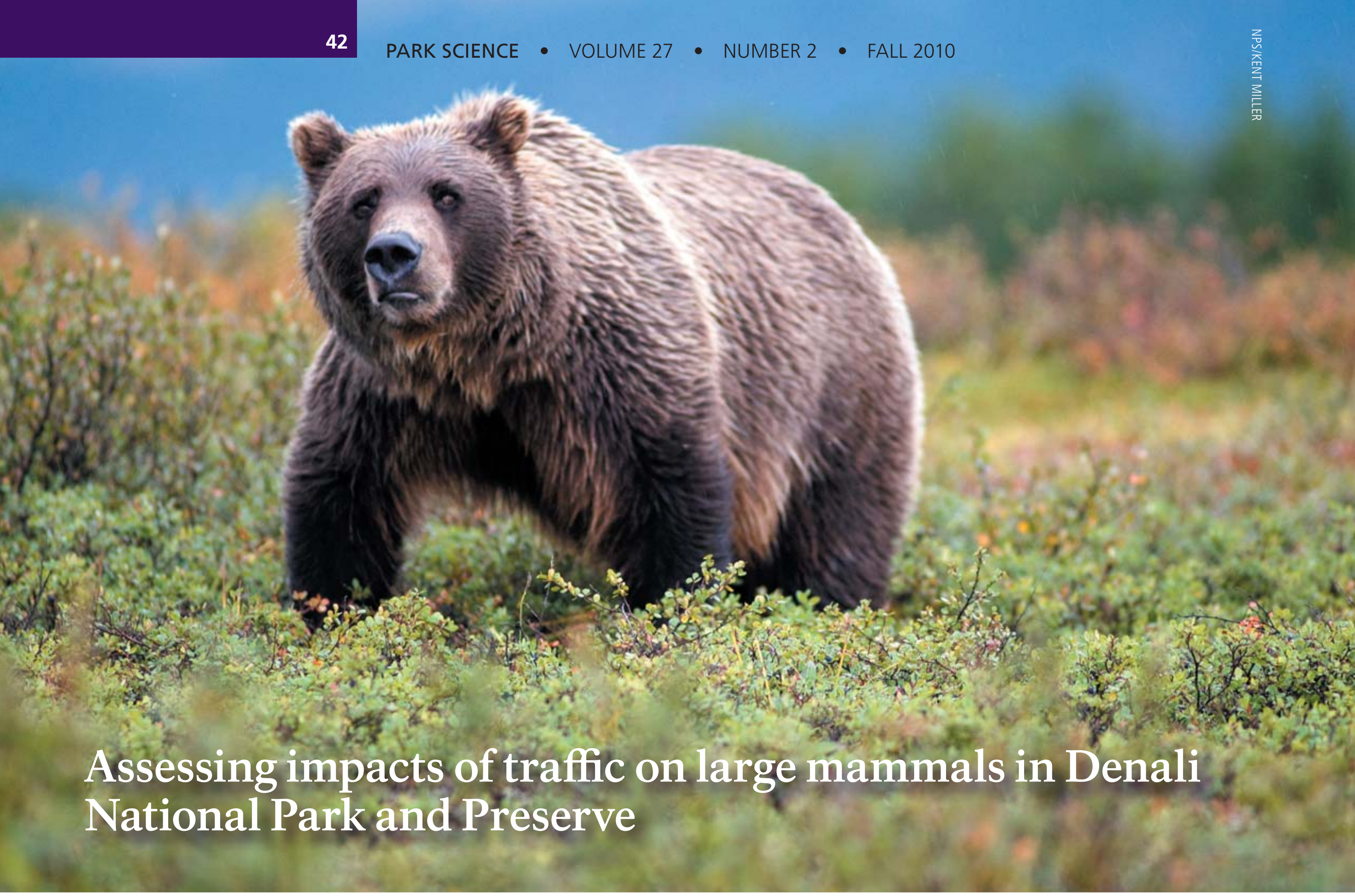

Assessing impacts of traffic on large mammals in Denali National Park and Preserve

By Laura M. Phillips, Richard Mace, and Thomas Meier

Figure 1. To assess potential impacts to wildlife from traffic patterns on the road in Denali National Park, managers analyzed fine-scale movement data from grizzly bears (above) and Dall's sheep (facing page, at top).

CREATED AS A WILDLIFE SANCTUARY IN 1917, Denali National Park (Denali) remains a spectacular place to view large mammals in their natural habitat. Shortly after the park was established, Superintendent Harry Karstens realized that one of the most urgent needs was "a main artery road through the upper passes" (Norris 2006). The National Park Service (NPS) envisioned a road that would allow visitors access to "the best possible views and vistas of the country" (Norris 2006). The Denali Park Road was completed in 1938 and provided a unique opportunity for visitors to view wildlife by accessing remote areas of open tundra, boreal forests, mountain vistas, and rugged terrain within the park. Little thought was given to the potential impacts that a road could have on the large mammals the park was established to conserve, although an unexpected benefit was apparent shortly after its construction. Easier access to the interior of the park and cabins built along the route allowed rangers to more successfully patrol the park and protect wildlife from poaching (Norris 2006). However, as visitation continued to increase, managers noticed that disturbance of the magnificent wildlife visitors expected to see from the park road was also increasing (Tracy 1977; Singer and Beattie 1986).

Because the Denali Park Road is the only means to reach the park interior, most potential resource impacts from visitation are confined to the road corridor. Today it is well established that with roads and vehicles comes environmental degradation, and as a result, environmental protection now plays a key role in transportation policy and decisions (Forman et al. 2003). As Denali managers began to reevaluate the park's system for transporting people on the Denali Park Road, they realized that determining potential impacts on wildlife from any changes that may be made to traffic volume and patterns on the road was a priority. Roads and vehicles may affect wildlife in many ways, including degrading the quality of adjacent habitat, restricting movements, and altering behavior (Trombulak and Frissell 2000; Forman et al. 2003). Previous wildlife studies in Denali suggested that traffic restricted the movements of Dall's sheep (*Ovis dalli*) as they traveled between winter and summer ranges (Dalle-Molle and Van Horn 1991), caused moose (*Alces alces*) to shift away from the road (Singer and Beattie 1986), and produced flight reactions in caribou (*Rangifer tarandus*) and grizzly bears (*Ursus arctos*) (Tracy 1977; Singer and Beattie 1986; Burson et al. 2000). While these studies pointed to possible impacts, they were limited to observations made within the road corridor and generally failed to comprehensively link negative effects with traffic patterns.

Abstract

In 2006, managers of Denali National Park and Preserve (Denali) implemented a number of integrated studies to comprehensively reevaluate the strategy for transporting people in the park. Given Denali's history as a world-class wildlife viewing park, managers realized that they should examine potential impacts on wildlife from any changes that may be made to traffic volume and patterns on the road. We used Global Positioning System (GPS) technology to study the fine-scale movement patterns of grizzly bears and Dall's sheep, as well as the distribution and abundance of other large mammals along the park road, to identify possible links between traffic volume and wildlife behavior. We documented 444 and 121 crossings of the Denali Park Road by GPS-collared grizzly bears (n=11) and Dall's sheep (n=17), respectively, during the study. Grizzly bears in this study were most active during the daylight hours and made most of their road crossings during periods of high traffic volume. Our study revealed that both grizzly bears and Dall's sheep in Denali responded negatively to increased traffic volumes by increasing their movement rates when approaching the road. Dall's sheep also shifted away from the road at higher traffic levels. Bus drivers recorded the locations of wildlife sightings along the road, which revealed areas with greater opportunities for viewing large mammals. The distribution and abundance of these sightings are important for visitor satisfaction and wildlife protection. Because access to the Denali Park Road is restricted, park managers have a level of control over vehicle use that is not available to many working to mitigate impacts of traffic on wildlife populations. Our study found evidence that vehicle numbers or patterns of vehicle behavior on the road affected wildlife distribution and movements; however, the magnitude of those effects did not appear to be great. Managers should carefully consider the potential to increase impacts on wildlife to unacceptable levels when analyzing transportation alternatives prior to implementing any changes.

Key words: Dall's sheep, Denali National Park and Preserve, Global Positioning System (GPS), grizzly bear, movement, roads, traffic, wildlife

NPS/JARED WITHERS

NPS/THOMAS MEIER

Figure 2. A wildlife biologist attaches a GPS collar to a grizzly bear in Denali National Park. GPS collars collected one location per hour from 15 May through 20 September 2006, and were programmed to automatically release from the animal after the study.

The objective of our research was to examine the movement and distribution of large animals relative to the Denali Park Road to assess potential correlations between traffic volume and patterns, and wildlife behavior (see fig. 1, page 28). To do this, we used Global Positioning System (GPS) technology to study the fine-scale movement patterns of Dall's sheep and grizzly bears (fig. 1, facing page), as well as the distribution and abundance of other large mammals along the park road. Results from this study would then be integrated with concurrent studies on visitor experience (see Manning and Hallo, pages 33–41) and traffic patterns to assess potential impacts of various alternative transportation strategies using a simulation model (see Morris et al., pages 48–57).

Methods

We captured grizzly bears from a helicopter using standard aerial darting techniques in May 2006 and Dall's sheep from a helicopter using net gunning techniques in March 2007. We fitted 20 bears and 20 sheep with GPS collars that collected one location per hour from 15 May through 20 September, when they were programmed to automatically release from each animal (fig. 2). We used location data from 17 bears (4 males and 13 females) and 18 sheep (7 males and 11 females) to examine movements and road crossing behavior in relation to vehicle numbers and traffic patterns. Two male bears were not used in analyses as they were the

In Focus: Denali Park Road

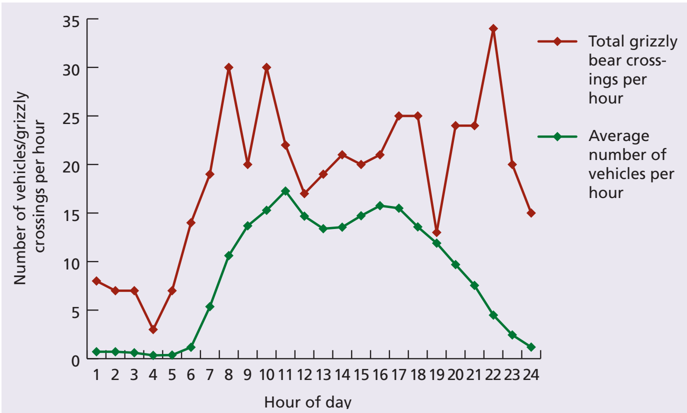

Figure 3. Grizzly bears crossed the Denali Park Road during all hours of the day, but crossings were more frequent in midday when most vehicles were on the road. That study bears crossed the road most frequently during periods of high traffic suggests that bears were not altering their activity patterns to avoid disturbance from the road.

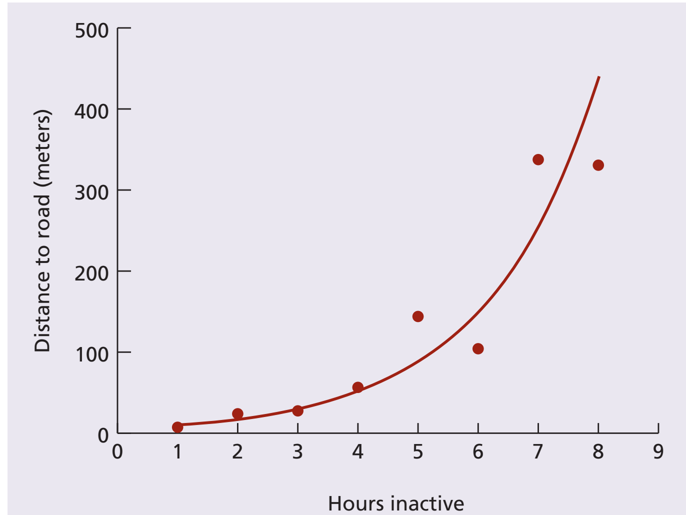

Figure 4. Grizzly bears were inactive (movement rates <10 meters/hour [33ft/hr]) for longer periods of time farther from the Denali Park Road, suggesting that they were less comfortable being either relatively stationary or asleep while near the road corridor.

dependent young of collared females and their movements were autocorrelated with those of their mother. One collar placed on a female bear was not retrieved from the field. Data from two collared Dall's sheep were not used in analyses because one animal died prior to the end of the study period and one GPS collar failed to provide any data.

We obtained hourly summaries of vehicle numbers by road section using traffic counters placed at six locations along the road. We collected information about the number and distribution of large mammals (grizzly bears, caribou, Dall's sheep, moose, and wolves [*Canis lupus*]) along the road from touch-panel interfaces installed in 20 buses. Bus drivers entered the species type observed when they stopped to view wildlife along the road. Data entered into the panels were geo-coded automatically by GPS Automatic Vehicle Locator units installed on each bus. Managers implemented a "quiet night" of minimal or no traffic as an experimental control during the summer seasons of 2007 and 2008. Traffic was limited to urgent or emergency travel from 10 p.m. on Sundays until 6 a.m. on Mondays to examine potential impacts on the number of wildlife viewing opportunities for visitors on morning trips into the park.

Roads and vehicles may affect wildlife in many ways, including degrading the quality of adjacent habitat, restricting movements, and altering behavior.

Main findings

Individual bears had home ranges at varying distances from the Denali Park Road. Eleven grizzly bears were classified as having home ranges that straddled the road. Of the six bears that did not cross the road, three had home ranges that were adjacent to the road but did not cross it and three had home ranges more than 3 km (2 mi) from the road. We documented 444 crossings of the Denali Park Road by bears whose ranges straddled the road. The number of crossings ranged from 2 to 136 among individuals. Grizzly bears crossed the road during all hours of the day, but made crossings more frequently during the period when most vehicles were on the road (fig. 3). Bears were inactive (movement rates <10 meters/hour [33 ft/hr]) mostly during hours of darkness. Bears spent longer periods of inactivity farther from the road (fig. 4). Bears moved faster when crossing the road than immediately before or after crossing. We noted some differential use of three general land types (tundra, mountain, river channel) between genders and seasons. In general, female grizzly bears made greater use of mountain habitats while male bears moved much more extensively throughout the tundra and river channel land types.

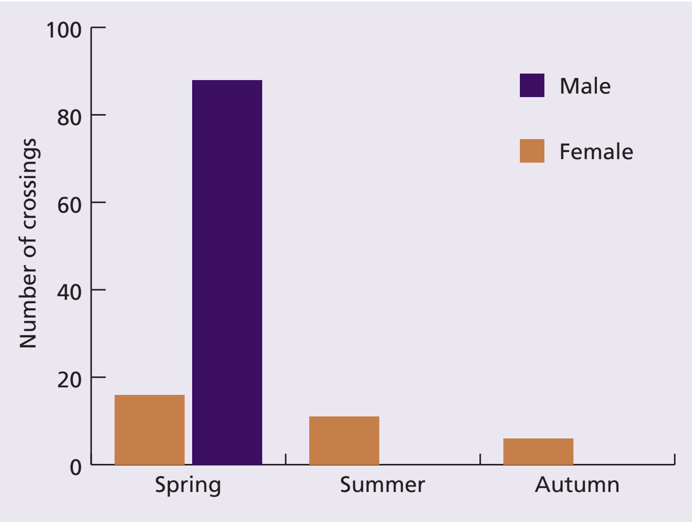

Figure 5. Both male and female Dall's sheep crossed the road during summer, but male sheep made more crossings than females and crossed only in spring. Forage is available at higher elevations later in summer in Denali National Park, so disturbance of sheep within the road corridor during spring may have a greater impact on them than during the remainder of the summer.

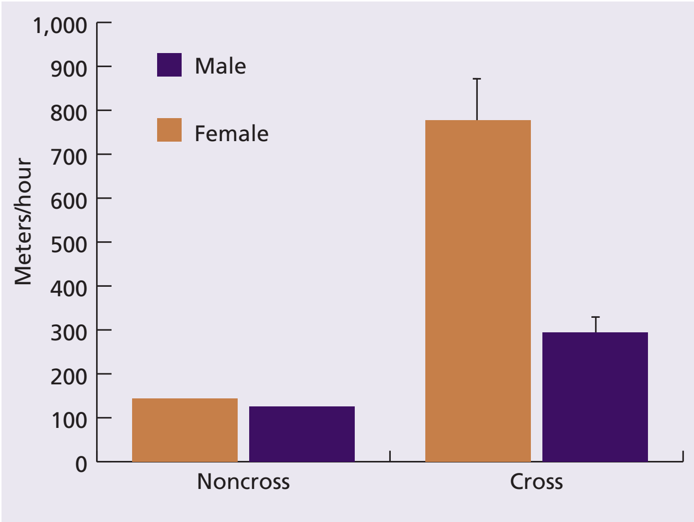

Figure 6. Dall's sheep moved at a faster rate as they crossed the road in Denali than the general movement rate. Increased movement speed of sheep while crossing suggests that they were wary of human activity along the road and used speed to minimize the duration of contact with humans.

We did not detect any changes in bear use of the land types [tundra, mountain, and river channel] when adjacent to, or while crossing, the road.

We did not detect any changes in bear use of the land types when adjacent to, or while crossing, the road. When bears did cross the road, they typically moved from the mountains on one side of the road to mountains on the opposite side.

We recorded 121 road crossings by Dall's sheep during the study. Both sexes crossed, but male sheep made more crossings than females (33 female, 88 male). Female sheep crossed the road 3 times on average (range = 1–8), while males crossed 12.6 times (range 0–51). Male sheep crossed the road only in the spring (15 May to 30 June), while females crossed throughout the study period (fig. 5). Like bears, Dall's sheep moved at a faster rate as they crossed the road compared with general movement rates, and movement rates increased with higher traffic levels (fig. 6). The distribution of sheep locations showed a shift away from the road as traffic volumes increased. The proportion of locations within 300 meters (984 ft) of the road declined from 22% at <10 vehicles/hour to 9% at >20 vehicles/hour.

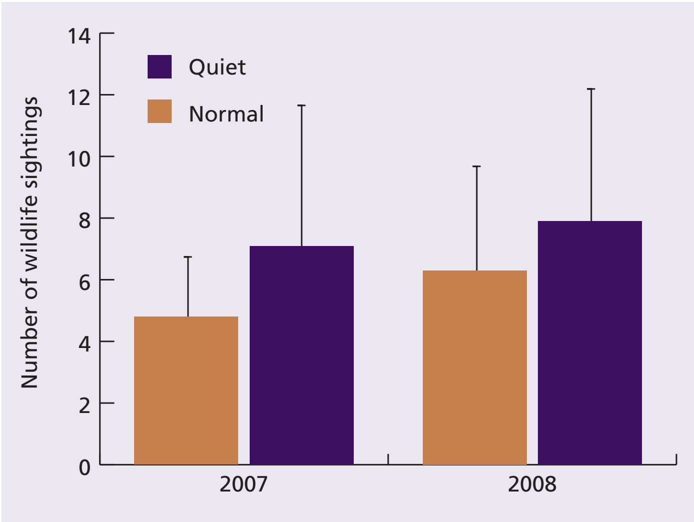

Figure 7. Bus drivers recorded a slight increase in the number of wildlife sightings on Monday mornings after nights of little or no traffic on the park road (quiet) compared to mornings after regular nighttime traffic levels (normal).

The highest number of bear, sheep, and caribou sightings recorded by bus drivers occurred between miles 32 and 45. Traffic levels were significantly lower on quiet nights than on regular nights along the entire length of road. We noted a slight increase in number of recorded wildlife sightings on Monday mornings after quiet nights compared with normal mornings, but the increase was not statistically significant (fig. 7).

Conclusions

To our knowledge this is the first telemetry study to investigate relationships between grizzly bears and vehicular traffic along a single unpaved road with relatively low traffic volumes in a national park setting. Conversely, most previous studies were conducted in nonpark environments either where bears were hunted legally or illegally or where other forms of human-caused mortality were prevalent (Waller and Servheen 2005; Graves et al. 2006). In most of these cases, biologists assume that bears are somewhat wary of human presence. In contrast, biologists generally assume that grizzly bears in Denali are habituated to, or have become tolerant of, human presence over time. The high number of bear sightings from buses shows that bears have not been completely displaced from the road corridor.

Wildlife may respond to human activity by changing the timing of their activities to minimize deleterious interactions (Forman et al. 2003; Yri 2006). Grizzly bears in this study were most active during the period of day when road traffic was heaviest. This pattern of relatively high activity during daylight hours is the norm for grizzly bears across their range (Hechtel 1985; Wenum 1998). That our study bears were most active and crossed the road mostly during periods of high traffic suggests that bears were not measurably altering their temporal patterns of activity to avoid human disturbance from the road.

We inferred some behavioral effects of road traffic from our telemetry data. We found that duration of time when bears were inactive was shortest nearest the road and increased as distance from the road increased. Furthermore, the longest bouts of inactivity occurred at more than 300 meters (984 ft) from the road during high traffic periods. These data suggest that bears were less comfortable being either relatively stationary or asleep while near the road corridor. Grizzly bears significantly increased their movement speed while crossing the Denali Park Road. This increase suggests that bears were cognizant of human activity along the road, and used speed to minimize the duration of contact with road traffic.

Our study revealed that Dall's sheep in Denali responded negatively to increased traffic volumes by increasing their movement rates when approaching the road and shifting away from the road at higher traffic levels. While many studies have investigated the potential for vehicles to affect sheep behavior and distribution, most have examined individual or group responses to the approach of individual vehicles, or general distribution of sheep relative to road corridors, rather than volume or patterns of traffic (Papouchis et al. 2001; Keller and Bender 2007). Our results reflected a threshold distance for response to disturbance by showing that sheep within 300 meters (984 ft) of the road shifted farther away at higher traffic volumes and that small increases in the number of vehicles on the road could have impacts on Dall's sheep movements. Movement of sheep away from the road corridor at higher traffic volumes may decrease the amount of habitat available for foraging. This may be most relevant to sheep during the spring season, when they most frequently cross the road and "green-up" has not yet occurred at higher elevations.

Managers at Denali may want to consider mitigating impacts on sheep by tailoring any traffic increases to avoid migration periods, or by scheduling bus departures to create quiet periods of low traffic on the road to protect wildlife crossing opportunities.

The potential restriction of movement by sheep because of traffic impediments may be of greater concern to park managers than is loss of habitat. Migratory movements of sheep from their winter range to summer use areas may be important to the health of sheep populations in Denali because seasonal range shifts allow them to take advantage of the most nutritious forage available. It also allows for connectivity among groups of sheep and has important implications for population viability (Nichols and Bunnel 1999; DeCesare and Pletscher 2006).

The tendency for large mammals to be observed more frequently on mornings after nighttime traffic levels were reduced suggests that vehicles on the park road may be impacting wildlife viewability. The locations of wildlife sightings recorded along the road reveal areas with greater opportunities for viewing large mammals. Distribution and abundance of these sightings are important for visitor satisfaction and wildlife protection.

Because access to the Denali Park Road is restricted, park managers have a level of control over vehicle use that is not available to many working to mitigate impacts of traffic on wildlife populations. Our study found evidence that vehicle numbers or patterns of vehicle behavior on the road affected wildlife distribution and movements; however, the magnitude of those effects did not appear to be great. Managers should carefully consider the potential to increase impacts on wildlife to unacceptable levels when analyzing transportation alternatives prior to implementing any changes. Managers at Denali may want to consider mitigating impacts on sheep by tailoring any traffic increases to avoid migration periods, or by scheduling bus departures to create quiet periods of low traffic on the road to protect wildlife crossing opportunities. By integrating standards for maintaining opportunities for wildlife crossings into a traffic simulation model, managers could possibly forecast how well alternative transportation scenarios meet these targets.

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