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Impacts of Mesquite Distribution on Seasonal Space Use of Lesser Prairie-Chickens☆

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ABSTRACT

Loss of native grasslands by anthropogenic disturbances has reduced availability and connectivity of habitat for many grassland species. A primary threat to contiguous grasslands is the encroachment of woody vegetation, which is spurred by disturbances that take on many forms from energy development, fire suppression, and grazing. These disturbances are exacerbated by natural- and human-driven cycles of changes in climate punctuated by drought and desertification conditions. Encroachment of honey mesquite *(Prosopis glandulosa)* into the prairies of southeastern New Mexico has potentially limited habitat for numerous grassland species, including lesser prairie-chickens *(Tympanuchus pallidicinctus)*. To determine the magnitude of impacts of distribution of mesquite and how lesser prairie-chickens respond to mesquite presence on the landscape in southeastern New Mexico, we evaluated seasonal space use of lesser prairie-chickens in the breeding and nonbreeding seasons. We derived several remotely sensed spatial metrics to characterize the distribution of mesquite. We then used these data to create population-level resource utilization functions and predict intensity of use of lesser prairie-chickens across our study area. Home ranges were smaller in the breeding season compared with the nonbreeding season; however, habitat use was similar across seasons. During both seasons, lesser prairie-chickens used areas closer to leks and largely avoided areas with mesquite. Relative to the breeding season, during the nonbreeding season habitat use suggested a marginal increase in mesquite within areas of low intensity of use, yet aversion to mesquite was strong in areas of medium to high intensity of use. To our knowledge, our study is the first to demonstrate a negative behavioral response by lesser prairie-chickens to woody encroachment in native grasslands. To mitigate one of the possible limiting factors for lesser prairie-chickens, we suggest future conservation strategies be employed by land managers to reduce mesquite abundance in the southern portion of their current range.

Introduction

Before European settlement, the central Great Plains were largely unbroken prairies. Since that time, the contemporary Great Plains have been heavily fragmented and the natural processes that once maintained their structure have been disrupted by encroachment of woody shrubs, anthropogenic disturbances, and changes in climate (Brown, 1989; Engle et al., 2008). These impacts, which are manifested in habitat fragmentation and degradation, are key threats to species that rely on prairie ecosystems (Heimlich and Kula, 1991; Vickery et al., 1999). Furthermore, interactions between natural and anthropogenic disturbances can exacerbate the encroachment of woody shrubs and differences in soil and site fertility make some environments more vulnerable to shrub encroachment than others (Fuhlendorf et al., 2008).

Several woody shrub species that exhibit high rates of encroachment on grasslands are honey mesquite (*Prosopis glandulosa*, hereafter mesquite) and eastern redcedar *(Juniperus virginiana)*. Across the Great Plains, eastern redcedar encroachment appears to be the greatest species of concern in northern and eastern regions, whereas mesquite is the greatest species of concern in southern regions (Falkowski et al., this

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issue). The dynamics of historic and current encroachment of mesquite in the southern Great Plains, particularly New Mexico, are poorly described and understood. Potential factors contributing to contemporary mesquite expansion in New Mexico include fire suppression, livestock grazing, and changes in climate (Hastings and Turner, 1965; Neilson, 1986; Brown, 1989; Fredrickson et al., 1998; Fredrickson et al., 2005).

Mesquite has expanded into or contracted from the grasslands of New Mexico in response to drought and desertification interceded by periods of cooling (Fredrickson et al., 1998). At the time of European settlement, New Mexico was characterized primarily by a grassland prairie ecosystem but has been slowly encroached by woody shrubs since (Humphrey, 1958; Fredrickson et al., 1998). The widespread dispersal of mesquite in New Mexico following European settlement is believed to have occurred primarily via seed dispersal by livestock (Fredrickson et al., 1998, 2005). Mesquite seeds are resilient to digestion and are actively dispersed by domesticated animals such as cattle, sheep, and goats (Kneuper et al., 2003). The Camino Real, a primary road for European settlers to cross the Jornada del Muerto of New Mexico, is still visible in satellite imagery due to the high density and prominence of mesquite on the historical route. The thick mesquite cover is a legacy of European settlers and their livestock (Fredrickson et al., 2005). Dispersal of seeds by livestock, lack of fire, and changing climate patterns that promote mesquite prevalence has resulted in widespread distribution of mesquite in New Mexico (Brown, 1989).

Previous work has documented the abiotic and biotic impacts that mesquite encroachment has on ecosystem processes. Mesquite alters carbon and nitrogen dynamics of the environments it invades and fundamentally changes soil bacteria and fungi, thereby altering patterns of litter decomposition (Throop and Archer, 2007; Creamer et al., 2011; Hollister et al., 2010). Mesquite presence decreases near-surface temperatures relative to native grasslands (Beltran-Przekurat et al., 2008), increases evapotranspiration (Nie et al., 2012), outcompetes other desert plants with its comparatively deep root structure, and increases spatial heterogeneity in respiration (Cable et al., 2012). Moreover, mesquite decreases both perennial grass and herbaceous biomass and reduces forage for both wildlife and livestock (Teague et al., 2008; Mohamed et al., 2011).

The impacts of mesquite encroachment are far encompassing and complex, and the full magnitude of these effects is still unclear. As encroachment of woody plants increases across grasslands, birds that depend on grasslands can suffer a steady decline in available habitat (Lloyd et al., 1998; Peterjohn and Sauer, 1999; Herkert et al., 2003). Encroachment of woody plants also fragments habitat, resulting in the decline of many grassland-obligate birds (Coppedge et al., 2001). Lesser prairie-chickens *(Tympanuchus pallidicinctus)*, for example, are a species of conservation concern that require large contiguous blocks of grassland environments (Woodward et al., 2001).

Mesquite encroachment has been identified as degrading or potentially limiting habitat availability for lesser prairie-chickens across their contemporary range (Van Pelt et al., 2013; USDA, 2014). Few studies, however, have attempted to quantify these effects, even though the impact of mesquite is of special importance to management and conservation of lesser prairie-chickens in New Mexico (Hunt and Best, 2010; Behney et al., 2012). Conversion to a mesquite-dominated landscape is thought to ultimately be unsuitable for lesser prairie-chickens. Moreover, once established, the vertical vegetation structure of mesquite may provide predator perches (Fuhlendorf et al., 2002; Hagen et al., 2004). Predator avoidance may impact use of an environment by avian species, and individuals may modulate their use on the basis of the perception of predation risk (Thomson et al., 2006). Predatory birds, for example, are more abundant in areas containing mesquite than areas lacking mesquite within environments occupied by lesser prairie-chickens (Behney et al., 2012). It is speculated that lesser prairie-chickens may avoid areas because of perceived higher predation risk due to the presence of predatory birds (Behney et al., 2012). Despite active research into many impacts of mesquite encroachment, the relationship between mesquite presence and patterns of seasonal use of habitat by lesser prairie-chickens is unknown.

Understanding the relationship between distribution of mesquite and habitat used by lesser prairie-chickens is important for conservation strategies that consider the negative effects of mesquite presence and/or aim to minimize further loss of habitat. Our goals were to use resource utilization functions (Marzluff et al., 2004; Kertson et al., 2011) to evaluate how mesquite distribution and the seasonal abscission of the foliage of mesquite mediated the use of habitat by lesser prairie-chickens in the breeding and nonbreeding season.

Methods

Study Area

Our study area encompasses 1,147 km^2 and is composed of two properties administered by the Bureau of Land Management and a complex of private and state holdings surrounding these properties in Chaves and Lea counties (Fig. 1). The Sand Ranch and Mescalero Sands Area of Critical Environmental Concern are located north and south of Highway 380 near Caprock, New Mexico. Both areas have a history of disturbance in the form of herbicidal treatments, wildfire, grazing, and low levels of energy development. Broadly, the study area is composed of two diverse mosaics of primarily shinnery oak *(Quercus havardii)* prairie-dominated sandhills and sandy plains (Pettit, 1979; Doerr and Guthery, 1983; Smythe, 2006).

Capture and Radiotelemetry

We captured male and female lesser prairie-chickens during the breeding season from March through May of 2013 and 2014. During morning hours, we used 12 x 12 m pulley-operated or magnet-operated drop nets (Wildlife Capture Services LLC, Flagstaff, AZ), whoosh nets (Hawkseye Nets, Virginia Beach, VA), and walk-in funnel traps (Haukos and Smith, 1989) to capture birds on leks (i.e., communal breeding grounds). Whoosh nets were composed of 13.7 × 4.6 m mesh nets propelled from a ground-level position by bungie cords. Walk-in traps were a series of chicken wire enclosures connected by fencing, where birds are funneled toward a conical wire doorway (Haukos and Smith, 1989).

Once captured, we aged, sexed, weighed, and fitted birds with very high frequency (VHF) or satellite transmitters. We used barring on their 9th and 10th primaries to age birds and pinnae feather length and eye comb color to determine sex (Copelin, 1963; Toole, 2005). We used a necklace-style harness with a durable string looped to attach VHF transmitters to captured birds (American Wildlife Enterprises, Monticello, FL). We used a backpack harness design to attach satellite transmitters (22-g, solar-powered PTT-100 models Microwave Telemetry, Columbia, MD) composed of Teflon ribbon and crimps fashioned from copper pipe to secure the ligature. GPS fixes from satellite transmitters were transmitted every 2 h, for a total of 12 transmissions per day.

We used triangulation to locate radio-tagged birds with azimuths taken <60 min apart to limit error due to movement (Kenward, 2001). We used receivers (Model R1000 Communications Specialists Telemetry Receivers, Orange, CA) and dipole yagis to assist in preliminary location of birds and then three-element yagis to estimate the precise location of birds. We used Global Positioning System (GPS) units (Garmin eTrex30 GPS, Olathe, KS) to obtain Universal Transverse Mercator (UTM) coordinates for observer locations of birds. Any bird whose location was unchanged for ≥2 days was walked-up on and visually verified if it was alive or dead. We collected locations for females daily during the breeding season and males at least two to three times a week. Following the breeding season, we located males and females two to three times per week. We used Location of a Signal (LOAS, Ecological Software Solutions LLC, Hegymagas, Hungary) to process telemetry azimuths and triangulations. We censored any triangulated locations with error