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Woodland caribou range occupancy in northwestern Ontario: past and present

G.D. Racey[1] & T. Armstrong[2]

[1] Ontario Ministry of Natural Resources, RR#1 25th Sideroad, Thunder Bay, Ont., Canada P7C 4T9 (raceyge@epo.gov.on.ca).
[2] Ontario Ministry of Natural Resources, 435 James Street S., Suite 221, Thunder Bay, Ont., Canada P7E 6S8.

Abstract: A zone of continuous woodland caribou (*Rangifer tarandus caribou*) distribution is defined for northwestern Ontario. This zone establishes a benchmark for measuring the success of future management of habitat and conservation of populations. Inventory of key winter, summer and calving habitats reaffirms the concept of a dynamic mosaic of habitat tracts that supports caribou across the landscape. The historical range recession leading to this current distribution has been associated with resource development, fire and hunting activities over the past 150 years, and numerous attempts at conservation over the last 70 years. The decline was apparently phased according to several periods of development activity: i) early exploitation in the early to mid-1800s; ii) isolation and extirpation of southern populations due to rapid changes in forest use and access between 1890 and 1930; and iii) further loss of the southernmost herds due to forest harvesting of previously inaccessible areas since the 1950s. Lessons learned from history support current conservation measures to manage caribou across broad landscapes, protect southern herds, maintain caribou habitat as part of continuous range, maintain large contiguous tracts of older forest and ensure connectivity between habitat components.

Key words: caribou, development, forest management, habitat, history, populations, wildlife.

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Introduction

The status of woodland caribou (*Rangifer tarandus caribou*) in northwestern Ontario has been debated widely because information on population size and range occupancy is inadequate. Kelsall (1984) suggested that caribou were secure in local areas in Manitoba, Ontario and Quebec, but considered the southeastern Manitoba, Slate Islands, Pukaskwa and Lake Nipigon populations threatened. He considered Ontario's woodland caribou part of the "vulnerable" western Canada population. This recommendation was based on various estimates of the population size or status of caribou in Ontario by de Vos & Peterson (1951), Cringen (1957), Banfield (1961), and Simkin (1965). Recent estimates of population size (Cumming, 1998) suggest that the provincial population is relatively stable, but that, based on numbers and threats, forest-dwelling woodland caribou should be considered "threatened" (Cumming, 1997). Population estimates for forest-dwelling woodland caribou are difficult to obtain, imprecise and unreliable (Thomas, 1998). We believe this to be true in the forests currently used for commercial purposes in northwestern Ontario.

Although reliable population estimates are lacking, it is clear that caribou range in the Lake Superior - northwestern Ontario area has become more restricted since the mid 1800s. Cringen (1957) documents the extirpation of caribou in Minnesota, Michigan and Wisconsin and suggested that caribou had disappeared from 30 000 square miles (76 800 square km) of range west of Lake Superior. A more detailed account of current distribution and historical recession of woodland caribou range in Ontario was provided by de Vos & Peterson (1951). These declines in the Lake-Superior - northwestern Ontario area coincide with general trends observed across North America (Cringen, 1957; Bergerud, 1974; Cochrane, 1996; Mallory & Hillis,

1998). Range recession maps suggest a gradual recession in Ontario caribou range over the last century (Darby & Duquette, 1986; Darby *et al.,* 1989; Cumming & Beange, 1993).

Apparent decline in the numbers and distribution of caribou in Ontario has resulted in a history of management actions, starting with closure of the hunting season for caribou in 1929. Since then, caribou management has been supplemented by widespread caribou survey work conducted in the 1950s (Simkin, 1965), and broad habitat assessment (Ahti & Hepburn, 1976). Initial attempts at caribou policy development began in the 1970s and 1980s (Darby *et al.,* 1989), although there is no provincial caribou policy at this time. Forest management guidelines were developed in the 1990s (Racey *et al.,* 1991; Racey & Armstrong, 1996) but it is too early to evaluate long-term effectiveness of these guidelines. Debate continues over appropriate management strategies and has led to demands for better information about current range utilization, better understanding of how and why caribou suffered this historical decline and what the implications may be for survival of caribou in the commercial forest of northwestern Ontario.

In northwestern Ontario, the current management objective is to halt the northward recession of caribou range and maintain range occupancy (OMNR, 1998). We suggest that achievement of this objective over the long term may be evaluated by monitoring change in range occupancy rather than by population estimates. This paper looks at the current and past distribution of woodland caribou in northwestern Ontario, and describes ecological, social and economic factors associated with the historic decline in range. Improved understanding of the nature of past range recession will support development of management strategies to avoid future range loss.

Materials and methods

Study Area

The study area included all of northwestern Ontario within the currently licensed commercial forest (Fig. 1). This forest includes the Lac Seul Uplands,

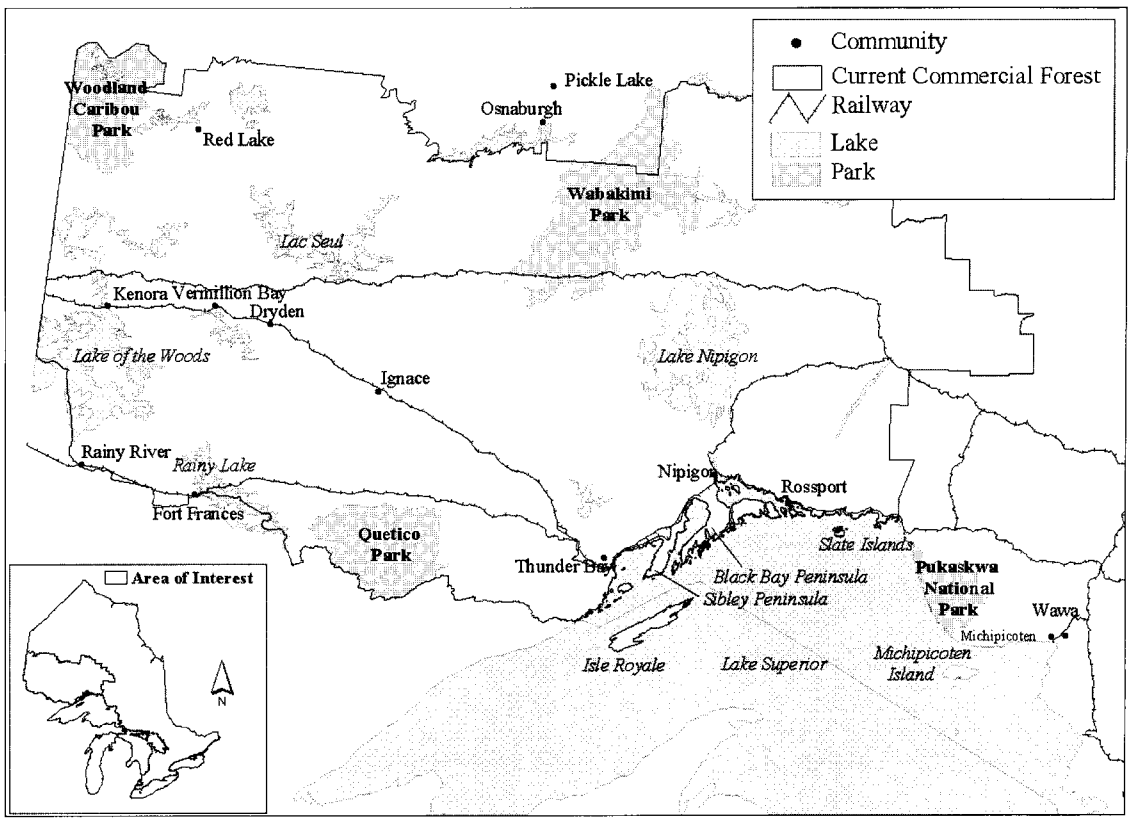

Fig. 1. Northwestern Ontario study area showing communities, major lakes, forest management units and Provincial Parks referenced in text.

Lake of the Woods, Rainy River, Thunder Bay - Quetico, Lake Nipigon and a small portion of the Big Trout Lake ecoregions of the Boreal Shield ecozone (Ecological Stratification Working Group, 1995). Woodland caribou are considered native to the entire study area. This area has had a long human development history; it was occupied by paleo-Indian cultures and later by the Ojibway and Cree peoples, followed by European exploration in the late 17th century. Development of northwestern Ontario was driven by the fur trade until the mid 19th century, and more recently by forest, mining, transportation, agriculture, tourism and recreation industries.

Current Range Occupancy

Current range occupancy was defined by reliable observations of caribou activity since 1990. Presence of caribou within cells of a 10 km UTM grid was recorded. Caribou presence data were obtained from a variety of sources including surveys of caribou winter habitat and calving sites between 1988 and 1997 (Timmermann, 1998a; b) incidental sightings during regular early winter moose (*Alces alces*) surveys (Bisset, 1991), reports to Ontario Ministry of Natural Resources (OMNR) staff from foresr workers, anglers, hunters, trappers, tourism operators and naturalists, and location data from a concurrent habitat use study (Hillary, 1998) involving 25 caribou (19 females, 6 males) fitted with Argos Satellite collars between 1995 and 1998.

Historic Range Occupancy

Historic range occupancy was determined on the basis of the most recent record of caribou presence within UTM grid cells. Evidence was obtained from archeological studies of late pre-historic and early historic (1600-1800) periods, fur trade diaries, land survey records and railway construction records. Other historical documents that made reference to observations of woodland caribou and which provided relatively specific geographical locations were also used. Old Department of Lands and Forests (pre-1972), and OMNR (post-1972) wildlife survey information and internal correspondence was used to identify and verify areas and times of previous occupancy.

Regional Habitat Map

A regional map was produced to depict the nature of seasonal habitat use within current occupied range. Significant areas of winter, summer and calving habitats currently used within the study area, and the main directions of travel between them were mapped. Data for this map were assembled from the same wide variety of sources used to map current range occupancy. Winter habitat surveys were conducted by OMNR staff in late winter (February-March) and occasionally earlier in winter. Areas of high concentrations of caribou tracks were delineated and recorded as winter habitat. Where surveys of the same areas spanned multiple years, the areas used in all years were considered in delineating winter habitat tracts (Timmermann, 1998a).

Some summer and calving habitat was identified through incidental observations from forest workers, trappers, anglers, hunters, naturalists and tourist operators. Areas with significant, observed summer use by caribou were considered summer habitat. A general area, lake, group of islands or wetland complex was considered used for calving if cows and calves were observed there during the May - June post-calving period, or if evidence (e.g. recent calf tracks) was observed in the vicinity during those same time periods. In addition, since the early 1990s, calving surveys of high potential lakes have been conducted to determine if specific lakes contain islands, peninsulas or shorelines used for calving (Timmermann, 1998b). Only a small portion of the overall caribou range has been surveyed for calving areas. Aerial monitoring of caribou and caribou tracks during the fall and spring, combined with recorded movements of 25 radio-collared caribou were also used to delineate habitats and some major travel routes between habitats.

Chronology of Caribou Decline

A general description of the chronology and circumsrances surrounding the decline of caribou in northwestern Ontario was generated after reviewing available data and records from a wide array of common and obscure sources, and examining circumstances and data associated with five geographic case studies. Substantial interpretation was required to understand some historical written accounts with vague references to general locations. Some parts of the study area had no historical information on caribou.

Results

Range Occupancy

The plotting of current (1990-1997) records of woodland caribou occurrence revealed that caribou

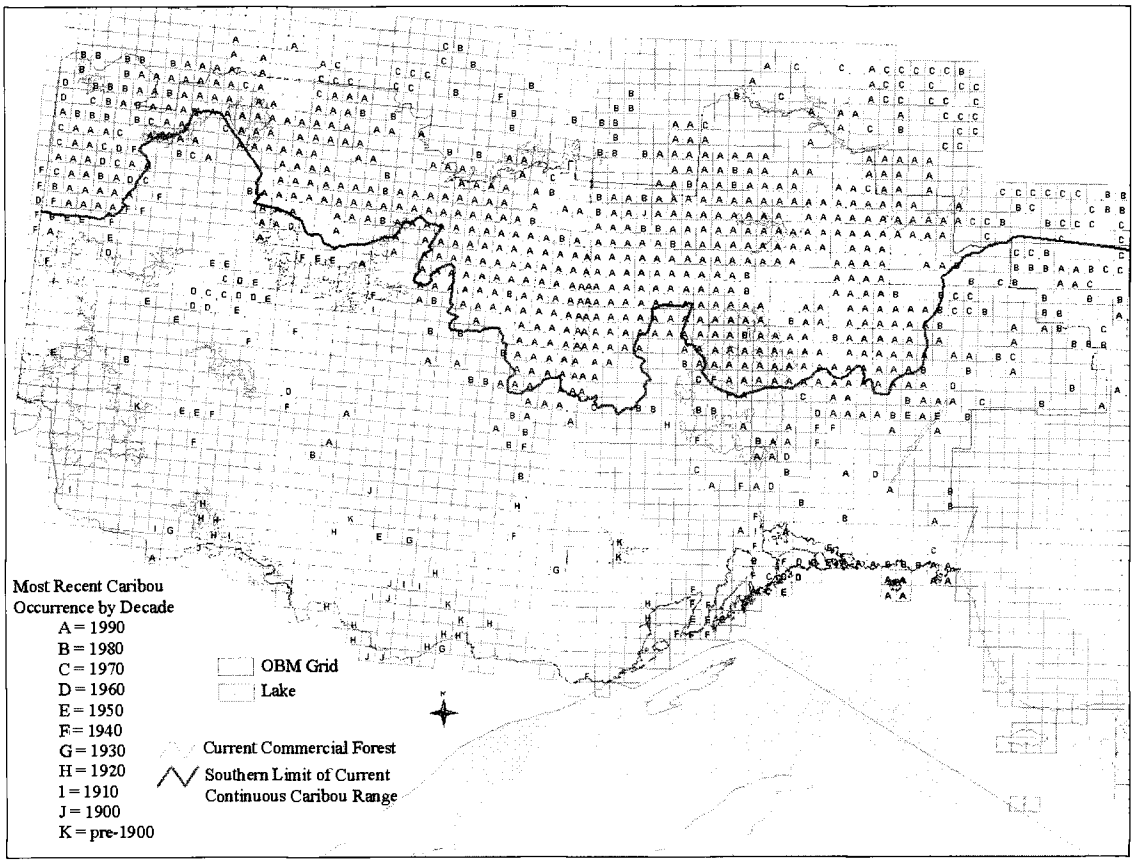

Fig. 2. Woodland caribou range occupancy map identifying locations of most recent caribou observations by decade. The southern boundary of the zone of continuous distribution and woodland caribou range occupancy map identifying locations of most recent caribou observations by decade. Observations are recorded on 10 km UTM grid.

distribution is essentially continuous across northwestern Ontario (Fig. 2). From these data, a southern limit of continuous caribou distribution could be distinguished and delineated. Isolated populations south of this area exist on some of the islands and adjacent shore of Lake Superior. The majority of the recent inventory work has been focused on areas near the southern range limit, and within the commercial forest. The lack of recent data near the northern boundary of rhe study area reflects less complete caribou inventory effort.

Regional Recession in Caribou Range

Plotting the decade of most recent caribou occurrence revealed the extent of caribou range recession over the past century (Fig. 2). While historical data were sparse, a pattern is evident. Several discrete clusters of caribou habitat spanned the southern edge of the study area, just north of the Canada-USA border, at sometime in the period between the early 1900s and the 1920-30s. Historical records show that for the same period of time, many of the areas with no evidence of use were heavily disturbed by fire, human development and logging. Caribou persisted along the shoreline of western Lake Superior until the 1950s, and until the 1970s in the Black Bay area. More recent occurrences in the 1940s, 1950s and 1960s were scattered across the region midway between the Canada-USA border and the current southern range limit. A significant cluster of activity south of the current range limit persisted into the 1970s, and occasional recent sightings are scattered immediately south of the range limit in several areas particularly in the eastern portions of the study area. The following case histories represent data describing the context for occupancy and eventual decline of caribou in these southern habitats.

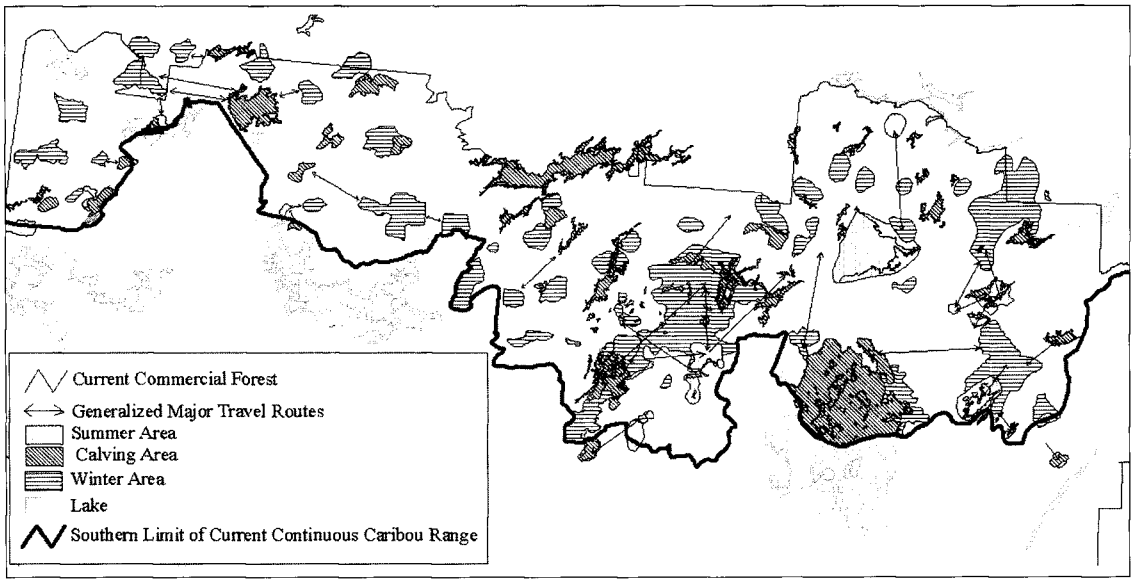

Fig. 3. Coarse mapping of woodland caribou winter habitat utilization and major calving areas for the current commercial forest of northwestern Ontario.

Regional Habitat Map

Regionally significant caribou seasonal habitats are spaced relatively evenly across the northern landscape (Fig. 3). Calving areas are generally widely dispersed, with some considered of greater value from a strategic perspective. The pattern of habitat use suggests concentrated caribou activity within the broader fabric of the continuous range distribution shown in Fig. 2. The absence of large gaps between used habitats combined with the relatively continuous nature of range occupancy does not suggest the presence of discrete herds.

Case History 1: (1830s Ungulate Drought)

Caribou populations appeared to reach a temporary low point during the early 1820s to 1840s. The decline seemed to be widespread, but no obvious explanation for the synchronous widespread ungulate "drought" is evident. This occurred before the advent of large-scale forest harvesting, railway construction, or development of agriculture in the region. Fritz and Suffling (1993) attributed low caribou and moose populations and harvests in the vicinity of Osnaburgh House from 1820 to 1860 to large-scale wildfire activity that created a burned area of approximately 250 km in length. This rarity of ungulates was also documented in the vicinity of Forr William and the west end of Lake Superior (Haldane, 1824), and the scarcity of caribou in the Kaministiquia River valley was corroborated by Murray (1849). Cochrane (1996) identified several references to low abundance of caribou between Fort William and Lake of the Woods in 1822, Mille Lac in 1824, and between Fort William and Fond du Lac in 1831. Lytwyn (1986) suggested over-hunting was a factor in caribou declines as early as the late 1700s.

These references support the understanding that caribou were an important part of the northwestern Ontario fauna in the early 1800s, an important food for native peoples, used in trade, yet inexplicably uncommon during that period. They also suggest that factors other than logging may influence decline of ungulates across broad areas.

Case History 2: (Lake of the Woods - Northwestern Minnesota)

Caribou once occupied mosr of the landscape surrounding Lake of the Woods when De Noyen became the first white man to visit in 1688 (Mead, 1981). This area was relatively unique in that by 1890 it appears to have supported four ungulate species: white-tailed deer (*Odocoileus virginianus*), moose, caribou and elk (*Cervus canadensis*), and all four were used by natives and Europeans as food and even a trophy hunt (Brown, 1890-1893). Sawmilling industries started to increase pressure on forest resources, especially pine ecosystems, after 1879 and harvesting further increased following the development of pulp mills in Fort Frances in 1914

and Kenora in 1922 (Mead, 1981). Archaeological data from the Hudson's Bay Company Whitefish Bay Post shows that caribou were consistently used as food until 1895, when white-tailed deer became the primary ungulate used (Pers. comm. P. Reid, Regional Archeologist, Kenora) This shift in use coincides with the increase in logging activity and a probable improvement in habitat quality for white-tailed deer. By 1927 most forest area surveyed east of Lake of the Woods had been cut over or burned (Phillips & Benner, 1926; van Nostrand, 1927). Large amounts of burned area were also common in the vicinity of Rainy River in the mid to late 1890s (Niven 1890; 1892; 1894; 1895).

In Minnesota and Southwestern Manitoba, caribou declined more slowly. These areas contain vast bog and fen complexes which may have provided refuge from predators and hunting pressure, as well as providing habitat that was not in industrial demand. Beginning in 1932, major efforts were made ro preserve caribou in northern Minnesota, including establishment of the Red Lake Game Preserve, resettlement of homesteaders, blocking of drainage ditches, introduction of beaver (*Castor canadensis*), wolf (*Canis lupus*) control, inrensified enforcement, and the blasting of wallows (Berg 1992). Nevertheless, Fashingbauer (1965) noted that by 1937 the last native band of woodland caribou consisted of three cows occupying rhe muskeg area known as the "Big Bog" between upper Red Lake and Lake of the Woods. Manweiler (1939; 1941) noted that agricultural development along Rainy River isolated this population, and interrupted their traditional migratory route between calving islands in northwestern Ontario and winter habirat in norrhwestern Minnesota. Caribou reintroduction efforts begun in 1938 failed ro produce a viable self-sustaining population (Bergerud & Mercer, 1989).

Very rare sightings of individual caribou or small groups persisted east of Lake of the Woods until 1961 (internal OMNR correspondence, 1961). These observations were later attributed to movement of animals from farther north. Caribou populations persisted northeast of Lake of the Woods (Cliff and Clay Lake) until 1977 and north of Lake of the Woods until the present (Umphreville Lake) (OMNR data).

The decline of caribou in the vicinity of Lake of the Woods is consistent with cumulative impacts of hunting pressure, habitat alteration by fire and logging, isolation from contiguous range, range expansion by white-tailed deer with increased exposure to the parasitic brainworm *Parelaphostrongylus tenuis,* and increased predation (caribou were protected in Minnesota and Ontario when the final decline and disappearance occurred).

Case history 3: Boundary Waters - Quetico

Woodland caribou resided in the vicinity of the current Quetico Provincial Park and rhe Minnesota Boundary Waters Canoe Area until approximately 1930. Sewell (1888) noted that much of the area east of the present Quetico boundary was burned over in a great fire, but that caribou were still abundant west of Bitchu Lake. Likewise large fires were also prevalent to the west, in the vicinity of Rainy Lake (Niven 1892; 1895). The northern portion of Quetico was one of the major east-west canoe and trade routes prior to construction of the Canadian Pacific Railway (CPR) in the 1870s. Logging for white (*Pinus strobus*) and red pine (*P. resinosa*) and other sawlogs became big business in rhe area that became rhe park in 1908, and continued along most of the waterways beyond the 1930s . Large fires also altered the habitat in 1910, 1917, and 1929. Hunting was active throughout the country until 1929 as caribou slowly diminished.

Woodland caribou sightings between 1900 and 1930 became less and less common as the cumulative impact of habitat alteration, hunting and changing wildlife composition became more apparent. The fires of 1929 and 1930 seemed to be followed by an influx of white-tailed deer (Pers. comm. B. Soini & A. Primeau); deer range expansion was widespread across northwestern Ontario at rhat time.

It appears as if the caribou in the vicinity of Quetico Park became isolated from continuous range as early as 1900 due to wildfire, construction of the railway and hunting along access corridors associated with canoe routes and the railways. Once it became isolated, it was only a matter of time until the population declined as a result of continued hunting from settlers, travelers, and commercial hunters supplying the logging camps. Habitat loss resulting from further fires and logging, the influx of white-tailed deer and the associated risk of brain worm and predators eliminated caribou from this area around 1930.

Case History 4: (North Shore of Superior)

On the north shore of Lake Superior, hunting pressure was heavy as early as the late 1700s (Lytwyn,

1986). Cochrane (1996) describes the decline of caribou on Isle Royale, and the shores of Lake Superior. These researchers also document traditional use of woodland caribou by natives, use by settlers, miners and loggers, and the continued existence of caribou on the north shore of Lake Superior into the 1890s. At that time the tourist trade across the north shore (*e.g.* Pays Plat, Nipigon, Port Arthur) was becoming big business, and caribou were widely advertised in travel brochures as a game species and a general attraction. The north shore CPR Line provided economical access to opportunities for resource development, tourism and settlement.

By 1919 logging operations began on the Sibley Peninsula, leading to an increase in the occurrence of white-tailed deer. A 1924 land grant to settlers at Pass Lake created habitat disturbance at the north end of the Peninsula, severing any landscape connection with the northern mainland. Similar harvesting and land settlement was occurring in the viciniry of Nipigon. By the 1930s caribou were still noted as an attraction for rourists, although hunting for caribou was not allowed. By 1950 deer and moose were common across the Sibley Peninsula, Black Bay Peninsula and St Ignace Island. Occasional sightings of caribou occurred on the Black Bay Peninsula, the islands off Rossporr, the mainland between Rossport and Wawa and the isolated population on the Slate Islands. At this time caribou also occurred east of Long Lake and along the eastern shores of Lake Nipigon, although population size is poorly documented. By 1972, caribou were more or less resrricted to a remnant population on the Slate Islands and a 1.5 km wide strip of land along the Lake Superior shoreline of Pukaskwa National Park (Bergerud, 1989), although infrequent observations inland continued. Habitat disturbance and access east of Long Lake and north of Terrace Bay, and the lack of consistent caribou observations in that area during the last 20 years has led to the conclusion that the caribou on the north shore are now an "isolated" population.

Case History 5: Cliff Lake

The decline of caribou ar Cliff and Clay Lake is rhe latest and probably best documented of range recession events (Brousseau, 1979). This area was home ro an observed 36 caribou during the winter of 1966-67, when recommendations were made to conserve and maintain a natural habitat for this species (Hansson, 1967). At that time, the area inhabited by caribou was largely undisturbed by roads and logging. Wolf hunting was a widespread practice at that time, with 254 gray wolves bountied in Department of Lands and Forests Kenora District during 1968 (OMNR file data). Some poaching occurred - two hunters were convicted of illegally killing a caribou from this herd in October of 1967 (OMNR file data).

Correspondence from local offices identified the value of the commercial timber under existing license and questioned; "are the aesthetic and scientific values sufficient to protect and save them and their range?" (internal OMNR correspondence). The corporate response was that any remnant herd was valuable, public attitudes toward non-game were shifting, and staff should examine alternate areas where equally good timber could be obtained (internal OMNR correspondence). Planning took place between 1967 and 1969, access development and logging began in 1970 and continued until 1982. The caribou population in the survey area declined from 32 in 1972 to 12 in 1978 (Brousseau, 1979). Although some caribou continued to use rocky jack pine-dominated ridges neighboring rhe study area these animals also soon disappeared. Apparent increases in white-tailed deer, wolf activity and human activity all coincided with the decline of caribou. Caribou activity located west of the Cliff Lake study area also disappeared during the same time frame as the decline within the Cliff Lake study area (Pers. comm. D. Anderson, OMNR).

Discussion

Caribou Range Occupancy

The zone of continuous distribution of caribou in northwestern Ontario (Fig. 2) is supported by discrete seasonal habitats distributed across that zone (Fig. 3). Most of these seasonal habitats are associated with large tracts of older forest embedded in a landscape disturbed by fire and logging. This concept is an important principle upon which the northwestern Ontario caribou habitat management strategy (Racey *et al.*, 1991; OMNR, 1999) is based. It implies the need for a landscape-level habitat management strategy predicated upon a dynamic, shifting mosaic; this concept is substantially different from defining and managing discrete herds or protecting only currently used habitat tracts. Caribou habitats within the zone of continuous distribution are dependent in part on land capability and in part on current suitability. Many of these

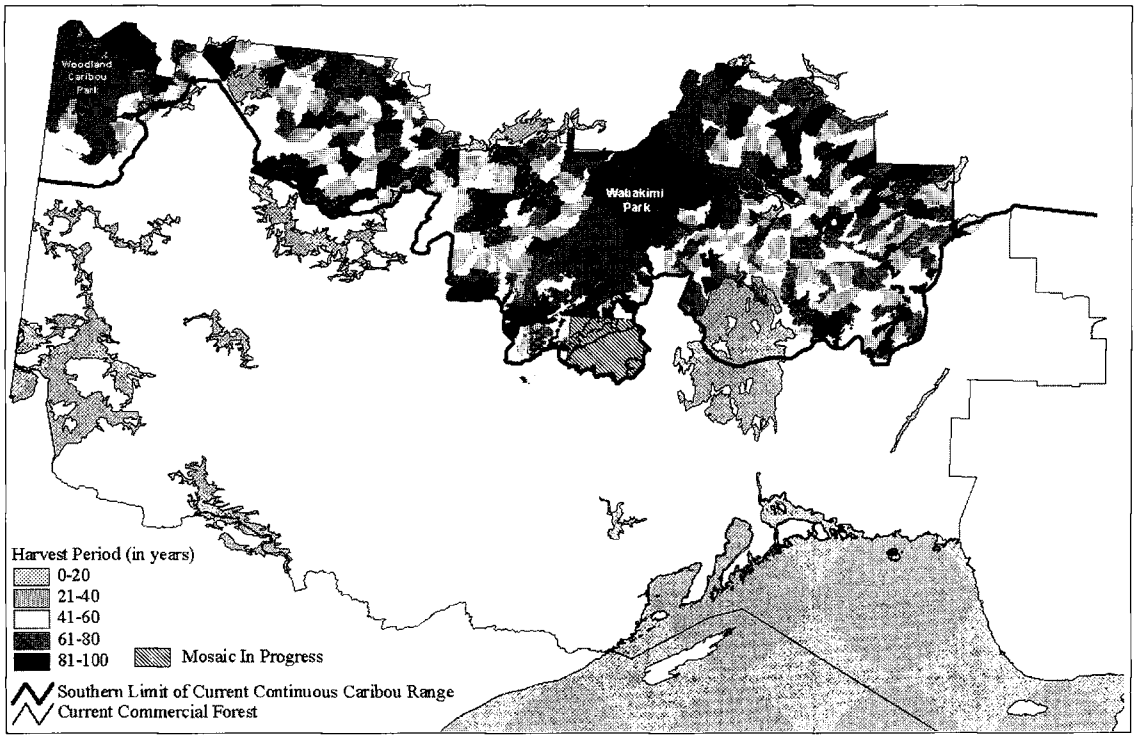

Fig. 4. Existing caribou habitat management mosaic for northwestern Ontario identifying the large tracts of forest that will be retained or allocated at various times to provide for a continuous supply of caribou winter and year round habitat (OMNR 1998).

used habitats may persist for a period of time until a disturbance takes place, at which time other habitats will need to be available. There is a strong resemblance between the natural habitat mosaic created primarily by wildfire (Fig. 3) and the mosaic planning process (Fig. 4) (OMNR, 1999), which is intended to provide guidance for the sequencing and spacing of large harvest blocks in order to ensure future habitat supply and availability in a managed landscape. It is postulated that a similar relationship between continuous range and discrete high value habitats existed across northwestern Ontario in the late 19th and early 20th centuries.

Recession of Caribou Range in Northwestern Ontario.
The lessons from historical dara and case studies suggest that caribou decline had several phases. There was an inirial period of early exploitation when caribou were taken as encountered, usually for food or trade. As northwestern Ontario was developed, access, wildfire and forest harvest led to isolation and fragmentation of southern populations. These populations later became depleted due to continued habitat alteration, hunting and disease. Mechanization in forest management activities, access development and the advent of road hauling of logs opened up previously inaccessible areas leading to decline of previously isolated populations. Since 1960 a steady northward progression of timber harvest has led to a more systematic recession of caribou range. The majority of early range recession was apparently not "gradual". This recession involved a series of "collapses" of relatively isolated populations, and not a gradual recession as could be inferred by maps of range recession (e.g. Darby *et al.*, 1989).

Caribou hunting by both natives and Europeans was a fact across northwestern Ontario throughout the 1800s, and when caribou were in low abundance in the 1820s to 1840s severe hardship was encountered by residents.

Fragmentation and alteration of habitat was assisted as early as 1855 by development of the Sault Ste Marie locks. This permitted development of a widespread, export-based sawmill industry and led, in part, to the development of the railroad from

Thunder Bay through Dryden to Kenora in the late 1870s (Bray & Epp, 1984). By 1880, sawmilling activity was abundant in the vicinity of Thunder Bay, Fort Frances, Kenora, Dryden, and Nipigon, with much of the activity centred on waterways. Another significant factor was the burning of large areas of land west of Thunder Bay (Sewell, 1888; 1890), in the vicinity of Rainy Lake (Niven, 1890; 1892; 1894), and a large fire (140 km long) between Vermillion Bay and Ignace in 1882 (Wice, 1967). By 1900, this creared several relatively isolated groups of woodland caribou across the southern portion of northwestern Ontario. These groups were located along the north shore of Lake Superior and the Lake Superior islands including Isle Royale, in the general location of Quetico Provincial Park, and in the vicinity of Lake of the Woods and northern Minnesota.

The northwestern Ontario economy boomed from 1900-1920 with settlement and agricultural development in the vicinity of Dryden, Rainy River and Thunder Bay. It was supported primarily by the development and growth of a pulp industry rhat was much less "discriminating" on the size and species of trees used than the sawmill industry (Bray & Epp, 1984). A strong tourism industry based on rail travel distributed food and trophy hunters across the north shore of Lake Superior (Bray & Epp, 1984). It is conceivable that as early as 1920-1930 the southern boundary of the continuous distribution of caribou may not have been unlike the distribution map produced by. deVos & Peterson (1951). This map suggested that caribou existed in the areas south and west of Lac Seul (Cliff Lake area), across to Lake Nipigon, and with scattered occurrence east of Lake Nipigon to the Lake Superior shoreline and islands to Pukaskwa National Park. Although caribou existed below that line, these animals were isolated in fragmented landscape patches as discussed in case studies 2 and 3. Habitat alteration due to timber harvest was occurring along most water-accessible areas, hunting was still widespread, and human-caused and natural fire continued to play a significant role in depleting mature forest areas. In the 1920s white-tailed deer range was expanding along with a presumed increase in predators in the Lake of the Woods area (Voigt *et al.*, 1992). Brainworm associated with white-tailed deer may have been a contributing factor to widespread decline. By 1929, when the hunting season for caribou was closed, the caribou in the southerly part of the study area may already have been doomed due to the cumulative direct and indirect impacts of human activity, with the exception of the animals along rhe north shore of Lake Superior.

The 1930s-1950s brought a mining boom to many areas in northwestern Ontario, and roads followed the development of mining communities. The 1950s brought forestry mechanization, automation, and road hauling and new areas that were previously remote began to be opened up to timber harvest. This was driven in large part by the need of the forest industry to have a year-round supply of wood and to avoid rhe seasonal and unreliable nature of river drives. The mainland areas north of Lake Superior, west of Lake Nipigon and in the Cliff Lake area became vulnerable at that time, and caribou declined accordingly. In the last 20 years, a number of timber companies accessed and harvested areas that overlap the southern boundary of the current zone of continuous distribution. Harvest has been creeping northward in a relarively systematic manner until the first approximation of the northwestern Ontario caribou habitat management strategy was introduced in the early 1990s. Caribou habitat continues to be under pressure from forest management in many of the southerly portions of this zone of continuous distribution and caution is advised if caribou are to be maintained (Cumming, 1992). History suggests it would be undesirable to isolate and protect components of the landscape independent of a comprehensive landscape management approach.

Management Implications

No single factor identified in the case studies can be cited as the cause of decline. In all cases, the cumulative impact of early hunting, timber harvest, habitat alteration, disease, shifts in range of white tailed deer and moose, shifts in predator-prey balance, wildfire, construction of road and rail access corridors and land clearing for agriculture, have contributed to the decline of caribou in northwestern Ontario. Multiple factors appear to interact to the detriment of woodland caribou, stemming primarily from the access and exploitation of natural resources. Clearly, thoughtful resource management strategies that consider broad landscape impacts are required to halt the decline of caribou, particularly for the forest-dwelling ecotype. The lessons from the case studies do not support a caribou management approach focused on individually defined and geographically discrete caribou herds. Given the history of caribou range loss, managing only at the

local level could readily lead to habitat fragmentation and eventual isolation and extirpation of local populations. A holistic approach to managing forested landscapes is advocated, where all aspects of forest health are addressed: forest structure (size of disturbances and habitat tracts and how they are distributed on the landscape), forest composition (age class structure, tree species representation, and stand composition) and ecosystem function (predator-prey relationships, habitat value, food availability, refuge *etc.*). Range occupancy may only be maintained by implementing a comprehensive ecosystem-based approach that modifies social and economic needs to operate within the bounds of maintaining boreal forest health.

This historical review of caribou range recession demonstrates the value of range occupancy data for tracking change in status of woodland caribou. Such data are particularly valuable when population estimates are difficult to obtain and unreliable, as they are for caribou.

It is clear that a successful caribou conservation program will require consideration of both population and habitat management strategies, and managers must recognize that the two interact. Woodland caribou habitat management is a very complex issue, requiring both long-term temporal perspectives and large-scale spatial perspectives in order to address requirements for specific food, shelter and movement habitats, as well as habitats that provide a high probability of avoiding predators. Our information on biological requirements and limitations is incomplete and examination of historical information allows us ro better undersrand the current status of caribou, and to make future projections. However, habitat should not be managed without considering the implications for populations. Population dynamics are an important consideration in caribou survival, given the sensitive balance between predator and prey numbers (Bergerud, 1985; Seip, 1992; Thomas, 1992). Hunting and subsistence use were probably significant factors in at leasr some of the early extirpations and range recessions of caribou, and the impact of changing incidence of predators and disease cannot be under-estimated.

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