

Effects of fenced transportation corridors on pronghorn antelope movement in Petrified Forest National Park, Arizona

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Introduction

Pronghorn (*Antilocapra americana*) is a species of special concern in Arizona and throughout other areas of the western USA. Intensified management is necessary to ensure that present population levels can be maintained. Because pronghorn have large home ranges and because land-ownership patterns in the West are quite diverse (i.e., there is “land checkerboarding”), proper management of this animal can occur only if management occurs uniformly across land-ownership boundaries.

Pronghorn are generally considered a nomadic mammal, moving among habitats in response to changing conditions due to drought, winter storms, forage and water availability (O’Gara and Yoakum 1992; Ockenfels et al. 1997). In some areas, it is believed that fenced rights-of-way fragment pronghorn habitat and restrict movements, thereby isolating populations or preventing migration to seasonal ranges (Buechner 1950; O’Gara and Yoakum 1992; van Riper and Ockenfels 1998). With the increased habitat fragmentation that is occurring throughout the West, pronghorn populations are having a more difficult time in maintaining traditional migratory behavior (Ockenfels et al. 1994; O’Gara and Yoakum 1992).

This study was initiated to examine how management of lands in northern Arizona, particularly National Park Service (NPS) areas, influenced home ranges and movement patterns of pronghorn. Our objectives were to: (1) document pronghorn movement patterns; (2) determine home-range sizes for adult female and male pronghorn; (3) identify what types of barriers isolated pronghorn; and, (4) ascertain how NPS management practices can influence movement among pronghorn populations.

Study area

We selected a study area that encompassed Petrified Forest National Park (Figure 13.1). Lands of this region are characterized by undulating terrain with rugged mesas or hills throughout, and numerous gullies extending from highly-eroded cliffs, similar in physiographic composition to much pronghorn antelope habitat throughout the western USA. Elevation within our study area ranged from 1,650 to 1,800 m, with the Puerco River being the only major waterway. Yearly precipitation is low (1941-1970: $\bar{x}$ = 18.7 cm), with over one-half of the rainfall occurring during brief thunderstorms during July–September (Sellers and Hill 1974). Average snowfall is only 12.4 cm.



Figure 13.1. Relocations of radio-collared pronghorn within the environs of Petrified Forest National Park, Arizona (shaded area), during monitoring between 1992-1994 (Part A), and ongoing monitoring since December 2000 (Part B). In 1992-1994, pronghorn were captured and radio-collared both north and south of the BNSF railway line; in 2000, only pronghorn north of the railway were captured. Graphics courtesy of Arizona Game and Fish Department.

Great Basin grassland (Brown 1994) and juniper (*Juniperus* spp.) woodland dominate the landscape. Blue grama (*Bouteloua gracilis*) and alkali-sacaton (*Sporobolus airoides*) are the predominant grasses. Sagebrush (*Artemisia* spp.), saltbush (*Atriplex* spp.), rabbitbrush (*Chrysothamnus* spp.), and Mormon-tea (*Ephedra* spp.) are scattered throughout, often forming small thickets. Snake-weed (*Gutierrezia* spp.) is abundant in localized poorer-condition sites. Plant nomenclature follows Kearney and Peebles (1960).

Methods

Capture and location. Using a net-gun fired from a helicopter, we captured adult pronghorn in mid-October 1992 and then in January 2001. All animals were radio-equipped, ear-tagged, and released at their capture sites. We located pronghorn aerially and from the ground each month between October 1992 and September 1994, and then weekly from January to August 2001. The Universal Transverse Mercator (UTM) coordinates of detections were derived to the nearest 0.1 km from U.S. Geological Survey 7.5-minute maps, and we also used a (GPS) receiver to calculate coordinates. All UTM-coordinate files were transferred into an ArcView geographic information system (GIS). Statistical tests were performed with SPSS/PC+ software (Norusis 1990).

Movements. Using features in the software package HOME RANGE (Ackerman et al. 1990), we calculated movements for each animal. The 100% minimum-convex polygon method was selected as our estimate of home-range size, with a 50% convex polygon as the estimate of high-use areas. We tested for site- or gender-related differences, as well as site $\times$ gender interactions, in home-range and core use size with 2 $\times$ 2 ANOVAs. We used t -tests within each site for gender-related comparisons.

Results

Capture and relocation. We initially captured, radio-collared and ear-tagged 20 (15 females, 5 males) pronghorn in 1992. These animals were relocated 1,736 times (Figure 13.1). In 2000, we captured 9 antelope, 5 females and 4 males, and at present have 298 relocations.

General movements. Normality tests indicated that long-distance movements were not normally distributed, whereas mean distance and greatest distance between any two consecutive locations were likely sampled from normally distributed populations. Mean movements did differ ($F = 5.34$; $df = 1,36$; $P = 0.027$) by gender (Table 13.1); females ($\bar{x} = 3.3$ km, $SD = 0.5$, $n = 28$) tended to move more in their home ranges than did males ($\bar{x} = 2.9$ km, $SD = 0.5$, $n = 9$). No site $\times$ gender interactions were observed ($F = 0.72$; $df = 1,36$; $P = 0.404$), with much of the gender-related difference explained by a correlation ($r = 0.64$, $n = 37$, $P < 0.001$) between mean movements and greatest movements.

Specific movements. For the 20 adult pronghorn captured in the northeastern study site, females tended to move more ($t = 2.26$, $df = 18$, $P = 0.036$) than males, and greatest movements of females were more variable and exceeded ($t = 2.41$, $df = 17.63$, $P = 0.027$) those of males (Table 13.1). Most (76%) pronghorn exhibited at least some movements greater than 10 km. The 9 individuals captured in 2000 had similar movement patterns to those recorded in 1992-1994 (Figure 13.1).

Rights-of-way crossings. Crossings, by both females and males, of the paved but unfenced road in Petrified Forest National Park occurred throughout this study, with 165 crossings from 1992-1994 and 34 crossings recorded in 2001. However, we recorded no pronghorn crossing paved highways that were fenced (e.g., Interstate 40) or crossing the Atchison, Topeka, and Santa Fe (AT&SF) or Navajo spur railroad rights-of-way (Figure 13.1). In fact, some of the home ranges seemed bounded by these fenced transportation corridors. For example, pronghorn captured north of the AT&SF in 1992 and 2001 had home ranges bounded by the railroad right-of-way to the south and Interstate 40 to the north, resulting in a linear shape. Those

captured south of the railroad in 1992 had non-linear home range shapes, more typical of pronghorn home-range patterns throughout the western USA (O'Gara and Yokum 1992).

Variable	Females	Males
<i>n</i>	15	5
Mean distance moved (a)	3.3	2.7
SD	0.6	0.4
Range	2.5-4.4	2.0-2.9
No. movements ≥ 10 km	36	7
No. movements ≥ 20 km	3	0
Mean of greatest distance moved (a)	14.4	9.0
SD	8.0	2.0
Range	6.0-35.0	6.5-10.6

- (a) Distance (km) between 2 consecutive locations for each animal as calculated by HOME RANGE (Ackerman et al. 1990), then averaged for mean distance.
 (b) Distance (km) between 2 consecutive locations.

Table 13.1. Movement characteristics of adult pronghorn antelope from 1992-1994 in the environs of Petrified Forest National Park, Arizona.

Home Ranges and Core Use Areas

Home-range sizes clustered in the 75-125 sq km range, with few encompassing <50 sq km, while 3 home ranges >250 sq km were for females that had made large-scale seasonal movements (Table 13.2). Home-range sizes did not vary by gender ($F = 2.09$; $df = 1,36$; $P = 0.158$), but home-range sizes and variability were larger ($t = 2.15$, $df = 22.32$, $P = 0.042$) for animals confined by the two fenced transportation corridors (i.e., freeway and railroad). There was no ($F = 0.06$; $df = 1,36$; $P = 0.805$) site $\times$ gender interaction. The greatest influence on home-range shapes of the radio-collared pronghorn was human-related development, particularly fenced highways and railroad rights-of-way.

Movement Enhancement Studies

Following the 2001 capture, animals were followed to make sure that they were not crossing rights-of-way. During the initial four months of 2001, animals maintained the same home-range structure that we observed from 1992 through 1994 (Figure 13.1). No animal crossed a fenced transportation corridor. All present fences along the railroad right-of-way have been georeferenced and entered into the park's GIS data base. In June 2001, at select locations we installed wildlife movement enhancement bars. We are monitoring pronghorn movements to ascertain if they utilize these structures. Following six months of tracking, if animals have not crossed the railroad right-of-way, fencing will be removed along the railroad tracks within the park boundaries. Monitoring of animals will continue over the next 12 months to ascertain when and where animals cross the railroad right-of-way.

Discussion

In our discussion we will first compare pronghorn home range and movements between our study site and other areas of the western USA. We will then discuss what

did, or did not, constitute a movement barrier. A third topic of discussion will be the potential role national parks play in the management of pronghorn in northern Arizona and in other areas of the western USA. Finally, we will examine potential new management actions, framed in some of the management tools developed during this study.

Variable	Females	Males
<i>n</i>	15	5
Mean home-range size (sq km) (a)	124.0	81.7
SD	59.6	40.9
Range	56.5-243.2	44.4-140.0
Mean core use area (sq km) (a)	21.2	9.2
SD	5.4	7.4
Range	9.7-28.1	2.1-20.6

- (a) Home-range size using 100% minimum convex polygon and core use area using 50% minimum convex polygon from HOME RANGE (Ackerman et al. 1990).

Table 13.2. Home-range characteristics of adult pronghorn antelope from 1992-1994 in the environs of Petrified Forest National Park, Arizona.

Movement and Home-range Comparisons

Movements. Differences in pronghorn movements that we found were partially related to the availability of a permanent water source. Within Petrified Forest National Park, the Puerco River provided permanent water throughout the year. However, north of the railroad pronghorn had to leave the park for livestock water sources.

Home-range comparisons. Pronghorn had significantly larger home ranges than recorded for other populations over the western USA. This was due in large part to the animals that were confined between the railroad and freeway rights-of-way. Ockenfels et al. (1994) also showed that in central and northern Arizona transportation corridors played a dominant role in pronghorn home range sizes.

Movement Barriers

Fenced highway right-of-way. Buechner (1950), working in Texas, recorded the negative effect that highway rights-of-way fences had on pronghorn movements. White (1969) demonstrated that fenced highways blocked the movement of pronghorn in northern Arizona during a severe winter storm, resulting in losses of as much as 80% of some herds. In central Arizona, Ockenfels et al. (1994) provided further evidence of substantial fragmentation of pronghorn habitat and isolation of pronghorn herds by fenced highways. From over 3,000 relocations during their study, not a single animal crossed a fenced highway.

Fenced railroad right-of-way. The AT&SF railroad line roughly follows the 35th parallel of northern Arizona, crossing through the middle of Petrified Forest National Park. In our study area, we demonstrated that pronghorn are isolated into discrete populations by the AT&SF railroad right-of-way. Similar fragmentation probably occurs in many other areas in the state and throughout the West, particularly if the railroad tracks are tightly fenced on both sides.

Unfenced rights-of-way. Although considerable traffic occurs seasonally on Petrified Forest park roads, these unfenced paved roads did not adversely affect the

movement patterns of pronghorn during our study. Ockenfels et al. (1994) observed similar patterns relative to dirt roads (e.g., Dugas Road) in central Arizona.

Management Implications for NPS Areas

The extreme fragmentation to pronghorn populations in this study leads us to believe that rights-of-way fences are the major factor affecting pronghorn movements across their range in Arizona. This is accentuated in small management areas such as the many smaller national parks in Arizona. Fragmentation of habitat by fenced rights-of-way impairs movement of pronghorn and probably affects survival and genetics of those herds. To facilitate movement and interchange among herds, it is imperative that NPS make every effort to reduce the effect of fenced rights-of-way on pronghorn populations. The pronghorn can then freely move as perturbations occur (e.g., winter kills as described by White 1969).

Another factor affecting localized movement and influencing pronghorn home ranges in northern Arizona is permanently available water. Draw-down of the water table by wells, coupled with anthropogenic manipulation of the environment, have negatively influenced historically used watering sources. In fact, Bright and van Riper (1999) found that the greatest movement out of Wupatki National Monument to secure water took place during September, that time of year when pronghorn are hunted in northern Arizona.

Possible mitigation features that could be undertaken by NPS areas in northern Arizona include: (1) removing fences along rights-of-way; (2) expanding rights-of-way dimensions by placing fences further away from the road or railroad, then modifying those fences to permit better movement of pronghorn; (3) relocating rights-of-way out of pronghorn habitat; (4) relocating animals, particularly to the section of Petrified Forest north of Interstate 40; (5) providing permanent wildlife movement enhancement bars on fences along park boundaries; and, (6) providing signs on unfenced park roads warning visitors of wildlife movement corridors. Careful attention should also be given prior to any fencing of presently unfenced roads, highways, and railroads.

The issues confronting NPS areas in dealing with pronghorn management in northern Arizona are only an indication of a much larger problem facing managers of protected areas around the world. If managers wish to have their protected areas function as species reservoirs (i.e., sources instead of sinks), they have to: (1) begin to forge active partnership with contiguous landowners to manage resources on a much broader ecosystem basis (as was done with Petrified Forest National Park and Burlington Northern Santa Fe railroad); then (2) decide to what degree they are willing to allow hands-on active management to occur, particularly when managed lands cannot adequately support a species over its annual cycle; and, finally, (3) standardize (or partition) the degree of hands on management among *all* managers of areas within each ecosystem.

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