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Note

Bison (*Bison bison*) activity fragments subnivean tunnels of small mammals

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Abstract

Ecological interactions between ungulates and small mammals are generally not well understood. Here, we report an observation of unusually extensive small mammal (likely Meadow Vole [*Microtus pennsylvanicus*] or Tundra Vole [*Microtus oeconomus*]) tracks above the snow, exiting from trails and bed sites created by Bison (*Bison bison*) in northern Canada. We believe that weather and snow conditions were optimal for this observation. Although alteration of above-snow activity of small mammals in response to snow compaction by ungulates is probably not a rare event, it is not often reported. The effect on voles of exiting their subnivean tunnels as a result of Bison activity is unclear, but may be detrimental to their overwinter survival. Ungulate activity compacts snow, fragmenting small mammal tunnels resulting in loss of their insulative value for voles, and making it harder for them to dig new tunnels. Clearly, determining the effect of snow disturbance by gregarious ungulates on voles or other microtines, particularly regarding their overwinter survival, requires detailed investigation. Nevertheless, this observation provides new information on the ecological interactions between ungulates and small mammals, particularly from the boreal forest, where such information is largely lacking.

Key words: Bison; *Bison bison*; *Microtus*; subnivean; snow; voles; winter ecology; Yukon

Ecological interactions between ungulates and small mammals are generally not well understood. Such interactions undoubtedly occur frequently, with unknown consequences to the interacting species. Most of the few studies investigating these relations have focussed on the impact of ungulate grazing on the size of small mammal populations (e.g., Hayward *et al.* 1997; Keesing 1998; Matlack *et al.* 2001; Weickert *et al.* 2001; Torre *et al.* 2007) or the composition of small mammal communities (e.g., Muck and Zeller 2006; Saetnan and Skarpe 2006; Parsons *et al.* 2013). Other ecological interactions between ungulates and small mammals and those from biomes other than grassland, savannah, or temperate forests are less known (but see Keesing and Crawford 2001; McCauley *et al.* 2008; Jung *et al.* 2010, 2019; Navarro-Castilla *et al.* 2017).

Knowledge of such interactions in northern biomes, particularly during winter when snow cover is persistent, is especially scant. Yet, winter is a defining season for survival of northern small mammals that remain active, such as voles (*Microtus* spp., *Myodes* spp.; Hansson and Henttonen 1985; Korslund and Steen 2005; Boonstra and Krebs 2012; Haapakoski and Ylönen 2013; Johnsen *et al.* 2017). In the north, winter-active small mammals typically rely on snow cover and subnivean tunnels to survive (Hannson 1986; Courtin *et al.* 1991; Hansen *et al.* 1999; Bilodeau *et al.* 2013a,b; Soininen *et al.* 2015). Subnivean tunnels provide shelter from most predators and insulate small mammals from frigid ambient temperatures; hence, alteration or destruction of such tunnels might affect overwinter survival. Here, we report an observation of unusually extensive small mammal activity above the snow, coincident with trails created by reintroduced Bison (*Bison bison*) in the boreal forest of northern Canada.

On 22 January 2020, while conducting field studies on Bison, we observed a group of ~20–30 Bison in a large sedge meadow adjacent to Sceptre Lake

(61.12710°N, 136.40598°W), Yukon, Canada. There was abundant disturbance (compaction) of the snow cover from Bison walking, bedding, and feeding in the meadow. Within the meadow, we also observed several dozen sets of small mammal tracks emerging from areas of snow disturbed by Bison. The size and characteristics of the tracks were similar to those described for voles (*Microtus* spp.; Elbroch 2003). Although we did not measure trails made by these small mammals, many of them extended ≥25 m across the top of the snow. Snow depth was ~30–40 cm. We do not know the number of voles that made the trails we observed.

Our interpretation of these observations was that a population of voles—likely Meadow Vole (*Microtus pennsylvanicus*) or Tundra Vole (*Microtus oeconomus*)—inhabited the meadow and had established a network of subnivean tunnels beneath the snow. Bison had subsequently occupied the meadow, likely because it provided good foraging habitat, with abundant sedge (*Carex* spp.), a preferred winter food item for Bison in the region (Jung 2015; Jung *et al.* 2015). Bison activity compacted the snow, however, and likely disconnected the voles' tunnel systems. Voles travelling in the tunnels abruptly came out on a Bison trail or bed and travelled above the snow—sometimes for considerable distances—before returning under the snow. A similar observation was made in relation to Field Voles (*Microtus agrestis*) exiting their tunnels where they intersected with human trails in the snow (Hansson 1986). In hindsight, over the years we have made many similar observations of small mammal tracks above the snow in areas of concentrated activity or trails of Bison, Caribou (*Rangifer tarandus*), Moose (*Alces americanus*), or Elk (*Cervus canadensis*; T.S.J. pers. obs.), but not nearly to the same extent as this observation.

For more than two weeks before this observation, there was virtually no wind or new snow in the region, and the existing snow was dry, which likely provided optimal conditions for an accumulation of observable small mammal tracks. This allowed us to see the abundance of tracks made by voles exiting their subnivean tunnels where they intersected with areas of Bison activity. Our observation would likely have been difficult under different weather and snow conditions. Indeed, Hansson (1986) noted that snow conditions affect the density and distribution of snow tracks made by Field Voles in Finland.

If our interpretation of this observation is correct, then Bison (and other gregarious ungulates, e.g., Caribou or Elk) could detrimentally influence overwinter survival of voles where they co-occur. Voles travelling on top of the snow in open habitats are quite detectable and susceptible to predation by birds of prey (e.g., various owls) as well as mammalian carnivores. Moreover, in particularly cold temperatures, voles are susceptible to freezing (Courtin *et al.* 1991). Fragmentation of their tunnels because of snow compaction by Bison could result in some voles being caught above the snow or cold air infiltrating their tunnel system, both of which would subject voles to ambient temperatures. Temperatures in the region for 16 days before our observation were −30° to −45°C. Although we did not observe any signs of predation or find frozen voles, as our time at the remote site was unfortunately limited to <45 min, and we did not actively search for evidence of either. Alternatively, compacted snow created by ungulate trails may be beneficial for voles. Accumulated CO_2 in vole tunnels is a concern when the snow becomes deep (≥30 cm; Penny and Pruitt 1984); however, fragmentation of tunnels by ungulate trails may provide ventilation to the surface and release CO_2 (Hansson 1986).

Our observation provides further insight into the ecological interactions between ungulates and small mammals in the boreal forest, where such information is lacking. Although not previously reported, ungulate compaction of small mammal tunnels undoubtedly occurs wherever these species co-occur during winter. Compaction of snow by ungulates changes the subnivean environment for small mammals, likely by affecting the insulative value of snow, as well as fragmenting existing tunnels and making it more difficult to dig new tunnels. Clearly, targetted research is needed to assess the effects of ungulate disturbance of snow cover on small mammals. Our observation, in addition to others (e.g., Soper 1941; Matlack *et al.* 2001; Weickert *et al.* 2001; Jung *et al.* 2010, 2019), increases understanding of interactions between Bison and small mammals. This observation illustrates ecological interactions that may result from restoring Bison to their native range (Sanderson *et al.* 2008).

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