Rangeland Ecology & Management 68 (2015) 349–353

Contents lists available at ScienceDirect

Rangeland Ecology & Management

journal homepage: http://www.elsevier.com/locate/rama

Habitat Selection by Free-Ranging Bison in a Mixed Grazing System on Public Land☆

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ARTICLE INFO

Article history:
Received 29 January 2015
Received in revised form 11 May 2015
Accepted 14 May 2015

Keywords:
GPS telemetry
habitat selection
human-wildlife conflict
Resource Selection Function
sexual segregation

ABSTRACT

Domestic livestock have replaced bison *(Bison bison)* on almost all the remaining rangelands of North America. One of the few places where bison and cattle *(Bos taurus)* comingle on shared rangelands is in the Henry Mountains (HM) of southern Utah. Ranchers there are concerned, however, that bison are selecting the same grazing areas that are needed by cattle. We used global positioning system telemetry on bison across the entire HM rangeland to determine which habitats are most important for bison throughout the seasonal cycle. Sexual segregation was also measured (using the segregation coefficient, *SC*) to determine if bison bulls exert localized impacts by congregating in certain habitats separate from cow/calf groups. The HM bison exhibited low levels of sexual segregation for both the breeding ($SC = 0.048$) and nonbreeding seasons ($SC = 0.112$). We found bison habitat use to be diverse and dynamic, with bison grazing effects distributed widely across habitats throughout the seasonal cycle. Patches of grassland, whether naturally occurring or created through burning or mechanical treatments, were favored regardless of their distance to water. Our findings should assist ranchers and agency personnel in moving forward with the integrated management of free-ranging bison and cattle on the HM rangeland, with implications for bison conservation on public lands elsewhere in the United States.

Introduction

With commercial ranching and subsistence pastoralism being practiced on 40% of the earth's land surface, resolving human–wildlife conflicts on rangelands is a major challenge in global biodiversity conservation (Wrobel & Redford, 2010). Rangelands constitute much of the matrix of land within which protected areas are embedded, and this matrix is especially important for sustaining viable populations of large ungulates (Redford et al., 2011), of which the American bison *(Bison bison)* is a case in point. Once numbering in the millions, the entire North American plains bison population declined to <100 wild animals by the late 1800s (Hedrick, 2009). Bison numbers have rebounded to ~500 000 thanks to conservation efforts, but only ~20 000 of these bison are found in conservation herds, with the remaining ~480 000 being found in commercial livestock production herds (Freese et al., 2007). Of those, most are intensively managed on fragmented landscapes and are introgressed with cattle genes (Halbert & Derr, 2007). In addition to concerns of disease transmission, perceived competition with livestock is one of the main factors prohibiting large-scale bison restoration on a continental scale (Freese et al., 2007). One of the only places where free-ranging plains bison comingle with cattle on open rangeland is in the Henry Mountains (HM) of southern Utah.

Established in the early 1940s with bison from Yellowstone National Park (Nelson, 1965; Popov & Low, 1950), the HM bison herd now numbers ~325 adults (posthunt) and is controlled primarily by sport hunting. The presence of bison on public allotments leased for cattle grazing has become a source of contention between local cattle ranchers and the state and federal management agencies (UDWR, 2007). A search for mentions of the HM bison in a major Utah daily newspaper *(Deseret News)* and the Utah Legislature archives revealed an increase in the conflict, with no mentions before 1991, eight mentions between 1991 and 1995, and 13 mentions in between 2007 and 2012 (Ranglack & du Toit, 2015a). The main concern expressed by the ranchers was that bison were reducing the standing crop of grass in summer on allotments that were designated for cattle in winter.

To complicate the issue, the HM bison herd is a public resource managed by a state agency (Utah Division of Wildlife Resources), but the HM rangeland is mainly a checkerboard of federal and state land with a federal agency (Bureau of Land Management) responsible for regulating cattle grazing. The cattle are owned by individual ranchers and corporations with permits to graze about 4 200 cows (with calves) in winter and 800 in summer, whereas the bison herd comprises < 400 adults year-round.

Most studies of bison and cattle interaction have focused on the ecological comparability of the two grazers (Allred et al., 2011; Kohl et al., 2013), which is important considering that cattle have replaced bison

☆ Research was funded by the Utah Division of Wildlife Resources and Utah State University.
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http://dx.doi.org/10.1016/j.rama.2015.05.008

across the majority of the historic bison range. However, for the restoration of bison at an ecologically meaningful scale, bison and cattle will likely graze on shared rangelands. This leads to many concerns from the livestock producer community, primarily concerning disease transmission, property damage (especially to crops and fences), and competition for grazing resources (Gates et al., 2010). With adequate surveillance and management, disease concerns can be controlled (Nishi et al., 2002), and the movements of cattle across the landscape can be controlled through spatial management of water and mineral licks (Bailey, 2004; Porath et al., 2002), reducing the need for fencing. Competition, however, is difficult to manage, and so it is important to quantify bison habitat use before implementing management actions aimed at addressing perceived conflicts with cattle habitat needs. Early work in the HM discovered that bison and cattle have 91% dietary similarity (van Vuren & Bray, 1983), indicating a high potential for competition and leading to a local perception that bison are strong competitors with cattle for grazing resources. Dietary overlap alone might not, however, be an indicator of competition if habitat use by bison and cattle is differentiated in time and space. A previous study in one part of the HM identified only a 29% overlap in space use, with bison ranging farther—in both distance and elevation—from water than cattle (van Vuren, 2001). In the Great Plains, too, cattle stay close to water and prefer wooded areas, whereas bison movements are less influenced by distance to water and they display no preference for wooded areas (Allred et al., 2011).

Identifying overlaps in habitat use throughout the year is important for understanding the overall dynamics of a mixed-species grazing system, but competition is most likely to occur during the season in which grazing resources are most limiting (Odadi et al., 2011). On the HM rangeland, winter is the most limiting season, when annual grasses have died and perennial grasses have reallocated nutrients to their roots. We thus used global positioning system (GPS) telemetry on bison to determine their patterns of habitat use through each phase of the seasonal cycle. Our main objective was to provide rangeland managers and ranchers with accurate information regarding where and when bison use habitats of particular importance to cattle. Also, because sexual segregation is common in bison elsewhere, we investigated the possibility that bison bulls, although small in number, could degrade certain habitats if they "camped" there in bachelor groups whereas mixed cow–calf groups roamed more widely.

Methods

Study Area

The HM study area in south-central Utah (lat 38°5′N, long 100°50′W) includes arid, semiarid, and alpine habitats for bison during their seasonal migrations from low to high altitudes, across an area of nearly 125 000 ha. The topography of the area is highly variable, with flat mesa tops separated by steep canyons in the low elevations, whereas the mountains themselves are steep and rugged. The nearby Hanksville weather station (lat 38°22′N, long 110°43′W) records mean annual precipitation of 152.4 mm and annual mean maximum and minimum temperatures of 22.1°C and 2.94°C, respectively (1981–2010; data managed by the Western Regional Climate Center). Apart from bison, cattle are the only other large grazers in the region. Mule deer (*Odocoileus hemionus*) are present on the HM, but their preference for forbs suggests negligible levels of competition with the grazers (van Vuren & Bray, 1983). A small herd (~20 animals) of elk *(Cervus canadensis)* is also present, though the Utah Division of Wildlife Resources actively manages against elk, using sport hunting in an attempt to eradicate the herd to prevent competition with the highly prized mule deer. Black-tailed jackrabbits *(Lepus californicus)* and desert cottontail *(Sylvilagus audubonii)* are common in the low and mid elevations. Mountain lions *(Puma concolor)* and coyotes *(Canis latrans)* use the study area, but their populations are controlled by government and private entities. Detailed descriptions of the study area can be found in Nelson (1965) and van Vuren and Bray (1986).

Data Collection

Lotek satellite-download GPS telemetry collars were deployed on bison across the entire HM area in January 2011, transmitting location data at 6-hour intervals (0000, 0600, 1200, and 1800 hours). A helicopter capture team was used to net-gun and collar bison, targeting 25 females and 20 males. Because there are ~325 adult bison in the HM, collars were distributed such that roughly one in every seven adult bison encountered was captured and collared. Individual animal age was not known until the bison was captured, at which point age was estimated on the basis of tooth eruption and wear. Collars that stopped transmitting due to damage, death of the individual, or premature drop-off were replaced in January 2012, June 2012, and January 2013. A total of 47 individual bison, 28 females and 19 males, wore a GPS collar for some duration during the study period of January 2011 to December 2013.

Any data collected within 10 days of an individual's capture were removed from the data set to reduce disturbance effects. Any locations that were collected outside of the designated collection schedule or with a dilution of precision greater than 8 (D'eon & Delparte, 2005) were also removed to ensure the accuracy of the collected data. The data were then grouped by sex and season. Spring was designated as March to May, summer as June to August, fall as September to November, and winter as December to February. The locations for each sex and season combination, plus female annual use, were used to create minimum convex polygons (MCPs) using ArcGIS. These were used to delineate the area within which classified habitats (land cover types) were assumed to be available to the HM bison population in each season, resulting in nine separate MCPs. Random GPS points were then generated using the Geospatial Modeling Environment at a 1:1 ratio to the actual number of bison locations for each sex and season combination to allow for the direct comparison of used habitat (GPS collar data) with available (random GPS points) habitat types and landscape variables.

Land cover classifications, digital elevation models, and the locations of roads and water sources were obtained from the Utah Automated Geographic Reference Center, the Bureau of Land Management, and the Utah Division of Wildlife Resources, all at the 30 × 30 m scale. All land cover data were verified and corrected where needed through ground truthing and the use of recent (2011) aerial photography. Southwest Gap Analysis Project data (USGS, 2004) were used to construct a land cover dataset, with land cover descriptions collapsed into 12 types: alpine meadow, aspen woodland, barren, "burn," "chaining," coniferous woodland, grassland, grass–shrub mix, shrubland, oakbrush, piñon–juniper woodland, and riparian. In the "burn" land cover type, most trees were absent and the herbaceous vegetation comparatively dense, following prescribed or accidental fires. The "chaining" areas were the result of past habitat manipulations to improve grazing conditions by breaking down piñon–juniper woodland using parallel bulldozers connected with chains. We recorded Euclidean distance (km) to roads and water sources for each pixel, together with aspect and slope from the digital elevation model in ArcGIS. Aspect was then reclassified for analysis as a categorical variable with eight levels, corresponding to the cardinal directions (N, NE, E, SE, S, SW, W, and NW).

The cattle on the HM rangeland are cows with calves, so we were sex specific in our analysis of bison habitat use. For sexual segregation analysis, direct observation of bison on the HM was conducted between May 2011 and August 2013. Seasons were defined as breeding (July to August) and nonbreeding (September to June). Observations were primarily collected during the summer months (May to August), with monthly trips throughout the remainder of the seasonal cycle as possible. Direct observation of bison proved difficult in the winter months as the bison tended to use a large roadless area with extremely rough topography that made access prohibitively difficult. When a bison group was located, group size and composition (numbers of bulls,