Mule deer and pronghorn migration in western Wyoming

Hall Sawyer, Fred Lindzey, and Doug McWhirter

Abstract Migratory mule deer (*Odocoileus hemionus*) and pronghorn (*Antilocapra americana*) populations rely on seasonal ranges to meet their annual nutritional and energetic requirements. Because seasonal ranges often occur great distances apart and across a mix of vegetation types and land ownership, maintaining migration corridors to and from these ranges can be difficult, especially if managers do not have detailed information on mule deer and pronghorn seasonal movements. We captured, radiomarked, and monitored mule deer ($n=171$) and pronghorn ($n=34$) in western Wyoming to document seasonal distribution patterns and migration routes. Mule deer and pronghorn migrated 20–158 km and 116–258 km, respectively, between seasonal ranges. These distances represented the longest recorded migrations for either species. We identified a number of bottlenecks along the migration routes of mule deer and pronghorn, but the most critical appeared to be the 1.6-km-wide Trapper's Point bottleneck, which was used by both mule deer and pronghorn during their spring and autumn migrations. Housing developments and roadways apparently have reduced the effective width of this bottleneck to <0.8 km. We estimate 2,500–3,500 mule deer and 1,500–2,000 pronghorn move through the bottleneck twice a year during spring and autumn migrations. Identification and protection of migration corridors and bottlenecks will be necessary to maintain mule deer and pronghorn populations throughout their range.

Key words *Antilocapra americana*, bottleneck, migration, mule deer, *Odocoileus hemionus*, pronghorn, seasonal range, Wyoming

Western Wyoming is home to one of the largest, most diverse ungulate populations in the Intermountain West, including mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), elk (*Cervus elaphus*), moose (*Alces alces*), bighorn sheep (*Ovis canadensis*), and mountain goat (*Oreamnos americanus*). The Green River Basin (GRB) supports approximately 32,000 mule deer and 48,000 pronghorn during the winter (Wyoming Game and Fish Department [WGFD] 2000). Maintenance of these populations and protection of their habitats are primary concerns among private and public sectors. Energy and housing development have increased in the region (Bureau of Land Management [BLM] 1999, 2000; Taylor and Lieske 2002), and large tracts of native range are being fenced and subdivided, or converted to access roads and well pads. Increased development may impact wildlife populations, especially mule deer and pronghorn because they occupy many of the ranges where housing and energy development are most prevalent. Additionally, mule deer and pronghorn populations in the region are thought to migrate long distances

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between seasonal ranges, and many of the migration routes are unknown. The objective of this study was to document seasonal ranges and migration routes of mule deer and pronghorn that winter in the GRB, so that management of these species could be improved.

Study area

We defined the GRB as that area north of WY 28, west of the Wind River Range, east of the Wyoming Range, and south of the Hoback Rim; an area about 15,000 km^2 with elevations ranging from 1,900–2,500 m. The GRB was characterized by sagebrush (*Artemisia* spp.) and sagebrush–grassland communities, interspersed with greasewood (*Sarcobatus vermiculatus*) flats, and agricultural croplands along many of the riparian corridors. Approximately 80% of the GRB was federal land administered by the Bureau of Land Management (BLM). Dominant land uses included livestock grazing, recreation, agriculture, and energy extraction.

Methods

We used helicopter net-gunning techniques to capture and radiomark adult (>1 year) mule deer on winter ranges in the northern GRB and adult female pronghorn on summer ranges in Grand Teton National Park (GTNP) and the Gros Ventre River Drainage (GVRD). We restricted pronghorn capture to early morning (0600–1000 hours) to avoid running pronghorn in hot (>24°C) conditions. We blindfolded and hobbled mule deer and pronghorn to facilitate the handling process and minimize injuries. We fitted mule deer with standard, very-high-frequency (VHF) radiocollars (9D, Advanced Telemetry Systems, Isanti, Minn.) or store-on-board Global Positioning System (GPS) collars (TGW 400, Telonics, Mesa, Ariz.) equipped with mortality sensors. We programmed GPS collars to attempt fixes every 1 or 9 hours. We fitted pronghorn only with VHF transmitters (8C, Advanced Telemetry Systems, Isanti, Minn.). We located mule deer and pronghorn from fix-winged aircraft every 7–10 days, or as weather conditions allowed, during spring and autumn migrations. Additionally, we monitored pronghorn from the ground during spring migrations, locating them approximately once per day. We estimated pronghorn group size for both aerial and ground locations.

We calculated average daily movements for GPS data using the Animal Movements Extension for ArcView® Geographic Information System [GIS] 3.2 (Environmental Systems Research Institute, Redlands, Calif.). We measured migratory distances in ArcView® GIS 3.2 by plotting animal relocations and digitizing the approximate route connecting winter and summer ranges. We calculated means and standard errors of mule deer and pronghorn movement rates and distances and then used a standard *t*-test to detect differences ($P<0.05$). We considered radiomarked animals migratory if winter and summer ranges did not overlap (Brown 1992). We defined transition ranges as those areas radiomarked animals occupied between winter and summer ranges.

Results

Between February 1998 and January 2001, we captured and radiomarked 171 adult mule deer (12 m, 159 f) across winter ranges in the GRB. Of those, 27 were equipped with GPS collars and 144 with traditional VHF collars. Between February 1998 and April 2001, we collected 4,726 and 31,285 locations from VHF- and GPS-marked deer, respectively. Fix-rate success for GPS collars was 99%, of which 94% were 3-dimensional (i.e., ≥4 satellites used to determine locations).

Of the 166 mule deer we monitored for ≥4 months, 95% ($n=158$) were migratory. Mule deer migrated 20–158 km ($\bar{x}=84.1$, SE$=2.01$, $n=158$; Figure 1) north and northwest to summer in portions of 5 different mountain ranges: the Wyoming, Salt River, Snake River, Gros Ventre, and Wind River ranges (Figure 2). Data from GPS collars that oper-

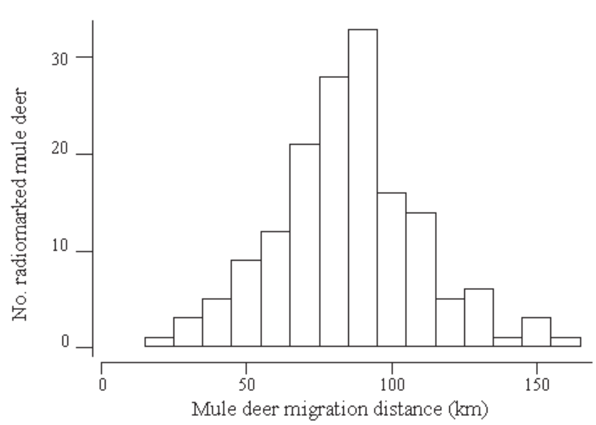

Figure 1. Frequency histogram of distances moved by radiomarked mule deer during spring and autumn migrations in western Wyoming, 1999–2001.

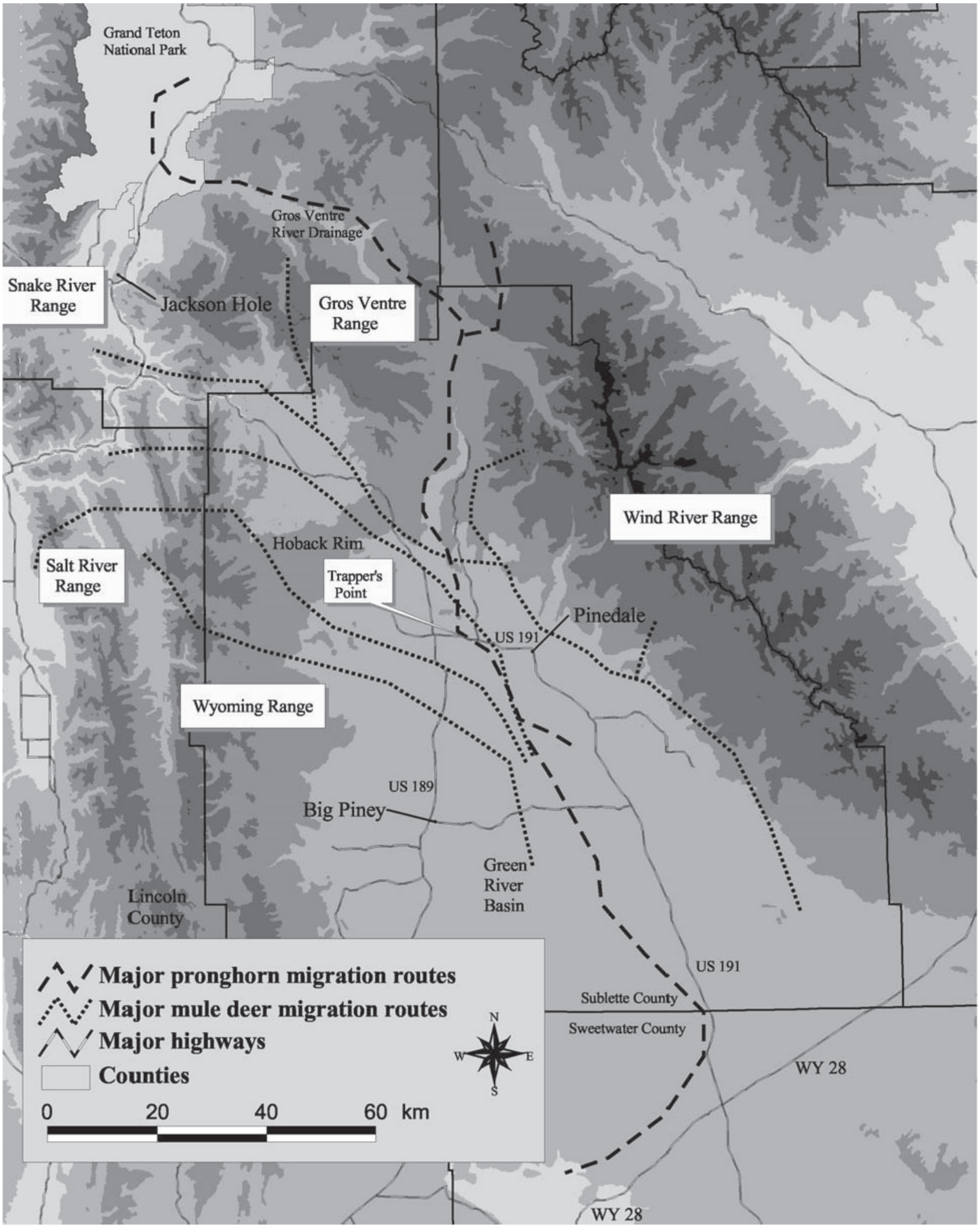

Figure 2. Location of major mule deer and pronghorn migration routes (1998–2000) in western Wyoming.

ated through a complete annual cycle indicated mule deer migrated at a gradual, steady pace rather than making quick, long-distance movements. Average daily movements during spring (1 April–15 June) and autumn (15 October–1 December) migrations ranged from 2–5 km and averaged 3.3 km (SE=0.09, n=15) and 3.3 km (SE=0.19, n=13), respectively. Daily movement rates of GPS-marked mule deer were similar during spring and autumn migrations. Although movement patterns and timing were variable, mule deer used common migration routes, transition ranges, and parturition ranges. Generally, spring migrations began in early April and ended in June when mule deer reached their high-elevation (2,438–3,048 m) summer ranges, approximately 60–90 days after migration began. Autumn migrations began in late October or early November, with mule deer arriving on low-elevation (<2,286 m) sagebrush winter ranges in December. Overall, mule deer spent 4–5 months of the year on mid-elevation (2,134–2,438 m) transition ranges characterized by abundant grass and forb communities intermixed with mountain shrubs. Mule deer appeared to remain on transitional ranges as long as snow conditions allowed, before moving onto winter ranges.

We captured and radiomarked 34 adult female and 1 yearling female pronghorn during July, 1998, including 12 in the GVRD and 23 in GTNP. Two of the marked pronghorn died from capture-related injuries early in the study. We located the 33 collared pronghorn 981 times between August 1998 and June 2000. These aerial locations were supplemented with 202 ground observations during migration periods. All marked pronghorn monitored ≥4 months were migratory and traveled 116–258 km ($\bar{x}$ =177.2, SE=6.16, n=32; Figure 3) to winter ranges in the GRB (Figure 2). Because we did not have GPS collars on pronghorn and our relocation schedule was 7–10 days apart, we could not determine the precise timing of migrations (i.e., start and end day). However, autumn migrations (October–December) in 1998 and 1999 were completed in relocation intervals that averaged 19 days (SE=2.11, n=59), while spring (March–June) migrations in 1999 and 2000 were completed in relocation intervals that averaged 73 days (SE=2.72, n=57). We documented 8 pronghorn migrations in autumn 1998 that were completed in <7 days. Compared to autumn, spring migrations took significantly longer (t_{114}=15.66, $P\leq$ 0.001) because pronghorn movements were limited by snowpack. Consequently, pronghorn spent more time on transition ranges in the spring compared to autumn. Pronghorn left winter ranges in late March or early April and arrived at summer ranges in the GVRD or GTNP by late May or June, 60–90 days after migration began.

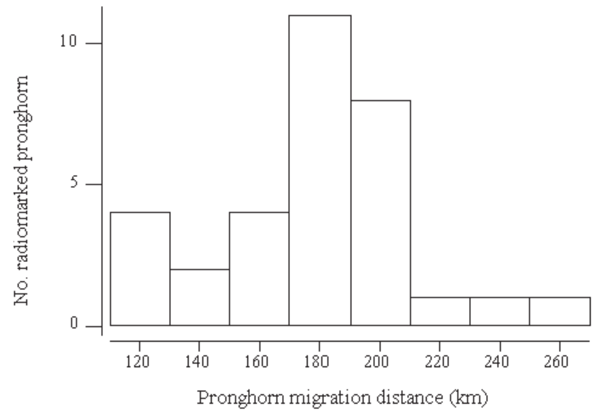

Figure 3. Frequency histogram of distances moved by radiomarked pronghorn during spring and autumn migrations in western Wyoming, 1998–2000.

Discussion

Mule deer migrations in the GRB generally were much longer than those reported in Colorado (Garrot et al. 1987), Idaho (Brown 1992, Merrill et al. 1994), Washington (Eberhardt et al. 1984), and California (Nicholson et al. 1997). Although mule deer migrations of up to 130 km have been reported in parts of Montana (Mackie et al. 1998) and up to 115 km in Idaho (Thomas and Irby 1990), seasonal migrations documented in the GRB appear to be the longest ever documented in the western states. Among Wyoming deer populations, no other herd migrates farther or through more rugged terrain. Seasonal migrations of 8–32 km have been documented in the Laramie (Sawyer and Lindzey 2000*a*), Owl Creek (Allen 1995), and Absaroka ranges (Gillin and Lindzey 1986). Porter (1999) documented mule deer migrations of 100 km in south-central Wyoming, but they occurred exclusively in desert environments and gentle topography. Management of mule deer in the GRB is complicated by the long-distance movements across a variety of habitats and mix of land ownership. Because the GRB provides winter range for mule deer that occupy 5 different mountain ranges in western Wyoming, protecting migration routes and conserving seasonal ranges are essential for the long-term maintenance of this mule deer population.

Pronghorn migration in western Wyoming. Photo by Mark Gocke of the Wyoming Game and Fish Department.

Although mule deer in the GRB migrated long distances, their rate of movement (3.3 km/day) was substantially slower than travel rates reported in Idaho, where mule deer migrations were characterized by rapid movements of 5–20 km/day with periodic breaks in between (Thomas and Irby 1990). Seasonal migrations of mule deer in the GRB took as long as 90 days to complete and reflect the importance of transition ranges to this mule deer herd. Transition ranges provide deer with better foraging opportunities than those often available on winter ranges, allowing them to recover body condition earlier in the spring and maintain body condition later in the autumn, before entering winter (Short 1981). In the absence of high-quality forage on winter range, the most appropriate migratory behavior for deer is to remain on higher-elevation ranges where vegetation typically is of better quality (Garrott et al. 1987). Because fetal biomass increases rapidly after mid-gestation and birth mass is an important predictor of fawn survival, ample nutrition during the final third of gestation is a significant factor in deer productivity (Verme and Ullrey 1984). Additionally, small improvements in body condition during late autumn or early winter may substantially reduce overwinter mortality (Hobbs 1989). Effective transition ranges alleviate pressure on winter ranges by minimizing the amount of time deer must spend there. Radiomarked deer typically occupied these ranges for 4–5 months during the year (i.e., April, May, early June, November, and December).

The 116–258-km seasonal migrations of pronghorn to and from the GRB were the longest recorded for this species. Movement patterns were similar to those suggested by Harper (1985) and Segerstrom (1997), who first indicated pronghorn from GTNP migrate through the GVRD and into the GRB. Movement data were consistent with patterns documented by Hoskinson and Tester (1980), who found the timing of spring pronghorn migrations in Idaho were dependent upon snow conditions while the autumn migrations were not. Many (90%) radiomarked pronghorn left GTNP and the GVRD in the autumn prior to snow accumulation. During the spring, however, pronghorn appeared to follow the snowline north, moving as quickly as snow conditions allowed. Consistent with some pronghorn populations (Kitchen 1974, Bruns 1977, Ryder and Irwin 1987, Byers 1997), shifts in group size and composition were common throughout the year, particularly on winter ranges (Sawyer and Lindzey 2000*b*). It was not uncommon to find collared animals together 1 week and in separate herds the next week.

Management implications

Summer, transition, and winter ranges are equally important components of mule deer and pronghorn ranges in western Wyoming. The relative importance of each likely will change annually, but loss or degradation of one will not be compensated for by the others. Managers should recognize the importance of all seasonal ranges for maintaining healthy and productive mule deer (Short 1981, Clements and Young 1997) and pronghorn populations. Currently, summer ranges appear most secure because of their large size and relatively protected status within United States Forest Service (USFS) and National Park Service (NPS) lands. The mid- and low-elevation transition and winter

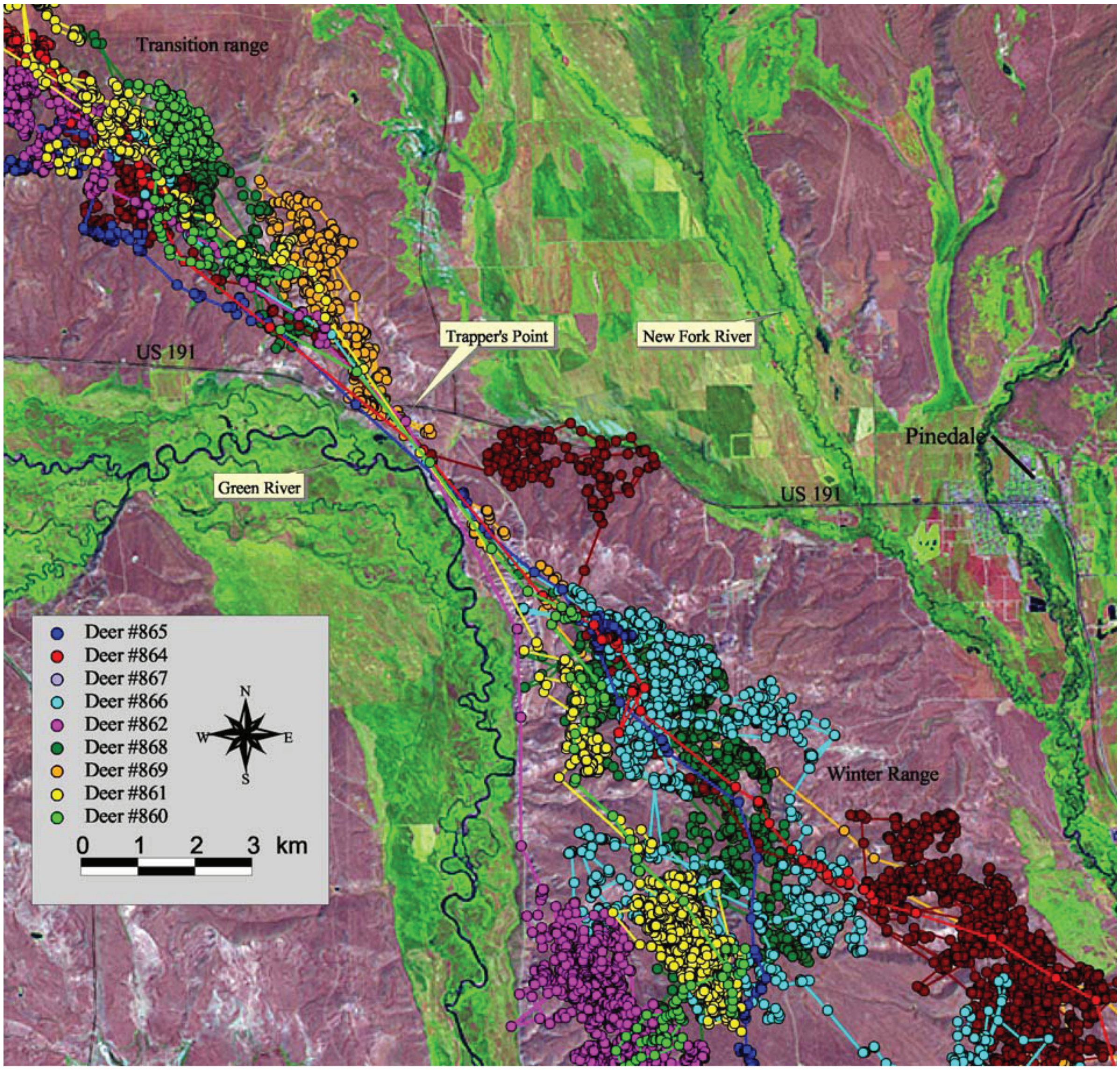

Figure 4. Hourly locations and movement patterns of 9 GPS-marked mule deer through the Trapper's Point bottleneck in western Wyoming, January–April, 2001.

ranges, however, occur on BLM or privately owned lands that have much more potential for direct habitat losses (e.g., subdivisions and energy development) and indirect habitat losses resulting from increased levels of human disturbance.

Fences, road networks, and increased human disturbance associated with energy and housing developments also can influence the effectiveness of mule deer and pronghorn migration routes. Migratory bottlenecks are those areas along migration routes where topography, vegetation, development, or other landscape features restrict animal movements to narrow or limited regions. Bottlenecks create management concerns because the potential to disrupt or threaten established migratory routes is much greater in these restricted areas compared to areas where animal movements are not restricted. We identified a number of bottlenecks along the migration routes of the mule deer and pronghorn, but the most critical appeared to be the Trapper's Point bottleneck, which was used by both mule deer and pronghorn during their spring and autumn migrations. Trapper's Point was a naturally occurring bottleneck, restricted to 1.6 km in width and length by river and riparian habitats on either side (Figure 4). Additionally, the bottleneck was bisected by US 191, a highway that separates large contiguous sagebrush winter ranges to the south, from transition ranges to the north. The Trapper's Point bottleneck consisted of a narrow sagebrush ridge that mule deer and pronghorn use to move between winter and transition ranges (Figure 4). Housing developments have narrowed the effective width of the bottleneck to $\leq$0.8 km. The Trapper's Point bottleneck was used by approximately half ($n = 81$) of radiomarked mule deer and all radiomarked pronghorn. Based on population estimates provided by the WGFD (WGFD 2000, Sawyer and Lindzey 2000*b*, Sawyer and Lindzey 2001) and proportions of radiocollared animals in the area, we estimated 2,500–3,500 mule deer and 1,500–2,000 pronghorn moved through the bottleneck twice a year during spring and autumn migrations. These population segments represented approximately 8–11% of the mule deer and 3–4% of the pronghorn populations wintering in the GRB.

Concurrent with our study, the Office of the Wyoming State Archaeologist unearthed a 6,000-year-old pronghorn kill site in the core of the Trapper's Point bottleneck (Miller et al. 1999). According to Miller et al. (1999), prehistoric hunters apparently took advantage of the natural bottleneck and killed migrating pronghorn with primitive, stone-tipped weapons. Several behavioral characteristics of pronghorn, including gregariousness and avoidance of perceived obstructions, favored the communal hunting strategies by prehistoric groups using various types of corrals and traps (Arkush 1986, Frison 1991). Interestingly, stage of development of fetal bones found at the site indicated the kills occurred in late March or early April (Miller et al. 1999), corresponding with the timing of spring pronghorn movements we observed during our study.

Migration is an adaptive behavioral strategy that allows animals to avoid resource shortages in temperate regions (Baker 1978) and find greater food sources prior to breeding (Sinclair 1983). Migrations between summer and winter ranges generally follow traditional routes that are learned and passed on from mother to young (McCullough 1985). Archaeological evidence suggests migration routes in western Wyoming have been used for thousands of years (Miller et al. 1999), providing access to a variety of seasonal ranges across large areas and rugged terrain. Without migratory routes, many of the seasonal ranges in western Wyoming would be inaccessible to mule deer and pronghorn, and it is unlikely current populations could be maintained. Thus, identification and protection of migration routes should be considered an integral part of mule deer and pronghorn management. Across entire migration routes, special attention should be paid to migration bottlenecks because small changes in land use or habitat alterations could potentially sever established migration routes. Management of migration bottlenecks should be a top priority for land and wildlife agencies to ensure land-use decisions facilitate continued wildlife movements.

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