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Using sterilization to change predation rates of wild coyotes: A test case involving pronghorn fawns

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ABSTRACT

Surgical sterilization of coyotes (*Canis latrans*) reduced their predation rate on domestic sheep. We investigated whether sterilizing coyotes would similarly change coyote predation rates on pronghorn antelope (*Antilocapra americana*) neonates. From May 2006 to March 2008, we radio-collared 71 pronghorn fawns to determine survival rates in southeast Colorado, USA. During the first year of the study, all coyotes were reproductively intact. During the second year, we surgically sterilized 15 coyotes from 10 packs in the southern half of the study area, while nine coyotes from seven packs in the northern half were given sham sterilizations (i.e., remained reproductively intact). In addition, we estimated the availability of alternative prey and coyote density on both areas to evaluate predator–prey factors that could interact with the sterilization treatment. Using the known fate model in Program Mark, we constructed models with and without a treatment effect, plus year, area, individual covariates, alternative prey indices, and predator density to estimate pronghorn fawn survival rates. Results from model averaged parameter estimates and cumulative summer survival indicated coyote sterilization increased survival rates of pronghorn fawns by reducing predation rates of fawns. While fawn survival was higher overall in the north area, after treatment was applied, cumulative pronghorn fawn survival during the summer of 2007 in the south area was 242% higher for pronghorn fawns captured in sterile coyote territories (0.44; 79-day interval survival rate) compared to fawns captured in intact coyote territories (0.18). There was also a significant local area effect, but no relationship between fawn survival and individual fawn covariates of sex, birth weight, birth date, or age. No relationship was detected between fawn survival and lagomorph abundance index, rodent abundance index, or coyote density. Surgical sterilization of coyotes was useful in reducing predation rates on pronghorn fawns.

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1. Introduction

Coyotes (*Canis latrans*) are considered an abundant and expanding native species in North America. Their population expansion has been enhanced by altered landscapes and the loss of top carnivores (Gompper, 2002; Berger and Gese, 2007). One concern with the expansion of native predators is their impact on prey species. In North America, predation of ungulate neonates can be the primary cause of mortality (Linnell et al., 1995). Coyotes are especially adept at killing pronghorn (*Antilocapra americana*) fawns (Byers, 1997). Studies have shown coyote-caused mortality of pronghorn neonates exceeds 75% of total mortality (Gerlach and Vaughan, 1990; Dunbar and Giordano,

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2003) and can lead to fawn:doe ratios <1:100 (Dunbar and Giordano, 2003). Where ungulate populations are declining or critically low, limited fawn recruitment can affect the persistence of local populations (Bright and Hervert, 2005; Berger et al., 2008). Under these circumstances, coyote management may be required to sustain ungulate populations. Coyote control in areas of fawn birthing could increase chances of fawn recruitment into the population (Smith et al., 1986; Bright and Hervert, 2005).

Management of coyote predation for domestic animals is complex and involves using several techniques (Knowlton et al., 1999). There are added challenges for coyote management for wild ungulate populations, such as pronghorn or mule deer (*Odocoileus hemionus*), due to unrestricted animal movements, extent of the landscape, cost of the effort, and lack of public support. Non-lethal management techniques for domestic animals, such as animal husbandry, guard animals, repellents, or aversive conditioning, are impractical for wildlife management. Habitat management is often the most obvious non-lethal method by which to influence ungulate population dynamics (Gaillard et al., 2000; Ballard et al., 2001; Forrester and Wittmer, 2013) with the interaction of forage quality and predation often being mediated by climate (Hopcraft et al., 2010). Lethal control of coyotes is frequently the only method available for managers to cope with predation. However, lethal control is a source of controversy to the public (Kellert, 1985; Messmer et al., 2001) and in some cases may not be biologically effective, particularly in cases where predation is not a limiting factor to the ungulate population (Ballard et al., 2001; Hurley et al., 2011; Forrester and Wittmer, 2013).

One non-lethal method to control coyote predation is changing predatory behavior through reproductive interference (i.e., reduce the energetic demands of provisioning pups). Till and Knowlton (1983) showed removing coyote pups from a den reduced predation on domestic sheep and hypothesized that the absence of pups reduced energetic needs of the pack, thus reducing predation on larger food items. Sacks et al. (1999) found offending coyotes responsible for sheep predation were the breeding, territorial animals and recommended that control efforts focus on these individuals. Zemlicka (1995) demonstrated sterilization of captive coyotes did not affect social or territorial behaviors. Bromley and Gese (2001a) found surgical sterilization of coyotes resulted in an eightfold reduction of predation on lambs. In addition, results from a modeling study comparing sterilization and other lethal strategies, indicated sterilization offered the most lasting impact on coyote population dynamics (Conner et al., 2008). Surgical sterilization is less objectionable to the public and has the potential to be more successful biologically because it can persist for several years, whereas lethal control generally is applied annually. In addition, sterilized wild coyote pairs continued to defend their territory against neighboring coyotes and maintain pair bonds (Bromley and Gese, 2001b; Seidler and Gese, 2012).

Since coyote predation on lambs can be reduced using sterilization (Bromley and Gese, 2001a), then it may work in a wildlife application as well. In this study, we tested the hypothesis that surgical sterilization of coyotes would increase survival rates of pronghorn fawns by decreasing coyote predation rates on fawns, using a Before-After-Control-Impact paired (BACIP) field study design (Stewart-Oaten et al., 1986; Smith, 2002; Gotelli and Ellison, 2004). To evaluate factors impacting coyote predation on pronghorn fawns, we also examined levels of alternative prey availability and coyote density, as well as individual fawn covariates of sex, birth weight, and birth date. Our study is the first to examine the use of sterilization on coyotes as a non-lethal management tool to reduce predation on wild neonates.

2. Methods

2.1. Description of study area

We conducted this research on the 1,040 km^2 Piñon Canyon Maneuver Site (PCMS) in Las Animas County, Colorado, USA. The study area encompassed the home-range boundaries of radio-collared coyotes and the locations of radio-collared fawns involved in the study (approximately 350 km^2). Average elevation on the PCMS was 1520 m, mean temperatures ranged from 1 °C in January to 24 °C in July (Shaw and Diersing, 1990), and mean annual precipitation was 305 mm (Milchunas et al., 1999). Harvest of coyotes was not permitted for the duration of the study. Nearly 60% of the PCMS was identified as shortgrass prairie dominated by blue grama (*Bouteloua gracilis*), galleta (*Hilaria jamesii*), and western wheatgrass (*Agropyron smithii*) (Shaw et al., 1989). Many shrub communities occurred within the grassland communities along alluvial fans, waterways, and slopes. These were characterized by black greasewood (*Sarcobatus vermiculatus*), fourwing saltbush (*Atriplex canescens*), Bigelow sagebrush (*Artemisia bigelovii*), winterfat (*Krascheninnikovia lanata*), small soapweed (*Yucca glauca*), and tree cholla (*Opuntia imbricata*). Woodland communities were composed primarily of oneseed juniper (*Juniperus monsperma*) and pinyon pine (*Pinus edulis*) mixed with grassland or shrubland species. Woodlands dominated the canyons and breaks. Areas that were defined as burned had natural or prescribed fires during or after 2004.

2.2. Description of study design

This study was designed to test the prediction that fawns born in territories of sterile coyotes (i.e., no pups) would have higher survival rates than fawns born in territories of intact coyotes (i.e., with pups). Using a Before-After-Control-Impact paired (BACIP) field study design (Stewart-Oaten et al., 1986; Smith, 2002; Gotelli and Ellison, 2004), the first year of the study was a baseline year in which no treatment (i.e., sterilization) was applied. We captured and radio-collared fawns in two sites (north, south) and determined survival rates in both sites for the baseline survival rate estimates. During the second year of the study, we sterilized coyotes in the south area, while sham-operating coyotes in the north area (i.e., remained reproductively intact). To maintain hormone levels, female coyotes were tubal ligated and males were vasectomized,