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Conflicting management objectives on the Colorado Plateau: Understanding the effects of bison and cattle grazing on plant community composition

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ABSTRACT

The American Bison (*Bison bison* Linnaeus) in the Henry Mountains are one of the last free-roaming, genetically pure herds of bison remaining in North America. Anecdotal evidence indicates that this herd is utilising a cattle winter range during the summer and fall, creating a conflict between the state agency that manages the bison, and the Bureau of Land Management (BLM) and local ranchers. In theory, the addition of bison grazing pressure could reduce forage availability in the short term and lead to undesired changes in the plant community in the long term. Our objective was to determine whether bison have altered the plant species composition of the cattle winter range. We characterised plant species composition, percent cover, and grazing intensity on three adjacent, geomorphologically similar mesas. Grazing regimes were different on the three mesas, one with bison and cattle present, one with cattle only present, and the third with neither cattle nor bison present. Vegetation surveys were accompanied by a 28-year remote sensing time series to test for temporal shifts in an index of primary productivity. We found a higher grazing intensity on two dominant forage species on the bison plus cattle grazed mesa in fall, before the cattle were turned out to winter pasture. Despite this difference in grazing intensity, we found few differences in species composition, percent cover, or NDVI across the three grazing regimes. Our results suggest that high intensity summer bison grazing, while likely creating short-term reductions in forage availability, has not caused differences in plant community composition or productive potential. Shifts in community composition can take years to unfold and just as long to correct; therefore, continued monitoring of the combined effects of cattle and bison is needed.

Introduction

Rangeland ecosystems provide ecosystem services including food and fiber production, biodiversity, climate regulation, water supply, and recreation. However, trade-offs among ecosystem services exist, meaning that a particular land management practice may promote one service but reduce another, leading to conflict (Bennett et al., 2009). Many rangelands are managed for both livestock production and for ecosystem services, primarily biodiversity and recreation, provided by wild ungulate populations. The potential for conflicting management objectives involving wild and domestic herbivores exists in *Africa* (du Toit 2011; Odadi et al. 2011), *Asia* (Mishra et al. 2004; Namgail et al. 2007), *Europe* (Kuemmerle et al. 2010; Latham 1999; Putman et al. 2011) and *North America* (Manier & Hobbs 2007).

Such a conflict is occurring in the Henry Mountains of southeastern Utah, which provide forage for domestic cattle, bison, deer, and other wildlife, refugia for unique flora and fauna, and recreation. The mountain range, located on the Colorado Plateau, is home to one of the last free-roaming, genetically pure herds of American bison (*Bison bison* Linnaeus) remaining on public land. The Henry Mountain bison herd was first established in 1941, with fifteen cows and three bulls relocated from Yellowstone National Park, Wyoming. Five more bulls were added to the herd in 1942 (Van Vuren 1979). Over the last decade, a portion of the 412-member bison herd has begun using cattle winter range during the late summer and early fall. Cattle are generally put onto the same rangelands in the late fall. The perceived overlap between bison and cattle use has created a conflict between the Utah Division of Wildlife Resources (UDWR), the Bureau of Land Management (BLM), and the local ranchers. At the heart of this conflict is the question of whether

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the bison herd, which has a high value for recreation, is negatively impacting the rangeland and its ability to provide sustainable food and fiber production.

Overgrazing on the Colorado Plateau has resulted in decreased productive potential as measured by reductions in plant growth, regeneration, and nutrient availability (Fernandez et al. 2008; Neff et al. 2005), leading to both short and long term negative effects. In the short term, grazing can reduce forage available to domestic and wild herbivores. In the long term, higher stocking rates can eventually lead to loss of important forage species and reductions in above and belowground productivity (Adler et al. 2005; Fernandez et al. 2008). Long-term negative impacts can also be mediated by the seasonality of grazing events. Grazing during the growing season removes reproductive structures, reducing seed production and a plant's ability to respond to environmental stress. In sagebrush steppe ecosystems, for example, spring grazing can reduce the abundance of perennial grasses, and increase shrub abundance and bare ground cover, while fall grazing may favour grasses over shrubs (Adler et al. 2005; Kitchen & Hall 1996; Laycock 1967).

Little is known about whether bison have a different effect than cattle on Colorado Plateau plant communities. In the Great Plains, differences between bison grazing and cattle grazing appear minor in comparison to differences between grazed and ungrazed pastures (Towne et al. 2005). Specifically, moderate grazing by both bison and cattle causes an increase in spatial heterogeneity and in turn floristic diversity (Hartnett et al. 1996; Hickman et al. 2004; Olff & Ritchie 1998; Towne et al. 2005). Bison and cattle movements and aggregations across the landscape can also influence changes in community composition. Cattle tend to concentrate in areas where water and shade are available. Bison are much less restricted by proximity to water, which allows bison herds to graze more extensive areas (Plumb & Dodd 1993; Van Vuren 2001). For example, in Yellowstone National Park, seasonal migration of bison potentially increased unselective foraging, consequently limiting negative effects on desirable forage species, such as grasses and forbs (Augustine & McNaughton 1998). Thus, while bison and cattle diets are likely to be similar, their spatial-temporal use of the landscape may differ. Maintaining spatial-temporal variation within native rangelands is believed to increase heterogeneity fundamental to grazing landscapes and may be an important approach to land management that simultaneously considers biodiversity and agricultural productivity (Fuhlendorf & Engle 2001).

Our goal was to inform future management decisions by determining the extent to which bison have altered plant communities on cattle winter range in the Henry Mountains. We focused on three research questions: (1) Is the presence of bison increasing grazing intensity or altering the season of utilisation on these rangelands? (2) Do areas grazed by bison and cattle, areas grazed only by cattle, and ungrazed areas differ in species composition? If so, do current differences in plant community composition provide evidence that bison grazing is causing degradation? (3) Based on long-term remotely sensed vegetation data, does the timing of vegetation change coincide with the increase in bison use? To answer these questions we compared plant community composition, plant cover, and soil parameters on three separate mesas with different grazing histories: bison and cattle grazed; cattle grazed; and, ungrazed. We used a 28-year time series of a remotely sensed Normalised Difference Vegetation Index (NDVI), a measure of vegetative activity closely correlated with productivity, to complement the spatial comparison across the three mesas. This time series could confirm that current differences in plant species composition reflect changes in bison use that began around the year 2000, when the bison appear to have begun utilising the low elevation winter range.

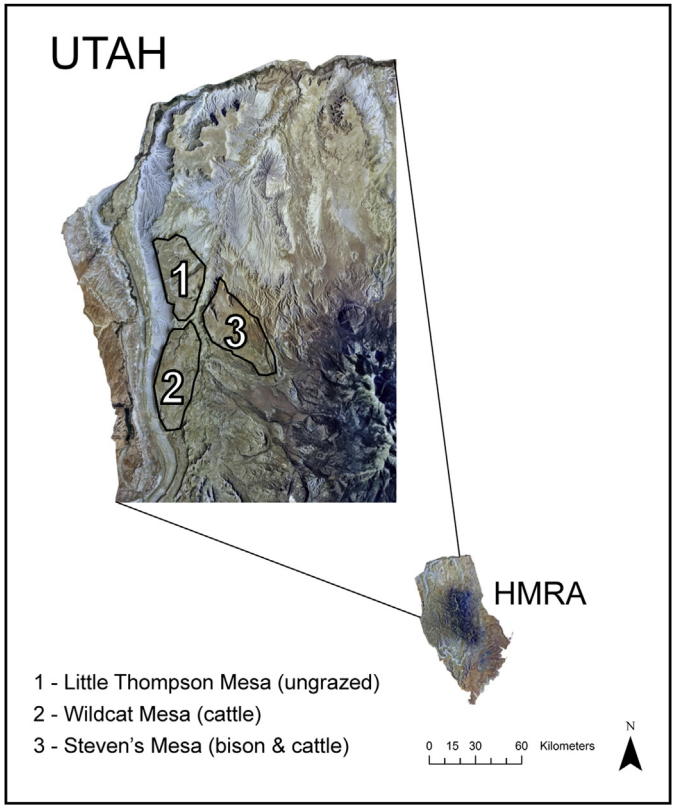

Fig. 1. The Henry Mountain Resource Area (HMRA) is part of the Colorado Plateau in southeastern Utah (38°6.53′ N, 10°48.82′ W). Our study area takes advantage of three adjacent geomorphologically similar mesas on the west side of the Henry Mountains, spanning approximately 225 km^2 of grasslands and shrublands characteristic of the Colorado Plateau. Individual mesas are denoted with numbers: (1) Little Thompson Mesa (ungrazed); (2) Wildcat Mesa (cattle grazed); and, (3) Steven's Mesa (bison and cattle grazed).

Methods

Site selection and limitations

The Henry Mountains are part of the Colorado Plateau in southeastern Utah (Fig. 1; 38°6.53′ N, 10°48.82′ W). Hanksville, the closest weather station about 40 km to the north has a mean annual temperature of 11.8 °C, a mean annual precipitation of 142.75 mm (Moller & Gillies 2008). The official Natural Resource Conservation Service (NRCS) ecological site description (ESD) for our study area is Semi-desert Sandy Loam with the associated Four-Wing Saltbush (*Atriplex canescens* [Pursh] Nutt.) plant community (Soil Survey Staff, NRCS 2013). The ESD also indicates, "as ecological condition deteriorates due to overgrazing," the perennial bunchgrasses decrease while *Gutierrezia sarothrae* ([Pursh] Britton and Rusby), *Chrysothamnus visidiflorus* ([Hook.] Nutt.), and *Opuntia fragilis* ([Nutt.] Haw.) increase (Soil Survey Staff, NRCS 2013). This study takes advantage of three adjacent geomorphologically similar mesas on the west side of the Henry Mountains, spanning approximately 225 km^2 of grass-shrublands characteristic throughout the Colorado Plateau. Little Thompson Mesa does not have either cattle or bison present, has no water source, and is difficult to access. Wildcat Mesa has cattle present during the winter months, and Steven's Mesa has cattle present during the winter and bison present in late summer and early fall. Hereafter, we refer to Little Thompson as the "ungrazed" mesa, to Wildcat as the "cattle" grazed mesa, and to Steven's as the bison and cattle ("B&C") grazed mesa.