Evidence of Arboreal Lichen Use in Peatlands by White-tailed Deer, *Odocoileus virginianus*, in Northeastern Alberta

A. David M. Latham[1] and Stan Boutin

Department of Biological Sciences, CW405, Biological Sciences Building, University of Alberta, Edmonton, Alberta T6G 2E9 Canada
[1] e-mail: ADM.Latham@yahoo.co.nz

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Within the past 10 to 15 years, White-tailed Deer (*Odocoileus virginianus*) have extended their geographical range to include most of northern Alberta. In the boreal forest they are most abundant in well-drained upland habitat. We report the occurrence of unusually large numbers of deer seen in a large fen complex in the west side of the Athabasca River Caribou range in northeastern Alberta. Further, we report an observation that suggests that deer may be using arboreal lichen (old man's beard; *Bryoria* spp. and *Usnea* spp.) as a winter food in this region. We discuss the potential ecological ramifications of this observation for Woodland Caribou (*Rangifer tarandus caribou*) in northeastern Alberta.

Key Words: White-tailed Deer; *Odocoileus virginianus*; arboreal lichen; peatlands; range expansion ; northeastern Alberta.

Increasing deer populations have become a major force of ecological change throughout many parts of the world (Alverson et al. 1988; Fuller and Gill 2001; Rooney 2001; Côté et al. 2004). In particular, overbrowsing by deer has been shown to drastically alter forest composition and structure, and potentially modify interactions throughout food webs (e.g., Gill 1992; Putman and Moore 1998; Cooke and Farrell 2001; Fuller and Gill 2001; Husheer et al. 2003; Côté et al. 2004). Deer population increases are generally attributed to regulated hunting seasons and quotas, and land management practices that have increased forage availability and reduced predator densities (Nelson and Mech 1986; Alverson et al. 1988; Fuller and Gill 2001; Côté et al. 2004). In addition, warmer winters have been correlated with increased recruitment and overwinter survival of deer, particularly at higher latitudes (Albon et al. 1983), and may be playing a role in the current range extension of some species (Fuller and Gill 2001).

In North America, White-tailed Deer (*Odocoileus virginianus*) populations have shown dramatic range extensions and population increases in recent years (Côté et al. 2004), and have been reported as far north as the Northwest Territories, Canada (Kuyt 1966; Gainer 1995; Veitch 2001; Rue 2003). Although White-tailed Deer are known to use a wide variety of habitats across their range, in their more northerly extent they are particularly associated with aspen parkland and agriculture (Wishart 1984; Nietfeld et al. 1985; Rue 2003). In southern Alberta, Canada, White-tailed Deer numbers increased dramatically during the 1940s and 1950s in response to habitat changes resulting from a series of wet years and an absence of prairie fires (Webb 1967; reported in Wishart 1984). They had become well-established in northwestern Alberta (Peace River Parklands) by the mid-1980s (Wishart 1984). In northeastern Alberta, however, they appear to have moved north of the agricultural belt only in the last 10 to 15 years (Wishart 1984; Gainer 1995; Charest 2005; Latham 2009). Changes in land management practices, most notably the spread of agriculture and forestry, as well as warmer winters are most often implicated in the northward range expansion of White-tailed Deer in this region (Wishart 1984; Charest 2005).

White-tailed Deer densities within the boreal forest of northeastern Alberta are low compared to most of their range. For example, deer densities of >7/km^2 have been reported from northeastern USA (Alverson et al. 1988; deCalesta 1994) and southeastern Canada (Huot et al. 1984), 1.7 deer/km^2 have been estimated for the boreal-agricultural fringe region of northeastern Alberta (Alberta Sustainable Resource Development, unpublished data), and 0.7 deer/km^2 have been estimated for the boreal forest of northeastern Alberta (Latham 2009). Although most frequently found in boreal-mixed forest in northeastern Alberta (James et al. 2004), White-tailed Deer have previously been reported from the extensive peatlands in this region (Found 2007; Latham 2009). Though peatlands likely offer grasses and forbs for deer to forage on during the growing season, there is no information regarding winter food habits of White-tailed Deer in western Canadian peatlands (Wishart 1984). The primary objective of this note is to report the possible use of arboreal lichen as a food source by White-tailed Deer in a large peatland complex in northeastern Alberta during winter.

Methods

We conducted aerial surveys as part of a long-term ungulate monitoring program on the west side of the

Athabasca River (WSAR) Caribou, *Rangifer Tarandus*, range in northeastern Alberta during the winters of 2004 to 2007. The WSAR range is approximately 15000 km^2 of boreal-mixed forest (approximately 40% of the study area) and peatland (approximately 60% of the study area) habitat, and is situated to the east of the town of Wabasca (55°57'N, 113°49'W). Peatland within the range is characterised by Black Spruce (*Picea mariana*) bogs and Black Spruce-Tamarack (*Larix laricina*) fens. Well-drained uplands are characterised by Trembling Aspen (*Populus tremuloides*), White Spruce (*Picea glauca*), Balsam Fir (*Abies balsamea*), and Jack Pine (*Pinus banksiana*). Terrestrial (e.g., *Cladina* spp. and *Cetraria* spp.) and arboreal (*Alectoria* spp., *Bryoria* spp., and *Usnea* spp.) lichens are common in the study area. See Bradshaw et al. (1995) for a detailed description of vegetation in the study area.

Historically, Moose (*Alces alces*) and Woodland Caribou (*Rangifer tarandus caribou*) were the primary ungulate species found in this region of Alberta, although both occurred at low densities compared with much of North America (Hauge and Keith 1981; Stuart-Smith et al. 1997). Previous research showed that Moose were most abundant in well-drained uplands, while Caribou were found almost exclusively in peatlands (James et al. 2004). Based on aerial transect surveys conducted in the mid-1990s, White-tailed Deer were rare in WSAR (James et al. 2004). Although they have increased in density across much of northeastern Alberta in recent years (Charest 2005; Latham 2009), the vast fen/bog complexes that typify WSAR are considered poor deer habitat (Huot et al. 1984; Rue 2003; James et al. 2004). Mule Deer (*O. hemionus*) and Elk (*Cervus elaphus*) occurred at low densities within small portions of the range (A.D.M. Latham, unpublished data).

We used a fixed-wing aircraft to survey an 8000 km^2 portion of the WSAR range that included both extensive peatland habitat and well-drained upland habitat. Surveys consisted of east-west transects spaced at 1 (~1850 m) or 2 minute intervals of latitude. A minimum of 2100 km was flown in each survey. Transects were flown at a speed of 80 knots and an altitude of 80 to 110 m above ground level. One observer recorded ungulates seen from the right side of the aircraft, and a second observer recorded ungulates seen from the left. Surveys were conducted after fresh snow fall (>10 cm) during February or early March (survey date was dependent upon snow conditions).

Results

We saw an average of 3.9 (± 0.83; 95% *CI*) White-tailed Deer per 100 km flown in winter, 2004-2007. Approximately 61% of deer were seen in well-drained uplands, while 39% were seen in peatlands. Only in early March 2007 were comparable numbers of deer seen in uplands and peatlands, 41 and 39, respectively. Twenty-five (nine groups) of the White-tailed Deer seen in peatlands in March 2007 were in large Tamarack and Black Spruce-Tamarack fens between Parallel Creek (west) and the Athabasca River (east) (approximately 55°36'N, 112°50'W). Canopy cover within this fen complex ranged from approximately 10 to 20%. The average distance from the groups of deer in this complex to the Athabasca River was 2.3 km (range: 0.7 km to 3.4 km). Approximately half the deer seen were bedded in and around Tamarack and Black Spruce trees, while the remaining individuals were standing. Observations of two standing deer (from two different groups) suggested that these individuals were feeding on long strands of arboreal lichen hanging from Tamarack trees. Though we were unable to determine lichen species, the most abundant arboreal lichen hanging from trees in peatlands in WSAR is old man's beard (*Bryoria* spp. and *Usnea* spp.).

Discussion

Recent evidence suggests that arboreal lichens may similarly be browsed by White-tailed Deer in uplands during winter in northeastern Alberta. For example, a qualitative assessment of Trembling Aspen-White Spruce forests on the western boundary of WSAR in March 2008 revealed that deer (as determined by tracks and pellet groups) had caused an obvious and extensive browse line on arboreal lichen to a height of approximately 1.6 m (A.D.M. Latham, unpublished data). Further, a young White-tailed Deer buck was observed from approximately 20 m feeding on Old Man's Beard hanging from a White Spruce in this same area in November 2008 (A.D.M. Latham, personal observation). The buck fed for approximately 15 minutes, occasionally standing on both hind legs to feed, before moving off into the forest apparently unaware of any human presence. Similar behavior and browse lines of comparable heights have been reported from elsewhere in North America (Harlow 1984). A quantitative assessment of lichen use by White-tailed Deer in WSAR is required to gain a greater understanding of the magnitude of this phenomenon (i.e., is it widespread or confined to areas where deer yard).

The use of arboreal lichens by White-tailed Deer has been reported on Anticosti Island, Québec, southeastern Canada (Huot 1982), Michigan, USA (Harlow 1984), and the southern Appalachian Mountains (Harlow and Downing 1969). Despite this, it is important to note that in addition to arboreal lichen use, the White-tailed Deer observed in fens during the described survey may also have been utilizing Tamarack and Black Spruce as a food source (Blouch 1984). Although we did not observe deer feeding on these species, they have been recorded as a "last resort" food in Ontario, Canada (Blouch 1984). The comparatively low nutritional value of these tree species suggests that lichens should be preferred (Harlow 1984; Huot et al. 1984). Further, arboreal lichens have greater

digestibility values than many species of conifers and hardwoods (Mautz et al. 1976; Hobbs et al. 1981), possibly because of lower concentrations of plant secondary compounds (Ditchkoff and Servello 1998). Indeed Ditchkoff and Servello (1998) state that "selective foraging for arboreal lichens by deer could significantly raise overall diet quality and reduce over-winter loss of mass".

We are unsure why a higher proportion of White-tailed Deer were seen in peatlands in March 2007 compared with other years. However, the comparatively deep snow (50-60 cm in 2007, compared to 30-40 cm in 2004-2006; E. Christiansen, Alberta Sustainable Resource Development, unpublished data) in 2007 may have necessitated the use of arboreal lichen as a food, and the absence of a crust on the surface of the snow in that year may have facilitated greater access to this food source. Although snow conditions (particularly deep, dense or crusted snow that is unable to support the weight of deer; Kelsall 1969) may cause peatland complexes to be less accessible to deer in some years, it is important to note that low numbers of deer have been reported from peatlands in all of the aerial surveys that we have conducted since 2004 (Latham 2009). Consequently, it is possible that White-tailed Deer may similarly have used lichen as a source of nutrition during previous winters.

As in many parts of the world, there is concern about increasing deer populations in Alberta and their potential to cause substantial ecological change. Whether White-tailed Deer in Alberta have increased because of industrial or agricultural conversion of the boreal forest, various climatic factors, or a combination of all of these factors remains unknown. However, we do know that the boreal forest of northern Alberta roughly delimits the northerly extent of White-tailed Deer range (Wishart 1984; Charest 2005). We also know that White-tailed Deer densities are comparatively low in this region of Alberta (Wishart 1984; Latham 2009). Hence, the boreal forest of northern Alberta is likely marginal habitat for White-tailed Deer, and deer are likely severely food limited during winter in this northern environment. The observation reported here sheds light on a possible survival strategy for White-tailed Deer during harsh winters.

Further, the observation that we report suggests that there is the potential for direct competition for food (i.e., lichen) between White-tailed Deer and Woodland Caribou. Although White-tailed Deer are not common in the more interior portion of the WSAR range, Woodland Caribou are found comparatively close (~ 2 km) to the Athabasca River (and other areas of adjacent upland habitat) in some parts of the range (Latham 2009). Consequently, direct competition between these two species may occur in areas of spatial overlap, a phenomenon that could result in temporal competitive exclusion of Caribou from portions of otherwise suitable habitat. Historically, Caribou use of peatlands provided them with a virtual refuge from predation as Moose (primary prey) and Wolves, *Canis lupus*, (shared predator) tended to be most abundant in uplands (James et al. 2004). Any increase in the number of deer (a novel primary prey species) in peatlands may upset the spatial separation strategy employed by Caribou which reduces predation risk (Bergerud et al. 1984; Latham 2009). Consequently, the observation that we report here has important implications to understanding and managing White-tailed Deer range expansion, and lessening their impact in Woodland Caribou systems in northern Alberta.

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