ECOLOGY OF THE FORT RELIANCE - ARTILLERY LAKE AREA

by

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A report compiled to provide information requested for the planning of a new National Park.

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INTRODUCTION

By memorandum of May 8, 1970 the Director, National and Historic Parks Branch, Department of Indian Affairs and Northern Development, asked the Canadian Wildlife Service to undertake ecological studies at a proposed National Park site in the Fort Reliance - Artillery Lake area. The area, about 1,400 square miles in extent, is shown on Map 1. The studies were to provide a basis for master planning and interpretive planning before the commencement of park development. Among major requirements were an assessment of animals, plants and landforms, the mapping of plant communities and landforms, and the mapping of migration routes and ranges of animals where warranted. Particular attention was to be paid to representative, outstanding, unique, or fragile components of the landscape and biota. The work was to be submitted in the form of a documented report.

Near the end of May, 1970, Kelsall and Kuyt were asked to undertake the required work as a joint enterprise. It was quickly apparent that expert assistance would be required for landform and cover mapping. Zoltai's assistance was arranged with the concurrence of the Director, Prairie Region, Canadian Forestry Service. Despite an already full field season, Zoltai provided preliminary landform and vegetation classifications on air photos before mid-July. He subsequently verified his classifications on the ground and provided both the accompanying landform and vegetative cover maps, and most of the descriptive and interpretive text that is relevant to them.

Zoltai as an author should I'm really be saying this

The general area was known to, from past participation in

Both Kelsall and Kuyt had visited and worked in the proposed park and surrounding areas from time to time for many years. Principally, their activities were concerned with studies of barren-ground caribou and wolves. Zoltai had not previously visited the forested part of the area but he had spent some time on the tundra just to the east of the proposed park in 1968.

verbose

We camped

A field camp was established at Artillery Lake on July 19, and studies were carried out worked from it until August 4 when a move was made by aircraft we were flown to Fort Reliance. An aircraft was used for several days to visit otherwise inaccessible and remote parts of the study area but most work, both at Artillery Lake and at Fort Reliance, was conducted on foot and by boat. Zoltai joined the field party on August 4 and left to resume his other duties on August 13. The field camp was withdrawn on August 20, 1970. The field work was hampered by the fact that Kelsall injured his right knee on July 24 and could walk thereafter only with the aid of crutches. We were also hindered by extraordinary amounts of rain and wind which severely curtailed travel by all means.

ACKNOWLEDGEMENTS

The authors acknowledge assistance received from many sources. Dr. W. E. Stevens, Wildlife Research Supervisor for the Western Region, Canadian Wildlife Service, assigned the project and maintained a helpful interest throughout the work. The involvement of Zoltai was made possible through the kind permission of Mr. M. Drinkwater, Director, Prairie Region, Canadian Forestry Service. The National and Historic Parks Branch of the Department of Indian Affairs and Northern Development

loaned some field equipment and donated the use of a house at Fort Reliance. Dr. N. S. Novakowski and Mr. J. S. Burton, with the Department in Ottawa, expedited a number of matters, including the procurement of aerial photographs.

The National Museum of Canada, through Dr. D. A. McAllister, provided advice and materials for the collection of fish. Identification and verification of fish and of some of the bird and mammal specimens collected in the study area were carried out by Drs. D. A. McAllister, Mr. W. E. Godfrey and Mr. P. M. Youngman of the National Museum. The latter also arranged for the cleaning of some skeletal material. The University of Alberta's Department of Zoology, through Dr. V. Lewin, loaned small mammal traps, cleaned additional skeletal material from specimens, and helped with the identification of birds. Dr. C. H. D. Clarke provided information and the use of a personal collection of photographs dating from 1937 and earlier.

People living at Fort Reliance were helpful in many ways. All personnel at the Ministry of Transport meteorological station assisted from time to time. Mr. and Mrs. Gus D'Aoust provided hospitality and much information as did Mr. and Mrs. Ted Butler of Trophy Lodge. People in the office of the Superintendent of Game, Yellowknife, N.W.T. were of great logistic help, particularly Mr. Henry Mann and Mr. Archie Mandeville.

Mr. M. B. Schultz of the Canadian Forestry Service, and Mrs. Ragna Baumann and Mr. Clint Jorgenson of the Canadian Wildlife Service, made the maps. Gateway Aviation Ltd., Wardair Canada Ltd., and Ptarmigan Airways Ltd. did the flying connected with the field work.

HISTORY

Archaeological record

It is scarcely possible to consider the ecology of the study area without considering the prehistory. Indians were part of the natural ecosystem long before recorded history. The aborigines were as much a part of the natural landscape as the other fauna, and the flora, which they used to their advantage. There are still Indians, based at Snowdrift and Fort Reliance, who hunt, trap, and fish in the proposed park and who are part of the natural ecosystem.

Pioneering archaeological work was done within the tundra portion of the proposed park by R. S. MacNeish in 1949 (MacNeish, 1951). Between 1966 and 1969, W. C. Noble, of McMaster University, made four archaeological expeditions all of which involved parts of the area under consideration here. He has produced a report which summarizes past work and presents his new findings (Noble, in press).

The great difficulty with archaeological interpretation is that while sites of human activity are readily found, they are generally not stratified. Therefore, it is difficult to develop chronology. Noble believes that the central forest-tundra zone of northern Canada has been occupied by humans since at least 5000 B.C.

The archaeological components are defined on the basis of artifacts found at ~~literally~~ dozens of sites on the tundra and in the forest fringe. For example, in 1966 and 1969 Noble found a total of 78 new archaeological sites in the southern portions of Artillery Lake, along Pike's Portage, and around Charlton Bay, the lower Lockhart River,

and in the area of Fort Reliance. Those all represent changing patterns of human occupancy of the area ~~over a very long period of time extending~~ up to the present, while ~~to what~~ Noble calls the Reliance Complex dated about 1780 to 1840.

Our observations confirm that artifacts are common. We found stone artifacts in several places on the tundra, mostly on eskers where the wind had exposed bare soil and mostly above the level of the abandoned shoreline on Artillery Lake. In two places, on the large esker near our campsite and on the east side of Artillery Lake near Crystal Island, we found places where stone tools had been made. The implements included both large and small projectile points suitable for arrows and some larger points perhaps suitable for harpoons or lances. We found cutting tools and scrapers of various sorts. Two large lunate tools, one of quartz and one of black shale, were probably scrapers although neither showed appreciable wear.

Noble thinks that the Artillery Lake complex of archaeological sites dates from about 3000 to 2500 B.C. although MacNeish (1951) thought that it was older. In any event, the evidence all suggests that the area has been continuously occupied by hunters since the earliest times.

Recent Indians

The history of the modern Indian has been presented by a number of authors, notably Clarke (1940), Jenness (1956 and 1958), and Vanstone (1961 and 1963). There are, of course, major references to the Indians of the area in all the major works of the earlier explorers.

The present Indian residents of Snowdrift and Fort Reliance are mostly Chipewyans. Those are the people with whom Samuel Hearne (1795)

travelled during his epic journey from Fort Prince of Wales on Hudson Bay to the mouth of the Coppermine River in the years 1769 to 1772. At that time they were the dominant group over the whole of the southern tundra. They appeared to range the tundra widely during summer months and to withdraw into the trees during winter. The Crees had previously inhabited at least some portions of the forest-trundra fringe. They were displaced by the Chipewyans at a time when the latter successfully repelled them from an active westward advance in their population. Even within the memory of living Indians, the Chipewyans used to frequent the treeline and the southern tundra in summer months, particularly near Artillery Lake and the headwaters of the Snowdrift River. Today excursions north of treeline are confined to a few enterprising trappers in winter and caribou hunters in late summer and winter.

To the west of Chipewyan country, and the proposed park, the southern tundra was the summer home of the Yellowknives and the Dog Ribs. Hearne (1795), Franklin (1823) and Back (1836) all described how those groups fought among themselves. The Yellowknives, who are now either extinct or nearly so, appear to have been the most venturesome, travelling far onto the tundra seasonally and apparently moving through Chipewyan country when good relations prevailed between the two peoples.

Snowdrift is the northern-most permanent settlement of Chipewyans at the present time, although two families reside at modern Fort Reliance. Sizeable villages, in which many disintegrating cabins are still evident, were once inhabited on the west bank of the Lockhart River where it empties into Charlton Bay, and on the west side of Artillery Lake about two miles inland from Timber Bay. The visible ruins in both are

relatively modern dating, probably, from the late 1920's and early 1930's when white fox furs were particularly valuable, and barren-ground trapping played a prominent role in the economy. A number of decaying trapper's cabins, dating back to that era, were found by our party in isolated patches of timber near tree line. Further north were several stone-walled dugouts in eskers, usually indicated by luxuriant patches of fireweed (Epilobium augustifolium). The latter presumably were used by white trappers.

Vanstone (1961 and 1963) described in detail the origins and history of the present community at Snowdrift. Some of the inhabitants traditionally hunted and trapped in the proposed park but many, perhaps most, came from other areas to the south and west. If continued hunting and trapping rights should be granted to Indians in a new national park, it would be well to keep this in mind. There would be a great difference between granting continued rights to the relatively few Indians who have genuine traditional claims to the parkland and granting rights to the entire village.

The recorded history of the Chipewyans in the area is one of violent economic ups and downs. Back (1836) showed as well as anyone how closely the Indian economy was tied to the migratory caribou. When caribou movements were early, or late, or when migrations were missed entirely as is still sometimes the case, the Indian economy suffered. The terrible privation suffered during the winters of Back's occupancy of Fort Reliance were typical of what happened when the caribou did not appear. Almost certainly the prehistoric cultures were also tied to the caribou. The strategic locations of many of the archaeological sites can be explained in no other way.

In addition to starvation, disease has laid a heavy hand on the Chipewyans from time to time in the past. There have been several devastating outbreaks of influenza, the last one of major proportions being in 1929 when many people died. Tales of that terrible outbreak are still told by survivors and it has been graphically described by Ingstad (1933).

Recent History

The recent, recorded history of the proposed park must start with Samuel Hearne (1795) who passed through, or just beyond, the northern tip of the tundra portion on his outward journey to the mouth of the Coppermine River in 1771. Back (1836), with his large and scientifically oriented party, established old Fort Reliance in 1833, using it as his main base of operations for his decent of the river which now bears his name during the following summer. An expedition searching for traces of the lost expedition of Sir John Franklin also descended the Back River in 1855 (Anderson, 1857).

Subsequently, to the turn of the century, there were a number of travellers in the region. Among the most interesting were Pike (1892) and Whitney (1896), both of whom left popular accounts of their journeys. The latter did not quite touch on the new park, but the former did, and left his name on the major portage route to the tundra from Charlton Bay. Both give interesting accounts of the way of life of the Indians of their time and much valuable information on the general natural history of the area. A most curious expedition was that in 1897-1898 by C. J. "Buffalo" Jones (Inman, 1899). Jones travelled to the site of

old Fort Reliance where he built himself a snug cabin around one of Captain Back's original chimneys. His purpose was to capture muskoxen and to take them south for display purposes. The local Indians, believing that if some muskoxen left the country all the rest would follow, gave him much trouble once his purpose was known, and they cut the throats of the young animals which he did manage to capture. David Hanbury (1904) reached Great Slave Lake in 1899 by ascending the Thelon River. He attempted the descent of the Lockhart River between Artillery Lake and Great Slave Lake where he lost much of his gear. He returned to the lower Thelon by the Artillery Lake route the following year.

In 1900 J. W. Tyrrell (1902) mapped the Thelon River, and followed Pike's Portage route to the tundra and return. Following the turn of the century there have been many expeditions and many exploration parties for various purposes. E. T. Seton's canoe trip with E. A. Preble in 1907 was important even though brief. Seton used scientific findings in later works (Seton, 1908 and 1929) and his popular account "The Arctic Prairies" (Seton, 1911) provides a fine description of most of the important areas in the proposed national park. Also important from a point of view of natural history was the expedition of Hornby and Critchell-Bullock in 1924 and 1925 (Critchell-Bullock, 1930-31; Hornby, 1934). They wintered, with hardship, in an esker at the north end of Artillery Lake.

There is little need to detail the subsequent history of the area. For the most part it can be inferred from the many references to the results of field work given in the balance of the text. It is worth noting that in addition to the trading post at Snowdrift which was

established in 1923, but which is not actually in the national park, a Royal Canadian Army signal station was established at Fort Reliance in 1947. There, it joined an already existing Royal Canadian Mounted Police post which was established in the late 1920's in order to keep order among the large numbers of trappers and prospectors which invaded the country about that time. The signal station, in addition to providing communications, has maintained a continuous, valuable climatological record. In 1957 the station was taken over by the Canadian Department of Transport, and it has subsequently been staffed by meteorologists.

There are many tales to be told of the brief era of the barren-ground trappers, between the 1920's and the second Great War, and of the continuing saga of the prospectors, and mining developers. For the most part they still await a chronicler.

CLIMATE

Prior to 1948 there are only scattered meteorological records from the study area. Back (1836) kept detailed records of natural phenomena including weather, during those periods when he was at Fort Reliance between November, 1833 and March, 1835. J. W. Tyrrell (1902) also kept detailed weather records during his traverse through the area, down the Thelon River, and back again between April and September, 1900. Back's records are of particular interest since they show that the winter of 1834-35, which he thought severe, was indeed cold when compared to recent climatic averages.

Normals for temperature and precipitation, as compiled by the Meteorological Branch of the Department of Transport (1968a and 1968b),

are shown on Table 1. Data were gathered between 1948, when an army signal station was established at the present settlement site, and 1960. The normals therefore are based on a 12 year average rather than a 30 year average as desired for most purposes by international standards.

Fort Reliance, being in the center of the study area, is probably as representative of overall climate as any one point could be. However, the settlement is at lake level (519 feet above sea level) and much of the surrounding country, including the Artillery Lake area, is 600 to 1000 feet higher. Both the difference in elevation, and the undoubted modifying effect of the huge east arm of Great Slave Lake, suggest that climatic normals from Fort Reliance are not fully representative of those to be found on the tundra to the northeast or on the higher portions of the peninsulas to the west.

The data on Table 1 show that, in common with much of the Northwestern Transition Zone of the Boreal Forest Region (as defined by Rowe, 1959), Fort Reliance has cold winters, cool summers, and rates of precipitation in the range usually associated with deserts. Below freezing temperatures have been experienced in every month of the year except August. Above freezing temperatures have been experienced in every month except January, but the mean daily temperatures for December, January, February, and March are all below zero, and those for April and October below freezing.

Mean total precipitation is only 8.74 inches when snowfall is converted to rain at the ratio of 10:1. According to Radojicic (1967) Great Slave Lake has four inches of moisture deficiency. However, in many northern areas moisture deficiencies are compensated for, at least

in part, by a slow runoff which is retarded by permafrost conditions, and by the insulating effect on the land of such close growing plant associations as heaths, Sphagnum mosses, and sedges.

There is less than 0.5 inches of total monthly precipitation, practically all of it in the form of snow, from January to May inclusive, about 4 inches of total precipitation from June to September inclusive, mostly in the form of rain, and about half the annual snowfall occurs during the balance of the year, October, November and December. While there are 44.1 inches of snow annually there are seldom more than 20 inches on the ground at any one time. Winter travel is easy for large mammals such as caribou and moose, and for humans equipped with snowshoes, sleds and modern motorized equipment.

The frequency of thunderstorms is important in forested portions of the Northwest Territories. Destructive forest fires often follow in the wake of such storms. Fort Reliance has an average of 3.3 thunderstorms per year - mostly from late June through August. This is about average for forested points in the Northwest Territories. Fort Smith (12.2 thunderstorms/year) and Fort Simpson (7.5) have appreciably more (Canada Dept. Transport, 1968c).

There are 89 frost free days at Fort Reliance, between June 19 and September 17, based on the twelve year average to 1960. The last frosts following winter have varied between May 24 and July 11, and the first frosts of autumn have varied between September 1 and October 3. The longest frost free period in any one of the years of record has been 122 days and the shortest period a mere 62 days (Canada Dept. Transport, 1968f).

From a logistic point of view the most important climatic data are the times of break-up, when the ice on Great Slave Lake disappears sufficiently to permit navigation in spring, and freeze-up, when navigation becomes impossible due to the formation of ice in the autumn. Those dates vary from year to year, depending on prevailing temperatures in spring and on the depth to which the ice freezes during the preceding winter. The last factor depends on air temperatures and, espeically, the depth and duration of insulating snow cover during the period of ice formation in autumn and early winter. With heavy snowfalls just after first ice formation, ice depths are minimal - with no snow until long after freeze-up, ice depths are maximal.

Navigation by commercial vessels is usually possible during the second or third week in June, although it might well be the last of that month in some years before they could break through to Fort Reliance. The meteorological station reports (pers. comm.) Charlton Bay clear of ice on June 28, 1965; June 26, 1966; June 16, 1968; July 10, 1969 and June 17, 1970. Pilots of vessels have reported ice in McLeod Bay as late as July 14 in some years. Kelsall encountered no navigational problems with ice, and only a few residual pans in McLeod Bay, during a canoe trip from Yellowknife to Fort Reliance July 5 to 8, 1956. Float equipped aircraft can often land in open water along lee shores long before Charlton Bay is ice-free in spring. Thus in 1965, while the bay was not clear of ice until June 28, the first aircraft landed at Fort Reliance on June 9.

The area between Maufelly and Fairchild Points is a special area, due to water currents. It freezes late and breaks up early.

The Fort Reliance area is therefore earlier in break-up than Charlton Bay proper.

Most vessel operators prefer to have their equipment off the lake by mid-October although open water may prevail for another month. At Fort Reliance the first ice on Charlton Bay has been noted as early as October 29 (1965) and as late as November 19 (1968). The dates for the complete freezing of Charlton Bay are less varied - November 11, 1965; November 27, 1967; November 26, 1968; November 15, 1969. The larger McLeod Bay, to the west, may freeze about the same time as Charlton Bay, or may be much later (e.g. January 8, 1969).

Scattered records suggest that break-up is highly varied on Artillery Lake. Back (1836) found 4 feet of ice along the shore on June 15, 1834. On May 26, 1900, J. W. Tyrrell (1901) found open water along the shores, and large central ice pans, on the small lakes on Pike's Portage. From then until June 8 he travelled on Artillery Lake mostly by sled, and following that by canoe although he encountered continuous trouble with drifting ice until he left the lake on June 21. Clarke (1940) found similar ice conditions on Artillery Lake in 1937. The late Mr. Matt Murphy (pers. comm.) told of crossing Artillery Lake by dog sled in late July (July 22?) in one of the many years which he spent as a trapper in that country. Kuyt was unable to land near Crystal Island with a float plane on July 10, 1967 when most of the lake was still covered with ice. No such difficulties were encountered, however, on July 6, 1966 and July 18, 1968. There are no positive records of freeze-up on the tundra in the new park site but, judging from experience elsewhere, it may occur before the end of September in some years.

A party of caribou biologists were able to move camp by float plane from the foot of Artillery Lake on October 16, 1957, to Atkinson Lake, to the southeast, where they froze in on October 17.

For additional, historic climatic records from the Fort Reliance - Artillery Lake area the reader should refer to Back (1836), Tyrrell (1901) and Clarke (1940). In addition to the data specified above, the Canadian Department of Transport has presented 12 year average data on maximum precipitation in 24 hours (1968b); means and frequencies for cloud cover and mean sea level pressures (1968c); mean and extreme values for humidity (1968d); percentage frequency of winds, average wind speeds and computed and annual maximum wind speeds (63 m.p.h. max. from 13 years of data) (1968e) and probability tables for spring and autumn frost (1968f).

GEOLOGY

The geology of the proposed park is extremely involved and will not be detailed here. Some specific points are mentioned in connection with physiography. The entire area is within the Precambrian Shield, and the bedrock (exposed in many places) is all Protozoic and Archaean in age. Sedimentary and igneous rocks are both well represented. Minor mineral occurrences, particularly copper and iron in various forms are frequently encountered. Many cliff faces, and frequently exposed bedrock, offer unlimited opportunity for geological interpretation and demonstration. Folds, joints, scarps, unconformities, bedding planes and many other textbook features of structural geology are common.

The Geological Survey of Canada has been active in the area since the turn of the century, when Bell (1902) visited Fort Reliance via McLeod Bay and described the geology encountered en route. While most geological reports and maps pertain to the structural geology of the area, many provide insight into historical geology, physiography and other facets of the general landscape.

The structural geology has been well mapped. The most recent sheets are at the scale 1:253,440 (1 inch = 4 miles) and are complete with descriptive notes (Canada Dept. Energy, Mines and Resources, 1968a and 1968b). They include the park site, except most of the area north of 63°N latitude. The extreme northwestern portion of the park is covered at the same scale by a map (Folinsbee, 1952) and a paper (Folinsbee, 1950). The east arm of Great Slave Lake was mapped earlier by Stockwell (1936 and 1938), and Wright (1952) produced a paper on the Reliance area. Wright (1967) has also produced a comprehensive report on the surficial, general and economic geology of the southeastern barren grounds, including the northern portion of the park, with maps at the scale 1:1,000,000. Craig (1964) presented a more detailed report on the surficial geology with a map at the scale 1:506,880. This report describes the many east-west oriented eskers and drumlins of the tundra. It also shows the position of some unique "ice-block ridges" in the extreme northern section of the area.

The Geological Survey has also produced aeromagnetic maps, at the scale 1 inch = 1 mile, for nearly the entire area.

Prospectors and mining geologists have long been attracted to the east end of Great Slave Lake because of the McDonald Fault, associated

smaller faults, and the known and assumed mineralization associated with them. Despite much exploration, trenching, drilling and associated activities no mines, or strong prospects, have been found in the proposed park (Lord, 1951).

PHYSIOGRAPHY

The entire area lies within the Precambrian Shield, and its surface features are dominated by bedrock, modified locally by glacial action. On Pethei Peninsula the bedrock formations produce a rugged and picturesque topography of frequently north-facing vertical cliffs rising several hundred feet from the water (Fig. 1). The highest portions of the peninsula lie about 900 feet above lake level. Flat topped cuestas are formed by soft rocks that are capped by harder rocks, such as diabase or limestone (Wright, 1952). Erosion of the bedrock has created a number of deep steep-walled canyons. Relief in some areas is broken and precipitous and provides a spectacular landscape which is one of the most valuable attributes of the proposed park.

In strong contrast, the rest ofthe area is underlain by crystalline, granitic rocks and presents a less spectacular, but still rugged topography. North of the McDonald fault which runs northeastward south of Great Slave and Artillery Lakes (Stockwell, 1936), the bedrock is massive granite (Wright, 1967). Although the local relief is seldom more than 200 feet, abundant bedrock outcrops occur, especially between Artillery Lake and Great Slave Lake (Fig. 2). South of the prominent McDonald fault, the drift cover is considerably thicker, often completely masking the bedrock surface. The relief here is mainly formed by glacial landforms,

Glacial deposits suggest that the latest glaciation occurred from an easterly direction (Craig 1964, Wright 1967). Advancing over Precambrian terrain, the glacier eroded the bedrock surface, but due to the resistant nature of the bedrock was not able to produce much drift material. The till cover is consequently thin over most of the area, although locally thick till may occur in some valleys or in streamlined drumlins. Rivers carrying meltwater within and under the melting ice sheet deposited long trains of eskers, consisting of sand and gravel materials. The tundra portion of the proposed park has many eskers and drumlins, mostly east-west oriented, which form dominant landscape features.

A huge glacial lake, Lake McConnell, was formed in front of the melting ice in the late Pleistocene (Craig, 1965). Although this lake reached its greatest extent west of the Great Slave Lake basin, it also flooded the low lying areas in the eastern part of its basin. Raised beaches, some 500 feet or more above the present lake level, give an indication of its former extent. The large sand deposit in the Lockhart River basin, extending about halfway between Great Slave and Artillery Lakes, probably represents deltaic deposits into this lake whose water level once stood somewhat above the 1,000 foot contour.

Evidence was found of a higher water stage in the Artillery Lake basin, and Craig (1964) mapped some raised beaches above the east shore of the lake, but it is not known whether this was confluent with glacial Lake McConnell. Abandoned shore features suggest that the water level stood about 30 feet above the present lake level.

The main force shaping the landscape after glaciation was erosion. The hillsides, often denuded of their plant cover by fires, were subject

to erosion by slope wash. Often only large boulders were left on bare bedrock hills after the finer particles were washed away (Fig. 3). In some poorly drained depressions peaty material has accumulated, although the rate of peat accumulation appears to be very slow under the prevailing climatic conditions. Permafrost modified most of the surface features in the northern third of the area where patterned ground, polygons and frost boils are abundant.

Water might be considered the dominant physiographic feature in the proposed park. Great Slave Lake is one of the world's largest lakes. It is 10,980 square miles in surface area. Less well known is the fact that it is also one of the world's deepest lakes, at least 2,015 feet deep in the east arm. The other major lake, and one that is wholly within the proposed park, is Artillery Lake. It is 50 miles long and up to 8 miles in width.

That short portion of the Lockhart River which connects the two big lakes drops 671 feet in little over 16 miles and provides some of the most spectacular, and currently least accessible, scenery in the area. Many falls and rapids are found along the route but two, Parry Falls (130 feet in height) and Tyrrell Falls (85 feet in height) are particularly noteworthy. There are other falls and rapids in the area, some of which should be considered as major assets.

The proposed parksite contains a myriad of lakes of all sizes, including some of potential biological interest because of their isolated location high on the Pethei Peninsula. A majority of the lakes on the peninsula and through the forested area are rugged and rocky. On the tundra, many of the lakes have attractive sand beaches which are often associated with eskers and drumlins.

Landforms

In the course of this study 16 different landforms were identified and mapped from aerial photographs (Appendix I). Most were visited in the field, permitting a tentative description of the materials that compose them.

Bedrock is exposed in many areas. On the Pethei Peninsula it consists of a great variety of sedimentary rocks (shale, sandstone, limestone, mudstone, greywacke, dolomite, argillite and conglomerate) as well as intrusive diabase and diorite (Hoffman, 1968 and Canada Dept. Energy, Mines and Resources, 1968a and 1968b). The till derived from this bedrock is equally variable, but is generally of a loam or sandy loam texture, and is somewhat calcareous. The bedrock in the rest of the area is mainly granite or granite gneiss, and the till derived from it is a non-calcareous loamy sand. The till of all origins is generally stony and contains many boulders.

The till sheet over vast areas is thin and discontinuous (Fig. 2). Till less than 3 feet thick over bedrock was mapped as shallow till. Along the foot of escarpments on the Pethei Peninsula till-like material may collect (Fig. 1). It contains a great deal of debris washed down from above and rock fragments from the escarpment face. This material was identified as colluvium, which is usually thick, but locally thin over bedrock.

In local areas the till may be concentrated because of events during deglaciation. In the northern part of the area the till sheet is thick and shows hummocky, knob-and-kettle topography typical of stagnating, melting ice sheets. Curious ring-shaped till ridges occur in association with these stagnation deposits.

Drumlins, in the form of elongated, streamlined hills (Fig. 4) were formed by actively advancing ice. Locally, especially on Pethei Peninsula, even bedrock outcrops were given a streamlined shape by the advancing glaciers; these landforms are known as "roches moutonnées".

Glaciofluvial materials are mainly concentrated in eskers and associated outwash. Eskers are long, sinuous ridges that often rise 100 feet above the landscape (Fig. 5). The material of eskers and kames (isolated hills of glaciofluvial origin) is sand and gravel. Outwash aprons often extend some distance along the eskers; their material is usually rock-free sand. Eskers often terminated in small ice-marginal lakes, where the outwash deposits are more extensive and less gravelly. The outwash and esker materials may have been re-worked by later streams and re-deposited as fluvial sands and gravels; however, these materials are restricted to valleys in contrast to eskers which may cross low ridges. In some areas, especially east of Artillery Lake, sub-glacial rivers deposited eskers, but in other sections they eroded the unconsolidated mantle, exposing bare bedrock along their courses.

Lacustrine sediments, the deposits of glacial Lake McConnell, consist mainly of stone free, fine grained materials, ranging from clay (Fig. 6) to fine sand. Because of their occurrence in valleys and their lack of relief, these sediments are usually covered with deposits of peat of varying thickness, and contain permafrost even on Pethei Peninsula. Raised beaches may be found to high elevations around Great Slave Lake. Some are true beach deposits, other are wave-cut terraces (Fig. 7).

Alluvial deposits may be found near rivers, where they were deposited during flooding. The material is generally fine grained, with inclusions of organic debris. Alluvial fans on Pethei Peninsula were formed by material eroded by creeks in areas of high relief and deposited at the foot of mountains.

Permafrost features

Permafrost is a result of the effect of climate on the ground temperature. Its manifestations, therefore, become more evident under increasingly severe climatic conditions.

In the south, roughly coinciding with the forest fringe (Map 2) permafrost is found near the surface only in peat deposits or in fine grained lacustrine deposits. In the peat, it occurs as low (2-3 feet high) peat plateaus, with the active layer being less than 2 feet. These peat plateaus are usually interspersed with unfrozen peat deposits. The lacustrine sediments containing permafrost are usually poorly drained and are covered by up to 2 feet of peat. The layer that melts in the summer is 3.5 to 4 feet thick. Active frost boils are sometimes present (Fig. 6).

Farther north, approximately in the tundra ecotone (Map 2), permafrost becomes more extensive on the low-lying, moist areas. Some peatlands display a polygonal pattern (Fig. 8), believed to be caused by the development of ice wedges in the ground. It is not known whether these polygons are actively growing in this area or whether they are fossil features.

In the most northerly part of the area, in the tundra (Map 2) patterned ground becomes dominant, showing that permafrost occurs in all soils. Ice wedge polygons are readily noticeable on the top of drumlins (Fig. 4) where vegetation growing in polygon trenches emphasizes the pattern. In other areas circular patches that are free of vegetation occupy large areas (Fig. 9). These may mark the sites of collapsed frost boils. In other areas the bare patches are surrounded by a ring of soil (Fig. 10), undoubtedly the remains of frost mounds. Mounds of rock, sorted into polygonal pattern may be seen in the shallow parts of many lakes (Fig. 11, 12). On some hillsides the thawed, supersaturated soil may slide downslope on the frozen subsoil, often resulting in solifluction terraces (Fig. 13). Permafrost affects some types of bedrock by splitting and shattering them (Fig. 14). In the summer the soils affected by permafrost may be dry on the surface, but the water table, held up by the permafrost, is usually within 2 feet of the surface. On dry soils, such as found on esker ridges, the soil may be loose, although the temperature of the soil may be below freezing, therefore containing permafrost.

VEGETATION

The proposed park contains two biomes, the northern boreal forest to the southwest and the tundra to the northeast. A number of ecologists have classified those areas using varied criteria. The best known classification, particularly among non-ecologists, is still Merriam's (1894 and 1899) life zone concept based largely on temperatures. Under his system the park site may be divided into the Hudsonian and

Arctic zones along lines that agree rather well with other concepts. Shelford (1945) used indicator species of plants and animals to provide a division into the forested Spruce-Moose Biome and the treeless Cladonia-Caribou Biome. Tundra indicator species might have been better chosen since, in the study area, caribou and Cladonia lichens are as abundant in the forest as on the tundra.

For our purposes the most useful division is one that recognizes the northern boreal forest, an area of intergradation or ecotone, and the tundra. Rowe (1959) calls the first two the Northwestern Transition Section and the Forest-Tundra Section, of the Boreal Forest Region. Since we used maps of smaller scale than those by Rowe (1959), our definition of zone boundaries is more detailed than his. We have referred to the zones as Forest Fringe, Tundra Ecotone and Tundra.

Many plant collections have been made in or near the proposed park. Clarke (1940) mentions most of the early collectors. Porsild and Cody (1968) provide a bibliography on the subject complete to about 1966. The zonation in their checklist is, unfortunately, too broad to be of great help in identifying specific flora of the park site. Scotter (1966a) has provided a valuable annotated checklist of vascular plants of the east arm of Great Slave Lake, although none of his 17 collection sites was in the proposed park. We added three species to his list for the forested part of the area. Cypripedium passerinum Richards was found in the spruce-feather moss forests near the settlement of Fort Reliance. Dryas integrifolia Vahl was collected at Fort Reliance, and was common on tundra areas as well. Boschniakia rossica (Cham. & Schlecht) Fedtsch. was found by Kelsall in 1956 at the mouth of the Hoarfrost River, which was not visited in 1970.

There are no specific references to vascular plants for the Artillery Lake region. Polunin's (1959) "Circumpolar Arctic Flora" is an excellent general reference and Porsild (1957) is helpful with some plants even though he deals primarily with the arctic archipelago. Vaccinium microcarpum (Turcz.) Hook and Solidago decumbens Greene var. oreophila (Rydb.) Fern were collected on Artillery Lake at latitude 63° 16' N., about 35 miles north of their indicated range (Porsild and Cody, 1968).

The bryophytes of the area surrounding the proposed park are known through collections by Scotter (1962, 1963, 1966b) and Holman and Scotter (1967). The lichens have been thoroughly collected, both in and surrounding the park (Thomson, et al., 1969), 343 species being reported. The many species of locally abundant fruticose and foliose terrestrial lichens constitute the chief winter food for caribou. These lichens and other range plants have been the subject of detailed studies in the Great Slave Lake area by Banfield (1954), Kelsall (1957, 1968) and Scotter (1963, 1967b).

The Fort Reliance sand plain

The great series of raised beaches at the northeast end of Charlton Bay constitute a unique component of the proposed park. On these beaches are located the site of the original Fort Reliance, built in 1834 (Back, 1836), the chimneys of which are still standing, and an Indian village, used until recently. The sand plain's value is enhanced because it was the subject of a special study which described its physiography and plant succession in great detail (Raup, 1930). The beach ridges of which it is composed, rise progressively to about 600 feet

above present lake level. The Lockhart River cuts through them to the west and it is dissected by a small stream to the east.

Raup recognized four types of dynamic habitat: the emerging beach, the beach lagoon, the margins of the dissecting stream and the sliding sand of erosion terraces. He described the succession that is taking place, from the aquatic plants of the emerging beach and lagoons, to the open spruce-birch parkland on mature beach terraces. These are beautiful, but fragile environmental components.

A similar succession of beach ridges, on a narrower front, marks the commencement of Pike's Portage from Artillery Lake. There the trees are now mostly birch though they once included great spruce some of which travellers converted to lobsticks (Seton, 1911).

Zonation

The study area extends from a treed region in the south into the tundra of the low Arctic. Although the transition is gradual we suggest recognition of three locally significant vegetation regions (Map 2).

1. The Forest Fringe, occupying the Pethei, Douglas and Kahochella peninsulas is characterized by tall spruce trees, with a ground vegetation of lichens and moss. Elements of a more southerly forest, the closed forests of spruce with a carpet of feather moss, are present in favourable locations and in areas protected from fires. Fire often destroys the open spruce-lichen forest and results in open spruce-birch vegetation.

The dominant tree species are black spruce (Picea mariana), white spruce (Picea glauca), tamarack (Larix laricina) and white birch

(Betula papyrifera, var. neoalaskana). Some scattered jack pine (Pinus banksiana) occurs, but trembling aspen (Populus tremuloides) and balsam poplar (Populus balsamifera) are botanical rarities, growing only in specific locations.

The shrub species include alder (both Alnus rugosa and A. crispa), willow (Salix spp.), Labrador tea (Ledum groenlandicum) on the uplands and Kalmia polifolia, Andromeda polifolia and Chamaedaphne calyculata, as well as Labrador tea in peaty areas. Ground lichens constitute an important part of the vegetation, but only in areas which escaped fires within the last century.

2. The Tundra Ecotone extends from Great Slave Lake to approximately latitude 63° 05' N. It is characterized by open spruce-lichen forests on flats and slopes, but with nearly treeless, tundra-like vegetation on the summits of the relatively low ridges. These summits resemble the tundra in that they support few trees, but the species of the plant communities are those of the southern zone. In wetlands both the southerly treed muskegs and the more northern cottongrass (Eriophorum spp.) types are present. The southerly occurrence of polygons in peatlands coincides with the southern boundary of the tundra ecotone, but permafrost surface features were not noted on mineral soil.

The tree species are black and white spruce, tamarack, and white birch. Among the shrubs alders (Alnus rugosa and A. crispa), glandular birch (Betula glandulosa) and sweet gale (Myrica gale) are abundant. The narrow-leafed Labrador tea (Ledum decumbens) is at least as abundant as L. groenlandicum.

3. The Tundra occupies the northern part of the area and is characterized by the absence of trees. Low growing, often prostrate, ericaceous shrubs may be found on ridges and slopes while the lowlands are occupied by willow, glandular birch or by cottongrass (Eriophorum spp.). Near the southern edge severely stunted trees, usually white spruce, may be found in protected spots, generally on sandy deposits.

Dwarf birch and willows are the tallest plants, especially in snow patch habitats. Dwarf arctic willows, billberry (Vaccinium uliginosum), red bearberry (Arctostaphylos rubra), crowberry (Empetrum nigrum) as well as lichens form a sometimes scant vegetative cover. Ridge tops are frequently bare of vegetation, possibly because the winds remove the protective snow cover in winter.

In the course of our study several major vegetation types were identified, based on their morphological, rather than floristic features. This permitted the use of aerial photographs in delineating areas of different vegetation (Appendix II). The following vegetation types were identified:

1. Closed forest of tall trees

Mature stands of closely spaced black or white spruce, over 50 feet tall, usually with a dense carpet of feather mosses. These stands occur as small patches in protected valleys and along stream courses.

2. Open forest of tall trees

The mature stands consist of trees over 25 feet tall, forming an open forest of widely spaced black or white spruce with a nearly continuous ground cover of lichens (Fig. 15 and 16).

2f. Open forest of tall trees, recently affected by fire

Fire induces great changes in the composition of the vegetation (Fig. 17). The regeneration after fire consists of black or white spruce and white birch, forming an open stand (Fig. 18 and 19). Small clumps of trees mark ~~those which have~~ many of the and persist escaped fire. Alder and willow grow in the tall shrub layer. Ground lichens are almost absent.

3. Open forest of stunted trees

Trees growing under stress tend to be dwarfed. Such stunted black spruce and tamarack trees may be found on wet peatlands in the south. In the tundra ecotone trees are growing under a climatic stress. The species are mainly black spruce, but white spruce will dominate stands growing on sandy soils. Dwarf birch and ericaceous shrubs are locally abundant in the tundra ecotone. Ground lichens form a dominant ground cover, together with dwarf ericaceous shrubs.

3f. Open forest of stunted trees, recently affected by fire

Repeated fires deplete the nutrient status of the soil and promote soil erosion. Under such circumstances low, scattered black spruce may grow. If protected from fire, this vegetation type may develop into open forests of tall trees, provided the climatic stress is not too great.

3t. Open forest of stunted trees, on permafrosted clay

Wet clays and other fine grained soils develop permafrost 3-4 feet below the ground even in the forest fringe. Scattered, low black spruce grow on these sites (Fig. 20 and 21).

4. Treeless, with dwarf shrubs

The well drained ridges and slopes of the tundra support no trees, but

are sparingly covered by dwarf ericaceous shrubs (Fig. 22). Lichens form an important part of the ground cover.

4f. Treeless, or nearly so; recently affected by fire

This vegetation type occurs mainly in the tundra ecotone on ridges. Although it superficially resembles the tundra, the species present are those of the south. White birch, tall willow and alders will grow here, together with few spruce (Fig. 23). Lichens are often abundant on the ground. This vegetation type is probably the result of fire, where the trees are very slow in re-vegetating the burned areas, probably because of climatic conditions.

4w. Treeless, with low shrubs and grass

Depressions in the tundra grow relatively tall (3-6 ft.) willows or dwarf birch (Fig. 24), especially where snow accumulates. The wetlands may support sedge and cottongrass in flat meadows or in tussocks. Low mounds of Sphagnum may be found in some depressions, often in a polygonal pattern.

5. Bare ground, other than exposed bedrock

Ridge tops and esker ridges in the tundra region have very little vegetative cover. Blowouts in sandy outwash deposits prohibit the development of vegetation. Vegetation types 4, 4W and 5 usually form a pattern in the tundra (Fig. 25 and 26).

INVERTEBRATES

The invertebrate fauna of the proposed national park is little known. Our collections were not systematic, and were limited to fresh

water forms such as are found in plankton hauls and minnow seines. The following discussion is based, therefore, on a review of the literature.

Limnological Material

The limnology of Great Slave Lake has had attention as it relates to the production of commercial fishes. Thus Rawson (1949 and 1951) lists some of the abundant zooplankton forms found during studies of fish production in Great Slave Lake. Larkin (1948) has reported on populations of two important crustaceans in the lake. There may be other reports of which we are unaware. R. S. Anderson of the Canadian Wildlife Service identified for us plankton from several hauls of a plankton net in Great Slave Lake near Fort Reliance. The collections suggested that zooplankton is comparatively sparse, as would be expected in such clear cold waters.

Our collections, and those reported on above, include four genera of Rotatoria (Keratella, Polyarthra, Kellicottia and Asplandiana); three members of the Copepoda (Limnocalanus, Diaptamus and Cyclops); one member of the Mysidaceae (Mysis) and one member of the Amphipoda (Pontoporeia). In addition, we collected two Gastropods (Lymnaea elodes Say) in a lake high on the Pethei Peninsula and L. catascopium Say in Artillery Lake, and a Pelecypod, Sphaerium intidum Clessin at our camp on Artillery Lake. A determined effort would undoubtedly result in the finding of many fresh water invertebrates in addition to those currently known.

Arthropoda: Arachnida

The Arachnids appear to us to be an interesting segment of the fauna in the area studied. Particularly on the tundra, spiders are visibly abundant and morphologically varied. There they have adapted for a terrestrial life in the absence of trees and high shrubs. It is suggested that spiders might make an interesting subject for nature interpretation. Papers by Bishop (1949) and Kurata (1949) list spiders from Keewatin and Mackenzie respectively.

Arthropoda: Insecta

A number of sub-divisions of the phylum Arthropoda, class Insecta, are known to be present in the park because they have been studied in northern Canada on a broad basis. To a large extent this is because of the northern insect survey which was inaugurated as a joint project of the Defence Research Board, Department of National Defence, and the Division of Entomology, Department of Agriculture in 1947. The survey made systematic collections in many parts of northern Canada, including some collection sites in and near the proposed park. Many of the collections are still not sorted and classified and that unfortunately is the case with some that would be of particular interest here.

Northern Canada, as an environment for insects, has been considered briefly by Freeman (1949) and at greater length by Munroe (1956). The latter reference is systematically detailed and takes into consideration almost all facets of the environment including physiography, climate, soils, vegetation and the glacial and post-glacial history. It should be among required reading for persons involved in detailed planning or interpretation in the area under consideration.

The northern insect survey necessarily paid particular attention to the biting insects which are of importance to man in the north. A number of the reports provide valuable information on the distribution of mosquitoes (Freeman, 1952), black flies (Shewell, 1957 and 1958) and the Tabanids, the so called bulldog and deer flies (Freeman, 1953). Of general interest, although not directly relevant to the park area, are a paper dealing with the biting flies at Churchill, Manitoba (Twinn, et al., 1948) and three dealing with the general biology and control of biting flies in northern Canada (Twin, 1950, 1951 and 1955).

In regard to mosquitoes and black flies, it is worth noting that there is a general pattern to their phenology which is common to northern areas. Mosquitoes tend to commence emerging during late June and the peak of their abundance is generally early in the second week in July. Thereafter their numbers diminish rapidly, and their nuisance value to man is relatively slight from about mid-July until their disappearance with the first heavy frosts of autumn. Black flies, on the other hand, generally commence emerging during the first week in July and their numbers increase throughout that month. Therefore, while the harassment value of mosquitoes is diminishing, that of the black flies continues to increase. Often they remain abundant until frosts in August reduce their numbers (Kelsall, 1968).

We know of two short papers on distribution of Canadian arctic and sub-arctic butterflys (Freeman, 1951 and 1958). Many of the species discussed have been collected at, or near Fort Reliance. We are not aware of any specialized papers dealing with arctic moths, but the

Lepidoptera in general have been the subject of general reference texts and field guides, some of which show northern distribution in North America.

The Siphonaptera are known because a monograph has been written on Canadian forms (Holland, 1949) and because the distribution of northern fleas have been separately published (Holland, 1958). The northern members of the Muscidae, which includes house flys and their relatives, have been the subject of a monograph (Huckett, 1965) and the distribution patterns of the northern sub-family Scatomyzinae have been separately described (Vockeroth, 1958).

VERTEBRATES

Amphibians and reptiles

Reptiles almost certainly do not occur in the proposed park. The red-sided garter snake (Thamnophis sirtalis parietalis) occurs near Fort Smith and on the salt plains of Wood Buffalo National Park. It seems unlikely that it has invaded the Precambrian country to the north and east.

While there are no amphibians on record from the park site it seems possible that at least two species of frogs may eventually be found in the more thickly forested portions. Both the boreal chorus frog (Pseudacris nigrita septentrionalis) and the wood frog (Rana sylvatica) are found along the Slave River, on Great Bear Lake, and elsewhere in country ecologically comparable with some portions of the peninsulas and the Fort Reliance area (Preble, 1908 and Logier and Toner,

1961). Most biological explorations of the area, like ours, have been too late in the season to hear frogs.

Fish

The fish of Great Slave Lake, a major economic resource, have been the subject of numerous studies. Rawson (1951) has provided an annotated list of the species present and detailed descriptions of them can be found in Slastenenko (1958), and in McPhail and Lindsey whose nomenclature is followed here. Rawson listed 22 species, exclusive of some ciscoes (Leucichthys spp.) which were not identified specifically. The majority, but not all, have been identified in the east arm. Kelcher (1963) defined movement in 10 species of fish in Great Slave Lake through tagging.

Commercial fishermen have been allowed 9,000,000 pounds of whitefish and trout per year, but catches have not exceeded 6,000,000 pounds and are usually much less (Jenness, 1963; Radojicic, 1967). Early estimates of productivity were in the neighborhood of 3 to 5 million pounds per year (Rawson, 1949). All waters of Great Slave Lake north of the Pethei and Kaochella peninsulas are closed to commercial fishing.

Sport fishing, primarily for lake trout and grayling, has been established for years on Great Slave Lake, most active fishing lodges being in or near the proposed park. Pike and yellow pikeperch (walleye) are of lesser importance. Pike exceeding 30 pounds in weight and trout in the range of 40-50 pounds are frequently caught. According to Radojicic (1967) world record grayling (5 lbs.) came from the east arm of the lake.

The fish of other waters in the park are less well known. Clarke (1940) gives some records from Artillery Lake and the Lockhart River.

We attempted an inventory of the fishes occurring in the area. A minnow seine and gill nets of varying mesh size were used, supplemented by some rod and reel angling. We were not able to devote as much attention to this phase of our work as was desirable.

Hauls with a minnow seine (28 m. by 1.5 m., mesh size 13 mm.) were carried out at seven stations on Artillery Lake, at four stations near Fort Reliance, and at one lake between the two. Attempts were made to make minnow seine hauls in the high-altitude lakes on the Pethei Peninsula. Most of the lakes there proved to be narrow and the shores were frequently precipitous rock faces. Those factors rendered the lakes unsafe for landings in the aircraft (Cessna 180) at our disposal. We managed to land in two of the lakes but found the shores too rocky for our minnow seine and a haul in a lake at 62° 41' N, 110° 57' W was inconclusive. The snail Lymnaea elodes Say was observed to be abundant in that lake. Collections using a gill net (15 m. by 1.5 m., mesh size 75 mm.) were made at one station on Artillery Lake. A similar collection, using a gill net (15 m. by 1.5 m., mesh size 25 mm.) was made near Fort Reliance. Hand caught collections, one in each location, were made on Artillery Lake and near Fort Reliance. Most fish taken with the minnow seine were from sandy shores, sometimes with a few rocks, of lakes and streams in depths of less than one meter. Fish taken in gill nets were collected in depths varying from one to three meters. Collecting stations are shown on Map 1.

Our collections of fish were donated to the National Museum of Natural Sciences, Ottawa.

1. Arctic lamprey, Entosphenus japonicus

This species may be confined to the western portion of Great Slave Lake.

2. Lake trout, Cristivomer namaycush

Lake trout were observed in many locations on Artillery Lake and near Fort Reliance. In addition to our collections at sites 2, 7 and 15 we observed a large trout estimated at 10-12 lbs. near the mouth of the Lockhart River in the northeast part of Artillery Lake. In August 1958 Kuyt saw a 20 lb. trout taken off Crystal Island and the previous year he observed frequent trout angling success near the first rapids on the south end of Artillery Lake. Much earlier, Tyrrell (1902) and Clarke (1940) reported trout to be abundant in Artillery Lake. In 1970, most of the trout observed or caught by us were in the 4-8 lb. range but several fish in a refrigerator at Fort Reliance were much larger, the biggest one taken by angling that summer weighing 34 lbs. Clarke (1940) and Rawson (1951) found lake trout abundant in the east arm and near Fort Reliance. Rawson found the trout there smaller than in other parts of Great Slave Lake. His interpretation was that an east to west migration existed during the life of the trout. A nematode Cystidicola sp. was collected from a lake trout caught at Fort Reliance.

3. Round whitefish, Prosopium cylindraceum

This whitefish was taken at stations 3, 7, 11, 13, 14 and 15 on Artillery Lake and on the east side of Charlton Bay. A single sweep of the minnow seine at site 11 yielded a single species catch of 23 round whitefish. Rawson (1951) found the main concentration of this species to be in the east arm of Great Slave Lake.

4. Lake whitefish, Coregonus culpeaformis

Rawson (1951) found this whitefish "extremely rare" in McLeod Bay, and common elsewhere in Great Slave Lake. Kennedy (1953) made a detailed study of this species in Great Slave Lake. It is present in Artillery Lake (Clarke, 1940).

5. Shallow water cisco, Leucichthys artidi

We did not find the cisco common except at our main camp on Artillery Lake (stations 1, 2), where a single sweep of the seine over a sandy bottom yielded about 145 small ciscoes of less than two inches in length. The other three collections (9, 13, 15) consisted of single specimens at each, one of which was taken in a gill net. Clarke (1940) reported the cisco to be common along the route he travelled and Rawson (1951) found ciscoes to be widely spread in Great Slave Lake. There are at least two species of Leucichthys, in addition to L. artidi, in Great Slave Lake (Rawson, 1951).

6. Inconnu, Stenodus leucichthys

Common in most of Great Slave Lake but rare in the eastern portion according to Rawson (1951) and Clarke (1940). We did not see it.

7. Arctic grayling, Thymallus arcticus

We collected the grayling at one station (7) on Artillery Lake with the minnow seine. In 1958 Kuyt caught several by angling near the first rapids on the Lockhart River below Artillery Lake. In 1970 we found the species common in the east portion of Charlton Bay. Residents of Fort Reliance indicate that the best grayling fishing is to be had near the mouth of the Lockhart River and we took four large fish (2-3 lbs) there. Clarke (1940) reported grayling taken at Fort

Reliance and Rawson (1951) found the species to be abundant in the east arm of Great Slave Lake.

8. Northern pike, Esox lucius

While making a minnow seine haul in the mouth of a muddy stream (site 13), we caught an 11.5 lb. pike. It was our only collection of that species. Fort Reliance residents indicated the pike is rarely taken near that settlement. Tyrrell (1902) reported pike to be abundant in Artillery Lake but Clarke (1940) could not confirm its presence there. Rawson (1951) found that the pike rarely occurred in the east arm of Great Slave Lake.

9. Goldeye, Amphiodon alosoides

The goldeye has been reported only as far east as Talthelie Narrows at the western end of the park (Clarke, 1940).

10. Suckers, Catostomus commersonni and C. catostomus

Immature forms of suckers (Catostomus sp.) were collected at site 4. The small fish were observed among partly submerged stones along a lake shore and were caught in a jar. Tyrrell (1902) reported "carp" (undoubtedly suckers) on Artillery Lake but Clarke (1940) was unable to net any there. Rawson (1951) made collections of the white sucker (C. commersonnii) and the longnose sucker (C. catostomus) in Great Slave Lake. He caught the latter in the east arm only and found it rare.

11. Chub, Couesius plumbeus and Platygobio gracilis

Rawson took the lake chub (C. plumbeus) commonly at Resolution and Yellowknife Bay but the flathead chub was found only in the Slave River delta and at the Mackenzie River. We saw neither.

12. Shiners, Notropis atherinoides and N. hudsonius

Both shiners were found by Rawson only in the western portions of Great Slave Lake, with N. hudsonius being somewhat more widely distributed. We saw neither.

13. Burbot, Lota lota

We took only one two-inch long burbot in the minnow seine in a swift tundra creek (site 5). Tyrrell (1902) relates a curious story about a huge black fish seen in earlier years by his companions in Artillery Lake. The description of the fish indicates it may have been a burbot but the size (20-30 ft.) is undoubtedly an exaggeration. Clarke (1940) did not collect this species. Although Rawson (1951) found it widespread in Great Slave Lake it was not frequently encountered in the east arm.

14. Troutperch, Percopsis omiscomaycus

Although the troutperch was commonly taken by Rawson in the western part of Great Slave Lake, it was not seen by us.

15. Yellow pikeperch, Stizostedion vitreum

This species, commonly called walleye, has not been found in the east arm, and it may be commoner in small lakes adjacent to Great Slave than in the big lake. It features in a minor way in both commercial and sport fisheries southwest of the park area.

16. Sculpins, Cottus ricei and C. cognatus

The slimy sculpin (C. cognatus) was taken at 10 of the 16 locations sampled and it was the most widespread fish in our collection. Rawson (1951) found it common in Great Slave Lake where it is important as a food species for pike, burbot, trout and other fish. Clarke (1940) found the slimy sculpin at Fort Reliance. The spoonhead sculpin

(C. ricei) was taken in only two locations near Fort Reliance. We did not take it on Artillery Lake. Rawson (1951) found it to be much less common in Great Slave Lake than the slimy sculpin. A third species, Triglopsis thomsonii, was commonly caught by Rawson in deep water (5 to 461 meters), but not seen by us.

17. Ninespine stickleback, Pungitius pungitius

This stickleback was collected at four stations on Artillery Lake and at two near Fort Reliance. The largest catches were made near the north end of Artillery Lake in a creek mouth near old Fort Reliance (Station 13) and in a small protected bay near Fort Reliance (Station 16), where a number of inch-long specimens were scooped up by hand. Rawson (1951) found this species to be the most abundant small fish in his collections from Great Slave Lake.

Birds

Birds were investigated in the study area mostly through direct observation and by reviewing the literature. Less than a dozen were collected, most of them victims of our small mammal traps. Unpublished field notes, covering the authors' previous work in the area, were consulted as were the residents of Fort Reliance. Indirect evidence of birds, such as tracks, droppings, regurgitated pellets and old nests added further information.

The small mammal population was low during 1970 and lemmings (Lemmus and Dicrostonyx) were scarce on the tundra. Consequently, birds preying on small mammals would be expected to be rare, and otherwise common species such as rough-legged hawk and short-eared owl were not observed. Our late arrival in the field (July 19) precluded seeing

spring migration, and our departure from Fort Reliance (August 20) was too early to allow us to see more than the beginning of southward migration. These factors, and the short duration of our field work account in part for the paucity of bird observations.

Major sources of reference to the birds of the area include Clarke (1940), Snyder (1957) and Godfrey (1966). Nomenclature in the listing of birds follows Godfrey.

1. Loons

All four species of loons found in Canada breed in the proposed park. We did not identify yellow-billed loons (Gavia adamsii) but they have been reported as common (Seton, 1908; Clarke, 1940). Common loons (Gavia immer) were seen in five locations from Artillery Lake to Fort Reliance. Two arctic loons (Gavia arctica) were seen in a bay a few miles northeast of Fort Reliance and red-throated loons (Gavia stellata) were seen and heard twice near our main camp on Artillery Lake. Kelsall saw a red-throated loon with two downy young, and a common loon, at the mouth of the Hoarfrost River, July 16, 1956. On October 11, 1957 Kuyt saw a large loon, either a common or yellow-billed loon, at the south end of Artillery Lake.

2. Grebes

We did not see much suitable grebe habitat and grebes were not observed. Red-necked grebes (Podiceps grisegena) and horned grebes (Podiceps auritus) breed in the area (Godfrey, 1966). Pied-billed grebes (Podilymbus podiceps) might occur in the forest fringe.

3. White pelican

The closest breeding colony of pelicans (Pelecanus erythrorhynchos) is just southeast of Fort Smith. Strays have been reported further north along the Slave River and in summer on Great Slave Lake (Godfrey, 1966). We did not see pelicans and their occurrence in the park is unlikely.

4. American bittern

Bitterns (Botaurus lentiginosus) were not seen although they breed in the forest fringe (Godfrey, 1966). Marshes and wet meadows, the usual habitats of bitterns, were not frequently encountered.

5. Whistling swan

Whistling swans (Olor columbianus) migrate through the area enroute to tundra breeding ranges (Hornby, 1934). They might breed in the northern portion of the area surveyed.

6. Geese

One large Canada goose (Branta canadensis) was observed at the north end of Artillery Lake and four birds were seen at our main camp about 10 miles to the south. A flock of about 10 Canada geese was observed feeding in a shallow pond near Kipling Lake. Much of the Thelon River area northeast of Artillery Lake is used as a moulting area for large Canada geese (Kuyt, 1966) and the geese we saw might constitute post-moult aggregations. Kelsall saw two Canada geese with young near the mouth of the Lockhart River at old Fort Reliance in 1956.

White-fronted geese (Anser albifrons) were not observed although they might breed in suitable habitat in the northern portion of the park. Ross's geese (Chen rossi) and lesser snow geese (Chen c. caerulescens) were not observed. They breed predominantly on the arctic islands and in

coastal habitat. They occur as migrants in the study area (Hornby, 1934).

7. Ducks

Most lakes in the park have deep water, rocky shores and little emergent vegetation. Waterfowl are therefore scarce and only a single surface-feeding duck, a female pintail (Anas acuta) was observed in July at our main camp on Artillery Lake. Of the surface-feeding ducks, Godfrey (1966) lists mallards (Anas platyrhynchos), pintail, green-winged teal (Anas carolinensis) and American widgeon (Mareca americana) as breeding in the area. Blue-winged teal (Anas discors) and shovelers (Spatula clypeata) might occur. Among the diving ducks old squaws (Clangula hyemalis) were reported five times, all near our main camp on Artillery Lake. An aggregation of three adults and four juveniles is included. Kuyt saw two old squaws on October 11, 1957 on the Lockhart River, just below Artillery Lake. Greater scaup (Aythya marila) were observed near our main camp on Artillery Lake (adult female and brood of five half-grown young) as well as near the north end of Artillery Lake where there were two families, consisting of eight young and a parent each. Common scoters (Oidemia nigra) were observed August 14 (three birds near old Fort Reliance) and August 16 (four birds off Maufelly Point).

Of the diving ducks, the occurrence of redheads (Aythya americana) and ring-necked ducks (A. collaris) must be considered unusual. Canvas backs (A. valisineria), lesser scaup (A. affinis) and buffleheads (Bucephala albeola) are expected to occur. Common goldeneyes (Bucephala clangula), white-winged scoters (Melanitta deglandi) and surf scoters

(M. perspicillata) may breed in the area (Godfrey, 1966). On August 27, 1958 Kuyt saw one ruddy duck (Oxyura jamaicensis) near rapids at the foot of Artillery Lake, somewhat north of its reported range. Common mergansers (Mergus merganser) and red-breasted mergansers (Mergus serrator) were both seen. Small flocks of the former, apparently moulting aggregations, were observed at the north end of Artillery Lake. Red-breasted mergansers are expected to breed in the area (Godfrey, 1966). Kelsall saw common mergansers near Fort Reliance in 1956.

8. Hawks

Of the true hawks, only goshawks (Accipiter gentilis) are expected to occur and possibly to breed. Sharp-shinned hawks (A. striatus) may stray into the forest fringe (Clarke, 1940).

9. Buteo hawks

Rough-legged hawks (Buteo lagopus) breed in the park. We did not see them in 1970, a possible consequence of the low density of small mammals. In 1958, Kuyt observed these hawks east of Crystal Island and found unoccupied nests on the island. A nest found there on July 10, 1966 contained two eggs and a small downy young.

10. Eagles

During our work, an adult bald eagle (Haliaeetus leucocephalus) harassed by a pair of long-tailed jaegers, was seen over the Lockhart River three miles above Artillery Lake. Two large nests in spruce trees were observed several miles north of Anderson Falls on the Lockhart River and one adult was seen on Kipling Lake. In 1958 Kuyt saw a large tree nest just east of Crystal Island and attributed it to a bald eagle. In 1968

he saw a bald eagle nest, containing one young bird, on a cliff ledge about seven miles southwest of Fort Reliance.

Golden eagles (Aquila chrysaetos) nest in the east arm of Great Slave Lake (Snyder, 1957). Nests, possibly of that species, were observed high up on cliff ledges along the Lockhart River near Fort Reliance, where Hornby (1934) found a pair nesting. Kuyt, in 1969, observed several nests on ledges on the steep cliffs of the western portion of Pethei peninsula, as did Kelsall in 1956.

11. Marsh hawk

Marsh hawks (Circus cyaneus) are not expected in the area, except as strays. Hornby (1934) reported the species in October 1925, northeast of Artillery Lake.

12. Osprey

Ospreys (Pandion haliaetus) may occur in the forest fringe.

13. Falcons

Gyrfalcons (Falco rusticolus), peregrine falcons (Falco peregrinus) and pigeon hawks (Falco columbarius) are known to breed in the area. Kelsall saw a pigeon hawk on the lower portion of Pike's Portage in July, 1956. The three species have been found nesting or have been seen with recently fledged young on, or in the vicinity of, the islands in the south central portion of Artillery Lake by Kuyt and others in recent years. Should a park be formally established the mapping of known nests of raptors, and their rigid protection, should have high priority.

14. Grouse

We saw willow ptarmigan (Lagopus lagopus) and rock ptarmigan (Lagopus mutus). The latter were observed only once, a brood of seven half-grown

young and parent flushed from birch thickets near our main camp on Artillery Lake. Willow ptarmigan were more common but only a single brood of eight flying young was seen at the north end of Artillery Lake. Between October 9 and 16, 1957 Kuyt observed hundreds of willow ptarmigan migrating south across the lower part of Artillery Lake. Most had partly assumed their winter plumage. Both species have been commonly seen at Fort Reliance, at various times, in winter. A spruce grouse (Canachites canadensis) was flushed during our work about seven miles northeast of Fort Reliance. Fresh tracks in sand, attributed to that species, were seen at Kipling Lake. Sharp-tailed grouse (Pedioecetes phasianellus) and ruffed grouse (Bonasa umbellus) may occur in the southern and western portions of the study area.

15. Sandhill crane

We saw no sandhill cranes (Grus canadensis) but they occur widely over the tundra (Snyder, 1957) and in northern forests. Seton (1908) observed six flying over Fort Reliance.

16. Sora rail

Sora rails were not seen or heard by our party and, since the species requires marshes, it is unlikely that it occurs commonly in the area.

17. Plovers

Semi palmated plovers (Charadrius semipalmatus) were common on the tundra. Immatures, including a flightless downy chick were seen near our Artillery Lake camp. We did not record golden plovers (Pluvialis dominica) although Clarke (1940) saw them commonly at Artillery Lake in 1936. They may breed in the northern portion of the park site. One black-bellied plover (Squatarola squatarola), believed to be a female, was

observed on July 29 on an esker at the north end of Artillery Lake. That area is well south of the known breeding range. The ruddy turnstone (Arenaria interpres) was not observed. It may occur in the area during migration.

18. Snipe and sandpipers

Common snipe (Capella gallinago) breed in suitable habitat throughout the area, but we saw none. Snipe breed on the Thelon River (Clarke, 1940). Breeding records were established at our camp on Artillery Lake for least sandpipers (Erolia minutella) and semi palmated sandpipers (Ereunetes pusillus). Lesser yellow-legs (Totanus flavipes) were observed at our main camp on Artillery Lake and ten miles south in a wooded area. A female, defending a nest or young, was seen July 23 some miles west of our camp. The species, expected to breed in the area surveyed (Godfrey, 1966), was previously reported by Seton (1908).

Spotted sandpipers (Actitis macularia) breed in the area (Godfrey, 1966). They were reported at Clinton-Colden Lake by Seton (1908) and were twice seen by us near Fort Reliance. One of three pectoral sandpipers (Erolia melanotos) observed on Artillery Lake was collected. Solitary sandpipers (Tringa solitaria) were not observed by us and Godfrey (1966) does not include the park within the known breeding range. However, Kuyt found the species breeding near the Thelon River about 220 miles northeast of Fort Reliance, and it undoubtedly occurs in suitable habitat near that settlement. Short-billed dowitchers (Limnodromus griseus) and stilt sandpipers (Micropalama himantopus) may occur in the area, the former as a stray and the latter during migration. No other sandpipers were observed although knots (Calidris canutus), white-rumped

sandpipers (Erolia fuscicollis), dunlins (Erolia alpina), buff-breasted sandpipers (Tryngites subruficollis), long-billed dowitchers (Limnodromus scolopaceus), Hudsonian godwits (Limosa haemastica) and sanderlings (Crocethia alba) could occur during migration. Migrating Baird's sandpipers (Erolia bairdii) were observed at Artillery Lake by Clarke (1940).

19. Phalaropes

The only phalarope to be expected in the area, the northern phalarope (Lobipes lobatus), was observed on two occasions near our main camp on Artillery Lake. On July 20 we watched a male whose behaviour on a small tundra pond indicated that a brood of young was nearby.

20. Jaegers

Parasitic jaegers (Stercorarius parasiticus) and long-tailed jaegers (Stercorarious longicaudus) were observed in various locations on Artillery Lake. Most of the observations involved a pair of birds. The former was more common than the latter.

21. Gulls

Herring gulls (Larus argentatus) were seen almost daily. Almost invariably herring gulls will put in an appearance when a camp is set up on the tundra and their behaviour in that respect is similar to that of gray jays in forested regions. A flightless chick was captured and banded near the north end of Artillery Lake. Immature California gulls (Larus californicus) and Bonaparte's gulls (Larus philadelphia) were observed at Fort Reliance. The latter were also seen by Kelsall in 1956. A pair of adult Bonaparte's gulls was observed at our main camp on Artillery Lake, somewhat north of its reported breeding range (Godfrey,

1966). Mew gulls (Larus canus) were seen on several occasions near Fort Reliance, where we expect them to breed. Gulls migrating through the study area may include glaucous gulls (Larus hyperboreus), Thayer's gulls (Larus thayeri), and Sabine's gulls (Xema sabine).

22. Terns

Arctic terns (Sterna paradisaea) were seen in almost all locations. About 12 adults and three flightless chicks were observed on a small island west of our main camp on Artillery Lake. Adult and flying young common terns (Sterna hirundo) were observed on August 7 at Fort Reliance. Caspian terns (Hydroprogne caspia), although breeding near Yellowknife (Weller, et al., 1969) were not observed by us.

23. Mourning dove

Mr. Ted Butler, a summer resident at Fort Reliance reported seeing a mourning dove (Zenaidura macroura) there several years ago. Mr, Butler also informed us that the R.C.M.P., formerly stationed at Fort Reliance, reported in their diary the sighting of two mounring doves about 1930. The nearest published record of this species appears to have been near Fort Smith (Kuyt, 1967).

24. Owls

Great horned owls (Bubo virginianus), great gray owls (Strix nebulosa), hawk owls (Surnia ulula), short-eared owls (Asio flammeus) and boreal owls (Aegolius funereus) are all reported as breeding in the southern portions of the study area. We saw no owls. Seton (1908) reports a hawk owl collected by his party on Artillery Lake. Short-eared owls, diurnal owls common on the tundra, probably were absent because of low numbers of small mammals. We did not work as far north as the southern

extent of the snowy owl's (Nyctea scandiaca) breeding range (Godfrey, 1966). Undoubtedly that species occurs in winter.

25. Night Hawk

Common nighthawks (Chordeiles minor) have not been reported from the porposed park. Their reported breeding range (Godfrey, 1966) is further south. Kelsall has twice (1952, 1953) found nighthawk's nests on islands in the east arm southwest of the Pethei Peninsula.

26. Woodpeckers

An adult male northern three-toed woodpecker (Picoides tridactylus) was collected near Fort Reliance. No other woodpecker was observed by us but on August 3 we heard the call of a flicker, undoubtedly the yellow-shafted flicker (Colaptes auratus), from a large stand of spruce on the west side of Artillery Lake at latitude 63° 09' N. Clarke (1940) found flickers breeding at Fort Reliance where we observed several nest holes in dead trees. Black-backed three-toed woodpeckers (Picoides arcticus) as well as their congener probably nest in the forest fringe. Yellow-bellied sapsuckers (Sphyrapicus varius) and hairy woodpeckers (Dendrocopus villosus) are expected to occur in forested areas.

27. Flycatchers

Mr. G. D'Aoust, a long-time resident of Fort Reliance reported a small gray-brown bird nesting on a log on the outside of a cabin. There is a good possibility that the bird was the eastern phoebe (Sayornis phoebe), reported by Clarke (1940) as breeding in the area. We saw no flycatchers although yellow-bellied flycatchers (Empidonax flaviventris), Traill's flycatchers (Empidonax traillii), least flycatchers (Empidonax minimum) and olive-sided flycatchers (Nuttallornis borealis) could

occur in the area, with the last mentioned possibly breeding (Godfrey, 1966).

28. Horned lark

Horned larks (Eremophila alpestris) were observed on a number of occasions while we were camped at Artillery Lake. We did not establish evidence of breeding but others have (Clarke, 1940).

29. Swallows

We did not see swallows in 1970. In 1966, 1967 and 1968 Kuyt found several colonies of 20-30 nests of cliff swallows (Petrochelidon pyrrhonota) on Crystal Island, where Clarke (1940) reported the species breeding. Earlier, Seton (1908) reported a conony on the "Beaverlodge" on Artillery Lake, a colony found to be still in existence in 1958 by Kuyt. There is also a colony, seen in 1956, on a small island at the south end of Taltheilei Narrows. Clarke (1940) reported barn swallows (Hirundo rustica) at Fort Reliance. Godfrey (1956) shows breeding range for tree-swallows (Iridoprocne bicolor) extending to the park site.

30. Gray jay

Gray jays (Perisoreus canadensis), both adults and juveniles, were observed in a large stand of spruce near treeline on the western side of Artillery Lake, at Fort Reliance and at several stations along Pike's Portage.

31. Raven

Ravens (Corvus corax) were frequently seen in the forest but were less common on the barrens. An old nest attributed to this species was found on a ledge on a low rock outcrop east of our camp on Artillery Lake. Ravens scavenged several times near our camp where an immature bird

was photographed at close range. We saw ravens 15 miles west of The Gap and saw them scavenging in company with herring gulls at Fort Reliance. In October 1957 Kuyt saw five ravens on the Lockhart River and in 1966 he found a nest with three young on Crystal Island.

32. Common crow

We did not observe common crows (Corvus brachyrhynchos) and although Clarke (1940) saw a flock of 20 at Artillery Lake, and reported it as common at Fort Reliance, its occurrence in the study area must be considered rare.

33. Boreal chickadee

Boreal chickadees (Parus hudsonicus) were observed by Clarke (1940) at Fort Reliance. We saw the bird in three different locations in the same area.

34. Thrushes

American robins (Turdus migratorius) were seen in small numbers in spruce on a long esker west of our main camp on Artillery Lake, where they undoubtedly nest. We also saw the bird in forested areas to the south including Fort Reliance. Clarke (1940) established nesting records for the species at Fort Reliance. We found gray-cheeked thrushes (Hylocichla minima) common in the "Last Woods" on the west side of Artillery Lake. An immature was accidentally caught in a mouse trap near our main camp on Artillery Lake. Swainson's thrush (Hylocichla ustulata) might occur in the southwestern corner of the study area but we did not observe it.

35. Kinglet

Godfrey (1966) shows the northern limit of the breeding distribution

of the ruby-crowned kinglet (Regulus calendula) as immediately south of the park. We did not encounter the species.

36. Pipit

Water pipits (Anthus spinoletta) were observed at our camp on Artillery Lake (adult carrying food on July 26) and at the north end of that lake. Small flocks were observed on August 7 east of Crystal Island.

37. Waxwing

Bohemian waxwings (Bombycilla garrulus) breed in the southern portion of the study area including Fort Reliance (Godfrey, 1966). We did not observe them.

38. Shrike

On July 23 Kuyt saw a flock of seven northern shrikes (Lanius excubitor) on a wooded esker west of our camp on Artillery Lake. At least six of the seven birds were juveniles. If the young were hatched locally, as seems likely, they constitute a 60-mile northward extension of the breeding range as given in Godfrey (1966). Seton (1908) observed two northern shrikes at Fort Reliance.

39. Starling

Common starlings (Sturnus vulgaris) were not observed by us. Kuyt (1965) reported a starling breeding on the Thelon river, 225 miles northeast of Fort Reliance, where it could be expected to put in an appearance.

40. Vireos

Red-eyed vireos (Vireo olivaceus) and warbling vireos (Vireo gilvus) occur immediately south of the area studied (Godfrey, 1966).

41. Warblers

Tennessee warblers (Vermivora peregrina) were observed three miles

northeast of Fort Reliance. Unidentified yellow-green warblers, possibly the same species, were observed west of our main camp on Artillery Lake and near old Fort Reliance. A black-poll warbler (Dendroica striata) was observed west of our main camp on Artillery Lake. On August 19, 1958 Kuyt observed a yellow warbler (Dendroica petechia) on the east side of Artillery Lake at latitude 63° 03' N. Myrtle warblers (Dendroica coronata) and Wilson's warblers (Wilsonia pusilla), which breed in the study area, were not observed. A number of other warblers of probable occurrence, notably magnolia warblers (Dendroica magnolia), palm warblers (Dendroica palmarum), northern water thrushes (Seiurus noveboracensis) and American redstarts (Setophaga ruticilla), were not observed by us, although some of these species were reported by Seton (1908) and Clarke (1940).

42. Blackbirds

Red-winged blackbirds (Agelaius phoeniceus), possibly breeding in the area, were not seen. Rusty blackbirds (Euphagus carolinus), observed at Kipling Lake by Seton (1908), were seen by us on the west side of Artillery Lake at latitude 63° 10' N. Clarke (1940) reported that a common grackle (Quiscalus quiscula) was seen in 1935 by the R.C.M.P. at Fort Reliance.

43. Finches

Pine grosbeaks (Pinicola enucleator) breed at Fort Reliance (Godfrey, 1966). A flock of large finches seen at a distance on August 12 near Fort Reliance may have been pine grosbeaks. Common redpolls (Acanthis flammea) were seen on numerous occasions on Artillery Lake. Its congener, hoary redpolls, (Acanthis hornemanni) were not definitely identified.

Pine siskins (Spinus pinus) and red crossbills (Loxia curvirostra) were not seen but might occur as strays. A small flock, containing both sexes of white-winged crossbills (Loxia leucoptera), was seen on August 8 near Fort Reliance.

Savannah sparrows (Passerculus sandwichensis) were encountered everywhere as were Harris's sparrows (Zonotrichia querula) and white-crowned sparrows (Zonotrichia leucophrys). All three species, adults and juveniles, were accidentally taken in mouse traps. Kuyt found a Harris's sparrow nest with four young in 1966 on Crystal Island. Tree sparrows (Spizella arborea) were observed several times, once carrying food to young. Chipping sparrows (Spizella passerina) and Lincoln's sparrows (Melospiza lincolnii) were observed once each near Fort Reliance. Slate-colored juncos (Junco hyemalis) were seen twice near Fort Reliance. White-throated sparrows (Zonotrichia albicollis), fox sparrows (Passerella iliaca), song sparrows (Melospiza melodia) and swamp sparrows (M. georgina) were not seen.

Lapland longspurs (Calcarius lapponicus) were common on the tundra. Several immatures were killed in traps and the species was observed flocking on Crystal Island on August 7. We did not identify Smith's longspur (Calcarius pictus), which breeds in the Artillery Lake area (Godfrey, 1966) but Clarke (pers. comm.) saw it on Crystal Island on July 21, 1970.

Snow buntings (Plectrophenax nivalis) were not seen and perhaps they do not nest in the study area. On October 10, 1957 Kuyt watched a flock of about 40 birds cross the Lockhart River near Artillery Lake. These finches were reported in the area by Seton (1908) and Clarke (1940).

Seton (1908) reported a chestnut-collared longspur (Calcarius ornatus) on Aylmer Lake. This report, incorrectly quoted by Clarke (1940), is probably an error.

Mammals

The mammals of the study area were investigated through small mammal trapping (1,810 trap nights), through observation, through interrogation of residents at Fort Reliance, through our previous experience in the area and, most important, through a review of the literature. Nomenclature, and ranges, in the following annotated listing follow Hall and Kelson (1959) unless otherwise specified. Subspecific designations are used in cases where we have examined specimens and are suggested in most cases where there is little doubt of their validity.

The mammals cover a wide range of those that might be expected in the northern boreal forest and tundra. A majority are common to both, although scarcely any of them are equally abundant in both biomes.

In many cases boundaries between subspecies, and even species, are shown on the best available range maps as passing through the proposed park. Most such boundaries have been artitrarily drawn, but they do pose a real challenge to the taxonomist. The systematic collection of large series of the mammals involved is the only way to clarify the situation in regard to most of them. This sould be done promptly if a park is established.

1. Shrews

We were unfortunate in not capturing shrews, although the animals are well known to residents of Fort Reliance. At least three species

may be found in the area. They are the masked shrew (Sorex cinereus), and arctic shrew (S. arcticus) and the pigmy shrew (Microsorex hoyi). Kelsall has seen both arctic shrews and masked shrews taken near Muskox Lake about 70 miles northwest of the northern extremity of the study area. According to Hall and Kelson (1959) the boundary between S. c. cinercus and S. c. ugyunak crosses Artillery Lake. The zoology museum, University of Alberta has two masked shrews collected at Fort Reliance in 1944. A fourth species, the water shrew (S. palustris) has been taken north of the north arm of Great Slave Lake (Jackson, 1928) and a fifth, Sorex vagrans, is well known along the Slave River to Fort Resolution (Findley, 1955). Both might theoretically be found within the study area although the general habitat is much different from that which the species prefer.

2. Varying hare (Lepus americanus)

Varying hares, probably referable to the subspecies macfarlani, are found throughout forested portions of the study area. Northern limits are not known although they probably coincide approximately with treeline. We did not see signs of varying hares on Artillery Lake but scats, and some of the animals, were seen at Fort Reliance. The varying hare is one of the famous periodic, or cyclic, mammals found in Canada. Its fluctuations, in an approximate 10-year cycle, have been studied by many people and notably by Elton (1933 and 1934), Elton and Swynnerton (1935 and 1936), Chitty and Elton (1937), and Chitty (1948 and 1950) in the Canadian north.

Portage, and the animals were frequently heard or seen in the general area of Fort Reliance. One was seen August 9 at "The Gap" between Douglas and Pethei peninsulas.

6. Beaver (Castor canadensis)

Beaver, referable to the subspecies canadensis, are uncommon in the study area, perhaps in part because they are extensively trapped, and because the habitat is marginal for them. We saw a few old beaver cut branches on Great Slave Lake. Clarke found similar evidence at the foot of Kipling Lake on Pike's Portage. A few beaver are traded at Fort Reliance annually, but most of them come from south of the study area. Under protection beaver would increase throughout the timbered portions of the study area. Certainly some habitat is suitable for them.

7. White-footed mouse (Peromyscus maniculatus borealis)

Clarke (1940) considered that white-footed mice were abundant to timberline and that is probably correct. We took the species abundantly at Fort Reliance and around Charlton Bay, as have others, but not elsewhere. We caught 18 in 1,810 trap nights. One specimen is known to have been taken east of Crystal Island during caribou studies in 1958.

8. Red-backed mouse

We took 65 red-backed mice during 1,810 trap nights - the most commonly caught small mammal. Remains of red-backed mice were the most commonly met on examination of scats of carnivores and regurgitated pellets of raptors. Hall and Kelson (1959) suggest two species, and three subspecies, of red-backed mice in the study area. They are Clethrionomys rutilus dawsoni, C. r. washburni and C. gapperi athabascae. The latter

is most apt to be found in the forest. The sub-species C. r. dawsoni has been identified from Fort Reliance and C. r. washburni has been taken at Artillery Lake (see Hall and Kelson, 1959 and Manning, 1957). An examination of the material collected by us during 1970 leads to the belief that gapperi was not collected and that most, and probably all, are referable to C. r. washburni, primarily because of great zygomatic width on the skulls and color characteristics as described by Hanson (1952) and Manning (1957). The genus is apparently abundant in the new park site, in both forest and on the tundra, and it is quite possible that both species will be found there. Subspecific differences will certainly provide some interesting puzzles for the taxonomists.

9. Heather vole (Phenacomys intermedius mackenzii)

Three specimens were "trapped on the forest edge at Fort Reliance" by Banfield (1951). We took 8 specimens from both forest and tundra. Two maxillary teeth of P. intermedius were found in fox scats from near our camp on Artillery Lake.

10. Meadow vole (Microtus pennysylvanicus drummondii)

Banfield (1951) took single specimens of meadow voles at Fort Reliance and Clinton-Colden Lake. Earlier, Preble (Allen, 1910) took many in the park area. We found the subspecies on both tundra, and in the forest. Two left mandibles were recovered from a wolf scat found near our camp on Artillery Lake. The much larger yellow-cheeked vole (M. xanthognathus) might be present in the proposed park in view of its known range.

11. Muskrat (Ondatra zibethicus)

Muskrats, almost certainly referable to the subspecies spatulatus, have been reported from Artillery Lake (Clarke, 1940) and from Fort Reliance (Banfield, 1951). Suitable habitat is limited in the clear rocky waters

in the east end of Great Slave Lake but the animals are probably present wherever it is found. Hall and Kelson (1954) show a boundary between the subspecies spatulatus and albus lying only a short distance east of the park.

12. Brown lemming (Lemmus trimucronatus trimucronatus)

We took only one brown lemming, near our camp on Artillery Lake. Of 42 carnivore scats and raptor pellets collected by us, none contained brown lemming remains. It had been previously recorded once from Artillery Lake and many times further north at Clinton-Colden and Aylmer Lakes. Lemmings, often without any specific designation, were mentioned by virtually all the early explorers and field parties to visit the area.

13. Collared lemming (Dicrostonyx groenlandicus)

We took 5 collared lemmings near our campsite at Artillery Lake. Most were juveniles and, unfortunately, the only adult in the series had a damaged skull. Therefore, subspecific designations are difficult. Primarily on the basis of color as described by Anderson and Rand (1945), and because it has previously been identified from Artillery Lake, our specimens are tentatively referred to richardsoni. The subspecies kilangmuitak has also been identified from slightly farther up the Lockhart River. Here again we have subspecific boundaries of a small mammal in the park to provide an interesting problem for morphologists. Two fox scats and a raptor pellet from Artillery Lake contained remains of D. groenlandicus.

14. Porcupine (Erithizon dorsatum)

Porcupines, probably referable to the subspecies dorsatum, are known

but uncommon about the east arm of Great Slave Lake. Banfield (1951) reported an occurrence at Lynx Lake in 1949, on the tundra about 75 miles east of present park boundaries. Kuyt (1965) recorded evidence of porcupine in the Thelon Game Sanctuary, 115 miles northeast of the northern tip of the proposed park. The scarcity of the animals is probably due to their being on the margins of their range, and to their value to the Indians, who eat them and use the quills for embroidery.

15. Coyote (Canis latrans)

While coyote specimens are not known to have been taken in the new park, there seems little doubt that they are occasionally found there. Clarke (1940) supplied a hearsay record of a coyote at Artillery Lake for the trapping season of 1935-36. They are reported occasionally by Indians and others from the vicinity of Fort Rae, Yellowknife, and Snowdrift - well east of the limit shown by Hall and Kelson (1959) for the species. Mr. T. Butler, a summer resident at Fort Reliance, told us he saw the tracks of a coyote there in 1970.

16. Wolf (Canis lupus)

Hall and Kelson (1959), reflecting the work of earlier taxonomists, show the ranges of four subspecies of wolves joining at the east end of Great Slave Lake. This is, of course, an absurdity. Kuyt (1969) has recorded ear tagged wolves crossing the arbitrary boundaires separating these questionable subspecific ranges. Jolicoeur (1958), in a study of multivariate geographical variation in northern wolves, concluded in part that "Multivariate biometrical differences between populations (of wolves) appear approximately proportional to geographical separation." Wolves are found throughout the proposed park, and while

we saw none in 1970 we found droppings and tracks everywhere. Skeletal material was found near our main camp and Kuyt saw a wolf mandible on Crystal Island in 1966. Both of us have seen wolves commonly in winter among caribou herds in the general park area and on August 23, 1958 Kuyt photographed two white wolves east of Crystal Island. Wolves constitute an interesting part of the fauna of the proposed park and, under protection, there might be possibilities for public viewing of those magnificent animals.

17. Arctic fox (Alopex lagopus)

Arctic foxes, referable to the subspecies innuitus are common components of the fauna, particularly in winter when they may invade the forest fringe for a short distance. A long-time resident of Fort Reliance showed us a remarkable photograph, depicting three arctic foxes resting on snow-covered fuel drums in front of the M.O.T. buildings. During our investigations in that area we found the skulls of an adult and juvenile arctic fox, undoubtedly taken there by trappers. Although we saw none on Artillery Lake they probably breed occasionally in the tundra portions of the proposed park. Banfield (1951) found a den on Clinton-Colden Lake just to the north. The arctic fox was the backbone of the economy during the short and hectic era of the barren-ground trapper in the late 1920's and through the 30's. Much of the trapping activity centered around Fort Reliance and Artillery Lake. This brief episode in Canadian history would lend itself well to interpretation and information programs. The major existing reference is Ingstad (1933). The 4 year "cycle" in arctic foxes, and lemmings, has been dealt with extensively by Chitty (1938, 1939, 1940, and 1950) and Chitty and Chitty (1937, 1941 and 1945).

18. Colored fox (Vulpes fulva)

The colored fox is found throughout the proposed park and, on the tundra, probably competes with the arctic fox for denning areas. A vacant den, presumably used by this species, was found in the side of an esker near our camp on Artillery Lake. Tracks were also found and on August 3 we saw a black or dark cross fox on the beach about 12 miles south of our Artillery Lake camp. The taxonomy of these foxes requires study since a boundary between two subspecies is shown as running through the east end of Great Slave Lake. The subspecies (abeitorum) has been identified from Fort Reliance. The subspecies (alascensis) has been identified on the north side of Great Slave Lake to the westward and Hall and Kelson (1959) show its range extending eastward from Artillery Lake.

19. Black bear (Ursus americanus)

Black bears, referable to subspecies americanus, are common animals in the forested portions of the proposed park and are occasional wanderers on the tundra as well (Jonkel and Miller, 1970). At least two black bears were shot in the immediate vicinity of Fort Reliance during the summer of 1970, one while maurading a cabin on Fairchild Point and the second in the forest near the settlement. The latter had been attracted by plentiful blueberries, raspberries and gooseberries growing wild in the area. The settlement usually has bears in the vicinity, probably because of the practice of dumping garbage in cribwork containers in the surrounding woods. Clarke (1940) told of a cinnamon colored bear damaging mining exploration buildings at Fort Reliance as early as 1937. Banfield (1951) saw bear signs in the Fort Reliance area and picked up portions of a skull near the mouth of the Lockhart River.

20. Grizzly bear (Ursus richardsoni?)

Grizzly bears are common on the tundra portions of the proposed park and might be expected occasionally in any of the forested sections except, possibly, the peninsulas. While we saw none of the animals, fresh tracks and droppings were abundant everywhere on the tundra. On several occasions we found long light brown hairs caught by pitch of white spruce trees, marked by claws of bears, presumably of this species. C. H. D. Clarke saw a grizzly about July 21st, 1970, as it swam from Crystal Island to the mainland. Most travellers in the area have made mention of the species. There is no doubt that it enters the forest. Extensive exploitation of patches of Hedysarum (liquorice-root) in wooded areas south of our camp hinted at the presence of these bears. In the early 1950's both grizzly bears and black bears were common scavengers at mine garbage dumps at Stark Lake well south and east of Fort Reliance. In 1956 Kelsall saw the remains of a bear that had been shot on Pike's Portage about a mile above Charlton Bay. According to Clarke (1940) the Chipewyan Indians seldom molest the big bears, "prudence and veneration being apparently combined in their attitude". The taxonomy of the species is in doubt.

21. Marten (Martes americana)

Marten, probably referable to the subspecies actuosa are found throughout the forested portions of the proposed park. Their populations fluctuate widely and unpredictably.

22. Weasels

We were unfortunate in not securing any weasels, although the animals probably accounted for some otherwise inexplicable losses from our small mammal traps. There are two species in the park. The common

one is Richardson's weasel (Mustela erminea). The subspecies richardsonii may be found in the forest. The related arctic weasel (M. e. arctica) has been identified on the tundra just beyond the proposed park boundary, and is likely common on the park tundra. The local distribution of these two subspecies should be determined. The least weasel (M. rixosa) was taken by Preble and Seton (1911) at old Fort Reliance. Hall and Kelson (1956) show the range of the species extending far northward from the proposed park onto the tundra. Kelsall found a specimen at Bathurst Inlet in 1950. The species, probably referable to the subspecies rixosa, is doubtless sparsely distributed over the entire area.

23. Mink (Mustela vison)

Mink, referable to the subspecies lacustris, are common in the proposed park. Clarke (1940) gave a number of records from tundra areas north of Fort Reliance, and Kelsall has seen mink taken near Aylmer Lake about 100 miles northwest of the park boundary. On August 21, 1958 while Kuyt was cooking a lake trout freshly caught in the first rapids below Artillery Lake, a mink and four large young not only were seen at close range but shared in the meal as well. In 1970 we saw no mink but we did see their tracks occasionally in the forest.

24. Wolverine (Gulo luscus)

Wolverine, referable to the subspecies luscus, might be expected anywhere within the proposed park. We saw fresh tracks on the west side of Fairchild Point, and Kelsall got a fleeting glimpse of a wolverine near camp on Artillery Lake.

25. Otter (Lutra canadensis)

We saw two otter, probably referable to the subspecies preblei, swimming in Kipling Lake on Pike's Portage. They are undoubtedly found in suitable habitat throughout the forested portion of the area and likely on the tundra as well.

26. Lynx (Lynx canadensis canadensis)

Lynx are known throughout the proposed park. They are doubtless more common within the forested areas, where they depend much on the snowshoe hare for sustenance, and where their numbers fluctuate with those of the hare. Elton and Nicholson (1942) dealt extensively with lynx fluctuations in the north. Seton (1911) took a lynx on Artillery Lake and we saw fresh tracks there not too far from our campsite. It is commonly taken by trappers throughout the area.

27. Moose (Alces alces)

Moose, referable to subspecies andersoni, are relatively common animals and might be found anywhere within the porposed park. Normally a mammal of the forests, they stray regularly onto the tundra where they are found even in winter in suitable willow thickets. We saw a moose between Artillery Lake and Fort Reliance and tracks in a number of areas around Charlton Bay.

28. Barren-ground caribou (Rangifer tarandus arcticus)

Barren-ground caribou have been the staple and preferred food of the local Indians since well before recorded history began. They are migratory within the park boundaries, although a few might be found about Artillery Lake at any season. Thus in the spring of 1957 a few thousand barren-

ground caribou dropped their calves just to the east of Artillery Lake - an unusual occurrence. Throughout the summer of 1970 some caribou, mostly adult bulls, appeared to have stayed in the vicinity of Artillery Lake. We photographed several. There have also been times, as during the winters of Back's occupancy of the fort which he built, when the animals are unaccountably absent. The usual pattern of movement in the park area is as follows: In late August the animals move southward from summer ranges far out on the tundra, and they frequently appear in large numbers about Artillery Lake. Sometimes they briefly penetrate the forests for considerable distances at that time, and they may even touch the north shores of Great Slave Lake. During the rutting season, in late October, they are generally on treeline and, again, frequently in the vicinity of Artillery Lake. The first heavy snowfalls of the autumn seem to trigger migration, and the animals move into the forest in vast numbers, frequently going through the Fort Reliance area if the ice on the big lake is frozen so that they can walk on it. Sometimes they winter in appreciable numbers in the vicinity of Charlton Bay and on the peninsulas. Often they go further south and west. Reverse migration generally commences in April and the animals are often moving strongly through the east end of Great Slave Lake and onto the tundra throughout April and May. The adult cows are in the front of the movement and they are followed by increasingly large numbers of younger animals and adult males which bring up the rear. Some commonly used routes of travel for caribou are shown on Map 3.

The history and movement of barren-ground caribou have been described by Banfield (1954) and Kelsall (1968) in particular. In addition to

many general references by such people as Back (1836), Pike (1892), Whitney (1896) and Wheeler (1912), Kindle (1917) and Robinson (1938) have published observations directly related to the new park.

29. Muskox (Ovibos moschatus)

Muskox, referable to the subspecies moschatus, have traditionally been found in the Thelon Game Sanctuary to the north and east of the proposed park, and in the Clinton-Colden and Aylmer Lake regions to the north. They are still found in both those places. Kuyt (1971) has reported a sighting by Water Resources people who saw three muskox near the south-west corner of Artillery Lake. There is no reason for doubting this most unusual record. However, the entire tundra portion of the park would appear to be adequate habitat for the animals and, under protection, they should thrive there. Tener (1965) and Hone (1934) provide complete accounts of the history and biology of Canadian muskoxen.

The above account deals with mammals which are known to be within the proposed park, and with a few that are probably there. On the strength of projected ranges, and other evidence having varied degrees of probability, we suggest a hypothetical list of an additional 9 mammal species. They include the little brown bat (Myotis lucifugus), least chipmunk (Eutamias minimus), woodchuck (Marmota monax), northern flying squirrel (Glaucomys sabrinus), bog lemming (Synaptomys borealis), jumping mouse (Zapus hudsonius), fisher (Martes pennanti), skunk (Mephitis mephitis) and woodland caribou (Rangifer tarandus sylvestris). Most of these species have been found to the west, particularly along the Slave River. The little brown bat and skunk have both been reported, but most likely in error, from the east end of Great Slave Lake. Woodland

caribou were reportedly once common on islands in the eastern part of the east arm of Great Slave Lake, and are still to be found west of the north arm of Great Slave Lake and south of the lake. However, we know of no evidence whatever that they may still be found in the proposed park. Clarke (1940) considered them "very rare in the Reliance district" and absent on the islands and north of the east arm of Great Slave Lake.

SPECIAL VALUES AND PROBLEMS

Park boundaries

We were asked to comment on the adequacy of the proposed boundaries of the park. A first consideration is to include the major features of geological, topographical, and historical interest in the area. In our opinion that has been done adequately, except that the waterfalls and rapids on the lower Lockhart River have apparently been excised at the request of hydroelectric development interests.

Since the spectacular lower Lockhart River must rank at, or near, the top on any list of priority features in the new park we recommend that the matter be reconsidered. There is now no essential requirement for the sort of electrical power which could be generated from the Lockhart River that is known to us. If the national interest required the development of such power in future it might be possible, through careful engineering, to develop the river within reasonable limits and still preserve the essential character of the area. Certainly the excising of the falls at this time appears to represent a short sighted and narrow viewpoint.

ERRATUM

There is no page 72

It would be ecologically desirable to enlarge the northern portion of the proposed park. The purpose would be to ensure a sufficient land area so that some of the large and spectacular members of the fauna could maintain home ranges, or denning ranges, within it. That is not now the case, and this constitutes the major ciriticsm of the park proposal as it stands. The land area on either side of the Lockhart River and Artillery Lake is too narrow to enclose ranges for animals such as wolves, bears, wolverine or for other desirable elements such as muskoxen should they be reintroduced. Our suggestion would be a westward expansion of the boundaries to include the Hoarfrost River from Great Slave Lake to Walmsley Lake, and an eastward expansion to include the historic headwaters of the Hanbury River. The changes are illustrated on Map 4.

The change would add about 775 square miles to the park. First, it would ensure that the west side of the scenically desirable Hoarfrost River is included in the park. It would enclose a piece of land hopefully large enough to provide denning ranges, or home ranges, for everything except barren-ground caribou. There would be natural and somewhat constraining boundaries both east and west. Possibilities for varied canoe routes would be much enhanced.

It should also be mentioned that those proposed boundaries which run through the waters of Great Slave Lake (Map 1) may well pose enforcement difficulties. For the benefit of commercial fishermen particularly, they should be based on obvious landmarks so far as possible.

Old Fort Reliance and other landmarks

The parkland on the raised beaches at the site of old Fort Reliance has been mentioned as an asset of particular merit. The remains of the original fort, built by Captain Back in 1834, are still visible in the form of old stone chimneys. Those chimneys should be preserved as items of historical significance and consideration might be given to the restoration of the fort. The character of the original structure is known in detail, as is that of the scientific observatory which Back had built nearby.

The relatively modern abandoned Indian village, which is across the Lockhart River from the old fort comprises a rather unsightly collection of about a dozen log cabins in various states of disrepair. It is suggested however that the village reflects the way of life of the resident Indians and that it might be worth preservation, or even reactivation. The modern village about three miles north of the head of Timber Bay on Artillery Lake could be similarly treated.

Other links with the past include several crumbling trapper's cabins, most of them made of logs but some with stone walls, which were found in scattered pockets of spruce, and as dugouts on eskers. These mostly date back to the times when arctic fox and wolf trappers were active in the Artillery Lake area.

Hiking trails and canoe routes

The proposed park offers unlimited opportunity for the development of canoe routes, hiking and cross-country ski trails. Since hiking and canoeing, together with fishing and the simple appreciation of scenery and other aesthetic values, will provide the main attraction in the new

needs rewording

park, it would be wise to develop them early and well. The Pike's Portage canoe route is mentioned elsewhere. Canoeing on Artillery Lake and on portions of Great Slave Lake, except along the shore lines, should not be encouraged except among experts, as a safety precaution, but there are many places on the tundra and in the forest where day long, overnight or longer canoe tours could be developed. The inclusion of the Hoarfrost River system in the park would enormously enhance this feature. The upper headwaters of the Hoarfrost provide good paddling, good scenery, and an historic atmosphere.

The development of hiking and cross-country ski trails will offer challenge to the planner. Because of the rugged nature of the country it is possible to develop even quite short trails through magnificent scenery. Even within the narrow confines of Fairchild Point hiking can be pleasant and offer almost constantly changing vistas. High ridges on the south side of the Lockhart River provide an excellent base for an aesthetically pleasing hiking trail from which the spectacular series of rapids and waterfalls could be viewed.

Since conventional forms of outdoor recreation such as swimming, horseback riding and the like can only be developed in a limited way, if at all, extra time and thought would be warranted on facilities for people wishing to travel and see the country under their own power. The black flies and mosquitoes are bad in season (mid-June to early August), and winters are cold. Hikers, skiers and canoers would benefit if fly-proof and winterized trail cabins were built for their use.

Some of the traditional canoe routes and trails used by Indians, and by early travellers heading for the Thelon River and elsewhere, should be investigated and activated.

Pike's Portage

Pike's Portage to the tundra is scarcely over a century old and yet it is steeped in history and interest, and it was probably in frequent use prehistorically. We suggest that the route be maintained so that many persons can see and enjoy it.

The route is about 18 miles long, and the most formidable barrier is the first 3 1/2 miles upward from Great Slave Lake to Harry Lake. The park might consider maintaining directly, or in the form of a concession, a number of canoes on each of the chain of lakes which make up the portage route. Assuming that there will be a road from Charlton Bay to Artillery Lake, visitors could drive to Artillery and then canoe back via the portage without the necessity of carrying canoes from one lake to the other. It would be a simple matter to see that alternating parties went up the portage and down the portage, thus ensuring that there were always canoes ready for the next party. The route is scenically and biologically interesting. There are a number of places where lookouts could be developed which would add great interest. The trip would be of particular interest when caribou are moving through, as they often do in late summer and early autumn. We saw bald eagles and otter on the portage, even though we only stopped briefly at Kipling Lake, and there are many other birds and mammals as well.

Campsites in fragile environments

On Artillery Lake, Pike's Portage, and elsewhere, it is now possible to see examples of the sort of impact which human use has on easily destroyed plant and land associations such as are found near

treeline. It is noteworthy, for example, that trees are scarce or absent nearly everywhere along the shores of the north half of Artillery Lake even though scattered pockets of trees are fairly frequent in suitable habitat a few miles back from the lake. Particularly on the east side of Artillery Lake, when flying at low elevations, we noted bleached stumps of small groves of trees that had been cut for fuel and other domestic uses by hunters and trappers in the past. In several places, particularly on eskers we found evidence, in the form of ancient stumps and roots, of substantial spruce growth in the past where none exists at present. In some such places residual charcoal suggested that groves had been destroyed by people using them for fuel. In recent years, caribou hunters at the extreme north end of Artillery Lake and near Lockhart River have cut spruce on eskers in many places, for fuel, tent pegs and bedding.

With the development of a National Park, and the inevitable influx of tourists travelling by all means possible, the potential for the quick destruction of "outpost" groves of trees, and concurrent soil erosion as the land is denuded, will become progressively greater. People must be permitted to travel the treeline and tundra areas but they must decidedly be restrained from making consumptive use of treeline vegetation. The problem is complicated because the small groves of stunted spruce, which are found on and beyond treeline, generally provide the most attractive campsites. Our recommendation would be that travellers be restricted to particular routes and campsites. Campsites should be frequent, so that people have a meaningful choice of location, and they should be supplied with firewood which could be hauled by tractor in winter from the south.

Noteworthy among the fragile environments of concern are the large expanse of parklands on the site of old Fort Reliance which has been scientifically described by Raup (1930); the primarily deciduous parklands on the raised beaches which form the start of Pike's Portage; the scattered spruce forest that is found on Crystal Island on Artillery Lake, and small larch and spruce groves on and beyond treeline wherever they may be found.

Construction of roads and airstrips

At some stage in development it may be desirable to construct an all-weather airstrip to service the park and, perhaps, associated developments outside. It would be possible to construct an airstrip near the base of the Pethei Peninsula to the west of Charlton Bay. However, such as airstrip would be much lower than surrounding land and approaches in inclement weather would be hazardous. It seems more rational that an airstrip should be built on the tundra, perhaps to the east of the south end of Artillery Lake. It would be practical to build such as airstrip completely outside park boundaries.

Park headquarters will presumably be on Great Slave Lake for a number of good reasons. It seems reasonable to assume that park headquarters will be connected directly, or through incorporation of a short boat trip across Charlton Bay by road with Artillery Lake. It would take little effort to connect such a road with an airstrip.

The use of gravel and sand is inherent in the construction of roads, airstrips and building sites. Park planners must be much concerned about where construction materials come from. The use of the Fort

Reliance sand plain or other obvious sources around Charlton Bay for construction sand and gravel would constitute vandalism. A source should be located and designated at the outset of park development. Our recommendation would be that one of the eskers or glacial ridges east of the southeast corner of Artillery Lake be sacrificed for the purpose. The remains of the esker chosen might also serve as the base for the airstrip. The connecting road from Artillery Lake to Charlton Bay could be built, starting from the gravel source, if heavy equipment were flown to Artillery Lake during winter months. Alternatively, heavy equipment could be taken to Fort Reliance by water during summer months and then driven to the gravel source in winter over the unimproved route.

There may be sources of gravel near Great Slave Lake that could be used for construction purposes. However, it should be remembered that any such use will leave an unsightly scar on the landscape that cannot be readily repaired.

If an airstrip and connecting road were planned, immediate consideration should be given to relocating the Ministry of Transport meteorological station from its present point at the east end of Great Slave Lake to a higher elevation east of Artillery Lake. It is our understanding that, from the communications point of view, this would be a much more satisfactory location for the work which is carried out. Radio communications from and to Fort Reliance are notoriously unreliable. There is reason to believe that transmitters and receivers at higher elevations to the north would be consistently more useful. It is understood that an air beacon, incorporating the building of a 300-foot tower, is planned for Fort Reliance. That beacon, to bridge a gap

between Yellowknife and Baker Lake, would be much better placed to the north and east as well, for both practical and aesthetic reasons. The perfect solution might be the relocation of the meteorological station at the site of a gravel esker cum airstrip as suggested above.

Motor vehicles

The use of mechanical methods of transportation must be strictly regulated in the new national park. Mechanized transport of various types will be essential to the maintenance of the park, but unlimited use of such transportation by the general public would leave destruction in its wake.

Helicopters and fixed wing aircraft have long been used in the area for fishing, trapping, and other activities. There already exists a substantial tourist industry based on fly-in fishing and camping. The establishment of a national park might tend to concentrate aircraft and outfitters in the immediate area. It would be impossible to enforce fishing regulations, hunting regulations, and regulations relative to the use of particular areas for camping and other activities without strictly regulating the use of aircraft. Our suggestion is that aircraft be permitted for official uses of park personnel, and that the use of aircraft for private or commercial purposes be restricted to the provision of transportation between only a few developed or specifically designated areas. There must be strict regulations against low elevation harassment of birds and mammals. At least one outfitter presently makes extensive use of aircraft to allow tourists to view the spectacular waterways of the lower Lockhart River and also, when they are encountered, to look at barren-ground caribou and other large mammals.

The use of motor boats will be essential to park administration. It is recommended that, in order to preserve the wilderness character of the park, the general public not be permitted to use outboard motors except on the largest waters where it is hazardous to travel with small craft. Large waters would include those portions of Great Slave Lake which touch on the park site, Artillery Lake and Walmsley Lake. Even then restrictions on activities may be necessary. Caribou, for example, should not be harassed when swimming.

Overland and oversnow vehicles, particularly those in the category of all terrain vehicles, pose a particular hazard to country of the sort which the new park site encompasses. They would make any portion of the park's open country available to travellers with resultant hazard to the environment both directly through mechanical action of the vehicles, and indirectly through the actions of the persons who drive them. The use of such vehicles should be either prohibited entirely, except for park administrative purposes, or restricted to carefully designated routes. As in the case of aircraft, the possibilities for harassment of animals, particularly by oversnow vehicles, is great.

There may be pressure from Indian hunters, if they are permitted to continue operations within the park, to use internal combustion engines in various sorts of vehicles for transport. Representations to permit this should be stoutly resisted except in the case of outboard motors as outlined and, perhaps, in cases where oversnow vehicles are used for point to point transport along designated routes.

Indian artifacts

In some respects the whole of the proposed park seems to be an archeological site. It has been used by nomadic hunters since time immemorial. W. C. Noble (pers. comm.) of McMaster University has found dozens of classifiable archeological sites on Pike's Portage alone. A sharp-eyed collector can pick up artifacts almost everywhere on the tundra where there is exposed sand or gravel, where campsites might have been located in the past, or where hunters might frequently have travelled. We found projectile points, scrapers, knives, small drilling tools, and other artifacts made of stone. A pinkish or brownish quartzite seemed to be the most common material used. Many of the artifacts which we found had been broken. We also discovered several places where abundant stone flakes showed that artifacts had been made.

National Parks staff would find it impossible to prevent casual travellers from picking up artifacts of the sort which we found. We recommend that the National Parks Branch sponsor immediate, full-scale archeological exploration of the entire area in order to ensure a complete record of its ancient history. The archeological history of the area should be completed before large numbers of tourists are attracted. Following archeological exploration, perhaps an incentive system might be developed which would reward travellers in the park for turning in artifacts, and for providing information regarding their source.

Cemeteries

We noted three small Indian cemeteries in the study area, and there are undoubtedly more. They are worth identifying and preserving.

An Indian cemetery a short distance up Pike's Portage is recent enough so that it is still possible to get data on the people that are buried there. The relationships of some of the Indians who frequent Fort Reliance are interesting and worth recording while it is still possible to do so. We also found a small cemetery on a high cutbank just across the river from the site of the Indian village at old Fort Reliance, and one with a single grave on an esker east from Crystal Island on Artillery Lake.

Indians and hunting

It is understood that commitments may be considered necessary to allow Snowdrift Indians to exercise ancestral rights to hunt, fish and trap in the area of the proposed national park. However, our recommendation is that every alternative be investigated and that all possible restrictions be imposed. We have complete sympathy for native hunters and trappers who have to eke out a tenuous existence living off the land in a harsh environment. However, we also recognize an overriding national interest and feel that the policy of prohibiting consumptive uses of wildlife in national parks should not be subverted if there are alternatives.

In principal it should be possible to look on a small number of hunters, fishermen, and trappers as part of the ecosystem. However, it must be recognized, that as long as they are present birds and mammals will continue to be wary and shy of humans, and some marginal species such as mink, beaver and otter will be in constant danger of local extirpation. Persons bargaining with the Snowdrift Indians might keep the following possibilities in mind.

First, mentioned earlier, few of the people now living at Snowdrift actually have long-established ancestral claims to the park. Many of the Snowdrift people were recently attracted there from the south, east, and west, when the trading post was established. Only a handful of present residents have been using the park on any regular basis except, perhaps, as a place to hunt caribou in the late summer and early autumn. In our opinion bargaining with the Snowdrift people need not be all inclusive, although it might be difficult to establish who has, and who has not, valid claims on the land.

Consideration might also be given to geographical restriction of hunting, fishing, and trapping areas within the park. It would be desirable to restrict such activities to the east side of the Lockhart River and Artillery Lake. Despite the presence of an abandoned Indian village on the west side of Artillery Lake it is our impression that, in historic times, most Indian activity has been to the east. In any event, if the park is to fully meet its potential as an area for the preservation and ecological well-being of the major faunal components of the country there must be an inviolate refuge of the sort that could be provided west of Artillery Lake.

The Indians might be receptive to alternative suggestions. For example, if it is found that relatively few families are involved in traditional usage it might be possible to guarantee them some sort of continuing employment in the park, or to underwrite some reasonable amount of annual transportation so that they could range beyond the park to hunt and trap. The Snowdrift Indians might consider favorably some such proposal as building a road, and maintaining transportation on it, so that they could travel directly from Charlton Bay to the valley of

the Snowdrift River to hunt, fish and trap. After all, the main reason why Pike's Portage and Artillery Lake have been used is because they have provided the only easy access route to the tundra in the whole of the country. If an easier route were provided the Indians might welcome it. It might be worth considering a road from Charlton Bay, eastward to about the vicinity of the Snowdrift River, and then northeastward to the vicinity of the headwaters of the Hanbury River. Such a road would enable the Indians to bypass the park completely, but still obtain the best of hunting, trapping and fishing.

Pollution

Fragile environments are the most easily polluted. Evidence of this is abundant in, and around, the settlement of Fort Reliance. Rubbish of all sorts litters the ground in the vicinity of the old army signal station and the Ministry of Transport establishment. Much solid garbage has already gone into the lake along shorelines of the settlement. In an effort to dispose of garbage, log crib works have been built throughout the bush behind the settlement and have been filled in over the years. There are, of course, many abandoned oil and gas drums.

The clean up and removal of the present burden of accumulated garbage would be expensive. Probably the most practical means for disposing of it would be to load it on barges and haul it to some point where it could be incorporated in a landfill.

It is worth noting that ground water supplies at the settlement are already polluted to the point of uselessness. Over the years there have been many small spills of fuel oil and other petroleum products on

the ground. Some years ago, we were told, a spill of about 10,000 gallons of fuel oil occurred. The rock of which the point is composed is extremely porous and spilled materials have been absorbed. The result is that water taken from wells in the rock now smells and tastes so objectionable that it is used only for bathing, and then reluctantly. Fortunately this condition does not extend to the water of Great Slave Lake and it is there that the settlement will have to look for its future supplies. The Ministry of Transport already has plans to abandon its wells and develop a water supply from the lake.

Eagles and falcons

The more rugged and scenic portions of the park will not only be attractive to tourists but are frequently favoured as nesting habitat by eagles, falcons and the rough-legged hawk. We know of nests of bald eagles and golden eagles on the precipitous cliffs in the east arm of Great Slave Lake and along the picturesque Lockhart River between Artillery Lake and Charlton Bay. Peregrine falcon, gyrfalcon, pigeon hawk and rough-legged hawk (all of which are known nesting birds in the proposed park area) are satisfied with smaller cliffs, large boulders, steep cutbanks or trees (Kuyt, 1962).

The nest habitat, and the behaviour at the nest site, of most of these raptors makes them vulnerable to even unintentional disturbance as a result of human visitation. That disturbance may be out of proportion to the birds' nesting densities due to their habits of nesting at focal points of potential human interest.

Gyrfalcons are early breeders and it is unlikely that tourists will encounter incubating gyrfalcons during the critical season. Rough-legged hawks exhibit violent fluctuation in population numbers and it is unlikely that human disturbance will have a lasting effect on the population. Peregrine falcons, however are the latest nesting species of the arctic raptors, and dates of egg laying in the Thelon River are between June 2 - 28 (Kuyt, in press). Studies have also shown that peregrine falcons on the whole, nest on more accessible cliffs than gyrfalcons. Unfortunately, the peregrine falcon in many parts of its range is now classified as an endangered species, due in part to the incidence of pesticide residues in the bird's tissues.

All tourists must be made aware of the dangers inherent in prolonged visits to raptor nest sites, particularly early in the season. Unless great discretion is used when visits are made the tourist's camera will kill as surely as the firearm.

Mammalian taxonomy

In the section dealing with mammals it has been shown that in many cases the boundaries of taxonomic subdivision, at both specific and sub-specific levels, are shown within the park boundaries on the best available range maps. To a large extent this is, of course, because of inadequate collecting and definition in the past and because the combination of treeline and the east end of Slave Lake make a convenient place for doubtful cartographers to draw lines. Nevertheless the problems are real and should be elucidated as quickly as possible once a firm decision has been made to establish the park.

The most efficient way to deal with most of the small mammals would be through intensive trapping for whatever time is necessary to secure adequate series of skins and skulls for study. Two or three small field parties, of two or three men each, should be able to do a comprehensive job in a single summer.

Some of the larger mammals such as red foxes, or less common animals such as weasels, may have to be collected by park personnel, or through arrangement with local Indian trappers, over longer periods of time.

In some cases it will probably develop that there are no grounds for showing more than one species, or subspecies, in the park. In other cases it will undoubtedly be shown that there either are two or more species or subspecies or that two species or subspecies integrate within the park area. A thorough knowledge of these matters would be scientifically interesting, and would provide the basis for some interesting zoological interpretation for the public.

Bears

As noted earlier, black bears are found throughout the study area and grizzly bears might be found anywhere except, perhaps, on the peninsulas and islands in the east arm of Great Slave Lake. Both species create problems of human safety in the area. For example, both species frequented refuse heaps and dumps of extensive mining exploration operations in the Stark Lake area for several years about 1950. In the summer of 1956, Kelsall examined the remains of a female grizzly bear which had been shot by a trapper about a mile and a half up Pike's

Portage from Great Slave Lake because the bear disputed the right-of-way. During the early summer of 1970 a black bear persistently prowled about, and tried to gain entry into a privately owned cabin on the southwest tip of Fairchild Point. It was finally necessary to destroy the bear. A second black bear visited berry patches in the immediate vicinity of the settlement while we were there, and it was shot by a resident.

Park planners should keep the bear nuisance and attendant danger in mind when considering such things as garbage disposal, and the placement of fish cleaning stands. Bear proof methods of garbage disposal are essential. They offer some challenge to planners in areas where frequent pickup and removal of the garbage to central incinerators may not be possible and where rock substrate will usually inhibit burial. Consideration might be given, in remote areas, of the construction of deep pits with bear proof covers. Wherever the volume of garbage justifies frequent pickup and complete incineration those methods should be used. Tourists and travellers should always be warned that the debris from fish cleaning operations are attractive to bears, and that canoes and boats which smell fishy are frequently damaged or destroyed by the animals.

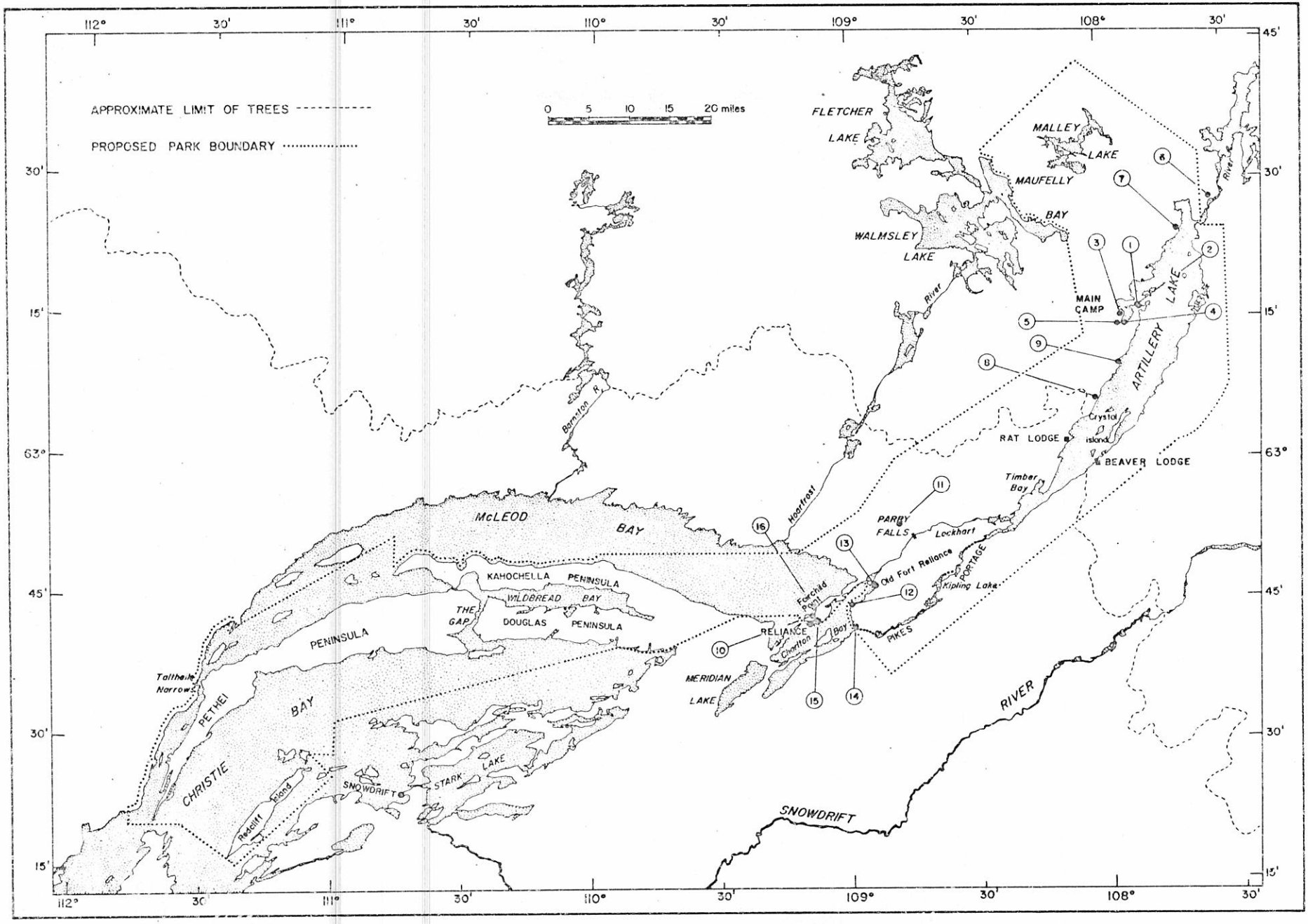
Caribou migration

Barren-ground caribou are probably the most spectacular part of the fauna of the proposed park. In many, perhaps most, years a few caribou will be found in the park site at all times. In some years spring migration will carry all of them north of the park but, even so, they will probably be completely absent only for a period of 5 or 6 weeks around the month of July.

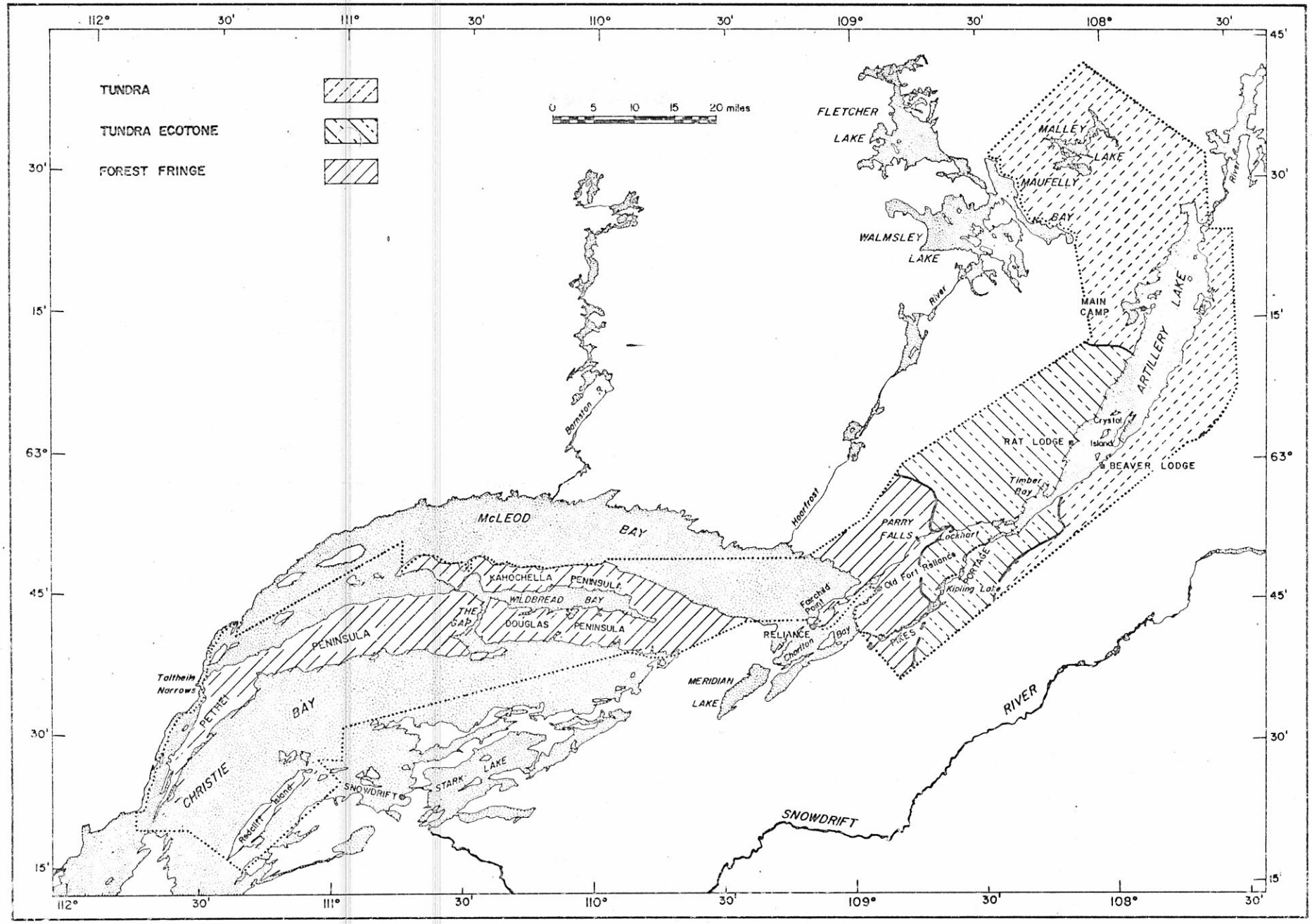
Map 3 shows lines of frequent movement on the part of caribou and the seasons at which they have been noted. In addition to the commonly used late summer, winter, and spring migration routes caribou have been observed to winter at one time or another in almost every portion of the park. They are not apt to spend long periods in winter on the roughest terrain, but they do visit it. They are less frequent on the tundra than they are in the forest in winter. Most frequently the bulk of the migrating herds simply pass through the park to the southwest during migration to winter ranges and return to the northeast towards spring in the following year.

The observation of wintering herds of barren-ground caribou is a unique experience. A low volume but extremely high quality tourist experience could be built about such activities. A few winterized cabins in strategic locations would probably have caribou around them in four or five winters out of ten. For best results, however, mobile camps using large tents and wood stoves are entirely adequate and comfortable provided the people using them are properly dressed and equipped.

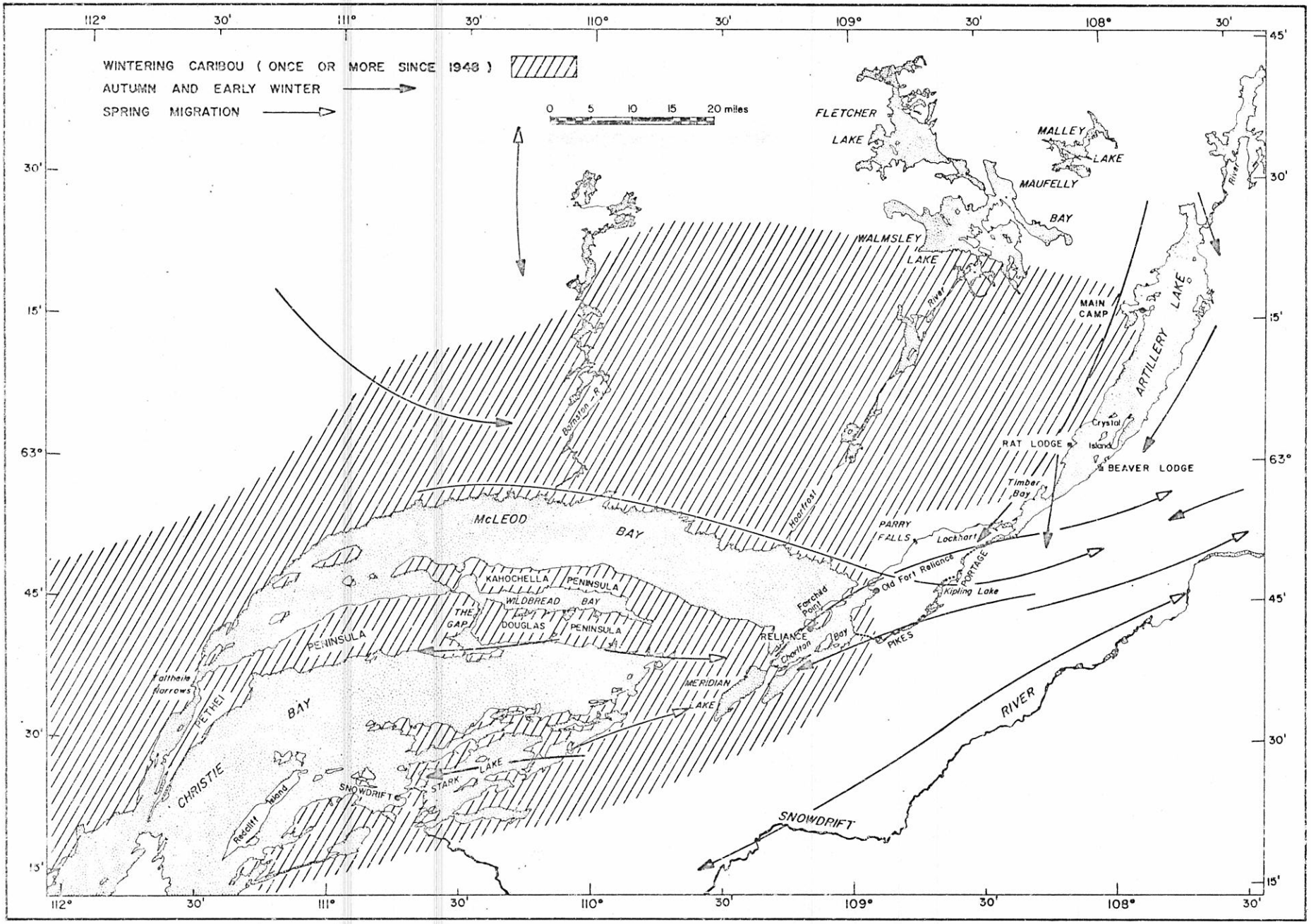
The development of a tourist industry in mid-winter in the Northwest Territories seems an unlikely possibility. However, it should be noted that already a few hardy souls are paying well to accompany residents on traplines and dog team trips, and some of the journeys already made by novices have been extensive and successful.



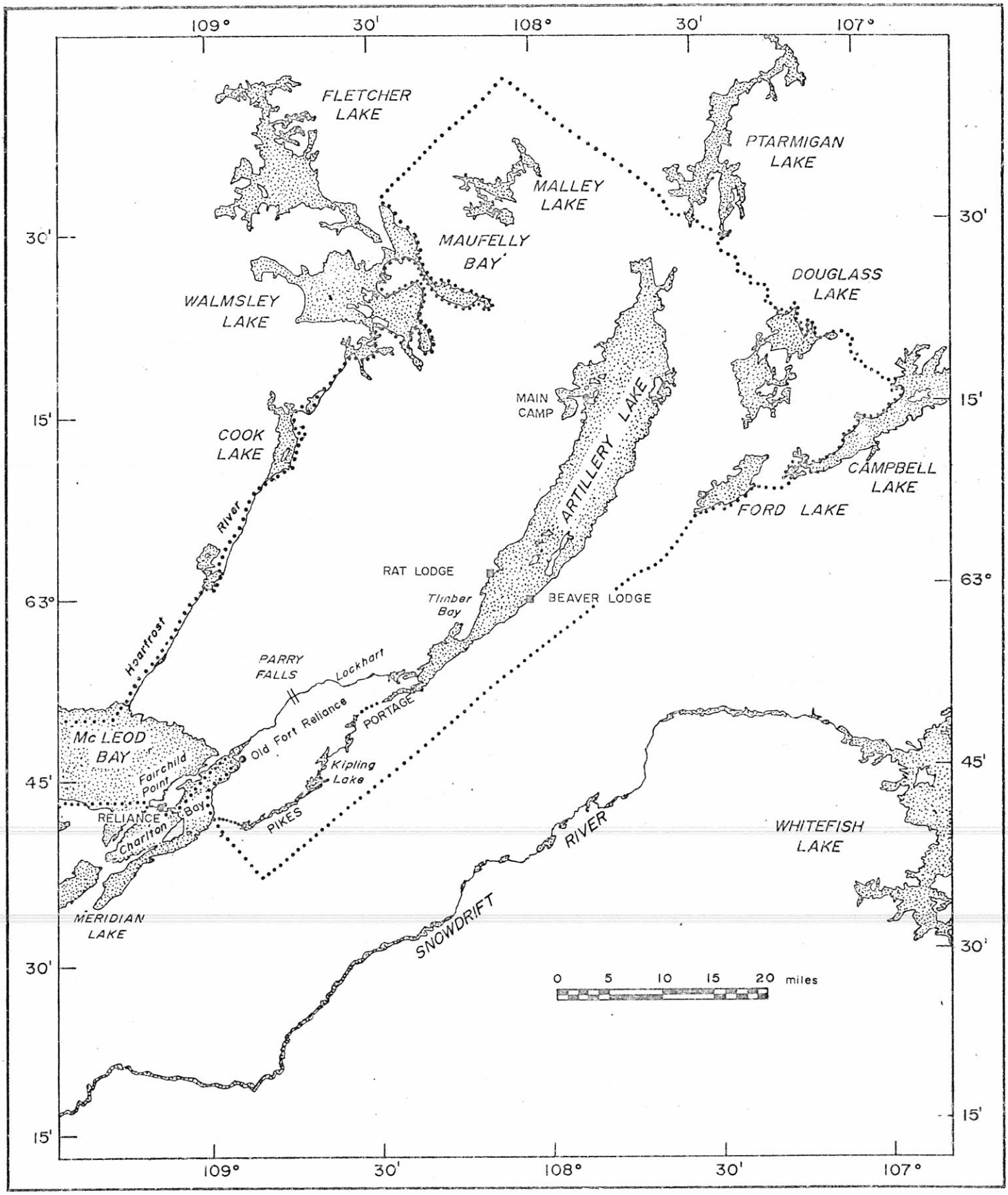
Map 1. Proposed national park. Fish sampling stations are shown by numbered circles.



Map 2. Vegetation zones in the proposed national park.



Map 3. Routes of frequent movement for barren-ground caribou through the proposed national park.



Map 4. Proposed boundary, based on biological considerations, for Artillery Lake area of park site.

Table 1. Climatic normals for temperature (in °F) and precipitation (in inches) for Fort Reliance, N.W.T. Normals shown are averages from the period 1948-60. (Canada Dept. Transport, 1968.)

Temperature and Precipitation	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean daily	-21.4	-17.6	- 4.5	14.3	33.8	46.6	55.2	55.3	43.7	24.0	7.0	-11.6	19.0
Mean daily maximum	-13.9	- 8.6	6.3	25.0	42.3	56.3	64.0	62.5	49.2	32.0	13.6	- 4.0	27.1
Mean daily minimum	-28.9	-26.6	-15.2	3.6	25.2	36.8	46.3	48.0	38.2	22.0	0.3	-19.1	10.9
Maximum	31	43	43	59	74	85	90	86	81	64	44	33	90
Minimum	-60	-57	-58	-35	-24	21	30	34	19	-10	-45	-50	-60
Mean rainfall - inches	0.00	0.00	T	0.02	0.21	0.74	1.10	1.08	0.89	0.28	0.01	T	4.33
Mean snowfall - inches	4.0	4.1	4.0	3.6	2.2	0.2	T	0.0	1.3	7.9	9.4	7.4	44.1
Mean total precip. - inches	0.40	0.41	0.40	0.38	0.43	0.76	1.10	1.08	1.02	1.07	0.95	0.74	8.74
No. days with measurable rain	0	0	0	1	4	5	8	9	8	3	0	0	38
No. days with measurable snow	9	8	8	7	4	1			2	9	13	12	73
No. days with measurable precip.	9	8	8	7	7	6	8	9	9	11	13	12	107
Max. precip. in 24 hrs. - inches	0.31	0.25	0.30	0.66	0.38	1.50	1.57	1.35	0.85	0.66	0.45	0.78	1.57

RECOMMENDATIONS

1. The completion of archaeological studies should have high priority in the proposed park, since artifacts and other evidence of early man are often exposed and vulnerable to vandalism.

2. The recent history of the modern Snowdrift and Fort Reliance Indians should be gathered quickly while "old timers" are still available to talk to.

3. The preservation and restoration of two abandoned Indian villages and several trappers cabins should be considered.

4. Several small cemetaries should be identified, and their history gathered.

5. The recent history of white settlement and activity in all fields (trapping, fishing, mining exploration, government field work) should be systematically gathered without delay.

6. The remains of old Fort Reliance should be preserved and consideration given to a program of restoration.

7. Studies of the invertebrate fauna should be encouraged once a park is established since the field is largely unexplored.

8. The limnology of the proposed park, and especially of some high, isolated lakes on the peninsulas, is worth early and systematic study as there may be special values involved.

9. The definition of bird ranges and phenology should be pursued with the objective of producing a comprehensive listing.

10. Raptorial birds are worth special study and protection.

11. The theoretical presence of some mammal species needs investigation and the limits of some small mammals known to be present need definite study.

12. The problem of specific and/or subspecific identification of some mammals and their ranges is urgent and includes masked shrew, red-backed mouse, collared lemming, wolf, colored fox, grizzly bear and Richardson's weasel.

13. Bears, now a nuisance, will become increasingly so, and dangerous, unless garbage disposal is handled cleanly and frequently, preferably by high temperature incineration.

14. Wintering and migrating herds of barren-ground caribou, the most spectacular part of the fauna of the park, might form a basis for attracting winter visitors.

15. The reintroduction of muskoxen should have consideration once a park is established.

16. The proposed boundaries of the park, on the tundra, are inadequate for the maintenance of home ranges, or denning ranges of mammals such as fox, wolverine, wolf and bears, and the boundaries should be extended.

17. The lower Lockhart River, truly spectacular, should be included within park boundaries unless its destruction for water power can be shown to be most urgently required by overriding national interests.

18. The Fort Reliance sand plain, and some other areas are fragile, high value features worthy of particularly careful treatment.

19. Hiking, cross-country skiing, and canoeing, and the development of minimally required facilities to foster those activities, should have high priority in the new park. Traditional routes, particularly, should be maintained.

20. Travellers in the proposed park must be much restricted in consumptive use of environmental components - particularly fragile vegetative associations. don't cut trees ?

21. Roads, airstrips and similar construction should be planned with great care and sources of sand and gravel for such work should be located and identified at the outset.

22. Consideration should be given to establishing an airstrip, and re-establishing the meteorological station, outside the park.

23. The use of mechanical methods of transportation should be strictly regulated and restricted primarily to that required for necessary park administration, to use of outboard motors on certain large

waters, and to use of low-flying aircraft between particular and limited points of development.

24. Every alternative to the continued use of the park by indigenous hunters and trappers should be investigated and all possible restrictions imposed if the complete exclusion of such activities is not possible.

25. The employment of local Indian people should have high priority, as a possible alternative to continued hunting rights in the park, and they could engage in road, trail and building construction, wood cutting and hauling, guiding by dogsled and canoe, consulting on restoration of native villages and cemetaries, and patrol duties.

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