge of sex-specific habitat preferences may improve elk management by providing a better understanding of the effects habitat perturbations may have on both sexes. Our objective was to compare habitat selection patterns of adult male and female elk during late spring and summer.

Study Area

Elk habitat use patterns were examined in the Bighorn National Forest (BNF) of north-central Wyoming. The BNF encompassed 6000 km^2 at elevations ranging from 1200 to 4018 m. Vegetation, characterized by juniper (*Juniperus osteosperma*) at low-elevations, ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) at mid-elevations, and lodgepole pine (*Pinus contorta)* and spruce-fir (*Picea engelmannii, Abies lasiocarpa*) dominating the higher elevations, was typical of the central Rocky Mountains. Aspen (*Populus tremuloides*) stands were present but uncommon. Large natural openings and high-elevation gentle slopes were often dominated by big sagebrush (*Artemisia tridentata*) and/or Idaho fescue (*Festuca idahoensis*). Despain (1973) provided a detailed description of vegetation, soils, geology, and climate of the Bighorn Mountains.

Methods

Helicopter net-gunning was used to capture and radio-collar adult (>1 yr) elk. Thirty radio-collared elk (15 male and 15 female) from separate social groups were monitored during three sampling periods in 1995 and 1996: 1) 30 May-8 June, parturition; 2) 23-29 June, 3-4 weeks post-calving; and 3) 25-31 July, 7-8 weeks post-calving. We located and attempted to sight each elk from the air twice during each period; flights were conducted ≥ 1 day apart to increase independence of relocations. Universal Transverse Mercator coordinates of radio-collared elk were recorded using a global positioning system.

We examined habitat selection at three spatial scales by identifying vegetation types included within 13-ha (200-m radius), 52-ha (400-m radius), and 112-ha (600-m radius) circular areas around each location. Coordinates of elk locations were organized with Map and Image Processing Software (MIPS v.5.2). Buffer zones were created in ARC-INFO and habitat measurements (mean patch size and Shannon Diversity Index) processed in FRAGSTATS (McGarigal and Marks 1994). The Wyoming Game and Fish Department used remote sensing techniques to develop a digital vegetation map that classified every 30 m x 30 m pixel within the B F into one of 13 different vegetation types (Table 1).

We measured habitat selection by developing selection ratios from use-availability data of male and female elk locations (Manly et al. 1993). Elk locations from 1995 and 1996 were pooled within sexes. Although Thomas and Taylor (1990) and Schooley (1994) identified potential problems with pooling data from different years, it was necessary to meet sample size minimums suggested by Alldredge and Ratti (1986). Used units were defined as the circular areas centered around elk locations and available habitat was delineated as that contained within a minimum convex polygon constructed from all elk locations during sampling periods. However, because snowpack limited habitat available to elk during the first sampling period, data from this period were analyzed using a smaller area delineated by the minimum convex polygon constructed from elk locations from only this period. We a signed selection ratios 90 percent confidence intervals and considered vegetation types selected for if

Table 1. Vegetation types and availability (%) classified by GIS during 3 sampling period [a] on the Bighorn ational Forest, Wyoming, 1995-96.

Vegetation types classified by GIS		Availability (%) Period 1[b]	Periods 2,3
SHR	Sparse herbaceous rangeland	4.62	7.96
MHR	Medium herbaceous rangeland	16.61	16.38
GHR	Green herbaceous rangeland	5.51	4.42
WIL	Willow/moist site shrubs	2.57	2.62
ASP	Aspen/cottonwood	0.50	0.35
SP/F	Spruce/fir	18.12	19.13
DF	Douglas-fir	10.75	6.26
LP	Lodgepole pine	16.62	24 74
RIP	Riparian moist grass/sedge/rush	3.46	3.23
ES	Early seral lodgepole	2 67	2.38
SB	Sagebrush	16 60	10.49
JUN	Juniper	0.13	0.08
MH	Mountain mahogany	1.56	0.89

[a] Period 1 30 May-8 June, Period 2: 23-29 June, Period 3 25-31 July.
[b] Availability of vegetation types was analyzed separately during period 1 due to snowpack conditions at the time (see Methods).

intervals were greater than 1, selected against if intervals were less than 1, and selected in proportion to availability if intervals contained 1 (Manly et al. 1993).

Results

Habitat selection patterns differed between male and female elk during each of the three sampling periods and at all three spatial scales (Table 2). However, patterns were similar within sexes and across spatial scales. Males selected exclusively for timbered areas, while females selected for a mix of forage and cover types.

Mean patch sizes of areas selected by male elk ($\bar{x}$ = 2.15 ha, SE = 0.07) were larger (t_{318} = 4.69, $P < 0.001$) than areas used by females ($\bar{x}$ = 1.74 ha, SE = 0.05). Consequently, areas selected by male elk had lower Shannon Diversity Index values

Table 2. Habitat selection[1] by male and female elk for each sampling period at 3 spatial scales (13 ha, 52 ha, 112 ha) on the Bighorn National Forest, Wyoming 1995-96.

Vegetation	30 May-8 June			23-29 June			25-29 July		
types	13 ha	52 ha	112 ha	13 ha	52 ha	112 ha	13 ha	52 ha	112 ha
FEMALE ELK									
SHR	0	0	0						
MHR	0	0	0	0	0	0	0	0	0
GHR	+	+	+	+	+	+	+	+	+
WIL				0	0	0			
ASP	+	+	0						
SP/F				+	+	+	+	+	+
DF	0	0	0						
LP	0	0	0	0	0	0			
RIP		0	0	+	+	+	+	+	+
ES	0	0	0	0	+	+	0	0	+
SB	+	+	+						
MALE ELK									
SHR									
MHR				0	0	0	0	0	0
GHR	0	0	0	0	0	0			
WIL					0	0			
ASP	0	0	0		0	0	0	0	0
SP/F				0	0	+	+	+	+
DF	+	+	+	0	0	0			
LP	0	0	0	0	0	0	0	0	0
RIP				0	0	0	0	0	0
ES				0	0		0	0	0
SB	0	0	0						

Selected against (-), selected for (+), or selected in proportion to availability (0).

than those areas selected by female elk (t_{335} = -4.80, P < 0.001). Landscape measurements; were only calculated for the 112-ha scale.

DISCUSSION

The appropriate scale for any ecological analysis should match the goals of the study (Powell 1994). Selecting the wrong scale or failing to consider scale creates the potential for misleading results or data misinterpretation (Bowyer et al. 1996). Edge ct al. (1987) believed that an area larger than just that area adjacent to the radio location influenced elk habitat selection and placed a 200-m radius around elk locations to define sampling unit size. Other research has demonstrated how variable such as forage-cover ratios, patch size, and roads influence the scale at which elk site selection occurs (Wisdom et al. 1986, Thomas et al. 1988, Lyon and Canfield 1991). Of the three scales examined in this study, we believe the 112-ha area was the most appropriate sampling unit size to study elk habitat use. This scale detected the most selection, allowed ample room for potential errors in telemetry (Sawyer 1997), and was most likely to contain habitat features important to elk in a 24-hour period.

We found that habitat selection of male and female elk differed during spring and summer. Females were primarily as ociated with open foraging areas during parturition, and shifted to a mixture of forage and cover areas as the summer progressed and calves developed. Females selected for sagebrush and green herbaceous rangelands during the parturition period (30 May-8 June) when they had young, immobile calves. Sagebrush communities apparently provided both cover for newborn elk calves and abundant, high-quality forage during early June (awyer 1997). Male elk selected exclusively for Douglas-fir during early spring and used open forage areas less than or in proportion to their availability

Female elk continued to select for open vegetation types (GHR, RIP, ES) 3-4 weeks post-calving (23-29 June), as calves became more mobile and less dependent on hiding to avoid predators. Although these foraging areas no longer provided abundant low-level hiding cover for calves, female elk also selected for spruce-fir stands, presumably for the security cover they offered the entire herd. These selection patterns continued through the third sampling period (26-31 July)

Male elk continued to select only for timbered vegetation types during late June and July, using other vegetation types less than expected or in proportion to availability. Their timber or cover preference shifted from the lower-elevation Douglas-fir stands to montane and subalpinc spruce/fir stands. The tendency for male elk on the BNF to select for dense timber stands was consistent with Marcum and Edge (1991), who found that male elk in western Montana occupied more heavily forested areas than females during the spring and summer.

Selection for timbered areas rather than open foraging areas suggested that habitat use by male elk on the BNF was based principally on security needs. Males apparently met nutritional requirements within or immediately adjacent to the e timber stands. However, this did not necessarily indicate male elk compromise foraging efficiency. Males are often solitary or occur in small groups and do not require the large foraging areas necessary to sustain the larger female calf groups. During the second and third sampling periods in 1995, average male group size was five (n = 17, SE=0.73), whereas the average female group 'iize \Vas 50 (11 = 28, SE = 10) (Sawyer 1997). Foraging alone or in small groups may allow male elk to maximize nutrient intake within security-type habitats. Although male mule deer occupied areas of lower resource quality than females, availability of forage per individual deer did not differ between the sexes because of the low density of males (Bowyer 19 4).

Elk maximize forage intake and minimize their energy expenditures when forage and cover areas are of adequate size and in close proximity (Wisdom et al.

1986). Most habitat effectiveness models incorporate a variable that accounts for size and juxtaposition of forage and cover areas (Witmer et al. 1985, Wisdom et al. 1986, Thomas et al. 1988, Sawyer et al. 1998). Generally, timber stands must be at least 200 m wide to receive optimal use by elk along the cover/forage edge (Witmer et al. 1985). Because areas used by male elk consisted of larger habitat patches, they were more likely to contain timber stands 200 m in width and the valuable edges associated with them.

Selection patterns of adult male and female elk markedly differed during spring and summer. Males preferred forested habitats with larger patch sizes and less diversity, whereas females selected for more diverse foraging areas in open habitats with smaller patch sizes. The reproductive-strategy theory for sexual segregation in ungulates (Main and Coblentz 1996) provides a useful framework to speculate why sexual differences in elk habitat selection occur. It suggests segregation is due to predator avoidance strategies of females with young and forage optimization by adult males (Geist 1982, Jakimchuk et al. 1987, Skogland 1989, Main and Coblentz 1990, Bleich et al. 1997). The theory predicts that females should select habitats conducive to the survival of their offspring, which they apparently do, by providing newborn calves with protective cover and older calves with abundant, high-quality forage. The theory predicts males should seek out areas that maximize forage intake. Males apparently were able to do this within or near timber stands, presumably because smaller male groups require less plant biomass than the larger female/calf groups, and exploiting feeding areas adjacent to security cover allows them to forage more efficiently.

Management Implications

Managing elk habitat often focuses on the effects different land uses, such as logging, grazing, hunting, and other human disturbances, have on elk populations (Boyd et al. 1986). Most research addressing these and other questions has been restricted to female elk. Sexual segregation between male and female elk occurs most of the year, however, for biological and management reasons, males are less frequently considered in habitat use studies. The habitat needs of females and their young are perceived, either correctly or incorrectly, as a priority in many habitat studies and subsequent management actions. For example, much of the deforestation and fragmentation that has occurred on national forests was often intended to encourage higher levels of elk use (Thomas 1991). Such a management practice often was deemed appropriate because of documented habitat preferences of female elk in the northwest, where Thomas et al. (1979) suggested an optimal forage/cover ratio for elk of 60:40. Groves and Unsworth (1993) cautioned that a forage/cover ratio of 60:40 might be optimal for elk in certain ranges, but clearly does not have wide-ranging applicability. Ironically, the same fragmentation and loss of cover has led to problems associated with elk vulnerability (Hillis et al. 1991, Thomas 1991, Vales et al. 1991, Christensen et al. 1993), including increased road densities and reduced hunting opportunities. Although healthy elk populations occur throughout the western states, managers continue to struggle with maintaining desired sex ratios (Bender and Miller 1999) and lowering elk vulnerability. Although large blocks of security habitat can benefit male elk during the hunting seasons by reducing vulnerability (Hillis et al. 1991), our results indicated the value of large, contiguous timber stands for mature male elk were not limited to that period. Such stands also should be considered on spring and summer ranges.

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