Seasonal Distribution and Major Movement Patterns of Caribou and Moose in the Spatsizi Wilderness Area, British Columbia

by

Rudy Boonstra*

and

A.R.E. Sinclair**

25p.

Addresses: *Division of Life Sciences
Scarborough College
University of Toronto
1265 Military Trail
West Hill, Ontario
M1C 1A4

**Institute of Animal Resource Ecology
University of British Columbia
2204 Main Mall
Vancouver, B.C.
V6T 1W5

1982.

INTRODUCTION

The Spatsizi Plateau Wilderness Area in northern British Columbia contains one of the last major concentrations of woodland caribou (Rangifer tarandus caribou) (Banfield 1961) in the province. It is estimated that between 2000-2500 caribou inhabit this and adjacent areas (Osmond-Jones et al. 1977). In British Columbia, this species has received relatively little attention. Edwards and Ritcey (1959, 1960) studied the caribou in Wells Grey Provincial Park and Freddy (1979) has recently completed a study of the nearly extinct Selkirk caribou herd on the B.C.-Idaho border. However, in other regions, considerably more is known about woodland caribou ecology (Cringan 1957; Bergerund 1971, 1973, 1974; Shoesmith and Strong 1977). They appear to be behaviorally diverse, being primarily solitary in the closed boreal forest (Shoesmith and Storey 1977), but showing periods of gregariousness in mountain regions (Bergerud 1973). Moose (Alces alces andersoni) also occur in the Spatsizi, as they do throughout the boreal forests of Canada (Banfield 1974). They are essentially solitary, though sometimes they gather in groups of 3-4 in winter.

The purpose of this paper is to describe methods of survey, and analysis of distribution and movements of large ungulates such as caribou and moose. These methods are suitable for remote regions where ground work is difficult or impossible. The movements of caribou in the Spatsizi have yet to be described, yet knowledge of these movements and distribution are necessary for future conservation and management. The Spatsizi is of special interest for it supports one of the last remaining large herds of mountain caribou and it has almost no disturbance by man except for annual hunting.

Study Area and Methods

The Spatsizi Plateau Wilderness Park (Fig. 1) was formed in 1975 and is approximately 1000 km north of Vancouver, B.C. It covers ~~6,750~~ 6,214 km^2 and surrounds Gladys Lake Ecological Researve (~~33~~ 18.56 km^2). The terrain is primarily mountainous, but the rugged relief in many areas of the park gives way to wide open alpine plateaus and wide glacier-shaped valleys. In addition, many rivers and lakes are found throughout the area.

The climate of the Spatsizi, as described by Pojar (1976), is generally cloudy, moist, and cold. At Cold Fish Lake, in the centre of the study area but north of the main mountain range, mean monthly temperatures reach a high of +10°C in July (mean maximum 16.4°C) and a low of -20°C in January (mean minimum -24.7°C). Winters are long and cold with mean monthly temperatures below freezing from October to April. Summers are cold and cloudy; Geist (1971) recorded 22 consecutive rain days in August 1962. However, total precipitation is not high (550 mm) and it is spread fairly evenly through the year. The lowest precipitation occurs March-June.

There is a gradient of temperature and precipitation in the area, with the warmest and driest parts being in the north and north-east along the lower Stikine and Spatsizi rivers. The snowpack here is 30-50 cm. In the higher mountain ranges to the southwest, precipitation is higher and snowpack is 150-200 cm. The southeast of the Spatsizi Park and Tatlatui Park are higher and therefore colder than the northwest of the study area.

The region was surveyed by systematic aerial reconnaissance (Maddock 1979). Over the wide valleys and flat plateau regions, we flew parallel transects 5 km apart. In the narrow valleys, we flew along them but ensured that

every block on the map was surveyed. The only area not surveyed included the steep, rugged alpine terrain of glaciers and vertical faces not suitable for caribou and moose. We used a Cessna 185 aircraft with pilot and navigator in front and two observers in the back. Each observer surveyed his side of the aircraft up to 1 km from the plane. We also counted all animals within a transect of approximately 150 m width that formed a sub-sample of the 1 km width. The transcect was marked by strings attached to the aircraft strut and calibrated by the method described in Norton-Griffiths (1978). Counts of animals within this transect were used for estimates of population size.

Flying height was kept, as far as possible, at 150 m (500 ft.) using the pressure altimeter calibrated at one airstrip. The navigator (A.R.E.S.) used the contour map and experience to judge height. If the aircraft was too high, observers did not record sightings and a return transect was made. Air speed ranged between 160 and 200 km/h.

We used the most detailed contour maps available, these having a scale of 1:250,000. The entire Spatsizi map (sheet #104H, National Topographic Series, Department of National Defence, second edition, 1974), the southern portion of Cry Lake (sheet #104I), the western portion of Toodoggone River (sheet #94E), and the northern portion of McConnell Creek (sheet #94D) were divided into grid blocks. Each block was 2.5 km wide (6.25 km^2) and identified by column and row coordinates. These were subdivisions of the map 10 x 10 km grid. Since our survey path was about 2 km wide, we covered the majority of the 2.5 km wide block.

Four aerial surveys were conducted over the Spatsizi area: March 5-8, 1976, May 25-27, 1976, September 28-30,1976, and March 1-3, 1977. The number of kilometers flown on each survey was 2005, 1759, 2063, and 1800 km respec-

tively. Though the majority of the transects were concentrated in the park, some flights were made to the north, east, and south of it to see if caribou were also using these areas and in what concentrations. The grid coordinates, and the number and species of ungulatels seen were recorded by observers onto tape recorders and subsequently transcribed onto computer sheets.

To relate the distribution of caribou and moose to the vegetation, the vegetation of each grid block in the park was obtained from forest cover maps (Resources Analysis Branch, Ministry of the Environment, British Columbia). Within each block, the percent cover of each vegetation type was classified according to a modified Domin Scale (Kershaw 1973). The scale used had the following classes:

Scale	Percent Cover of Block
10	100
9	>75
8	50 - 74
7	33 - 49
6	25 - 32
5	13 - 24
4	3 - 12
3	1 - 2
2	trace
1	none

The forest cover types on these maps were reduced to the following classes (Fig. 2). The vegetation description is taken from Pojar (1976).

Alpine: This cover type is the dominant one in the Spatsizi area. It includes all land above the timberline (approximately 1525 m) whether it is vegetated or not. The forest cover maps made no distinction between rock and vegetation for this class. Pojar (1976) describes the alpine zone as including: (a) heath dominated by white mountain

heather (Cassiope tetragona), mountain avens (Dryas integrifolia), dwarf willows (Salix reticulate, S. polaris), and bryophytes; (b) tundra with the same dwarf willows, Festuca altaica grass, Carex sedges, and most importantly for caribou, lichens.

Sub-alpine Forest: This is the second most abundant class and all cover types in which sub-alpine fir (Abies lasiocarpa) forms a major component of the vegetation (>20% of gross volume) are included. Sub-alpine fir may be associated with white spruce (Picea glauca), lodgepole pine (Pinus contorta), or any combination of these. In general, the Abies community occurs at higher elevations and forms the tree line. The closed canopy sub-alpine fir include feather moss, while more open areas support poorly developed dwarf birch (Betula gladulosa) and crowberry (Empetrum nigrum). Ground lichens are common.

Spruce: All cover types in which white spruce forms a major component of the vegetation are included. Spruce may be associated with any one or combination of the following minor species (10-19% of gross volume): sub-alpine fir, trembling aspen (Populus tremuloides), lodgepole pine, black spruce (Picea marina). The few situations in which black spruce forms a major component of the cover are also included in this class because it is always associated with white spruce as another major component of the vegetation and in total, this cover type accounts for only 0.82% of the entire study area.

Spruce forest is normally found on lower slopes and valley bottoms up to about 1400 m. The stands are open and associated with a well-developed shrub layer of dwarf birch and grey willow (Salix

glauca). The ground level includes dwarf shrubs such as crowberry, soapberry (Sherpherdia canadensis), mountain bilberry (Vaccinium vitis-idaea), and Labrador tea (Ledum groenlandicum); and herbs such as Lupinus arcticus, Epilobium angustifolium, Limnaea borealis amongst others. Mosses and lichens are common, the species being similar to those in the lodgepole pine cover type.

Spruce/Pine: In this type, white spruce and lodgepole pine forms more or less equal components of the cover. The herb and shrub vegetation is similar to the spruce and pine cover types.

Pine: Lodgepole pine forms the major component of the cover in this type, but can be associated with the following minor species: white spruce, black spruce, or trembling aspen.

The frequent seedlings and saplings of white spruce in this area indicates the seral nature of this pine community. The shrub layer is not well developed, though dwarf birch and grey willow are most abundant. However, at ground level, lichens are common and abundant, and especially those eated by caribou, Cladina mitis, C. rangiferina, and C. alpestris. Epiphytic lichens are also abundant.

Brush: In this type, few or no trees are found and the vegetation is dominated by dwarf birch (S. glauca, S. alaxensis, S. barclayi) and various willow species.

Burns: In this area, regeneration of trees had not yet occurred to a significant extent after a fire. Shrubs were poorly developed but similar to spruce and pine types.

Aspen: Trembling aspen forms the major component in this type, but it is also associated with other cover types; e.g., white spruce, lodgepole pine or balsam poplar (Populus balsamifera). Aspen communities are common on drier sites along the major valleys, especially on south-facing slopes of the Spatsizi, Stikine, and Klappan rivers. Some dense stands of stunted aspen (2-7 m height) reach 1500 m. The shrub layer includes Salix scouleriana, soapberry, prickly rose (Rosa acicularis), and bearberry (Arctostaphylos uva-ursi). Lichens and mosses are uncommon, as are epiphytes.

We also include in this type, the few stands of balsam poplar. Poplars occupy moister sites than aspen and well developed stands are found only in the northwest of the study area on flood plain terraces of the Stikine and lower Klappan rivers. The shrub stratus is sparse, but the herb layer is rich with broad-leaved forbs (e.g., Delphinium glaucum, Lupinus arcticus). Lichens are almost absent. Snow cover in both the balsam poplar and aspen stands is heavier than in the conifer cover types. Although neither the forest cover maps nor Pajar (1976) mention white birch (Betula papyrifera), we noticed it throughout the area, but particularly in the aspen types.

Swamp and Muskeg: This type includes all boggy areas which support little or no tree cover.

River/Lakes: The spatsizi and Stikine rivers are predominant in the north. Lakes are most numerous in the southeast of the area (Fig. 1).

In general, the majority of the Spatsizi was rock and alpine plateaus (49%) (Fig. 2). Coniferous trees dominated the forest cover, with sub-alpine fir and white spruce being the most common. Below-timberline, there was relatively little open ground (not including rivers and lakes); areas with brush, burns, and swamps/muskeg accounted for only 6.5% of the total area.

To determine whether selection by caribou and moose occurred for specific vegetation classes, only grid blocks which were actually flown over in a particular survey were included in the analysis. Each of these blocks was classified according to the presence of a particular vegetation class in it and to the presence of caribou or moose. A vegetation class was regarded as present in a block if it covered at least 3-12% of the area. We mesured the degree of association of either caribou or moose with a vegetaton type by using Cole's (1949) coefficient of association. Although Hurlbert's (1970) coefficient of association was calculated at the same time, we did not use it since both coefficients were very similar. Cole's coefficient ranged from +1 to -1, with zero indicating random association. The major shortcoming in our analysis resulted from the large size of the blocks we used, because of the small scale of maps that were available to us. The large blocks sometimes included many vegetation types, and were, therefore, more heterogeneous than we would have liked. The mountainous terrain, with the rapid changes in altitude, caused the vegetation to be heterogeneous over short distances. Nevertheless, major patterns of association did become obvious.

Results

CARIBOU

Cole's coefficient of interspecific association between caribou and the vegetation classes is shown in Figure 3 and their distribution over the park is shown in Figure 4. Both the March 1976 and March 1977 surveys took place in late winter when temperatures fluctuated around -10°C. Snow depth was around 50 cm in the conifer areas and caribou were digging through it to the herb layer. In both surveys, none of the association coefficients were significant, indicating that caribou were found throughout the vegetation types in proportion to their occurrence in the transects (Fig. 3). In both years, the caribou were found wintering in the northern half of the park along the Stikine River, with major concentrations occurring along the eastern edge of the Spatsizi Plateau. In both years, the largest herds seen (1976 - 68 caribou and 1977 - 208 caribou) were seen in the sub-alpine zone on the same slope. In Marh 1976, flights were restricted to the main park area and the immediately adjacent land. However, in 1977, one flight was conducted into and south of Tatlatui Park, but we saw no caribou tracks. We also conducted one flight north of the Stikine River along the McBride, Turnagain, Tucho, and Pitman Rivers. Only three small groups of caribou were sighted along the Turnagain River, though caribou tracks were numerous on that river. Therefore, in March, caribou showed no preference for any vegetation type, but they did concentrate their activities in the northern portion of the park.

In late May 1976, snow had melted from most of the area below the tree line in the north and centre of the study area; rain fell intermittently and temperatures were around +5°C. However, snow still covered the area south of

Caribou Hide camp on the upper Stikine River, in the southeast of the study area. This area is higher and colder, and snow showers were frequent. Caribou were scattered in small groups throughout the north, centre, and east of the area (Fig. 4), and, unlike the March surveys, no large groups were seen. They were moving south in lines through Lawyers Pass at the edge of the snow. It appeared they were following the snow melt southwards. Under these conditions, caribou showed a significant preference for brush ($P < .005$), burns ($P < .005$), and spruce-pine stands ($P < .025$) only (Fig. 3).

In late September 1976, autumn was approaching and snow showers were occurring in the alpine areas, although it was still raining below the tree line. Caribou showed a significant preference for the alpine zone ($P < .05$) and a significant avoidance of spruce ($P < .01$), and spruce-pine ($P < .01$) forests (Fig. 3). The largest concentrations were seen on the Spatsizi Plateau above Cold Fish Lake (70), in the alpine and sub-alpine zones of Mt. Tomias and Blueberry Mt. (herds of 150 and 240), and in the alpine zone above Brothers Lake (52). Small herds were also seen on Mt. Tomias in the alpine zone east of Lawyers Pass. One flight was made north of the Stikine following the Pitman and Tucho Rivers and back on Kutcho Creek, but no caribou were seen. One flight was made into Tatlatui Park and south of it to Thutade Lake, and six caribou were sighted in the alpine zone just south of Thutade Lake. Therefore, at this time of year, caribou were primarily concentrated in the alpine zones in large herds, in anticipation of the rut which begins around October 10th. We estimated this date by back extrapolation from the sighting of the first calf in late May.

MOOSE

Moose showed no significant preference for any vegetation type in March 1976, though their preference for spruce-pine forests and burns approachd significance ($P < .10$) (Fig. 5). Many of the moose were associated with valley bottoms and the largest concentrations were seen on the lower Spatsizi River around Highland Post. In March 1977, there was a significant avoidance of alpine areas ($P < .025$) and a significant preference for pine forests ($P < .025$), and for brush ($P < .001$) with spruce and spruce-pine forests approaching significance. The two largest concentrations were seen on the upper Ross River and on the Dawson River, both locations where they were not seen in 1976 (Fig. 4). In contrast, relatively few were found on the lower Spatsizi. No moose were seen on the flight into Tatlatui Park and south to the Sustut River. In the flight north of the Stikine (see Caribou section), only two moose were seen, again on the Turnagain River.

In May 1976, moose showed a significant preference for spruce forests ($P < .05$) and the preference for burns approached significance ($P < .10$) (Fig. 5). They were widely distributed throughout the area with no large concentrations seen anywhere and only one moderately large concentration seen on the Spatsizi River. No moose were seen in Tatlatui Park on the one flight made into the area.

In September 1976, there was a significant avoidance of alpine area ($P < .01$) and a significant preference for brush ($P < .025$) (Fig. 5). They were widely distributed with no major concentrations seen anywhere (Fig. 4).

Discussion

The caribou population in the Spatsizi area underwent marked seasonal shifts over the four time periods examined in our study. In late winter (the March surveys), they were concentrated in the northern half of the park with the largest concentrations occurring in the sub-alpine zone. However, this zone was not occupied exclusively; all other vegetation types were occupied in proportion to their presence on the area. None were found south of the Spatsizi River. In contrast, both Edwards and Ritcey (1959) in Wells Grey Provincial Park and Freddy (1979) in southern B.C. - northern Idaho, found the caribou exclusively occupying the sub-alpine spruce-fir forest, eating primarily arboreal lichens (Alectoria spp.) (Edwards and Ritcey 1960). Bergerud (1974) found that caribou in Newfoundland, which also tended to occupy mountainous habitat, chose a variety of habitats, depending on snowfall conditions. During winters of deep snow, they sought high, exposed, wind-swept ridges. At other times, sub-alpine areas with few trees and exposed lichen woodland provided the best habitat. Their diet constituted primarily of arboreal lichens and evergreen shrubs. In the low altitude study in Manitoba, Stardom (1975) found that caribou were found in open bogs, feeding on ground lichens, but they also moved to jackpine (Pinus banksiana) rock ridges and fed on arboreal lichens. The common denominator amongst all these studies was extensive though not exclusive use of arboreal lichens. In addition, the habitat used appeared to be determined by the availability of the food supply which was determined by the snow cover. This suggests that the caribou in our study may have been forced out of the southern end of the park because it was higher in elevation and had deeper now cover.

The late May survey took place just prior to the calving period. One cow with calf was actually sighted in a dwarf birch - willow meadow. The significant selection of burns and brush vegetation suggests that they were lacking for more open habitats, perhaps in which to calve. In Galdys Lake Ecological Researve region of Spatsizi, Geist (1971) noted that caribou cows gave birth on the highest mountain ridges, again suggesting their need to seek secluded sites less vulnerable to predators. Of the cows monitored during the study of Shoesmith and Storey (1977), all calved on islands where predators were less abundant. However, cows did not seek secluded sites in the study of Bergerud (1974), where no wolves occur, nor in the studies on the barren land caribou by Lent (1966) and Kelsall (1968), where wolves do occur. Perhaps the selection of secluded sites depends partly on their availability (they may not be available on the tundra) or on selection pressure.

In the fall, pronounced selection for the alpine zone and an avoidance of spruce and spruce-pine forests was found. This coincided with the annual rut. Similar use of high exposed areas on mountains have been found by Bergerud (1973) on Mt. Albert, Quebec. In Newfoundland, Bergerud (1974) indicated that caribou used open areas for the rut but did not specify where these open areas were. Bergerud (1973) suggested that alpine zones were used because they facilitated herd formation and allowed females to breed with the most dominant male. The males in his study formed a dominance hierarchy. It is unclear which sex initiated herd formation. Bergerud (1974) indicated that in Newfoundland, the males left the timber at the end of the summer to be with the females in the open areas. The females would benefit most from this arrangement, for they are assured of being bred by the strongest males rather than by just any male that they might encounter in the timber. However, in

males, only the strongest would have this privilege.

Habitat selection by moose in the Spatsizi was similar to that reported in other studies. In fall, moose selected open habitats with brush in them, but avoided alpine areas. In winter and late spring, moose selected burns and brush plus heavily forested habitats of spruce and pine, and in one case (March 1977), again showed a significant avoidance of alpine areas.

The importance of early seral stage plant communites to moose populations has been well documented (Hatter 1950, Phillips et al. 1973, Krefting 1974, Irwin 1975, Peek et al. 1976), for they provide an abundance of browse species such as willow (Salix spp.). Logging can also result in an abundance of these browse species. Near Prince George in north-central B.C. (600 km southeast of our study), Eastman (1978) found that willows, red-osier dogwood (Cornus stolonifera), and grasses were the dominant foods in fall; willow, paper birch, and red-osier dogwood were dominant foods in early winter; and sub-alpine fir, willow, and paper birch were dominant foods in late winter. The latter shift to consumption of some coniferous vegetation was due to a shift in habitat. Because of the deeper snows in late winter, moose moved to heavily forested areas in late winter. This shift to coniferous forest in late winter has also been reported for other areas across North America (Edwards and Ritcey 1956, Tefler 1970, Kelsall and Prescott 1971, Krefting 1974, Peek et al. 1974, Rolley and Keith 1980).

The selection for both open and forested habitat in late winter and spring in our study suggests that vegetation diversity may be an important variable. In Alaska, LeResche et al. (1974) found that high vegetation heterogeneity characterized winter moose habitat. Eastman (1978) found that partially logged sites were preferred over all other sites. Similar findings

have been reported by other workers (Prescott 1968, Peek et al. 1976). Moose in our study were usually found near rivers or streams in March and May (note that Figs. 2 and 4 only indicate the larger rivers). These habitats provide high vegetation diversity because of river flooding, erosion, changes in stream channels, and ice damage (Peek 1974). Riparian habitat was also used extensively by moose in Alaska (Mould 1979) and in Montana (Peek et al. 1974).

In conclusion, we describe a technique for monitoring the movements, distribution, and habitat preferences of large mammals, such as caribou and moose, in difficult terrain. The technique is efficient in time, manpower and cost, compared to alternative ground studies. The four surveys showed that there was a migration of caribou northwest for the winter (towards the warmest area with the least snow cover) and southeast in the spring. Habitat preferences of both caribou and moose conformed with results from other areas. Caribou showed little habitat selection in winter, perhaps because the ground lichens and herbs on which they fed were abundant in all major habitats in the northern Spatsizi. although we were unable to conduct more frequent surveys at that time, we suggest that further systematic surveys should be carried out to fill in the gaps and test our present conclusions.

Acknowledgements: We would like to thank all those who helped with the surveys in various ways, in particular, Ron Bruns as pilot, D.S. Eastman, and D. Hatler as observers. The surveys were funded in part by the British Columbia Fish and Wildlife Branch, Provincial Parks Branch, B.C. Ecological Reserves, and the National Scientific and Engineering Research Council of Canada. To these we express our thanks.

REFERENCES

Banfield, A.W.F. 1961. A revision of the reindeer and caribou, genus Rangifer. Nat. Mus. Canada. Bull. No. 177, 137 pp.

Banfield, A.W.F. 1974. The mammals of Canada. Univ. Toronto Press, Toronto, 438 pp.

Bergerud, A.T. 1971. Abundance of forage on the winter range of Newfoundland caribou. Can. Field Nat. 85:39-52.

Bergerud, A.T. 1973. Movement and rutting behavior of caribou (Rangifer tarandus) at Mount Albert, Quebec. Can. Field Nat. 87:357-369.

Bergerud, A.T. 1974. The role of the environment in the aggregation, movement, and disturbance behavior of Caribou. In The behavior of ungulates and its relation to management. Ed. by V. Geist and F. Walter. IUCN Publ. No. 24, pp. 552-584.

Cole, L.C. 1954. The measurement of interspecific association. Ecology 30:411-424.

Cringan, A.T. 1957. History food habits, and range requirements of the woodland caribou (Rangifer caribou) of continental North America. Trans. N. Am. Wildl. Conf. 22:485-501.

Eastman, D.S. 1978. Habitat selection and use in winter by moose in subboreal forests of north-central British Columbia, and relationships to forestry. Ph.D. Thesis, Univ. British Columbia.

Edwards, R.Y. and R.W. Ritcey. 1956. The migrations of moose herd. J. Mammal. 37:486-494.

_____. 1959. Migrations of caribou in a mountainous area in Wells Gray Park, British Columbia. Can. Field Nat. 73:21-25.

_____. 1960. Foods of caribou in Wells Gray Park, British Columbia. Can. Field. Nat. 74:3-7.

Freddy, D.J. 1979. Distribution and movements of Selkirk caribou, 1972-1974. Can. Field Nat. 93:71-74.

Geist, V. 1971. Mountain sheep: A study in behavior and evolution. Univ. Chicago Press. pp. 383.

Hatter, J. 1950. Past and present aspects of the moose problem in central British Columbia. Proc. 30th Ann. Conf. West. Assoc. of State Game and fish Commissioners. pp. 150-154.

Kelsall, J.P. 1968. The migratory barren-ground caribou of Canada. Canadian Wildlife Service Monograph Number 3, 340 pp.

Kelsall, J.P. and W. Prescott. 1971. Moose and deer behavior in snow. Can. Wildl. Serv. Rep. Ser., 15, 24 p.

Irwin, L.L. 1975. Deer-moose relationships on a burn in northeastern Minnesota. J. Wildl. Manage. 39:653-662.

Kershaw, K.A. 1973. Quantitative and Dynamic Plant Ecology. Edward Arnold, London, pp. 308.

Krefting, L.W. 1974. Moose distribution and habitat selection in north-central North America. Nat. Can. 101:81-100.

Lent, P.C. 1966. Calving and related social behavior in barren-ground caribou population. Anim. Behav. 13:259-264.

LeResche, R.E., U.S. Seal, P.D. Karns, and A.W. Franzmann. 1974. A review of blood chemistry of moose and other Cervidae, with emphasis on nutritional assessment. Can. Nat. 101:263-290.

Maddock, L. 1979. The "migration" and grazing succession. In Serengeti - Dynamics of an ecosystem. Eds. A.R.E. Sinclair and M. Norton-Griffiths. pp. 104-129. Univ. Chicago Press, Chicago.

Mould, E. 1979. Seasonal movement related to habitat of moose along the Colville River, Alaska. Murrelet 60:6-11.

Norton-Griffiths, M. 1978. Counting animals. 2nd Ed. African Wildlife Leadership Foundation, Nairobi, 139 pp.

Peek, J.M. 1974. A review of food habits of moose in North America. Nat. Can. 101:195-215.

Peek, J.M., R.E. LeResche, and D.R. Stevens. 1974. Dynamics of moose aggregations in Alaska, Minnesota, and Montana. J. Mammal. 55:126-137.

Peek, J.M., D.L. Urich, and R.J. Mackie. 1976. Moose habitat selection and relationships to forest management in northeastern Minnesota. Wildl. Mono. 48, 65 p.

Phillips, R.L., W.E. Berg, and D.B. Siniff. 1973. Moose movement patterns and range use in northwestern Minnesota. J. Wildl. Manage. 37:266-278.

Pojar, J. 1976. Vegetation and some plant-animal relationships of ecological reserve No. 68, Gladys Lake. Ecological Reserves Unit, Victoria B.C., 146 pp.

Prescott, W.H. 1974. Interrelationships of moose and deer of the genus Odocoileus. Nat. Can. 101:493-504.

Rolley, R.E. and L.B. Keith. 1980. Moose population dynamics and winter habitat use at Rochester, Alberta, 1965-1979. Can. Field-Nat. 94:9-18.

Shoesmith, M.W. and D.R. Storey. 1977. Movements associated behavior of woodland caribou in central Manitoba. 13th Internat. Cong. Game Biol. pp. 51-64.

Stardom, R.R.P. 1975. Woodland caribou and snow conditions in southeast Manitoba. In Proc. 1st Internat. Reindeer/Caribou Symposium. Univ. Alaska, Fairbanks, pp. 436-461.

Telfer, E.S. 1970. Winter habitat selection by moose and white-tailed deer. J. Wildl. Manage. 34:553-559.

Fig 1

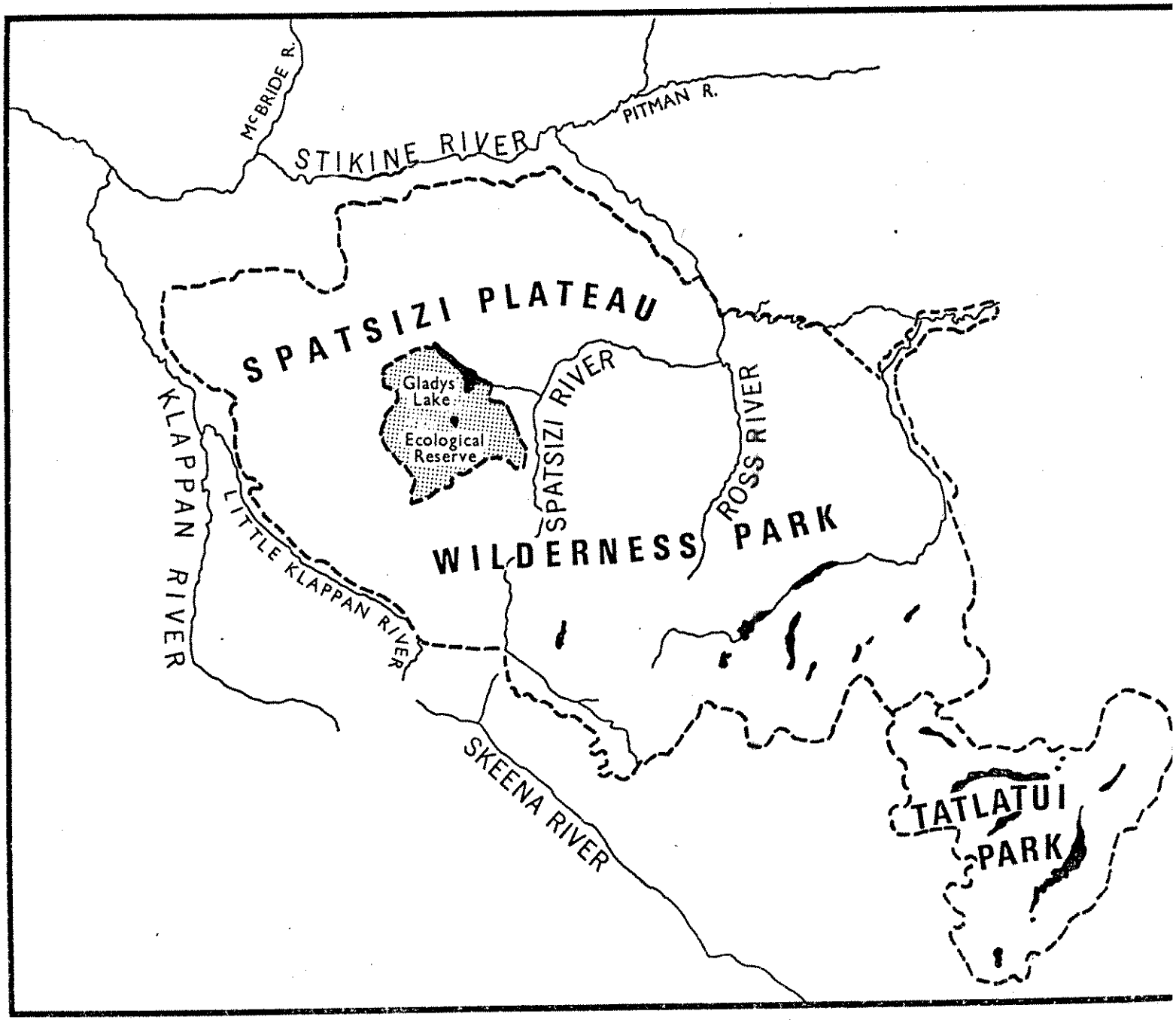
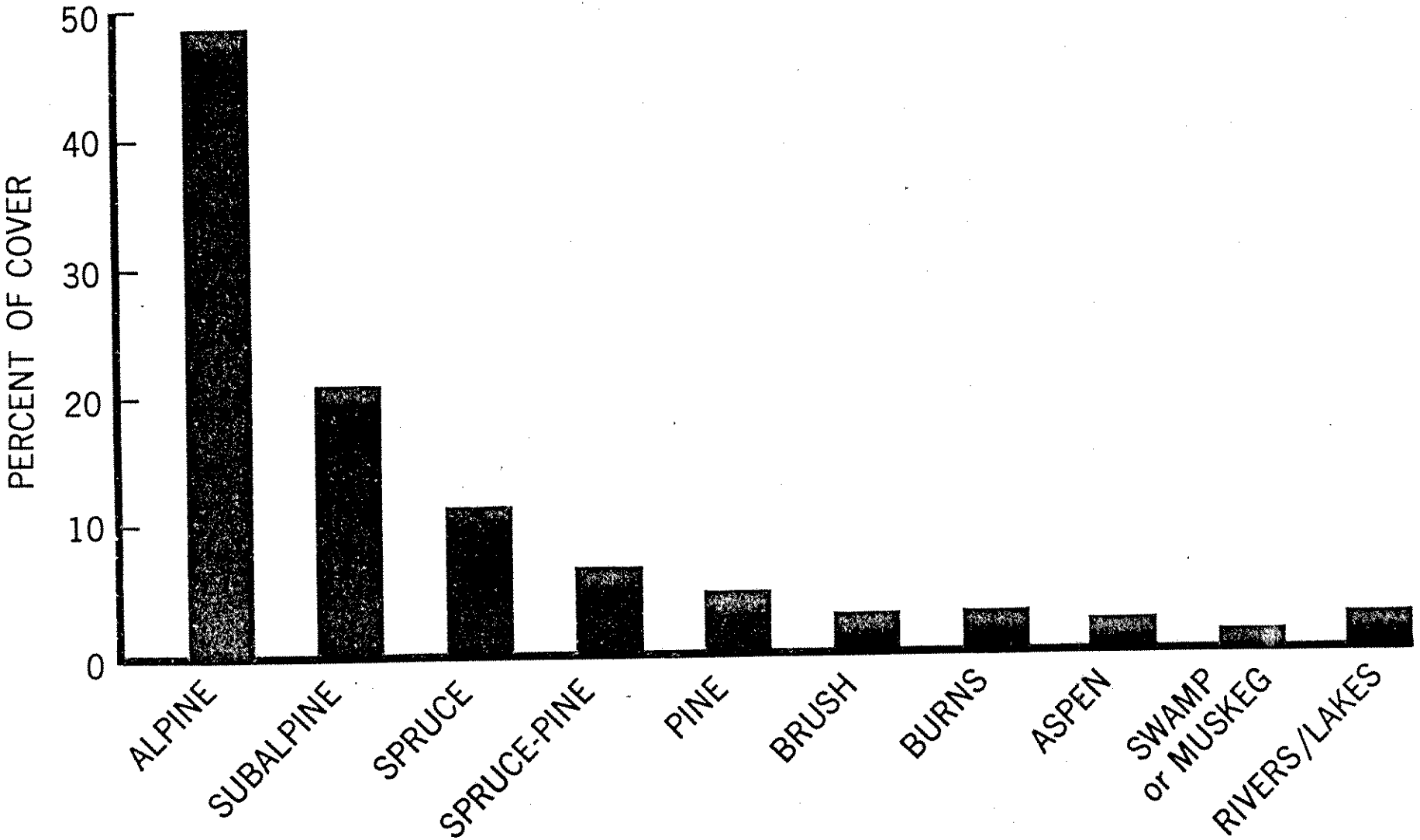

McBRIDE R.
PITMAN R.
STIKINE RIVER
SPATSIZI PLATEAU
WILDERNESS PARK
Gladys Lake
Ecological Reserve
SPATSIZI RIVER
ROSS RIVER
KLAPPAN RIVER
LITTLE KLAPPAN RIVER
SKEENA RIVER
TATLATUI PARK

Fig 2


PERCENT OF COVER
50
40
30
20
10
0
ALPINE
SUBALPINE
SPRUCE
SPRUCE-PINE
PINE
BRUSH
BURNS
ASPEN
SWAMP or MUSKEG
RIVERS/LAKES

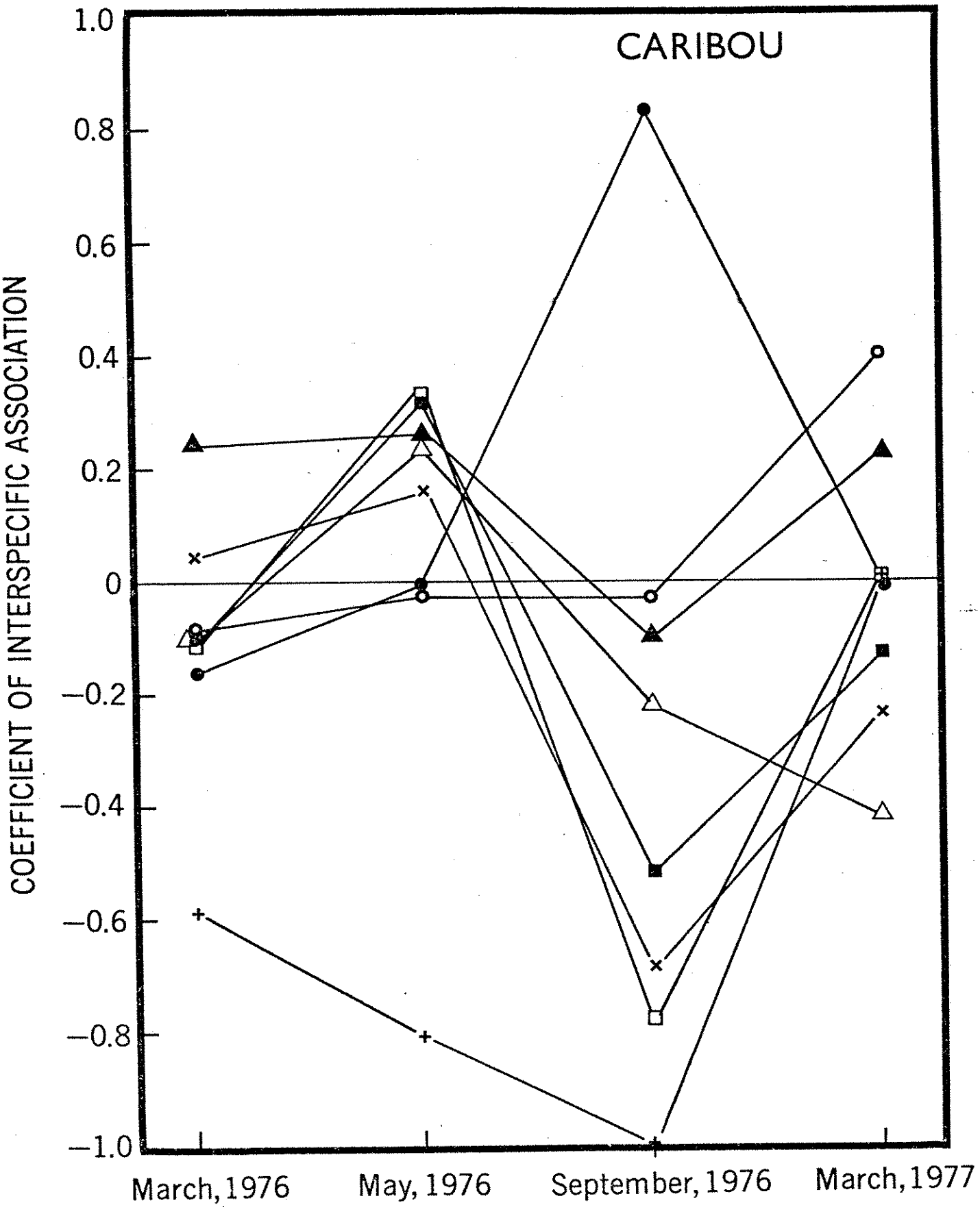
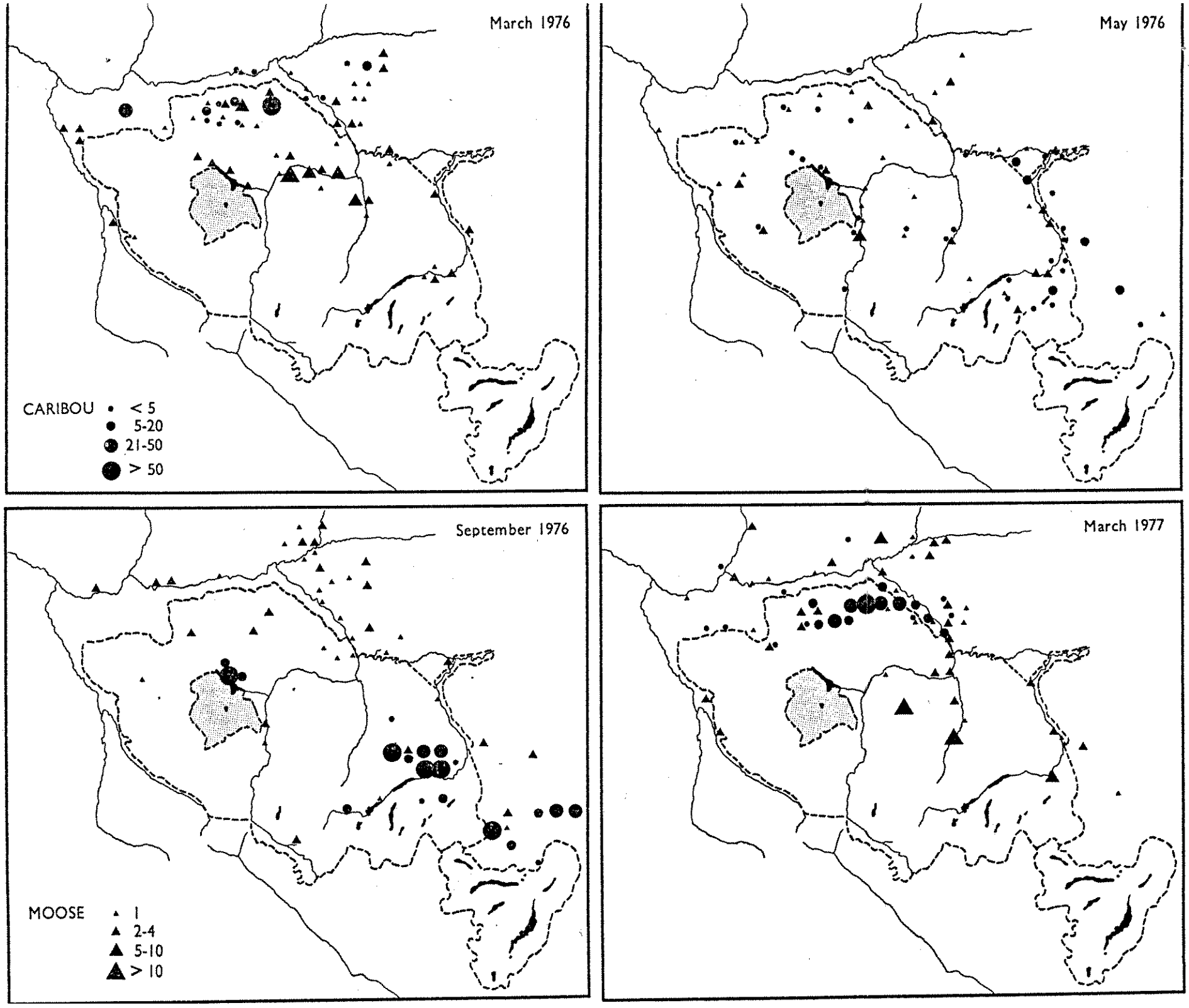

CARIBOU
COEFFICIENT OF INTERSPECIFIC ASSOCIATION
1.0
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1.0
March, 1976
May, 1976
September, 1976
March, 1977

Fig 3


March 1976
May 1976
September 1976
March 1977
CARIBOU
< 5
5-20
21-50
> 50
MOOSE
1
2-4
5-10
> 10

F3 4

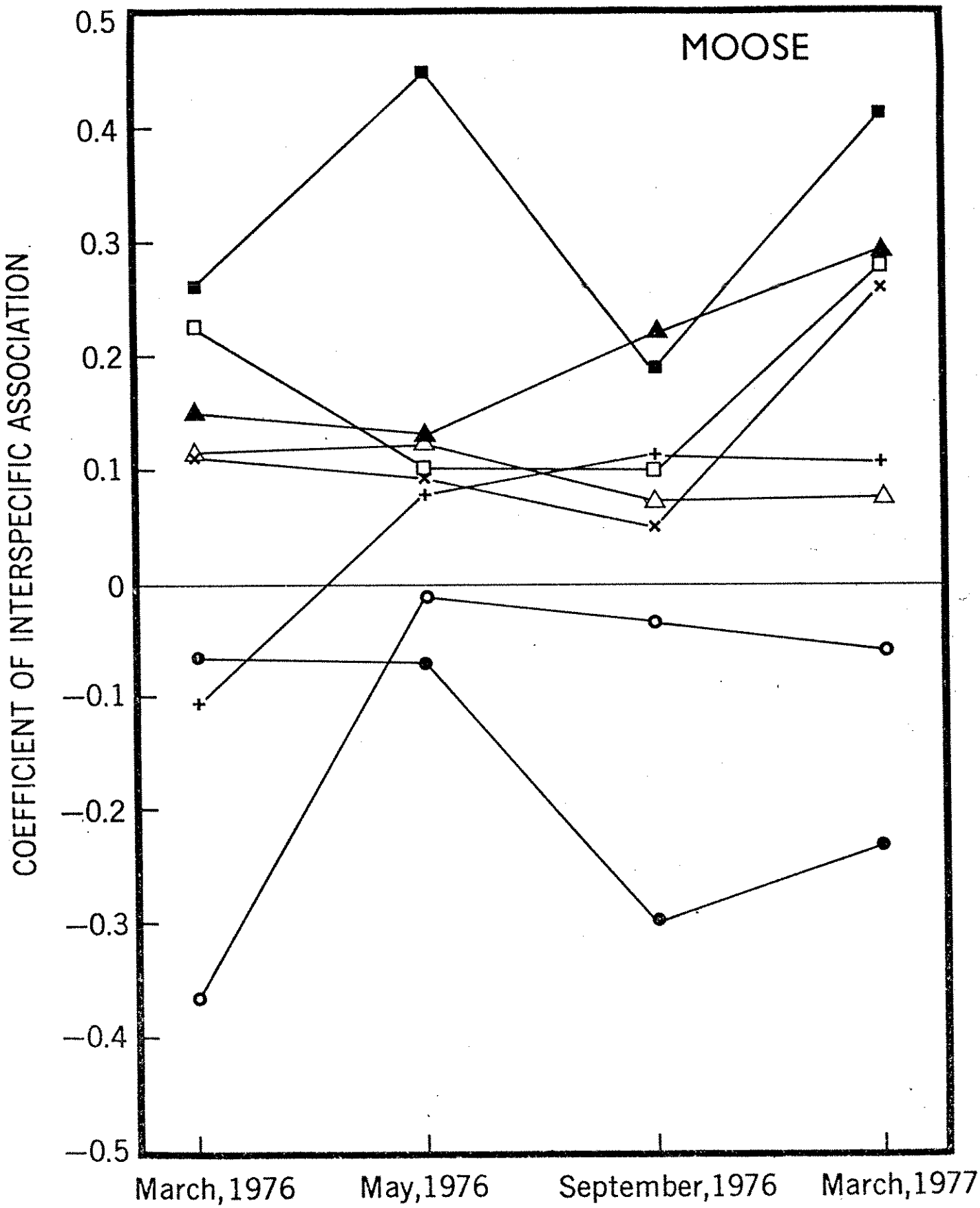

MOOSE
COEFFICIENT OF INTERSPECIFIC ASSOCIATION
0.5
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
March, 1976
May, 1976
September, 1976
March, 1977

Fig 5