Moose, *Alces alces,* Winter Browse Use in Central Labrador

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To determine the effect of forestry practices on the availability of winter Moose forage, we recorded Moose browse along four 250 m transects in each of five forest regeneration ages. Browse use was greater on 20- and 30-year-old regenerating stands as compared with recently clearcut stands (5 and 10 years old) or mature forest (> 150 years old). Willow (*Salix* sp.) followed by White Birch (*Betula papyrifera*) had the highest proportion of browsing by Moose.

Key Words: Moose, *Alces alces,* browse, logging, Labrador.

Since the early 1950s, Moose (*Alces alces*) have expanded into Labrador, independent of introductions on the Labrador coast (Mercer and Kitchen 1969; Dalton 1986*; Chubbs and Schaefer 1997). Conversions of mature forests into early and mid-successional seres are partly responsible for Moose increases in most of North America (Bergerud and Manuel 1968; Collins and Helm 1997; Rempel et al. 1997) since Moose tend to be associated with mid-successional forests (Bergerud and Manuel 1968; Telfer 1974; Pierce and Peek 1984; Collins and Helm 1997; McCracken et al. 1997; McLaren et al. 2000). It is unlikely that the first expansion of Moose into Labrador resulted from forest cutting; most cutting is limited to discrete areas isolated from the historical distribution of Moose in eastern Canada and logging largely began in the late 1960s (FMDPT 2003*) after Moose had become established in Labrador (Chubbs and Schaefer 1997). However, anticipated increases in logging in Labrador (FMDPT 2003*) will likely increase the amount of forest in successional stages favorable to Moose, possibly increasing Moose densities.

Moose favor areas of highest forest productivity, preferring 5- to 15-year-old regenerating stands where vegetation reaches heights of 3 m and is thus available above snow (Dodds 1960; Bergerud and Manuel 1968; Telfer 1974; McLaren et al. 2000). The mosaic of food and cover produced by logging can benefit Moose. High quality food is important for storing winter fat and provides females with the nutrients required for rearing young (Leptich and Gilbert 1989), while thermal cover is important for energy conservation (Schwab and Pitt 1991). Early and mid-aged clearcuts are favorable to Moose relative to forested stands in part due to more total browse (Telfer 1974; Schwab et al. 1987; Collins and Helm 1997) and because wind exposure reduces snow depths (Schwab et al. 1987). Early regenerating and pre-commercially thinned Balsam Fir (*Abies balsamea*) stands may also attract Moose, depending on site type (Thompson et al. 1992; McLaren et al. 2000).

There is considerable geographical and seasonal variation in Moose diets, yet coarse patterns exist (Peek 1974). In boreal forests during winter, Moose make high use of White Birch (*Betula papyrifera*), Mountain Maple (*Acer spicatum*), and Balsam Fir saplings, willow (*Salix* sp.), and with lesser amounts of Red-osier Dogwood (*Cornus stolonifera*), Pin Cherry (*Prunus pennsylvanica*), Mountain Ash (*Sorbus americana*), and *Viburnum* spp. (Dodds 1960; Bergerud and Manuel 1968; Peek 1974; Proulx and Joyal 1981; McLaren et al. 2000). Leaves and annual growth stems of the above species are dominant spring and summer forage. Additional summer foods include plants such as Yellow Water Lily (*Nuphar microphyllum*), horsetail (*Equisetum* sp.), fireweed (*Epilobium* spp), and sedges (*Carex* spp.) (Dodds 1960; Irwin 1985).

To determine the effects of forest harvesting on Moose browse, we documented Moose browsing across regenerating clearcuts of four ages (5 to 30 years old) and mature, uncut forests.

Study Area

The study was conducted from 28 June to 10 August 2004 within 40 km of Happy Valley-Goose Bay (53°19'N, 60°25'W), Newfoundland and Labrador, Canada (Figure 1). Sites were located in the High Boreal Forest Ecoregion of Labrador (Meades 1990*); this region contains the most productive forests for commercial timber in Labrador (Wilton1959; Lopoukhine et al. 1975). The moderately rolling terrain is dominated by Black Spruce (*Picea mariana*) and Feather Moss (*Pleurozium schreberi*) forest at the higher elevations and Balsam Fir/Black Spruce/White Birch forest at slightly lower elevations (Lopoukhine et al. 1975). This area experiences a mean annual temperature of -0.5°C (mean monthly range: -18.1 to 15.4°C) and precipitation amounts of 949 mm, half of which falls as snow (Environment Canada Climate Normals: http://www.msc-smc.ec.gc.ca; viewed 27 September 2004). Snow remains on the ground from October through June. Approximately 12% of this study area was commercially harvested from the late 1960s to 2004 (FMDPT 2003*). The area is accessible to hunters and the most recent density estimates reported 0.168 Moose/km^2 in 1994 (Chubbs and Schaefer 1997).

Methods

We established twenty 250 m-long transects in different stands, with four transects representing four clearcut ages (approximately 30, 20, 10, and <5 years following cutting) and uncut mature (>150 years old) forest. We selected stands ranging from 30 to 700 ha and those within the same age group were chosen as far apart as possible (≥ 700 m) while still being accessible. Prior to harvest, stands were dominated by Black Spruce and classified as commercial, i.e., supporting > 100 m^3 of timber per ha with canopy height ranging from 9.5 to 18.5 m tall and crown closure ranging from 50 to 75%. Our mature forest transects reflected this variation and all sites had regenerated. Transects in harvested stands started at commercial mature forest edges and were oriented to avoid all other stand edges, roads and patches of remnant forest.

Transects consisted of evenly spaced plots at 50 m intervals. Each plot consisted of five 4.5 m^2 circular subplots: one central and the remaining four in the cardinal directions 10 m from the centre. Within each subplot, plant species, number of stems and occurrence of Moose browsing were recorded.

Results

Most browsing occurred in the 20- and 30-year-old stands, with willow being the most proportionately, 0.50 and 0.80, respectively, browsed species. Willow accounted for only 0.8% of total stems but represented 16.5% of the total stems browsed across 20- and 30-year-old stands. The second most proportionately browsed species was White Birch (0.33 and 0.48 in 20- and 30-year-old stands, respectively). Considerably smaller proportions of Mountain Alder (*Alnus crispa*), Balsam Fir and Black Spruce were browsed. There was virtually no browsing in clearcuts < 15 years old and forests > 150 years old.

Discussion

Throughout their range and between seasons, species browsed by Moose varies, but tends to be dominated by willow when available (Peek 1974; McCracken et al. 1997; Collins 1999). Similarly, we found that willow was the most proportionately browsed species in Labrador. Our second most proportionately browsed species, White Birch, was also a prominent Moose browse throughout Canada (Dodds 1960; Peek 1974). However, in contrast to other regions (Dodds 1960; Bergerud and Manuel 1968; Thompson et al. 1992) proportionately little Balsam Fir was browsed in our study. Balsam Fir is generally a winter food (Dodds 1960) and may be selected only when deciduous species are unavailable or where Moose densities are high (McLaren et al. 2000). Moose are reported absent from apparently suitable habitat in Labrador and are possibly limited by Wolf (*Canus lupus*) predation, illegal hunting, and snow depths (Trimper et al. 1996). Although snow depth could limit food supply (Schwab et al. 1987), it also increases expended energy (Schwab and Pitt 1991). Illegal hunting, Wolf predation and energy costs of snow depth may depress Moose populations enough that they can forage on the preferred willow and White Birch rather than resorting to Balsam Fir.

Our finding of more Moose browsing in 20- and 30-year-old stands is similar to other studies that found greater amounts of browse and Moose densities in regenerating clearcuts (Telfer 1974; Schwab et al. 1987; Leptich and Gilbert 1989; Collins and Helm 1997; Thompson et al. 1999; McLaren et al. 2000). However, our peaks in Moose browsing occurred 10 – 15 years later than suggested by Dodds (1960) and Telfer (1974), likely due to the slower regeneration rate in our study area than in more southerly Moose ranges. Our results suggest that increases in forest cutting may increase Moose densities by enhancing browse production. However, the lack of browsing on less preferred species (e.g., Balsam Fir) indicates Moose are probably not limited by winter browse and therefore Moose may not increase as rapidly as in other areas. Although we found few browsed stems outside 20 – 30 year old clearcuts, Moose may use these areas to graze on herbs during summer and fall. Browse surveys alone may not be enough to quantify Moose diets – fecal and rumen analyses and foraging observations would help to better determine seasonal Moose forage preferences (McCracken et al. 1997).

Increased Moose densities resulting from logging may enhance recreational and sustenance activities; e.g., viewing and hunting. However, increased Moose densities are believed to increase Woodland Caribou

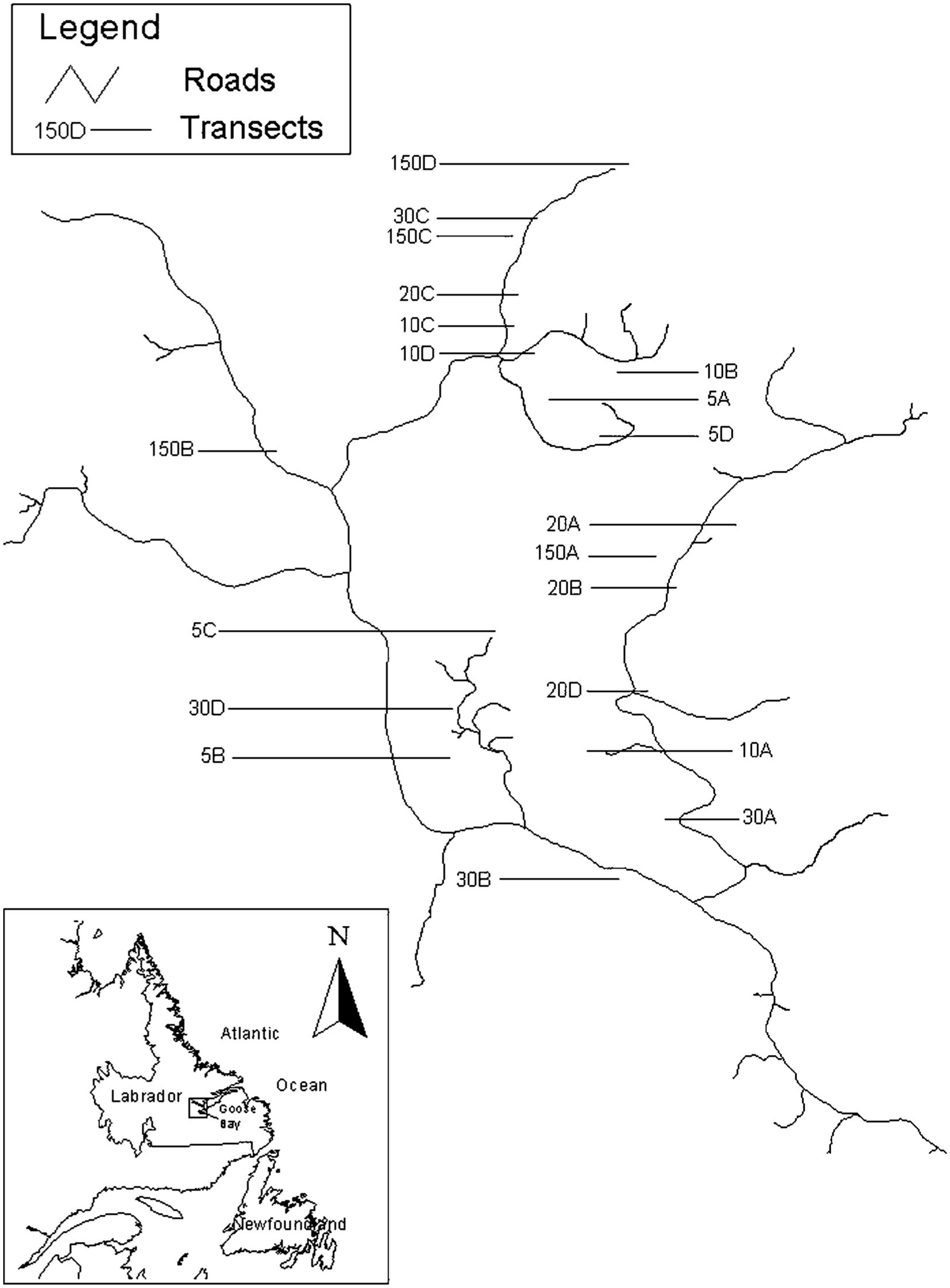

FIGURE 1. Study area showing the locations of each of the four (A, B, C and D) transect locations for each clearcut age (5, 10, 20, 30, and 150 years).

TABLE 1. Proportion of plant stems browsed by Moose and standard error according to clearcut age (n = 100 per age).

Plant species	Number of stems	Browsed stems	Proportion	Standard error
5 years				
Abies balsamea	302	0	–	–
Picea mariana	623	0	–	–
Alnus crispa	0	0	–	–
Betula papyrifera	3	0	–	–
Salix spp.	0	0	–	–
10 years				
Abies balsamea	165	1	0.006	0.006
Picea mariana	657	0	–	–
Alnus crispa	0	0	–	–
Betula papyrifera	7	0	–	–
Salix spp.	8	0	–	–
20 years				
Abies balsamea	912	6	0.007	0.003
Picea mariana	1429	2	0.001	0.001
Alnus crispa	118	11	0.093	0.013
Betula papyrifera	45	15	0.333	0.071
Salix spp.	26	13	0.500	0.100
30 years				
Abies balsamea	627	4	0.006	0.003
Picea mariana	1111	2	0.002	0.001
Alnus crispa	0	0	–	–
Viburnum edule	0	0	–	–
Betula papyrifera	129	63	0.488	0.044
Salix spp.	10	8	0.800	0.133
> 150 years				
Abies balsamea	345	0	–	–
Picea mariana	930	0	–	–
Alnus crispa	0	0	–	–
Betula papyrifera	1	0	–	–
Salix spp.	7	0	–	–

(*Rangifer tarandus*) mortality possibly thorough an influx of large predators; e.g., Wolves (Bergerud and Elliot 1986; Klein 1991; Seip 1992; Schaefer et al. 1999) and Black Bears, *Ursus americanus* (Mahoney and Virgl 2003). Boreal populations of Woodland Caribou are threatened in Labrador (Schmelzer et al. 2004*), so it may be desirable to reduce Moose forage, notably White Birch and willow, on regenerating clearcuts. Our results indicate that accelerating the passage of clearcuts through earlier successional stages by aggressive Black Spruce planting and targeting Moose forage in pre-commercial thins would have the greatest negative impact on Moose winter forage.

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