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Spatial response of coyotes to removal of water availability at anthropogenic water sites

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ABSTRACT

Features containing year-round availability of free water (hereafter water sites) and areas affiliated with water sites (i.e., riparian zones) occurring within arid landscapes represent a potential limiting resource for some desert dwelling vertebrates. Little is known about the relationship between water sites and mammalian carnivores. An increase of water sites in portions of the Great Basin Desert in Utah reportedly contributed to an increase in coyote (*Canis latrans*) abundance. We examined frequency of visitation and spatial affinity of resident coyotes for water sites at the home range scale extent. Visitation to sites with available water averaged 13.0 visitations/season (SD = 13.5) and ranged from zero to 47. We documented no visits to water sites in 16% (10 of 64) of seasonal home-ranges, <5 visits within 39% (25 of 64) of home ranges, and 25% (28 of 113) of coyote home-ranges did not contain a water site. Water sites associated with riparian vegetation experienced higher visitation than guzzlers (no riparian vegetation present). We found no evidence that removal of water influenced home range size or spatial shifting of home range areas. Water sites, especially guzzlers, do not represent a pivotal resource for the coyote population in our study area.

1. Introduction

Identifying the extent to which organisms utilize certain resources on a given landscape, and the impact of such use, has become a central tenet of animal ecology. Investigations determining the spatial relationships between animals and the resources they utilize can guide conservation and management strategies (Morris, 2003; Onorato et al., 2011; Briggs et al., 2012) and predict the impacts of varying land use (Wilson et al., 2014) and climate change scenarios (Costa et al., 2010). It has been long established that resources available to animals in a given spatial mosaic are often used at variable levels (Manly et al., 2002; Begon et al., 2005). Resources can serve as a requisite component of species habitat (Schroeder et al., 2004; Cain et al., 2012; Edgel et al., 2014), while other resources may be utilized, they are not required (Manly et al., 2002).

Landscape features with year-round availability of free water (hereafter water sites) and adjacent areas affiliated with water sites (i.e., riparian zones) occurring within arid landscapes represent a potential limiting resource. Many species of terrestrial vertebrates are dependent on water sites (Gill, 2006; Vaughan et al., 2010); regular intervals of free water uptake are needed to maintain metabolic functions necessary for an individual's survival (Silanikove, 1994; Larsen et al., 2012). Other species of vertebrates utilize water sites for drinking as a resource subsidy; they have the ability to persist on preformed or metabolic forms of water alone (Harrington et al., 1999; Cain et al., 2008; Hall et al., 2013). In most cases, investigations focusing on water uptake and wildlife have documented overall use (e.g., visitations to or activity/sign at water sites) at the species or community level (e.g., an index) rather than determining patterns of individual water use (Rosenstock et al., 2004; Morgart et al., 2005; Jennifer et al., 2010; Whiting et al., 2010). Such individual based investigations are needed to determine water site visitations per individual, the proportion of a population utilizing water sites, and to determine the relevancy of water sites as a habitat component (Shields et al., 2012). In addition to providing water uptake opportunities, water sites can facilitate establishment of riparian vegetation that provide resources that confer a reproductive, nutritional, safety, or thermoregulatory

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benefit to a degree greater than areas not affiliated with water sites (Bock and Bock, 1984; Doyle, 1990; Schulz and Leininger, 1991; Shafroth et al., 2005).

Water sites influence individual space use and species habitat quality for a host of terrestrial vertebrates (Harrington et al., 1999; Allen, 2012; Cain et al., 2012; Ogutu et al., 2014), or can have little to no impact (Krausman and Etchberger, 1995; Cain et al., 2008). The majority of investigations focused on populations of large herbivores in xeric landscapes, where water sites are more influential than in mesic landscapes (Larsen et al., 2012). Such an emphasis on this group of animals is likely due to a host of factors including, but not limited to, logistical (e.g., VHF or GPS transmitter mass) and political (e.g., the disproportionate amount of research funding allocated toward game versus nongame animals) factors (Simpson et al., 2011).

Infrequent investigations have examined the relationship between water sites, water use, and the influence of such use on mammalian carnivores. Allen (2012) reported that 100% of GPS-collared dingoes (*Canis lupus dingo*) regularly visited water sites, though the frequency of visitations varied by individuals and temporal factors, and suggested the dingo population was dependent on water sites. However, determining patterns of use and the impact of water sites on many desert dwelling carnivores has not been achieved; to date, investigations have only chronicled indexes of visitations to water sites (Rosenstock et al., 2004; Atwood et al., 2011; Hall et al., 2013) or indexed activity for areas distant from and close to water sites (Hall et al., 2013).

Coyotes (*Canis latrans*) occur in a host of wildland, rural, and urban landscapes across a broad spectrum of mesic and arid environments (Bekoff and Gese, 2002), but the degree to which this species utilizes water sites, and the relationship between water sites and space use remains unexplored. Coyote populations are often managed due to issues relating to human-wildlife conflict (Knowlton et al., 1999; Conner et al., 2008; Poessel et al., 2013) or conservation of threatened or imperiled species competing with coyotes (Cypher et al., 2000; Moehrenschlager et al., 2007). It has been posited that the distribution and abundance of coyotes in the Great Basin Desert has increased in part due to the addition of water sites, by way of relaxing the limitation of arid systems to coyotes (Arjo et al., 2007; Kozlowski et al., 2008), thus increasing overall habitat quality for coyotes (Kozlowski et al., 2012). As a result, discerning the relevancy of water sites to coyotes has both management and conservation implications.

The physiological demands and behavioral characteristics of coyotes are such that water sites are more likely to be utilized than more desert-adapted carnivore species, like the sympatric kit fox (*Vulpes macrotis*) (Golightly and Ohmart, 1983), a species of conservation concern in several western states (Dempsey et al., 2014). For example, in the absence of water, coyotes theoretically need to consume 3.5 times the number of prey items than kit foxes to meet energetic requirements (Golightly and Ohmart, 1984). Thus, if prey items are a limiting factor on a landscape the addition of free water sites could serve as a resource subsidy to coyotes. Coyotes in the Great Basin Desert were classified as rare during the 1950s (Shippee and Jollie, 1953) and coyote abundance in this area has increased since the 1970s (Arjo et al., 2007). Further, kit fox density has been found to be negatively correlated with coyote abundance (Arjo et al., 2007), and it has been posited that a marked increase of permanent water sites in the Great Basin Desert since the mid-twentieth century may have indirectly decreased available kit fox habitat by way of increased interspecific competition and intraguild predation from coyotes, leading to reduced kit fox abundance (Arjo et al., 2007; Kozlowski et al., 2008, 2012).

Clearly, further investigation is needed to determine the extent to which water sites are utilized by coyotes in arid landscapes, and if water sites represent a requisite habitat component for coyotes in arid regions. If water sites represent a limiting factor for a coyote population, it would be expected that coyote home ranges will overlap with water sites and that these water sites would be regularly utilized by coyotes, thus a reduction of available water sites would prompt a spatial response by coyotes. Elucidating the relationship between water sites and coyotes has the potential to influence kit fox conservation strategies and coyote management programs, as well as increase our general understanding of the effects of free water on wildlife in arid environments. The overall objective of our study was to determine the impacts of water sites on coyotes in an arid landscape. Specifically, we aimed to determine: 1) the frequency of water site visitations by individual coyotes, 2) whether removal of water availability at water sites reduces coyote visits to water sites, 3) if the removal of water availability at water sites facilitates a change in coyote home range sizes, and 4) if removal of water availability at water sites facilitates a shift of coyote home range areas.

2. Methods

2.1. Study area

We conducted our research on 1127 km^2 of the eastern portion of the U.S Army Dugway Proving Ground (DPG) and the adjoining lands managed by Bureau of Land Management (BLM), located approximately 128 km southwest of Salt Lake City, in Tooele County, Utah, USA (Fig. 1). Elevations ranged from 1302 m to 2137 m. The study site was located in Great Basin Desert, where winters were cold, summers were hot and dry, with the majority of precipitation occurring in the spring. Annual weather consisted of mean air temperatures of 12.7 °C (range: −20.0–40.6 °C) and mean precipitation of 150 mm (MesoWest, Bureau of Land Management & Boise Interagency Fire Center). In the study area, we identified 23 permanent water sites consisting of 10 guzzlers, 4 natural springs, and 9 man-made ponds/catchments. Guzzlers were designed to allow no run-off or access to water by rooted vegetation. Thus, there was no riparian vegetation component associated with guzzlers. In addition, the eastern portion of the study area managed by the BLM contained 3 livestock tanks that were at times operational during winter and spring cattle grazing (November 1 to April 1). Springs and man-made ponds were often associated with riparian communities primarily comprised of tamarisk (*Tamarix ramosissima*) (Emrick and Hill, 1999). Anthropogenic water sites (i.e., guzzlers, ponds, and livestock tanks) were developed between the 1960s and 1990s (Arjo et al., 2007). Thus, the ratio of anthropogenic to natural water sites within the study area was at least 3:1, with slight seasonal variability occurring due to the turning on/off of livestock tanks. We inspected all permanent water sites (e.g., ponds, springs, guzzlers) and livestock tanks within the study area monthly to confirm water availability. Water sites were considered permanent if they contained water during $\geq$3 of the monthly checks for each 4-month canid biological season and year (e.g., 2011 breeding season; Dempsey et al., 2014). There was no free-flowing water present on the study area. Additional water sites (e.g., hardpans, rainfall, drainages) were ephemeral pools (<1 week); thus we assumed they were homogenous throughout the study area and did not influence overall space use of coyotes relative to water sites.

The study area consisted of predominately flat playa punctuated with steep mountain ranges. The lowest areas consisted of salt playa flats sparsely vegetated with pickleweed (*Allenrolfea occidentalis*). Slightly higher elevation areas were less salty and supported a cold desert chenopod shrub community consisting predominately of shadscale (*Atriplex confertifolia*) and gray molly