Woodland caribou and forestry in Northern Ontario, Canada.

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Abstract: Expansion of logging in remote Ontario boreal forest requires mitigation of effects on woodland caribou. Three examples of caribou-forestry interaction are reviewed. In two, caribou were apparently displaced from peripheral portions of their winter range by logging. In the third, caribou disappeared when exposed to: logging in a central third of their winter range; increased deer density, and; a probable increase in predation. In all cases there is no evidence of human harvest. The literature plus experience in Ontario suggest the following mitigative techniques: protection of winter concentration areas, significant calving areas and traditional migration routes from logging; directing timber harvest to forest stands of least value to caribou; restricting disturbance to one large clearcut in a peripheral portion of range rather than dispersing it over a large portion as several small clearcuts; modified site preparation and regeneration, and; restricted road access. Research is required on the effect of forestry on caribou with and without mitigation, and on causes for effects observed.

Key words: caribou, decline, forestry, mitigation.

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Introduction

Woodland caribou (*Rangifer tarandus caribou*) inhabiting boreal forest usually form groups of less than 50 that move ut to 100 km between seasonal ranges. Gregarious in autumn, winter and early spring, they are essentially solitary in late spring and summer (Simkin, 1965; Shoesmith and Storey, 1977; Fuller and Keith, 1981; Darby and Pruitt, 1984; Edmonds and Bloomfield, 1984).

The Ontario distribution of woodland caribou has steadily receded since European settlement (deVos and Peterson, 1951). It is still receding (Fig. 1). Population density is low, 0.014 to 0.021/km^2 (Simkin, 1965; Hamilton, 1979). Two hypotheses have emerged as reasons for caribou declines. One states caribou populations are limited by seasonal range quality and availability (Klein, 1968; Geist, 1978). Logging, land clearing, fire and human disturbance force caribou onto unsuitable range. The second states populations are regulated by hunting and predators and are little affected by disturbance (Bergerud, 1974a; Bergerud *et al.*, 1984).

Recent expansion of logging into remote boreal forest of northern Ontario requires mitigation of effects on caribou. Our objectives are: (1) review habitat requirements of woodland caribou in boreal forest; (2) summarize the forest management context; (3) summarize forestry-caribou interactions in Ontario; (4) recommend mitigative techniques, and; (5) identify research needs.

Habitat requirements in boreal forest

Studies of woodland caribou in boreal forest show that: use of mature and overmature pine (*Pinus* sp.) and spruce (*Picea* sp.) forest is high; use of deciduous forest is low, and; open muskegs, lakes and islands are preferred for foraging, bedding, escape and calving (Simkin, 1965; Euler *et al.*, 1976; Shoesmith and Storey, 1977; Fuller and Keith, 1981; Darby and Pruitt, 1984; Edmonds and Bloomfield, 1984). While

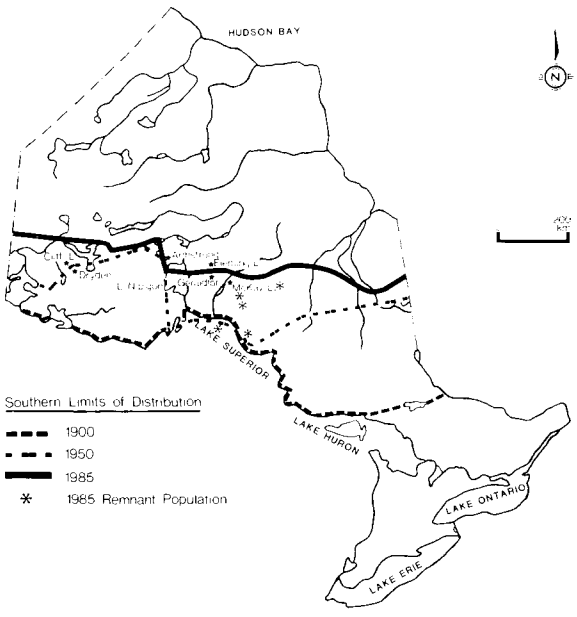

Fig. 1. Distribution of woodland caribou in Ontario from 1900 to 1950 (deVos and Peterson, 1951), to 1985 (unpublished data, OMNR).

caribou can use a variety of habitat types, they nevertheless exhibit strong seasonal preferences governed by forage availability, predators and snow conditions.

In spring and summer, caribou feed on forbs, deciduous leaves, lichens, fungi, grasses and sedges (Simkin, 1965; Bergerud, 1972). Where these are widely abundant, caribou use a greater diversity of habitats in spring and summer than in winter (Fuller and Keith, 1981; Darby and Pruitt, 1984). Spring dispersal of cows and calves plus use of open muskegs, lakes and islands may be anti-predator strategies (Simkin, 1965; Shoesmith and Storey, 1977; Fuller and Keith, 1981). Similarly, caribou may use shorelines, open muskegs and exposed ridges for relief from insects (Shoesmith and Storey, 1977; Edmonds and Bloomfield, 1984).

In autumn and winter caribou feed on arboreal and terrestrial lichens, sedges and bog ericoids; woody browse is not a dietary staple (Simkin, 1965; Bergerud, 1972; Darby and Pruitt, 1984; Edmonds and Bloomfield, 1984). During early winter, caribou feed in muskegs until snow restricts activity, then crater on coniferous uplands where snow is less deep, or feed on arboreal lichens. Frozen lakes and creeks are used for travel, escape, resting and drinking slush water (Stardom, 1977; Fuller and Keith, 1981; Darby and Pruitt, 1984; Edmonds and Bloomfield, 1984).

Although it has been argued that lichens are not essential for caribou survival (Bergerud, 1972, Euler *et al.*, 1976), they are a valuable winter food. During winter, caribou metabolic rate and protein requirements are reduced while carbohydrate demands are high. Lichens, although low in protein, are rich in carbohydrates (Russell and Martell, 1984). Nutrients missing in lichens are contained in evergreen shrubs and graminoids consumed (Klein, 1982).

Woodland caribou may use traditional migration routes to move between summer and winter range (Stardom, 1977; Edmonds and Bloomfield, 1984), but fidelity to such routes is not strict. Stardom (1977) reported the Sasaginnigak herd in eastern Manitoba followed the same migration route in only 3 of 4 years. In other areas caribou did not show cohesive and unidirectional movements (Shoesmith and Storey, 1977; Fuller and Keith, 1981). Individual or herd movements may be as great as 84 km (Edmonds and Bloomfield, 1984), but distances of 10 — 40 km are more common (Stardom, 1977; Fuller and Keith, 1981). Some caribou use the same range year round (Fuller and Keith, 1981; Darby and Pruitt, 1984; Edmonds and Bloomfield, 1984).

Forest management context

Forestry in northern Ontario is directed to mature and overmature conifer for paper production. Clearcuts of 50 to several thousand hectares are common, selective cutting is rare, and cuts are modified only for site protection and other resource values. Post-logging treatment may involve scarification, prescribed burning, natural or artificial seeding, or planting. Forestry activities are governed by forest management agreements (FMA's) between the companies and the Ontario Ministry of Natural Resources (OMNR). Timber management plans, renewable every 5 years, provide direction for 20 years, and operational details for the next 5 years.

Mitigation of effects on woodland caribou must be achieved within the FMA framework. The options for special designation of caribou habitat are limited: (1) exclusion; (2) withdrawal, and; (3) deferment. Exclusions, minimal in size and number, are lands where rights to timber resources are permanently alienated before the FMA is signed. Withdrawals are lands where

such rights are alienated after signing. All FMA's stipulate a maximum amount of withdrawal, generally 5% of the annual allowable cut by species group per annum. Deferments are areas where cutting is delayed, usually for 10 years maximum, with no limit on amount deferred.

Areas of Concern are areas of value to other users identified at both the 20 and 5 year planning levels. Examination of the concerns may result in normal or modified forestry operations, or reserves. However, the mechanism for implemention must be withdrawal or deferment. For example, shelter patches and travel corridors are usually deferments. If required for more than 10 years they must be withdrawn or depleted from the productive forest inventory, and equivalent timber elsewhere must be provided to the company. In most cases cut size is only modified through use of shelter patches and travel corridors. Other changes must occur through persuasive negotiation.

Clearcut logging alters caribou habitat in more ways than simple reversion to an early successional stage unfavourable to slow-growing lichens. Stand conversion from coniferous to deciduous species may occur, especially where poplar (*Populus* spp.) are common. This is due to rapid vegetarional reproduction of deciduous trees and shrubs. Lichens, fungi and some ericoids are replaced by vasculars. Woody browse proliferates, benefiting moose (*Alces alces*) in winter, but not caribou.

Forestry and caribou case histories

Since 1960 there have been several cases in northern Ontario where small groups of caribou (10 to 40) disappeared or were displaced when logging occurred in their range. Usually, documentation and data relating to these cases are poor or non-existent, for example at McKay Lake near Geraldton (Fig. 1). However, in three cases there are sufficient data to provide insight to the problem.

Fleming Lake, Geraldton District

For many years woodland caribou were known to winter near Fleming Lake north of Geraldton (Fig. 1). Twenty-one caribou were observed in December, 1981; other caribou were likely present but not observed (Mark Sobchuk, OMNR, Fort Frances, pers. comm.). Forest composition of the winter range (170 km^2 was 61% mature and overmature conifer (80 yrs or older), 11% immature conifer, 9% deciduous forest, 7% mixed forest, 8% muskeg and open land, and 4% water.

From 1980 to 1983, 1130 ha of mature and overmature conifer were cut in a southern 7% of the winter range; 630 ha were clearcut, and 500 ha were modified cut leaving rows of uncut blocks 5 ha in size, spaced 200 m apart. The modified clearcut was intended to protect sandy soils from erosion, improve regeneration success and secondarily mitigate the effects of cutting on caribou (M. Sobchuk, pers. comm.).

Nine aerial transect surveys (1.3 h each) were flown to monitor caribou distribution after cutting; one per month during December, January and February of 1981 — 82, 1982 — 83 and 1983 — 84. Results showed that caribou did not occupy any of the cuts. Instead, they were found in adjacent mature and overmature jack pine (*Pinus banksiana*) north of the cuts where terrestrial lichens were abundant. Some caribou tracks were observed along the northern boundary of the cuts, but none were observed within them. No caribou or caribou sign have been observed in the disturbed area to date (M. Sobchuk, pers. comm.).

No data are available on caribou reproductive or mortality rates. There is no evidence of human harvest of caribou in this winter range despite frequent patrols by Conservation Officers. Moose density ($0.12 \cdot km^{-2}$)did not increase after cutting, and white-tailed deer are not present. Wolf density is low but unquantified. However, wolf predation of caribou is not likely to have increased after cutting, because moose density did not increase.

Armstrong, Nipigon District

Since 1975 approximately 100 caribou have summered on islands in lake Nipigon and wintered on the mainland near Armstrong, 10 to 50 km away (Fig. 1). The winter range (180 km^2) is comprised of 35% mature and overmature conifer, 26% immature conifer, 11% deciduous forest, 17% mixed forest, 7% muskeg and open land, and 4% water. Most caribou activity in winter occurs on mature and immature jack pine-spruce-lichen uplands. The community of Armstrong (population 500), a road and the Armstrong airport are located on northwestern and northern boundaries of the winter range respectively.

From 1974 to 1985, several contiguous clearcuts totalling 1140 ha were made in mature and overmature conifer in a western 6% of the winter range. Caribou have not used the cutovers since they were cleared, but continue to use adjacent uncut winter range (Blake Beange, OMNR, Nipigon, Pers. comm.). This was observed: on an aerial transect survey in 1983 and 1985 to monitor caribou winter distribution; on stratified random aerial quadrat surveys for moose in January 1976, 1979 and 1984, and; during casual observations of caribou and caribou tracks by OMNR staff. Local residents frequently view caribou and caribou tracks near the Armstrong airport adjacent to uncut winter range, but not in the cutovers.

No data are available on caribou reproduction or mortality rates. There is no evidence of human harvest of caribou despite frequent patrols by Conservation Officers. Moose density immediately west of the winter range was 0.16·km^{-2} in 1976 and 0.24·km^{-2} in 1979. To the southwest it was 0.36·km^{-2} in 1979. White-tailed deer are not present in the area. Wolves are present but no information is available on their density. Caribou numbers seem unaffected by increased moose density west of the winter range, so increased wolf predation of caribou is not implicated.

Cliff Lake, Dryden District

Brousseau (1978) reported caribou disappeared from the Cliff Lake area northwest of Dryden (Fig. 1) after logging occurred in their winter range. Caribou had been known to exist there for many years. Six aerial transect surveys in winter 1966 — 67 showed the number of caribou exceeded 36. Brousseau (1978) described how the distribution and number of caribou subsequently receded as cutting occurred from 1968 to 1978. Four aerial transect surveys in March, 1978, showed there were only about 12 caribou left, wintering on uncut rocky jack pine ridges. Annual pellet group surveys showed caribou density declined from 0.86 ± 0.35·km^{-2} ($P<0.05$, n=318 plots) in 1972 to zero in 1978 (n=320 plots). Cutting in the area has continued to date. No caribou have been seen in Dryden district since 1978 (W. May, OMNR, Dryden, pers. comm.).

Before cutting, the winter range of 270 km^2 (OMNR unpublished data; Brousseau, 1978) was 39% mature and overmature conifer, 15% immature conifer, 9% deciduous forest, 11% mixed forest, 9% muskeg and open land, and 17% water. By 1978, 15% was clearcuts 60 to 1600 ha in size, scattered among lakes in central and eastern portions (33%) of the winter range. A road bisected the winter range, and large cuts and a road surrounded its eastern and northern margins.

Brousseau (1978) suggested the decline or possible emigration of caribou was due to logging. He speculated the reasons may have been direct, through habitat destruction and disturbance, or indirect through increased wolf (*Canis lupus*) predation and illegal hunting. However, it appears other factors were involved. The density of white-tailed deer (*Odocoileus virginianus*) was high from the 1960's to approximately 1975 (W. May, pers. comm.). No data on deer density are available for the Cliff Lake area, but deer density in a wintering area 50 km south was 8.6 ± 2.3·km^{-2} in 1964. Moose density in the Cliff Lake area (0.18 ± 0.07·km^{-2}, $P<0.10$) did not increase during the period of caribou decline. There is no information on wolf density, but wolf-killed deer were commonly seen on the lakes. A high density of wolves may have increased predation rates on caribou. The meningeal worm, *Parelaphostrongylus tenuis*, may have been a mortality factor (Anderson, 1971) since deer densities were high for at least 5 years before the caribou started to decline. No evidence of human harvest of caribou was observed during patrols by Conservation Officers from 1972 to 1977, (Carl Hansson, OMNR, Dryden, pers. comm.), even though Brousseau (1978) mentioned the possibility.

Discussion

Concensus in the literature has not been achieved on the reasons for caribou displacement or decline, but it appears that both the habitat-disturbance and predation-hunting hypotheses may be operative. In a few cases, disease may also be involved.

Forage and range condition can limit *Rangifer* population size, and affect distribution (Klein, 1968). Caribou mobility and low reproductive potential are adaptations to avoid population crashes (Bergerud, 1978). Deep snow can limit food availability (Stardom, 1977; Darby and Pruitt, 1984), enhancing the value of such adaptations. The low density of woodland caribou in boreal forest (Simkin, 1965; Hamil-

ton, 1979; Fuller and Keith, 1981) is a reflection of the low productivity of that environment. Populations of 50 caribou or less are very sensitive to slight changes in productivity or mortality (Bergerud, 1978).

Displacement to less suitable range may result in carrying capacity being exceeded, or lower herd productivity. Reimers *et al.* (83) showed that calf and adult reindeer on heavily grazed range in Norway had significantly lower body size than reindeer on good range. Also, pregnancy in female calves occurred frequently on good range but not on poor range.

Cutting of most mature conifer in an area may leave caribou no option but emigration. In Alberta, caribou did not feed in clearcuts larger than 2 ha and were known to cross a larger cut only once in four years (Edmonds and Bloomfield, 1984). Studies by Klein (1971), Calef (1974) and Cameron *et al.* (1979) suggest that abandonment of range may result gradually from the cumulative effect of adverse stimuli. Cows and calves are particularly sensitive to disturbance following parturition (Bergerud, 1974b).

In contrast to the habitat-disturbance hypothesis, Bergerud *et al.* (1984) argued that increased hunting and predation cause caribou declines. They examined eight caribou herds exposed to industrial activities or transportation corridors and found no evidence that disturbance or habitat alteration affected productivity. Instead, they found evidence that increased road access resulted in greater hunting mortality of caribou, and increased moose density resulted in greater wolf predation on caribou. Roads may also facilitate travel of wolves into a caribou area. Hunting of caribou has been prohibited in Ontario since 1929 except for subsistence hunting by native people. Natives harvest 2.4 to 3.6% of the caribou population per year (Simkin, 1965; Gray, 1978).

The three case histories in Ontario are pertinent. At Fleming Lake and Armstrong it appears logging caused displacement of caribou from peripheral portions of their range, yet range abandonment did not result and caribou numbers did not decline. At Cliff Lake the disappearance of caribou probably resulted from a combination of habitat destruction and predation, and possibly parelaphostrongylosis.

While the above information provides a starting point for understanding the effects of logging on caribou, speculation still surrounds the postulated cause and effect relationships. What conclusions then, can be drawn to help develop mitigative techniques? Firstly, caribou may not disappear if a relatively small peripheral portion of range is cut, especially if predation and human harvest are low, and deer are non-existent. Secondly, caribou are likely to disappear if widespread cutting occurs and moose or deer densities (*i.e.* predation or parelaphostrongylosis) are high.

In order for mitigative techniques to be practical they must be economically feasible and compatible with terms of the FMA's. Hence, selective or partial cutting are not viable options. Patch or strip cuts are acceptable only if used in Areas of Concern. Unfortunately, withdrawal and deferment limits, while reasonable for moose, may be unreasonable for caribou. Caribou should not be restricted to isolated areas of mature forest. Wildlife managers must strive to provide adequate habitat for caribou and argue for periods of deferment longer than 10 years.

The efficacy of mitigative techniques recommended below is not known. Research is needed on the effect of forestry on caribou with and without mitigation, and on the causes for any effects observed. The present forest management planning system allows for integrated resource management and implementation of such mitigative techniques.

Mitigative Techniques

1. Do not permit logging of winter concentration areas, significant calving areas or traditional migration routes. Maintain a 2 km and 1 km no-cut buffer around winter concentration areas and significant calving areas respectively. Do not log within one km of traditional migration routes. Avoid road access adjacent to or across such routes between April 1 and mid-May. The size of these buffers, while arbitrary, is our best estimate based on current information.
2. Direct timber harvest to forest stands of least value to caribou, such as black spruce (*Picea mariana*) uplands having a ground cover of feather moss (*Dicranum* sp., *Pleurozium schreberi*), or dense black spruce muskegs with an understory of labrador tea (*Ledum groenlandicum*).
3. Log summer range in winter and *vice - versa.*

4. Allow logging of peripheral portions of caribou winter range if caribou winter use of the periphery is infrequent, or if lichen biomass is low.
5. Restrict cutting to one large clearcut (130 to 500 ha) on the periphery of «caribou range» rather than disperse the same amount of cutting as numerous small clearcuts (less than 130 ha) over a large portion of range.
6. Control road access with signs or gates and scarify roads as soon as practical.
7. Lightly scarify cutovers and leave slash on site to increase humidity and encourage lichen regeneration (Eriksson, 1975). Burning is not recommended because it destroys lichens and stimulates growth of vascular plants (Eriksson, 1975).
8. Implement predator control if wolf predation rates on caribou increase. This is likely to occur if moose or deer densities increase following cutting.
9. Discourage moose and deer populations from increasing in or adjacent to caribou range. Application of herbicides to cutovers may do this while encouraging conifer regeneration.

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