THE UNIVERSITY OF MANITOBA

SEASONAL MOVEMENTS, HABITAT UTILIZATION, AND POPULATION ECOLOGY OF WOODLAND CARIBOU (*RANGIFER TARANDUS CARIBOU* GMELIN) IN THE WALLACE-AIKENS LAKE REGION OF SOUTHEASTERN MANITOBA

by

WILLIAM RICHARD DARBY

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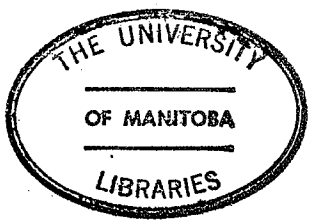

ABSTRACT

The ecology of 30 to 40 woodland caribou was studied in the Wallace-Aikens lakes region of southeastern Manitoba, from March 1975 to April 1977. Caribou activity was monitored by aerial and ground survey during months of snowcover and by ground investigations during snow-free periods. Seasonal ranges were largely overlapping, and the same central range was used during all seasons. Mean range size varied in different seasons as follows: spring 177.5 km^2, summer 130 km^2 (minimum), autumn 115 km^2, and winter 117.5 km^2. Logistic problems associated with the dense coniferous forest hampered the delineation of range size in summer. Hence, it is estimated that the summer range could have been as large as 530 km^2.

In general, the amount of range occupied varied inversely with amount of gregarious behaviour. Mean band size was 3.8 in spring, 1.1 in summer, 6.2 in autumn, and 5.5 in winter. Caribou became restless in late March, dispersed in April and early May, and were essentially solitary in summer. By October, caribou were reaggregated.

Habitat utilization and movements of caribou appeared to be governed by food preference and availability, nival conditions, predators, and insects. The winter range coincided with an area of mature jackpine-spruce forest and open bogs sandwiched between two

large stands of immature jackpine and mixedwood. In summer when a wide variety of food items was available, some caribou moved into surrounding habitats. In general, little use was made of less common spruce-fir-birch and black spruce-feathermoss associations.

The December calf crop was 12.5% in 1975 and 20% in 1976. Food supply did not appear to be a limiting factor to growth of the herd during two mild winters. Two incidents of wolf predation on caribou were confirmed; more probably occurred but were not detected.

At least 76.5% of cows in the study herd were antlerless, whereas most cows in surrounding herds were reported to be antlered. This suggests limited gene flow between the study herd and other herds adjacent to it.

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1. INTRODUCTION

Most of the general public has some knowledge of migratory barren-ground caribou (*Rangifer tarandus groenlandicus* L.), but few people realize that a larger counterpart, the woodland caribou (*R. t. caribou* Gmelin), exists in southern Canada. At present, the latter's range includes Newfoundland and most undeveloped areas of the boreal coniferous forest. Prior to European settlement, it included parts of the northern United States, but since 1750, the southern limit of distribution has receded steadily.

In the past, representatives of the genus *Rangifer* were divided into many species and subspecies by several classification schemes. Banfield (1961) consolidated all races into one species (*Rangifer tarandus*) with five extant subspecies in North America: woodland caribou (*R. t. caribou* Gmelin), Grant's caribou (*R. t. granti* Allen) of the Yukon Territory and Alaska, barren-ground caribou (*R. t. groenlandicus* L.) of northern Canada, Peary's caribou (*R. t. pearyi* Allen) of the Canadian Arctic Archipelago, and domestic reindeer (*R. t. tarandus* L.) of the Tuktoyaktuk Peninsula, Northwest Territories. However, consolidation of the genus by Banfield (1961) did not obviate the fact that many differences in behaviour still exist among the incorporated races, including those within the *R. t. caribou* subspecies

(*cf.* Shoesmith 1978).

Investigations of woodland caribou in closed forest habitat are exceedingly difficult, and little information exists on their ecology. Often, extrapolations cannot be made from the existing literature.

Reasons for the shrinking distribution and decline of woodland caribou are controversial. Nonetheless, widespread development of caribou habitat has always been attended by disappearance of the subspecies. Woodland caribou constitute a valuable resource for tourism, recreation, and the economy of native people. If mismanaged, the resource will disappear.

Baseline data on woodland caribou in developing areas of Manitoba are needed. Information on the ecology of local populations would be valuable in making management decisions. This study was initiated to obtain data on caribou in the Wallace-Aikens lakes area of southeastern Manitoba. For purposes of convenience, the caribou in this area will be referred to as the Aikens Lake herd.

The major objectives were: (1) to gather information on seasonal movements, distribution, and herd behaviour; and (2) to collect data on herd size, reproduction, mortality, and other aspects of population ecology. A minor objective was to examine aspects of habitat utilization.

2. LITERATURE REVIEW

2.1 Historical Decline

2.1.1 Summary of the Decline

From 1750 to 1950, woodland caribou populations across North America underwent a major decline in numbers, and the southern limit of distribution receded substantially.

Cringan (1956) presented a rigorous review of literature concerning the decline of eastern woodland caribou (*Rangifer tarandus caribou* Gmelin) and western woodland caribou (*R. t. sylvestris* Richardson). He followed the now outdated classification of Ellerman and Morrison-Scott (1951) and Miller and Kellogg (1955). Banfield (1961) presented a continental picture of past and present distribution of the consolidated subspecies *Rangifer tarandus caribou* (Gmelin) when he revised the genus. I will present a brief summary of the decline, concentrating on past and present distribution in northwestern Ontario and Manitoba.

In Newfoundland woodland caribou probably attained peak numbers in the early 1900's. They declined thereafter to a nadir of 1,000 to 2,000 around 1930 (Bergerud 1971). Since then, they have increased to approximately 8,900 by 1966 (Bergerud 1971).

In the Maritimes, caribou disappeared from Nova Scotia by 1924 (Cringan 1957), from New Brunswick by 1927 (Morris 1948), and from Prince Edward Island by 1873 (Cringan 1956). Reintroductions were attempted in Nova Scotia in 1939 (Tufts 1939) and 1968-1969 (Dauphiné 1975), but they failed.

The last sighting of indigenous caribou in the northeastern United States occurred in northern Maine in 1946 (Palmer 1949). However, they had essentially been extirpated from that state by 1916 (Cringan 1956). Dauphiné (1975) refers to Dunn (1965) concerning 24 caribou that were reintroduced to central Maine; they apparently dispersed and disappeared after release.

In the Gaspé Peninsula, Quebec, a relic population still exists in the Shickshock Mountains (Moisan 1958; and Banfield 1974). In northern parts of the province, numbers were lowest during the period 1954-1956 (Banfield and Tener 1958). The centre of abundance is presently near the Quebec-Labrador border (Juniper 1977). Recently, herds in the Ungava have been increasing. Juniper (1977) reported that, in 1973, the George River herd contained over 150,000 animals, the Caniapiscau herd contained approximately 2,500, and the Waco Sector herd about 8,000. He did not give a population estimate for the Leaf River herd.

In Ontario deVos and Peterson (1951) described the regression of range from the Lake Nipissing and Rainy River areas. Cringan (1957:488) described the recent distribution:

> "Woodland caribou currently occur right across northern Ontario, in the west, south to a line from Minaki to Savant Lake to the Black Bay Peninsula of Lake Superior, and in the east, south to a line from Puskaskwa on Lake Superior to Swastika."

DeVos and Peterson (1951) stated that caribou were last seen in the Fort Frances forest district about 1930.

The information of deVos and Peterson (1951) indicates that a nadir of numbers in Ontario may have occurred after 1930. They estimated the total population to be 1,300 to 3,000 in 1948-1949 and indicated that it was expanding. Subsequent estimates of 7,200 by Cringan (1957) and 12,600 by Simkin (1965) may only reflect better census techniques, but they are encouraging.

Woodland caribou disappeared from mainland Michigan and Wisconsin by 1905 (Cringan 1956). Caribou were seen on Isle Royale in 1911, but they were gone by 1926 (Simkin 1965). In Minnesota they remained in the Red Lake Wildlife Refuge until about 1940 when the last one was found crippled and dying (Banfield 1961). In 1942, 15 to 20 caribou were reintroduced in Minnesota (Swanson *et al.* 1945 *in* Banfield 1961). The animals were not observed after 1943 despite an aerial survey in March 1946 (Nelson 1947).

In the past, woodland caribou were known to occupy southeastern, eastern, and northern Manitoba, north to the Churchill, Nelson, and Hayes rivers (Seton 1909; and Banfield 1961). Soper (1961:45) reported:

> "In early times it doubtless inhabited the heights of both Duck and Riding Mountains, since, in this longitude, woodland caribou once occurred even as far south as Turtle Mountain (Bailey, 1926, p. 33)."

In regard to the latter, Banfield (1961:74) said:

> "There are records of woodland caribou antlers found in the Turtle Mountains, North Dakota, but it is difficult to know whether they indicated recent or prehistoric occupation of the area (Bailey, 1926, and Riis, 1938)."

In 1949 approximately 40 caribou were present in the Whiteshell Forest Reserve, and 17 occupied the Sandilands Forest Reserve (G. W. Malaher, pers. comm. *in* Banfield 1949). Since then they have ceased to inhabit the area south of the Oiseau River that empties into Lac du Bonnet. Caribou still occur in northwestern Manitoba as far south as Red Deer Lake and Long Point on Lake Winnipeg (Wardley 1973). G. W. Malaher (pers. comm. *in* Cringan 1957) reported that, after reaching a low point between 1930 and 1950, the provincial population increased and might number 4,000 or more. Soper (1961:45) wrote:

> "The largest known herd is northeast of Berens River, in the Hudwin Lake district, which is estimated to contain between 4,000 and 5,000 individuals."

This statement seems to overestimate the number of caribou in that area. Larche (pers. comm.) listed eight herds of woodland caribou east of Lake Winnipeg south of the Poplar River. The total estimate for all eight was 360 animals. Larger herds are known to occur in the northern region. Larche (1972) reported herds of 150 to 300 south of Cape Churchill and along Grassy River. However, he indicated that little information was available on most herds in the province. Mr. George Stevens (pers. comm.), a pilot with Ontario Helicopters Ltd., informed me that in October 1973 he observed 1,000 to 2,000 woodland caribou in

the large open bogs between Kiskitto Lake and Kiskittogisu Lake, northwest of Norway House (Mr. Stevens has flown barren-ground caribou surveys in the Northwest Territories).

In the other prairie provinces, present distribution seems to have changed only slightly from that in the past (Banfield 1949, 1961). Woodland caribou once occupied the upper Peace River, but Banfield (1961) showed the present range to be broken in that area. There is little information on which to review population trends in Saskatchewan, Alberta, or north of 60^{o} latitude.

Banfield (1961) reported that the present caribou range in British Columbia is broken in the region of Williston Lake and the upper Peace River Valley. Caribou still occur in northern parts of the province and in the Rocky, Selkirk and Monashee mountains south to the International Boundary. They are also found as far west as the eastern slopes of the Coast Range (Banfield 1961). While population data are available for certain herds (Edwards 1954, 1956; and Freddy 1979), I am not aware of any literature containing a provincial estimate, other than a "guess" of 5,000 by Banfield (1961).

Evans (1964) summarized past records of caribou distribution in the northwestern United States. Banfield (1949) referred to them as being present in Glacier National Park, Montana. Since 1900 caribou have been limited to areas near the International Border, although sightings further south were reported as late as 1959 and 1960 near Thompson Falls and Blackfoot River, Montana, respectively (Evans 1964). By 1972 the distribution was limited to the Selkirk Mountains of northwestern Idaho and northeastern Washington (Freddy and Erickson

1975). Freddy (1979:71) wrote:

> "Populations in northwestern Montana and other portions of northern Idaho have apparently been severely reduced in number or extirpated (Evans 1960)."

Freddy (1979) reported the Selkirk Mountain population on the International Border to number 25 to 30 during the period 1972-1974.

2.1.2 Reasons for the Decline

Several reasons have been postulated for the decline of woodland caribou following settlement by Europeans.

The possibility of emigration from the Maritimes and New England to the Gaspé Peninsula (Palmer 1938; and Riis 1938) was refuted by Moisan (1958) on the basis that populations in the Gaspé declined at the time of the supposed influx of caribou. Emigration was also blamed for declines in Quebec and Ontario, but for all cases Cringan (1957:489) concluded that:

> "Since confirming reports of immigration into neighboring areas are lacking, and increasing moose and deer populations were usually associated with such declines, it seems likely that in these cases caribou decreased because of changes in ecological conditions rather than as a result of emigration."

Increased hunting, sometimes coupled with increased natural predation, has been postulated by several authors. Bergerud (1971) attributed the decline of Newfoundland caribou to increased predation of calves by lynx (*Lynx lynx subsolanus* Bangs, referred to as *Lynx canadensis* Kerr *in* Bergerud 1971) and a heavy annual harvest of 6,000

to 8,000 adults by hunters. Excessive hunting was blamed as a major cause of decline in Ungava (Elton 1942; Banfield and Tener 1958; and Bergerud 1967). It was listed as a contributing cause in Nova Scotia (Anderson 1939 *in* Cringan 1956), New England (Blake 1926 *in* Cringan 1956), the Gaspé Peninsula (Moisan 1958), Ontario (Cringan 1956, 1957), Minnesota (Heinselman 1973), and the northwestern United States (Evans 1964). Certainly, as Cringan (1957:489) points out:

> "The gregarious instincts, nomadism and low reproductive potential of the form render it very vulnerable to overexploitation."

In many areas of original woodland caribou range, wolves were very scarce or absent (Banfield 1949; Moisan 1958; and Cringan 1956). Cringan (1956:160) stated:

> "In the Lake States and Ontario significant numbers of timber wolves first invaded caribou country when white-tailed deer extended their range north subsequent to 1860."

Wolf densities increased in Ontario (Simkin 1965) and British Columbia (Banfield 1949; and Edwards 1954) following the destruction of climax forest and an influx of deer (*Odocoileus* spp.) and moose (*Alces alces andersoni* Peterson). Simkin (1965) felt that the higher populations of wolves supported by moose and deer in peripheral caribou range of Ontario might have an adverse effect on caribou populations.

The destruction of climax forest due to lumbering, settlement and a concomitant increase in forest fires has usually been associated with local declines and regarded as a major cause of them (Fernow 1912 *in* Cringan 1957; Palmer 1938; Edwards 1954; Cringan 1957; Moisan 1958; and

Evans 1964). In most parts of the continental range these environmental changes were always attended by an influx of white-tailed deer or moose or both (Palmer 1938; Riis 1938 *in* Cringan 1956; Edwards 1954; and Cringan 1957). Intergeneric competition with these species was suggested in the past, but Cringan (1957) felt that it would likely be unimportant because of ecological segregation.

Bergerud (1974a) discussed four hypotheses for the decline of all subspecies of caribou in North America in the 1800's and early 1900's: (1) destruction of lichen pastures by fire and logging, (2) increased mortality from hunting and natural predation, (3) a combination of hypotheses 1 and 2, and (4) decline in Alaska because of emigration to marginal habitats during times of high density. He supported hypothesis 2 (1974a:757):

> ". . . that numbers declined because of increased hunting mortality and natural predation of some herds, and argues that the range-destruction hypothesis has not been shown to be either a necessary or sufficient cause to explain the decline."

With respect to woodland caribou, his arguments were stimulating, but I believe that their impact was eroded by his attempt to prove that one omnipotent factor was responsible and all others should be excluded. In general, hunting mortality and natural predation probably comprised the major factor involved in many areas. However, there are several examples of local situations where declines do not seem to be related to this factor alone, or perhaps at all.

Cringan (1956) reviewed the case of Laurentide Provincial Park, Quebec. In 1895 the park was established for the purpose of protecting

an estimated 10,000 caribou in the area. Caribou almost disappeared from 1910 to 1920, and they never came back in number. Cringan (1956:69) stated that because hunting was prohibited and most of the decline occurred within six months:

> "Hunting and wolves are ruled out. Since populations in surrounding areas declined at the same time, emigration is unlikely. Losses from malnutrition, changes in the range, an epizootic or an extrinsic climatic factor remain as logical explanations. . . . Caribou disappeared from the St. Maurice valley in 1914 . . . Extensive forest fires preceded this disappearance, and moose and deer moved in soon after."

The St. Maurice valley is immediately west of Laurentide Provincial Park.

In the Gaspé Peninsula, where wolves have never been known to exist (Moisan 1958), a combination of factors seemed to be associated with the decline. Moisan (1958) stated that heavy hunting occurred between 1900 and 1915 after which logging operations and appalling forest fires forced caribou to retreat to the central mountains. In addition, a mysterious epizootic also reduced the population. Moisan (1958:10) wrote:

> "Vers 1930, il en restait très peu, et cette baisse subite aurait été causée en partie par une épidémie qui aurait fauché le caribou entre 1920 et 1928. M. Steven McWhirter, un vieux guide et chasseur de New Richmond raconte avoir découvert, à plusieurs reprises pendant cette période, six ou sept individus en groupe, morts et gelés dans la neige. Un guide de Sainte-Anne des Monts nous a rapporté la même chose."

In British Columbia, Edwards (1956) found fluctuations of ungulate populations, including caribou, to be correlated with periods of deep

snow. His data for caribou are not complete but are suggestive. He cited the example of Wells Gray Park (Edwards 1954) where a major forest fire in 1926 destroyed 60 to 70% of the mature winter range and was followed by decline of mountain caribou by 1935. Edwards (1956:166) stated:

> "It may be more than coincidence that the decline occurred in deep snow years. While range reduction by fire was probably a major cause of the decline, deep snows may have brought the full impact of range reduction into operation."

Much of Bergerud's (1974a) argument against the "destruction of lichen range hypothesis" is based upon the fact that caribou do not require lichens *if* other foods are available (Murie 1935; Skoog 1968; and Bergerud 1972). However, in some situations, nival conditions may limit accessibility to other foods.

In addition, Edwards (1954:521) commented on causes of the decline in British Columbia as follows:

> "Many causes have been suggested for this decline, the most frequently heard being wolves, hunters including Indians, and moose which are said to be incompatible with caribou. None of these suggestions withstands careful scrutiny. Declines have occurred in wolf-free areas. The spectacular increase of moose throughout central British Columbia since 1920 has undoubtedly reduced hunting pressure upon caribou. Finally, every story of moose-caribou incompatibility, when examined, is based upon the caribou decline being concurrent with the moose increase, and not upon observation of the two species together in the field."

Recent research has introduced a new factor into controversy over the caribou decline in eastern North America. Work by Anderson and Strelive (1968) has shown that caribou readily develop cerebrospinal

nematodiasis caused by meningeal worm (*Parelaphostrongylus tenuis* Dougherty: Metastrongyloidea) transmitted from white-tailed deer. Anderson (1971) described how a small herd of reindeer developed signs of neurologic disease after being released on deer range on an island in Georgian Bay, Ontario. Necropsies were conducted on three reindeer after seven had died within about one year. An analysis of clinical and pathologic findings indicated that they had become infected with meningeal worm harboured by molluscs.

Other cases are similar. Behrend and Witter (1968) identified *P. tenuis* in a caribou that died four months after being penned on an island in Maine with a dense deer population. Trainer (1973) reported a case of 14 woodland caribou released on a game reserve in Wisconsin with a dense deer population. Within six months all of the caribou had succumbed to infections of *P. tenuis*. Circumstantial evidence is also supportive. On Isle Royale, Lake Superior, caribou disappeared about 1925 after white-tailed deer were introduced in 1906 (Karns and Jordan 1969). Bergerud (1974a), citing Peterson (1966), stated that the area from which caribou declined in eastern Canada coincides with the present range of white-tailed deer.

Anderson (1972) suggested that the decline of woodland caribou over much of its southeastern range may have been a result of neurologic disease caused by meningeal worm transmitted from white-tailed deer. Moreover, he predicted (1972:308) that:

> ". . . it will be impossible to reintroduce woodland caribou onto range now occupied by white-tailed deer with a high prevalence of meningeal worm."

Dauphiné (1975) described the disappearance of 51 woodland caribou reintroduced to Cape Breton Highlands National Park in 1968 and 1969. During the herd's decline between 1969 and 1972, three caribou were observed with signs like those of neurologic disease. After investigating all possible reasons for the disappearance, and having confirmed the presence of *P. tenuis* in the area, Dauphiné (1975) concluded that the herd may have succumbed to infections of meningeal worm.

The evidence for neurologic disease as a factor is highly supportive considering past reports of a mysterious decline in Laurentide Provincial Park (Cringan 1956), of an epizootic in the Gaspé Peninsula (Moisan 1958), and of failed introductions in Nova Scotia (Cameron 1958 *in* Dauphiné 1975) and Minnesota (Swanson *et al.* 1945 *in* Banfield 1961; and Nelson 1947).

2.2 Social Behaviour

The behaviour of reindeer and caribou of open habitats has received much study in Eurasia (Flerov 1952; Egorov 1967; Espmark 1964a-b, 1971; Naumov and Baskin 1969; Thomson 1973, 1975; and Skogland 1974), Alaska (Lent 1965, 1966; and Skoog 1968), subarctic Canada (Banfield 1954; Harper 1955; deVos 1960; Pruitt 1960; Kelsall 1968; Miller and Broughton 1973; and Miller 1974), and Newfoundland (Bergerud 1974b-c). However, little behavioural information is available for populations inhabiting closed forest. Most references to behaviour are incidental to other studies. Pertinent literature (Simkin 1965; Egorov

1967; Freddy and Erickson 1975; Stardom 1975; and Shoesmith 1978) suggests that caribou of closed forest are much less gregarious than open habitat forms.

In North America, barren-ground caribou and Grant's caribou are highly gregarious and migratory (Skoog 1968; Surrendi and DeBock 1976; and Kelsall 1968). DeVos *et al.* (1967) reviewed field studies on the social behaviour of barren-ground and Newfoundland caribou (Banfield 1954; Harper 1955; deVos 1960; Pruitt 1960; Lent 1965; and Bergerud 1961) and other North American cervids. They concluded that allelomimetic behaviour is most strongly developed in barren-ground caribou, and that social organization, social hierarchy, and leadership are not evident. Similarly, Lent (1966) and Bergerud (1974c) felt that groups of barren-ground caribou are loosely organized and that group behaviour is characterized by social facilitation. Bergerud (1974b), however, reported a social hierarchy in Newfoundland caribou, and he (1974c) suggested the importance of learned (ontogenic) responses in migratory behaviour.

Conversely, Miller *et al.* (1975) and Miller (1974) discussed the movements of 24 radio-collared Kaminuriak caribou and concluded that barren-ground caribou are socially cohesive. Miller (1974:77) stated:

> "I suggest that (1) the primary function of postcalving aggregation is socialization; (2) the core of the wintertime cow-juvenile band is formed by a matriarchal bloodline; and (3) the basic male social unit, the bull band, maintains from year to year a distribution of breeding bulls from common stock with learned behavioural habits that will assure, under natural conditions, a self-sustaining supply of breeders on the traditional rutting areas."

Miller *et al.* (1972) had previously advanced this hypothesis. Surrendi and DeBock (1976) presumably agree with it.

Information on the behaviour of reindeer in the USSR (Naumov and Baskin 1969) and Scandinavia (Espmark 1970; Skogland 1974; and Thomson 1975) suggests that leadership does occur, and that it plays an important role in migration (*cf.* Bergerud 1974c). The presence of a dominance hierarchy is also suggested, but opinions seem to vary on the subject of social cohesion (*cf.* Espmark 1970; and Thomson 1973, 1975).

Bergerud (1974c:Table 1) showed that caribou in Newfoundland were most gregarious during the post-calving (maximum aggregation size = 250) and rutting (maximum = 176) periods and had smaller aggregations at other times of the year.

> "Females did not appear to seek seclusion at calving but simply failed to keep up with other animals when in labour and thus were frequently alone at parturition . . . This was also Lent's (1966a) and Kelsall's (1968) conclusion for barren-ground caribou." [Bergerud 1974c:554].

Bergerud (1974b) presented an excellent account of rutting behaviour in Newfoundland caribou. He concluded that rutting aggregations were not harems (*cf.* Espmark 1964a) because the same animals were seldom seen together on subsequent sightings, and herd structure was quite open (*cf.* Lent 1965). Newfoundland caribou were gregarious in winter but aggregation size did not vary with changing densities or distribution (Bergerud 1974c).

Moisan (1958) referred to rutting groups in the Gaspé Peninsula as harems, but Bergerud (1973) concluded that they were not, because there

was no fixed social attachment between individuals.

In northwestern Ontario, Simkin (1965) found caribou to be essentially solitary in summer but gregarious in winter. In Manitoba, studies on woodland caribou were conducted by Shoesmith (1978) at Reed Lake, near The Pas, and by Stardom (1975, 1977) at Wallace and Aikens lakes in the southeast. Shoesmith concluded that the basic social unit of woodland caribou was the cow-calf pair with possible association of a yearling. Social units were largely solitary in summer, and the use of seasonal ranges appeared to be habitual. Stardom (1975, 1977) studied the winter ecology of caribou. He found that in a winter of thin snowcover aggregations were smaller, and caribou herds travelled extensively; in a winter of thick snowcover groups were larger, and band movements were restricted.

2.3 Seasonal Movements and Habitat Use

The extensive migrations of barren-ground caribou and Grant's caribou have been well documented (Banfield 1954; Kelsall 1968; Parker 1972; and Surrendi and DeBock 1976). In Alaska, Skoog (1968) referred to paths of movement of Grant's caribou as migration routes, but he apparently considered seasonal movements to be nomadic shifts in distribution rather than migrations.

Kelsall (1968) felt that migrations of barren-ground caribou were characterized by "goal orientation" and were probably funnelled by topography. He stated that particular animals may change migration routes. Moreover, winter and summer ranges and migration routes may

vary annually. Miller *et al.* (1972) considered the strong affinity of caribou for specific calving grounds to suggest that migrational paths were not only traditional but also learned. The traditional use of calving grounds in subarctic Canada has been documented by Kelsall (1968) and Darby (1978), and in Alaska by Lent (1966) and Skoog (1968).

Populations of Newfoundland caribou travel from 24 to 100 km between ranges in spring and autumn (Bergerud 1974c). Bergerud prefers to call these movements migratory since some animals return to the same calving grounds, thus fulfilling Heape's (1932) definition of migration. Bergerud (1974c) also documented the consistent use of specific calving grounds. These were located in areas of open habitat. During summer caribou in eastern Newfoundland dispersed into the forest cover. In western and southern Newfoundland, tree cover was sparse, and the large post-calving herds scattered to form groups on wind-swept ridges (Bergerud 1974c). In the Sandy Lake area (central Newfoundland) and Avalon Peninsula, partial segregation of sexes occurred in summer; males used more timbered areas and females used more open habitats. The rut occurred in open bogs, sedge marshes, and subalpine dry barrens (Bergerud 1974b). In winter caribou occupied both lichen woodlands and wind-swept subalpine habitats, depending upon snow conditions (Bergerud 1974c).

The distribution and movements of woodland caribou in Ungava represent a spectrum of migratory behaviour. The large George River herd migrates distances of up to 300 km; it spends summer on the tundra and has three specific calving grounds (Juniper 1977). In winter George River caribou occupy lichen woodland, forest-tundra, and tundra

and may change habitats in response to snow conditions (Bergerud 1967). Segregation of sexes in winter is similar to that reported for barren-ground caribou (Parker 1972). Conversely, the Caniapiscau herd west of Schefferville occupies the taiga year-round, is basically sedentary, and disperses before calving. Dauphiné *et al.* (1975:7) wrote:

> ". . . cows which wintered in the immediate vicinity of Caniapiscau Lake dispersed to calve in a rectangular area roughly 80 x 130 km which extends southeasterly from Delorme Lake . . . There were no large concentrations of females similar to calving areas at Vannes Lake and near Hebron Fiord [two calving areas of the George River herd]."

Woodland caribou in Ontario may have been migratory at one time, but now they are not (Simkin 1965). Simkin stated that, in general, southern herds are small and confined in their seasonal movements whereas larger herds of the north appear to move greater distances from summer to winter range. Brokx (1965) described the caribou habitat of the Hudson Bay lowlands. Herds in the Kenora-Sioux Lookout region are not migratory, and each herd is confined to the relatively small islands of suitable habitat which remain in the large areas of early successional forest (Simkin 1965). Simkin also reported that caribou cows use islands as calving sites at Irregular Lake near the Manitoba border, southwest of Red Lake.

Evidence concerning the movements of woodland caribou in the taiga of Manitoba suggests that caribou do not migrate, but they may undergo seasonal shifts of up to 65 km (Carbyn 1968; Crichton 1974; Shoesmith 1978; and Stardom 1977). Movements of the Shamattawa-York herd south

of the Nelson River are not clearly understood at the present time, but the herd was probably migratory in the past (Parker 1972). Woodland caribou have been reported to calve on the islands of Reed Lake (Shoesmith 1978) and Sasaginnigak Lake (Carbyn 1968).

Caribou in mountainous habitat of British Columbia and Quebec undergo altitudinal "migrations" in response to snow conditions (Edwards and Ritcey 1959; and Moisan 1958). Moisan (1958) stated that Gaspé caribou spend winter on the summits of Mount Albert and Mount Jacques-Cartier. Edwards and Ritcey (1959) described a double altitudinal migration in Wells Gray Provincial Park, British Columbia. Caribou move down in late summer to avoid deep alpine snow, then climb in January on consolidated snow to feed on arboreal lichens; they descend in April when snowcover leaves the valley floors, and climb again to alpine tundras in May or June.

Freddy and Erickson (1975) and Freddy (1979) reported that caribou inhabiting the Selkirk Mountains of northeastern Washington, northwestern Idaho, and southern British Columbia do not undergo seasonal shifts in elevation. They do, however, maintain traditional travel routes between and within drainages. The relationship of one of these routes to a heavily travelled highway was reported by Johnson and Todd (1977).

2.4 Food Habits

Bergerud (1972) studied the food habits of Newfoundland caribou. He found that in spring the animals sought rapidly growing green plants

and ate few lichens and bryophytes. Broadleaved evergreens, deciduous shrubs, and sedges were important. In summer reindeer lichens (*Cladonia* spp.) were important, but caribou preferred fungi and green leaves of deciduous shrubs and forbs. In autumn deciduous leaves became unavailable, and caribou switched to reindeer lichens and evergreen shrubs; in winter arboreal lichens and evergreen shrubs were most important, since adverse nival conditions limited the availability of ground forage. Bergerud (1972:922) concluded that:

> ". . . the heavy use of lichens does not necessarily imply that lichens are required in the diet if vascular plants are readily available . . . I believe caribou are generalists in their food habits (Skoog 1968). They are adapted to eat many kinds of foods including lichens, which most other ungulates avoid. This adaptation is one of many that permits the distribution of caribou in northern communities dominated by lichens."

Cringan (1957) studied the diet of woodland caribou on the Slate Islands in Lake Superior. In winter he observed heavy utilization of terrestrial and arboreal lichens and concluded that woody browse was relatively unimportant. In spring caribou pawed for roots and shoots of herbs, and for mosses, lichens, and fungi. In summer they ate the leaves of deciduous shrubs, herbs, lichens, and some aquatic plants.

Simkin (1965) found marked differences in the availability of food and food eaten between populations of woodland caribou living in areas of the Precambrian Shield of Ontario and in the Hudson Bay lowlands. He reported that caribou in the former used mainly ground and tree lichens in spring and early summer, supplemented by buds and twigs of deciduous trees. In summer only the leaves of deciduous plants were

eaten, plus forbs and ground lichens. In winter caribou used mainly ground lichens, the leaves of evergreen shrubs, and deciduous browse. In the Hudson Bay lowlands Simkin (1965) found that lichens were used extensively in summer, but the leaves of willow (*Salix* sp.), bog birch (*Betula glandulosa* Michx.), and sedges (*Carex* spp.) were the most important non-lichenous foods. In winter ground lichens (*Cladonia* spp.) comprised most of the diet, but the major species taken were different than those of caribou further south. Tree lichens, deciduous browse, evergreen shrubs, and sedges were also used.

Ahti and Hepburn (1967) provided a summary of foods probably important to woodland caribou in Ontario.

Bergerud (1972) pointed out that the preference of caribou for certain lichen species seems to vary from one area to another (*cf.* Ahti 1959; and DesMeules and Heyland 1969). However, the literature indicates that species of *Cladonia* are universally important (Kelsall 1968; Skuncke 1969; and Holleman and Luick 1977).

In the mountains of British Columbia, Edwards and Ritcey (1960) documented the food habits of caribou in Wells Gray Provincial Park. They observed a heavy dependence on arboreal lichens (*Alectoria* sp.) during winter (1960:5-6):

> "Within their winter habitat when snow is deep there is little else available, except for the foliage of conifers. Deep snow makes all low-growing vegetation more or less inaccessible. There is no evidence that coniferous plants are eaten, except for fragments ingested accidentally with lichens . . . Terrestrial lichens are scarce in Wells Gray Park."

They also wrote (1960:5):

> "In late autumn and early winter, and again in early spring, caribou seek out several evergreen plants in the forest, favoring . . . *Cornus canadensis, Pachystima myrsinites,* and *Linnaea borealis.*"

In summer Wells Gray caribou occupied the alpine meadows and fed on arboreal lichens, grasses, terrestrial lichen (*Cladonia bellidiflora*), mosses, sedges, and forbs. In general, Edwards and Ritcey (1960:4) stressed the following:

> "Caribou in this area feed on softer material, taking leaves from shrubs . . . but rarely twigs."

The observations of Freddy and Erickson (1975) and Freddy (1979) agree with those of Edwards and Ritcey (1960); the former found Selkirk Mountain caribou to depend on arboreal lichens in winter and spring.

3. THE STUDY AREA

3.1 Location and Physiography

Aikens Lake is situated about 180 km northeast of Winnipeg, Manitoba (Fig. 1). The total study area comprises approximately 1,600 km^2, although most investigations were confined to an area of approximately 1,150 km^2. Geographical limits of the study area are $50^{o}58'N$ to $51^{o}17'N$ and $95^{o}01'W$ to $95^{o}39'W$. The area is bounded by Wallace Lake and Wanipigow River on the south, Gammon River and Ford Lake on the north, Carroll Lake on the east, and Beaver Creek on the west. Most investigations were conducted from Wallace Lake north to Aikens Lake, and from Carroll Lake west to the Broadleaf River and Leaf Lake (NTS 52 M/3, 1:50,000). Field activities were based at the University of Manitoba Taiga Biological Station near Wallace Lake.

Elevation varies from approximately 350 m in the east to 300 m in the west. Topography is generally comprised of rock ridges, 5 to 30 m in height, interspersed with bogs and many lakes. Glacial action has oriented most open bogs and lakes in a northwest-southeast direction. Two major drainage systems, the Wanipigow and Gammon rivers, flow in a westerly direction. The Gammon River is a tributary of the Bloodvein River and joins it northwest of the study area. Both the Bloodvein and

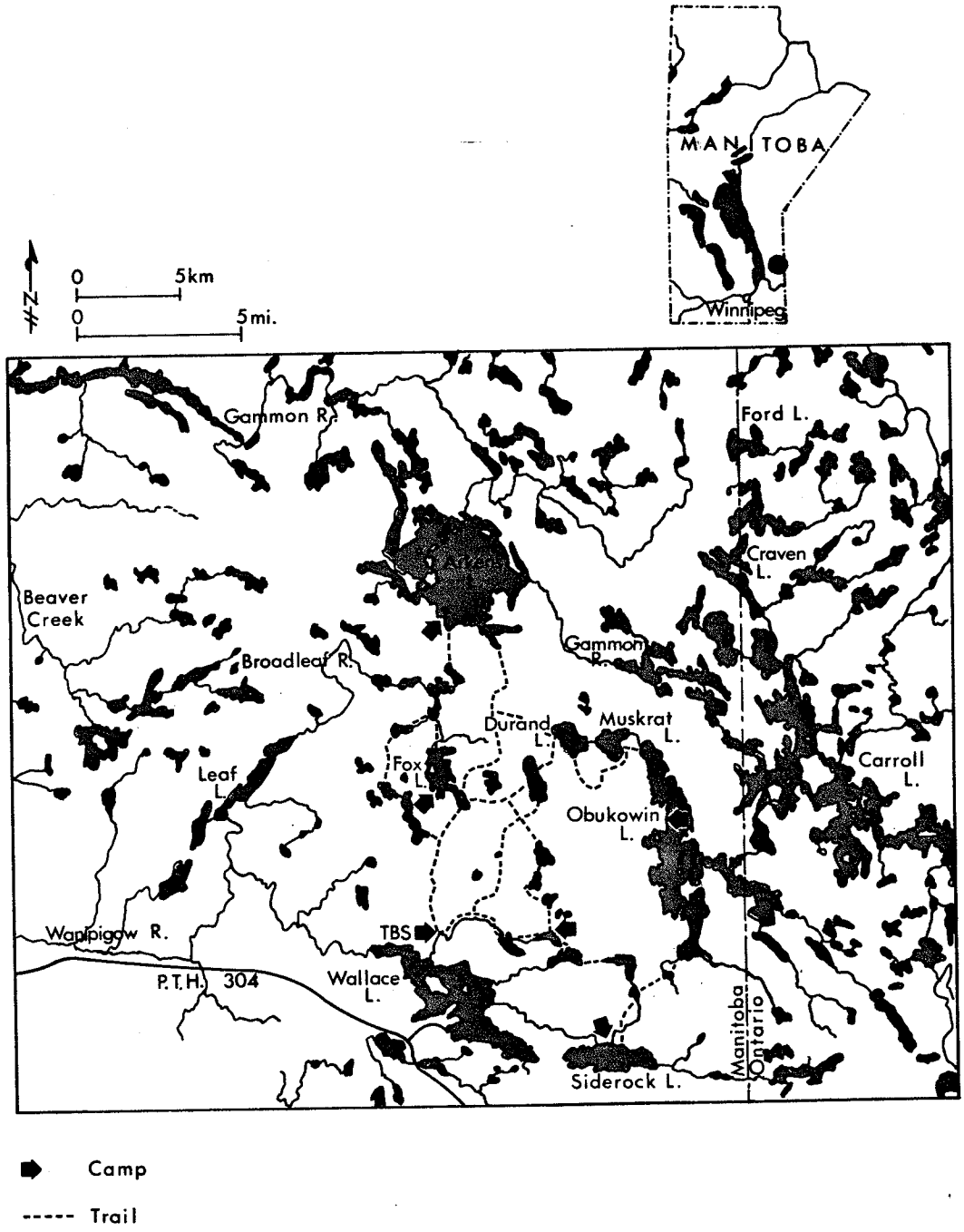


Figure 1. Location of the Aikens Lake study area in southeastern Manitoba.

Wanipigow rivers drain into Lake Winnipeg.

3.2 Geology and Soils

Exposure of ice-scoured bedrock is extensive throughout the study area. Surficial deposits are glacial in origin. Bedrock is Precambrian Shield, consisting of granite, granodiorite, quartz, diorite, metavolcanic, and metasedimentary rocks. The granitic complex, referred to as the Wanipigow River Quartz Diorite Suite by McRitchie (1971), includes all of the intrusive and gneissic rocks north of Wallace Lake.

North of Aikens Lake and the Gammon River the bedrock consists of pink biotite granite which Russell (1948) calls Aikens Lake Granite. The area to the south is hornblende and grey biotite granite, the latter being referred to as Wallace Lake Granite. A contact zone containing many pegmatite dykes exists between the two granite masses through southern Aikens Lake and along the Gammon River. The zone is evidenced by cliffs of 10 m along shores of an island and bay on the southern side of Aikens Lake.

Intersecting the granitic suite in the southern portion of the study area is a narrow latitudinal belt of volcanic material stretching across Wallace and Siderock lakes. This metasedimentary and metavolcanic sequence is part of the Rice Lake Greenstone Belt extending west to Lake Winnipeg (McRitchie 1971). The southern limit of the belt in the study area is the east-west trending Wanipigow River Fault which forms a high cliff of 30 m along the southern shore of Siderock Lake (Marr 1971).

Gold-bearing veins along the Broadleaf and Wanipigow river systems created much prospecting and mining activity in the 1940's. At present only a limited amount of prospecting takes place. Iron formation in the southern part of the Wanipigow River Suite is common but sub-economic.

Surficial deposits consist of glacial drift on which thin layers of grey-wooded podzolic soils are developing. Some areas are occupied by glacial outwash sand plains or glacial lake clays. Many upland areas have irregular boulder deposits and glacial erratics at or near the surface. Peat development occurs in many low-lying areas.

3.3 Climate

The study area has a boreal continental climate and lies within the dry subhumid moisture region (Weir 1960). Mean daily temperature is 18^{o}C for July and -20^{o}C for January. The frost-free period is approximately 100 days. Average annual precipitation is 53 cm, of which almost 40% falls as snow between 1 October and 30 April. Average annual snowfall is 152 cm. Freeze-over of rivers and lakes occurs from 19 October to 15 November. Initial breakup of ice occurs on 1 to 10 April for rivers and 17 April to 15 May for lakes.

3.4 Vegetation

The study area belongs to the Northern Coniferous Section of the Boreal Forest Region (Rowe 1972). Nomenclature of vascular plants

follows Gleason and Cronquist (1963); that of lichens follows Ahti and Hepburn (1967).

Fig. 2 shows the distribution of forest cover types for most of the study area based upon forest inventory maps of the Manitoba Department of Renewable Resources and Transportation Services. The central portion is mature coniferous forest dominated by jackpine (*Pinus banksiana*), white spruce (*Picea glauca*), and black spruce (*Picea mariana*) on uplands. Black spruce and tamarack (*Larix laricina*) dominate poorly drained areas. Sub-dominants include balsam fir (*Abies balsamea*), paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*).

Jackpine-lichen-rock ridges often have little soil; blueberry (*Vaccinium myrtilloides*), scattered paper birch and serviceberry (*Amelanchier* sp.) comprise the understory. Where upland areas have some overburden of soil, the principal shrubs include blueberry, buffaloberry (*Shepherdia canadensis*), bearberry (*Arctostaphylus uva-ursi*), pin cherry (*Prunus pensylvanica*) and red-osier dogwood (*Cornus stolonifera*).

Poorly drained areas generally support tamarack and black spruce bogs that vary greatly in tree density. Open bogs of peat moss (*Sphagnum* spp.) and sedge (*Carex* spp.) have relatively few trees (Fig. 3). Principal shrubs in these tussock-sedge bogs are leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), bog rosemary (*Andromeda glaucophylla*), cowberry (*Vaccinium vitis-idaea*), and small cranberry (*Vaccinium oxycoccos*). As tree density increases, black spruce becomes the dominant tree, sedges become sparse, and labrador

Figure 2. Distribution of forest cover types for most of the study area.

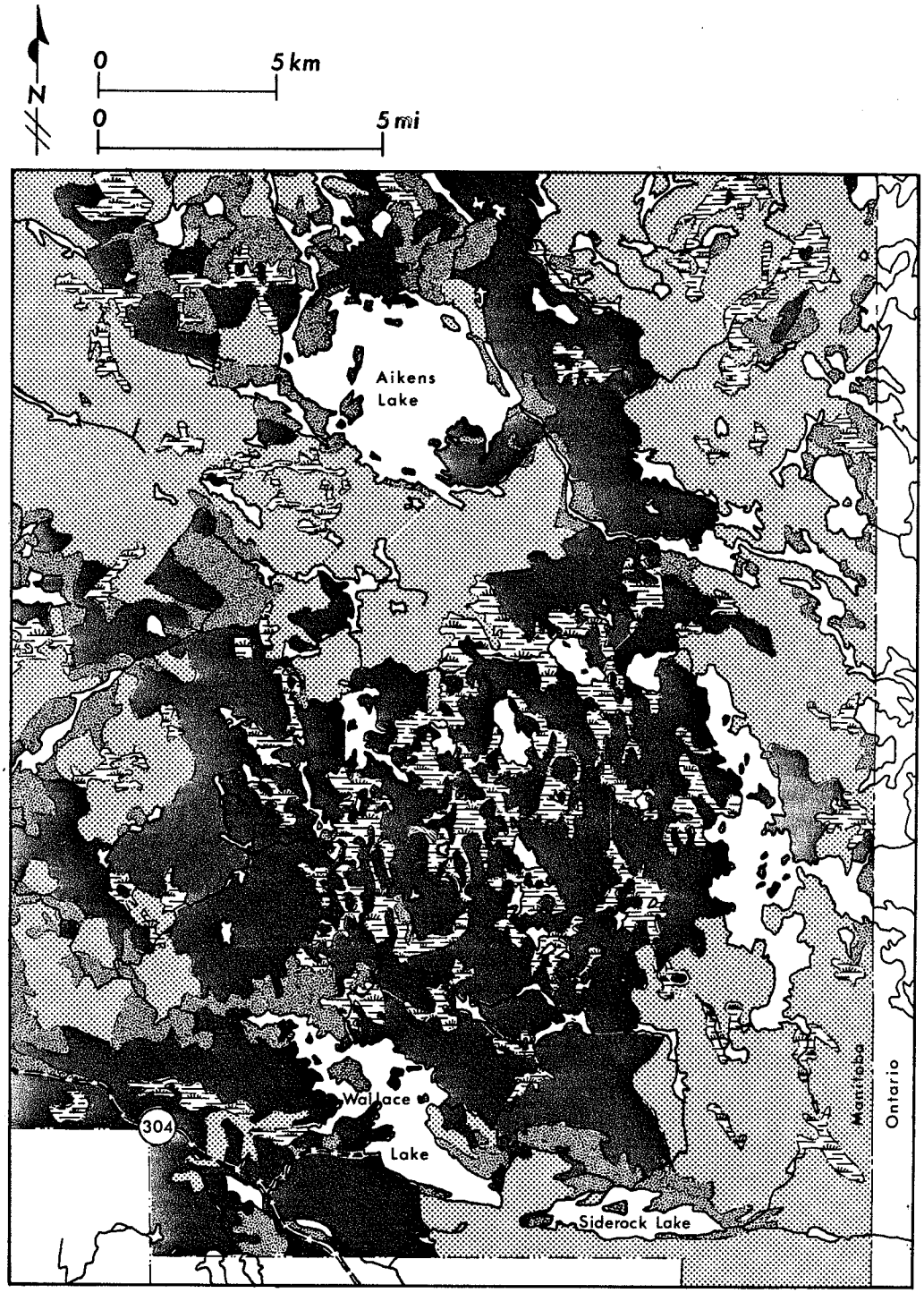

N
0
5 km
0
5 mi
Aikens Lake
Wallace Lake
304
Siderock Lake
Manitoba
Ontario
Mature coniferous forest
Immature coniferous forest
Mixedwood and deciduous forest

Figure 3. Open tamarack and black spruce bog south of Fox Lake.

tea (*Ledum groenlandicum*) becomes a dominant shrub (Fig. 4).

Large stands of immature jackpine lie to the east and west of the area of mature forest (Fig. 2). The Craven and Carroll lakes area to the east supports exceedingly dense stands of young jackpine 7 to 8 m high with only needle litter, logs, and bare rock on the forest floor. A few small areas of young trembling aspen are interspersed. In the west, coniferous succession is slightly more advanced, but immature jackpine still predominates.

Along the Broadleaf and Wanipigow river systems, and along the Gammon River northwest of Aikens Lake, mixedwood and deciduous stands contain immature to mature trembling aspen, balsam poplar, and paper birch (Fig. 2).

3.5 Fire History

The dense stands of young jackpine at Craven and Carroll lakes resulted from an extensive fire in 1948 (Stardom 1977). The western area of immature forest (Fig. 2) was burned during the period 1928-1941 and was part of an extensive fire to the northwest (Stardom 1977). At the outset of this study, the central area of mature forest had not received any substantial burning since 1928. Earlier fires, however, had created a diversity of age classes within this area.

On 5 June 1976, during the second summer of study, forest fires destroyed three areas of mature habitat: one at Obukowin Lake and two along the Gammon River upstream from Aikens Lake (Fig. 5). The fires were started by lightning strikes following very dry conditions in

Figure 4. Dense black spruce bog south of Fox Lake.

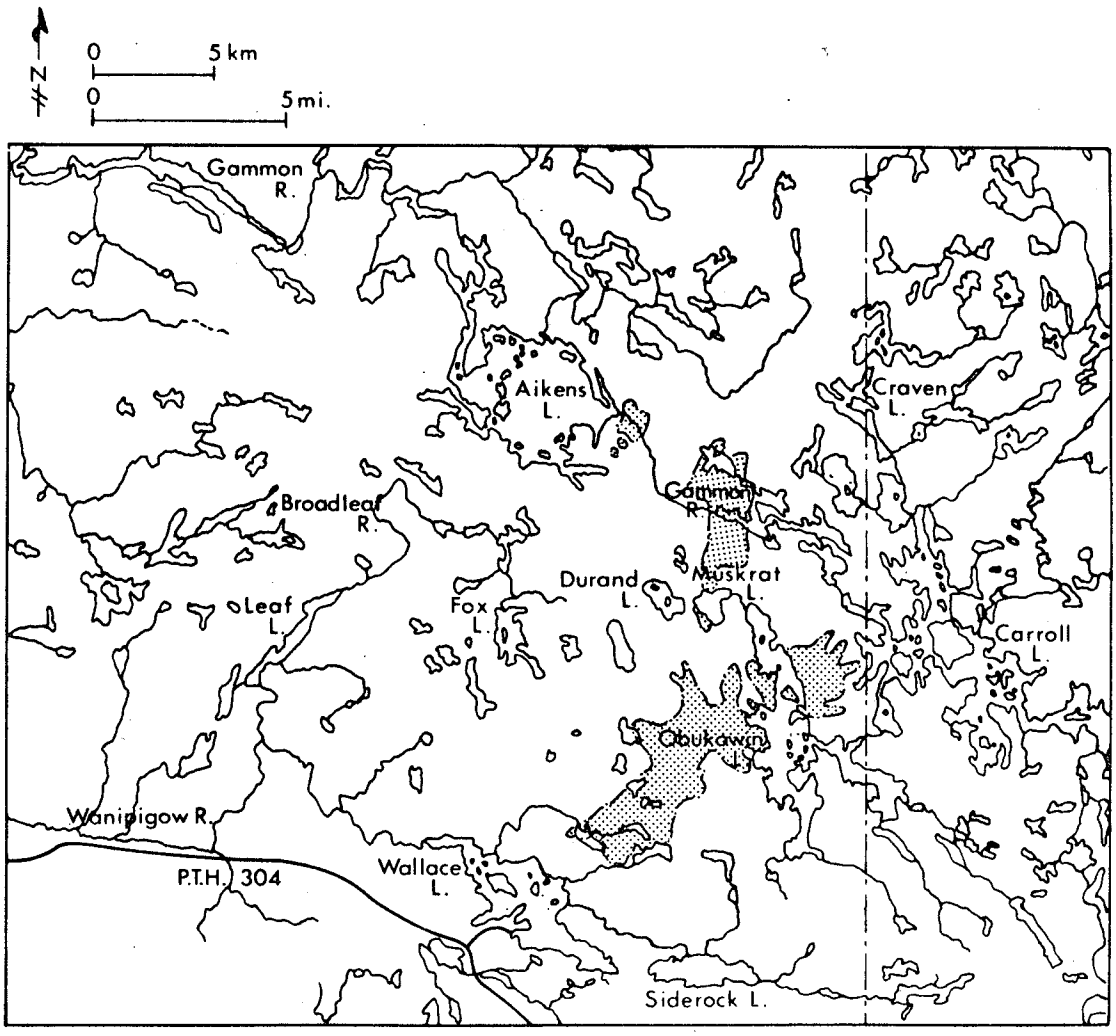


Figure 5. Distribution of 1976 burns.

April and May. The total area within peripheral limits of the burns was approximately 4,030 ha, but not all of it was destroyed. Many bogs and low stands of black spruce were not burned due to their higher moisture content. The fires usually followed dry ridges of jackpine and spruce.

Stardom (1977) pointed out that open bogs have largely escaped the effect of fire due to a lack of combustible trees and a moist substrate. Their protection over extended periods of time has allowed for substantial growth of arboreal lichens, a major food source for caribou in the area.

3.6 Human Activity

Human activity in the study area is largely restricted to trapping and tourism. The village of Bissett lies 20 km west of Wallace Lake, and P.T.H. 304 provides access to the southern limit of the area. Fishing lodges are present on Wallace, Aikens, and Carroll lakes. Abitibi Pulp and Paper Ltd. holds timber berths along the southern and southwestern margins of the study area. Except for small operations along the road, logging activity is restricted to these berths. Light aircraft activity is common, especially during the summer fishing season.

4. METHODS AND MATERIALS

4.1 General

Field work was conducted from 16 May 1975 to 1 April 1977, following two aerial survey flights on 30 March and 1 April 1975. During this period I spent a total of 380 days in the field. Most of the remaining time was devoted to operational support, report writing, and data analyses. From October 1975 to April 1977 I was assisted by Denis Rémillard, who spent 283 days working on this project. Several other people participated in field work providing 354 person-days of assistance. Thus, a total of 1,017 person-days was expended in the field.

During periods of snowcover, 36 hours of aerial survey were flown (ferry time not included) on 13 flights. The total distance travelled on foot, by canoe, boat, snowshoe, ski, and snowmobile exceeded 10,000 km.

The Taiga Biological Station north of Wallace Lake was used as a basecamp for field operations (Fig. 1). Trappers' cabins and tents were used as outcamps on Cabin Lake, Siderock Lake, Obukowin Lake, Aikens Lake, and Fox Lake. A system of trails was developed to facilitate ground travel in all seasons. The majority of time was

spent working from outcamps.

4.2 Range Determination

The minimum aggregate range and seasonal ranges are based upon observations of discrete caribou activity: tracks, cratering, pellet groups, hair, recently dropped antlers, small spruce and tamarack rubbed by bulls [distinct from moose (*Alces alces andersoni* Peterson) rubs], radio-telemetry detections, and visual sightings. Ranges were determined by plotting all observations and connecting the outermost points with lines. Seasonal ranges are based upon the calendar year because many aspects of caribou behaviour are relatively fixed in time (*e.g.* calving and rut). In addition, the calendar dates of seasonal change coincided fairly well with phenological observations during the study period (Figs. 6 and 7).

Autumn, winter, and spring ranges for each year were substantiated by aerial survey and ground investigations. In summer, however, the delineation of range size was made difficult by lack of snow and logistic problems associated with the dense coniferous forest. Minimum summer ranges were determined from observations of caribou activity, but not all of the study area could be investigated by ground work, and aerial survey in summer was not financially possible. Some caribou undoubtedly dispersed beyond the minimum summer range. Consequently, an estimated summer range for 1975 and 1976 was based upon: the minimum summer ranges; observed movements in spring 1976; observations of summer activity indicating the use of adjacent areas; interviews with

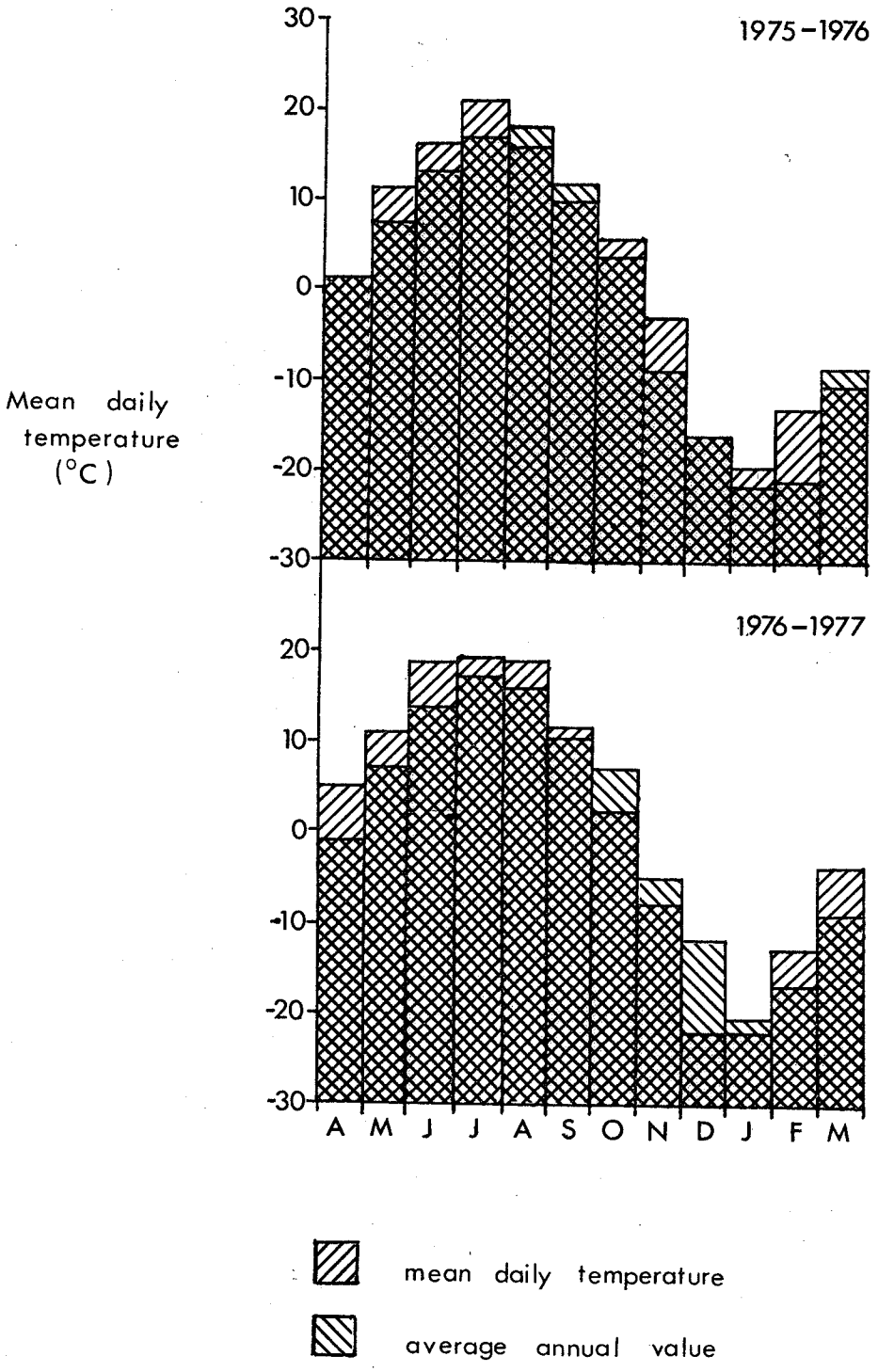


Figure 6. Monthly changes in daily temperature at the Bissett Meteorological Station for 1975-1976 and 1976-1977 compared to 30-year average values (Environment Canada 1975, 1976; and Fisheries and Environment Canada 1977).

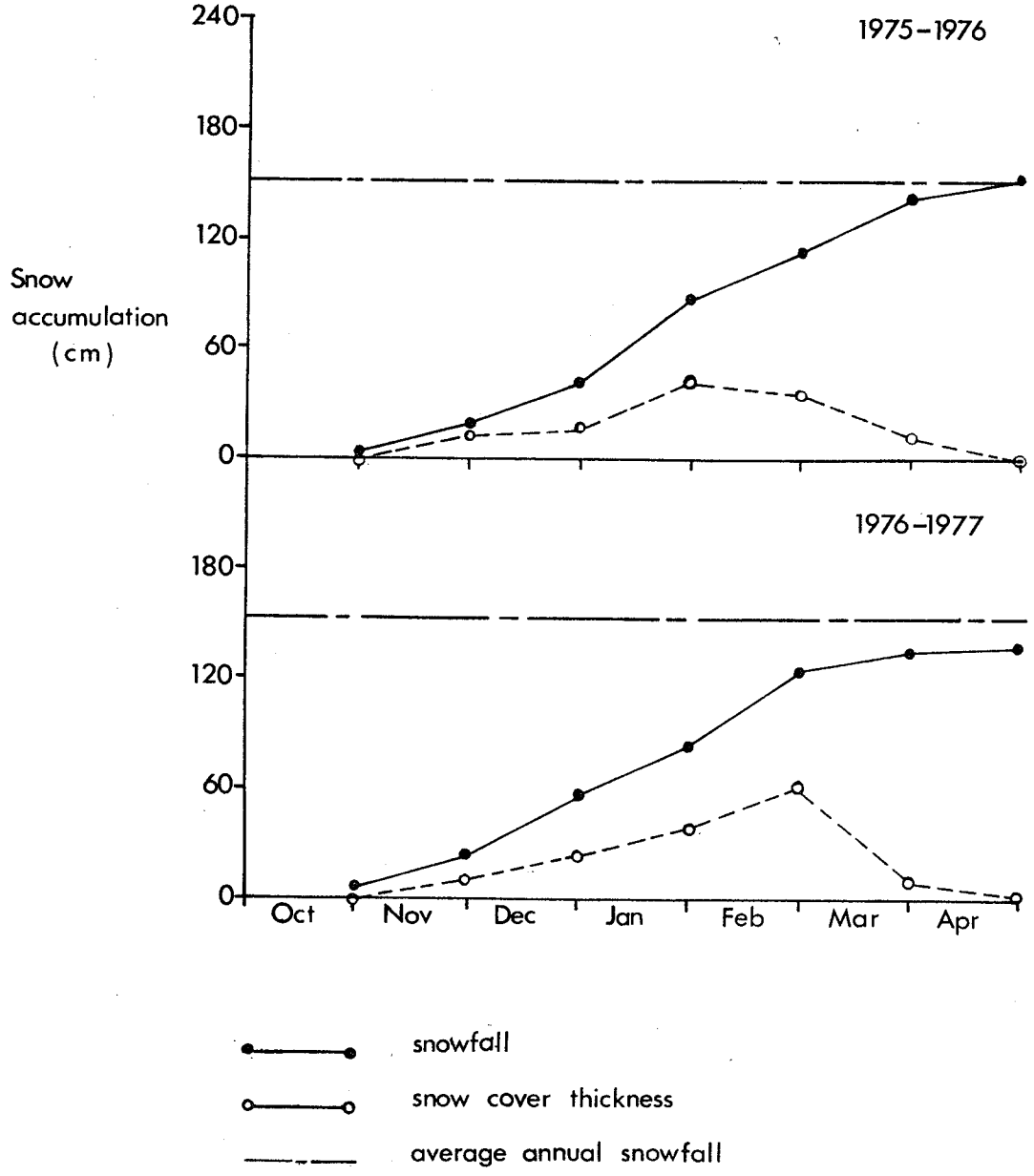


Figure 7. Comparative snowfall and snowcover thickness at the Bissett Meteorological Station for 1975-1976 and 1976-1977 compared to the 30-year average snowfall (Weir 1960; Environment Canada 1975, 1976; and Fisheries and Environment Canada 1977).

lodge personnel, canoeists, and fishermen; and results of intensive ground investigations along and near major water systems.

The approximate area of each range was determined by use of an acreage grid overlay (64 dots per square inch) on maps with scales of 1 cm = 0.50 km (1:50,000) and 1 cm = 0.97 km (1:250,000).

4.3 Aerial Survey

Aerial survey flights were usually flown once or twice monthly during periods of snowcover to monitor caribou movements and collect census data. The average duration of each flight was approximately 2 hours and 45 minutes. No surveys were flown during snow-free periods.

A series of 11 east-west transect lines was established over most of the study area (Fig. 8). Transects were flown with a three-seat Piper PA-12 aircraft at 144 km/hour and an altitude of 125 m. Transects were flown well beyond the area of caribou distribution to verify activity boundaries. Two observers each observed a strip 0.2 km wide on either side of the aircraft, permitting a minimum of 16.2% coverage of the area sampled. On some flights, the pilot acted as second observer. Tracks, cratering, and visual sightings of caribou, moose, wolves (*Canis lupus lycaon* Schreber), and unidentified cervids were plotted as being on or off transect. Observations were initially recorded on maps with a scale of 1 inch = 1.26 km (1:50,000) and later transcribed to a field diary by use of Universal Transverse Mercator Grid reference numbers. Visibility off transect was often hampered by a dense forest canopy. Upon completion of the transect survey, areas

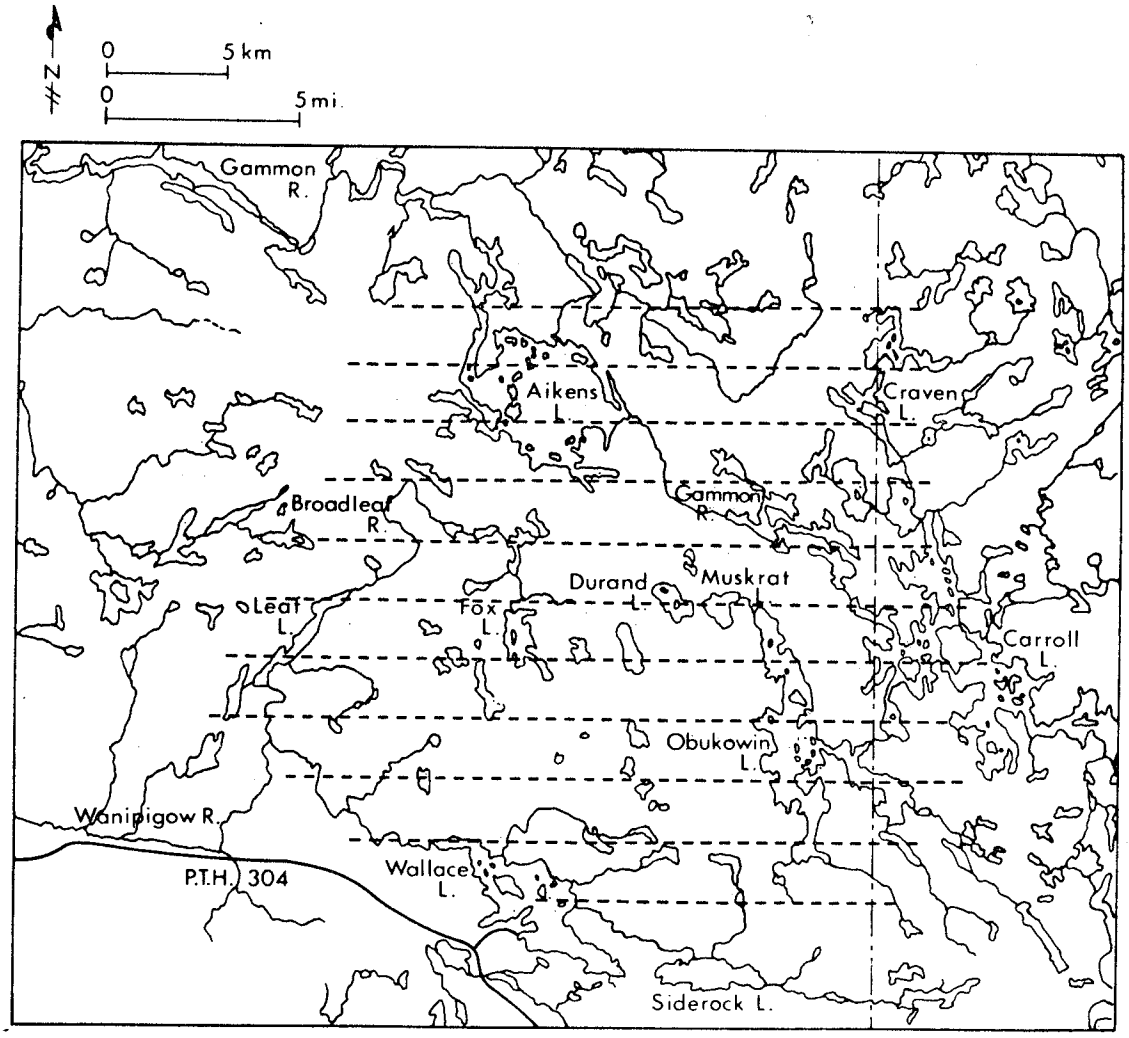


Figure 8. Transect lines used for aerial survey during periods of snowcover.

of fresh activity were investigated more intensively from the air and later on the ground, to determine their relationship to each other and the number of caribou at each site. When caribou were sighted, the group was circled to obtain photographs and data on total number, and sex and age ratio.

Aerial surveys were usually conducted on calm sunny days, since high contrast conditions facilitated track observations and photography. Caribou activity was differentiated from that of moose by cratering, presence of tracks of four or more animals, and distinctive behavioural patterns (*e.g.* tracks in open bogs indicating feeding activity on arboreal lichens). Moose sign was identified by distinctive browsing activity or visual sighting. Any sign not positively identified was recorded as unidentified cervid.

4.4 Ground Survey

In autumn, winter, and early spring, ground travel was on foot or by snowshoe, ski and snowmobile. Accessible areas of caribou activity were monitored on a daily basis. After each aerial survey, investigations concentrated on ground verification of sign.

Observations of activity of caribou, moose, white-tailed deer (*Odocoileus virginianus dacotensis* Goldman and Kellogg), unidentified cervids, wolves, lynx and cougar (*Felis concolor schorgeri* Jackson) were entered in my field notes. Data recorded for each observation of activity were: date, location by Universal Transverse Mercator Grid reference, number of animals, approximate age of sign, direction of

travel, mode of locomotion, group form, feeding activity, excrement, habitat, and any other behaviour of interest.

Snow data were collected at irregular intervals in three habitat types and usually at the same locations (Fig. 9). A modified NRC snow kit was used; techniques were those of Klein *et al.* (1950). Mean hardness values were calculated by averaging the sum of products of layer thickness and hardness over total thickness. Data on ice crusts were included in the mean values. When ice crusts were too thin to permit horizontal hardness measurement, vertical hardness was substituted.

Field work was not possible during spring breakup. High water levels and bad ice precluded ground or water travel, and aerial survey was not practical once snowcover disappeared. In 1975, 1976, and 1977, breakup was completed by the first week of May. Late spring investigations commenced on 4 June in 1975 and 18 May in 1976.

Late spring and summer investigations were conducted on foot and by canoe and boat. An intensive search was made of most lake and river systems, especially of sand beaches, to gather information on calving activity and other use by caribou. Over 80 islands and related mainland shores were examined. Informal interviews were also conducted with fishermen, canoeists, and personnel at fishing lodges. Summer investigations in mainland areas were conducted on foot. Data collection of caribou sign was similar to that for winter. Pellet groups dropped after the emergence of green vegetation were distinguished from winter droppings by their amorphous shape. Their approximate age was determined to be less than one year, one year, or

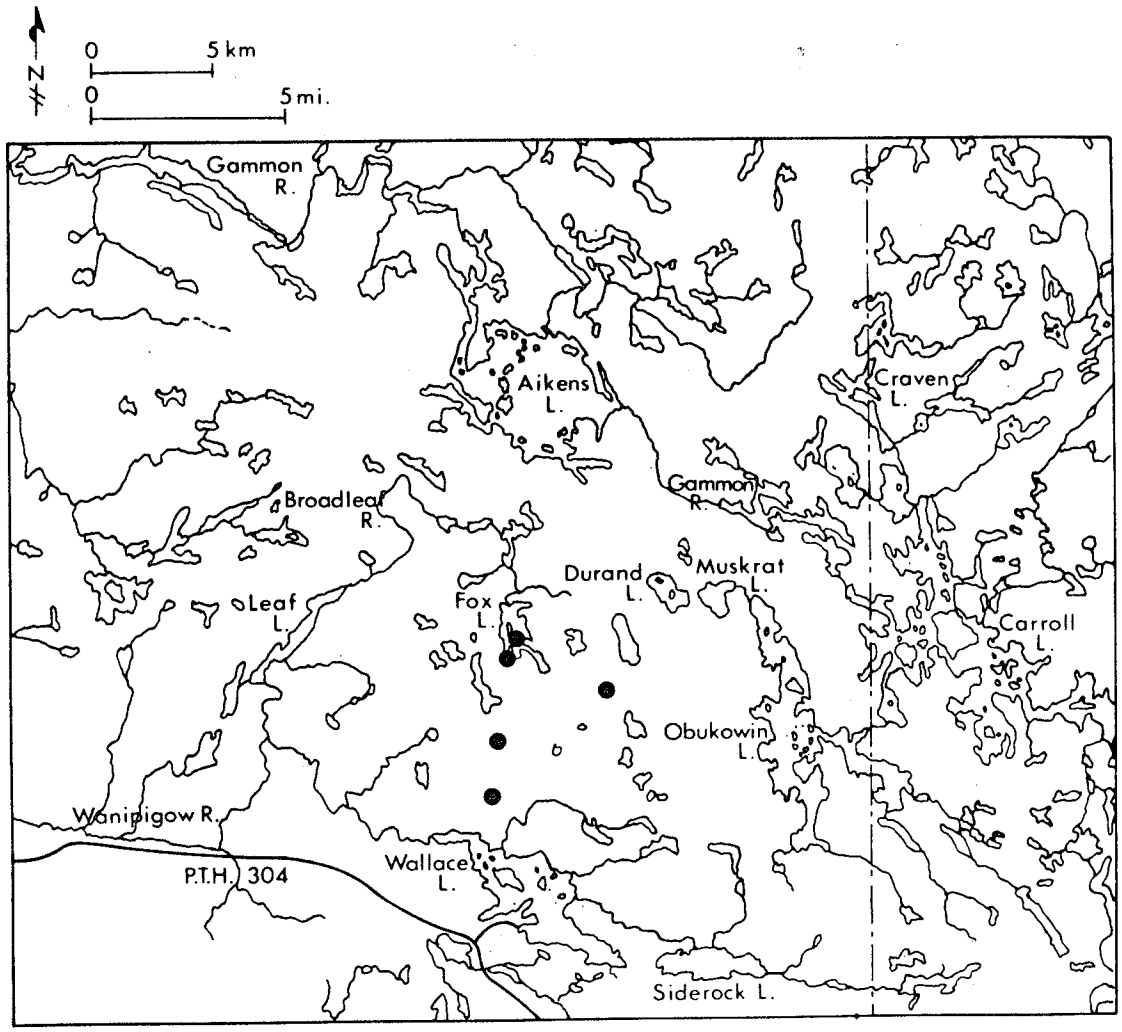


Figure 9. Locations where snow profile data were collected in the study area.

greater than one year by colour, hardness, moisture content and texture.

4.5 Census

Conventional census techniques for caribou in open habitat utilize transect density data from visual aerial survey and a 20% correction factor for caribou missed (Thomas 1969; Parker 1972; and Hawkins and Calef 1977). My initial attempts to use these techniques proved frustrating, due to a dense forest canopy. Visual observation of caribou on transect was neither reliable nor consistent. Consequently, aerial surveys were used to detect all areas of fresh caribou activity and to estimate the number of caribou in each area. After ground verification, the data were used to estimate population size on a total count basis.

Daily ground investigations were responsible for the discovery of some caribou whose activity might otherwise have been missed during aerial survey. In view of this and the fact that ground truthing was used in conjunction with aerial survey, a 10% correction factor was considered to be reasonable and applied to census data.

Sex and age ratio information was acquired by 35 mm aerial photography of caribou groups and in one case by visual observation from the aircraft. Identification of mature bulls was by size and by the presence of dark antler pedicles when they could be distinguished.

4.6 Live Capture and Marking

Woodland caribou were captured while swimming, using the technique of Miller and Robertson (1967). The animals were located by surveillance or driven off small islands in lakes. While two people drove the island, two others waited in a 16-foot boat with 10 hp motor at some distance away. Once in the water, the caribou was maneuvered away from shore and pulled to the side of the boat by use of a "shepherd's crook". It was then marked with an eartag and streamer or equipped with a radio-transmitter collar. Calves were taken on board for marking and sexing. Moose were also earmarked when the opportunity arose.

The marking materials were green cattle eartags, made of metal, and flourescent orange or red streamers. The streamers were 10 cm long and made of vinyl webbing.

A baiting experiment was conducted during February and March 1976 to determine if baiting would be a useful technique for live-capture in traps or corrals. Six baits were maintained at each of seven locations in an area of intense caribou activity. Baits at each location were set out for periods ranging from 11 to 34 days from 3 February to 9 March. Once or twice a week all baits were freshened and checked. Baits were exposed for a total of 1,020 bait-days. Each was placed on the flattened top of a mound of snow 60 cm wide and approximately 30 cm above the surrounding snow surface. Bait mounds were placed in a row alongside the snowmobile trail, about 10 m apart. Baits included: cattle salt block (NaCl); Co-Op 1:1 mineral block, product #57208;

50:50 oats and chopped straw; 50:50 alfalfa and chopped straw; 50:50 hay and chopped straw; and *Cladonia* spp. Chopped straw was added to high carbohydrate baits to avoid bloat.

4.7 Radio-Telemetry

Radio-telemetry equipment was manufactured by AVM Instrument Co., Champaign, Illinois, U.S.A. An AVM model LA-12 portable receiver was used in conjunction with a four-element yagi antenna and AVM model SB-2 transmitters with cold weather option. The transmitters were powered by model 303997 mercury batteries or Lithium 550 batteries. Frequency range of the receiver was 150.850 to 151.150 MHz.

Radio-transmitters were assembled into neck collars by an electronics consultant. Transmitters and batteries were covered with dental acrylic and attached to a canvas collar. Each collar was wrapped with colour-coded plastic tape. When placed on a caribou, the collar was opened up, placed around the neck and fastened with a metal snap and ring.

Ground reception was facilitated by a series of "tree towers" at strategic locations in the study area. Telemetry detections were achieved by standard triangulation methods.

Aerial detection was achieved while flying survey transects by two yagi antennae attached to the wing struts and oriented vertically along the wing axis. A switchbox and headphones were used in conjunction with the portable receiver. The operator switched from one side to the other until a signal was received. The antenna with the stronger signal

indicated the side on which the caribou was located. The point on transect at which signal strength was maximum was plotted and a line was drawn at right angles pointing to the target. After continuing on transect for 1 km, the aircraft was turned 90^{o} towards target. Again the point of maximum signal strength was plotted and a line drawn. The two radio bearings intersected at target location. The radio-collared caribou was then circled to achieve visual contact and collect other information.

4.8 Vegetation Mapping

No quantitative studies of vegetation were conducted because Stardom (1977) had described most of the major habitat types of the study area in quantitative terms.

In 1976 the vegetation of a calving island in Obukowin Lake was described in qualitative terms. A total of 11 vegetative cover types was recognized on the basis of tree and shrub association. The island was divided into plots 50 m by 50 m, and the boundary of each cover type was mapped. The abundance of six tree species, feather mosses, graminoids, ground lichens, 19 species of ground plants, and logs and litter was described subjectively as rare, occasional, frequent, abundant, or dominant for each cover type. The 19 species of ground plants were chosen arbitrarily, but an attempt was made to select species representing a cross-section of the diverse vegetation. A larger number of plant categories was too unwieldy to use with subjective techniques.

4.9 Food Habits

Food habits of free-ranging caribou were determined in winter by following caribou tracks and examining craters and other sign. In snow-free periods the identification of feeding activity was often confused by the local presence of moose. Consequently, feeding sign was only attributed to caribou when tracks, hair, or pellet groups verified the animal's identity, or when the animals were observed visually.

The food habits of a caribou calf hand-raised in the field were determined independently from those of free-ranging caribou. The calf was not penned or restrained. It was imprinted on myself and followed our field party on travels through many habitat types. The calf's food habits were recorded on an opportunistic basis, along with other aspects of its behaviour.

5. RESULTS

5.1 Seasonal Movements and Gregarious Behaviour

5.1.1 Seasonal Movements

During 1975 and 1976 I estimated that 30 to 40 caribou were present in the Aikens Lake herd (section 5.3.2). Fig. 10 presents their minimum aggregate range for the period 1974 to 1977. The range comprised approximately 350 km^2 and is based upon 780 observations of discrete caribou activity (n); 49 are visual sightings of one or more caribou. It consists of a crude polygon 28 km long from Leaf Lake in Manitoba to Carroll Lake in Ontario, and 21 km wide from Aikens Lake south to Wallace Lake. The herd used the centre of this range during all seasons. However, some caribou probably travelled beyond its limits during summer when the delineation of range size was made difficult by logistic problems. An estimated summer range for 1975 and 1976 is shown later; it represents the probable extent of summer movements.

Fig. 11 presents seasonal ranges of the Aikens Lake herd for the spring and summer of 1975 and the winter of 1975-1976. Insufficient data were obtained to delineate an autumn range for 1975. Sample sizes do not include radio-telemetry detections since caribou were not

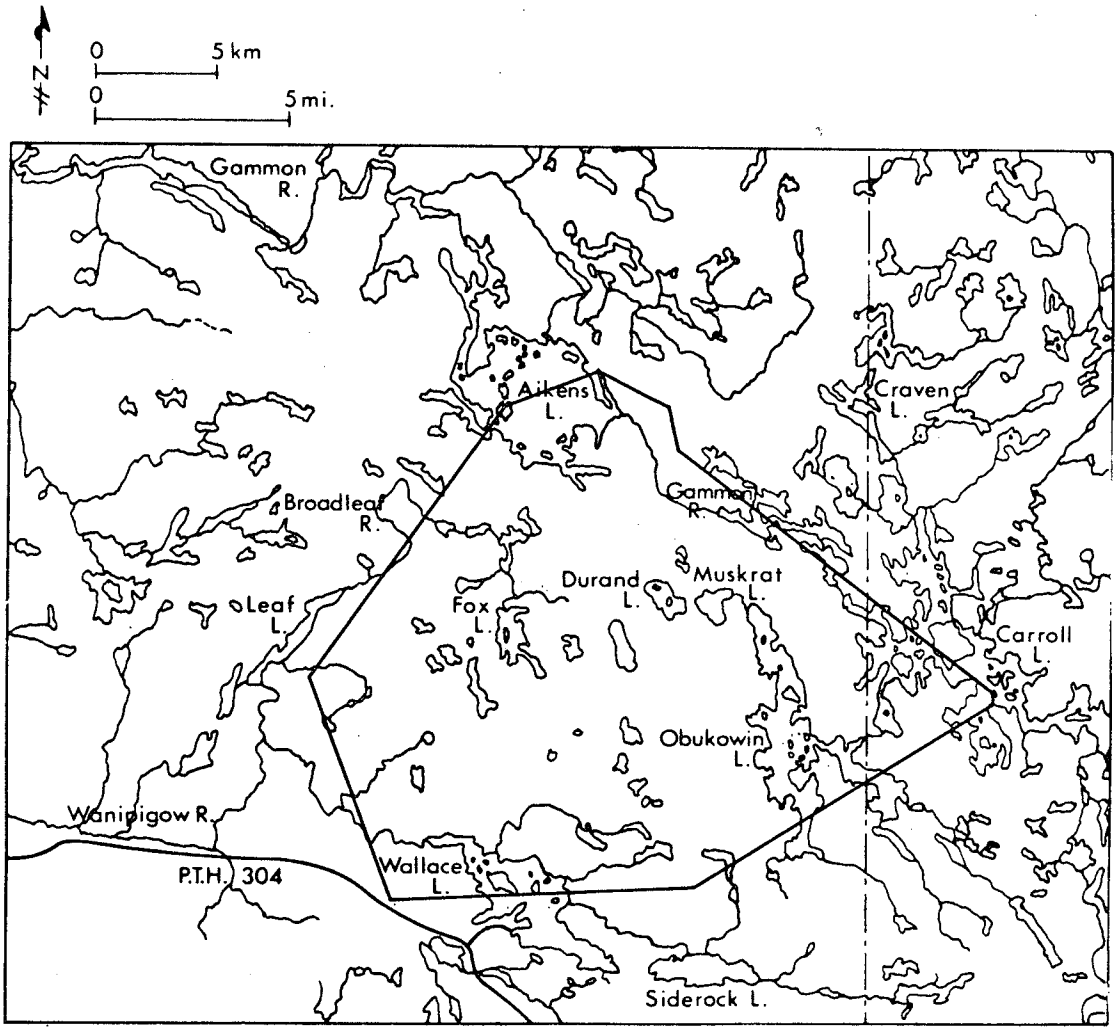


Figure 10. The minimum aggregate range known to have been used by Aikens Lake caribou from 1974 to 1977.

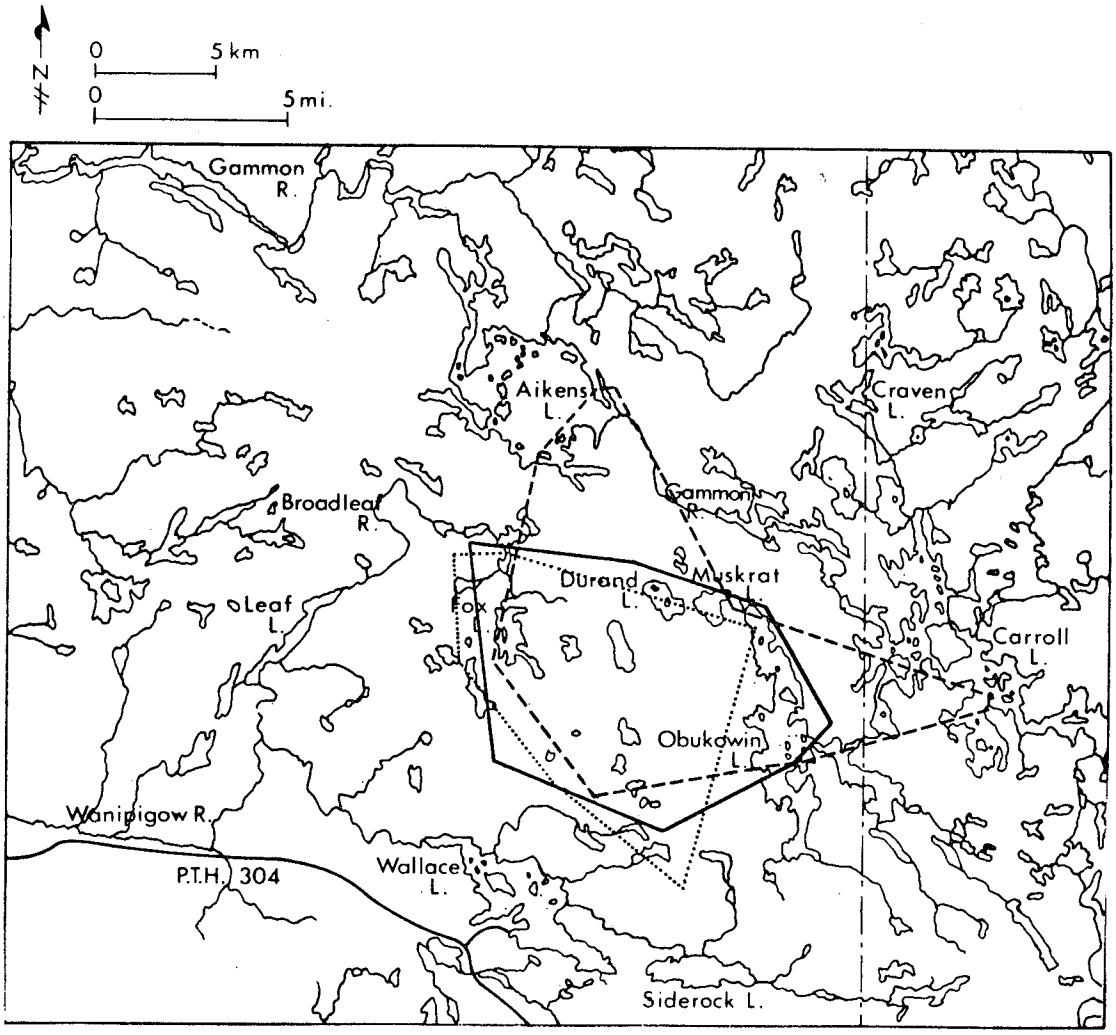


Figure 11. Seasonal ranges of the Aikens Lake caribou herd for spring and summer 1975 and winter 1975-1976.

equipped with radio-collars until spring 1976. The spring 1975 range (n = 42) comprised about 110 km^2 and was substantiated by aerial surveys in March and April, ground and waterborne surveys during May and June, and interviews conducted with canoeists and fishermen. No evidence of caribou activity was acquired for the area south and east of Aikens Lake during spring 1975. However, a greater amount of effort was expended investigating this area in the late spring of 1976. This revealed a small number of pellet groups, one-year old, which are included in the data for summer 1975; they could not be distinguished from spring droppings. Thus, a small amount of activity could have occurred along southern and eastern shores of the lake during late spring 1975, but it was not detected. Personnel and fishermen at the Aikens Lake Lodge reported seeing no caribou during spring or summer 1975.

Most visual observations in late spring 1975 occurred in and around a group of islands in the centre of Obukowin Lake. Field party members observed single caribou there on five occasions and a cow-calf pair on one occasion. Two of these caribou, one calf and a mature bull, were caught swimming in early June and were eartagged. A list of marked animals appears in Appendix I. Unfortunately, the bull drowned later in the summer during an attempt to equip it with a radio-collar. An autopsy report appears in Appendix II. No information on the calf has been acquired since its capture.

The minimum summer range for 1975 (n = 35) comprised 135 km^2 and was slightly larger than the spring range. The actual summer range was probably larger and is estimated below. Only two caribou were seen

on Obukowin Lake in the summer. In addition, an immature male was seen at Carroll Lake by personnel of the Carroll Lake Camp at the end of June. No activity of other Aikens Lake caribou was known to occur east of the Ontario border despite intensive investigation.

The winter range (n = 89), 95 km^2, was smaller than either the spring or minimum summer ranges. Its boundaries were verified by aerial surveys. Fig. 11 shows that a large amount of overlap existed for spring, minimum summer, and winter ranges in 1975.

Fig. 12 shows the seasonal ranges for 1976-1977. Data for each range include radio-telemetry detections; two caribou were radio-collared during the second year of study. The spring range for 1976 (n = 97) was relatively large: 245 km^2, compared to 110 km^2 for spring 1975. This difference was largely due to caribou occupying a smaller range in early spring 1975. It may also be due in part to less effort spent investigating the Aikens Lake area in late spring 1975, as mentioned before. Only one cow-calf pair and perhaps a second cow were known to be at Obukowin Lake in late spring 1976. One mature bull and a cow-calf pair were known to be at Aikens Lake.

The minimum summer range for 1976 (n = 171) was 125 km^2, but again the actual summer range was estimated to be larger. A slight increase over spring activity occurred at Aikens Lake but not at Obukowin. A summer sighting of a possible herd member occurred on P.T.H. 304 (F. Baker, pers. comm.). Infrequent sightings of caribou on the road have occurred in the past (section 5.3.6).

The autumn range for 1976 (n = 126) was smallest (115 km^2), and the winter range (n = 125) was 140 km^2. The boundaries of these latter

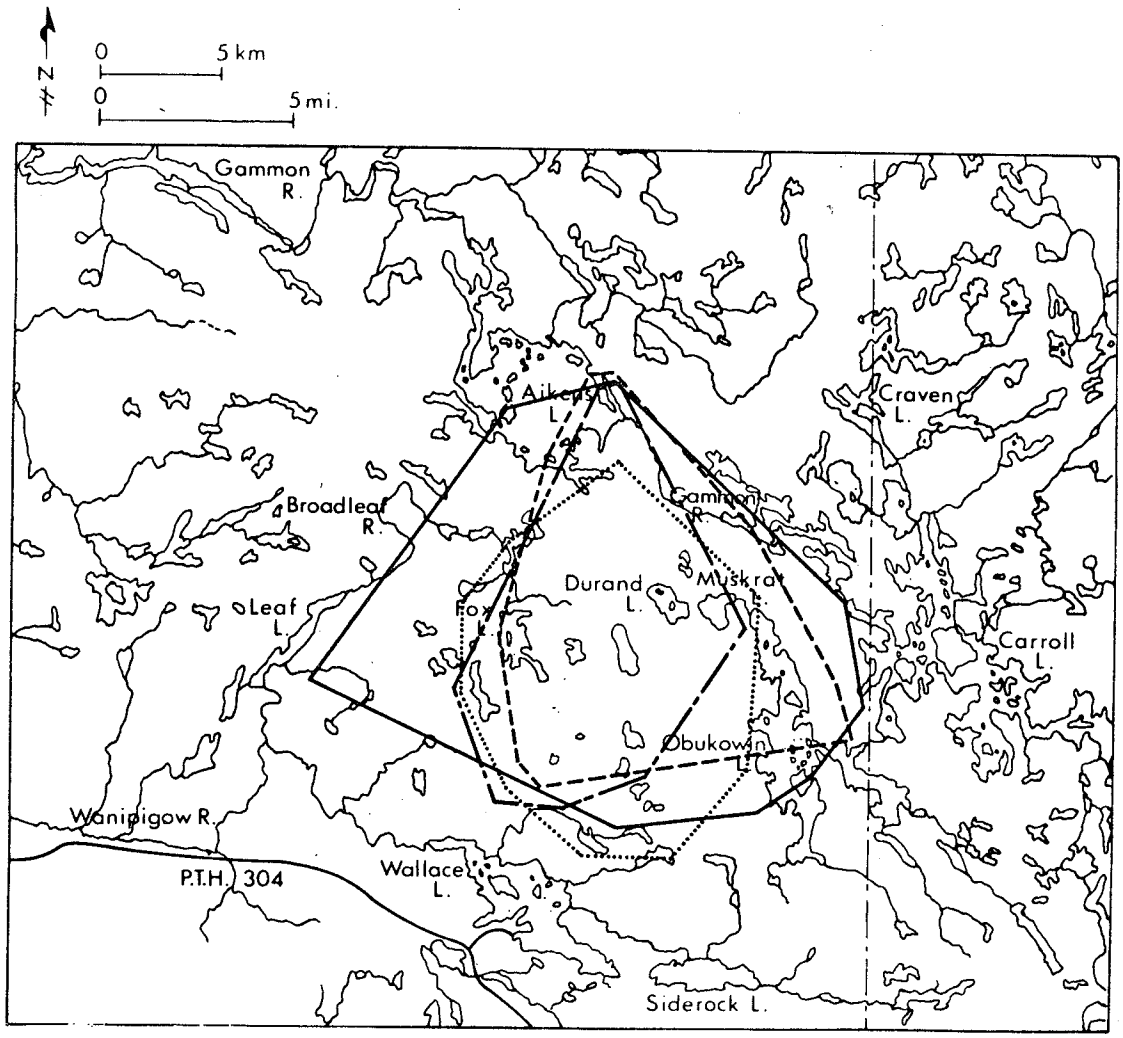


Figure 12. Seasonal ranges of the Aikens Lake herd for 1976-1977.

two ranges were substantiated by aerial surveys. Fig. 12 shows a high degree of overlap of seasonal ranges for 1976-1977.

Fig. 13 shows the estimated summer range for 1975 and 1976 (530 km^2). This is based upon the minimum summer ranges and observations indicating use of adjacent areas. Intensive investigations near major water systems, plus interviews with lodge personnel, fishermen, and canoeists, substantiated the eastern, southern, and northwestern margins of the estimated summer range. Only two observations of sign of Aikens Lake caribou occurred east of the Ontario border. These were the immature male seen at Carroll Lake Camp, and two bull antlers that had been dropped several years earlier on an island at the Gammon River outflow from Carroll Lake. Other caribou herds were known to use the area of Royd and Gammon lakes east of the study area, plus Haggart and Bulging lakes to the southeast (section 5.3.6).

Logistic problems made it difficult to monitor activity in the western and northeastern parts of the estimated summer range. Most information was acquired during summer 1976 when low water levels improved the observation of tracks on sand beaches. Some caribou were known to cross the Gammon River at various times, but their alternating direction of travel suggested that they did not range too far. Only six crossings were noted in summer 1976, excluding the movements of a radio-collared bull. All crossings were by single caribou except one involving three adults. Of these, five occurred within 1.5 km of Aikens Lake.

Similarly, caribou were known to use the area of Fox Lake in summer months, but it is not known how far west they dispersed. One

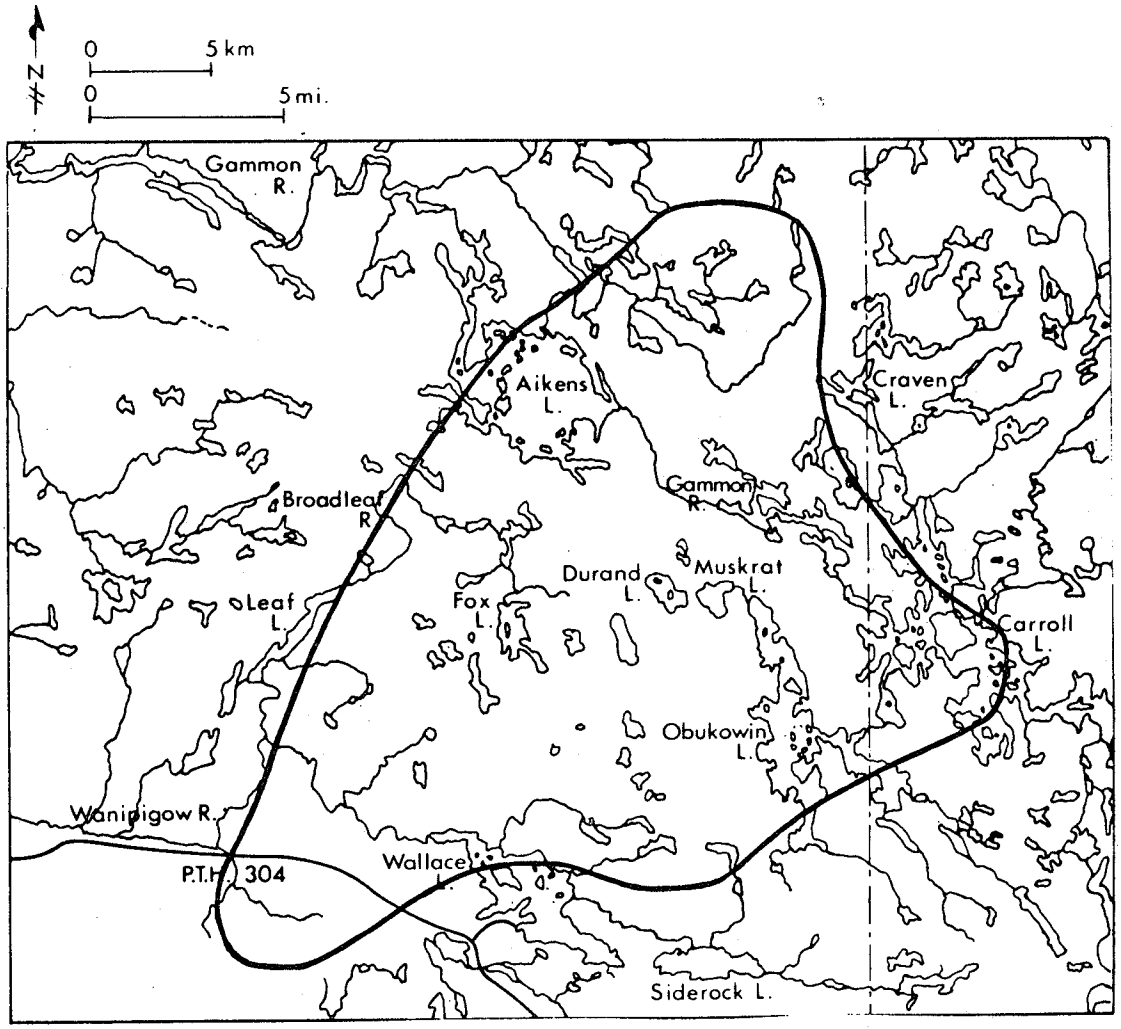


Figure 13. Estimated summer range of the Aikens Lake herd for 1975 and 1976.

trip was made up the Broadleaf River and canoeists were interviewed; no evidence of caribou activity was observed. In addition, investigations in October 1976 showed that many caribou had continued to use the winter range in summer. Thus, Fig. 13 shows the probable extent of summer dispersal.

Aikens Lake caribou were found to undergo seasonal changes in their gregarious behaviour (section 5.1.2). During winter months, caribou were aggregated into bands of 1 to 17 animals on the winter range. With the onset of spring, caribou became restless and subsequently dispersed. They expanded their range and by June assumed a more or less solitary behaviour.

Restlessness was found to precede the onset of dispersal and to vary in character from one spring to another. Fig. 14 depicts the extent of this restless movement for early spring (late March and early April) in 1975 and 1976. Warm temperatures and rapid deterioration of snowcover prevailed at that time of year (Figs. 6 and 7).

In 1975 caribou temporarily decreased the extent of their range. I conducted one aerial survey on 30 March 1975 which revealed the area occupied to be only 80 km^2 (n = 17). Five days later, on 4 April 1975, Hill (1979) saw 30 to 35 caribou together on Ridge Lake within this same area (Fig. 14). Conversely, in 1976, caribou expanded their movements from a winter range of 95 km^2 (n = 89) to an early spring range of 180 km^2 (n = 82). Both winters were relatively mild ones with no major differences in snowcover or weather during early spring.

In late March 1977, a shift in range again took place, but all animals moved northeast from their winter distribution (Fig. 15). The

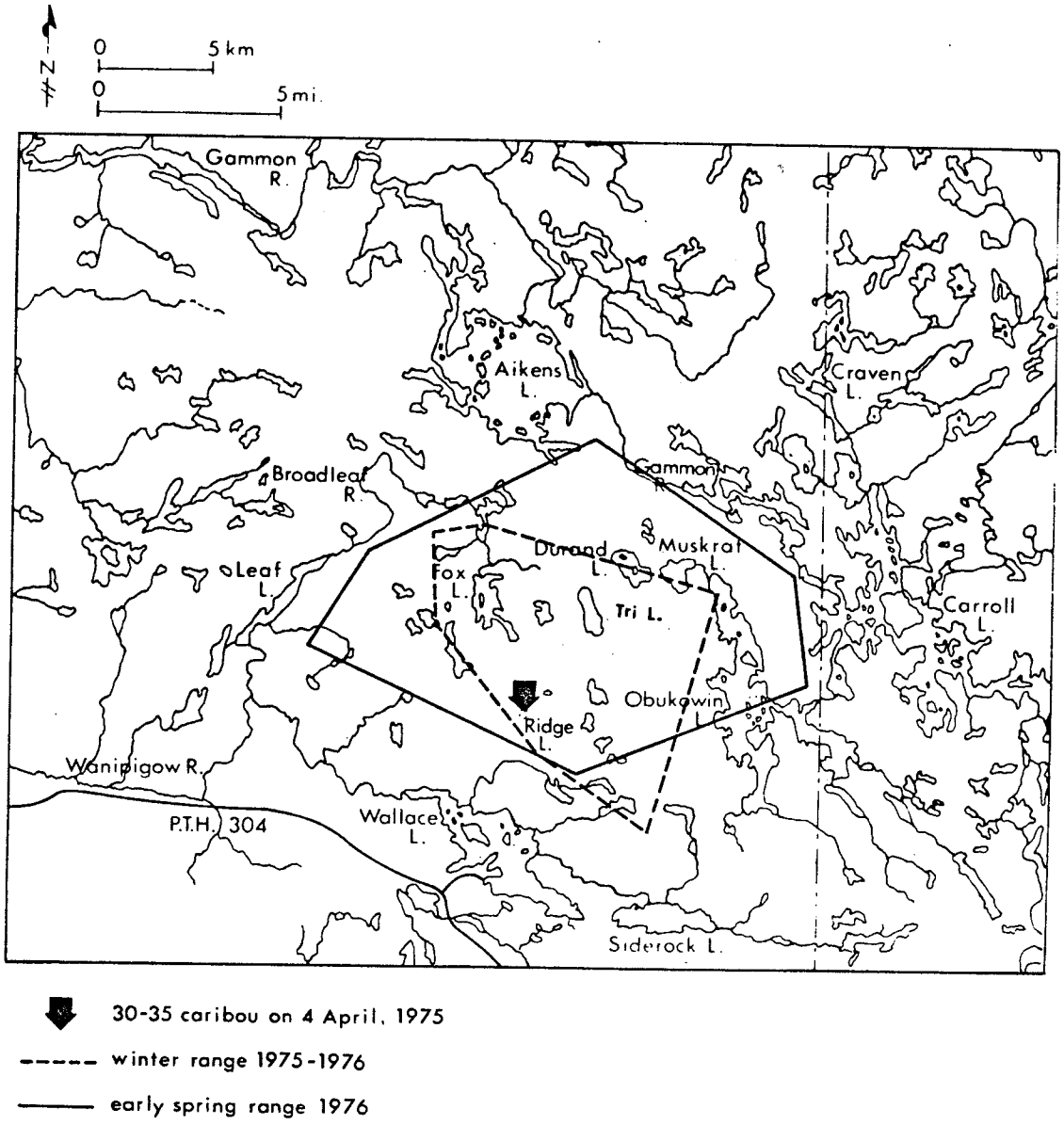


Figure 14. Early spring movements of Aikens Lake caribou in 1975 and 1976.

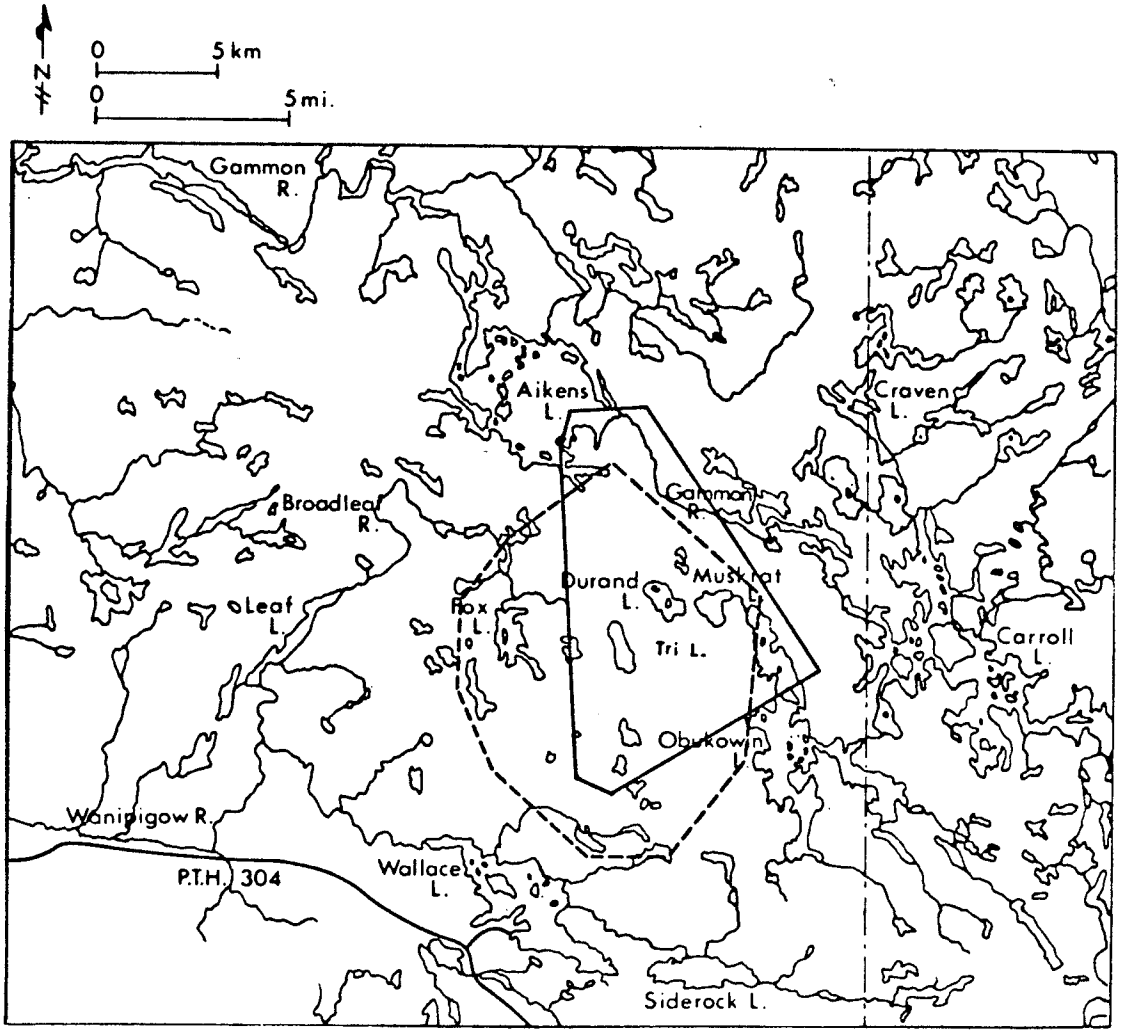


Figure 15. Early spring movements of Aikens Lake caribou in 1977.

area occupied decreased slightly in size from 140 km^2 (n = 125) in winter 1976-1977 to 100 km^2 (n = 42) in early spring 1977.

5.1.2 Seasonal Changes in Gregarious Behaviour

Table 1 summarizes the seasonal changes in mean band size and mean range occupied from 21 June 1975 to 1 April 1977. The data are organized to reflect the timing of spring dispersal; data for early spring (21 March to 4 April) are separated from those for late spring and summer (mid-May to 21 September).

Fig. 16 shows the relationship between amount of range occupied and the amount of gregarious behaviour. Caribou occupied a mean range of 140 km^2 during early spring 1976 and 1977. This is slightly larger than that for winter (117 km^2) and reflects an increase in restlessness, not the onset of dispersal. Mean band size for early spring was 5.8 (range = 1-19, n = 16) and similar to that for winter. Thus, caribou did not disperse before 1 April.

The mean minimum range for late spring and summer was similar to other seasonal ranges (145 km^2), but the actual summer range could have been as large as 530 km^2. Mean band size, on the other hand, dropped to 1.2 (range = 1-3, n = 55). Caribou were essentially solitary by June and remained so throughout summer when they were most often seen as singles or pairs. However, observations at Obukowin Lake in 1975 and at Aikens Lake in 1976 were often localized.

By 15 September, caribou were aggregating for the rut. Unfortunately, I was not able to observe rutting activity, despite

Table 1

Seasonal changes in mean band size and mean range occupied for Aikens Lake caribou from 21 June 1975 to 1 April 1977

	Early spring	Late spring and summer	Autumn	Winter
Mean range size (km^2)	140	145	115[a]	117
Estimated range (km^2)		530		
Mean band size	5.8 (n = 16)	1.2 (n = 55)	6.2 (n = 17)	5.5 (n = 82)

[a]1976 only.

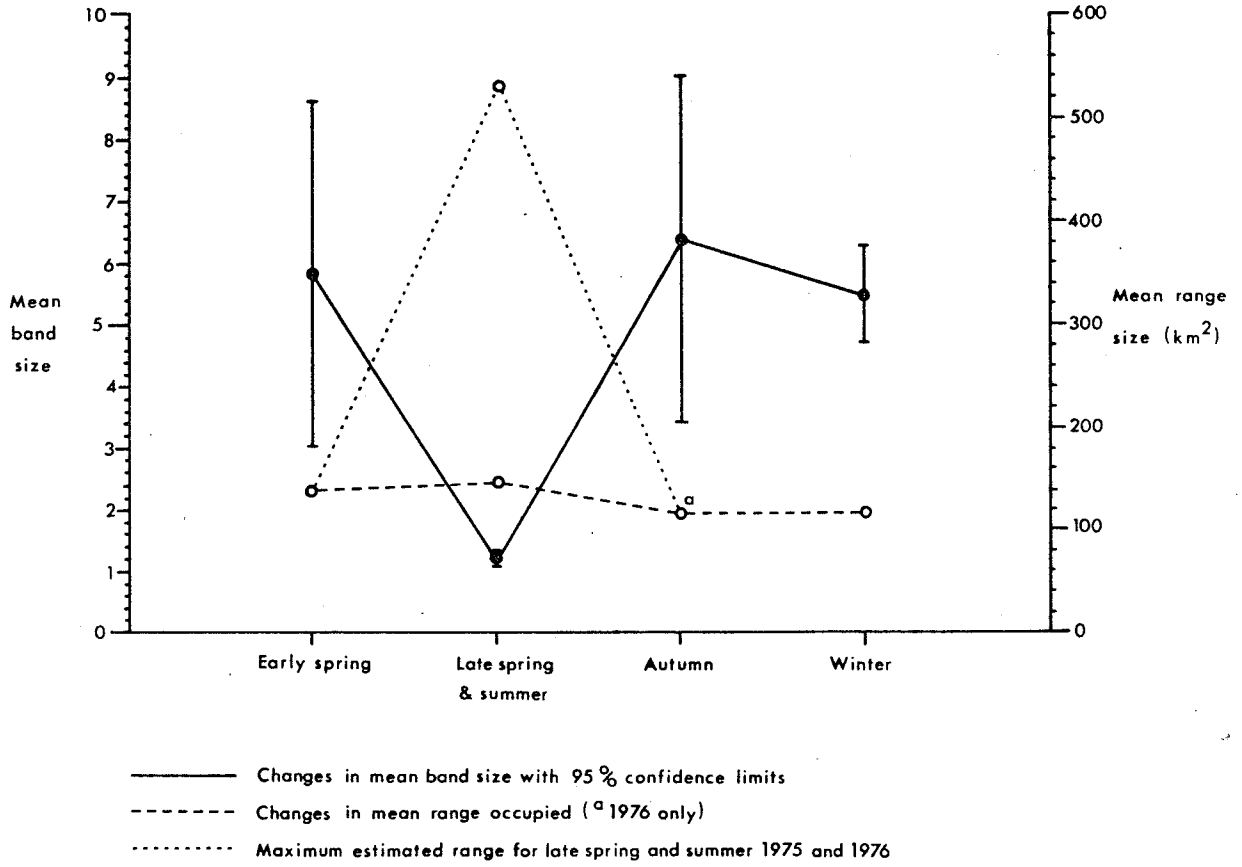


Figure 16. Seasonal changes in mean band size and mean range occupied for Aikens Lake caribou from 21 June 1975 to 1 April 1977.

several attempts to do so. Caribou were exceedingly difficult to locate and stalk successfully. Thus, no specific dates were determined for the peak rutting period. A mature radio-collared bull showed active movement within the distribution of cows from 20 September to the end of October.

Caribou were most gregarious during autumn, with a mean band size of 6.2 (range = 1-24, n = 17). The largest groups were observed in early December. Conversely, autumn range size for 1976 (115 km^2) was smaller than mean values for other seasons.

Caribou were gregarious throughout winter; mean band size was 5.5 (range = 1-17, n = 82). Mean range size (117 km^2) remained relatively unchanged from autumn. During both winters of study, caribou were aggregated into fairly small bands that exhibited considerable mobility. In addition, band size fluctuated greatly in both winters. No bands of consistent size were observed for more than two weeks.

5.1.3 Seasonal Ranges of Radio-Collared Caribou

Two mature caribou were equipped with radio-transmitter collars during 1976. These animals, Candy, a cow, and Blue, a bull, provided supplementary movement and activity data to the overview acquired for the population.

Fig. 17 depicts the seasonal ranges of Candy for the period May 1976 to March 1977. She was captured on 19 May 1976, while swimming with a young calf from an island in Obukowin Lake. The calf is believed to have been born on one of the islands. After release,

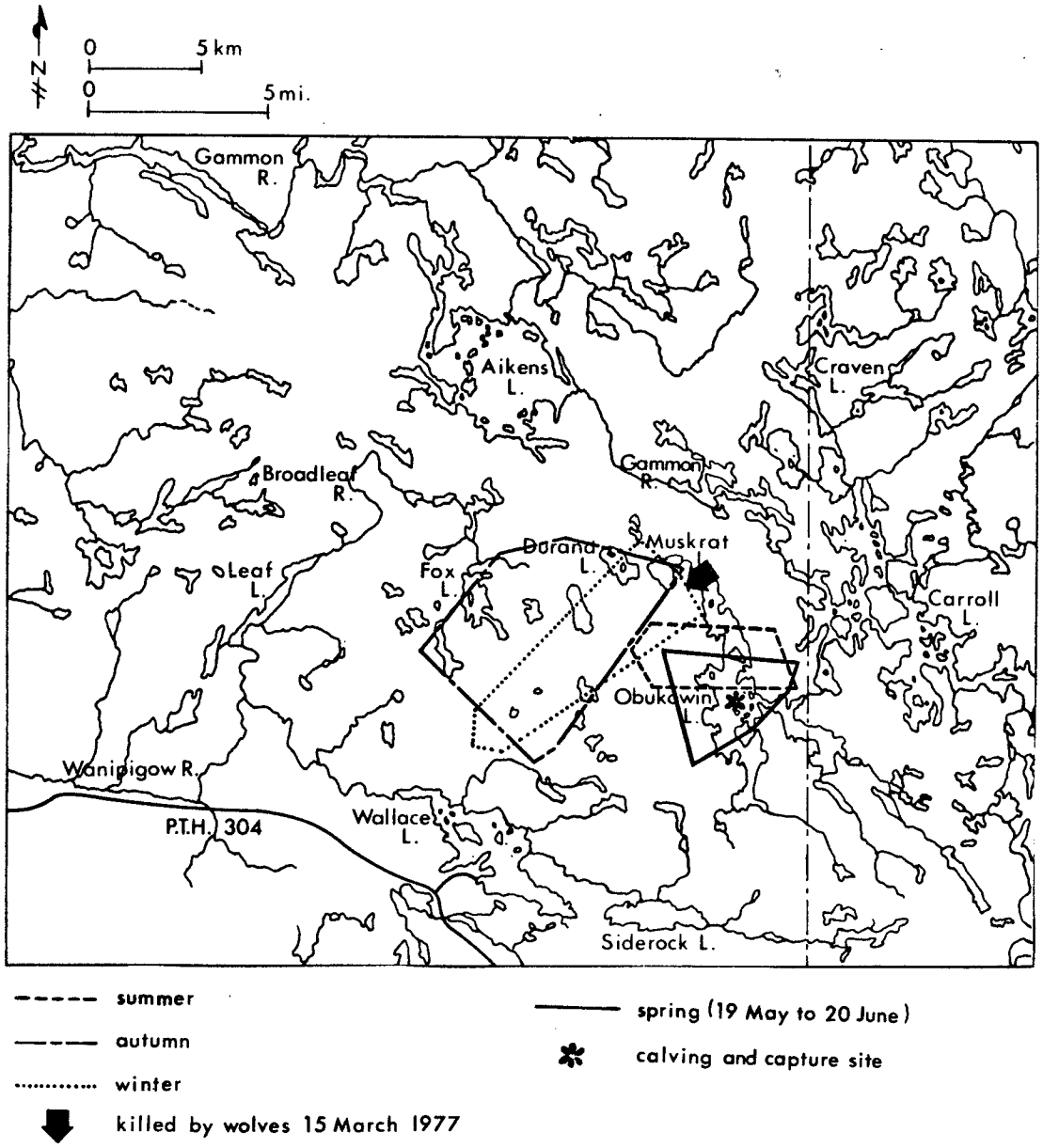


Figure 17. Seasonal ranges of the mature cow, Candy, May 1976 to March 1977.

Candy apparently failed to reunite with her calf. It was later captured and raised in the field for studies on growth, behaviour, and food habits (section 5.2.6).

During late spring and summer, Candy occupied quite small areas of 17.2 km^2 (n = 17) and 15.4 km^2 (n = 13), respectively. The late spring and summer ranges were adjacent and partially overlapping.

In late September, Candy moved approximately 7 km west to the area of open bogs occupied by caribou during the rut. While the herd decreased its range to 115 km^2 in autumn, Candy expanded her range to 56 km^2 (n = 31).

Due to reception difficulties with Candy's radio-collar in winter, only seven detections were obtained. On the basis of these limited data, she maintained a winter range of at least 34.4 km^2. On approximately 15 March 1977, she was killed by wolves. A description of the kill, as interpreted from fresh tracks and sign, is presented in Appendix III. Her age at death was estimated to be 9±1 years from annuli in the dental cementum. Autopsy results appear in Appendix II.

Until winter, radio-telemetry reception of Candy was quite successful. The mean success rate for spring, summer, and autumn was 83.6%. Most unproductive attempts to establish radio contact were followed by successful contacts later the same day. More prolonged periods of unsuccessful reception were infrequent, and contact was usually reestablished within 24 hours. This indicated that the animal probably did not range very far.

With the advent of winter, reception became unreliable, and the mean success rate of reception fell to 29.4%. Signal strength and

pulse rate decreased sharply as the ambient air temperature fell below -20°C. Below -25°C the collar ceased to transmit entirely, despite the manufacturer's "cold weather" modification. Prolonged exposure to cold resulted in frequency instability and channel skip from an original setting of 151.120 MHz to values that were often beyond the receiver's upper limit (151.150 MHz). A high proportion of unsuccessful attempts to establish radio contact were due to this problem. Reception during aerial survey was greatly improved, but a shortage of funds prevented more frequent use of this technique.

Seasonal ranges of the mature bull, Blue, are shown in Fig. 18. This animal was first observed on the shore of Aikens Lake during late June 1976. It was captured from a boat on 17 July and equipped with a radio-collar (Fig. 19). Intensive observation of the bull during July and August revealed very sedentary and habitual behaviour. Blue spent most of the summer at Aikens Lake occupying an area of only 9.8 km^2 (n = 57). He alternately occupied the long eastern point of the lake and the southeastern shore for several days at a time. In each area he repeatedly used specific beds in or near favoured feeding sites.

During summer, Blue disappeared for one to three days every four to six weeks. He went south of Aikens Lake on these occasions, but it was not possible to quantify his movements. It is likely that he went to the area of open bogs where the rut occurred in autumn.

Blue's autumn range comprised 52.9 km^2 (n = 22) and consisted of an elongation of his summer range to the south. I observed no evidence that he used the northern third of his autumn range after late September. During the rut, Blue was constantly moving about the

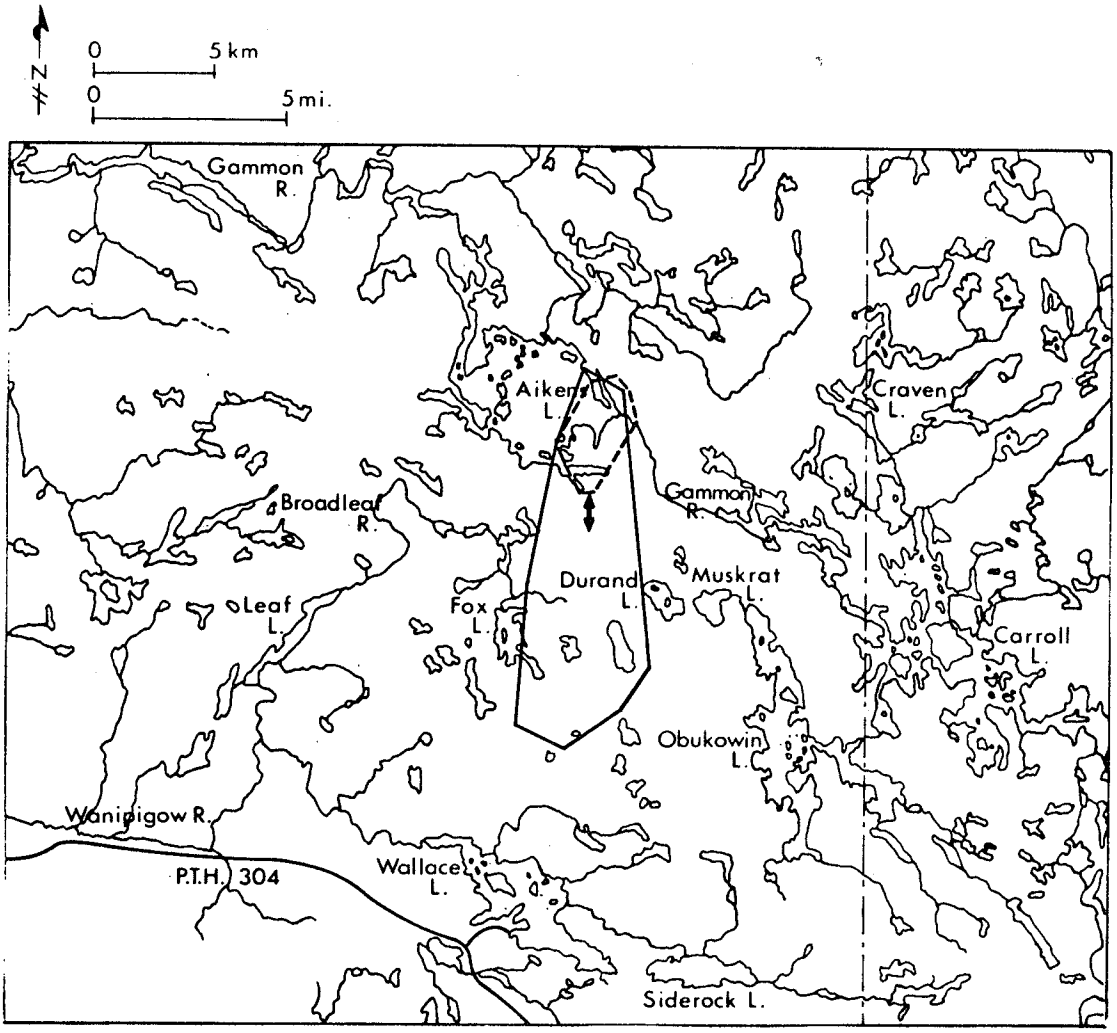


Figure 18. Summer and autumn ranges of the mature bull, Blue, 1976.

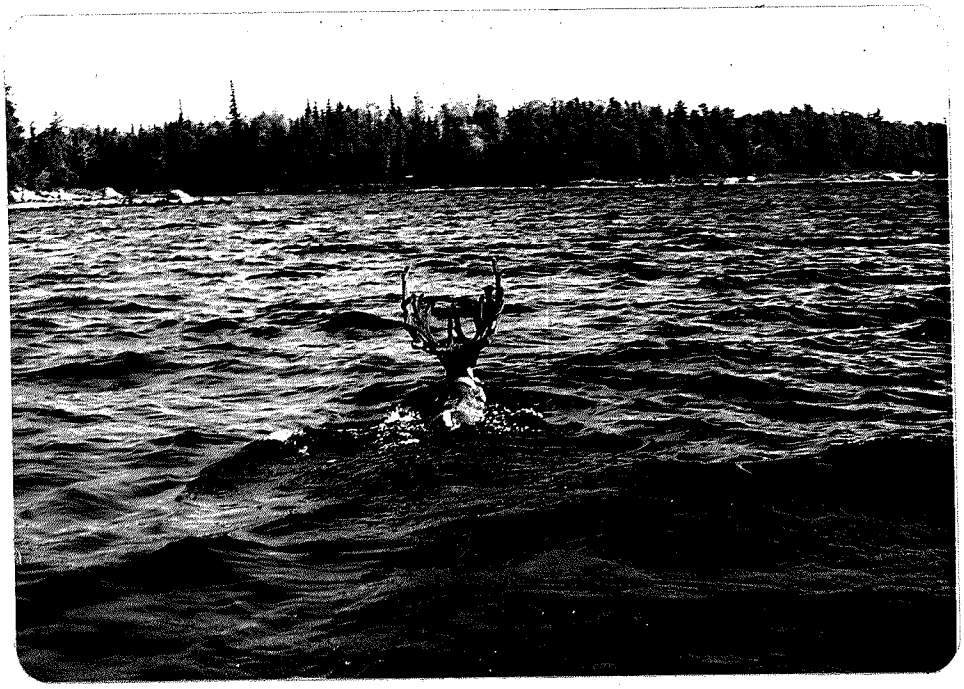


Figure 19. The mature bull, Blue, after being equipped with a radio-collar at Aikens Lake.

southern two-thirds of his autumn range. Unfortunately, his radio-collar ceased to work with the advent of cold weather in late November. Data on his winter range are therefore not available.

The summer success rate of radio-telemetry reception for Blue was 91.6%. This high level of success was mainly due to the bull's limited movements.

Until 15 November 1976, an autumn success rate of 59.2% was achieved. The decrease in success was due to two things. Essentially all travel during autumn was on foot, and Blue was seldom sedentary for any length of time. Some unsuccessful attempts were followed by successful detections later the same day. However, the lower success rate could have resulted in his autumn range size being slightly underestimated.

From 27 November 1976 to 30 March 1977, at least 50 attempts were made to reestablish radio contact with Blue on a wide range of frequencies. These were made from tree towers, high ridges, and an aircraft. None was successful.

During all seasons, the effective range of radio reception from tree towers and high ridges, for both animals, was 1.5 to 7 km. Although the maximum range from an aircraft was never tested, reception improved greatly with increased altitude. Major factors affecting the range of reception were ambient air temperature, weather, topography, and forest density. In summer, reception seemed to be slightly better at night.

5.1.4 Seasonal Rates of Daily Movement of Radio-Collared Caribou

Minimum distances travelled (displacements) between successive radio-telemetry detections were used to determine seasonal rates of daily movement for Candy and Blue. Non-standarized rates of movement were distorted by irregular sampling. As the time between detections approached zero, the displacement approached the actual distance travelled. To standardize the data, detections spanning an interval of 20 to 84 hours were selected. The decision to use these limits was arbitrary; the main criterion was to maximize sample size while maintaining comparable data for analysis. Those detections in which caribou had been disturbed by observer presence were omitted. Of 126 detections for both animals, 54 intervals were selected, spanning a mean time of 30.7 hours. Two to six detections ($\bar{X}$ = 2.6) exist for each interval. Displacements for each interval were summated and adjusted to 24 hours to represent daily movement. The adjusted displacements do not reflect all of the wanderings of each animal but serve to indicate the amount of travel recorded within the seasonal ranges shown in Figs. 17 and 18.

Table 2 summarizes seasonal changes in mean daily displacement for Candy and Blue. The largest daily displacement was 8.3 km for Candy in autumn. She travelled a minimum distance of 8.7 km in 25.3 hours on 1 November 1976. The smallest daily displacement was 0 km for Blue in summer. On 20 and 25 July and on 5 August 1976, he did not move a detectable distance over intervals of 28, 24 and 24 hours, respectively. The first two intervals are based on two detections and the third is

Table 2

Seasonal changes in standardized daily movement data for Candy and Blue, 1976

Season	Animal	Number of selected intervals	Mean interval duration (hours)	Range of daily displacements (km/day)	Mean daily displacement (km/day)
Late spring	Candy	4	22.9	0.4-5.6	1.9
	Blue	0			
Summer	Candy	4	42.1	1.4-2.8	1.5
	Blue	20	28.0	0.0-2.5	0.6
Autumn	Candy	13	29.6	0.8-8.3	2.2
	Blue	11	31.5	0.5-6.6	1.8
Winter	Candy	2	53.2	1.1-1.7	1.4
	Blue	0			

5.2 Habitat Utilization and Food Habits

5.2.1 Winter

Fig. 20 shows the distribution of forest cover types in the study area and the caribou winter range for 1975-1976. The area of mature forest occupied by caribou was sandwiched between large immature jackpine stands to the east and west. Areas to the south, west, and northwest contained stands of immature to mature mixedwood and deciduous forest: trembling aspen, balsam poplar, and paper birch. In addition, the winter range was centered on a group of large open tamarack and black spruce bogs. Surrounding areas had fewer bogs.

Caribou continued to use the mature forest and bog habitat during the winter of 1976-1977 (Fig. 21). They occupied a range that largely overlapped that of the previous winter but extended slightly farther north.

The large tracts of immature jackpine shown in Figs. 20 and 21 resulted from forest fires (section 3.5). The more recent of these burns were 25 to 35 years old. They were characterized by the area of Carroll and Craven lakes that supported exceedingly dense stands of young jackpine 7 to 8 m high with only needle litter or bare rock on the forest floor. Stands of the lichens *Cladonia arbuscula*, *C. mitis*, *C. alpestris*, and *C. rangiferina* had regenerated well in open areas and along shorelines, but other food for caribou was generally insufficient.

Most of the mature upland forest appeared to be a fire-generated

Figure 20. Distribution of forest cover types in the study area and the caribou winter range for 1975-1976.

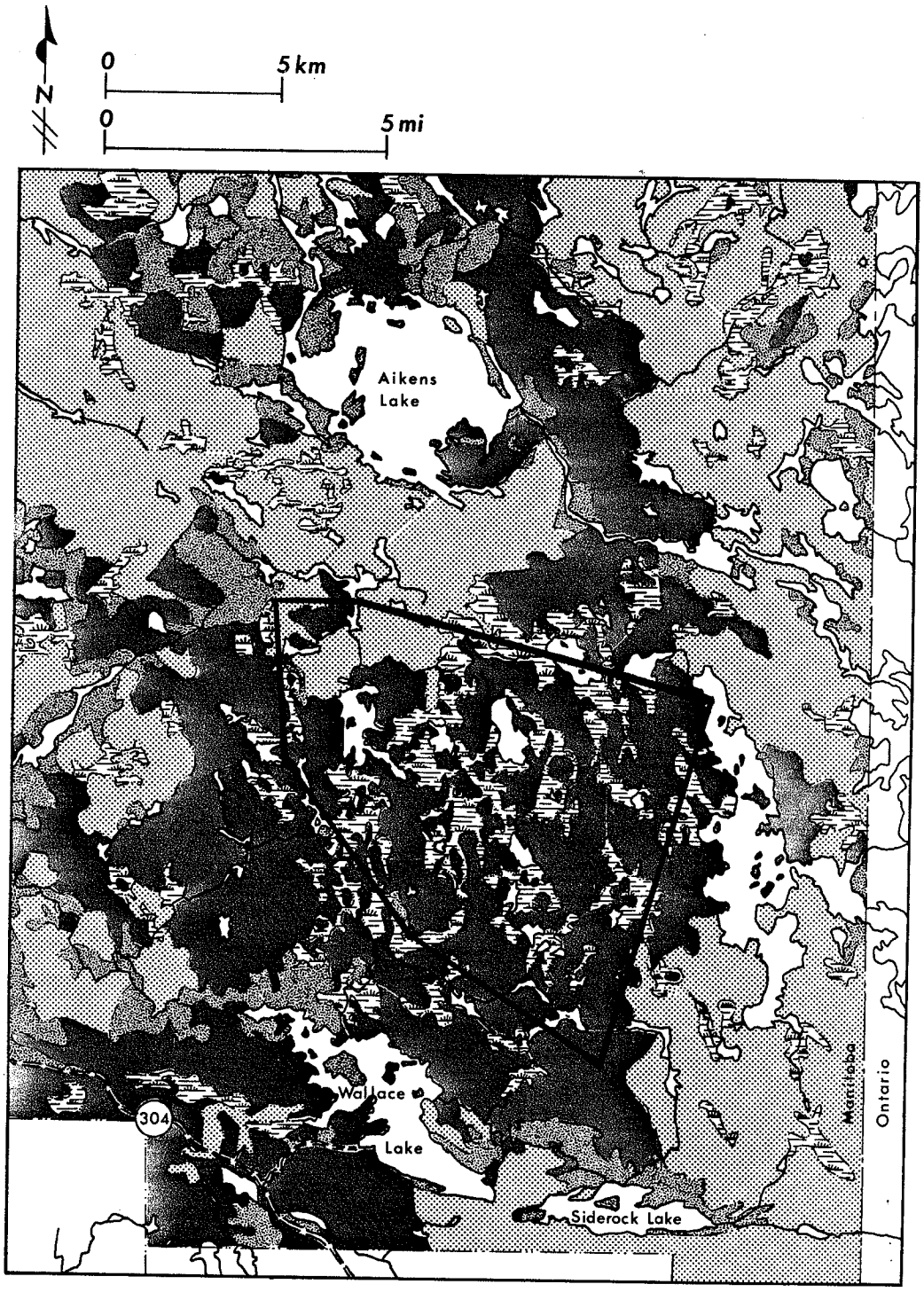

N
0
5 km
0
5 mi
Aikens Lake
Wallace Lake
304
Siderock Lake
Manitoba
Ontario
Mature coniferous forest
Immature coniferous forest
Mixedwood and deciduous forest

FIG 20

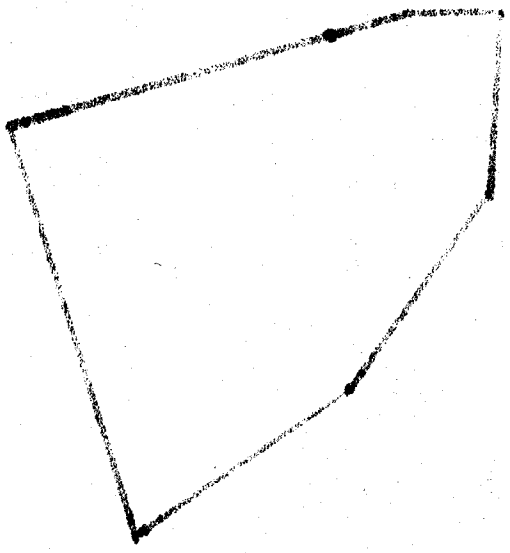


Figure 21. Distribution of forest cover types in the study area and the caribou winter range for 1976-1977.

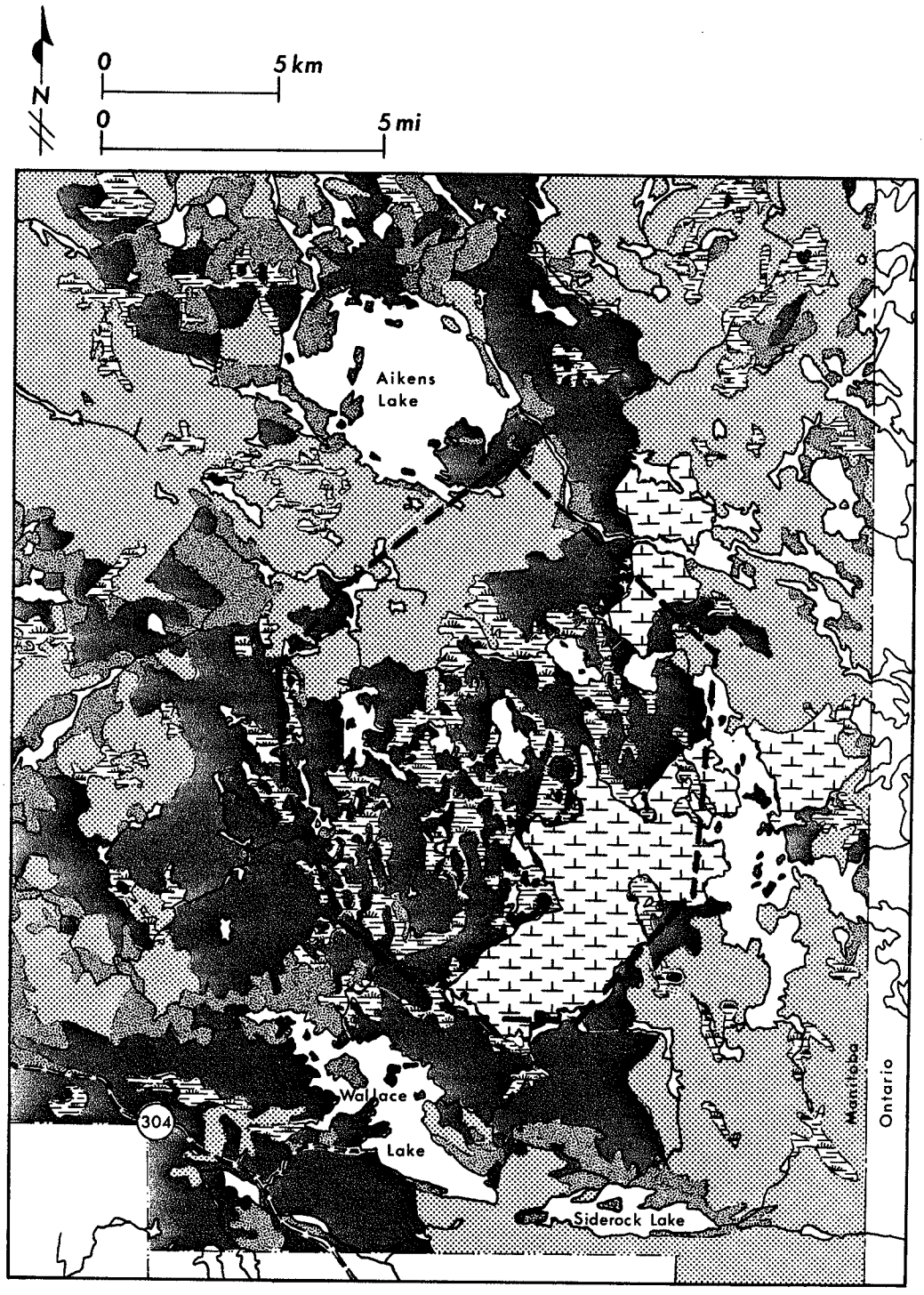
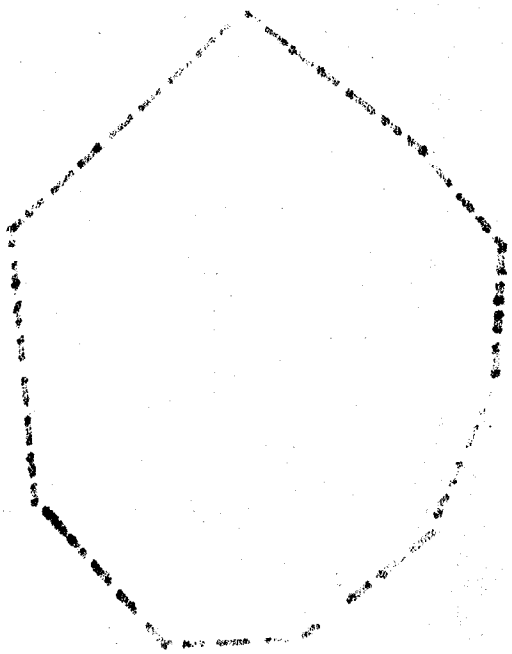

N
0
5 km
0
5 mi
Aikens Lake
Wallace Lake
304
Siderock Lake
Manitoba
Ontario
Mature coniferous forest
Immature coniferous forest
Mixedwood and deciduous forest
1976 burns

FIG 2



mosaic in which caribou usually occupied areas of jackpine and jackpine-spruce. Within favoured sites, lush stands of ground lichens and low ericaceous shrubs were established under relatively open canopies. Caribou made little use of black spruce-feather moss stands, and few areas of white spruce-balsam fir-white birch existed.

Table 3 summarizes forest cover type composition of the winter ranges for 1975-1976 and 1976-1977. Note the substantial proportion of semi-open and open bogs and the low percentage of mixedwood and deciduous forest.

Table 4 summarizes forest cover type composition of areas surrounding the winter ranges. There were fewer large open bogs in surrounding areas, and the percentages of immature jackpine forest and mixedwood and deciduous forest were both higher.

My observations of winter food habits indicate that Aikens Lake caribou do not use coarse woody browse as a staple element of their diet as do moose and white-tailed deer. Instead, they prefer lichens, sedges, and ericaceous plants (Table 5).

During early winter in both years of study, caribou made intensive use of open tamarack and black spruce bogs. They fed on arboreal lichens and dug feeding craters for sedges and ericaceous shrubs until nival conditions restricted their activity in open bogs. During late winter, caribou fed mainly on ground lichens on jackpine-rock ridges.

Caribou usually ate the tips of plants. They fed extensively on all plants exposed but very little on each. Two exceptions were observed. Firstly, when feeding on arboreal lichens on tamarack or black spruce, caribou often nibbled most of the lichens from parts of

Table 3

Forest cover type composition of the winter range for 1975-1976 and 1976-1977

Forest cover type	1975-1976		1976-1977	
	Area (ha)	Percent	Area (ha)	Percent
Semi-open and open bogs	892	9.4	1,160	8.3
Heavily treed bogs	2,109	22.2	3,001	21.4
Lakes	852	9.0	1,009	7.2
Mixedwood and deciduous	68	0.7	152	1.1
Immature jackpine	696	7.2	1,581	11.3
Mature coniferous	4,883	51.5	5,257	37.6
New burns			1,840[a]	13.1
Totals	9.500	100.0	14,000	100.0

[a]Bogs and lakes within limits of the new burns are not included.

Table 4

Forest cover type composition of areas shown in Figures 20 and 21 surrounding the winter range for 1975-1976 and 1976-1977

Forest cover type	1975-1976		1976-1977	
	Area (ha)	Percent	Area (ha)	Percent
Semi-open and open bogs	1,272	2.0	1,020	1.8
Heavily treed bogs	7,063	11.4	6,239	10.8
Lakes	8,768	14.1	8,585	14.9
Mixedwood and deciduous	6,627	10.7	6,379	11.1
Immature jackpine	20,856	33.5	19,381	33.6
Mature coniferous	17,578	28.3	14,780	25.6
New burns			1,280[a]	2.2
Totals	62,164	100.0	57,664	100.0

[a]Bogs and lakes within limits of the new burns are not included.

Table 5

Observations of some plant species eaten by Aikens Lake caribou in different seasons

Plant species	Winter and early spring	Late spring and summer	Autumn
	. . Number of observations[a] . .		
Ground lichens			
Cladonia rangiferina *Cladonia alpestris* *Cladonia mitis* *Cladonia arbuscula* *Parmelia* sp.	77	6	3
Arboreal lichens			
Usnea sp. *Alectoria* sp. *Ramalina* sp. *Evernia* sp. *Parmelia* sp.	56	12	8
Feather mosses			
Dicranum sp.	1		
Pleurozium schreberi	1		
***Sphagnum* moss**			
Sphagnum sp.	3		
Herbs			
Carex sp.	36		7
Corydalis sempervirens		1	
Epilobium angustifolium		1	
Equisetum sylvaticum		2	

. . . continued

Table 5 (continued)

Plant species	Winter and early spring	Late spring and summer	Autumn
	. . Number of observations[a] . .		
Trees			
Alnus crispa	5	1	
Betula papyrifera	1	1	
Larix laricina	5		
Salix sp.	4		
Shrubs			
Amelanchier		1	
Rosa acicularis		2	
Rubus strigosus		1	
Ericoids			
Andromeda glaucophylla	17		4
Chamaedaphne calyculata	4		1
Kalmia polifolia	10		3
Ledum groenlandicum	4		
Vaccinium myrtilloides	8		

[a]Mainly reflects the observer's ability to detect food eaten rather than the food preferences of caribou.

a twig or tree trunk, and they commonly broke twigs while pulling at the lichens. The finer portions of twigs were occasionally ingested with the lichens. Secondly, caribou at times fed so intensively on a small tamarack or paper birch (less than 1 m high) in a bog that they denuded it of the upper bark and limbs.

During most of the winter season, snowcover thickness was greatest in open bogs, less on jackpine-rock ridges, and least on lake ice (Figs. 22 and 23). Mean hardness values were less consistent, but snowcover on lake ice was usually harder than that in other habitats (Fig. 23).

Throughout most of each winter, snowcover thickness was less than the nival tolerance threshold of 65 cm determined for Aikens Lake caribou by Stardom (1975, 1977). During the winter of 1975-1976, maximum snowcover in semi-open and open bogs was 73 cm on 5 February (Fig. 22). Snowcover in these bogs only surpassed a thickness of 65 cm for approximately one week. Throughout most of the winter it varied from 46 to 54 cm. By comparison, snowcover on jackpine-rock ridges hovered around 40 cm.

Table 6 shows the percentage of observations of caribou activity recorded in each of four major habitats during the first winter of study. Observations are separated for periods of different nival conditions for comparison with Fig. 22. Some bias exists because caribou sign was more easily detected in open habitats, both on the ground and from the air. However, trends in the data are still apparent. During the period of maximum snowcover (1-8 February) I observed no appreciable decrease in the percentage of observations of caribou sign in semi-open and open bogs. However, I did observe that caribou

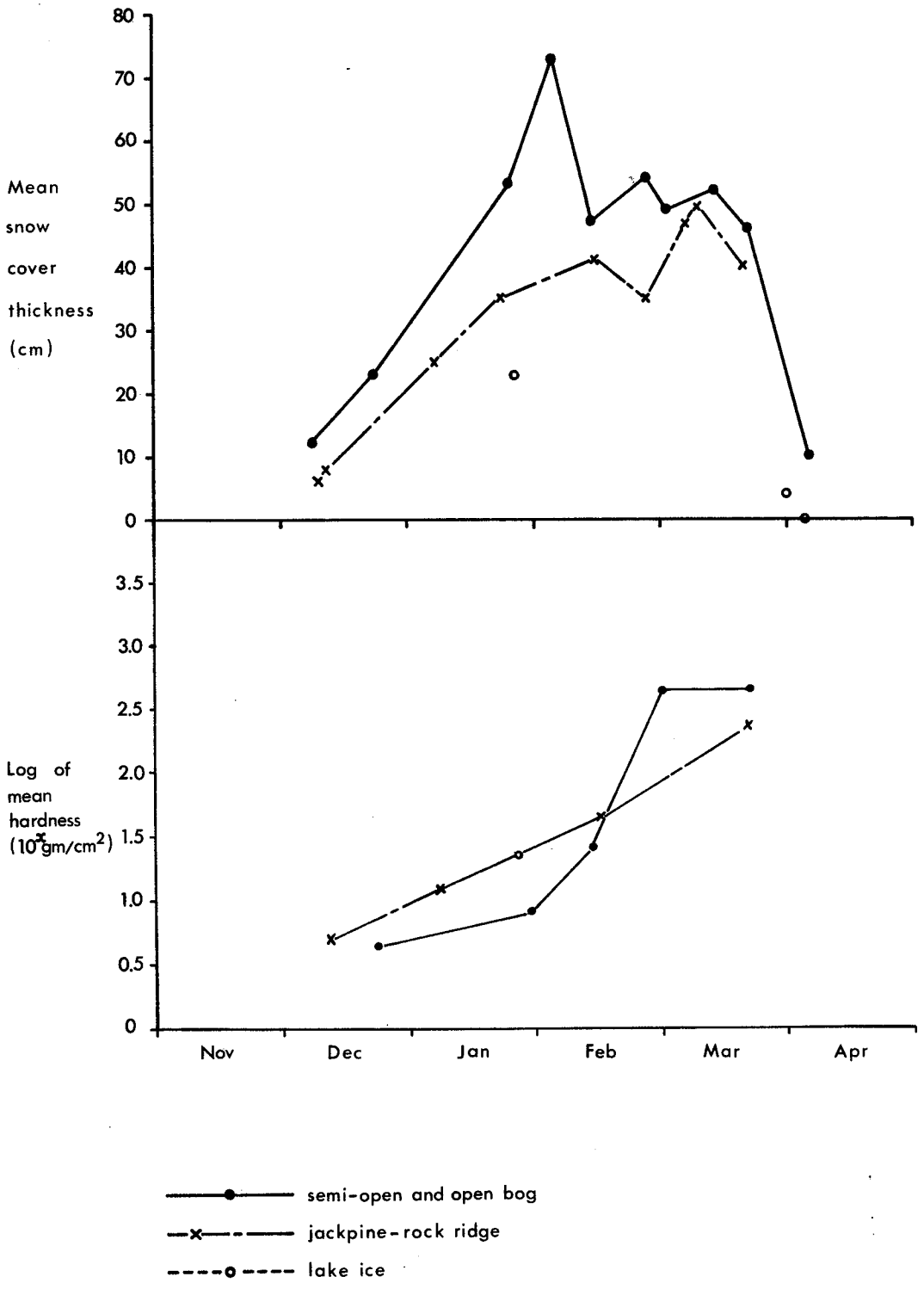


Figure 22. Summary of snowcover data for three habitats in the study area during 1975-1976.

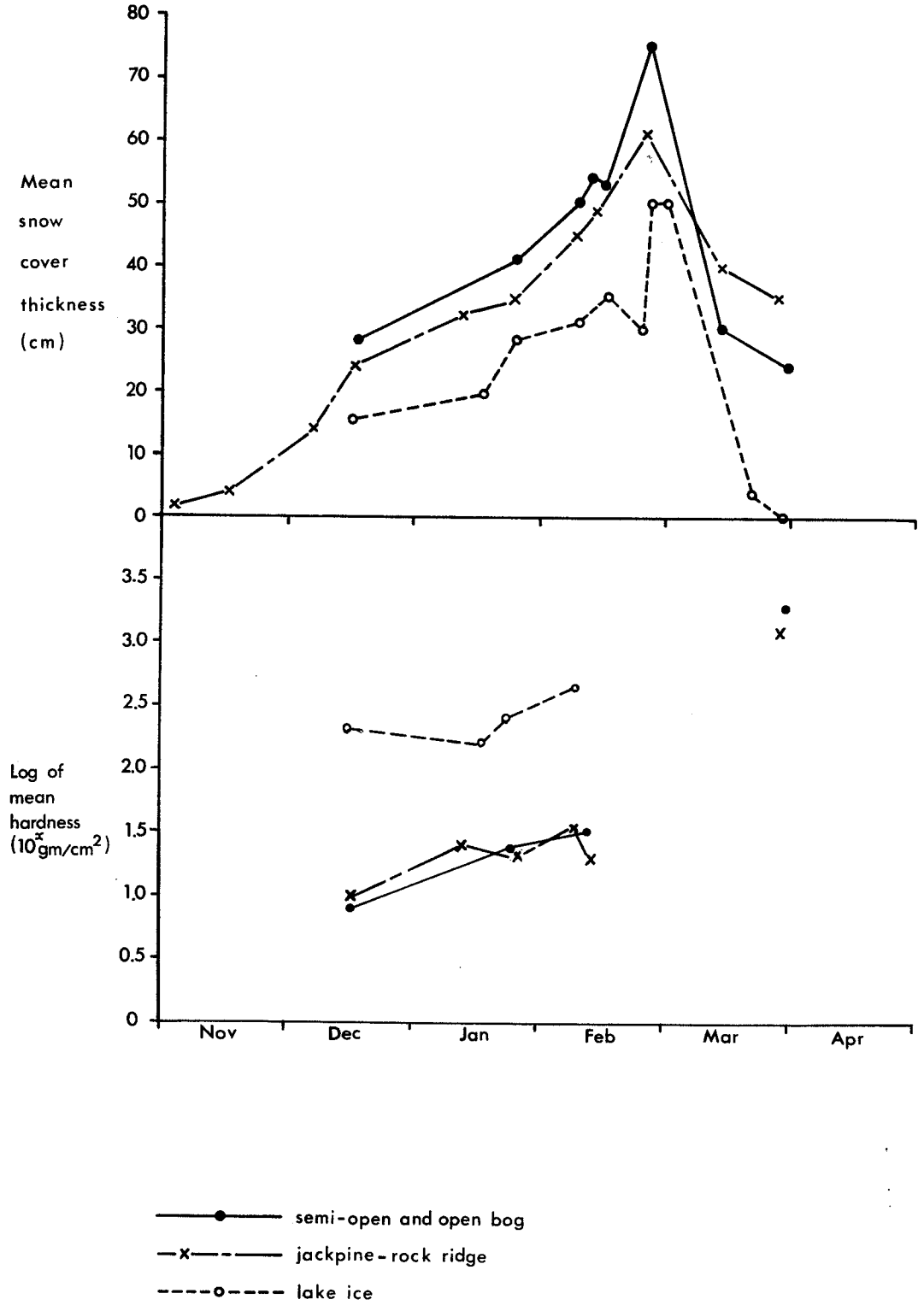


Figure 23. Summary of snowcover data for three habitats in the study area during 1976-1977.

Table 6

Percentage of observations of caribou activity in different habitats during periods of different nival conditions, winter 1975-1976

Habitat type	29 December to 31 January (n = 32, t<65 cm)[a]	1 to 8 February (n = 27, t≥65 cm)	9 February to 19 March (n = 45, t<65 cm)
	. . . Percent of observations . . .		
Semi-open and open bogs	34.4	33.3	33.3
Jackpine-rock ridges	37.5	37.1	46.7
Lake ice	28.1	18.5	15.6
Other	0.0	11.1	4.4

[a] t = snowcover thickness

switched most of their feeding activity to jackpine-rock ridges where they cratered for *Cladonia* spp. and some *Vaccinium myrtilloides* (Table 5). Caribou continued to cross bogs (thus keeping the percentage of observations high), but they generally did so at narrow locations and in single file.

Maximum snowcover thickness in the second winter coincided with a snowfall of 22 cm on 24 and 25 February (Fig. 23). Unfortunately, I do not have many activity observations for the following week. Thus, data in Column 2, Table 7, represent observations recorded when snowcover thickness exceeded 52 cm (11 February to 5 March). The proportion of observations in semi-open and open bogs declined by 14% during this period. However, the changes in behaviour described above were not readily apparent until snow depths were near maximum. The low percentage of observations in semi-open and open bogs from 9 to 19 March 1977 reflects a shift of most caribou to the northeast where few open bogs existed.

During both winters, little use was made of dense black spruce bogs. Lake ice was often used for travel, escape habitat and cratering for slush. Loafing on lakes was only common in late winter.

Mean hardness for snowcover in bog and ridge habitat was low until late winter and early spring (Figs. 22 and 23). No relationship to activity was apparent until that time. Caribou then either cratered on jackpine-rock ridges or fed at locations where melting and sublimation had exposed the ground vegetation (section 5.2.3).

On several occasions my technician and I observed cratering of snow on beaver lodges. Tracks around one of these suggested that some

Table 7

Percentage of observations of caribou activity in different habitats during periods of different nival conditions, winter 1976-1977

Habitat type	28 December to 10 February (n = 68, t<52 cm)[a]	11 February to 5 March (n = 59, t≥52 cm)	9 to 19 March (n = 16, t<52 cm)
	. . . Percent of observations . . .		
Semi-open and open bogs	39.4	25.4	6.2
Jackpine-rock ridges	27.3	42.4	43.8
Lake ice	16.7	20.3	43.8
Other	19.6	11.9	6.2

[a] t = snowcover thickness

caribou had been "playing" by climbing up and down on the lodge. Observations of a calf we raised in 1976 suggested that caribou may have been licking the dirt on lodges (section 5.2.6).

Fig. 24 shows the areas burned on 5 June 1976 in relation to the caribou winter range for both 1975-1976 and 1976-1977. Only seven of 125 observations (5.6%) of caribou activity occurred within the three burns during the winter of 1976-1977. No observations occurred in the burn near Aikens Lake, although caribou cratered in an open bog just south of it. Two occurred in the burn at Muskrat Lake, and five occurred in the Obukowin burn of which three were near the burn edge. Caribou crossed the Obukowin burn at least five times, and six observations of activity were located south of it.

This compares to 16 of 89 observations (18%) within the same areas the previous winter. All 16 took place near Cabin Lake in the southwestern corner of the subsequent Obukowin burn. Only three post-burn observations took place there. Thus, the only major change in winter range use was a decrease in activity near Cabin Lake. The loss of this part of the winter range was unfortunate. The ridges of mature jackpine between Cabin and Little Caribou lakes had been excellent sources of ground lichens. A mature crown canopy had permitted lichen growth but still accumulated heavy qali loads and served to reduce snowcover on the ground.

Of the total seven post-burn observations, two were located within the heart of a burn and both involved feeding activity. On 5 February 1977 my technician observed tracks of three caribou that had been cratering for sedges in an open tamarack bog north of Cabin Lake.

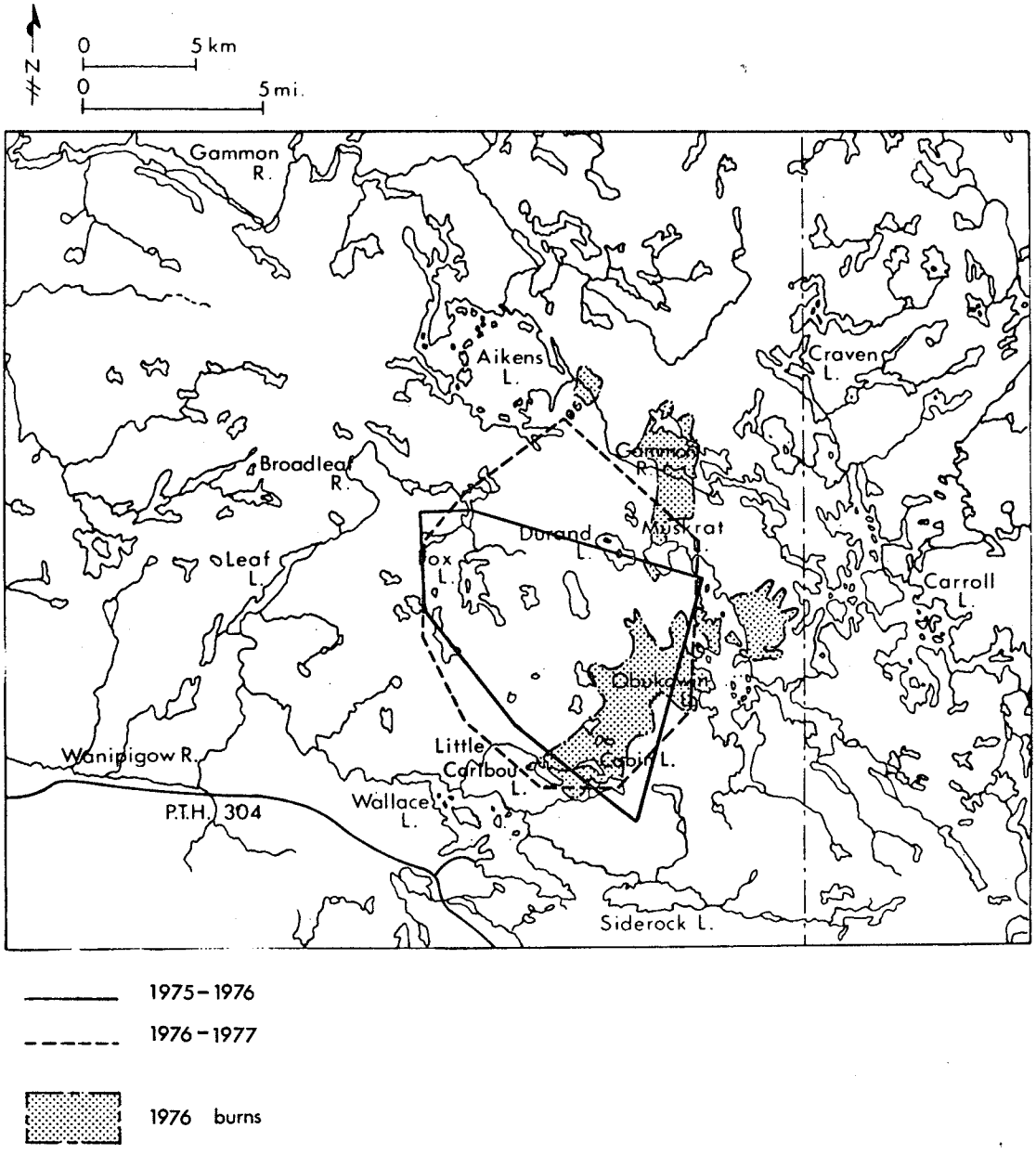


Figure 24. Distribution of the 1976 burns in relation to the caribou winter range for 1975-1976 and 1976-1977.

The southern portion of this bog and the surrounding ridges had been burned, but the caribou fed in an undisturbed part of the bog. On 15 February 1977, during an aerial survey, I observed fresh cratering and tracks of several caribou west of Obukowin Lake. The activity was located on a small burnt ridge in the middle of a moderately open tamarack and black spruce bog that was not burned.

Five of the seven post-burn observations occurred near edges of the burns, and two of these involved feeding activity. On 12 February 1977, two or three caribou had been wandering along a burnt ridge on the west side of Muskrat Lake. Tree trunks remained standing on the ridge, but all vegetation had been destroyed and rocky areas had been washed clean by summer and autumn rains. Regeneration had been very limited in the first summer. Still, the caribou cratered a few times, apparently without success. Then, on 15 February, during an aerial survey, I observed numerous fresh craters and tracks on jackpine-lichen ridges just north of the Obukowin burn. Some of the caribou had travelled 0.5 km into the burn and cratered on ridges that were entirely fire-blackened.

5.2.2 Winter Baiting Experiment

Despite a substantial amount of caribou activity in the area chosen for the experiment, only one caribou-bait encounter took place. On two occasions caribou passed close by the end of a row of baits (46 and 140 m), but no evidence of any response was apparent.

During the single encounter, caribou investigated two of six baits

but did not show any substantial interest in them. The six baits were arranged in a curved row along a lakeshore. On 24 or 25 February 1976, 12 to 15 caribou came onto the lake, passing amongst the six bait mounds. One caribou walked first to the 50:50 chopped hay-straw bait. The material had been nuzzled but none appeared to have been eaten. Tracks of the same caribou then led past the oats-straw combination to the 50:50 alfalfa pellet-chopped straw bait. It had also been nuzzled and some may have been eaten, but no substantial amount was consumed. All caribou then travelled further up the lakeshore.

Thus, caribou had to stumble onto baits before they acknowledged their presence, and then they showed only limited curiosity. Perhaps baiting would be more successful during a severe winter when food is more difficult to obtain.

5.2.3 Spring

During early spring of both years, caribou made intensive use of terricolous and saxicolous lichens exposed by sunlight in clearings on ridges, on south-facing slopes and on lakeshores (Table 5). By 1 April snowcover on the lakes was completely melted, and pools of water were often present on the ice. Caribou used lakes for travel and some loafing. On one occasion I observed four caribou browsing stems of young willow and green alder along the shore of Durand Lake. Caribou activity at beaver lodges was common.

By 1 April snowcover in open bogs was greatly reduced, and caribou tracks were sometimes observed that went from one snow-free spot to

another, a behaviour probably associated with feeding.

As mentioned in section 5.1.1, the onset of restlessness during late March was found to vary in character from one year to another (Figs. 14 and 15). Movements varied between years, but they reflect less association of caribou with semi-open and open bogs. Even in early spring 1975, when caribou aggregated before dispersing, an aerial survey on 30 March and the observation of Hill (1979) on 4 April showed virtually all activity to be concentrated on jackpine-rock ridges and along lakeshores (16 of 17 observations).

In each year, dispersal of caribou groups had occurred by June. The expansion of range reflects the use by caribou of a diversity of habitat types. Ground lichens became less important as foliage emerged; ground forbs and the leaves of deciduous trees and shrubs were apparently selected (Table 5).

While some caribou continued to occupy the winter range in late spring 1976, others utilized mixedwood and deciduous forest along the Gammon River, areas of mature forest at Obukowin and Aikens lakes, and immature jackpine stands south of Aikens Lake (Figs. 2 and 12). The latter area was more advanced successionally than the 1948 burn at Carroll and Craven lakes. It had more lichen growth, more diversity, and a higher shrub and forb density. No activity of Aikens Lake caribou was observed east of the Ontario border in late spring.

A limited amount of cow-calf activity was found on islands and lakeshores in three locations: Obukowin Lake, Aikens Lake and Fox Lake (Fig. 25). Activity of other caribou along major water systems was also limited. Cow-calf activity was not observed elsewhere, but an

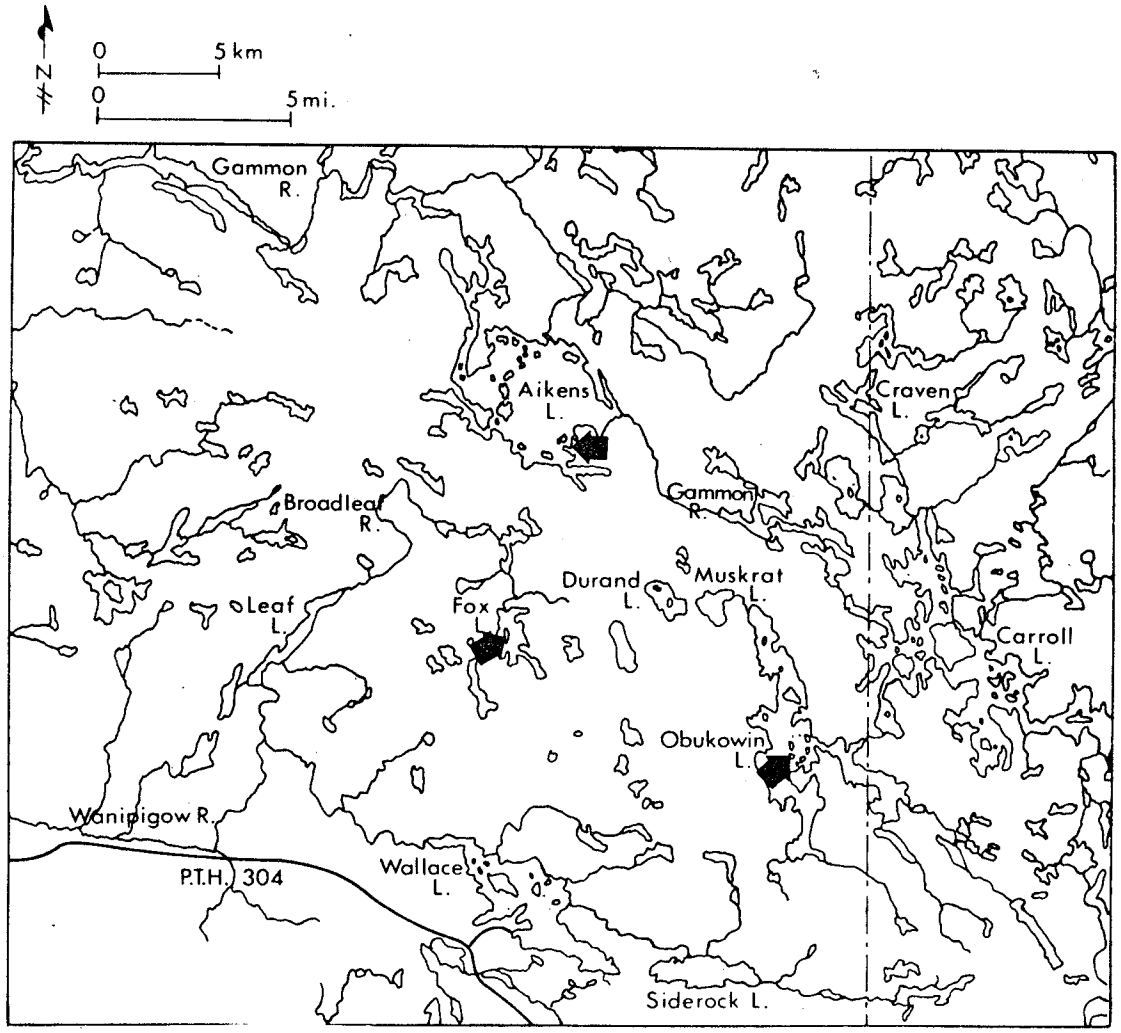


Figure 25. The known locations of cow-calf pairs in late spring 1975 and 1976.

extensive search of mainland areas was not conducted. Incidental hikes were made through mainland areas in late spring and summer, and ground survey of the central spring range was conducted in October 1976. These did not reveal any information on calving but they did verify summer use of mainland areas by other caribou. No doubt the mainland areas were also used in late spring.

Most sightings during late spring 1975 occurred within or near an insular complex in the centre of Obukowin Lake (Fig. 26). On 8 June, an antlerless cow and a calf were seen swimming from an island to the mainland. The calf was eartagged and estimated to be three to four weeks of age. The cow may have borne her calf on one of the islands; tracks and pellet groups of adult and calf caribou indicated that the islands had been used regularly. At the same time, a mature bull and one to three adult cows were using the area, but no evidence of other calves was observed.

On 19 May 1976, Candy and her calf were captured while leaving an island in the centre of Obukowin Lake. The calf was probably one week old at the time and was likely born on one of the islands. The only other evidence of caribou in the area during late spring was a single antlerless cow, possibly Candy, seen on 11 or 12 May by canoeists; it was swimming to one of the central islands.

The Obukowin Lake area was obviously important for some caribou during the calving period. The fire on 5 June 1976 destroyed a wide swath of forest on either side of the centre of the lake, but it did not burn the circle of islands. Candy continued to use the unburned areas (*e.g.* bogs) on either side of the lake, but no other caribou was

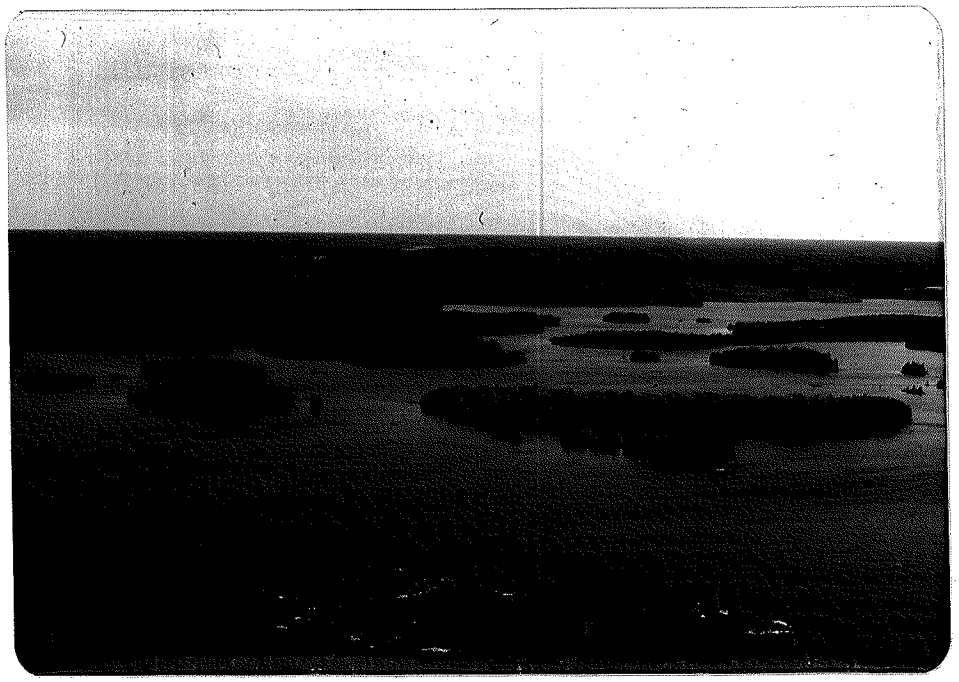


Figure 26. The central islands of Obukowin Lake.

known to do so.

During late spring of 1976 at least one cow-calf pair and one mature bull (Blue) were known to be using the southern and eastern shores of Aikens Lake (Fig. 27). On 11, 13 and 16 June, I observed fresh tracks of a cow and calf on sand beaches along the southern shore of the lake. Blue was sighted for the first time on 16 June. Evidence of his activity was observed along southeastern and eastern shores and on the long eastern point where the Aikens Lake Lodge is situated. Personnel at the lodge saw a mature bull (presumably Blue) on the point on 30 May. No evidence was acquired indicating use of the area by other caribou until later in summer.

Prior to the fire of 1976, the habitat around central Obukowin Lake was quite different from that to the north or south. At the northern end, the area east of the lake supported dense immature jackpine. The northwestern side supported black spruce-feather moss on most slopes and depressions, and mature jackpine with ground lichens on xeric sites. The southern and eastern third of the lake also supported immature jackpine. However, the central area, where most caribou activity occurred, was characterized by mature diverse habitat dominated by jackpine and black spruce. It offered a variety of deciduous shrubs and ground forbs as summer food for caribou. White spruce, balsam fir, paper birch, and trembling aspen were subdominant. Some of the more abundant shrubs were: green alder, serviceberry, bearberry, red-osier dogwood, pin cherry, wild rose (*Rosa acicularis*), red raspberry (*Rubus strigosus*), and blueberry. In some areas, young paper birch and trembling aspen saplings were present in the understory.

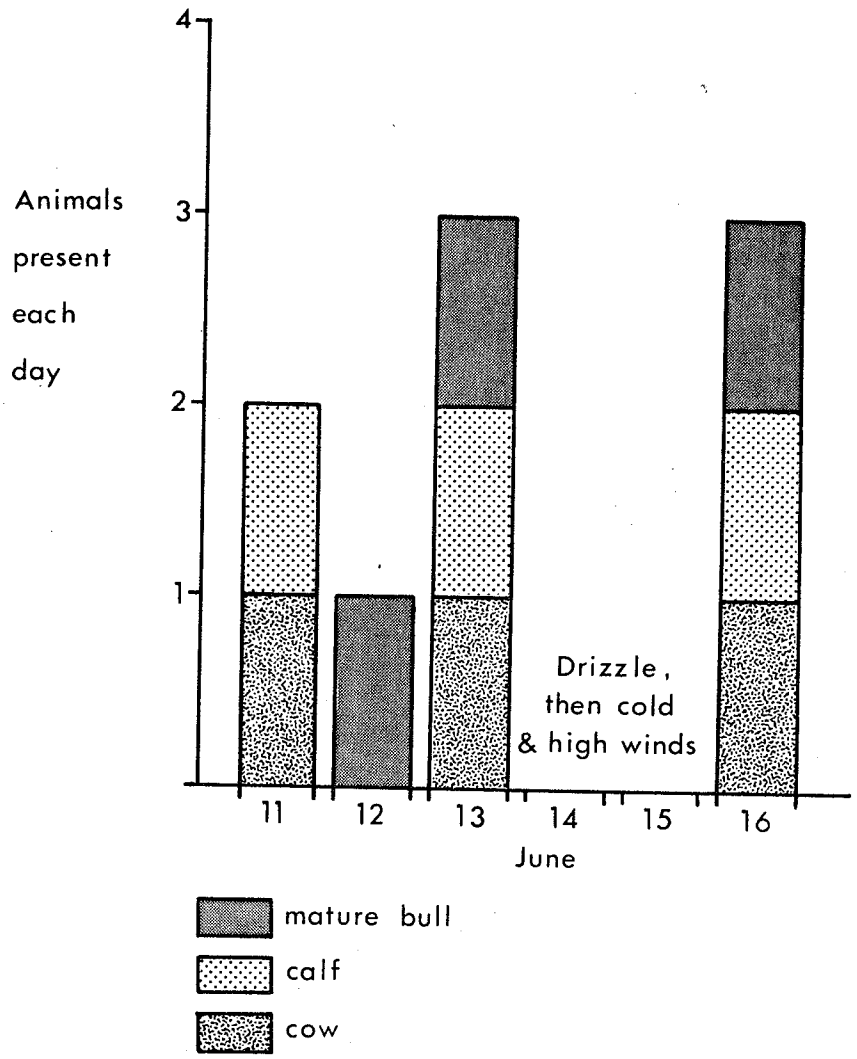


Figure 27. Caribou activity on sand beaches on the southern and southeastern shores of Aikens Lake, 11 to 16 June 1976.

Ground forbs were numerous and varied. Some examples are: spreading dogbane (*Apocynum androsaemifolium*), prince's pine (*Chimaphila umbellata*), bunchberry (*Cornus canadensis*), pale corydalis (*Corydalis sempervirens*), fireweed (*Epilobium angustifolium*), woodland horsetail (*Equisetum sylvaticum*), twinflower (*Linnaea borealis*), and round-leaved pyrola (*Pyrola rotundifolia*).

The islands in Obukowin Lake most often used by caribou were either diverse in vegetative character with areas of open forest, or they had substantial amounts of arboreal or ground lichens. However, some islands in the central circle, and many in the northern part of the lake, were not used very much. They were uniform in vegetative character and were covered by dense stands of white spruce-balsam fir-paper birch with some black spruce; ground cover was mainly feather moss and needle litter with some ground lichen.

Of those in the circle, two islands were used a great deal. Table 8 and Fig. 28 describe the vegetation of the largest of these in qualitative terms. Trees listed as ground cover in Table 8 are young saplings. Both islands were similar in character. The island shown in Fig. 28 was 5.7 ha in size; the other was smaller and was located immediately to the north. They had sloping shorelines, relatively open forest in some places, gentle topography, good conifer cover, small clearings, and a diversity of abundant deciduous shrubs and forbs. All ground lichens on the two islands were severely overgrazed and trampled. However, adequate supplies of ground and arboreal lichens were available on adjacent islands and on the mainland.

The vegetation of the southeastern and eastern shores of Aikens

Table 8

Composition of vegetation on a calving island in Obukowin Lake shown in Figure 28, August 1976

Sample plants	Open jackpine	Open spruce-fir-birch	Pine-spruce	Open paper birch	Balsam fir	Juniper clearing	Spruce-pine	Grass meadow	Feather moss clearing	Rock	Lichen clearing
	Forest cover type[a]										
Trees											
Abies balsamea	-	o	r	r	d	r	r	r	-	-	-
Betula papyrifera	r	o	r	f	r	-	r	r	-	-	-
Picea glauca	-	o	r	r	-	r	-	-	-	-	-
Picea mariana	r	a	a	f	-	-	a	-	-	-	r
Pinus banksiana	f	-	d	-	-	r	r	-	-	-	r
Populus tremuloides	-	r	-	-	-	-	-	-	-	-	-
Ground cover											
Abies balsamea	f	f	f	o	-	f	f	o	o	-	-
Amerlanchier canadensis	o	-	-	r	-	o	-	f	-	-	-
Aralia hispida	r	-	-	-	-	-	-	-	-	-	-

. . . continued

Table 8 (continued)

Sample plants	Open jackpine	Open spruce-fir-birch	Pine-spruce	Open paper birch	Balsam fir	Juniper clearing	Spruce-pine	Grass meadow	Feather moss clearing	Rock	Lichen clearing
	Forest cover type[a]										
Ground cover (continued)											
Arctostaphylus uva-ursi	-	-	-	-	-	-	-	o	-	-	-
Betula papyrifera	-	-	r	-	-	o	o	-	-	-	r
Chimaphila umbellata	o	r	-	d	-	o	-	-	-	-	-
Cornus canadensis	-	-	-	a	r	r	-	-	-	-	-
Dryopteris spinulosa	o	o	-	-	-	r	r	-	-	-	-
Epilobium angustifolium	-	-	r	-	-	r	-	-	-	-	-
Equisetum sylvaticum	-	f	-	-	-	-	-	-	-	-	-
Juniperus communis	f	o	-	o	-	f	-	f	-	-	o
Ledum groenlandicum	-	o	o	-	-	-	-	-	-	-	-
Linnaea borealis	o	-	r	d	-	o	-	r	-	-	-
Lycopodium annotinum	-	o	f	r	-	f	-	-	-	-	-
Lycopodium obscurum	o	d	o	f	r	o	o	-	-	-	-
Picea glauca	-	r	r	-	-	o	-	-	r	-	-
Picea mariana	-	o	-	-	-	-	f	-	r	-	-
Populus tremuloides	-	f	-	-	-	-	-	-	-	-	-

. . . continued

Table 8 (continued)

Sample plants	Open jackpine	Open spruce-fir-birch	Pine-spruce	Open paper birch	Balsam fir	Juniper clearing	Spruce-pine	Grass meadow	Feather moss clearing	Rock	Lichen clearing
	Forest cover type[a]										
Ground cover (continued)											
Prunus pensylvanica	o	-	r	-	-	r	-	r	-	-	-
Pyrola rotundifolia	o	-	r	d	-	-	-	-	-	-	-
Ribes glandulosum	o	r	-	-	-	o	r	r	-	-	-
Rosa acicularis	f	r	-	o	-	r	-	f	-	-	-
Rubus strigosus	a	o	-	a	-	d	o	d	-	-	r
Vaccinium myrtilloides	r	o	r	o	r	f	o	o	-	-	o
Feather mosses	d	d	f	r	o	d	d	d	d	-	o
Graminoids	d	o	r	d	-	f	f	d	-	-	r
Ground lichens	-	-	-	-	-	f	-	f	o	f	d
Litter	-	-	d	-	d	-	-	-	-	-	-
Logs	-	-	o	-	-	-	a	-	-	-	-

[a] r = rare, o = occasional, f = frequent, a = abundant, d = dominant; dash indicates not observed.

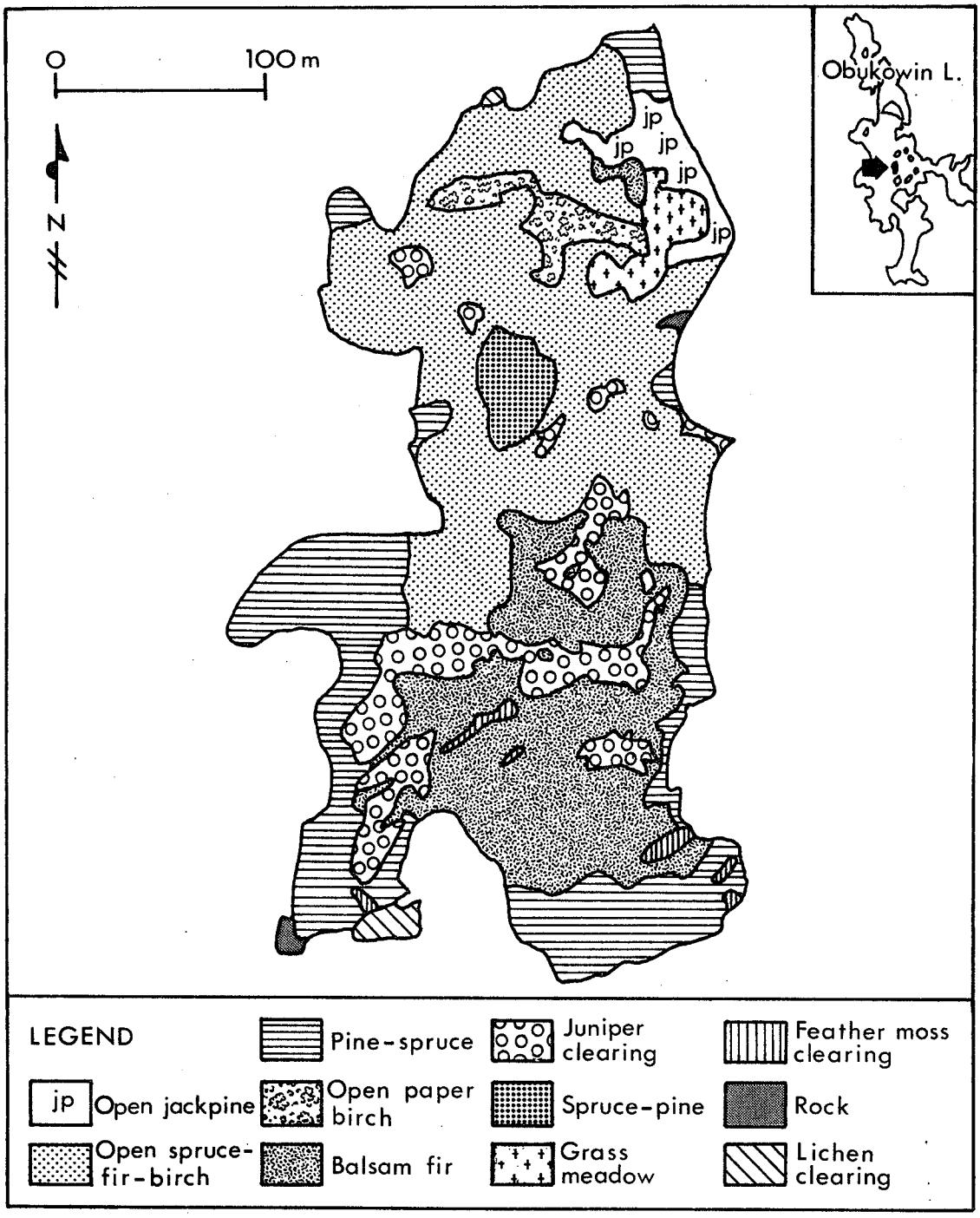


Figure 28. Forest cover types of a calving island in central Obukowin Lake, August 1976.

Lake, including Lodge Point, was mature jackpine-spruce forest similar to that of central Obukowin Lake. A diversity of habitat types was present with abundant supplies of lichen, ground forbs, and deciduous shrubs.

Surprisingly, caribou sign was found on only three islands in Aikens Lake despite numerous searches. Firstly, several groups of old summer pellets (1+ years) and some fresh tracks were found on the southern most island, but no other evidence of utilization was observed. The island had a high cliff on its northern side and rugged topography, but of all islands it was the most similar in vegetative character to those used by caribou at Obukowin Lake. It supported an open cover of mature black and white spruce with diverse ground cover and arboreal lichens available by numerous blowdown. Secondly, Blue was known to feed regularly on the island close to the southeastern shore of the lake. No evidence of cow-calf activity was found on the island, but calf tracks were often seen on a mainland beach next to it. Finally, one single fresh caribou track was found on the largest island near the western shore of the lake. Vegetation on most of this island was intermediate trembling aspen with some jackpine. Some forbs and shrubs were present, but most of the island was covered with leaf litter.

No caribou sign was observed on other islands or along the western and northern shores, although moose sign was common everywhere. The forest along these shorelines was a mosaic of mature black spruce and jackpine, immature jackpine, and trembling aspen. It was not characterized by a diverse understory as the southeastern shore was. However, it still appeared suitable for caribou. The other islands

were less suitable. They were mature spruce-fir-birch with only feather moss, needle litter, and some lichen on the ground.

A search of islands at Fox Lake revealed pellet groups of adult and calf caribou on the large island juxtaposed to the western shore of the lake (Fig. 23). This island was similar to the calving islands in Obukowin Lake in that it had a sloping shoreline, gentle topography, good visibility, and good cover of jackpine and black spruce. Lichens were in good supply, but ground forbs and shrubs were not as plentiful. The surrounding area was typical winter range comprising jackpine and lichen-rock ridges with tamarack and black spruce bogs.

5.2.4 Summer

Habitat utilization in summer was basically similar to that for late spring. Some plant species eaten by caribou in summer are listed with those for late spring in Table 5.

Section 5.1.1 showed that whereas minimum summer ranges for 1975 and 1976 were smaller than or similar in size to spring ranges, the actual summer range for both years may have been twice as large (Fig. 13). Most caribou activity within the estimated summer range occurred in mature habitats. Many caribou continued to occupy the mature jackpine forest and open bogs of the winter range. Only limited activity was observed in areas of immature jackpine at Carroll Lake, south of Aikens Lake, and on the upper Broadleaf River.

Only one observation of caribou activity occurred in the heart of the Carroll Lake burn. This was the immature male photographed in late

June at Carroll Lake Camp. The lodge owner told me it was the first caribou he had seen in that area since he bought the camp 19 years earlier.

Most caribou that crossed the Gammon River were going to or coming from mature jackpine-spruce forest to the northeast. Of six crossings (excluding those of Blue), five occurred within 2 km of Aikens Lake between mature habitat on the northeastern side and immature jackpine to the southwest (Fig. 2). Three of six crossings traversed the small 1976 burn near Aikens Lake, and one occurred within the new burn further upstream (Fig. 5).

Although most crossings occurred within the same stretch of river near Aikens Lake, I observed no evidence that topography funnelled caribou into specific crossing sites. The section of river between Aikens and Carroll lakes has few gorges or steep banks. Caribou generally crossed at quiet sections of river with sloping mud banks or sand beaches (Fig. 29).

Caribou activity was observed in the new Obukowin burn in summer but did not appear to be substantial. From 11 July to 11 September, Candy was well within the burn during five of 10 telemetry detections. She may have been using unburned bogs *etc.*, but food habit information (Table 5) suggests that she was also feeding on new regeneration. Much of the regeneration was comprised of food items actively sought by calf #146-B (*e.g.* leaves of young birch and alder suckers, pale corydalis, woodland horsetail, spreading dogbane, and fireweed).

During summer 1976, we monitored caribou activity at Aikens Lake from 13 July to 15 August inclusive, and from 15 August to 10 September

Figure 29. Blue crossing the Gammon River near Aikens Lake.

on an infrequent basis. All activity occurred along the eastern and southeastern shores and islands. Blue was a resident of this area and was quite sedentary. No calf tracks were observed in summer, but on 11 July personnel at the Aikens Lake Lodge saw a cow and calf swim from Lodge Point to the eastern mainland. This was probably the same pair known to have occupied the area in June. If they remained in the vicinity of Aikens Lake throughout summer, they were not active along the numerous sand beaches as they were in late spring. Other observations indicated that either one caribou occasionally occupied the area, or three to four each appeared once or twice.

In summer 1975, the last caribou seen on Obukowin Lake was an adult cow on 12 July. The last fresh sign on islands or near shoreline was observed on 24 July. In 1976, Candy continued to occupy mainland areas on both sides of Obukowin Lake after the fire of 5 June (some of the areas were not burned). She was within 0.5 km of shore on four of 10 days of telemetry detection during the summer but was never observed on the shoreline. On the other hand, Blue was often observed on the shore of Aikens Lake in 1976 until 15 to 30 September when he moved south to the area of open bogs. From 13 July to 10 September, he was within 0.5 km of shore on 34 of 34 days of telemetry detection. On 23 July and 7 September, we were not able to detect him in the vicinity of Aikens Lake. I suspect that he had moved inland on those days.

As outlined in section 5.1.3, Blue was sedentary and habitual in behaviour during summer. Most of his time was spent either bedded or feeding, and he used the same beds repeatedly. A total of 23 beds were

found in three areas that he occupied: six on Lodge Point, 10 on the southeastern shore, and seven on the island adjacent to that shore. I believe that most of these beds were used only by Blue; other caribou were seldom seen in the area and all pellets near the beds were large. Five beds were located on the shoreline, of which three were openly exposed on sand beaches, and two were made on feather moss and leaf litter behind screens of sweet gale (*Myrica gale*). Sixteen beds were located 20 to 150 m from shore, and two were located approximately 400 m from shore. Most of the former were in areas of mature jackpine, lichen, and feather moss, with small spruce or deciduous shrubs providing cover. The latter two were located in a black spruce bog with heavy ground cover of *Sphagnum* moss, labrador tea, leatherleaf, willow, and alder. Many feather moss beds were worn down to the earth from repeated use.

Blue was most active in early morning and evening and spent most of the daylight period bedded. On rainy days he was usually bedded more than 100 m from shore, but on sunny days he was often bedded on sand beaches or near shoreline. This was especially true if a brisk onshore breeze was present. Sometimes he was observed to shake his head in response to insect harassment; insects may have been a factor in his use of shorelines. In addition, he often foraged and bedded on the island adjacent to the southeastern shore in late afternoon, leaving it again at dusk. The island had good supplies of arboreal lichen on numerous blowdown.

Other investigations indicated that another bull used the southern shore of Fox Lake during late summer. It was never seen, but large

tracks and pellets, plus freshly thrashed spruce and tamarack saplings in early October, confirmed its identity. Other caribou were also present, but most of the sign on the southern point was similar to that of Blue.

On 9 September 1976, my wife and I observed Blue bedded on lodge point in an area of mature jackpine, lichen, and feather moss with an understory of white spruce. His neck was swollen and tatters of velvet were hanging from his antlers. Near his bed we found three young white spruce which had been thrashed intently.

Investigations of the herd's autumn and winter range revealed a clumped distribution of small thrashed spruce and tamarack, distinct from larger moose rubs, and similar to those defaced by Blue. Fig. 30 shows the distribution of these rubs found in the caribou range. I believe this distribution reveals the location of some mature bulls prior to the rut. One of these locations is at the south end of Fox Lake. Another is just north of Little Caribou Lake, an isthmus between two open bogs where we noted the activity of a single large caribou in early April 1977.

5.2.5 Autumn

The reaggregation of caribou near large open bogs in early autumn coincided with the death of ground forbs and leafy browse. Caribou depended on ground lichens, arboreal lichens, and bog flora at this time (Table 5). In 1976 much feeding and bedding activity occurred in the open bogs (Fig. 31), although jackpine-rock ridges were still used.

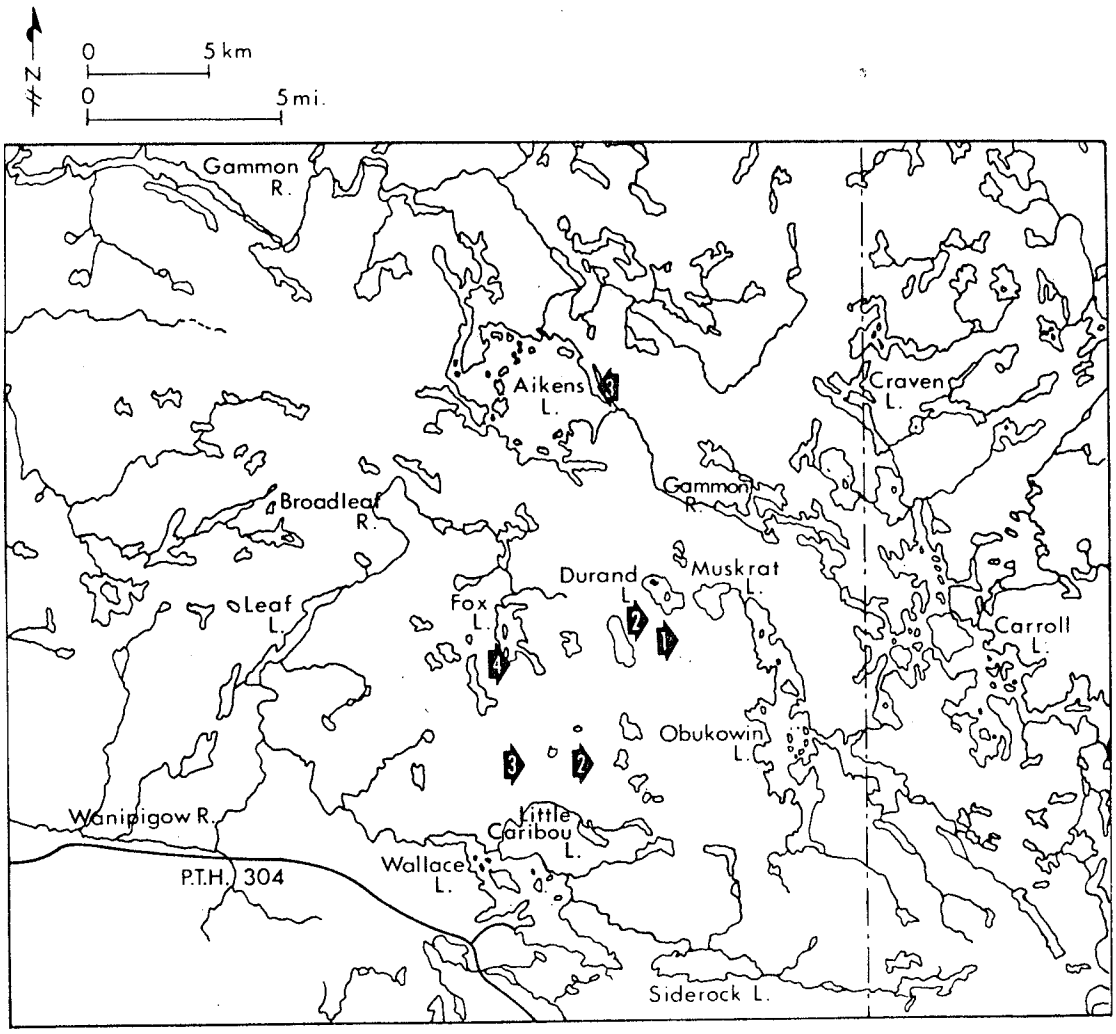


Figure 30. Distribution of young white spruce and tamarack thrashed by caribou bulls in late summer and autumn, 1976.

Figure 31. Woodland caribou in an open bog, October 1976.

Low water levels may have facilitated the use of bogs that year.

Rutting activity in 1976 was centred around open bogs between Fox, Muskrat and Little Caribou lakes. Observations suggested that habitat utilization was governed by feeding behaviour of groups of cows and non-breeding caribou. Thus, the relationship to open bogs was essentially the same as that for autumn in general.

Snowcover was thin in mid-December (Figs. 22 and 23), and nival conditions did not appear to influence the use of various habitats until later.

Aerial census flights in mid-December showed that mature bulls had lost their antlers by that time. Over the entire study, we found several antlers of mature bulls from previous years. Fig. 32 shows the location of these. The distribution of dropped antlers reflects the distribution of bulls in November and December of previous years.

5.2.6 Studies of Calf #146-B

When Candy was radio-collared on 19 May 1976, we were not able to return her to the island on which her calf was located. She remained on the mainland to the northeast for one day and crossed to the western shore on the night of 20 May. We thought that she had recovered her calf, so we resumed surveillance of the area. On 24 May we drove the island and found the calf to be present. In the next two days, Candy remained within 0.5 km of the western mainland shore opposite the island. After 21 May we observed no evidence that she was visiting the calf, so we captured it on 27 May. The female calf was estimated to be

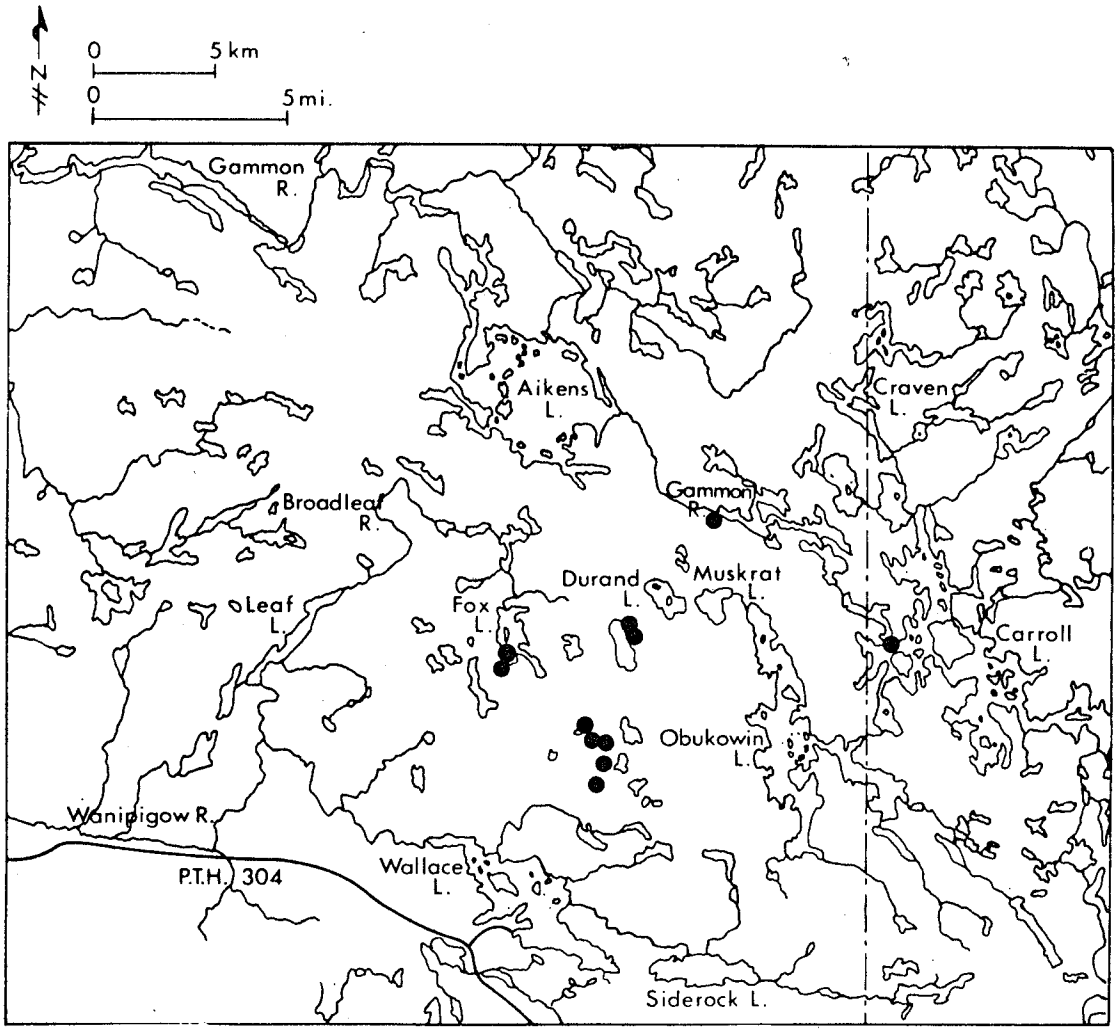


Figure 32. Location of bull antlers dropped in autumn of various years prior to 1976.

two weeks old by its size and stage of tooth eruption (Miller 1974). Details of weight and measurement are given in Appendix IV.

Table 9 presents a list of food species recorded for the calf from mid-July to November 1976 and their relative importance. Some other species were eaten prior to mid-July but are not listed here. Observations of the calf's behaviour and information in the literature (Bergerud 1972) indicate that prior to mid-July it may have taken a wider variety of foods through experimental tasting. After mid-July the calf's food preferences appeared to be more stable and representative of adult caribou.

Some aspects of feeding behaviour of the calf after mid-July clarified ambiguous issues of adult food habits. For instance, the calf commonly licked dirt on the upturned roots of trees blown down by the wind, presumably for the mineral content. The same motivating factor may cause caribou to crater snow from old beaver lodges in winter. In addition, calf #146-B usually browsed the leaves or tips of food plants including terricolous lichens. Only the tip or top half of ground forbs was consumed. When flowers were available, the calf commonly went from one forb to another, eating only the flowers. This was particularly true of fireweed. An exception to this apparent rule of dispersed feeding effort concerned arboreal lichens which were often consumed completely from sections of a tree trunk or branch.

Growth of the calf was probably retarded through separation from its mother and imprinting on man. Growth statistics for the calf are given in Appendix IV. Weaning was purposely delayed to compensate for the interruption in growth during the first weeks of life. While being

Table 9

Food species recorded for calf #146-B
from mid-July to November 1976 and their relative importance

Plant species	Relative importance
Ground lichens	
Cladonia rangiferina	high
Cladonia alpestris	high
Cladonia mitis	high
Cladonia arbuscula	high
Parmelia sp.	low
Arboreal lichens	
Usnea sp.	high
Alectoria sp.	high
Ramalina sp.	high
Evernia sp.	high
Parmelia sp.	low
Herbs	
Apocynum androsaemifolium	moderate
Carex spp.	moderate
Chimaphila umbellata	low
Cornus canadensis	moderate
Corydalis sempervirens	moderate
Diervilla lonicera	moderate
Epilobium angustifolium	high
Equisetum sylvaticum	moderate
Galium boreale	low
Polygonum cilinode	low
Pyrola rotundifolia	moderate
Trees	
Alnus crispa	moderate
Betula papyrifera	low
Populus tremuloides	moderate
Prunus pensylvanica	moderate

. . . continued

Table 9 (continued)

Plant species	Relative importance
Shrubs	
Amerlanchier sp.	low
Aralia hispida	low
Ribes glandulosum	low
Rosa acicularis	moderate
Rubus strigosus	moderate
Spiraea alba	low
Ericoids	
Andromeda glaucophylla	moderate
Chamaedaphne calyculata	low
Vaccinium myrtilloides	low

maintained on a 50:50 evaporated milk-water supplement, the calf gained weight at a maximum rate of 0.5 kg/day. However, after weaning, no food supplements were given, and the calf fed independently as it travelled with us through the study area.

At this time, I observed that it was greatly influenced in its feeding behaviour by activity of the "mother image", namely myself. If I was active, conducting vegetation surveys or observing browse sign, it fed constantly. If I was working at camp, it fed less frequently. Thus, a high level of feeding activity by its normal mother may have induced a faster growth rate through sympathetic induction. Occasionally we left the study area and placed the calf on well vegetated islands for one or two weeks. The calf usually failed to gain weight at these times, perhaps as a result of stress.

Bergerud (1974c) successfully introduced hand-reared calves to the wild in Newfoundland and later introduced wild calves with them. The wild calves remained in the area following the leadership of the tame animals who were then yearlings.

In autumn 1976 I decided to leave calf #146-B in an area of intense caribou activity southeast of Fox Lake. Very little wolf activity had been observed in this area in the winter of 1975-1976. The calf was equipped with a radio-collar and released on 29 October. Shortly after its release, a great deal of wolf activity occurred throughout the autumn range, and the calf was killed in early November. The radio-collar was retrieved in January 1977 with scattered clumps of hair. The collar was chewed but no bones or other remains were located under the snow.

5.3 Population Ecology

5.3.1 Historical Information

Very little information is available concerning the size of the Aikens Lake herd in past years. Joe Nespor, Manitoba Department of Mines and Natural Resources (pers. comm. *in* Stardom 1977) stated that during the regional caribou survey of December 1968, 46 caribou were observed in the area northeast of Obukowin Lake. Stardom (1977) estimated the population to number 35 to 37 animals in the winters of 1970-1971 and 1971-1972. He stated that three calves (12.5%) were present during the second winter.

5.3.2 Census

In 1975 and 1976 the best data on sex and age class structure were obtained by aerial survey in mid-December when groups of caribou were photographed in open bogs and on lakes. The best data for total count estimates were obtained during consecutive survey flights in late March and early April of 1975, 1976, and 1977.

In 1975 I conducted a survey flight on 30 March at which time all fresh caribou sign was concentrated in the area east and southeast of Tri Lake. Then on 4 April during an aerial survey, Hill (1979) observed 30 to 35 caribou on Ridge Lake, 4 km to the southwest (Fig. 14). I believe that most caribou were aggregated at that time. Application of a 10% correction factor for animals missed yields a

population estimate of 33 to 39.

In 1976 survey flights were conducted on 27 and 30 March and 2 April. Ground verification work was carried through to 4 April. An unadjusted total of 28 to 33 caribou was determined for six groups (Fig. 33). The adjusted estimate is 31 to 36.

In 1977 flights on 23 and 25 March were followed by ground verification to 1 April. A total of 30 to 36 caribou were located in five areas (Fig. 34). The adjusted estimate is 33 to 40.

I do not feel that census techniques used in this study were sufficiently reliable to indicate a population increase or decrease on a short-term basis. Therefore, the population estimate for early spring of all three years should be regarded as 30 to 40 animals.

Aerial photographs of a group of 24 caribou, taken on 16 December 1975, showed three calves to be present (12.5%). Of the other 21 caribou, at least 17 were not antlered, and only four cows and a young bull could be segregated by sex.

During an aerial survey on 10 December 1976, I observed a group of four caribou and obtained photographs of a group of six and a group of 10. Of the 20 caribou, four were calves (20%). Of the other 16 animals, only Candy, four cows and three large mature bulls could be segregated by sex. At least 13 of the 16 caribou over one year of age did not have antlers.

Unfortunately, it was not possible to identify yearlings in the photographs. In addition, bulls were not easily distinguished. Mature individuals had lost their antlers by mid-December. Of four bulls identified, only the young bull seen in 1975 still retained its

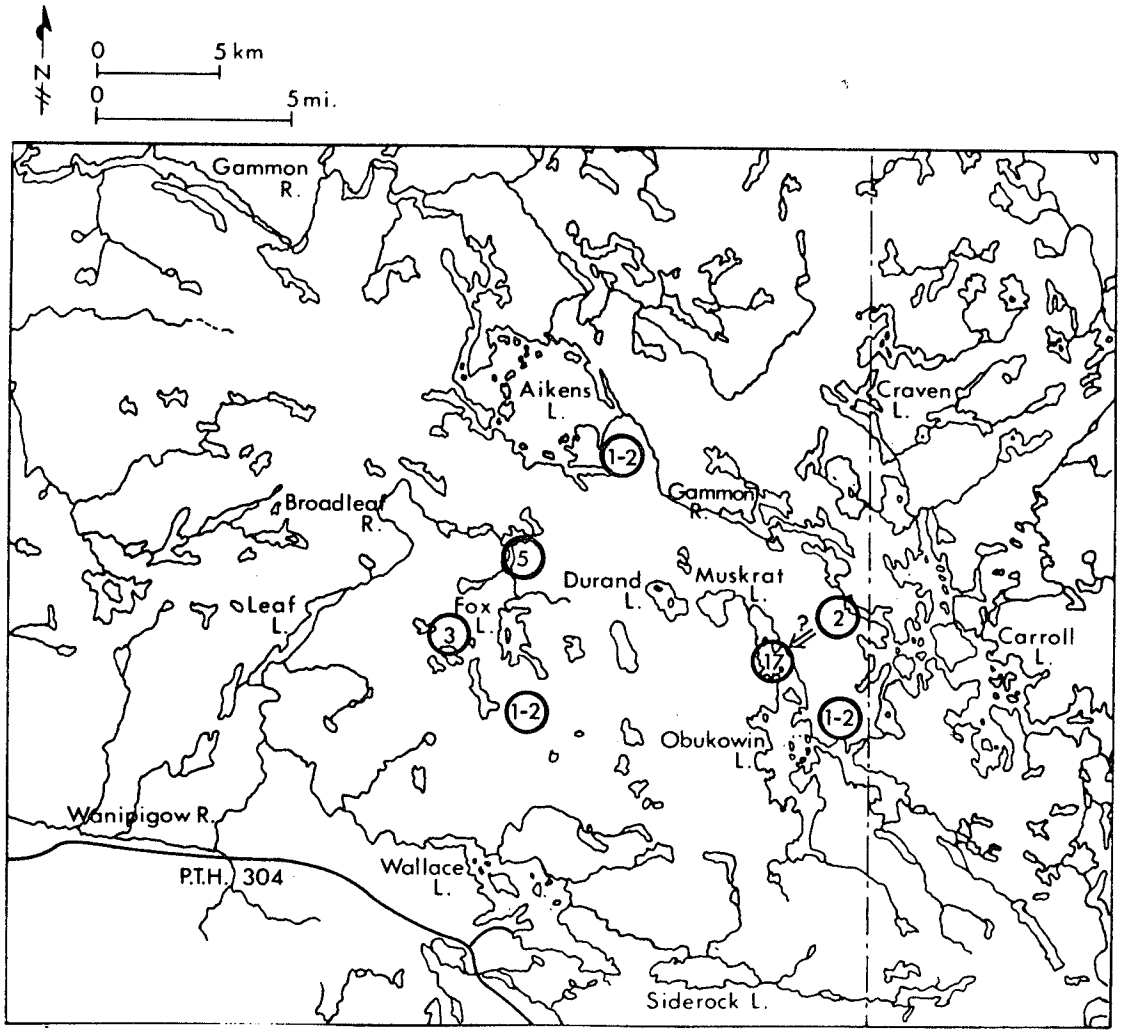


Figure 33. Size and location of caribou groups on 30 March 1976 used to estimate population size.

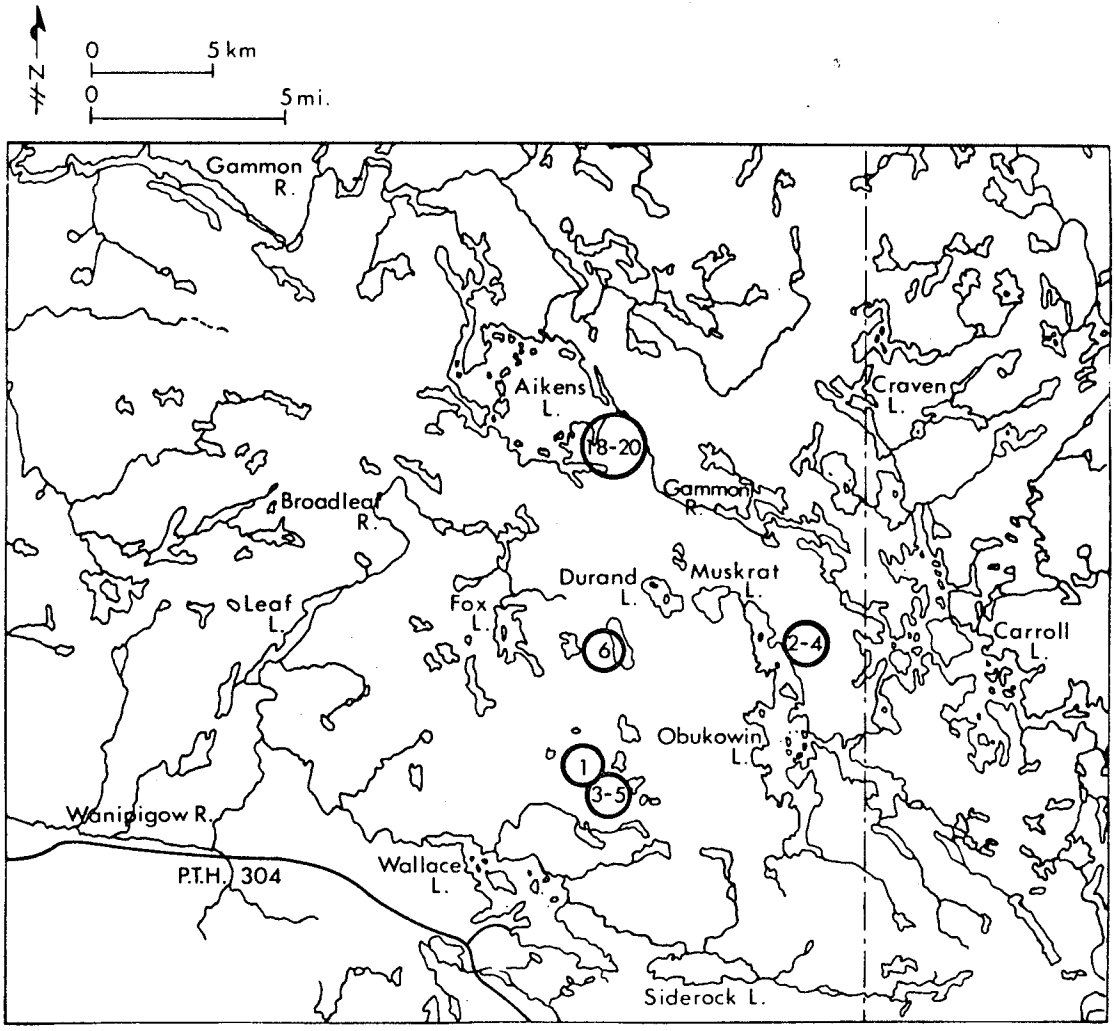


Figure 34. Size and location of caribou groups on 23 and 25 March 1977 used to estimate population size.

antlers in mid-December. Other young bulls were either not present or had also lost their antlers. Hence, sex ratio data could not be extracted from aerial photographs.

5.3.3 Reproduction

Spring observations of one calf captured in 1975 and another in 1976 indicated that they were probably born during the period 10 to 17 May. The average gestation period reported for wild caribou is 227 to 229 days (McEwan and Whitehead 1972; and Bergerud 1975). Based on a period of 228 days, the cows should have been bred during the interval 25 September to 2 October.

On 11 September 1976, Candy was still on the east side of Obukowin Lake, but she moved west for the rut by 3 October. Blue did not leave Aikens Lake until the third week of September at the earliest. Hence, caribou were probably not concentrated for the rut until approximately 20 September. Telemetry detections and observations of sign suggested that rutting activity occurred at least until mid-October.

As mentioned earlier, large samples of the population showed the autumn calf crop to be 12.5% in 1975 and 20% in 1976. If most adult bulls were not present in sampled groups because of behavioural segregation, the estimated calf crop would be artifically inflated. More mature bulls were identified in sampled groups in 1976 than in 1975. One would therefore expect the percentage of calves to be reduced, but it was actually larger. Thus, it does not appear that

behavioural segregation of bulls was a factor. Antlerless bulls are difficult to identify from a fixed-wing aircraft, and some may not have been recognized.

Pregnant female caribou shed their antlers at or after calving, whereas non-pregnant females and other caribou (except calves) shed their antlers earlier (Kelsall 1968; and Skoog 1968). The percentage of cows that never grow antlers (*i.e.* bald) varies considerably (Kelsall 1968; Skoog 1968; and Bergerud 1971). The proportion of antlered females can be used as a measure of natality when corrected for percent baldness (Simkin 1965; and Skoog 1968), or as a measure of gene flow between populations (Bergerud 1971).

I found that the majority of cows in the Aikens Lake herd were bald. Of 46 caribou observed closely, 17 were positively identified as cows, of which 13 (76.5%) were bald (Table 10). Other bald cows were probably present but could not be identified.

5.3.4 Mortality and Disease

Only two caribou mortalities were confirmed in the first year of study. One was the mature bull #143-B which drowned when we attempted to equip it with a radio-collar on 22 June 1975 at Obukowin Lake. The other was a mature cow shot from a group of 15 to 20 by a native hunter on 4 January 1976 at Fox Lake. Both of these animals appeared to be in good health when the heads and vital organs were autopsied (Appendix II).

In the second year of study, we located two caribou killed by

Table 10

Incidence of baldness for caribou cows observed closely from 30 March 1975 to 1 April 1977

Date	Group size	Minimum number of cows identified	Number of bald cows
12 July 1975	1	1[a]	1
16 December 1975	24	4	3
4 January 1976	1	1[a]	1
2 April 1976	4	3	2
11 October 1976	6	4	3
10 December 1976	10	4	3
Totals	46	17	13

[a]Captured or killed

wolves, and one caribou was rumoured to have been poached in autumn 1976 on P.T.H. 304 west of Wallace Lake. One wolf-kill was Candy who was killed near Muskrat Lake on 13 or 14 March 1977. Tracks and sign at the site clearly described the stalk and kill (Appendix III). We retrieved most of the carcass, and no physical abnormalities were discovered during autopsy which could have made her susceptible to predation (Appendix II). The second animal was a calf killed on Tri Lake on 17 or 18 March 1977. This was three to five days after Candy was killed 5 km to the east. The calf was totally consumed. Only the hide, one dentary, bone chips, and blood remained at the site.

Much less wolf activity was observed in the first year of study than in the second. From 21 March 1975 to 20 March 1976, 22 observations of discrete wolf sign were recorded, compared to 84 observations in the following 12 months. The complete pattern of wolf activity could not be discerned during snow-free periods, but aerial surveys and ground work from November to April revealed a substantial change in wolf distribution during the second year.

Fig. 35 shows the distribution of wolf sign recorded from 1 November 1975 to 3 April 1976 (n = 16). Despite investigations within the central caribou range, most wolf activity was observed in peripheral areas to the southeast. Tracks of two wolves were occasionally seen in the area of Wallace Lake, while a pack of four to five wolves, referred to as the Siderock pack, occupied the area between Siderock and Obukowin lakes. Tracks seen east of Obukowin Lake may not have been made by the Siderock pack. Only one scat was observed at Aikens Lake. No evidence of wolf predation on either caribou or moose was observed,

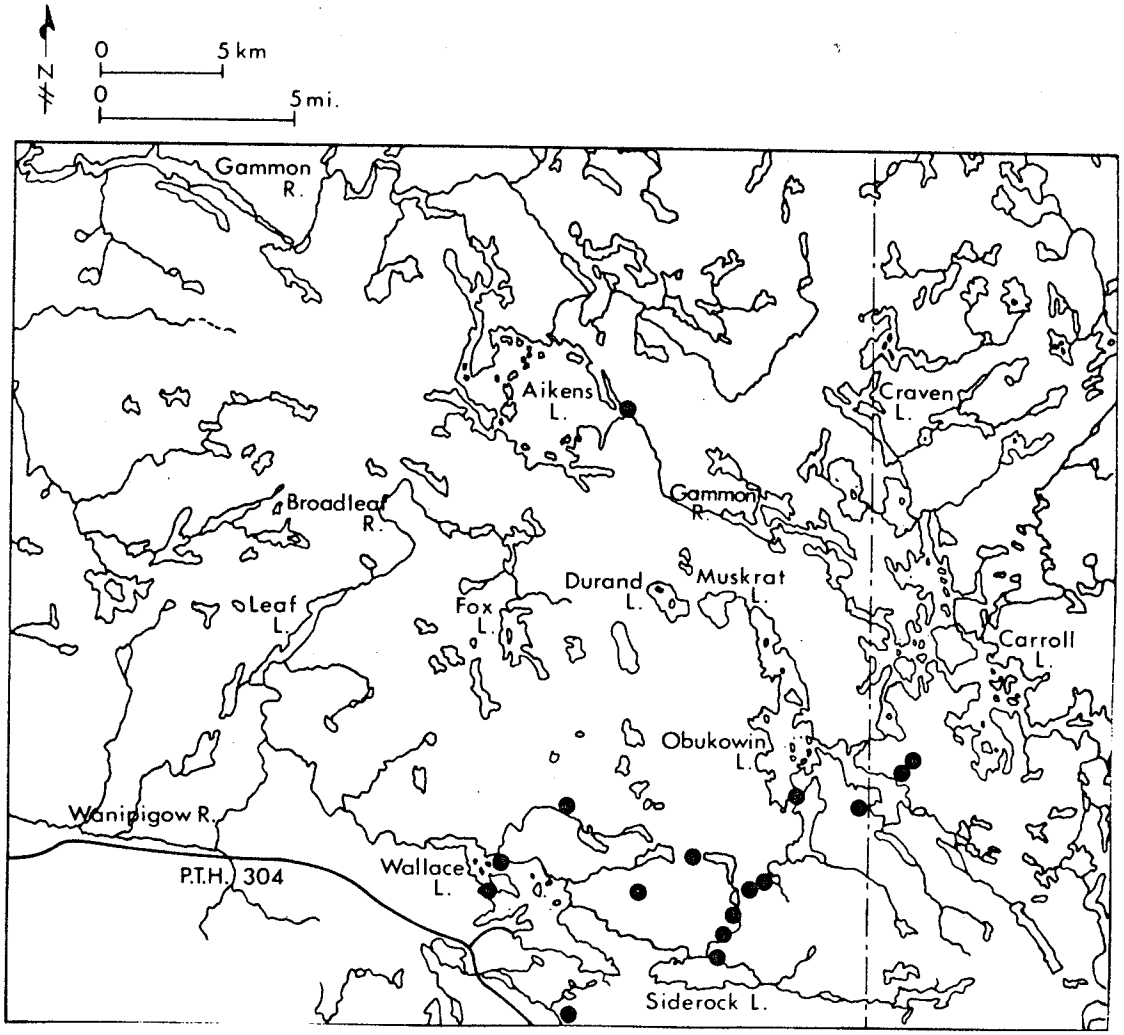


Figure 35. Distribution of wolf sign recorded from 1 November 1975 to 3 April 1976.

but moose hair observed in numerous wolf scats indicated that moose were taken. A limited amount of predation on caribou may have occurred.

During autumn 1976, an increase in wolf activity was noted in the caribou range. Fig. 36 shows the distribution of wolf sign observed from 1 November 1976 to 1 April 1977 (n = 61). On 13 November my technician observed fresh tracks of 20 wolves in a skiff of snow on Fox Lake. He back-tracked them and verified their identity as tracks of a single group. The wolves had separated into two groups of 11 and nine at the lake's southeastern end. No evidence of such a large group was subsequently observed, but continuous wolf activity prevailed in the caribou range until field work was terminated in April 1977. A pack of 10 was sighted on Fox Lake on 27 November. After that date, the number of wolves travelling together varied from one to 10. Single wolf tracks were often observed, and groups of two to five, and eight to 10, were common. It appeared that at least 10 wolves continued to occupy the caribou range, but pack cohesion was very loose. At the same time, a pair of wolves still occupied the area of Wallace Lake. This pair was made up of one large and one small wolf and seems to have been present in all winters from 1974 to 1977. It is not clear whether the Siderock pack remained a separate entity or was part of the larger group to the north. No wolf activity was observed on the eastern arm of Obukowin Lake. In addition to the caribou kills only one moose kill was confirmed, but other moose were taken since, again, moose hair was observed in numerous wolf scats.

In late spring and summer 1975, some wolf activity occurred at Wallace and Aikens lakes, but most sign was observed in the area of

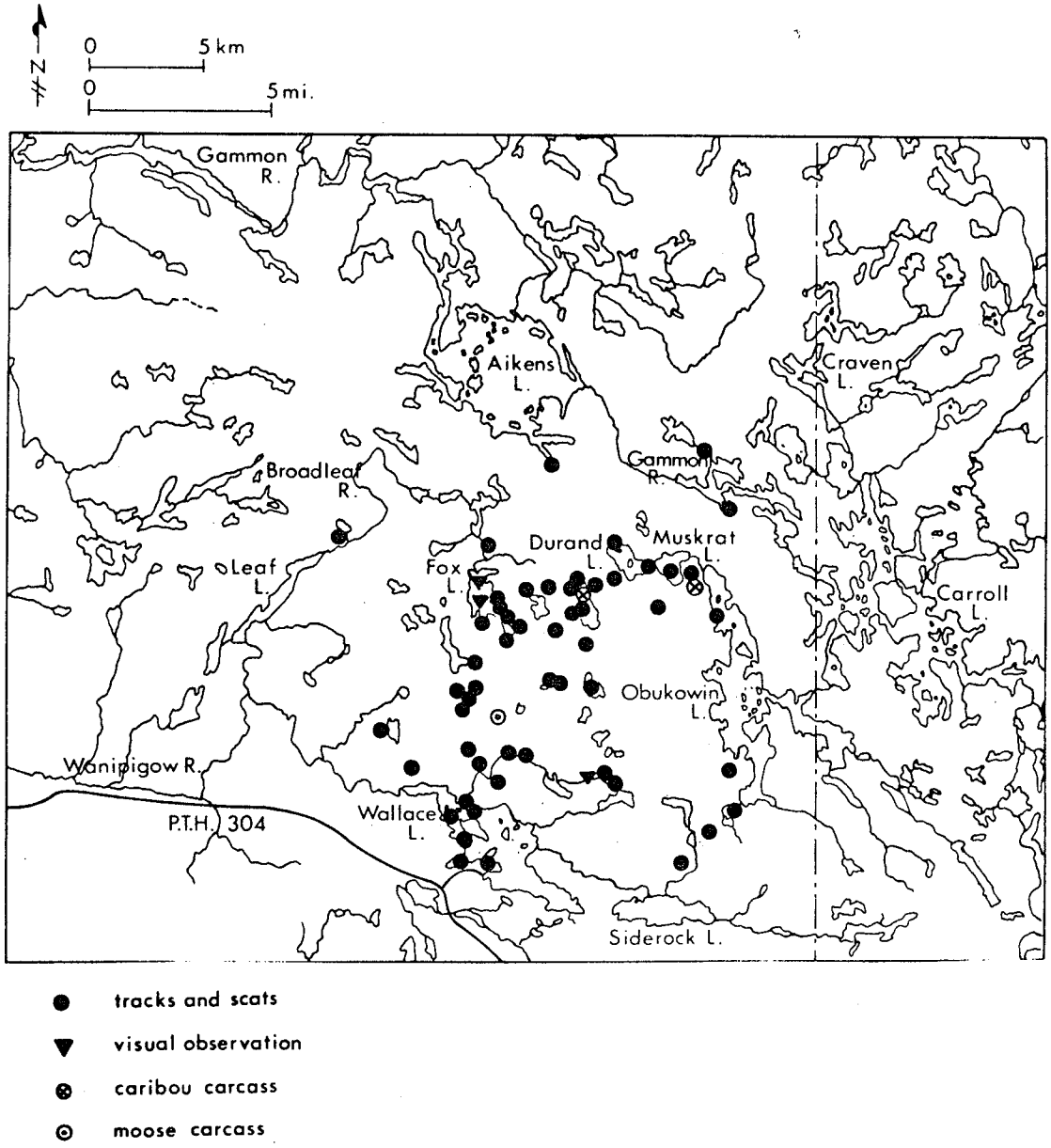


Figure 36. Distribution of wolf sign, sightings, and kills recorded from 1 November 1976 to 1 April 1977.

Siderock and Obukowin lakes. One pair apparently denned north of Siderock Lake, and the pack was active in that area. This was one of the few areas occupied by white-tailed deer. Wolf sign was first seen near the islands of Obukowin Lake on 10 July, and on 7 September adult and pup wolves were heard howling near the lake.

In late spring and summer 1976, most sign was observed in the area of Siderock, Obukowin, and Aikens lakes. I could not determine how many wolves were active at Siderock and Obukowin, but group size at Aikens Lake varied from one to three. At least one wolf travelled around the shoreline of Aikens Lake every five days to two weeks. No predation on caribou was confirmed for any area, but it probably occurred, especially on calves. Wolf tracks were sometimes seen in association with caribou and moose tracks at Aikens Lake. The wolves may have tested Blue on their occasional circuits of the lake.

In general, wolves in the study area appeared to make more use of moose, white-tailed deer, and beaver (*Castor canadensis canadensis* Kuhl) than caribou. This agrees with the observations of Hill (1979). Stardom (1977) acquired little evidence of wolf predation on Aikens Lake caribou in two winters of study.

Bergerud (1971) found lynx predation on caribou calves to be a serious problem in Newfoundland. Evidence of this sort is lacking on the Aikens Lake herd. Lynx were common in the study area, but it is unlikely they were a significant predation factor. A cougar was also reported on the eastern end of Carroll Lake when I talked to fishermen on 17 June 1976. However, this species was too rare to be a significant factor.

Autopsies of caribou did not include examination of intestinal tracts, but examination of heads, thoracic organs and other parts of the body revealed surprisingly few parasites and little evidence of disease (Appendix II).

5.3.5 Habitat Carrying Capacity

Observations of the mature coniferous forest between Aikens and Wallace lakes do not indicate that food supply was a limiting factor to growth of the caribou herd. The abundance of ground forbs and deciduous forage in late spring and summer provided a plentiful diverse food supply when caribou were recovering from the nadir of their physiological cycle (Dauphiné 1976). In autumn, winter and early spring, the diversity of food types was more restricted, but arboreal lichens, bog flora and productive stands of ground lichens provided caribou with adequate nutrition. The only observation of overgrazed habitat occurred on two islands used by caribou cows in Obukowin Lake. Ground lichens on these islands were severely overgrazed, although lichens were available on adjacent islands.

I observed a paucity of caribou sign in burns less than 50 years old. The amount of mature jackpine forest, and perhaps the number and quality of open tamarack and black spruce bogs, may be critical factors in determining theoretical carrying capacity. Still, it appears that the present amount of mature jackpine habitat in the study area could support a larger population of caribou.

I believe that other forms of environmental resistance are the

main factors determining population size. Studies by Stardom (1977) and other authors (Edwards and Ritcey 1959; Pruitt 1959; and Bergerud 1971, 1974c) have shown that severe nival conditions can limit food supply for caribou. This will be discussed later. Secondly, mortality due to old age, wolf predation, hunting and poaching may exceed recruitment in some years.

Moose activity was observed throughout most of the study area including almost half of the central caribou range where Stardom (1977) reported an absence of moose. In the other half of Stardom's (1977) area of moose exclusion, I recorded several observations of unidentified cervid sign during aerial survey, most of which were single tracks that could have been moose.

The only evidence of possible interspecific competition for food and space occurred on the central islands of Obukowin Lake. In 1975, a cow and calf moose were first seen on the islands on 11 June (Appendix I). Pellet groups indicated that they were probably present during the previous week when at least four caribou were using the islands (two cows, one calf, and one bull). In 1976, a different cow moose was observed on 21 May on the island south of the one where Candy and her calf were two days earlier. The cow moose bore a calf on the island during the interval 20 to 22 May. This pair continued to use the islands until at least 3 June (Appendix I). They were not seen after the fire on 5 June.

Observations of pellet groups during both springs suggest that caribou and moose shared three islands of the circle for at least a few days, but caribou stopped using the islands soon after moose were

sighted. No direct interactions were observed, but some ground forbs and the leaves of deciduous trees and shrubs were eaten by both (*e.g.* woodland horsetail and serviceberry).

White-tailed deer sign was only observed in the study area on three occasions. On 25 June 1975, I saw a young buck on the northern shore of Siderock Lake, and on 5 September 1976, fresh tracks of one or two deer were seen at the same location. This area was predominantly mixedwood and deciduous forest (Fig. 2). The third observation occurred on 12 November 1976. Tracks of two deer were seen in a skiff of snow of Fox Lake, an area of mature jackpine and lichen-rock ridges.

5.3.6 Immigration and Emigration

Fig. 37 shows the approximate range of adjacent caribou herds in Manitoba and Ontario. To the northwest, the Sasaginnigak herd (approximately 55 animals in 1970-1972) occupies the area between Lake Winnipeg and Sasaginnigak Lake (Stardom 1977). To the south, the Owl Lake herd (approximately 65 to 71 animals in 1970-1972) ranges between the Manigotagan River and Flintstone Lake (Stardom 1977). To the southeast, the Irregular Lake herd occupies the area of Bulging, Haggart, and Irregular lakes in Ontario. It was estimated to contain 100 to 150 animals from 1961 to 1965 (Simkin 1965). No caribou herds are reported for areas immediately northeast of Aikens Lake.

No incidents of immigration or emigration were confirmed for the Aikens Lake herd during the two years of study. The high percentage

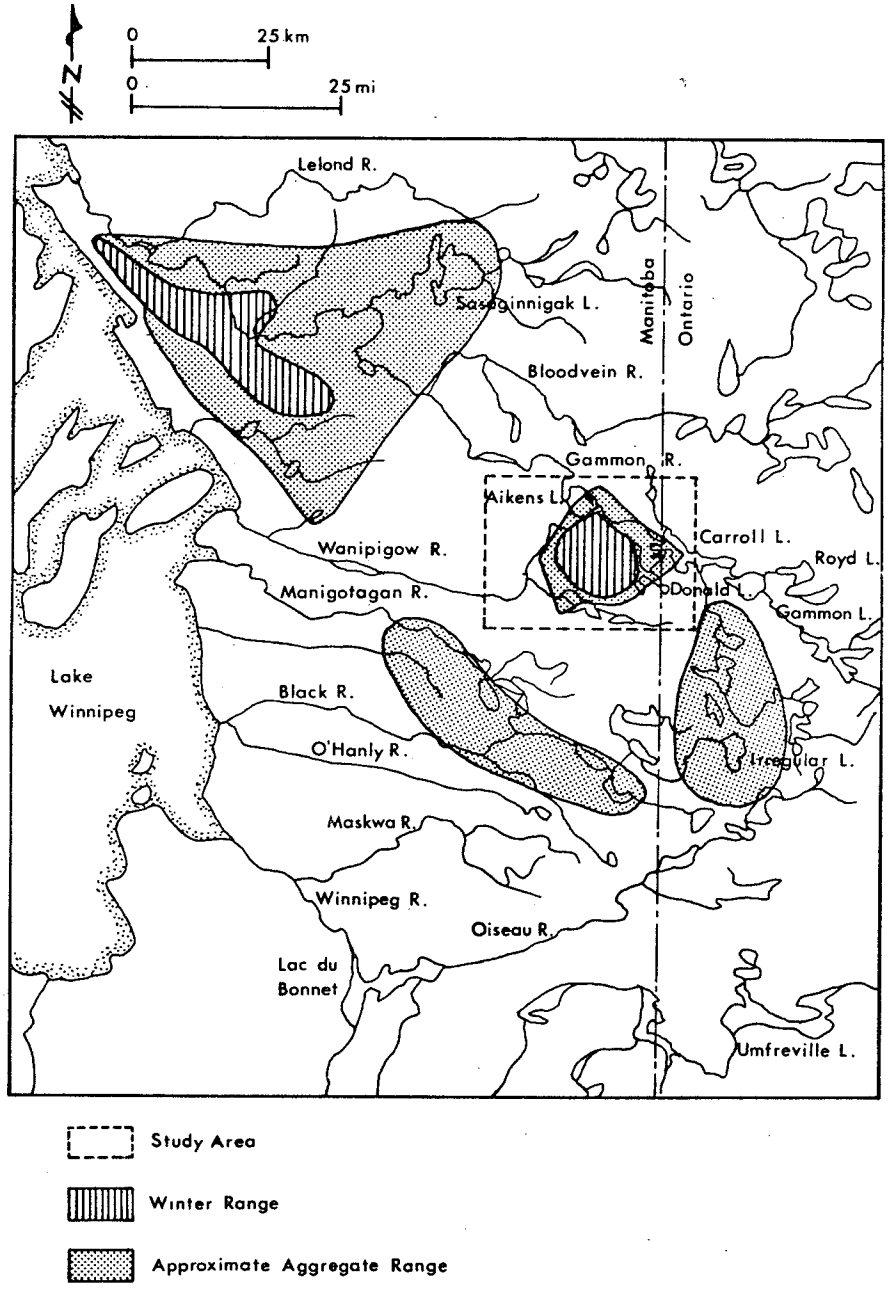


Figure 37. Approximate ranges of caribou herds adjacent to the Aikens Lake herd (Simkin 1965; and Stardom 1977).

of bald cows in the population contrasts sharply with that for surrounding herds. Simkin (1965) reported that 19.3% of cows in Ontario were bald. He did not give specific data for the Irregular Lake herd but gave examples that cows in the herd were usually antlered. Most cows in the Sasaginnigak and Owl Lake herds are also antlered (V. F. J. Crichton, pers. comm.). This suggests that gene flow between the Aikens Lake herd and surrounding populations is limited. However, the proximity of adjacent populations and caribou activity observed between ranges suggest a limited amount of interchange. Most interherd movement probably occurs in spring and summer when dispersal results in an expanded range. Some immature bulls may emigrate during rut, but in winter, gregarious behaviour and close association with open bogs likely limit emigration.

Fig. 38 identifies five areas in which immigration and emigration would be most likely to occur. Most observations of peripheral caribou activity occurred in two of these: P.T.H. 304 between Bissett and Wallace Lake, and southeast of Siderock Lake. Observations at the former include one adult seen on 3 July 1976 (F. Baker, pers. comm.) and one adult track in June 1974 (W. O. Pruitt, pers. comm.). Caribou of the Owl Lake herd were sometimes seen in the Quesnel and Happy lakes area. Sightings were closest to Siderock Lake on 29 November 1976, when 16 caribou were seen approximately 6 km to the southeast (V. F. J. Crichton, pers. comm.). Fresh tracks indicated that they came from the southeast. I observed no evidence of interaction between these animals and Aikens Lake caribou.

On the eastern side, the 1948 burn extends as far as Donald Lake

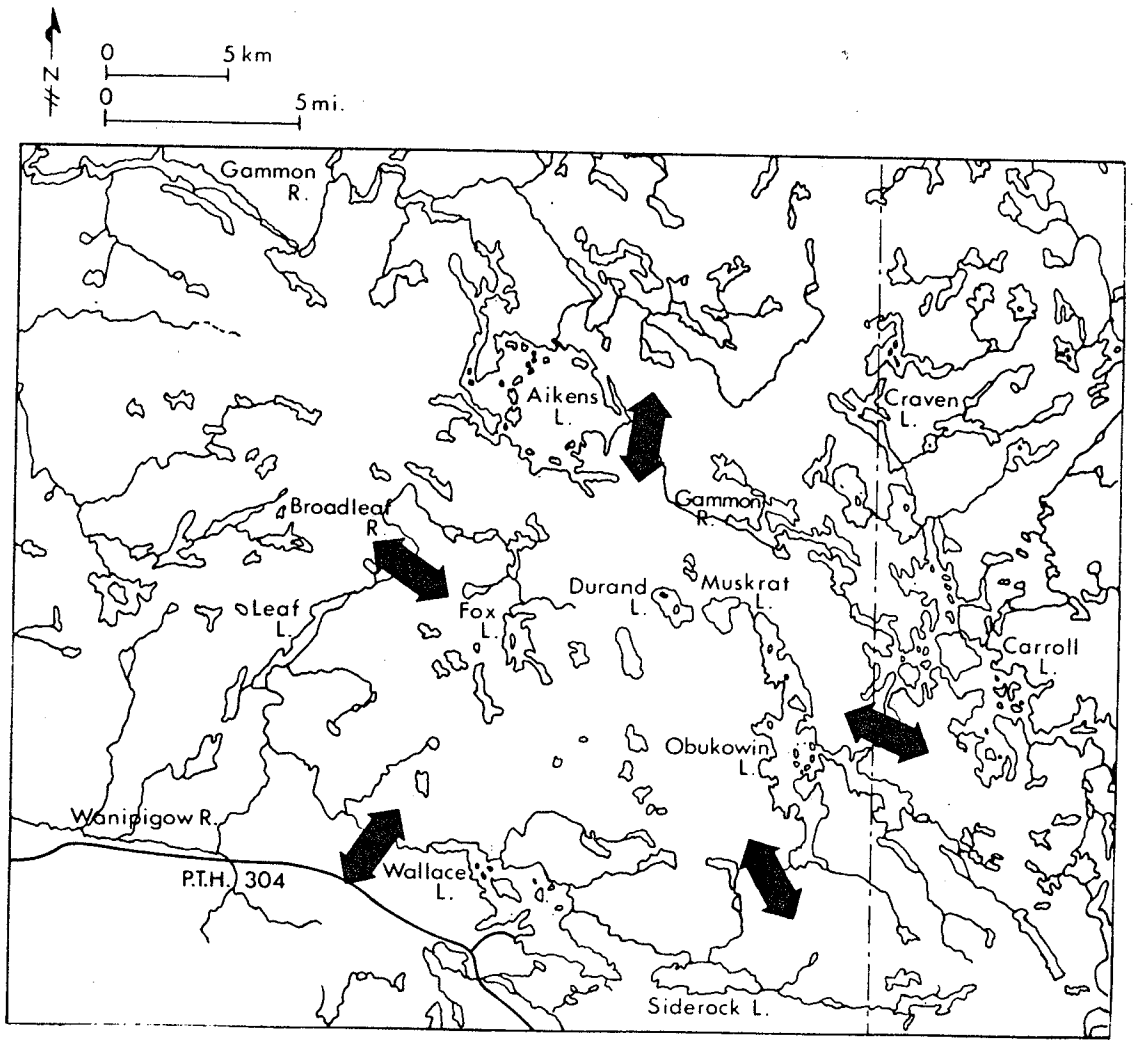


Figure 38. Probable routes of immigration and emigration for the Aikens Lake herd, 1975 to 1977.

(Fig. 37). The paucity of caribou sign within the burn suggests that it discourages movement between the Aikens and Irregular Lake herds. Interviews with owners of Carroll Lake Camp and Larson's Camp at the eastern end of Carroll Lake produced the following information. The only caribou seen on Carroll Lake in 19 years was the juvenile male, presumably of the Aikens Lake herd, in late June 1975. Other caribou were seen in mature forest at Royd Lake and to the south at Haggart and Irregular lakes. The most northern of the Haggart sightings was a dead calf on Haggart River, 6.5 km south of Carroll Lake and south of the 1948 burn.

Any immigration or emigration occurring in the north or northwestern portions of the study area would probably involve interchange with the Sasaginnigak caribou herd. No evidence of any movement northwest of the Broadleaf River was observed. However, the western expansion of range in early spring 1976 (Fig. 14) indicates that the possibility cannot be discounted.

Most caribou movement during the study was to the north-northeast across the Gammon River east of Aikens Lake. As mentioned earlier, the small number of crossings recorded and their alternating direction of travel suggest only limited range expansion to the northeast. However, immigration or emigration would not have been detected.

6. DISCUSSION AND CONCLUSIONS

6.1 Seasonal Movements and Gregarious Behaviour

Results of this study show that Aikens Lake caribou were gregarious in winter and essentially solitary in summer. From May to September, caribou were most often seen as singles or pairs. They may have been loosely associated, because observations were often localized. These results agree with other studies of caribou in closed forest habitat (Simkin 1965; and Shoesmith 1978).

Simkin (1965:39) presented hunter questionnaire data and field observations which showed that:

> "Ontario woodland caribou are not very gregarious during the period from immediately prior to calving time through to October. During October, November and December, herds gradually increase in size and groups of 10 to 20 are common in the winter."

Simkin (1965) also mentioned that, if pregnant females or cows with young calves were seen with other caribou, it was usually with other gravid or maternal cows.

Shoesmith (1978) found that mean group size of woodland caribou at Reed Lake, Manitoba, varied as follows: spring 2.6 (n = 21); summer 1.7 (n = 144); fall 3.2 (n = 38); and winter 4.6 (n = 36). This

compares favourably with my data for Aikens Lake caribou: spring 3.8 (n = 30); summer 1.1 (n = 41); autumn 6.2 (n = 17); and winter 5.5 (n = 82) (modified from original data for Table 1). I found a marked decrease in mean band size from early spring (21 March to 4 April) to late spring and summer (15 May to 21 September) (Table 1). In view of this, and the fact that waterborne investigations did not commence until mid-May, active dispersal must have occurred during April and early May. Caribou aggregated in late September and were most gregarious in early December. The only exception was one occasion on 4 April 1975, when 30 to 35 were seen together (Hill 1979).

Shoesmith (1978) pointed out that wild reindeer in closed forests of Finland disperse in summer and behave in a similar manner, according to Montonen (1972). Spring dispersal has also been reported for caribou in the taiga of Quebec (Dauphiné *et al.* 1975) and for reindeer in taiga of the Kola Peninsula, USSR (Flerov 1952).

Gregarious behaviour is much more pronounced in caribou and reindeer that occupy open habitats in summer (Kelsall 1968; Parker 1972; Bergerud 1974c; and Thomson 1973). Miller (1974) and Bergerud (1971, 1974c) considered the clumping of caribou in open habitats during calving and post-calving to be an adaptation to limit loss by wolf predation. This is based on the hypotheses that predation would be redirected to debilitated animals on the periphery and back trails of aggregations (assuming spatial regulation of wolves) (Miller 1974), and that calves which do not join herds would be conspicuous to wolves and be selected against (Bergerud 1971, 1974c).

It does not seem likely that such selective pressures would be

operative in the taiga of Aikens Lake; restricted visibility alone seems to refute this. Indeed, the selective advantages of being scattered seem obvious (Bergerud 1974c). Shoesmith (1978) predicted that, if barren-ground caribou were introduced to the taiga of Reed Lake, they would become solitary in summer just as woodland caribou introduced on the tundra would become gregarious. I would be inclined to agree.

I have provided evidence that gravid cows of the Aikens Lake herd disperse prior to calving. This is consistent with observations of Simkin (1965) and Shoesmith (1978). I observed no evidence of a specific calving area for the population. On the contrary, two cow-calf pairs were found 15 km apart, and a third presumably different pair was also dispersed. It is not clear how this relates to behaviour of caribou at Sasaginnigak Lake or Reed Lake in Manitoba, or Irregular Lake in Ontario. Some cows in these populations return to the lakes each year to calve on islands (Carbyn 1967; Crichton 1974; Shoesmith 1978; and Simkin 1965).

During early spring of 1975, 1976, and 1977, Aikens Lake caribou became restless, but they did not disperse until after the first week of April. The restlessness was probably due to decreasing thickness of snowcover, mild temperatures and lengthening photoperiod. The behaviour associated with restlessness varied in each of the three years. In 1975 restlessness was manifested in the form of temporary aggregation; in 1976 caribou bands expanded their range and seemed to travel in an independent fashion; and in 1977 all caribou exhibited a synchronous shift in range to the northeast.

Stardom (1977) reported that during a winter of thick snowcover Aikens Lake caribou were aggregated into a few large bands that were fairly sedentary; in a winter with less snow they were in smaller bands that exhibited considerable mobility. During most of each winter of my study, snowcover was relatively thin, and my observations agree with the latter. I also found that band size fluctuated greatly in both winters. No bands of consistent size were observed for more than two weeks. This is quite different from Ruttan's (1960) observations of woodland caribou at Sled Lake, Saskatchewan, in the winter of 1959-1960. He reported at least 92 caribou to occupy an area of 260 miles^2 (666 km^2) in 17 groups containing two to 20 animals each. He stated (1960:15) that:

> "Although several groups were often associated for several days, feeding near each other and often using the same runway between feeding and loafing spots, there was no definite evidence that groups broke up or mingled with other groups."

Ruttan (1960) does not provide any information on snowcover, but his observations of limited movement and the use of runways through the snow imply that it was thick. Meteorological records for 1960 for La Ronge and Meadow Lake, Saskatchewan are incomplete, but they show that snowcover thickness was 41 cm at the end of February at the former (Canada Department of Transport 1960a) and 36 cm at the end of March at the latter (Canada Department of Transport 1960b).

In other areas, the aggregation and movement responses of caribou to snow conditions both agree and disagree with the observations of Stardom (1977) and myself. In the following passage of Bergerud

(1974c:571), the term "animals" refers to aggregations, not individual animals:

> "The density of caribou in winter in Newfoundland depended on the size of available food patches. Animals congregated, if food was available, only on wind-swept ridges in winters of deep snow. Animals were more dispersed if the winter was mild with food everywhere abundant . . . These changes in distribution and densities were not reflected in changes in aggregation sizes."

The changes in caribou density observed by Bergerud are similar to those observed at Aikens Lake, but the fact that mean aggregation size was stable in winters of different severity is different. Parker (1972:52), referring to Kaminuriak caribou, reported that:

> "During winters of excessively deep snow in the taiga, caribou continue to move, generally back toward the treeline, seeking out areas containing favourable snow conditions, particularly areas with minimum snow depths . . . When snow depths are not much greater than average, caribou wintering in the taiga may become relatively sedentary, with densities increasing throughout the late winter months. Caribou tend to disperse over a wide area when winter snow depths are less than average and restrictions on movement and feeding are minimal."

The many differences in nival and habitat conditions from one area to another are bound to be reflected in behaviour, not to mention the effect of a migratory habit. Yet, the similarities to observed behaviour at Aikens Lake are apparent.

I found that woodland caribou at Aikens Lake occupied essentially the same range year round. Seasonal ranges for the herd were largely overlapping. Mean range size varied as follows: spring 177.5 km^2, minimun summer 130 km^2, estimated summer 530 km^2, autumn 115 km^2, and

winter 117.5 km^2 (Figs. 11, 12 and 13; early spring 1977 not included). Seasonal range of the herd was smallest in autumn and largest in summer. This sedentary behaviour is apparently different from the behaviour of Sasaginnigak caribou which undergo a seasonal shift in their range (Carbyn 1968; Crichton 1974; and Stardom 1977). I also found that, in general, the amount of range occupied by the Aikens Lake herd varied inversely with the amount of gregarious behaviour.

Shoesmith (1978) monitored the movements of 11 radio-collared caribou at Reed Lake but did not present data for the entire herd(s). He found that mean seasonal range for individual caribou varied as follows: winter 253.4 km^2, spring 107.7 km^2, summer 13 km^2, and autumn 69.3 km^2. I do not have data on Candy or Blue for the entire spring period. Their mean values for summer (12.6 km^2) and autumn (54.5 km^2), however, compare very closely with those reported for Reed Lake caribou. Winter range size for Candy was based on only seven telemetry detections (34.4 km^2). Her winter range was probably larger, but it would not have exceeded the 1976-1977 value for the herd (100 km^2). Reed Lake caribou, therefore, seem to occupy a larger winter range than caribou at Aikens Lake.

Daily movement data for Candy for late spring through to winter show that she was relatively sedentary. Mean daily displacement varied from 1.4 km/day in winter to 2.2 km/day in autumn. No significant difference was apparent among seasonal means. Blue was very sedentary in summer (0.6 km/day) and significantly more active in autumn (1.8 km/day) (Student's t, $p<0.05$). Candy was significantly more active than Blue in summer ($p<0.05$), but there was no difference in autumn.

Bergerud (1974c) described the limited summer movements of seven bulls in forest in Newfoundland. Their mean daily displacement was 0.7 km during July and August (fly season), 1.6 km during June and September (no flies), and 1 km for the entire summer period. These data are very similar to those for Blue. Bergerud (1974c) also reported home range size for four of the bulls during various periods in the summer. These varied from 1.4 km^2 to 16.1 km^2 and averaged 5.1 km^2. This compares to Blue's summer range of 9.8 km^2, not counting his infrequent forays south of Aikens Lake. Shoesmith (1978) stated that a mature bull at Reed Lake occupied 2.2 km^2 from 3 to 20 August.

During October 1976, I was not able to observe rutting activity, but field data suggest that groups of one to 15 cows and non-breeding caribou wandered in and around an area of open bogs. Radio-telemetry data on Blue gave me the impression that bulls attended these groups for several days in succession but often travelled from one group to another, searching for cows in heat.

Bergerud (1974b:401) described similar behaviour for bulls in Newfoundland during pre-rut:

> "The large sexually active stags 'made-the-rounds' and visited many temporary groupings of does."

Bergerud (1974b) stated that during the breeding period large mating herds were often formed which mature bulls attended unless defeated in a fight. In other years, however, the herd structure resembled that of the pre-rut period with smaller "rutting companies". Herd structure at Aikens Lake would probably involve "rutting companies" if enough mature bulls were available.

6.2 Habitat Utilization and Food Habits

Habitat utilization and movements of Aikens Lake caribou appeared to be governed by food preference and availability, nival conditions, predators and insects.

Edwards and Ritcey (1959) and Stardom (1975) provided evidence that, in winter, woodland caribou are found first in vegetationally suitable areas and react secondarily to various nival conditions within the winter range. My observations of Aikens Lake caribou agree with this.

During both years of study, the caribou winter range coincided with an area of mature jackpine-spruce forest. Most of the mature uplands appeared to be a fire-generated mosaic in which caribou usually occupied areas of jackpine and jackpine-spruce. Within favoured sites, lush stands of ground lichens and low ericaceous shrubs were established under relatively open canopies. The winter range was also centred on a group of large open tamarack and black spruce bogs. This relationship of winter range to habitat was the same in 1970-1971 and 1971-1972 (Stardom 1977).

Food habit information from this study and others shows that, once deciduous forage dies with the first frosts of autumn, caribou prefer lichens, broadleaf evergreens and sedges (Moisan 1958; Edwards and Ritcey 1960; Simkin 1965; and Bergerud 1972). Caribou also show a reluctance to feed on coarse woody browse (Cringan 1957; Edwards and Ritcey 1960; and Kelsall 1968). At Aikens Lake, these food preferences were best satisfied in the area of mature jackpine and

open bogs. Surrounding areas had fewer open bogs, fewer lichens, and more deciduous woody browse. These observations reinforce Stardom's (1975:331) conclusion that:

> "The winter range . . . was surrounded by vegetation types suitable as food sources."

Stardom (1975) concluded that the threshold of sensitivity to snowcover thickness for Aikens Lake caribou was 65 cm. This was higher than the threshold of 60 cm for barren-ground caribou reported by Pruitt (1959). Although investigation of threshold levels was not an objective of my study, observations of caribou behaviour in open bogs were consistent with Stardom's (1975) conclusions.

Bergerud (1974c) considered that the common rationale for different responses to snowcover was movement to a relatively more available food supply. My observations also suggest this. In both winters of study, caribou were exposed to snowcover in open bogs exceeding 65 cm for one week in February. They responded by decreasing the amount of travel in bogs only slightly. However, they showed more tendency to cross bogs at narrow locations in single file, and they switched most of their feeding activity to jackpine ridges where they cratered for *Cladonia* spp. A longer period of exposure to snow depths exceeding 65 cm would probably produce more dramatic responses.

Stardom (1975) reported that Aikens Lake caribou spent up to 70% of their daily activity periods in open bogs during November and December 1970, feeding on arboreal lichens. I also found that caribou used these bogs intensively through autumn and early winter, until snow conditions restricted their activity. They fed on arboreal lichens and

cratered through the snow for sedges and ericaceous plants. However, the number of observations of activity recorded in open bogs never exceeded 40% of my total observations for four habitat types: semi-open and open bog, jackpine-rock ridge, lake ice, and other. In addition, my observations of activity were biased in favour of open habitats.

Lake ice was often used in winter for travel, escape habitat, and cratering for slush. Loafing on lakes was only common in late winter or early spring. This is similar to observations of Stardom (1977). Cratering for slush has also been reported for caribou in Wells Gray Park, British Columbia (Edwards and Ritcey 1959), and in Maine (Cabot 1939 *in* Edwards and Ritcey 1960).

Food habit observations of calf #146-B and wild caribou indicate that in late spring and summer caribou fed on a wide variety of deciduous leaves and ground forbs, in addition to lichens. This has also been reported for other populations of woodland caribou (Edwards and Ritcey 1959; Simkin 1965; and Bergerud 1972). The use of a variety of food items in summer probably carried some caribou into other habitats (*e.g.* isolated stands of mixedwood and deciduous forest), but caribou preferred mature, yet diverse, habitats of jackpine. They occasionally used dense black spruce bogs (seldom used in winter) and often used open tamarack-black spruce bogs.

Bergerud (1974a) stated that, assuming an adult sex ratio of one male to two females, calves at birth should represent at least 30% of the population. This is a reasonable assumption for the Aikens Lake herd; 30 to 40 caribou should produce at least 10 to 13 calves. Calving on islands was reported by Simkin (1965), Carbyn (1967), and Shoesmith

(1978). Despite intensive investigations in late spring and summer, the maximum number of cow-calf pairs I located on islands and shorelines was three in 1976. The most important islands were those in the centre of Obukowin Lake. In 1975, one to three single cows were seen there, plus one cow-calf pair. But many cows in the population must have calved in mainland areas. Only one island suitable for calving in the centre of the range was not examined. It was located in Durand Lake (Fig. 25). Several cows were probably using high ridges or islands in sedge bogs for calving.

Islands used by cows and calves in Obukowin and Fox lakes were similar to those described by Simkin (1965) as calving islands in Irregular Lake, Ontario. Bergerud (1974c) described the calving grounds of Newfoundland caribou. They were bogs and marshes interspersed with open dry uplands, hills, or spruce islands. Caribou in the Gaspé Peninsula of Quebec calve in the forest (Bergerud 1974c). Dauphiné *et al.* (1975) reported small numbers of calving females dispersed in string bogs north of Caniapiscau Lake, Quebec.

I believe that cows and calves of the Aikens Lake herd which used islands in lakes were responding to predation pressure by wolves. Wolf sign was often seen at Aikens, Fox, and Obukowin lakes. In addition, cows and calves may have found some relief from insect harassment on wind-swept islands. Insects were troublesome to calf #146-B that we raised in the field. Mainland calving sites are probably selected on the basis of these factors.

Most Aikens Lake caribou made only limited use of islands and lakeshores in late spring and summer, especially after mid-July. This

was supported by evidence that many caribou continued to use the winter range during summer, and that some caribou crossed the Gammon River back and forth to the northeast.

Three mature bulls were known to use shorelines intensively. One was bull #143-B on Obukowin Lake. The second was a bull on Fox Lake, and the third was Blue at Aikens Lake. Blue used shorelines throughout summer. Many of his beds were located on sand beaches which he often used on sunny, windy days, presumably to escape insect harassment. Bergerud (1974c) described analagous behaviour for some bulls in Newfoundland. Edwards and Ritcey (1959) mentioned the use of forest openings, beaches, and bogs by caribou in Wells Gray Park, British Columbia, during spring and autumn.

6.3 Effects of Fire

The common view regarding post-fire succession in the boreal coniferous forest is that white and black spruce are climax species, and that burned stands, in the absence of subsequent fire, will eventually revert back to these conifers (Kelsall *et al.* 1977). The climax associations reported for forests typical of the study area are black spruce-feather moss, and white spruce-balsam fir-white birch (Ahti and Hepburn 1967; and Heinselman 1973).

The mode of post-fire succession depends on characteristics of individual sites and the proximity of seed sources (Kelsall *et al.* 1977). Methven *et al.* (1975 *in* Kelsall *et al.* 1977) studied post-fire succession in northwestern Ontario. They found that, in practice,

burned stands regenerate to the same species that were dominant before the fire; they hypothesized that fire rather than succession is the basic mechanism of change.

Kelsall *et al.* (1977) reviewed the literature on fire in the boreal forest. They concluded (1977:4) that:

> ". . . fire and the resulting forest mosaic are natural features of long standing; and . . . the Boreal Forest can be characterized as a fire-dependent ecosystem. Trees, other plants, birds, mammals, and other animals of the forest have evolved in response and adaptation to the frequency, extent, and intensity of fire. With some possible exceptions, a mosaic of varied successional stages in the Boreal Forest provides a richer habitat for a more varied and abundant fauna than does the monotypic spruce forest characteristic of unburned areas."

Heinselman (1971, 1973) studied the role of fire in ecological succession in the Boundary Waters Canoe Area, Minnesota, where fire suppression has been effective for 60 years. The area possesses some tracts of boreal forest that are similar to those at Aikens Lake. By means of tree-ring analysis, charcoal fragments, and fossil evidence (including pollen), Heinselman (1973) determined that the area was a fire-dependent ecosystem with a natural fire rotation time of about 100 years (time to burn and reproduce an area of equivalent size). Kelsall *et al.* (1977:24) summarized their findings by citing Heinselman (1970):

> "The primeval landscape was a vast mosaic of stands in various age classes and successional stages following fires, interspersed with recently burned areas."

The most successionally advanced stands were local elements of the mosaic that had escaped fire (*e.g.* islands in lakes) (Kelsall *et al.* 1977). Heinselman (1973) found that the most successionally advanced stand at Boundary Waters Canoe Area still possessed a remnant super-canopy of post-fire origin (360 years old). Technically, it had not yet achieved a climax stage.

Undoubtedly, fire has also been part of the ecosystem at Aikens Lake since primeval times. Pioneer post-fire communities on uplands in this area are usually very dense stands of young jackpine. It takes 40 to 50 years before successional processes start to thin them out and create diversity. It is unlikely that the subsequent stands of mature jackpine could perpetuate themselves in the absence of fire, because fire is required to open the serotinous cones and expose mineral soil beds required for seedling establishment (Rowe and Scotter 1973). In many parts of the study area I have observed a low density of young black and white spruce growing under mature jackpine, but I have not observed any mature jackpine stands with an understory of young jackpine. In the theoretical absence of fire, then, it is likely that typical climax associations would eventually supersede jackpine.

Mature jackpine stands have a relatively open canopy and sparse understory that permit high productivity of ground lichens and low ericaceous shrubs, both important as food for caribou. Sunlight is vital for ground lichens (Ahti and Hepburn 1967). The closed canopy and dense understory of climax spruce-fir-birch, and the ubiquitous ground cover of bryophytes in climax black spruce-feather moss associations, reduce food production for caribou.

My observations show that Aikens Lake caribou favour (1) open tamarack and black spruce bogs, and (2) a mature, yet diverse, jackpine habitat. Areas of immature jackpine (25 to 40 years old) were seldom used, as were areas of black spruce-feather moss and islands supporting dense uniform stands of spruce-fir-birch in Obukowin and Aikens lakes. Stardom (1977) pointed out that fire has had little effect on open tamarack and black spruce bogs in the study area due to a low tree density and moist substrate. This has permitted the lush growth of arboreal lichens that caribou rely on in autumn and early winter. I suggest that mature jackpine constitutes the most important upland forest type, and that fire therefore plays an important role in the maintenance of desireable caribou habitat.

Ahti and Hepburn (1967) prescribed selective burning of overmature jackpine, black spruce-feather moss, wooded muskegs, and *Sphagnum fuscum* peatlands (where arboreal lichens are not important) as the best means of range management for woodland caribou in Ontario (*cf.* Euler *et al.* 1976). I believe that the key factors determining forest suitability for Aikens Lake caribou are the amount of mature jackpine and open bog habitat, and the time since burning. A sufficient amount of mature jackpine is essential for maintenance of the herd.

The effect of fire on the winter range of barren-ground caribou populations has been a controversial topic for many years (Banfield 1954; Kelsall 1968; Scotter 1964, 1967, 1970, 1971; Bergerud 1974a; Bunnell *et al.* 1975; and Miller 1976). A discussion of this controversy would constitute a thesis in itself; it will suffice to say that Johnson and Rowe (1975), Bunnell *et al.* (1975), and Kelsall *et al.*

(1977) reflect current thinking that the normal rate of annual burning (approximately 1% of total area) is not excessive, and barren-ground caribou are probably not as endangered by it as has been previously thought.

With regard to new burns, Candy continued to occupy areas within the Obukowin burn during summer 1976. She probably used bogs that were not burned and took advantage of lush regenerating ground forbs and paper birch suckers on burnt ridges. The herd's winter use of 1976 burns decreased by 56% from limited use of the same areas the previous winter. This shows that caribou tended to avoid the new burns. However, caribou were known to cross the burns and some feeding activity was observed within their limits.

6.4 Population Ecology

Census results for the period 1975 to 1977 yield a population estimate of 30 to 40 caribou for the Aikens Lake herd. This indicates no appreciable change in herd size since 1972, according to data of Stardom (1977). It is less than the 46 caribou observed in 1968 (J. Nespor, pers. comm. *in* Stardom 1977).

Calving probably occurs in mid-May. The December calf crop was 12.5% in 1975 and 20% in 1976. Stardom (1977) stated that three calves were present in the herd in the winter of 1971-1972 (12.3%). Simkin (1965) reported the mean winter calf crop for Ontario caribou to be 16.7% for the interval 1960-1964. Bergerud (1971) reported the November percentage of calves in the Interior herd of Newfoundland to

vary from 7.8 to 24.7% during the period 1958-1967 (these percentages occurred in the presence of lynx predation but in the absence of wolves). Kelsall (1968) reported the late winter percentage of calves in western barren-ground populations to vary from 6.9 to 26.6% during the period 1947-1961.

Food supply did not appear to be a limiting factor to growth of the herd. The only evidence of overgrazing occurred on two islands in the centre of Obukowin Lake. However, the amount of mature jackpine forest, and the number and quality of open bogs, may be critical factors in determining theoretical carrying capacity.

Ahti and Hepburn (1967) felt that food supply was not a limiting factor to the growth of caribou populations in Ontario. I believe that other forms of environmental resistance are the main determinants of population size.

There are only a few examples of free-ranging caribou in North America starving to death as a result of severe nival conditions (Kelsall 1968; Skoog 1968; and Bergerud 1971). Dauphiné (1976) stated that malnutrition was not an important cause of death among Kaminuriak adults. McEwan and Whitehead (1972) suggested that survival of neonatal calves depends primarily on the level of nutrient intake of the dam during late pregnancy. Dauphiné (1976) suggested that malnutrition of Kaminuriak cows is rarely a direct cause of death to calves, but that instead it renders calves more vulnerable to other forms of mortality. This may not be true of other areas (Bergerud 1971), but it is a possibility during years of severe nival conditions.

No evidence of wolf predation on caribou was observed during 1975

and the winter of 1975-1976. It probably existed at low levels, but most wolf activity was peripheral to the caribou range. A substantial increase in wolf activity was observed within the caribou range the following year, and at least two members of the herd were killed.

I observed no evidence of poaching during the two years of study, but one caribou was rumoured to have been poached, and one cow was known to have been shot by a native hunter. Stardom (1977) reported two caribou poached with the use of aircraft in February 1971. Woodland caribou are particularly vulnerable to this. They utilize frozen lakes as loafing areas, travel routes, and escape habitat, and are easily spotted when doing so. They will often run out into the open if buzzed by an aircraft, and a herd will frequently fail to flee if an aircraft lands quietly nearby.

Bergerud (1974c) felt that the use of open areas of habitat, plus their gregarious behaviour and inability to perceive motionless objects, makes caribou extremely vulnerable to hunting.

Assuming an adult sex ratio of one male to two females, calves at birth should represent at least 30% of the population (Bergerud 1974a), in this case at least 10 to 13 calves. December calf crop during the study averaged 16.3%. Thus, by December, five to seven calves would survive and five would perish. Overwinter hazards could easily claim another calf, leaving four to six.

Table 11 presents a hypothetical tally of mortalities that could occur in any given year. It becomes apparent that, with a small population, any mortality factors are potentially severe. It is not difficult to eradicate the annual increment. Stability of the

Table 11

Hypothetical tally of mortalities
for the Aikens Lake herd for any given year

Source of mortality	Adults	Calves
Old age	1	0
Accidents, exposure, disease	1	2
Hunting and poaching	1-2	0
Predation	1	3-4
Totals	4-5	5-6

population could easily be disrupted by a new source of mortality associated with resource development (*e.g.* slight increase in poaching or road kills by automobiles).

One additional mortality factor could arise from the interspersion of commercial forestry operations and caribou habitat at Aikens Lake. Early successional growth in clear-cuts could produce a corresponding increase in the number of white-tailed deer. If caribou and deer were occupying the same or adjacent areas, the transmission of meningeal worm could lead to neurologic disease. The decline of caribou in some areas has been attributed to this disease (Anderson 1971; and Dauphiné 1975).

No incidents of immigration or emigration were confirmed. The high percentage of bald cows in the Aikens Lake herd suggests little gene flow with surrounding populations. However, the proximity of the latter indicates that interchange could easily occur.

7. SUMMARY

(1) From March 1975 to April 1977, I studied the seasonal movements, habitat utilization, and population ecology of 30 to 40 woodland caribou at Aikens Lake in southeastern Manitoba.

(2) The Aikens Lake herd occupied essentially the same range year-round. Mean range size varied as follows: spring 177.5 km^2, minimum summer 130 km^2, estimated summer 530 km^2, autumn 115 km^2, and winter 117.5 km^2.

(3) In general, the amount of range occupied varied inversely with the amount of gregarious behaviour. Caribou were gregarious in winter and essentially solitary in summer. Mean band size was 3.8 in spring, 1.1 in summer, 6.2 in autumn, and 5.5 in winter. In summer, some caribou may have been loosely associated.

(4) During most of each winter of study, snowcover was thin, and caribou were aggregated in small bands that exhibited considerable mobility. Band size fluctuated greatly in both winters; no bands of consistent size were observed for more than two weeks.

(5) Restlessness was found to precede the onset of spring dispersal and to vary in character from one spring to another. In late March 1975, caribou decreased the extent of their range and aggregated before dispersing. In 1976, caribou expanded their movements and increased the amount of range occupied by almost two-fold. In 1977, the area occupied decreased slightly, and all caribou shifted their range to the northeast.

(6) I observed no specific calving area for the population. Instead, gravid cows appeared to disperse prior to calving.

(7) Two mature caribou, a cow and bull, were radio-collared. Mean seasonal range size for the cow was 17.2 km^2 for late spring, 15.4 km^2 for summer, 56 km^2 for autumn, and 34.4 km^2 for winter. Summer and autumn values for the bull were 9.8 km^2 and 52.9 km^2, respectively. The cow was significantly more active than the bull in summer ($p<0.05$), but no significant difference in daily rates of movement occurred in autumn. The bull was significantly more active in autumn than in summer ($p<0.05$).

(8) Habitat utilization and movements of Aikens Lake caribou appeared to be governed by food preference and availability, nival conditions, predators and insects.

(9) During both years of study, the caribou winter range coincided with an area of mature jackpine-spruce forest and open bogs sandwiched

between two large burns of immature jackpine and mixedwood. Most of the mature uplands appeared to be a fire-generated mosaic.

(10) In autumn and winter, caribou preferred lichens, broadleaf evergreens and sedges. They showed a reluctance to feed on woody browse. These food preferences were best satisfied in the mature jackpine-spruce forest and open bogs of the winter range.

(11) During short intervals (one week) when snowcover thickness exceeded 65 cm, caribou switched much of their feeding activity from open bogs to jackpine-lichen ridges. They also tended to cross bogs in single file at narrow locations. These observations were consistent with the nival tolerance threshold of 65 cm determined for Aikens Lake caribou by Stardom (1977).

(12) Lake ice was often used in winter for travel, escape habitat, and cratering for slush. Loafing on lake ice was only common in late winter or early spring.

(13) In late spring and early summer, caribou fed on a variety of deciduous leaves and ground forbs in addition to lichens. The use of a variety of foods probably carried some caribou into other habitats than mature coniferous forest.

(14) Most caribou made only limited use of islands and lakeshores in late spring and summer, especially after mid-July. Most cows

probably calved in mainland locations.

(15) Throughout the year, caribou favoured open tamarack and black spruce bogs, and a mature, yet diverse, jackpine habitat. Little use was made of climax spruce-fir-birch or black spruce-feather moss associations. I suggest that mature jackpine constitutes the most important upland forest type, and that fire therefore plays an important role in the maintenance of desireable caribou habitat. The key factors are the amount of mature jackpine and open bog habitat, and the time since burning. A sufficient amount of mature jackpine is essential for maintenance of the Aikens Lake herd.

(16) Forest fires burned three portions of the caribou range in summer 1976. Caribou tended to avoid the new burns during the following winter. However, some caribou were known to cross the burns and some feeding activity was observed within their limits.

(17) Calving probably occurred in mid-May. The December calf crop was 12.5% in 1975 and 20% in 1976.

(18) Food supply did not appear to be a limiting factor to growth of the herd. The only evidence of overgrazing occurred on two islands in the centre of Obukowin Lake.

(19) No evidence of wolf predation on caribou was observed during 1975 and the winter of 1975-1976, although it probably existed at low

levels. In 1976-1977, a substantial increase in wolf activity occurred. At least one cow and one calf were killed.

(20) Only one caribou was known to have been shot in 1975, and in 1976 one caribou was rumoured to have been poached on P.T.H. 304.

(21) At least 76.5% of cows in the Aikens Lake herd were antlerless.

(22) No incidents of immigration or emigration were confirmed. The high percentage of antlerless (*i.e.* bald) cows is quite different from surrounding populations in which most cows are apparently antlered. This suggests little gene flow with surrounding herds. However, the proximity of the latter indicates that interchange could easily occur.

8. RECOMMENDATIONS CONCERNING MANAGEMENT

(1) Present regulations of the Manitoba Department of Renewable Resources and Transportation Services prohibiting sport hunting of woodland caribou south of the Gammon River at Aikens Lake should be continued. The Aikens Lake caribou herd is small, and any increase in present mortality rates could seriously jeopardize the herd's existence.

(2) Commercial timber operations should not be conducted in or near caribou habitat where white-tailed deer infected with meningeal worm could increase in number. If infected deer frequent areas occupied by caribou, foci of transmission could develop. An increase in caribou mortality due to neurologic disease could result.

9. RECOMMENDATIONS CONCERNING PARK DEVELOPMENT FOR MAINTENANCE OF CARIBOU HERDS

(1) Development of areas in or near caribou habitat should be delayed until sufficient data on the caribou herd(s) are available to determine zoning and regulations. Areas important for caribou should be designated as special zones where human activity would be controlled. Caribou should not be confined to relatively small areas of isolated habitat.

(2) The number of roads and trails cutting through an area of caribou habitat should be minimized, because they facilitate travel and provide access for hunters, poachers, and wolves. If roads are constructed, they should avoid intersecting caribou trails. If intersections occur, efforts should be made to minimize road kills (*e.g.* reduced speed limits).

(3) Large campgrounds and intensive recreational activities are not compatible with woodland caribou. A low density of canoeists or fishermen in powerboats (less than 10 hp) is not a problem. Lakes used during calving, or other areas that are periodically sensitive, could be regulated for human use on a temporal and user-density basis.

(4) A road to Obukowin Lake should not be built. At present, the four-mile portage between Siderock and Obukowin lakes acts as a filter excluding large powerboats and irresponsible people. If a road to the Bloodvein-Gammon river system is necessary, it should circumvent areas occupied by caribou.

(5) Certain areas (*e.g.* open bogs or islands in lakes) are used intensively by woodland caribou at certain times of the year. It may be worthwhile to erect viewing towers near these areas to facilitate interpretation and public appreciation of the species. Felled trees laden with arboreal lichens might attract caribou to a specific viewing location.

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11. APPENDICES

Appendix I

List of marked animals

Species	Age	Sex	Date captured	Location	Radio-collar colour	Eartag number	Ear streamer colour	Left or right ear	Remarks
caribou	calf		8-vi-75	Obukowin Lake		142-B		R	
caribou	adult	M	9-vi-75	Obukowin Lake		143-B		L	drowned 22-vi-75
moose	adult	F	11-vi-75	Obukowin Lake		147-B	red	R	
moose	calf	F	22-vi-75	Obukowin Lake		145-B	red	R	
caribou	adult	F	19-v-76	Obukowin Lake	red & white				killed by wolves 15-iii-77
caribou	calf	F	27-v-76	Obukowin Lake	yellow (1-x-76)	146-B	red	R	killed by wolves xi-76
moose	calf	F	3-vi-76	Obukowin Lake		148-B	orange	R	
caribou	adult	M	17-vii-76	Aikens Lake	blue				

Appendix II

Autopsy Reports

Autopsy report for mature bull #143-B

Species: *Rangifer tarandus caribou*
Sex: male
Age: 6 years

Body length: 186 cm
Tail length: 17 cm
Hind foot length: 64 cm
Ear length: 15 cm

Total weight: 210 kg (estimated)
Eviscerated weight: 168 kg
Organ weights: lungs 4,328 g
heart 1,600 g

Collector: W. R. Darby
Collection number: WRD-1
Date of collection: 22-vi-75
Location: Obukowin Lake
Eartag number: 143-B

Head length: 46 cm
Head width (maximum): 19.8 cm
Mandible length (cleaned): 34.8 cm

Antler condition: in velvet
Length of main beam left: 80 cm
right: 79 cm

Parasites: one cysticercus of *Taenia hydatigena* was found in the liver, and one unidentified nematode was found in the air passages of the lungs

Remarks: a small solitary granuloma was found in one of the pulmonary lobes

Cause of death: drowning

Examiners: W. R. Darby, Dr. F. A. J. Juck (head and organs), Dr. L. Graham (parasites)

Date of preliminary: 22-vi-75
Date of final: 6-xi-75

Autopsy report for mature cow shot at Fox Lake

Species: *Rangifer tarandus caribou*
Sex: female
Age: 4.5 years

Ear length: 12.5 cm

Collector: W. R. Darby
Collection number: WRD-2
Date of collection: 26-i-76
Location: Fox Lake

Head length: 45.5 cm
Head width (maximum): 18 cm

Antler condition: absent (bald)

Parasites: five cysticerci of *Taenia hydatigena* were found in the liver

Remarks: only the head and thoracic organs were available for examination

Cause of death: shot

Autopsy report for mature cow shot at Fox Lake (continued)

Examiners: W. R. Darby, Dr. F. A. J. Juck (head), Dr. L. Graham (parasites)

Date of preliminary: 26-i-76
Date of final: 3-i-78

Autopsy report for mature cow Candy

Species: *Rangifer tarandus caribou*
Sex: female
Age: 9±1 years

Body length: 190 cm
Hind foot length: 61 cm
Ear length: 12.8 cm

Organ weights: lungs 3,000 g
heart 1,013 g

Femur length: 32.6 cm

Collector: W. R. Darby
Collection number: WRD-3
Date of collection: 16-iii-77
Location: Muskrat Lake
Collar: red and white radio

Head length: 45.5 cm
Head width (maximum): 17.5 cm
Mandible length (cleaned): 29.7 cm

Antler condition: absent (bald)

Femur marrow condition: white to pale pink and solid

Remarks: The partial carcass was examined. Patches of hair (3 to 6 cm diameter) had been torn from the hide on both front shoulders and in three places on the back. There were two parallel lacerations on the rhinarium about 3 cm long. A firm fibrous adhesion was present between part of the right apical lobe of the lung and the rib cage (probably a result of pneumonia in previous years). P-1 of the left dentary was oriented vertically, but 90^{o} to its normal position.

Cause of death: killed by wolves

Examiners: W. R. Darby, Dr. F. A. J. Juck

Date of preliminary: 20-iii-77
Date of final: 3-i-78

Appendix III

Description of Candy's death by wolves

Candy was killed on approximately 15 March 1977 in an area of rock ridges supporting mature jackpine, some black spruce and good stands of *Cladonia* spp. Mean snowcover thickness on jackpine-rock ridges was 38 cm. Fig. 39 shows details of the stalk and chase. The following description provides an interpretation of the evidence.

Candy and a second caribou were bedded side by side on a jackpine-rock ridge. The beds and tracks showed that both animals had been facing north-northwest. The wind was blowing from the northwest. A substantial number of craters was located on part of the same ridge to the south and southwest. Four caribou beds were located about 200 m to the southeast, but it is not known if they were occupied when Candy was killed.

A group of four wolves walked in a southeasterly direction west of Candy and the other caribou. Three were travelling single file, and the other was 19 m to their right. They were following caribou sign and craters.

At a distance of 62 m southwest of Candy and the other caribou, the wolves changed direction abruptly. All four walked towards the caribou and spread out in a fan. Tracks showed that the wolves did not break into a run until they reached the beds of the two caribou. Apparently, Candy and the other animal were not aware of the wolves until they were very close.

The other caribou was bedded nearest the wolves. It bolted from its bed, defecating as it did so, and ran as fast as possible to the north. Remarkably, there were no footprints in the bed; the first footprints were 3.1 m from it. Each of the succeeding bounds was 3 m apart. The wolves did not give chase.

Candy must not have been aware of the wolves even after the other caribou fled. She stood in her bed before trotting away, and she did not defecate. She trotted 29 m, then stopped and turned 270^{o} to the left at a walking pace. Finally, she broke into a canter, heading northeast. Meanwhile, the wolves had broken into a hard run.

Tracks showed that one or two wolves first jumped at Candy after she had travelled 111 m from the bed. No blood or hair was observed at that point. Candy then turned east. A small amount of hair and blood was present at 139 m, where Candy slowed to a trot. One or two wolves jumped her again at 154 m. More hair was present on the snow, but there was little blood. At 175 m Candy apparently dragged one or two wolves for a short distance before breaking loose. At 186 m she was again

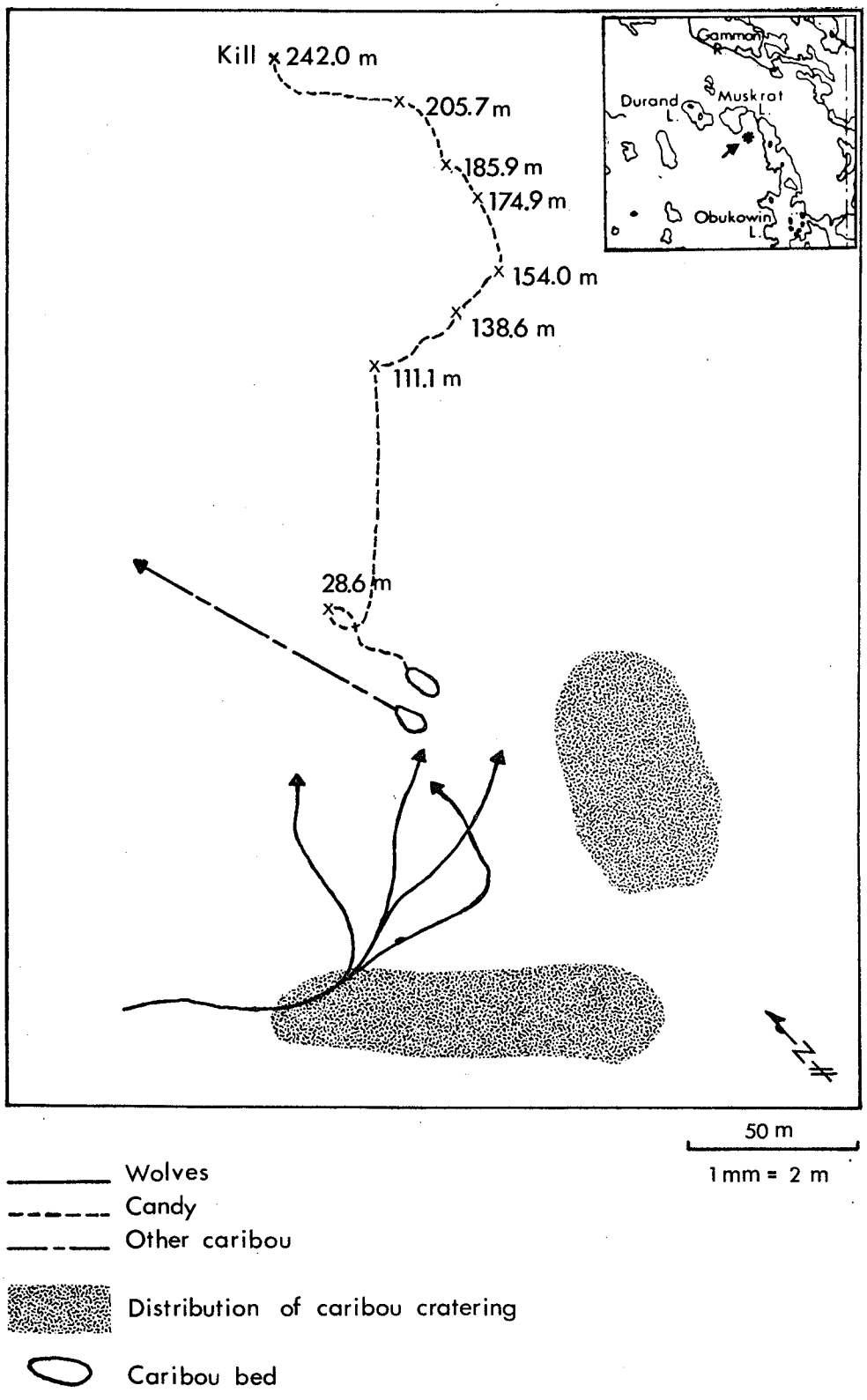

Figure 39. Movements of wolves and caribou during Candy's kill.

dragging one or two wolves, but once more she broke free. At 206 m the wolves got her down on the ground, but she was apparently able to get up and continue. There was still little blood on the snow. She may have dragged one or two wolves a short distance further, but at 242 m they got her down a second time and killed her.

When the carcass was discovered on 16 March 1977, there was nothing left behind the rib cage except the lumbar and pelvic bones and bones of the right hind leg. The anterior part of the animal was relatively untouched.

Appendix IV

Growth statistics for calf #146-B, May to October 1976

Date	Total length (cm)	Tail length (cm)	Hind foot length (cm)	Ear length (cm)	Back length (cm)[a]	Head length (cm)	Interorbital distance (cm)	Mandible length (cm)	Neck circumference (cm)	Girth (cm)[b]	Standing height to chest (cm)	Standing height to withers (cm)	Weight (kg)
27 May	97.0	9.0	40.0	10.0	42.5	26.0	11.0	16.0	26.0	56.5	45.0		11.8
19 June	105.5	10.5	44.0	10.0	46.0	27.0	11.0	18.0	26.5	60.0	47.0		15.9
28 June	108.0	11.0	45.0	10.0	48.0	27.0	11.5	18.0	27.0	60.5	47.5		17.3
4 July	109.0	11.0	45.5	10.1	48.0	27.0	11.8	18.5	27.0	64.0	48.0		20.0
11 July	117.0	11.3	46.0	10.1	50.0	27.2	12.0	18.5	28.5	66.0	48.0		22.1
18 July	124.0	11.3	47.0	10.5	52.5	28.0	13.0	19.8	30.0	66.5	48.5		25.0
9 August	127.5	11.6	47.9	11.1	55.5	28.3	13.6	20.3	31.5	71.5	49.9		30.4
22 August	130.0	12.0	48.0	11.3	55.7	30.0	14.0	20.5	32.0	76.0	51.0		28.2
7 September	133.5	12.0	48.0	11.5	56.0	30.5	14.0	21.5	33.0	77.0	51.5		27.3
10 October	135.0	13.0	49.0	12.0	60.0	32.0	14.5	22.5	35.0	86.0	52.0	86.0	33.2
17 October	135.0	13.0	49.5	12.0	60.5	32.0	14.5	22.5	35.5	86.0	52.0	88.0	33.2
29 October	139.0	13.0	50.0	12.0	61.0	32.5	14.5	23.0	35.5	86.0	53.0	88.0	34.1

[a]From withers to base of tail

[b]Behind front shoulders