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Original Research

Elk Foraging Site Selection on Foothill and Mountain Rangeland in Spring

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ABSTRACT

Previous research suggests facilitative grazing by cattle during the preceding summer-fall can enhance spring foraging habitat of Rocky Mountain elk *(Cervus elaphus nelsoni)*. However, previous studies were limited to 1 year or conducted within relatively small experimental pastures. We evaluated elk foraging site selection during spring across 4 years and 59 040 ha of foothill and mountain rangeland in northwestern Wyoming and west-central Montana. Elk in spring avoided foraging in nonforested portions of cattle-grazed pastures where cattle had not grazed during the previous summer — early fall. In contrast, elk selected foraging sites where cattle had grazed lightly (11 — 30% forage use) or moderately (31 — 60% forage use), and selection by elk was stronger for moderately grazed sites. Neither moderate nor light cattle grazing intensity were correlated with any other elk habitat attribute that we sampled, and both moderate and light cattle grazing intensity exerted more influence on elk foraging site selection than any other variables, including distance to security cover, distance to primitive roads, distance to improved roads, aspect, or slope. We developed and validated a resource selection model that correctly classified 80 — 89% of elk foraging observations across five study sites and 4 years. Resource managers can use our model to map predicted changes in elk grazing distribution when considering potential habitat adjustments in security cover, roads, or cattle grazing intensities and distribution. Our results indicate that resource managers can use targeted cattle grazing in summer — early fall to purposely modify elk forage conditions to 1) increase elk foraging efficiency in spring, 2) lure elk away from places needing rest or deferment from spring elk grazing, or 3) lure elk away from places where elk in spring are experiencing conflicts with humans, predators, or other wildlife.

Introduction

Habitat management for Rocky Mountain elk *(Cervus elaphus nelsoni)* presents varied challenges on foothill and mountain rangeland. In many areas, elk herd recruitment rates are declining due, at least in part, to nutritional limitations of their foraging habitat during spring (Cook et al., 2013). Poor foraging habitat quality in spring inhibits pregnant elk from 1) recovering body condition after winter losses, 2) satisfying nutritional requirements for accelerated fetal growth during the third trimester of gestation, and 3) preparing for the physiological demands of calving (Thorne et al., 1976; Cook et al., 2004; Cook et al., 2013). In contrast, Rocky Mountain elk populations in other areas are thriving, but excessive elk grazing is degrading vegetation and soil resources (Zeigenfuss et al., 2002; Gass and Binkley, 2011; Thrift et al., 2013). In these areas, elk grazing often occurs too frequently in the same locations, and habitat management is needed to provide periodic rest or deferment from spring elk grazing (Brewer et al., 2007; Thrift et al., 2013). In short, whether elk populations are thriving or declining, landscape-scale strategies are needed in many areas for managing Rocky Mountain elk spring foraging habitat (Brewer et al., 2007; Cook et al., 2013; Thrift et al., 2013).

Elk inhabiting foothill and mountain rangeland in the northern Rocky Mountains consume grass-dominated diets during spring (Stevens, 1966; Ngugi et al., 1992; Torstenson et al., 2006), and elk select foraging sites where the net rate of energy gain (i.e., foraging efficiency) is greatest (Fryxell, 1991; Gross et al., 1993; Wilmshurst et al., 1995). Foraging efficiency is maximized on graminoid-dominated sites with intermediate biomass and fiber content and without mature reproductive culms or excessive plant litter because tradeoffs are optimized among the amount, nutritional quality, and accessibility of the forage (Fryxell, 1991; Gross et al., 1993; Wilmshurst et al., 1995). Elk diets and foraging sites during spring in the northern

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Rocky Mountains often overlap greatly with those of cattle during the previous summer-fall (Stevens, 1966; Ngugi et al., 1992; Torstenson et al., 2006). This foraging niche overlap provides opportunities for facilitative grazing (Vesey-Fitzgerald, 1960; McNaughton, 1984), where cattle grazing during summer-fall can improve the accessibility or nutritional quality of forage available for elk to graze during the following spring.

The use of livestock grazing to enhance wildlife habitat was first advocated by Leopold (1933), and authors of several literature reviews, synthesis articles, and book chapters have reiterated that properly managed livestock grazing can be used to manage elk habitat (Mosley, 1994; Severson and Urness, 1994; Lyon and Christensen, 2002; Mosley and Brewer, 2006). In much the same way that prescribed burning prescriptions specify the timing and conditions for applying prescribed fire to achieve desired habitat modifications, facilitative or targeted livestock grazing prescriptions specify the livestock species and grazing conditions (e.g., timing, intensity, and frequency of livestock grazing) for using livestock grazing to enhance elk foraging habitat (Mosley and Brewer, 2006).

Facilitative cattle grazing can increase elk foraging efficiency by increasing elk forage digestibility and nutritive value, as well as by reducing excessive plant litter and standing dead plant material that impede plant growth and inhibit forage accessibility (Willms et al., 1979; Jourdonnais and Bedunah, 1990; Phillips et al., 1999; Short and Knight, 2003; Ganskopp et al., 2004). Consequently, elk during spring may favor foraging in areas that were grazed previously by cattle (Grover and Thompson, 1986; Jourdonnais and Bedunah, 1990; Frisina, 1992). Previous research results, however, are from 1-year studies or from within relatively small experimental pastures, or the studies did not adequately consider other habitat attributes that might have influenced elk foraging site selection (Vavra, 2005; Vavra and Riggs, 2010).

Our landscape-scale study investigated whether elk selected foraging sites in spring where cattle had grazed during the previous summer-fall. We also investigated whether cattle grazing intensity was positively related to elk foraging site selection independently of other habitat attributes, including distance to hiding cover, distance to security cover, distance to roads, slope, elevation, and aspect.

Methods

Study Area

We studied elk foraging site selection during spring on foothill and mountain rangeland of the Absaroka Mountains in northwestern Wyoming and the Big Belt Mountains in west-central Montana. The study area consisted of three study sites in Wyoming and two study sites in Montana. Study sites encompassed three large, private ranches and adjoining state and federal public lands, with nonforested rangeland totaling 30 180 ha in Wyoming and 28 860 ha in Montana. In Wyoming, the Rattlesnake study site was located 19 km northwest of Cody, Wyoming in the North Fork drainage of the Shoshone River. The Rock Creek study site and Diamond Bar study site were located in the South Fork drainage of the Shoshone River, 50 km and 60 km southwest, respectively, of Cody, Wyoming. In Montana, the Lingshire study site and Birch Creek study site were located 72 km northwest and 12 km west, respectively, of White Sulphur Springs, Montana.

Elk were abundant on the study area during winter and spring but not summer — early fall when elk occupied higher elevations outside the study area. Cattle had access to the entire 59 040-ha study area every year, and cattle grazing management was typical of many western ranches that incorporate foothill and mountain rangeland. Cattle grazed on native rangeland from approximately 1 June to 1 October each year (i.e., summer — early fall). Elk social avoidance of cattle (Mosley, 1999) did not influence elk foraging site selection on rangeland during spring (March to May) because cattle were confined to hayfields or seeded pastures until approximately 1 June. Cow/calf pairs grazed within rotational grazing systems in which cattle grazed every pasture every year, but cattle seldom remained in one pasture for more than 30–45 days at a time. Cattle stocking rate was moderate (2.8 ha/animal unit months [AUM] on the Wyoming study sites and 1.8 ha/AUM on the Montana study sites), and cattle grazing was distributed within fenced pastures via herding, placement of salt/mineral supplements, and the availability of drinking water.

Mean annual precipitation was 28 cm in the Wyoming study sites and 37 cm in the Montana study sites (Western Regional Climate Center, 2003). Elevations ranged from 1650 m to 3700 m on the Wyoming sites and 1280 to 2600 m on the Montana study sites. Topography varied from flat outwash plains and rolling foothills at lower elevations to steep mountains at higher elevations. Although forested plant communities were common at the higher elevations of our study area, nonforested habitats typically provide the majority of foraging opportunities for elk during spring (Stevens, 1966; Constan, 1972; Torstenson et al., 2006).

We studied elk foraging site selection exclusively on nonforested, foothill and mountain rangeland dominated by sagebrush grassland and mountain grassland plant communities. Prevalent perennial graminoids included bluebunch wheatgrass *(Pseudoroegnaria spicata),* Idaho fescue *(Festuca idahoensis),* prairie junegrass *(Koeleria macrantha),* needle and thread *(Hesperostipa comata),* and Sandberg bluegrass *(Poa secunda).* Common forbs included western yarrow *(Achillea millefoilium),* spiny phlox *(Phlox hoodii),* rose pussytoes *(Antennaria rosea),* milkvetch (*Astragalus* spp.), and lupine (*Lupinus* spp.). Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) were the dominant shrubs on higher and lower elevation sagebrush grasslands, respectively.

Elk Observations

Elk foraging sites were identified with systematic aerial surveys from fixed-wing aircraft. We identified elk foraging sites in Wyoming during spring of 4 years (2000, 2001, 2002, 2003) and during spring of 2 years in Montana (2002, 2003). Aerial surveys were conducted once monthly March to May 2000 and 2001 and bimonthly March to May 2002 and 2003. Flight transects were 0.8-km wide and flown about 150 m above the ground. Flight crews included an experienced pilot and observer, both of whom assisted in recording elk foraging locations. Each flight provided a complete reconnaissance of nonforested habitat within the cattle pastures on each study site, and aerial surveys were initiated in different locations within the study sites to mitigate potential biases of sampling a specific area at similar times within a flight. Aerial surveys began at sunrise and averaged 3 hours in length because a majority of elk foraging occurs during this time of day (Collins et al., 1978; Wickstrom et al., 1984; Green and Bear, 1990). Elk group size and elk use of nonforested habitat also increases during this crepuscular period (Anderson et al., 1998), which improves elk sightability from aerial surveys (Unsworth et al., 1990; Anderson et al., 1998; Cogan and Diefenbach, 1998). Although the potential for undetected individuals existed, sightability was improved because we evaluated nonforested habitat only and our aerial surveys were conducted during spring when elk group sizes were relatively large. Aerial sampling under these conditions likely detected ≥ 90% of the elk in our study area (Samuel et al., 1987; Anderson et al., 1998; Eberhardt et al., 1998).

An instantaneous observation of a cohesive group of elk (≥2 adults) constituted a single, independent observation. We considered our elk group observations independent because the time interval separating our aerial surveys (i.e., 2–4 weeks) was large enough to allow elk ample opportunity to select any site within their home range. Also, our study sites were large enough (mean = 11 808 ha) to encompass seasonal elk home ranges (Van Dyke et al., 1998; Anderson et al., 2005) and thereby large enough to provide elk sufficient opportunity to select any part of their home range and remain within our survey