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Contrasting Daily and Seasonal Activity and Movement of Sympatric Elk and Cattle☆,☆☆

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ABSTRACT

Elk (*Cervus elaphus* L.) and cattle (*Bos taurus* L.) co-occur on rangelands throughout western North America. Literature regarding range relations between elk and cattle, however, is contradictory, describing interspecific competition in some cases and complementary or facilitative relations in others. A better understanding of how sympatric elk and cattle behave at fine spatiotemporal scales is needed to properly allocate resources for these species. We used intensively sampled Global Positioning System (GPS) tracking data (1-sec intervals) to classify elk and cattle behavior and investigate their activity and movement strategies in the Blue Mountains of northeastern Oregon, United States, during summer and fall 2007. An ensemble classification approach was used to identify stationary, foraging, and walking behavior classes within the GPS datasets of mature beef and captive elk cows grazing in forested pastures during two randomized experiments, one in summer and the other fall. During summer, elk traveled farther per day, had larger walking budgets, exhibited more and longer walking bouts, and had higher walking velocities than beef cows. Cattle tended to emphasize intensive foraging over extensive movement and thus displayed larger foraging budgets and longer foraging bouts than elk. Site-by-species interactions, however, were detected for some foraging responses. During fall, when forage quality was limiting, elk exhibited a more foraging-centric mobility strategy while cattle emphasized an energy conservation strategy. These differing movement and energetic strategies tended to support the concept that elk and cattle occupy differing behavioral niches. Extensive foraging by elk and intensive foraging by cattle during summer correspond well with behaviors expected for elk searching out forbs in graminoid-dominated habitats and cattle foraging intensively on graminoids. Behaviors exhibited in the fall were consistent with elk continuing to exercise more selectivity among the available forage than cattle. These differing strategies, consequently, would moderate the potential for direct interspecific competition during summer and fall.

Introduction

Elk (*Cervus elaphus* L.) and cattle (*Bos taurus* L.) co-occur on range and forest lands throughout much of western North America. In the continental United States alone, sympatric elk and cattle may interact on more than 1.1 million km^2. As a native ungulate, elk function as an important ecosystem component, and as a huntable/viewable species, elk represent a high-value income source for rural economies (Bolon 1994). Revenues from rangeland cattle production are also of critical importance to many rural economies. Annually, many millions of kg of beef are produced on rangelands shared with elk (NASS 2016). Consequently, proper management of sympatric elk and cattle is of substantial ecological and economic importance.

Elk and cattle exhibit some broad similarities in dietary and habitat preferences (Stevens 1966; Mackie 1970; Hansen and Reid 1975; Sheehy and Vavra 1996; Beck and Peek 2005). Consequently, there has been a long-standing concern that these species compete with each for space and resources (Smith 1930; Olson 1943; Morris 1956; Julander and Jeffery 1964; Skovlin 1968; Nelson 1982; Yeo et al. 1993; Stewart et al. 2002). Yet despite these similarities and overlaps, sympatric elk and cattle are not necessarily competitors. There is, in fact, suggestive evidence of neutral or even complementary or facilitative relations between these species (Anderson and Scherzinger 1975; Grover and Thompson 1986; Hobbs et al. 1996). The question of

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whether elk and cattle are competing for resources, partitioning resources, or sharing resources is complex and may have multiple answers depending on the scale and seasonal timing of interest.

Regrettably, most if not all studies of resource partitioning between elk and cattle have been conducted at relatively coarse scales (e.g., habitat type or broader). Even as the increasing use of GPS tracking technologies improves the spatial resolution of available data, the temporal coarseness of the typical tracking dataset (e.g., hours or 10s of minutes) largely precludes their use for investigating elk-cattle relations at the patch and finer scales. For example, studies at the Starkey Experimental Forest and Range (SEFR) within the Blue Mountains of northeastern Oregon have reported evidence of resource partitioning and competitive exclusion between elk and cattle (Coe et al. 2001; Stewart et al. 2002). Data in these studies were acquired with LORAN-C automated telemetry at intervals of about 1 − 1.5 hr and thus allowed resource-selection analyses at the landscape scale. Evidence of resource partitioning at landscape scales, however, does necessary translate to range relations occurring at the patch scale.

Comparative studies suggest dietary overlaps between elk and cattle are often temporally offset (e.g., winter elk diets ≈ summer cattle diets) and occur more often in specific habitat types than in others (Stevens 1966; Beck and Peek 2005). Research at the SEFR suggests elk and cattle may occupy differing dietary niches during summer (Stewart et al. 2003). Elk summer diets tend to be dominated by forbs while cattle diets are graminoid dominated (Torstenson et al. 2006; Scasta et al. 2016). Consequently, from a dietary perspective, elk and cattle could occupy the same vegetation patch but exploit that patch quite differently. It is also quite likely these differing dietary preferences would promote differing behavior patterns between sympatric elk and cattle. In habitats where the understory is dominated by graminoids, as is common throughout the Blue Mountains, cattle foraging on graminoids would likely be less motivated toward mobility than elk searching out forbs within a background of graminoids. In such cases, elk would probably travel farther per day and express more transitions between foraging and walking bouts than cattle. Selective foraging and a focus on mobility by elk would, however, come with an increased energy cost. Foraging theory suggests these increased expenditure costs must be offset by nutritional gains (Charnov 1976; Wickstrom et al. 1984; Parker et al. 1996) and that elk seeking out a forb-rich diet might pursue an energetic strategy quite different from that of cattle at the patch-scale (Bergman et al. 2001). Our understanding of these fine-scale relations between elk and cattle, however, is still quite narrow. This limitation stems largely from past difficulties in continuously observing cryptic ungulates like elk throughout both day and night (e.g., Crane et al. 2016). While developments in GPS tracking technologies certainly have the potential to address this observation problem, to date no comparative GPS tracking studies of sympatric elk and cattle have been conducted at scales fine enough to resolve patch-scale behaviors. Consequently, management of sympatric elk and cattle has depended on science conducted at relatively coarse scales and thus the influence and complexity of fine-scale interspecific relations remain poorly understood and largely unaccounted for.

The goal of the current study was to address this knowledge gap using intensively sampled GPS tracking (1-sec intervals) data acquired from elk and cattle at the SEFR during summer and fall 2007. The specific objectives were to 1) contrast behavioral responses (e.g., daily distance traveled, activity budgets, and movement path characteristics) of sympatric elk and cattle at fine spatiotemporal scales on forested rangeland and 2) interpret fine-scale behavioral similarities and/or differences within contexts of niche partitioning, competitive or complementary range relations, and comprehensive resource-allocation management.

Materials and Methods

Study Area

This study was conducted at the SEFR, a USDA Forest Service research area (lat 45.24367°N, long 118.51333°W) in the Blue Mountains of northeastern Oregon about 48 km southwest of La Grande (see Rowland et al. 1997 for additional background). Two sites, Barn-Upper and Cuhna, located near the Handling Facilities of SEFR were subdivided by electric fencing into two adjacent pastures per site. Barn-Upper contained the Barn and Upper pastures while Cuhna contained the Cuhna East and Cuhna West pastures.

The Barn pasture (8.1 ha) was located at a mean elevation of 1 256 m and gently sloped (3.1 − 6.5°) toward the northeast. Mean elevation of the Upper pasture (13.7 ha) was 1 268 m with a northeasterly aspect and slopes of 0.63 − 6.1°. On the basis of the Hall (1973) plant community − type classification system, vegetation on both the Barn and Upper pastures was dominated by a mixed-conifer community (Ponderosa pine [*Pinus ponderosa* Lawson & C. Lawson], Douglas-fir [*Pseudotsuga menziesii* {Mirb.} Franco], and grand fir [*Abies grandis* {Douglas ex D. Don} Lindl.]) with a pinegrass (*Calamagrostis rubescens* Buckley) understory (Hall CW-G1-12). Mean graminoid cover for this community generally ranges from 20 − 80% while forb cover ranges from 0 − 20%. The Upper pasture also contained about 1.9 ha of a dry meadow community (Hall MD) composed primarily of Sandberg bluegrass (*Poa secunda* J. Presl) and rough bentgrass (*Agrostis scabra* Willd.). Forbs are generally uncommon or rare in this community type, but western yarrow (*Achillea millefolium* L.), tapertip onion (*Allium acuminatum* Hook.), and a few other forb species did occur as trace − 1% cover within the grasslands at this site. Herbaceous standing crop in forested communities ranged 1 108 − 2 237 kg dry matter (DM) ha^{-1} when sampled on 29 June 2007 (Summer). Standing crop in the dry meadow community at Upper was 1 573 kg DM ha^{-1} on that date. Fall standing crop (sampled on 22 September 2007) ranged 641 − 821 kg DM ha^{-1} in forested communities and 428 kg DM ha^{-1} in the dry meadow. Soils underlying the forested community at both Barn and Upper were coarse-loamy, isotic, frigid vitrandic haploxerepts, and soils associated with the dry meadow community were classified as loamy-skeletal, mixed, superactive, frigid lithic haploxerolls.

The Cuhna West (16.6 ha) and Cuhna East (17.1 ha) pastures occurred on a northeasterly aspect at mean elevations of 1 207 m and 1 185 m and slopes of 2.3 − 7.6° and 0.71 − 7.9°, respectively. Within the Cuhna West pasture, an area of 4.3 ha, representing the lowest elevations, was dominated by a Ponderosa pine-Douglas fir-snowberry (*Symphoricarpos albus* [L.] S.F. Blake)-oceanspray (*Holodiscus discolor* [Pursh] Maxim.) community (Hall CD-S6-11; Hall 1973). Graminoid cover generally ranges from 10 − 40%, forb cover from 0 − 5%, and shrub cover 20 − 70% in this community type. A dry meadow community of rough bentgrass, Kentucky bluegrass (*Poa pratensis* L.), intermediate wheatgrass (*Thinopyrum intermedium* [Host] Barkworth. & D.R. Dewey), and rushes (*Juncus* sp.) with trace amounts of forbs (e.g., western yarrow) occurred on the remainder of the pasture. Vegetation in the lowest elevations of Cuhna East was also classified to the Ponderosa pine-Douglas fir-snowberry-oceanspray community (6.4 ha). An additional 1.6 ha of these low-lying areas occurred as a Ponderosa pine − Douglas fir − elk sedge (*Carex geyerii* Boott) community (Hall CD-G1-11). Graminoids typically occur with 30 − 60% cover, forbs 0 − 5%, and shrubs 0 − 30 cover in this community type. The remainder of the pasture was dominated by the dry meadow community type described earlier. Summer standing crop ranged 2 901 − 4 039 kg DM ha^{-1} in forested communities and 2 513 − 3 084 kg DM ha^{-1} in the dry meadow community. Standing crop in fall ranged from 1 252 − 1 546 kg DM ha^{-1} in forested communities and 1 003 − 1 059 kg DM ha^{-1} in the dry meadow. Soils under the forested communities were coarse-loamy, isotic, frigid vitrandic haploxerepts and were loamy-skeletal, mixed, superactive, frigid lithic haploxerolls under the dry meadow community.

Experimental Design

This study included two experiments, one conducted during summer coinciding with peak production of native forages in the study

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