LONG-DISTANCE MOVEMENTS FROM ESTABLISHED BURROW SITES BY PYGMY RABBITS (*BRACHYLAGUS IDAHOENSIS*) IN SOUTHWESTERN WYOMING

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The pygmy rabbit (*Brachylagus idahoensis*) is the smallest leporid in North America and is endemic to sagebrush-steppe habitats of the Great Basin (Jansen 1946; Green and Flinders 1980). *Brachylagus idahoensis* is an extreme habitat specialist that relies exclusively on big sagebrush (*Artemisia tridentata*) for food and for protection from predators and thermal extremes; it is also the only native rabbit species that constructs extensive burrow systems (Green and Flinders 1980; Katzner 1994). Because of their dependence on this vegetation type, populations of *B. idahoensis* are vulnerable to habitat fragmentation, overgrazing, and sagebrush eradication (Holecheck 1981; Dobler and Dixon 1990). Although knowledge of *B. idahoensis* populations is limited, most are believed to be declining (Dobler and Dixon 1990; WDFW 1995; IUCN 1996). Observations of previously unknown aspects of the biology of this species have conservation implications in light of this decline and the associated sagebrush eradication occurring across much of the rangeland in western North America (Wiens and Rotenberry 1985).

Previous reports suggest that *B. idahoensis* is unlikely to cross open areas without shrub cover (Bradfield 1975; Weiss and Verts 1984), a behavioral trait that would augment the effects of habitat fragmentation. Herein, we report long-distance movements by a radio-collared *B. idahoensis* and evidence of movements by other uncollared rabbits through open areas that *B. idahoensis* does not inhabit. We also identify vegetative characteristics of burrow sites used by the radio-collared rabbit during its movement from the study area, compare them with burrow sites used by *B. idahoensis* that did not move from their core-use areas, and discuss possible implications of these observations.

We studied *Brachylagus idahoensis* during the winters of 1993 and 1994 (December to March) in the Quarry Trail area of Fossil Butte National Monument, west of Kemmerer, Lincoln County, Wyoming (elevation 2000 to 2200 m). Vegetation of Fossil Butte is dominated by patches of basin big sagebrush (*A. t. tridentata*) that grows thickly in pockets where precipitation accumulates along drainages and at the bases of adjacent hills. *Brachylagus idahoensis* inhabits these areas exclusively during winter, occupying an area proportional to the amount of *A. tridentata* cover above the snow (Katzner 1994; Katzner and Parker 1997). Adjacent drier hilltops and flat areas are covered predominately by alkali sagebrush (*Artemisia longiloba*), forbs, and grasses. The study area is surrounded on all sides by steep, unvegetated hillsides and cliffs, which do not support populations of *B. idahoensis*.

Radio-collared *B. idahoensis* were located 1 to 3 times each day as part of a larger study of their winter ecology (Katzner and Parker 1997). Additionally, rabbit surveys were conducted at monthly intervals by observers who walked 50 m apart throughout the entire study area. Because rabbit tracks and pellets stand out in the snow at distances >25 m, these local counts were very precise. The combination of these 2 techniques allowed consistent counts of all *B. idahoensis* within the study area. Distance of long-range movements was estimated from an enlargement of a United States Geological Survey 1:24,000 topographic map of the area.

We sampled vegetative characteristics at 10 of the burrows used by *B. idahoensis* on the study site and at 2 burrows used by 1 rabbit during its movements away from the study site. A 10-m^2 circle (1.78-m radius) was centered at each burrow, and we counted and measured living and dead *A. tridentata* shrubs >13 cm tall for which the canopies were within or touching the circle (Gahr 1993; Katzner 1994). On each living shrub, we measured the maximum height of the living and dead components, the minimum height of the living component, the average canopy size ([maximum + minimum] ÷ 2), and the amount of living vegetation (recorded as percent alive); we also measured the height and canopy size of dead shrubs. Variables were averaged for each burrow site. We used a *t*-test designed to compare a single observation with the mean of a sample to determine potential differences between characteristics of the 2 burrows used during long-distance movements and the 10 burrows at the study site (Sokal and Rohlf 1995).

Of the 7 male and 8 female *B. idahoensis* radio-collared in this study, only 1 moved long distances from the study site. A male weighing 375 g was captured and radio-collared on 26 January 1994 and was located daily between 27 January and 8 February (Katzner 1994). This individual regularly used 3 sites within the study area; its daily movements averaged 29.5 ± 5.0 (SE) m, and the maximum distance between telemetry relocations was 104 m. In all cases, its use of habitat was consistent with that reported in other studies (Green and Flinders 1980; Weiss and

TABLE 1. Vegetative characteristics ($\bar{x} \pm$ SE) associated with 10 burrows used by *B. idahoensis* during winters 1993 and 1994 at Fossil Butte National Monument, compared with 2 burrows used by 1 rabbit as it moved 3.5 km from the study site. An * indicates a significant difference between the burrow and the averaged sites (t-test, $\alpha = 0.05$).

Variable	Average for 10 burrows	Burrow #1	Burrow #2
Number of living shrubs	20.0 ± 2.0	13.0	17.0
Percent alive	43.2 ± 2.2	65.8*	38.4
Maximum height living component	95.5 ± 6.5	64.3	70.2
Minimum height living component	38.6 ± 3.9	10.8	29.4
Maximum height dead component	82.7 ± 6.7	39.2	63.8
Average canopy size	75.2 ± 5.1	61.4	55.1
Number of dead shrubs	6.5 ± 1.2	3.0	15.0
Maximum height (dead shrubs)	48.4 ± 8.1	32.3	38.6
Average canopy size (dead shrubs)	33.3 ± 5.1	22.3	29.5

Verts 1984; Gahr 1993). The rabbit was last observed in the study area at 1140 hr on 8 February. By 1715 hr of the same day, it had moved south 600 m downhill, and was nestled between 2 boulders. The next day at 1815 hr, we found the animal 600 m farther west in a burrow on a hillside (burrow #1). A clump of *A. tridentata* shrubs (about 5 m × 7 m) surrounding the burrow was the only vegetation on the hillside. On 10 February, 16 hours later (1000 hr), the rabbit occupied a burrow 2.4 km northwest of the hillside in a stand of *A. t. tridentata* (burrow #2). It remained at this site for the rest of the day, and the next morning the radio-collar and some remains were found 500 m east of the burrow. We suspect that death was caused by an avian predator; golden eagles (*Aquila chrysaetos*) and great-horned owls (*Bubo virginianus*) were regularly observed in the area. The total minimum ground distance traveled between the 2nd burrow and the site where the rabbit was last seen in the study area was more than 3.5 km. More than half this distance was *A. longiloba* and low-forb habitat, vegetation communities not generally used by *B. idahoensis* (Green and Flinders 1980; Dobler and Dixon 1990; Katzner 1994). The rabbit could not have dispersed to these sites through continuous *A. tridentata* corridors. However, the route taken suggests that it used clumps of sagebrush as resting and foraging sites when crossing otherwise unsuitable habitat. Each of the burrow systems used in transit was extensive and was associated with *B. idahoensis* pellets from previous years. Therefore, these isolated patches must have been used by *B. idahoensis* in the past.

Green and Flinders (1980) reported maximum movements by *B. idahoensis* of 500 m, although 1 animal that they displaced 2.5 km returned to its original location. Gahr (1993) noted a maximum distance between telemetry locations of 1200 m. The longest movements were made by males during the breeding season, which typically begins between early February and mid-March, depending on weather conditions (Wilde 1978). Only Gahr (1993) suggested that some of these movements crossed areas not inhabited by *B. idahoensis*. We hypothesize that the movements of our radio-collared male were induced by the onset of breeding; similar behavior has been documented in more western *B. idahoensis* populations and in other rabbit species (Shields 1960; Chapman and Trethewey 1972; Gahr 1993). Anecdotal observations we made support this hypothesis. During February 1993, 3 *B. idahoensis* that were not previously in the study area were observed interacting with our collared females. Our surveys had accounted for all rabbits within the study site, and only 2 sites nearby (0.5 to 2 km from the females) had *B. idahoensis* populations. Because the number of animals within the study site remained the same (by the breeding season, all but 1 were radio-collared), we believe that the unmarked animals traveled at least 0.5 to 2 km through sparsely vegetated habitat to our collared females.

Burrows used by *B. idahoensis* within the study area were always located directly under *A. tridentata* shrubs. There are no published reports of *B. idahoensis* burrows in sites without *A. tridentata*. All 3 subspecies of *A. tridentata* (*tridentata, vaseyana,* and *wyomingensis*) were found at burrow sites, and at least 2 of the subspecies were present at all but 1 of the 12 burrows sampled. Burrows used during the long-distance movements of the radio-collared male were similar to those in the study site (Table 1). Variables related to shrub height also were similar to those reported by Gahr (1993) at burrows in western Washington (maximum height = 82.0 ± 19.7 cm [$\bar{x} \pm$ SD]), and to habitat measurements made in areas of the highest use within home ranges of *B. idahoensis* at Fossil Butte (Katzner 1994; Katzner and Parker 1997).

We recorded direct and anecdotal evidence of long-distance movements by *B. idahoensis*. These movements were through open habitat apparently unsuitable for long-term habitation; at least 1 was several times longer than the longest movement previously reported for this species. The similarity of

habitats at resting sites and in home ranges suggests that *B. idahoensis* may select certain habitats for resting during movement. Nevertheless, it appears that these animals will cross unsuitable habitats that, because of their extent, were previously considered barriers to movement. While we do not suggest that this is justification for further sagebrush eradication and fragmentation, it does imply that fragmented populations may not be as isolated as previously thought. This has important implications for consideration of recolonization rates of *B. idahoensis*, reintroductions (currently being considered in Washington), and conservation genetics. Future research on *B. idahoensis* should be designed to allow study of the timing, frequency, habitat associations, survival rates, and causative agents for this behavior. We suggest that it is particularly important to understand whether such movements reflect normal dispersal behavior, or are a symptom of ecological or population events that may be correlated with the decline of the species.

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