

MORTALITIES FROM CLIMBING ACCIDENTS OF TRANSLOCATED BIGHORN SHEEP IN ARIZONA

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ABSTRACT—Desert bighorn sheep (*Ovis canadensis*) are known for their climbing skills in rugged and steep terrain. Occasionally sheep die from climbing accidents. Between 1979 and 1995, the Arizona Game and Fish Department reintroduced desert bighorn sheep to areas within their historic distribution: northwest, southwest, southeast, and central Arizona. Because at least half of reintroduced sheep ($n = 412$) were fitted with radiocollars and monitored monthly, we documented mortalities by climbing accidents. None of 54 mortalities in the southeastern region and 53 mortalities in the southwestern region was identified as climbing accidents. However, climbing accidents caused 5 of 42 sheep mortalities in the northwestern region and 4 out of 54 mortalities in the central region. Most climbing accidents (7 out of 9) happened <9 months after sheep were translocated. Our data suggest that translocated desert bighorn sheep can be vulnerable to climbing accidents due to lack of familiarity with local terrain. Differential vulnerability between regions might be related to differences in substrate, ruggedness of terrain, or both at release sites. Additionally, sheep translocated from less rugged terrain might be more likely to fall in new areas than sheep translocated from more rugged terrain.

RESUMEN—El borrego cimarrón (*Ovis canadensis*) es conocido por sus habilidades para trepar en terrenos escabrosos y accidentados. Ocasionalmente borregos mueren en accidentes de trepar. Entre 1979 y 1995 el Departamento de Caza y Pesca de Arizona reintrodujo borregos cimarrones en áreas de su distribución histórica en ese estado: noroeste, suroeste, sureste y central. Debido a que aproximadamente la mitad de los borregos reintroducidos ($n = 412$) se equiparon con radiocollares y se monitorearon mensualmente, documentamos las mortalidades por accidentes al trepar. De 54 muertes en la región sureste y 53 muertes en la región suroeste, ninguna se identificó como mortalidad por accidente al trepar. Sin embargo, en la región noroeste, 5 de 42 muertes, y en la región central 4 de 54 muertes, fueron por accidentes al trepar. La mayoría de los accidentes al trepar (7 de 9) ocurrieron <9 meses después de que los borregos fueron reintroducidos. Nuestros datos sugieren que los borregos cimarrones reintroducidos pueden ser vulnerables a mortalidades por accidentes al trepar debido al desconocimiento del terreno local. Las diferencias en vulnerabilidad entre las regiones pueden estar relacionadas a diferencias en el sustrato y/o lo accidentado del terreno en los sitios de liberación. Además, los borregos reintroducidos provenientes de terrenos menos accidentados pueden estar más predispuestos a caídas en áreas nuevas que los que provienen de terrenos más accidentados.

Bighorn sheep (*Ovis canadensis*) are known for their climbing skills in rugged and steep terrain, and thus mortalities from climbing accidents of adults rarely are reported for this species (Johnson, 1958; Wishart, 1978; Festa-Bianchet, 1987; McCarty and Miller, 1998). In one of the few studies that addressed climbing mortalities in bighorn sheep, Festa-Bianchet

(1987) found that climbing accidents of adults ($n = 3$) occurred only during the rut, most likely as a result of more careless activities associated with mating behavior. From 1979 through 1995, the Arizona Game and Fish Department translocated bighorn sheep to areas of their historic range in Arizona. Bighorn sheep were translocated to 4 major regions of

Arizona: northwest, southwest, southeast, and central. Because approximately half of the translocated bighorn sheep ($n = 412$) were equipped with radiocollars and monitored at least once a month, we were able to document mortalities from climbing accidents. Radiocollars were equipped with mortality sensors so dead sheep could be located as soon as possible. When death date of a sheep was unknown, we assumed death occurred midway between the last date the sheep was known alive and the date mortality was detected. Deaths were classified as climbing accidents if sheep had numerous broken bones and were found at the base of cliffs or other high rugged terrain ($n = 7$), or were found wedged between rock crevices after apparent falls ($n = 2$).

Of 54 deaths in the southeastern region and 53 deaths in the southwestern region, none were identified as mortalities from climbing accidents. However, of 42 deaths of bighorn sheep in the northwestern region, 5 (4 adult females, 1 yearling female) were from climbing accidents. Dates of climbing accidents were March 1985 ($n = 2$), February 1986, September 1985, and December 1988. Of 54 deaths in the central region, 4 (adult females) were from climbing accidents. The dates were December 1983, August 1987, April 1988, and March 1996. Although breeding can be protracted in southern populations of bighorn sheep (Thompson and Turner, 1982), the rut in western Arizona and adjacent southeastern Nevada typically occurs from August to November (Russo, 1956; Leslie, 1977). Only 2 of 9 deaths occurred during this period, suggesting that the climbing accidents of translocated bighorn sheep were not related to mating behavior. Although all 9 climbing deaths were from female sheep, 80% of all radiocollared sheep were female; therefore, it is unclear if climbing deaths were related to gender.

We hypothesized that climbing accidents of bighorn sheep were related to lack of familiarity with local terrain, because adult and yearling sheep were translocated from other areas. If climbing accidents were related to lack of familiarity with local terrain, then these types of mortalities should occur relatively soon after release rather than later. To test this hypothesis, we determined length of time (in months) from release date to death date for all mortalities in the northwestern and central regions.

We then compared death dates (mean \pm SE) from climbing accidents to all other types of mortalities using a *t*-test (SAS Institute, 1985). Death dates from climbing accidents (9.6 ± 3.2 months; $n = 9$) occurred significantly sooner ($P = 0.011$; 95% C.I. for difference = 1.6 to 17.9 months) than all other types of mortalities (19.7 ± 2.2 months; $n = 85$). Most (7 of 9) climbing accidents occurred <9 months after translocated sheep were released.

Our data suggest that translocated bighorn sheep might be vulnerable to mortalities from climbing accidents due to lack of familiarity with terrain. It was unclear why bighorn sheep in northwestern and central Arizona were more vulnerable to this type of mortality than bighorn sheep in the southwest and southeast. Although terrain characteristics of capture and release sites were not recorded, differences in vulnerability among regions might have been related to differences in substrate, ruggedness of terrain, or both at release sites. It also might have been related to differences in ruggedness of terrain at capture sites, because sheep translocated from more rugged terrain might be less likely to fall in new areas than sheep translocated from less rugged terrain.

In northwestern and central Arizona, mortalities from climbing accidents ($n = 9$) represented 10% of all mortalities ($n = 94$). However, most deaths ($n = 48$) were from unknown and indeterminable causes. Thus, climbing accidents accounted for 20% of known causes of death. Proportion of deaths from climbing accidents in these areas was considerably higher than previously reported for adult bighorn sheep. Bighorn lambs are likely more vulnerable to falls than adults (Brundige, 1987), because juveniles play with each other at a fast pace (Geist, 1971) and are less familiar with local terrain. Conversely, adults are familiar with local terrain, including escape cover and important biological localities, such as birthing and seasonal feeding areas (Bleich et al., 1997; Krausman and Shackleton, 2000). However, adults translocated into new areas rapidly have to become familiar with local terrain to escape predators and find adequate birthing and feeding areas. This learning curve might result in more deaths of adults due to climbing accidents than in populations where adults are not translocated. However, occurrences of climbing accidents seem to vary greatly among

translocated populations, probably as a result of differences in substrate and ruggedness of local terrain and differences in climbing ability of individuals related to variation in ruggedness of terrain at capture sites. Climbing accidents apparently were not an important factor in the success of translocated herds in Arizona, because sheep populations have expanded and more than doubled in number from 1979 to 1995 due to this program.

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ABNORMAL ANTLERS AND PEDICLES ON ROCKY MOUNTAIN ELK IN NORTHERN ARIZONA

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ABSTRACT—Rocky Mountain elk (*Cervus elaphus nelsoni*) bearing malformed antlers have been observed in northern Arizona during the last 10 years. We collected measurements from 28 skulls of bulls bearing abnormal antlers from the Hualapai Indian Reservation in northwestern Arizona. Most abnormalities were unilateral. Deformed antlers were smaller and had fewer points than normal ones, and originated from deformed pedicles. The abnormal pedicles tended to be larger, and varied in orientation and location relative to normal pedicles. Some males lacked pedicles on 1 side, and the deformed antlers originated directly from the frontal bones. Similar antler and