WILDLIFE HABITAT - MACKENZIE VALLEY AND NORTHERN YUKON

An Inventory of Wildlife Habitat of the Mackenzie Valley and the Northern Yukon.

Prepared by the

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12. ATLASES* (in 7 separate volumes):

12.1 Atlas of Arctic Fox Habitat Maps (7 maps + descriptions)

12.2 Atlas of Beaver and Muskrat Habitat

* A limited number of these atlases are available for purchase from the Canadian Wildlife Service, Western Region, 1110 - 10025 Jasper Avenue, Edmonton, Alberta T5J 1S6.

Maps (30 maps + descriptions)

12.3 Atlas of Caribou Range Maps
(25 maps + descriptions)

12.4 Atlas of Porcupine Caribou
Herd Movement Maps (22 maps + description
of herd)

12.5 Atlas of Dall Sheep and Grizzly Bear
Habitat Maps (25 maps + descriptions)

12.6 Atlas of Moose Habitat Maps
(33 maps + descriptions)

12.7 Atlas of Waterfowl Habitat Maps
(33 maps + descriptions)

1. GENERAL SUMMARY

In late 1971, the Canadian Wildlife Service Special Habitat Evaluation Group began an extensive, preliminary inventory, which included wildlife assessments on large areas within, and adjacent to proposed gas and oil pipeline corridors in Canada's Western Arctic. (Note: The term "corridor" is used in this report for convenience to represent the general location of possible pipeline routes, but it is recognized that no corridor per se has yet been recognized or approved.) The inventory was timely, as plans for development of the North became headline news, and details of wildlife populations were for the most part little known.

The wildlife species included for study were selected primarily on the basis of social values and feasibility of short-term inventory, with some consideration directed to the susceptibility of the species to disturbance and some to esthetic values. Animals represented in the mapping series are: Caribou, Moose, Arctic Fox, Dall Sheep, Grizzly Bear, Beaver, Muskrat, and Waterfowl.

It is to be noted that the aim of the study has been a habitat inventory and not an inventory of wildlife populations. Because of the vastness of the area, the seasonal movements of various species, the natural fluctuations in populations numbers, and observation difficulties, a successful population inventory would not have been feasible in one calendar year. The ultimate goal has therefore been the production of a series of maps defining relative importance of landscape or habitat units. This series is a prerequisite to an assessment of potential problems related to any major developments.

1.1 Moose

Moose are widespread throughout the Mackenzie River Valley and northern Yukon. They are severely restricted in winter, however, to three main land forms. These are, in order of importance, river valleys, wetland complexes and upland slopes. The class ratings of areas depend primarily on the food species and the amount of shelter present. The importance of areas, on the other hand, depends on the quality and quantity of habitat, the abundance of animals and the location of the area (See Section 5.1.2).

Class 1 areas are primarily found in river valleys. Not only are they very important, but, because they are somewhat restrictive in winter, the high moose populations usually found in them are extremely vulnerable. Development of any kind in or around most of these areas will inevitably lead to a population reduction.

Class 2 areas are more diversified in habitat types. The Class 2 areas in river valleys may be rated almost as critical as Class 1 areas. In other situations, however, they tend to be larger and more dependent on disturbances. In these cases, they are not so critical.

Class 3 areas are also important in the river valley sites, where they are usually confined to a narrow band of riparian vegetation. The importance of Class 3 areas is more dependent on location than quality. This class becomes much more critical to moose in isolated and northern areas, especially along the Arctic Coast. Although they occur in very low numbers, moose there are entirely dependent in winter on the narrow riparian growths on the banks of streams winding through barren tundra. The other habitat types in this class, uplands and wetland complexes, are not often critical because they usually occur in large blocks, and the suitable habitat and moose populations are usually widespread.

Moose are very dependent on habitat disturbance for their existence. Flooding along fast-flowing mountain rivers and fires create almost all the available habitat, especially in the southern portion of the study area. In the north the shallow active layer over the permafrost limits the growth of browse species to along the river channels. In this case the habitat would appear to be held permanently in an early seral stage.

Interference with moose populations can be alleviated to a great extent through proper route selection. Avoidance of major wintering areas and important travel routes will provide the best solution. Problems resulting after construction from public pressures are unavoidable, and will require wise management programs.

1.2 Caribou

There are three sub-species of caribou found in Northern Canada - the woodland caribou, *Rangifer tarandus caribou*, the barren-ground caribou, *Rangifer tarandus groenlandicus*, and the reindeer, *Rangifer tarandus sibiricus*.

All three sub-species are located on the study area. Woodland caribou, probably the most widespread, are year-round residents. They can be found on both sides of the Mackenzie River as far north as the treeline on the east side, and to Arctic Red River on the west. There are two major groups of barren-ground caribou involved. One group, known as the Bluenose herd, is found east of the Mackenzie River and does not usually come into the Valley during its seasonal movements. The other important group, the Porcupine herd, has been termed the "International Herd" since its yearly movements involve parts of northeastern Alaska as well as the northern half of the Yukon. This caribou herd traditionally moves north and northwest into Alaska every spring. Basic routes are used in their spring migration and variations of these routes are followed in their fall southward migration. Wintering areas which have been used by the Porcupine herd vary from tundra plains on the Arctic Coast to the extremely mountainous areas south of the Peel River.

The remaining caribou may be barren-ground caribou, woodland caribou, feral reindeer or a mixture of sub-species. They apparently summer just south of the Eskimo Lakes and winter around and to the north and east of Travaillant Lake.

It has been possible to define four particular areas which seem to hold special significance for migratory caribou: staging areas, calving areas, mineral licks, and river crossings.

Movements and chronology of movements have been documented in detail for the Porcupine herd but not for the other groups and sub-species. All observations have indicated the variability and unpredictability of caribou movements. Much more data are needed on distribution, abundance, and movement behavior before accurate predictions can be made on impact.

Taking the variability of migration chronology and movement patterns into account, there are several possibilities for catastrophic pipeline effects on caribou. Obstruction and disruption of migratory behavior, particularly in spring, aircraft harassment, increased hunting pressures, noise disturbance from compressor stations, and deflection of migratory movements along berms or right-of-ways must all be considered definite possibilities. Once the exact routing of the pipeline is known, preventive measures that are now being studied should reduce most of these problems.

1.3 Dall Sheep

All Dall sheep habitat is situated west of the Mackenzie River. Habitat quality is not unduly limited as might be expected in more northerly latitudes.

The most important sections of Dall sheep range are wintering areas, lambing areas, and mineral licks. Winter range is considered the mcst important habitat and sheep are often concentrated on these ranges. Little is known about the location and characteristics of lambing areas. Ewes are known to favor very rugged habitat, and occasionally concentrate during the lambing period. Sheep, especially ewes and lambs, tend to concentrate around mineral licks, sometimes in large numbers, during the spring and summer.

Four major populations of Dall sheep occur in the study area: the Nahanni, Ram, Yohin-Liard group; the Mackenzie Mountains group; the Richardson Mountains group; and the British Mountains group.

Dall sheep are very susceptible to disturbance. Since sheep are concentrated in favorable areas in winter, and may concentrate around mineral licks and in lambing areas, these areas become much more critical.

It is unlikely that sheep will directly suffer from loss of habitat. Indirect disturbances, such as aircraft disturbance, excessive noise, fill and rock removal, and human activity are likely to be much greater problems. To keep the impact on sheep at a minimum, these factors must be closely controlled.

1.4 Grizzly Bear

Grizzly bear distribution along the pipeline corridor varies from almost nil in some southern sections to high densities in the northern and mountainous regions. Distribution and abundance of grizzly bear seems to depend more on availability of food than on specific habitat types. Information collected in the northern Yukon suggests that adult male bears have a very large home range, and appear to follow the migrating barren-ground caribou. Landform, topography, vegetative type and apparent food sources were considered in delineating and describing grizzly bear habitat.

Den sites are an important factor in considering grizzly bear habitat, and records indicate long-term use of individual dens. Disturbance or elimination of denning sites could have a drastic effect on the bear population in some locations. The amount of bear disturbance and the occurrence of man-bear interaction will probably increase as construction programs move into habitat supporting higher numbers of grizzlies. Adequate precautions and contingency plans should greatly reduce the probability of problems developing.

1.5 Arctic Fox

Arctic fox range is restricted to the arctic tundra regions of the study area. The main criterion used in assessing arctic fox habitat was the relative density of maternal dens on potential fox range.

The greatest concentration of arctic fox dens was found in the Herschel Island map area. Dens occurred on a variety of sites including sand dunes, frost heaves, and on the brims of river, lake, and stream banks. Nearly all den sites were in a position to command a good view of the surrounding area, and all were near fresh water.

Foxes prefer to den in areas of fine, well-sorted silt, sand or gravel. Extraction of granular material for pipeline construction could result in habitat degradation by reduction of denning sites. High density denning areas, such as those on the Herschel Island mapsheet, would be particularly vulnerable. This is especially so, as it is known that dens are used for long periods of time.

Harassment by aircraft, heavy equipment or explosives could result in females abandoning their young. Therefore, caution should be exercised in the area of dens during the whelping and denning period from mid-May to early September. Arctic foxes often scavenge during winter periods and are easily drawn to raw garbage. During the winter, hungry foxes show little fear of man, and will most certainly be attracted to camps situated in the area. This is not desirable, as foxes are known carriers of rabies.

1.6 Beaver and Muskrat

The most extensive areas of better quality beaver and muskrat habitat occur in the deltaic complex of the lower Mackenzie River and the thermokarst lakes within glacial lacustrine basins along the Ramparts River west of Fort Good

Hope, the Brackett River northeast of Fort Norman, MacKay Creek south of Fort Norman, and west of the Mackenzie River at Camsell Bend.

Lakes of the Old Crow Flats and several less extensive basins along the Porcupine River provide very favorable muskrat habitat but are of only minor importance to beaver. Drumlinized till deposits, between Fort McPherson and Martin House, provide a combination of drainage confinement and shoreline stability that beaver prefer for dam construction.

In the more southern regions, good beaver habitat is found within stream systems on the gently sloping flanks of several large plateaus. Very extensive organic overburden in the headwaters and excellent deciduous shrub cover along the meandering mainstem channels contribute to the overall value of these systems. Harris Creek north of Fort Simpson, the south fork of the Martin River and the Matou River near Sibbeston Lake, and the unnamed stream emptying into the northwest side of Trout Lake, all fall within the above category.

Two other areas of good quality beaver habitat worthy of mention are the Tetcela River, occupying a broad U-shaped intermontane basin on the west side of the Sibbeston Lake mapsheet and the deltaic region on the lower Kakisa River.

The relative value of muskrat and beaver habitat within the study area is dependant on a variety of physical and vegetational features. These features are a reflection of interacting and continuing geomorphic processes. Predicting changes in habitat which could be precipitated by construction activity necessarily implies a knowledge of both direct and indirect influences of such activity. The former may be readily quantified, within the construction zone, in terms of pond and lake basins drained, streams diverted etc. The latter, often involving much more subtle but widespread changes, cannot be readily quantified, or predicted, through preliminary habitat evaluation programs. For the present, a brief and speculative summary is included to relate probable activities to specific habitat types. The magnitude and overall implications of habitat alteration must be considered on an individual basis at each point of intersection on given construction routes.

1.7 Waterfowl

Waterfowl inhabit northern regions annually from May through September.

The Mackenzie River, including islands, is a most important and critical spring migration pathway whereon tens of thousands of geese, ducks, and swans congregate, moving gradually northward with signs of breakup. On arrival at their destinations, pairs disperse to breed on the countless lakes, ponds, and streams of boreal and tundra regions. In mid-summer, moulting flocks of flightless adult birds congregate along coastal and large inland waters. With approach of fall, small and large concentrations of waterfowl prepare for the long flight southward. The most spectacular concentrations form on the North Slope and estuarine areas off the Mackenzie Delta where several hundred thousand birds, mostly snow geese, condition themselves until freeze-up when they leave.

Many complexities of wetland habitats are related to quality, reflected in utilization by breeding waterfowl . In this inventory, emphasis has been placed on categorizing habitats and tabulating an assessment of the relative importance to the waterfowl. Extensive areas of notably good waterfowl habitat are: the Old Crow Flats, the Mackenzie Delta, the Tuktoyaktuk Peninsula and the dense wetlands adjacent to the Kakisa River. Other less extensive areas are equally, if not more, important on a per/acre basis, especially basins situated in alluvial sediments on floodplains and deltas. Generally, however, the northern wetlands are predominantly of low quality.

Construction influences related to waterfowl and wetland habitats are expected to be: loss and degradation of habitat; disturbance to waterfowl; and a potential localized over-harvest from hunting. The magnitude of environmental alteration on localized areas must be ascertained at points of intersection of construction routes and waterfowl habitat. To accommcdate these requirements, this inventory will be most valuable. Further additional studies are now in progress.

1.8 Rare and Endangered Species - Raptors

The raptors referred to in this report are the peregrine falcon, gyrfalccn, osprey, bald eagle and golden eagle. Although all five species are not equally rare or endangered, they may all be influenced by the construction of a pipeline. The construction phase of the proposed pipeline should not seriously affect raptors in general; however, it will contribute to the ever-increasing reduction of their numbers. Since raptors are wilderness species, the area actually affected by pipeline construction may be much greater than that in the immediate vicinity of the line. Nesting sites as far away as 1 or 2 miles or more cn each side of any construction activity, including camps, airports, haul roads, blasting, etc., may be influenced. All nest sites along the proposed route have not yet been located, so the actual number of raptors that will be involved is not kncwn.

Although construction disturbance will likely be temporary, its effects may be permanent. At least twc of the raptor species, the peregrine falcon and bald eagle, are known to be declining. Once displaced from traditional nesting sites, there is nc assurance that they will return.

The anticipated increased human pressures will also extend the area that will be affected. The effect of human presence and activities on raptors varies with season. Disturbance during the establishment of territories in early April or May, during the egg-laying and incubation period from May to June, and during the flightless period of the young from June to August may lead to abandonment or destruction of the nest and young. The threat of illegal egg collecting, irresponsible shooting of young and adult raptors and the robbing of young from nests for falconry will accompany increased human access and activity associated with the construction and operation of the pipeline.

The increased introduction of pollutants and chemicals into the northern environment could seriously affect raptors.

In summary, raptors are very sensitive to disturbance and have the potential of becoming the wildlife species most seriously affected by northern development. Careful selection of route and associated development location can keep the influence of pipeline construction at a minimum.

1.9 Rare and Endangered Species - Polar Bears

Polar bear conflicts are expected with pipeline activities. They are known to occur within the study area along the coast of the Beaufort Sea from west of Herschel Island, Y.T. to Baillie Island, N.W.T. Polar bears tend to concentrate near these islands because the open leads that occur in the offshore ice during the winter and spring are used by seals. Evidence indicates a shift away from Herschel Island since activity has taken place there in 1972.

Excessive noise from vehicular activity during the winter period is likely to be disruptive to coastal wildlife, particularly polar bears. The storage of fuel near the edge of the sea also raises a considerable threat to the marine ecosystem.

The outcome of man-polar bear encounters is extremely unpredictable. Many polar bears have little fear of man. Every attempt should be made to avoid attracting bears to camps or work areas and contingency plans must be ready if the bears do appear.

2. INTRODUCTION

Wildlife, although a simple word, encompasses a large variety of animals, of which each species has its own distinctive life cycle and habitat requirements. It is difficult to imagine a greater contrast than that between the sedentary beaver, living in its own small aquatic habitat, and the migratory birds, travelling thousands of miles twice a year to reach their nesting sites in the Arctic and to return to their wintering areas far south of the Canadian border. Equally great contrasts exist between the solitary grizzly bears, with territories of hundreds of square miles, and the dense herds of barren-ground caribou, which at certain concentration points, travel shoulder to shoulder in tens of thousands. And yet, beneath these obvious differences there is a common bond, the joint use of the same huge ecosystem, which unifies these animals. Beaver and waterfowl, although their life cycles are very different, occupy the same aquatic habitats; grizzly bear and barren-ground caribou have a relationship of predator to prey as well as occupying the same biotype.

The land is as equally complex as the wildlife it supports, and within the study area several major land systems exist. In the northwest, the coastal zone of the Arctic Ocean is prominent. The low, shelving coast grades gently into the undulating hills of the North Slope. Offshore, gravel and sandbars, sheltered bays and lagoons are common. South from the coastal zone, the hills of the North Slope, treeless and of a gently rolling nature, merge with the slopes of the British Mountains, with their steep valleys containing swift flowing rivers and streams. Still farther south, the dense wetland formations of the Old Crow Flats form a unique landscape feature.

The valley of the Mackenzie River is far from uniform. Distinctive features of interest in our assessment include its delta - by far the largest river delta in the Canadian Arctic - supporting, because of its dynamic hydrological regime and its fertile silt, a productive array of plant and animal life. The Delta alone is some 5,000 square miles in area, a mosaic of estuarine flats, levees, river channels, marshes, meadows and lakes. Other distinctive features of the River, as one proceeds south, are its many islands, densely covered with white spruce and willow, the large, numerous lakes of the floodplain, and the abrupt escarpments marking the valley edges. Farther south the riverbanks form unstable slopes, and important tributaries add their flow to the system. Changes in vegetation become apparent; low spruces, willows and birches in scattered groups on the poorly drained soils give way to dense stands of greater height in the valleys, and the bare uplands are increasingly encroached upon by the rather monotonous forests of the Boreal Forest Zone.

2.1 General Nature and Scope of Study

At the start of the project, in December 1971, it was realized that only one calendar year was available to complete a certain stage of the investigations. In view of the limited time, the paucity of relevant existing information, and past experience with mapping projects of large areas such as the Canada Land Inventory, it was decided to embark upon a mapping project of wildlife habitat. As a consequence, the main part of this report consists of a series of maps or 'Atlases' showing wildlife habitat units for a single species, or for a group of species combined. In general, four classes of habitat quality are shown. It is difficult to give a general description of "quality". The class ratings are based on the capability to produce wildlife, the present habitat conditions and the presence of animals; but the weight of these criteria differs with the rating systems used for the various species of wildlife.

It should be pointed out that the goal of the study is a habitat inventory, and not an inventory of wildlife populations. Due to the vastness of the area, the seasonal movements of certain animals and the difficulty to observe animals masked by a cover of vegetation, a population inventory would have been impossible to carry out successfully in such a short period. The Canadian Wildlife Service formed a Special Habitat Evaluation Group in December 1971, consisting of seventeen new employees. This group consisted of four teams, each of which was charged with a certain responsibility. At the start, the four teams were as follows:

<u>Arctic Fox, Grizzly Bear and Dall Sheep</u>

R. Glasrud[1], Biologist
J. Nolan, B. Goski, G. Wilde [1], technicians

<u>Beaver and Muskrat</u>

M. Dennington, Biologist
B. Johnson, H. Stelfox, C. Paley [1], technicians

---

[1]left during 1972

Moose, Caribou, and Raptors

W. Prescott, Biologist
G. Erickson, D. Smith, L. Walton, S. Harrison, [2] technicians

Waterfowl

H. Poston, Biologist
A. Doberstein, S. Barber, technicians

Porcupine herd of Barren-ground Caribou

E. de Bock, Biologist (under contract)

Rare and Endangered Species - Polar Bear

Dr. Ian Stirling (advisor)

Technical Advisor and Coordinator

G. Watson

Other workers gave valuable advice and although it is not possible to name each individual, we would like to thank Dr. T. Barry, V. Hawley, Dr. A. Pearson, E. Telfer, R. Fyfe, R. Nowosad and personnel of Renewable Resources Consulting Services Ltd., L.G.L. Ltd. Environmental Research Associates, Williams Bros. Ltd., Inter-disciplinary Systems Ltd., and last but not least, the residents of the communities within the study area who gave us valuable advice and assistance. The drafting, atlas lay-out and art work was capably undertaken by B. Chubb.

2.2 The Objectives of the Study

The objectives of the study were:

a) to construct a map series of a scale of 1:250,000 showing habitat units for the following species:

Moose
Caribou, cther than the Porcupine herd
Dall sheep and Grizzly bear
Arctic fox
Beaver and Muskrat
Waterfowl

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[2] transferred during 1972

b) to map, on the same scale, the movements of the Porcupine herd of barren-ground caribou.
c) to present information on rare and endangered species such as falcons and polar bears.
d) to forecast, on the basis of present knowledge and with the best judgement available, the possible effects of pipeline construction on wildlife and wildlife habitat.

2.3 The General Relationships to Pipeline Development

The general relationships of the study to concerns about pipeline development are direct. The wildlife habitat map series shows units of habitat, and by plotting the proposed pipeline routes, identification of areas of possible conflict can be made. However, it is not possible, on the basis of present knowledge, to gauge with accuracy the degree of effect such pipeline construction would have on wildlife and its habitat.

2.4 Organization of the Report

This report consists of two main sections:

a) a general section

b) a specialized section containing habitat maps and accompanying descriptions for each species or species group in booklet form called Atlases.

3. STUDY AREA

Any final pipeline route or transportation corridor will occupy a very small land area in terms of the North. It was necessary, however, to include a wide belt of terrain in order to be prepared for any variations from the originally proposed route and to identify important wildlife habitat units which might be affected by the construction of a pipeline and its aftermath, even though they may be miles away from the actual construction sites.

Complete mapsheets at a scale of 1:250,000 were used as base maps. A total of 33 mapsheets were designated as containing part of the proposed pipeline route or those that could be influenced by the pipeline or construction of the pipeline. The gecgraphical area covered by this study occupies approximately 151,000 square miles.

The number of maps investigated depended on the species and their range; e.g. arctic fox were found only along the Arctic coast; only seven mapsheets were used.

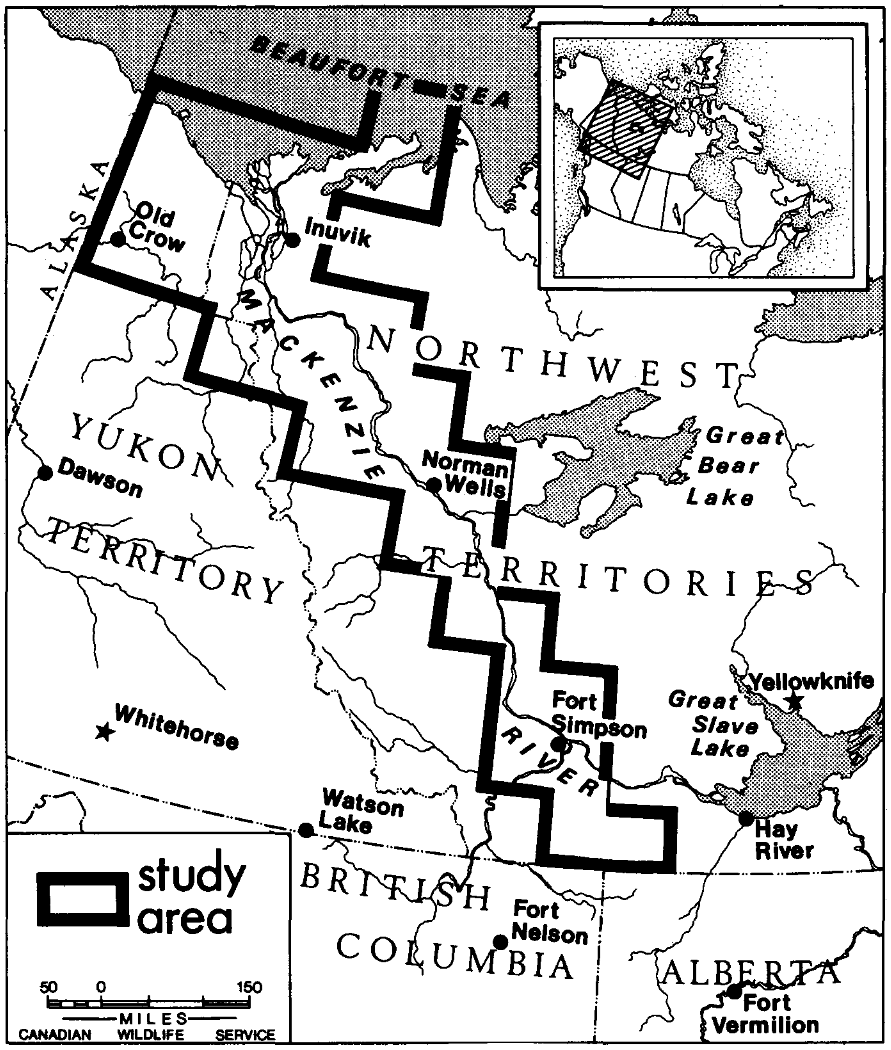

Figure 1. The area of inventory.

4. GENERAL METHODS

Considerations of the vast area included for study, combined with a one-year time constraint, demanded habitat classification systems general enough to allow evaluation by use of aerial photos and geological and forest cover maps, yet specific enough to facilitate identification of the components serving to limit or enhance any given wildlife habitat type. The former requirement was met through initial grouping of generically related landforms and/or associated wetlands; the latter through aerial surveys of habitat and associated wildlife populations.

4.1 Accumulation of Available Information

Initial preparation of the inventory began with a specific literature review, and compilation of existing reports.

Valuable insight was gained from lectures, and discussions with Canadian Wildlife Service personnel experienced in northern biological research. Dr. A. Pearson, Dr. T. Barry, Dr. N. Simmons, V. Hawley, Dr. J. Kelsall, R. Fyfe and E. Telfer all contributed information and ideas beneficial to the study. The factors to be considered became clearer due to this background research.

The Arctic Ecology Series supplied general species distribution material which assisted in identification of knowledge gaps. Similarly, the recently published Arctic Land Use Information Series, CWS reports, and miscellaneous publications were reviewed. For most species, only general data were available.

We are most grateful to the Northwest Project Study Group and Gas Arctic Systems for supplying preliminary and interim reports of 1971 field studies on northern wildlife.

4.2 Aerial Photo Interpretation and Unit Mapping

Using all available information on landforms, surficial geology, and vegetation, basic homogeneous land or wetland habitat units were outlined on 1:250,000 NTS topographic base maps. Primarily, aerial photographs and topographic maps were utilized, but use was also made of surficial geology data provided by the Geological Survey of Canada and forest classification provided by Forest Management Institute whenever available.

Each habitat unit was numbered for reference. It must be assumed that gradient zones exist between habitat classes, and delineation lines are only approximate.

4.3 Field Surveys and Data Collection

Ski-wheel-and float-equipped Cessna-185 aircraft were used for most survey flights. Bell-206 helicopters were used for low-level surveys in rugged mountainous terrain, and for surveys requiring ground inspections not available from fixed-wing aircraft. A De Havilland Beaver, STOL equipped Cessna-185 and a Piper Aztec C were used occasionally. The De Havilland Beaver and Piper Aztec C were found to be generally unsatisfactory for survey work. The De Havilland Beaver was excessively noisy and had poor visibility while the Piper Aztec C was too fast and had poor visibility. Both models of Cessna and the Bell-206 possessed the desired range, manoeuverability and visibility.

Almost all observation flights undertaken at speeds of 90-110 miles per hour and altitudes of 100 to 500 feet, were carried out with a pilot and a 2-man crew. One man acted as the observer and the other as a navigator. Both pilot and navigator could usually find time to make observations. The navigator would call out checkpoints at intervals and the observer would then describe the habitat or wildlife species numbers. Every effort was made to obtain unbiased visual information on all designated habitat units. The in-flight data were recorded on Sony (TC-40) cassette tape recorders. Each observation of mammals, birds, or animal sign was plotted as a numbered checkpoint on 1:250,000 topographic maps. Data were transcribed from tape records to notes.

To accompany the verbal field observations, a large number of 35 mm. slides were taken for later reference and comparison.

4.4 Analysis and Final Mapping

Data accumulated in the previous stages were gathered together and analysed. The preliminary unit boundaries on the 1:250,000 NTS base maps were adjusted, then the units were classified into a 4-class system taking all the data obtained into account. An explanation of the classification criteria has been included in this report and the Atlases.

The Atlases, one for each species group, contain general descriptions of mapsheet features and more detailed map narratives for each mapsheet. The narratives describe the habitat units or types used by that particular species.

5. RESULTS

5.1 Moose

5.1.1 Introduction

Moose were known to be found throughout the Mackenzie River system. They form an important food source for the native people and their hides are used for clothing, etc. Although a considerable amount was known about their general distribution, little was known or recorded about specific areas. It was this specific information that was necessary to determine the effects of pipeline construction.

The main objective of the 1972 field season was to carry out an inventory of moose habitat along a possible gas pipeline corridor that would run along the Mackenzie River valley from the Alberta - N.W.T. border to the Mackenzie Delta and through the Northern Yukon to the Alaska border. This inventory would allow the classification of land or habitat map units, using a 4-class system. Although habitat mapping was the prime objective, present moose distribution would also be determined. The ultimate goal was to produce a set of maps that would indicate critical and sensitive areas and allow an assessment of potential problems related to pipeline construction.

Since moose are restricted or tend to concentrate in "favorable" areas in the winter, it was our initial intention to gain more information on these areas of concentration. It would be in these areas that moose would be most affected by any disturbance. If moose concentrate to the same extent that some southern studies have indicated, disturbance in wintering areas could adversely affect the moose population of the surrounding area as well. We began this survey with three basic presumptions:

1. moose are capable of inhabiting all types of available habitat at various times of the year,

2. moose concentrate in favorable areas in winter,

3. these "favorable" areas will be most sensitive to disturbance.

5.1.2 Methods

The mapping and data gathering was undertaken in four overlapping "stages". These were as follows:

1. Aerial Photo Interpretation and Land Unit Mapping

Using all available information on landform, surficial geology and vegetation, basic homogeneous land or habitat units were outlined on the 1:250,000 topographic base maps. Each habitat unit was numbered for reference and a basic data sheet was compiled on each.

2. Moose Range Aerial Surveys - Winter

Aerial reconnaissance flights using fixed-wing aircraft were carried out to obtain the data necessary to determine preliminary habitat classification of the land units. All information obtained was recorded on data description sheets. When animals or tracks were observed, detailed descriptions of the habitat in their immediate vicinity were also recorded.

The winter reconnaissance surveys were begun February 1, 1972 and were completed by April 30, 1972. Due to fluctuations in manpower and weather conditions it was not possible to survey some areas during the winter. Data for these areas were obtained later in the summer.

3. Moose Range Aerial Surveys - Summer

The winter surveys were followed up by summer observation flights to areas with insufficient or no data. Although habitat descriptions were the prime objective of the summer flights, observations on spring - summer dispersal and distribution were also made. The same techniques as used in the winter surveys were used during the summer.

4. Final Map Preparation

The data obtained in the previously described stages were gathered together and analyzed. All unit boundaries were checked and revised. All units were then classified in a 4-class system taking all the data obtained into account.

The Four-Class System used is as follows:

Class 1 - Good combinations of shelter and food species, especially willow, are present, with the food species at the proper successional stage to provide and maintain abundant food supplies. Landform and vegetation combine to provide good quality shelter from the Arctic winds. There usually was considerable evidence of animals present. Relatively few obvious limitations were present other than those applicable to the whole region such as short growing season and extreme temperatures.

Class 2 - Fair combinations of shelter and food species occur with some obvious additional limitations, e.g. poor selection of food species and exposure to wind - through lack of adequate shelter, etc. Moose populations can still be high but are usually more spread out.

Class 3 - Generally poor combinations of shelter and food species are present in these areas, sometimes with a lack of shelter altogether. Food species can vary from sparse and/or patchy, to very abundant. The former situation is usually accompanied by an over-abundance of shelter and the latter by little or no shelter. Moose numbers are usually relatively low and the animals are more spread out.

Very small areas of Class 1 or 2 habitat have been combined and placed in Class 3. Their small size and their ability to support only small numbers of moose reduce their ability to support only small numbers of moose reduce their relative importance. Some areas of unrealized potential are also placed in this class, e.g. the Mackenzie Delta.

Class 4 - Areas having insignificant or nil moose habitat are placed in this class. Known and potential summer range have also been placed in this class.

Maps have been prepared using the above classification. These are accompanied by a general description of the mapsheet area and a detailed description of each habitat unit.

5.1.3 Results and Discussion

The habitat classification maps and accompanying descriptions are included in 'Atlas - Moose'.

From the beginning it became obvious that the winter range of moose was considerably more restricted than was previously indicated. In fact, throughout most of the study area the actual land area utilized by moose during the winter was so proportionately small, especially to the north, that it takes on a much more critical nature.

During the winter 1971-1972, above average snowfalls occurred, forcing moose to utilize the most favorable wintering areas available. At no time however, did the recorded snow depths exceed the limits established in southern studies that would severely restrict moose movements. The covering of food sources, low shrubs, etc., normally available in summer apparently forced the animals to concentrate in areas where abundant food supplies were available above the snow. This was generally in three habitat types; along river or stream valleys, around lake margins or in 5 to 50-year-old burns on upland sites.

The value of these types is dependent on the production of riparian and/or early successional vegetation such as willows, birch, and alder. Frequent flooding and ice-scouring action maintain the riparian vegetation, and fires play an important role in maintaining the important early stage of succession on most upland sites. The instability of some valley sides contributes to the maintenance of seral vegetation in some areas, especially those facing south.

Fires play a significant role in the creation of moose habitat. Except for floodplain areas, almost all present moose habitat has been the result of fire. The time of year and the intensity of the fire, as well as the qualities of the soils, interact in the determination of the type of regeneration. Burns that regenerate primarily in deciduous shrubs are very important to moose and are frequently used both winter and summer. The predominant climax stage of black spruce - lichen is not suited for moose and is usually avoided.

Beavers play a minor role in creating moose habitat. The building of ponds and the cutting of poplar, aspen, birch and willow help to re-establish the low and high shrub layer. The resulting small food patches amongst otherwise mature forest provide ideal winter habitat. This situation usually occurs along smaller slow-moving streams and is more common in the southern part of the study area.

Habitat Types

River valleys can be separated into two types. The first, (a) consists of slow-moving streams and rivers which usually have broad valleys. The stream may be meandering or linear but must be subject to frequent flooding or other disturbance to be attractive to moose. Flooding, often assisted by fire, maintains the riparian vegetation along the banks and oxbows. In areas of permafrost, the active layer goes much deeper along rivers. Species like poplar, aspen and white spruce most often grow under these conditions, with the latter being the common climax. The amount of deciduous shrubs such as willow and alder that occur depends on the extent of recent disturbance. The second, (b) consists of faster flowing rivers which usually have deep, narrow valleys, a braided channel and a flat floodplain. Annual flooding and ice action keeps the vegetation on the floodplain at an early successional stage. These valleys quite often have a typical arrangement of vegetation. There may be no vegetation on the many exposed gravel bars in the stream itself, while on the shore, and on some of the larger more stable gravel bars, willow and alder thrive. The active layer is deep and moisture is plentiful. The pH of the water is not usually as acid as in the slower moving streams. On the more stable areas flooded but not often damaged by ice or water, stands of poplar occur, usually bounded by white spruce. Fires rarely influence this type of habitat because of the steep valley walls, the abundant moisture, and the braided nature of the streambed often breaking the vegetation into isolated islands. The steep sides of the valley often contribute to food production, for, unless they are pure bedrock, they are usually unstable and readily eroded, providing a favorable base for the establishment of early successional shrubs.

Wetland complexes are areas or units containing many lakes and ponds. There are many varieties of wetland complexes - some poorly drained and some better drained types, such as flat lowland, hilly upland, acid bog and sedge-marsh types. Moose prefer those wetland complexes that have a rich deciduous shrub component. Shrubby shorelines generally occur around relatively well-drained sedge-marsh lakes. The shrub component is maintained by frequent flooding or by fires. The vegetation around the lakes quite often resembles that along the braided fast-flowing streams described above, consisting of deciduous shrub, poplar and white spruce. The surrounding upland vegetation, if favorable, adds to the significance of the complex - the better drained the upland the more deciduous species occur. Emergent aquatic vegetation is often utilized in late winter. Equisetum and sedges are also dug up and eaten. The lakes and ponds are also used during the summer for feeding, when aquatics are plentiful, and for cooling or relief from flies.

Upland sites are sometimes used by moose for wintering although this type is not commonly preferred. Upland wintering areas almost always occur on a slope, and are the result of fires. Being on a slope they are relatively well-drained, favoring regeneration to deciduous species, willow, alder, birch and sometimes poplar. These areas are frequently cut by many small streams which are quite often an important component of the winter habitat. In flatter areas the vegetation in the stream vicinity, being on a more moist site, tends not to burn as readily, leaving islands of mature vegetation. On steeper slopes the streams are often deeply eroded, again providing refugia from fires. These islands of vegetation or small vegetated valleys provide important shelter from the Arctic winds that would be particularly severe in an otherwise open upland burn.

Table 1 gives a breakdown of the various habitat units into types and classes, both burned and unburned, as well as giving a comparison between habitat to the north of Fort Good Hope and that to the south.

Class 1 areas are the most critical for moose and are most susceptible to any form of human disturbance. Most Class 1 areas are found in river valley situations and they are highly dependent on the riparian features of the vegetation. Less than a third have been influenced by fires. Since moose are often confined within these areas by topographic features in winter, they can become very vulnerable. The high populations that now winter in most of these areas may be the entire population from a surrounding region 5 to 10 times as large as the wintering area itself. It is extremely important that development of any kind be restricted in these Class 1 areas or their immediate vicinity since disturbance could be almost as destructive as habitat loss.

Class 2 areas are more diversified in habitat types. Fast-flowing, braided river valleys are the most common. In most cases these are similar to Class 1 areas but are usually smaller with less extensive riparian components. Being smaller and more restrictive, they may be rated as important locally to moose survival as any Class 1 areas, although less productive.

The valleys of slow-moving meandering type streams and wetland complexes are also important Class 2 habitat types. They too are largely dependent on the riparian vegetation for their importance but water level fluctuations are not the only prime factor in their creation. Fires have influenced a majority of these types and extensive areas of deciduous regeneration have resulted. The fire influence is usually temporary and the non-riparian components are unlikely to remain at the optimum successional level for any long period.

Table 1. Distribution of habitat units over various landforms

Habitat Types	River Valleys				Lake Complexes		Uplands and Slopes	
	Meandering		Braided					
	Burned	Unburned	Burned	Unburned	Burned	Unburned	Burned	Unburned
Classes								
*North								
Class 1	-	2	-	2	-	-	-	-
Class 2	1	8	-	17	2	2	-	-
Class 3	44	2	25	-	7	3	2	2
*South								
Class 1	9	10	2	13	2	-	-	-
Class 2	9	1	1	16	8	2	9	1
Class 3	35	26	29	3	15	24	19	45
Total Area								
Class 1	9	12	2	15	2	-	-	-
Class 2	10	9	1	33	10	4	9	1
Class 3	79	30	54	3	22	27	21	47

*North refers to those mapsheet areas north and west of Fort Good Hope and Ontaratue River.
South refers to the remainder of the study area.

Upland Class 2 sites are almost exclusively the result of fires. Slightly sloping, better drained areas tend to regenerate deciduous shrubs and trees, particularly along small drainages. Again the optimum successional stage is not long lasting and the importance of these areas is usually temporary. More permanency occurs on mountainous and northern sites where the influence of higher elevations and more severe climate keeps vegetation in the shrub stage considerably longer.

The majority of Class 3 areas are found along slow-moving meandering streams. Although heavily influenced by fires, the importance of most of these areas is due to small strips of riparian vegetation along the streams. Fires enlarge or rejuvenate this strip but on the whole are relatively ineffective at enhancing the quality. Many valleys associated with fast-moving braided streams have also been classed as Class 3. Most of these occur in mountainous areas and are Class 3 because of lack of shelter species. They tend to be composed of small strips of favorable food species, mostly willow and alder, in an otherwise open tundra or alpine situation.

Wetland complexes and upland sites also contribute a large portion of the Class 3 areas. Most are affected by fires. Many of the fires are old and the areas are now in a sub-climax stage of mature deciduous or mixed forest cover particularly on the hilltops and the better drained areas. The shrub component is abundant in the scattered openings in this type and near any water bodies or streams. Such areas usually occur in considerably larger blocks than most other classes and types, e.g. the Mackenzie Delta, the Old Crow Flats, the Ramparts Flats.

The importance of the Class 3 areas depends more on the location than the quality. Even low quality habitat becomes extremely important if it is the only available habitat for many miles around. This applies to the river valleys along the Arctic coast. They provide year-round habitat to only a small number of animals but any destruction of habitat or disturbance in these areas, especially in winter, could result in extirpating moose locally.

Distribution

Moose are found throughout the study area, being more abundant and widespread in the south but occurring right to the Arctic coast. Moose are seen during the summer in almost every type of habitat from stream bottom to mountain top. They are, however, somewhat more restricted in the northern tundra and are seldom seen very far from the riparian vegetation along the streams and rivers either in winter or summer.

The river valleys and associated floodplains provide the best year-round habitat available, although they are particularly important in winter. The islands in the Mackenzie River, for example, are heavily utilized in the winter. The broad willow flats found there are maintained at the optimum successional stage by frequent flooding and ice action. The river valley itself provides some shelter and nearby dense stands of conifers are available should better shelter be required.

The optimum sections of the Mackenzie, as described above, generally occur downstream from the mouths of major tributaries. Between these sections, the black spruce upland extends to the edges of the steep banks. The river is usually narrow and islands are absent. Flood damage often is minimal under these circumstances and the riparian vegetation favored by moose is generally not present.

The fast-flowing actively meandering or braided streams and rivers on the west side of the Mackenzie also provide optimum winter habitat. The annual torrents of meltwater and ice scour the banks and floodplains, keeping the riparian vegetation continually replaced. Often these areas are heavily utilized year-round except during the spring flood period. They are especially important in the north. The lack of shelter in the tundra permafrost regions has lowered the relative value and classification of valleys in those regions but their importance actually increases because of the absence of alternative sites.

Rivers on the east side of the Mackenzie River and in the south of the study area do not drain mountainous areas. They are slower flowing and are often associated with poorly drained upland boggy situations. Disturbance from the rivers, i.e. flooding, etc., is usually minimal. Their value is increased by fires depending on the existing drainage conditions. Better drained areas that have been burned usually regenerate with deciduous trees and shrubs, while poorer drained bogs often fail to regenerate or come back slowly with scattered and stunted black spruce.

The value of upland sites to moose is also dependent on fires and drainage patterns. The better drained upland sites quite often regenerate to birch, poplar or pine. Almost all upland sites useful to moose are the result of fires. Many were classed as unburned in Table 1 because they were presently in a sub-climax stage of mature deciduous or pine forest. Very often the openness of such stands result in some tolerant shrub species being available. The significant upland sites, none of which were rated Class 1, are more common south of the continuous permafrost regions. Only four marginal upland areas were found in the continuous permafrost zone north of Fort Good Hope.

The majority of the useful wetland complexes were also found in the south. They are most often related to major drainage systems although some occur in isolated upland areas. Only two are classed as Class 1 and both are the result of fire disturbance. The majority of the wetlands are marginal because of the relatively small shrub component. They are important, however, because of the large area many cover, and the large portion of the moose population they support.

5.1.4 Conclusions

Moose are widespread throughout the Mackenzie River Valley and northern Yukon. They are severely restricted in winter, however, to three main habitat types. These are, in order of importance, river valleys, wetland complexes, and upland slopes. The classification of an area depends primarily on the food species and the amount of shelter present. The importance of an area, on the other hand, depends on the quality and quantity of habitat, the abundance of animals and the location of the area.

Class 1 areas are primarily found in river valleys. Not only are they very important but, because they are restrictive, the high moose populations found in them are extremely vulnerable. Development of any kind in or around most of these areas will inevitably lead to a population reduction.

Class 2 areas are more diversified in habitat types. The Class 2 areas in river valleys may be rated almost as critical as Class 1 areas. In other situations, however, they tend to be larger and more dependent on disturbances. In these cases, they are not so critical.

Class 3 areas are also important in the river valley sites where they are usually confined to the narrow band of riparian vegetation. The importance of Class 3 areas is more dependent on location than quality. This class becomes much more critical to moose in isolated and northern areas, especially along the arctic coast. Although they occur in very low numbers, the moose there are entirely dependent in winter on the narrow riparian bands winding through barren tundra. The other habitat types in this class, uplands and wetland complexes, are not often critical because they usually occur in large blocks and the suitable habitat and moose populations are usually widespread.

Moose are very dependent on habitat disturbance for their existance. Flooding along fast-flowing mountain rivers and fires create almost all the available habitat, especially in the southern portion of the study area. In the north, the shallow active layer over the permafrost limits the growth of browse species to along the river channels. In this case the habitat would appear to be held permanently in an early seral stage.

5.1.5 General Implications and Recommendations

5.1.5.1 Implications

There are three main areas of concern for moose which would result from the construction of a gas pipeline from Alaska up the Mackenzie Valley to Alberta. These are:

a) habitat alteration, both destruction and enhancement,
b) obstruction or disruption of normal activity and movement behavior, and,
c) increased human pressures.

a. Habitat Alteration

Destruction of moose habitat could vary from the crossing of a moose wintering area at right angles by the pipeline right-of-way to the establishment of a 5,000 man camp, a large borrow pit or a 5,000 foot airstrip in the center of such an area. Since moose may be restricted in winter to a small portion of their summer range, major destruction within this area could severely reduce or eliminate a local population. It is assumed the proposed pipeline right-of-way will be 100 to 120 feet wide. This may represent a considerable portion of some habitat types. If the pipeline right-of-way follows one side of a stream valley through a moose wintering area for some distance it could effectively reduce the available habitat in that area and potentially reduce the local moose population by half or more.

The removal of gravel could also provide considerable impact on moose. In some places, gravel sources will be borrow pits and in others stream bottoms will be the only source. Borrow pits may not be located in areas presently heavily utilized by moose. The location of a borrow pit in a wintering area would probably destroy some habitat. Removal of gravel from stream bottoms could have much more disastrous effects. Riparian vegetation normally growing in these situations is extremely important to wintering moose. Willows, alders and poplars are commonly found here and are all important moose foods. Stripping gravel from the stream bottoms usually means the removal of any vegetation. Quite likely, all the available gravel would be removed. The replacement of gravel and re-establishment of the riparian vegetation could take a very long time, possibly forever, depending on the changes effected in the river course and bed.

It is unlikely that airstrips will be located in areas heavily used by moose, but if they are, the large area required will severely influence moose. The noise of the aircraft and asscciated human activity would have additive indirect effects.

Generally, direct destruction of habitat can be fairly accurately predicted and eliminated or reduced substantially in the planning stages. Also, effects may be tempcrary if related just to the construction stage.

Re-establishment in the disturbed area depends on the type and level of continuing disturbance associated with the operation and maintenance stages, as well as the rate and extent of revegetation of the disturbed area. Since vegetation growth would have to be controlled along the right-of-way to facilitate surveillance and maintenance, this area would likely remain lost to moose as habitat. The use of herbicides for this purpose would have questionable effects on a browse-eating species like moose. The revegetation of excavated, disturbed and gravelled areas will result in increased forage production. This may have mixed effects on mcose.

As a positive value, revegetation will increase, at least temporarily, the available summer forage. The plants, mostly grasses, will be fertilized to improve growth, and establishment will provide a greatly increased quantity and quality of nutrients.

The availability of fertilized green forage might attract animals closer to human habitation or access. The animals then become much more vulnerable to hunters and vehicle collisons, especially if a road is associated with the pipeline.

Unseasonal availability of fertilized green forage may also result in a delay in the necessary adaptive changes in the micro-organism complex of these ruminants which enable the animal to utilize the highly fibrous winter forage.

b. Obstruction of Normal Behavior Patterns

Although moose are not considered migratory, they have been found to undergo seasonal movements of a moderately extensive nature (Edwards, et al, 1956). Any above ground portions of a 48-inch pipeline would provide a definite barrier to moose movement. Even partial obstructicn would reduce efficient utilization of their habitat and would perhaps isolate necessary components of their range. Both these effects would mean a reduction in moose numbers.

A buried pipeline or a road would probably have only a minor direct effect, if any, individually, but the two combined could very likely have an additive effect. The two would provide not only a physical barrier but, due to the presence of vehicles and hunters on the road, any crossing by animals would be further discouraged.

So far, moose have not been documented as moving any distances in the Mackenzie Valley. However, the populations wintering on the islands undoubtedly move on and off these islands from the surrounding area, since no moose were recorded on them during summer investigations.

There are fewer available wintering areas on the east side of the Mackenzie than on the west side. It seems reasonable to speculate that it is primarily the moose summering on the east side that move to the main valley and the islands in the Mackenzie to winter. If this is so, then the animals must cross the area of the proposed pipeline at least twice each year. Interruption of this movement could have considerable local effects.

Data collected so far in the northern Yukon indicate that in this area there might be movements of considerable proportions taking place seasonally. With the observations of large fluctuations in moose numbers on the Old Crow Flats over the year, a movement onto the Flats in summer and then back in to the surrounding river valleys, particularly in the mountains to the north, in winter, seems likely. The broad river valleys of the Firth River and tributaries of the Porcupine and Old Crow rivers hold relatively large numbers of moose in winter. Fortunately, if this is the pattern of movement that does take place, neither of the presently proposed pipeline alternatives in the northern Yukon should interfere to any great extent.

Other factors that might influence movements are: the presence of odors of the pipe itself, of escaping gases, or from compressing machinery; the presence of sounds of compressor stations, camps, vehicles and blasting, the presence and use of winter haul roads from the Mackenzie River to the construction sites and snow accumulation caused by drifting along the pipeline right-of-way or berm or by plowing on adjacent roads. The plowed area may also be utilized as a movement corridor. This should not be harmful unless vehicle traffic is common along the road or animals are led away from traditional travel routes. Vehicle traffic can in itself discourage movement. If the animals are attracted to the haul roads by revegetation practices or by plowed areas, particularly in winters of deep snow, collisions may become a problem. In areas where gravel is scarce or lacking and revegetation is not effective in insulating the disturbed surface, the disturbed area might melt, forming an impassible moat in the summer. This has commonly occurred on some seismic operations over continuous permafrost, especially in already marshy areas.

The open ditch during construction could provide an effective trap. Normal associated construction activity should keep moose away, but in thickly wooded areas moose may suddenly appear and try to jump the 6 to 8 foot ditch. Adults may make it but calves certainly could not. Animals falling into the ditch would be killed or injured or, if not, would provide the difficult problem of getting them out.

Disturbances associated with pipeline construction, operation and maintenance activities such as increased human activity, the operation of heavy construction equipment, blasting and the use of all-terrain vehicles and low-flying aircraft, especially helicopters, could all disrupt normal behavior patterns, greatly increase physiological stress and force animals from their normal activity areas. Assuming the surrounding area is at capacity, then a reduction in local populations could result.

Fortunately most of these disturbances would only be related to the construction phase and are short-term, but the use of low-flying aircraft will undoubtedly continue during the operation and maintenance stages. Aircraft, particularly heliccpters, are extremely disturbing to moose. The process of getting closer for picture-taking or hazing although only for short periods, may have severe consequences on animals already under the extreme stresses of an Arctic winter. An animal chased for even short distances at -30° to -50° F., can very easily develop pulmonary emphysema which may lead to pneumonia and death. Death may not occur until weeks later. Running an animal for only 20 minutes may be enough to double the daily energy requirement, putting additional pressure on the habitat (Geist, 1971). Any additional stress on pregnant cows, particularly late in the winter, could mean loss of the calf or calves. There is also the possibility that an animal pursued by an aircraft could very easily, during its panicky flight, severely injure itself on obstacles, such as the sharp crusts of the snow. Fortunately moose are solitary animals and the effects of this disturbance are usually very local, but moose wintering in the more open northern situations, along the North Slope, for example, cculd be seriously affected since they are more conspicuous and are normally under more severe physiological stress. As the number of industrial and private aircraft increases in the north this problem will increase.

The use of all-terrain vehicles, snowmobiles, bombadiers, and hovercraft should have little impact if used strictly for the work of construction or maintenance. It is the unrestricted use for recreation that could have serious effects. Their impact is much like that described for aircraft.

The construction and maintenance of roads and airstrips accompanying the pipeline, as well as the increased use of all-terrain vehicles and aircraft, poses probably one of the greatest problems of all for moose. Increased access will lead to greatly increased hunting pressure, particularly along the pipeline route and accompanying roads and airstrips and around settlements and camps. If moose do move seasonally to and from wintering areas, they would become more vulnerable to hunters when they cross roads and the pipeline rights-of-way. Moose may learn to avoid these moose-hunter encounters by avoiding the road. Thus the combination of road and pipeline might not in themselves obstruct movement, but the addition of hunters could very well be enough to at least reduce moose movement across them. This would have the effect of maintaining the disturbance factor of the pipeline long after construction would have ceased.

c. Increased Human Pressures

The expected increase in human population will have two major effects: increased encroachment into critical winter habitat by settlements, development, etc., and increased hunting pressure by residents and non-residents.

The tremendous number of workers that will be employed on pipeline construction (some predictions are as high as 15,000) will undoubtedly have some influence on the surrounding wildlife populations. Pipeline workers will or can be closely controlled (firearms will be restricted, etc.) at least on the job, and they will be unlikely to have much free time. Expanding local populations will undoubtedly create a substantial increase in the high hunting pressure that now exists. Already large areas of low or nil moose populations exist in potentially good habitat around many northern communities, particularly those with large native populations. These "moose vacuums" will grow as the hunting population grows, and as the better methods of travel, for example, snowmobiles, aircraft and automobiles, become more readily available. The areas most influenced now will feel even greater pressure and the more remote areas will become more accessible. Non-resident hunting, at present exerting low pressure, will undoubtedly increase greatly as access increases. The native population presents the greatest problems. Most natives depend heavily on wild meat for winter food and they apply greatest hunting pressures when the moose are most vulnerable. Fortunately the use of dogs is not as popular as in the past and the requirement of wild meat as dog food has lessened considerably. The trend away from trapping, and relocation in and dependance on the settlements has likely reduced hunting pressures in some places, but hunting pressures have increased around the settlements as a result.

Not only will the local wildlife populations be in danger from increased access leading to increased hunting pressure, but any hunting along or near the pipeline could lead to indirect or accidental damage to the pipeline itself. Exposed valves and other equipment as well as the line itself could well pose the same type of target as power pole insulators do in the south.

Increased human populations will likely result in more man-caused wildfires. Fires have varying results on different wildlife populations and in different circumstances. For moose, the result is generally an improvement in habitat, at least in the 5 to 30 years following the fire. Moose prefer at least part of their range in an early successional stage when it provides the large amounts of deciduous browse species that moose require to survive. In fact, it is possible that the widespread occurrence of fires could have been responsible for, or at least hastened, the northern extension in moose range.

It should also be noted that the potential increase in the number of fires would lead to more intensive fire suppression efforts. This would definitely be required along the pipeline itself and near settlements because of the danger to installations and human life. Just what type of a balance between the occurrence and control of fires is desirable will require careful thought and much more investigation. Increased fire suppression will likely lead to a reduction in available moose habitat and consequently a reduction in population.

Although the magnitude of the problem of pollutants and chemicals is difficult to predict, loss of habitat will inevitably result from their misuse. Some potential pollutants are: sulfur dioxide from the exhaust gas, pump lubricants, flushing fluids, herbicides and pesticides. Research is underway on some aspects of these possible side effects for northern areas.

The use of herbicides to maintain the pipeline right-of-way and pesticides to control insects around camps should be strictly controlled. The breakdown rate of any chemical would be much slower in the cold arctic environment and the effects of these chemicals on animal systems under the stresses of an arctic winter could be much greater than further south. Extreme caution should be taken in introducing any such chemicals into the arctic ecosystem.

5.1.5.2 Recommendations

a. Habitat Destruction or Alteration

General route selection can alleviate most of the impact of the pipeline construction itself. There are very few important moose wintering areas located along the presently proposed pipeline route on the east side of the Mackenzie River. The few areas that are involved, mostly located along the tributaries of the Mackenzie River, will be crossed at right angles, destroying or altering very little of the areas.

The effects of indirect habitat destruction caused by the location of facilities like haul roads, airstrips, gravel pits and construction camps will vary with different locations. In general, haul roads should not be located along river valleys since most wildlife winter activity is located there. Nct only would the more important wildlife habitat be saved but animal-vehicle contacts would be fewer and many ercsion problems alleviated, if valley locations were avoided.

The removal of gravel from streams and river valleys could effectively remove the riparian vegetation so necessary and attractive to moose. Revegetation would probably be slow in the northern climate. As little gravel as possible should be taken from streams, and if taken, the location should be carefully selected. The large gravel pads, many roads and other habitat alterations resulting from the location of the extremely large constructicn camps envisioned, means that locations must be carefully selected. Miscalculations could have disastrous local ecological effects.

The reaction of moose to revegetation attempts cannot be predicted. Careful monitoring of the situation will be necessary so that if it proves to have a negative value, correctional measures can be immediately undertaken. Experiments with revegetation species that are not attractive to ungulates should be undertaken.

b. Obstruction of Movements

Knowledge on the behavior of moose following alteration in habitat is very limited and there is insufficient research done to enable reliable recommendations to be made on any adaptions in design of the pipeline to overcome any problem should it occur. Stipulations restricting times of construction may be required if this becomes an important problem. Hunting may have to be controlled in problem areas, possibly by establishing a no-hunting zone alcng the pipeline right-of-way during movement periods.

As to the effects of the other factors involved - odors, sounds, differential snow accumulation, winter haul roads, location of gravel sources and location of campsites - a better knowledge of moose behavior and distribution is needed. It can be predicted that should any of these factors or their location prove disturbing, the local moose population will be reduced.

Attempts will be made to document distribution and movement patterns in potential problem areas in 1973. Recommendations will be made at the time on methods to alleviate any specific problems that may develop.

The effects of low-flying aircraft are not so difficult to foresee but will be difficult to control. To reduce this problem, all attempts to prevent flying lower than 500 feet above the ground should be made, particularly during the winter and spring periods. Not only should personnel be informed that harassing wildlife is illegal but the physical and physiological damage that could occur to the animal should be stressed. Using an aircraft to hunt is illegal, except for transportation to the hunting area. The companies involved can and should be enforcing these types of restrictions and held responsible for any violations.

c. Increased Human Pressures

Problems involved with increased human pressures can only be solved by greater monitoring of the situation and the implementation and enforcement of more restrictive game regulations when and if they are needed. A good program of public education on wildlife conservation in the Northwest Territories would help tremendously.

Although potential problems can be anticipated from southern experience it will be necessary to identify and study each. More life history research is needed. Information such as annual production, normal carrying capacity of the range, age composition of the herd and normal mortality is required before adequate management policies can be formulated.

Once new regulations and management plans are proposed, much effort must be placed on enforcing them. An increased staff of enforcement personnel will be needed.

The principal impact on moose will be from increased access as a result of pipeline construction, accompanying roads and the increasing local human population. It may become necessary to restrict hunting and/or all vehicle traffic in vulnerable areas.

5.1.5.3 Conclusions

Although the pipeline right-of-way will mainly be chosen to meet engineering and construction requirements it must also be chosen to serve the greatest possible combination of interests of the public and the environment. Interference with moose populations can be alleviated to a great extent through proper route selection. Avoidance of major wintering areas and important travel routes will provide the best solution. Problems resulting after construction from public pressures are unavoidable and will require wise management programs to control. Moose are one of the most important wildlife species economically and socially in the north. With proper precautions it can remain so.

Table 2. A summary of the expected effects upon moose of the activities associated with the construction of a gas pipeline.

Activity	Potential Effects	Magnitude
Pipeline right-of-way	Direct destruction of wintering habitat	Light
Location of camps	Direct loss of wintering habitat	Light
Removal of sand and gravel along streams	The removal of riparian vegetation reduces the quality of mose moose wintering areas and therefore the carrying capacity	Severe
Increased fires	The immediate loss of wintering habitat. Long-term results often favorable to moose	Severe
Berms and road grades	- These may create travel lanes changing movement direction during seasonal movements	Light
	- Snow may drift beside elevated roads or berms (or may be plowed up) obstructing movements	Light
Noise-creating activities - construction vehicles, blasting, etc.	Animals may be forced into less favorable habitat by disturbance	Light
Reclamation procedures	Moose may be attracted to these areas where they are more vulnerable and away from traditional habitat	Light
Ditching	Animals may be diverted from normal movement patterns or may fall in	Light
Harassment from any source	In mid-winter the daily energy expenditure of the harassed animals may exceed the energy present in the total forage available, thus placing the animal in a negative energy balance. If this is compensated for in increased food consumption by the animals there would be an overall increase in pressures of animals on their food resources with a reduction in carrying capacity of the habitat.	Severe

Table 2. Cont'd.

Activity	Potential Effects	Magnitude
Aircraft use on pipeline project	Although moose can be disturbed by aircraft at any time during the year, disturbance would be particularly serious at calving time or in winter when the animals might be pressed by food shortages.	Moderate
Human Activity	Most wild animals avoid humans, therefore they may be forced into inferior habitat	Light
	Increased access to important wintering areas may increase the harvest of moose beyond the amount desirable.	Moderate

5.2 CARIBOU

5.2.1 Caribou other than the Porcupine herd

5.2.1.1 Introduction

There are two and possibly three sub-species of caribou to be found in the vicinity of the proposed gas pipeline route along the Mackenzie Valley. Woodland caribou, *Rangifer tarandus caribou*[3], and barren-ground caribou, *Rangifer tarandus groenlandicus*[3], are the species of major concern. The third sub-species is reindeer, *Rangifer tarandus sibiricus*[3], escaped over the years from the Canada Reindeer Project. The barren-ground caribou of the Porcupine herd (also *Rangifer tarandus groenlandicus*) are not included in this section of the report since they are reported on separately.

The woodland caribou is the most widespread of the sub-species within the Mackenzie River Valley. These animals are found from the Alberta border to just south of Inuvik along both sides of the Mackenzie River.

Most of the barren-ground caribou, other than the Porcupine herd, belong to what is collectively called the Bluenose herd. They were named after a large lake in the vicinity of their summer range. Estimates of this herd range widely from 20,000 to 150,000 animals. The range in estimates is undoubtedly due to the variety in survey efforts and techniques involved and the vast winter range available and used by this group.

The third sub-species, suspected to be in large part escaped reindeer or offspring of escaped reindeer, number from 1,000 to 2,000 animals and range between the Husky Lakes in summer and the Travaillant Lake - Iroquois River area in winter.

Because of the difficulty in separating groups and sub-species, especially from an aircraft, and the multi-species approach of the investigational team, all animals observed were classed as caribou. There was also no attempt made at obtaining numbers of animals involved.

The main objectives of this program were to determine

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[3]Classification follows Banfield 1962, and Hall and Kelson 1959.

the present distribution of caribou, to map and describe their range, and to assess the potential impact on the caribou and their habitat of the construction of an underground gas pipeline.

5.2.1.2 Study Area

The Porcupine Caribou herd that ranges throughout the northern Yukon is reported on in detail in the following section (5.2.2). Excluding the area occupied by this herd, a total of 25 mapsheets bordering the Mackenzie itself are included in the study area. No part of the Yukon is included.

5.2.1.3 Methods

The mapping and data gathering were undertaken in four overlapping "stages". These were as follows:

1. Aerial Photo Interpretation and Land Unit Mapping

Using all available information on landform, surficial geology and vegetation, basic homogenous land or habitat units were outlined on the 1:250,000 topographic base maps.

Each habitat unit was numbered for references and a basic data sheet was compiled on each.

2. Aerial Range Surveys - Winter

Aerial reconnaissance flights using fixed-wing aircraft were carried out to obtain the data necessary to determine caribou winter distribution in the land units. Every effort was made to obtain unbiased visual information on all designated habitat units. All information obtained was recorded on data description sheets.

The winter reconnaissance surveys were begun February 1, 1972 and were completed by April 30, 1972. Due to fluctuations in manpower and weather conditions, it was not possible to survey some areas during the winter and most areas were only surveyed once.

3. Aerial Range Surveys - Summer

The winter surveys were followed up by summer observation flights to areas with insufficient or no data. Although habitat descriptions were the prime objective of the summer flights, observations on spring-summer dispersal and distribution were alsc made. The same techniques as used in the winter surveys were used during the summer.

4. Final Map Preparation

All the data obtained were gathered together and analysed. The areas in which large numbers of caribou and tracks occurred were noted as heavy use areas. Since caribou wander widely and variably, descriptions of the lard units in which caribou and caribou tracks were observed were taken as suitable caribou habitat and the range boundary was extended to take in similar adjacent habitat. This, in conjunction with any recorded historical data, formed the basis for the delineation of caribou range.

5.2.1.4 Results and Discussion

The habitat range maps and accompanying descriptions are included in Atlas 3.

As previously stated, no attempt was made to distinguish the three sub-species of caribou that may have been involved in the study area surveys. However, some preliminary observations were obtained that are subject to verification by further study:

1. There was no evidence of movement across that section of the Mackenzie River within the study area. Kelsall (1968) observed limited numbers crossing from the east to the west bank at Fort Norman in the winter of 1950-51. The river should not present an insurmountable physical barrier except during the spring flood. It is frozen in winter, and caribou could swim it easily in summer.

2. All three sub-species are located on the study area. The woodland caribou, probably the most widespread, are year-round residents, although some localized movements take place. They can be found on both sides of the Mackenzie River as far north as the treeline on the east side, and to Arctic Red River on the west.

The western groups are restricted to the Mackenzie Mountains and adjacent foothills and lowlands. In these areas the range included in the study area is mostly marginal with the greatest concentrations found further to the west. Quite large groups were noted along the headwater streams of the Keele, Redstone, Carcajou and Arctic Red rivers.

Those animals east of the Mackenzie River are more widespread. Very few concentration areas were noted. They apparently radiate out in winter from the many plateaus and mountainous summer ranges. The Horn Plateau is an example of such an area. Others are suspected but not documented.

The barren-ground caribou, other than the Porcupine herd, are only found on the east side of the Mackenzie River. The major group involved is known as the Bluenose herd. It seems to be composed of two groups. One group may winter as far south as The Horn Plateau. In most years, major winter concentrations are east of the study area (Kelsall 1968), but some animals have been known to spend at least part of the winter along the Willowlake, Blackwater and Great Bear rivers, and areas between. The small mountain ranges extending along the east side of the Mackenzie River seem to form a barrier to major movements into the Mackenzie Valley itself.

Another group of the Bluenose herd apparently summers to the west of the Horton River. In returning to its winter range, which is usually to the east of Canot Lake, some animals often swing out across the Crossley Lakes to the Travaillant Lake - Little Chicago area, then to the east (Hawley, pers. comm.). Such a movement is unpredictable and was not documented in 1972.

The final group of caribou may be barren-ground caribou, woodland caribou, feral reindeer or a mixture of sub-species. They apparently summer just south of the Eskimo Lakes and winter around and to the north and east of Travaillant Lake. This group, estimated at between 1,000 - 2,000 animals (Hawley, pers. comm.), does not usually concentrate in one area like barren-ground caribou but stays in small groups of 2 to 20, much like woodland caribou.

3. Some observations on spring movements were made near Wrigley and Sibbeston Lake.

In February and March, caribou were spatially distributed throughout the areas to the east of the McConnell Range. On April 26, numerous tracks were found along the eastern base of the McConnell Range. Re-tracing the tracks, it was found that the herds had worked their way westward from the areas where they were seen in early February. Because of poor flying conditions in the McConnell

Range, attempts to trace and locate the animals were abandoned.

A similar situation occurred in the Sibbeston Lake area. Signs of caribou were totally lacking alcng the Nahanni Range during February and March but they were seen farther to the east. On June 14, several sightings cf cows and calves were recorded in the alpine tundra region of the Nahanni Range.

4. Suspected summer ranges and calving areas have been noted for some woodland caribou groups. That part of the Mackenzie Mountains in the study area and adjacent small mountain ranges, such as the Nahanni and Camsell ranges, often provide summer habitat for small local populations. The Horn Plateau, the Martin Hills, the Redknife Hills and the McConnell Range are also suspected to be utilized in summer by some lowland groups.

Several features of these mountainous alpine tundra areas are attractive to caribou. The abundant lichens, mosses and forbs provide excellent forage. This area is relatively cooler, more exposed to winds and drier than the forested wintering areas, providing some relief from the hordes of insects.

Although not documented, these areas may be preferred calving areas. They provide the open cover and rugged terrain features which aid in escaping predators. The importance of these types of areas has been established in other regions and could prove essential with some populations. The majority of the larger groups have established calving areas outside the study area.

5. Winter range for all sub-species primarily consists of open black spruce-lichen forests of mature age. The topography is usually flat to slightly rolling. Numerous scattered small lakes are common features. Drainage is not particularly important although better drained areas favor the production of lichens.

6. All large areas lacking open black spruce forest cover are usually avoided. This is especially true of recently burned areas. Just when burns become useable again varies and depends on regenerating rates of cover species and lichens. This may run well over 50 years on many northern sites. In most mcuntainous and hilly areas, caribou

rarely go above the treeline in winter although these areas seem highly preferred in summer. Large boggy areas are quite often avoided as well. Frozen lake surfaces are regularly used for bedding, and the emergent vegetation, especially Equisetum species, is heavily utilized around the edges. Lakes are quite often used for resting areas during sunny winter days.

7. Almost all of the caribou ranges found on the study area are located on the margins of major ranges that occur to the east, west and north of the study area. The small population north of Travaillant Lake is one exception. There may be other small local populations whose range is mostly within the study area as well.

5.2.1.5 Conclusions

All studies have indicated the variability and unpredictability of caribou movements. Fortunately, the presently proposed pipeline route does not cross any regularly used winter range of the large Bluenose herd.

Animals in quite large numbers have been known to occur in the vicinity of the route, but the Franklin Mcuntains tend to act as a natural barrier for the majority of this herd. There is the distinct possibility that in some year, or years, during and following construction, large numbers of wintering barren-ground caribou may be encountered.

The small herd of migratory caribou north of Travaillant Lake can be expected in the vicinity of the pipeline route each winter during and after construction, although this could vary annually.

Woodland caribou range will be crossed by the pipeline route at several locations south of Camsell Bend. After the pipeline crosses the river going north, however, it will keep generally to the western margin of known range until Little Chicago. Here it passes into the region around Travaillant Lake. Woodland caribou in this vicinity are not believed to be abundant and should not be directly affected to any great extent.

Many more data are needed on distribution, abundance, and movement behavior before accurate predictions can be made on impact.

5.2.1.6 Implications

1. There are no presently known areas of heavy caribou use that will be directly affected to any great extent by the presently proposed routes east of the Mackenzie River.

2. Disturbance from various construction sources both during and after construction will occur. The result should be temporary in most cases and not serious. Caribou are traditionally variable and may not be affected if disturbances are short-term.

3. Disruption of movement patterns is a distinct possibility in a few local areas and populations. The herd north of Travaillant Lake could especially be affected. So little is known on movement patterns that it is impossible to predict implications.

4. Increased hunting pressure along the pipeline corridor itself, and radiating from the increased population in centers along the route, may have an important influence, especially on the scattered woodland caribou herds.

5. Harassment from low-flying aircraft, both private and industrial, will increase and may have a disastrous effect on local populations. The larger groups will be most affected by this type of disturbance.

6. An increase in the number of wildfires could be disastrous to the caribou. Caribou avoid burned areas and it takes a very long time for these areas to reach the climax vegetational stages that will support them.

5.2.2 The Porcupine herd of Barren-ground Caribou

5.2.2.1 Introduction

For millennia the migratory barren-ground caribou was the primary source of food and clothing over great tracts of the Canadian North. In recent times the importance of the barren-ground caribou as a nutritional mainstay for northern peoples has diminished somewhat.

The Loucheux Indians of interior northern Yukon and Northwest Territories as well as the coastal Eskimos developed life styles which relied heavily on the seasonal appearance and movement of migratory barren-ground caribou.

In the northern Yukon, the importance of the barren-ground caribou to the native peoples has diminished slightly over the past decade. The native inhabitants no longer depend extensively on caribou for clothing, but they do depend overwhelmingly on the caribou as a food source.

The Porcupine herd of barren-ground caribou has been termed the "International Herd" since its yearly movements involve parts of northeastern Alaska as well as the northern half of the Yukon. Until very recent times the size and importance of this herd were disputed. Since the 1950's various Canadian and Alaskan agencies claimed that the Porcupine herd represented as few at 10,000 or as many as 200,000 animals. Studies carried out over the past two years suggest that figures from 70,000 to 140,000 animals more truly represent the population status of the Porcupine herd.

This herd remained essentially untouched outside of native harvests until the appearance of the whaling industry in Arctic waters. Primitive harvest methods available to Indians and Eskimos were vastly improved with firearms obtained by Indians at Fort Good Hope as early as 1825, and later from whaling ships wintering at Herschel Island and from representatives of the Hudsons Bay Company. The whaling industry and the Hudsons Bay Company both reached the northern Yukon in the 19th century.

Through a barter system, native hunters were encouraged to provide meat for whaling crews wintering at Herschel Island. The demands of resident natives and wintering whalers (on occasion exceeding 2,000 men) reduced the Porcupine Caribou herd by the early 20th century.

Since the cessation of the whaling era in Arctic waters, the Porcupine herd has apparently recovered, although there are no reliable figures for historical numbers. At present, harvest of caribou in the northern Yukon, with exception of animals taken on the Dempster Highway, is nearly exclusively by natives.

With intensified attempts at economic exploitation of non-renewable resources in the Canadian Arctic and Subarctic, public awareness has focused on the real or potential dangers to the environment and to renewable resources, represented in this case by barren-ground caribou. In the northern Yukon the Porcupine Caribou herd are increasing in value, both economically to the natives depending upon them as a food source, and aesthetically to the southern Canadian society.

This survey was undertaken to determine the size and status of the Porcupine Caribou herd. Also of major interest were movements of this herd which might conflict in any way with any industrial or exploration activities as well as any construction of transportation facilities such as pipelines and highways.

5.2.2.2 Methods

The field work described in this report was initiated on February 7, 1972 by C. Jorgenson and continued by other members of the Canadian Wildlife Service until April 30, 1972 when E. de Bock assumed responsibility. The survey continued through to October 31, 1972. Field work included intensive aerial surveys and aerial photography as well as surveys from ground camps to count and classify animals in an attempt to determine the status of the Porcupine Caribou herd. Survey efforts were restricted to the Yukon Territory north of Dawson City, to the Beaufort Sea, and east of 142° longitude. The following methods were used.

A ski-wheel-and float-equipped Cessna-185 aircraft was used for most survey flights. A STOL equipped Cessna-185, a DeHavilland Beaver and a Piper Aztec C were used occasionally.

During the 1972 field operations, surveys were based on Old Crow and Dawson City, Yukon Territory. All but three weeks of field work were carried on out of Old Crow.

Wintering caribou were located in early February by systematically flying major drainages of the Peel and Porcupine rivers. Surveys also included areas where caribou were known to have wintered, such as the southern Richardson Mountains. The extent of wintering areas was determined by flying the perimeters of areas used. Wintering caribou were periodically checked frcm early February. Tracks, feeding craters and the presence of animals were accepted as indicators of wintering areas. Perimeters of wintering areas were plotted on 1:250,000 and 1:1,000,000 topographical mapsheets.

Migratory routes were determined by continued air surveillance and by transect flights. In transect flights, parallel transects 4 or 8 miles apart were used. Flight elevations varied from 300 to 600 feet above the ground surface. Migraticn routes were traced by presence of animals or tracks and trails which were visible from survey altitudes.

Population estimates were derived by directly enumerating small groups and estimating numbers of animals in large groups. When gathering data on population estimates, the aircraft was slowed to 110 to 120 miles per hour.

Photography was used extensively in the 1972 field surveys.

Photography was also used on large massed herds. Photographs were filed according to date and location, and later estimated and counted for cross-checking initial on-site estimates.

In this report, seasons have been arbitrarily divided into the following time periods: winter (November 1 to March 15), a period of permanent snow cover; spring (March 16 to June 15), a period of disappearing snow and break-up of lakes and rivers; summer (June 16 to August 31), a period when mean minimum temperatures are above freezing; and fall (September 1 to October 31), when snow cover is not yet permanent.

5.2.2.3 Results and Discussion

Winter Range of the Porcupine Caribou Herd

Historical documentation and native folklore both indicate that all areas north of Dawson City, Yukon Territory, may be considered caribou winter range. Indeed, all areas of the ncrthern Yukon have been used as caribou winter range in past years. Large numbers of caribou historically wintered on the coastal plains and have in recent times done so in Alaska. Loucheux Indians of Old Crow describe caribou wintering on the nearby treeless Cld Crow Flats.

The most typical caribou winter ranges are located south of the treeline or south of the Porcupine River. Winter range of the barren-ground caribou in the western Arctic differs from that of caribou in the central or eastern Arctic. Western Arctic winter ranges are frequently in mountainous areas. Caribou utilize both the mature spruce - lichen forests of the foothills and valleys, and the high open slopes in mountainous areas. In the winter of 1971/72 the Porcupine herd utilized typical winter ranges.

Caribou wintering areas are characterized by mature or stable vegetational conditions, generally in mature spruce -

lichen forests. Wintering areas which have been used by the Porcupine Caribou herd vary from tundra plains on the Arctic coast, through lake margins and wet tundra areas of the Old Crow Flats, to the extremely mountainous areas south of the Peel River.

General Migration Routes

The migratory barren-ground caribou of the Porcupine herd traditionally move north and northwest into Alaska every spring. Basic routes are used in their spring migration and variations of these routes are followed in their fall southward migration.

Spring migration takes place over three separate routes which have been termed the Richardson Route, Old Crow Route, and the Western Route (Renewable Resources Consulting Services Ltd., 1971). Caribou travelling all three routes ultimately mingle and travel the same route in the terminal stages of their spring migration.

A. Richardson Route

The Richardson Route lies along the Richardson Mountains. Northward migrating caribou generally reach the southern Richardson Mountains by crossing the Peel River from two areas, the Knorr and Trevor ranges and from the Chappie Lake - Hungry Lake area. Caribou moving north along the Richardson Mountains generally enter them across their southern end and move north along the nearly snow-free crests. The main movements are along the eastern crests to about the level of the Vittrekwa River. From this point caribou move to the western crests of the Richardson Mountains at approximately the level of the Rat River. The caribou fan out and approach the south side of McDougall Pass from Horn Lake on the east to the Waters River on the west.

The Richardson Route terminates in the eastern Barn Range where it unites with the Old Crow and Western routes. The caribou sweep around from Mount Goodenough across the headwaters of the Big Fish River and Rapid Creek to the Blow River.

B. Old Crow Route

Caribou migrating north by the Old Crow route generally move out of the Ogilvie Mountains and cross the Peel River from about the level of Hungry Lake to the Whitestone River. The route lies along low wooded ridges across the southern and southwestern portions of the Eagle Plains west to the Miner River. Caribou travelling the Old Crow Route swing to the northwest, moving up to the Whitestone River and along the ridges between the Whitestone and Miner rivers to the area of the Fishing Branch River and the southern Keele Range. From the Fishing Branch River the route moves north to an area immediately south of Lone Mountain in the Keele Range. On reaching the northern Keele Range the caribou disperse and cross the Porcupine River from the Alaskan border to near the Waters River. Large numbers of caribou cross the Porcupine River in the vicinity of Old Crow at traditional river crossings, to be described later.

After crossing the Porcupine River, caribou disperse across the Old Crow Flats and wander to the southern edge of the Barn and British mountains.

The Old Crow and Richardson Migration Routes join in the Barn and British mountains then continue on to the west and northwest to eastern Alaska.

C. Western Migration Route

The Western Migration Route is the shortest of the three migration routes which can be defined. This route begins in the Tatonduk River watershed. Some caribou using this route swing up the western side of the Ogilvie Mountains, moving north along the Alaskan border directly towards the Salmon Fork River. However, the major migration route lies up along the Miner River. The Western Migration Route goes through the Bear Cave Mountain area where it joins the Old Crow Route and continues northward as the Old Crow route. Both portions of the Western Migration Route have joined the Old Crow Route by the time the level of Lone Mountain is reached.

There are an estimated 75,000 to 80,000 caribou migrating north each spring over the routes described. An estimated 35,000 tc 40,000 caribou migrate north over the Richardson Route. The Western Migration Route is used by an estimated 15,000 caribou. The balance of migratory caribou moving north take the Old Crow Route.

Important Areas

In two field seasons it has been possible to define four particular habitat situations which seem to hold special significance for migratory caribou. The first and most general of these situations can be termed staging areas. The significance of staging areas in the yearly cycle of the caribou is extremely difficult to assess. They seem to be repeatedly used at approximately the same time each year, often for approximately the same length of time. Superficially, staging areas appear to facilitate grouping prior to definitive movements. Some staging areas may be used for more than one purpose at different stages of the caribous' yearly cycle. For example, the valley lying between the Malcolm and Firth rivers appears to hold dual significance for caribou. The valley is initially occupied by herds of calving caribou and hence may be termed a calving area and as such is extremely important to the welfare of the caribou. This same valley is also used as a staging area for large post-calving herds in early July, immediately after returning from Alaska.

Other staging areas which have been recognized are: the Knorr and Trevor range areas south of the Peel River. These staging areas are used extensively in early spring, immediately prior to migration north to the Richardson Mountains.

The Keele Range immediately south of Lone Mountain is also fleetingly used as a staging area. Caribou migrating north pause briefly when reaching the area south of Lone Mountain. Then the caribou disperse east and west from Lone Mountain and move north toward the Porcupine River.

The area between the headwaters of the Blow, Driftwood, and Bell rivers as well as the headwaters of Rapid Creek is recognizable as another staging area. Large post-calving herds move into these highlands and mill around, generally remaining on the high treeless uplands. This area is used for approximately 10 to 14 days during mid-July.

The following characteristics seem typical of caribou staging areas: they are open and treeless, but fairly well vegetated with willows, sedges, some grasses, lichens and cotton grass.

Spring staging areas are high, rolling, wind blown ridges with little snow cover. They are used prior to initiation of migration and occasionally during migration.

Summer staging areas are open rolling valleys and uplands such as described above and are situated between the Firth and Malcolm rivers and at the headwaters of the Bell River. These areas are generally completely snow free with exception of infrequent snow banks.

There are three other situations, mineral licks, calving areas and river crossings, which have recognizable importance for caribou. Mineral licks are important because they attract caribou. One very heavily used mineral lick, discovered in 1972, is on the east bank of the Firth River. This mineral lick is used extensively by female and young caribou and may in fact contribute to the value of the staging and calving area in which it is situated.

Calving areas are obviously important areas to the welfare of a caribou herd. Five discrete calving areas were located in the northern Yukon during the 1972 field season. All calving areas found were on existing migration routes to Alaska.

The calving areas located have several conditions in common, the first and foremost being an absence of snow. Calving areas are all gently rolling valleys, well drained and fairly sheltered. In all calving areas there are good growths of cotton grass, the main food species of caribou during early summer.

Other important areas used by caribou are the river crossing sites. Many river crossings appear to be traditional, as natives of the area have taken caribou at these points for uncounted generations. Preferred river crossing points have several recognizable attributes. Caribou prefer to cross rivers from points where there is a gentle slope with good footing. They prefer to cross to similar slopes or broad shingles on the opposite shore. Caribou seem to be drawn into each crossing point from a considerable distance, as caribou were observed following river banks for several miles before crossing. Crossing points are generally in the apex of bends in the river. The point furthest in the direction of travel in the loop or bend of the river apparently creates the most favorable crossing condition. However, some rivers, such as the Firth, present serious obstacles in the form of extensive reaches of deep canyons where caribou are forced to cross under extremely perilous conditions.

Chronology of Caribou Movements

Since the migratory barren-ground caribou of the Porcupine herd are deemed of primary importance amongst the wildlife resources of the northern Yukon, special emphasis was placed on surveys of their movements. Aerial surveys of the Porcupine Caribou herd were maintained throughout the 1972 field season, and a summary of these observations for spring, summer and fall fcllows.

A. Chronology of Spring Movements

Aerial surveys of the Porcupine Caribou herd were initiated in early February, 1972. Initial contact with caribou was made on February 8, while animals were still dispersed on their winter ranges. Most caribou were wintering south of the Peel River. In early February a group of caribou were located north of the Peel River, between the Whitestone and Miner rivers. A large area was also being utilized between Parkin (Chevron Standard Oil Exploration base camp) and the Peel River. Significant numbers of caribou were located along the Dempster Highway on February 8.

A herd of approximately 4,000 caribou which had elected to winter in the eastern Richardson Mountains near the Vittrekwa River was still stationary between the Trail and Road rivers on February 12. This group of caribou had moved from the sparsely forested lower slopes to the crests of the Richardson Mountains onto the Richardson Migration Route by February 21. The caribou in the Richardson Mountains had not seriously begun to move by February 21, 1972.

Caribou were beginning to move north by mid-March. In survey flights along the Dempster Highway and the major tributaries of the Peel River, few caribou were observed. An estimated 10,000 caribou were located on the crest of the Trevor Range staging area on March 21. Caribou were beginning to group on the Knorr Range staging area at the same time. Caribou were moving northward out of the Ogilvie Mountains by March 21. Caribou in the Tatonduk River watershed had not begun to move by March 26, 1972.

Survey flights carried out on March 28 revealed that large numbers of caribou were moving north by the Richardson Migration Route. Four separate herds of 2,000; 7,000 - 10,000; 7,000 - 10,000; and 15,000 - 20,000 caribou were located as far north as the Road River.

Good numbers of caribou were preparing to cross McDougall Pass by March 28. Large numbers of caribou had crossed McDougall Pass and entered the northern Richardson Mountains by April 21. Migrating caribou were sweeping to the northwest across the headwaters of Rapids Creek toward the Blow River by April 28.

In early May, caribou moving north by the Richardson Migration Route were travelling rapidly. Several hundred caribou had moved west of the Blow River by May 1. As previously explained, once caribou had reached the Barn

Mountains all migration routes merged into one migration path which spanned the entire mountain range.

By late April many caribou were beginning to drift north by the Old Crow and Western Migration routes. Survey flights on April 27 revealed large numbers of caribou immediately south of Chappie Lake. At this time, caribou north of the Peel River and west of the Richardson Mountains were remaining essentially stationary.

Survey flights into the Ogilvie and Wernecke mountains on May 3 revealed extensive northward movements of caribou. In addition to location of caribou moving north on the Old Crow Migration Route, 2,500 caribou were observed on the Trevor Range staging area.

In the period May 1 to May 5 caribou began migrating rapidly to the north using both the Old Crow and Western Migration routes. Caribou from the Tatonduk River watershed were moving down the Miner River and caribou from the Ogilvie Mountains and Peel River were advancing onto the Fishing Branch River by May 5. Many caribou from the Hungry Lake area moved northwest across the Whitestone River towards the Fishing Branch River on this date also. In a survey flight south of the Peel River another 800 caribou were located on the Trevor Range. From these observations it appeared that caribou move onto the Trevor and Knorr ranges for a short time to group up then immediately start north across the Peel River. By May 7 large numbers of caribou from the Tatonduk River drainage were moving north over Bear Cave Mountain. On May 8, caribou were seen moving north into the Keele Range directly south of Old Crow. Within three days (May 11) caribou were approaching Lone Mountain. During a flight on May 11, 75 caribou were observed in the headwaters of the Bluefish River with additional animals seen near Johnson Creek moving into the northern Keele Range.

On May 13, 1,450 caribou were approaching the Porcupine River across the flats immediately south of Old Crow. At this time, large numbers of caribou were moving north out of the Keele Range at the headwaters of Johnson Creek. By May 14 some caribou had reached the Porcupine River and large numbers of animals were rapidly approaching the river on a wide front. The Porcupine Caribou herd began crossing the Porcupine River immediately west of Old Crow and at the mouth of Lord Creek by May 15. By May 17 caribou were crossing the Porcupine River in large numbers. In addition to these two initial crossing points, caribou began crossing the Porcupine River at many points by May 19, and were moving into the Barn and British mountains by May 20.

Caribou migrating north by the Richardson Route were joined by caribou from the Western and Old Crow routes in the Barn and British mountains by approximately May 20. By this date, most caribou from the Richardson Mountains had passed through the British Mountains.

Once across the Porcupine River the migratory impetus appeared to decrease; by May 26 caribou were leisurely drifting northward in small groups.

Many caribou in the Barn and British mountains and on the North Slope began to group into calving or nursery bands. The first caribou calf was observed on June 3; by June 8, 300 new calves were counted.

Five separate calving areas were identified in early June. A mineral lick located near one calving area on the Firth River appeared to attract large numbers of pre- and post-parturient cow caribou to the area. Following calving, caribou continued to move to the west into Alaska. Fragmented groups of caribou (mostly males) kept moving west into Alaska until the return of the post-calving herds in early July.

B. Chronology of Summer Movements

During survey flights in the Davidson Mountains on July 10, 1972, large returning post-calving caribou herds were located. An estimated 50,000 caribou were observed as they moved up the Clarence River to the Yukon - Alaska border. Two large herds re-entered the Yukon and moved east to the staging area between the Firth and Malcolm rivers, reaching this point by July 12. All caribou which had returned to the Yukon by July 12 regrouped in this staging area.

The large post-calving herds remained in the staging area for a short time. By July 15 these herds had begun to fragment as they moved to the east across the Firth River. Caribou moving tc the southeast moved along the northern edge of the British Mountains. At this point, it shculd be stressed that post-calving herds are generally larger and much more compact and thus much more vulnerable than at any other time of the year. By July 15 a single herd, estimated to contain 20,000 caribou, was situated between the Spring and Trail rivers in the northern foothills of the British

Mountains. Small fragmented herds of caribou were crossing the Babbage River on July 16. An estimated 40,000 caribou in fragmented herds were alsc located between the headwaters of the Trail and Babbage rivers. When moving east, caribou used nearly every pass between the Clarence and Trail rivers.

During survey flights carried out in mid-July it was determined that small fragmented herds of caribou continued to enter the Yukon for some time after entry of the two major herds. No estimates of numbers for the above small herds entering the Yukon are available, because it was impossible to intercept them before they had entered areas where caribou were already present.

On July 18 large caribou herds were seen across the Babbage River. One herd which had crossed the Babbage River, estimated at 12,000 caribcu, had moved as far east as the headwaters of Dog Creek. Post-calving herds continued to move to the southeast, and by July 21 a herd of 20,000 caribou had crossed the headwaters of the Blow River and was entering the northern Richardson Mountains. Two additional large herds totalling an estimated 30,000 caribou were approaching and crossing the headwaters of the Blow River by July 21. All caribou had reached the staging area between the headwaters of the Blow, Bell, Driftwood and Fish rivers by July 24, 1972. The above staging area shall be referred to as the Bonnet Lake staging area. Post-calving caribou herds remained in the Bonnet Lake staging area from July 24 through to July 31, 1972, when they began to return to the west across the Old Crow Flats.

Most caribou returned to Alaska by moving west across the Old Crow Flats. Significant numbers of caribou moved to the northwest into the Barn and British mountains, then continued westward to Alaska. By August 2, 5,000 caribou had reached Black Fox Creek, with 12,500 more approaching this stream. By August 5 many caribou had reached Alaska.

Survey flights subsequent to the return of the caribou to Alaska revealed that not all the post-calving caribou had returned to Alaska. Flights over the northern Richardson Mountains indicated that possibly as many as 2,500 to 4,000 caribou had remained in this area.

C. Chronology of Fall Caribou Movements

In the interval between the exit of caribou from the Yukon in early August and their fall re-entry in September, 1972, periodic survey flights were made into eastern Alaska in search of returning caribou. A survey flight on September

2 encountered caribou which appeared to be drifting to the east out of Alaska. A later flight, on September 6, revealed 2,500 caribou crossing the Coleen River in Alaska. Returning caribou drifted eastward in a leisurely manner until September 12, when 4,000 caribou were located in Thomas Creek. An estimated 15,000 caribou were observed moving to the east from the Coleen River in Alaska. Inclement weather in the period from September 12 to 15 curtailed survey flights, but on September 16 large numbers of caribou were seen moving eastward across the south slopes of the Barn and British mountains. Follow-up flights on September 17 revealed 33,000 caribou moving southeast across the Old Crow Flats. Caribou began crossing the Bell River by September 19 and the Porcupine River by September 21. By September 22 large numbers of caribou were crossing the Porcupine River and moving into the Keele Range. Initial crossings of the Porcupine River were made in the area from the Driftwood River to Berry Creek. During a September 25 survey flight large numbers of caribou were seen moving south over the Old Crow Range, and down to the Porcupine River. These caribou were crossing the Porcupine River immediately west of Old Crow.

After entering the Keele Range, caribou tended to move to the southwest. On a survey flight carried out on October 1, we observed an estimated 15,000 caribou in one herd moving west from the Salmon Fork River to the Yukon - Alaska border. Increasing numbers of caribou were also located moving south to the Salmon Fork River at this time. During the same period caribou were traced south of Bear Cave Mountain and large numbers of caribou had moved from the eastern Keele Range to the area of Bear Cave Mountain.

During survey flights into the Richardson Mountains on October 2, an estimated 1,500 caribou were located moving to the northeast from the Old Crow Flats, while increasing numbers of caribou were seen moving north from the Porcupine River.

On survey flights made to the south and southwest of the village of Old Crow on October 4 and 7, several thousand caribou were seen moving west into Alaska in an area between the Salmon Fork and Black rivers to the south, and the Porcupine River to the north. There was also a trend to move to the northwest towards the Porcupine River. During extended flights up the Coleen River in Alaska, the vanguard of a very large movement to the northwest was encountered; the caribou were beginning to cross the Coleen River to the northwest. Subsequent caribou survey flights beyond the Coleen River into the interior of Alaska became logistically difficult and were abandoned. Indirect reports from pilots flying in the interior of Alaska indicated that caribou had approached Arctic Village, a native settlement approximately 190 miles west of Old Crow on the Chandalar River, in numbers exceeding 30,000.

Aerial surveys were then concentrated on remnants of the Porcupine Caribou herd which were still moving south towards the Ogilvie River. On October 8 we saw caribou approaching the Dempster Highway near Mile 140, and several animals had already crossed the highway near Mile 110. At this time there was a definite movement to the southwest in the southern caribou migration. Inclement weather hindered survey flights from October 9 to 13, when a large caribou movement was detected at the headwaters of the Ogilvie River. Caribou which had moved south were now travelling west towards the headwaters of the Tatonduk River and the Mount King - Mount De Ville area.

Observations carried out between October 17 and 29 showed that after crossing the Ogilvie River, the migratory impetus decreased. The caribou drifted southwest toward the Yukon River and the mountainous region north of it. On October 29 large numbers of caribou were seen on ridges along the Yukon - Alaskan border above the Tatonduk River.

During frequent survey flights in the period of October 17 to 29 along the Dempster Highway, it became clear that few caribou approached this area in 1972. Those caribou which did cross the Dempster Highway were moving to the southeast. The bulk of the animals crossed the highway near North Fork Pass then moved east toward the headwaters of the Hart River.

Caribou which approached the headwaters of the Hart River largely retraced their paths and moved west into the mountains around the headwaters of the Blackstone River. Survey flights in the Ogilvie Mountains and the Dempster Highway areas were terminated on October 29, 1972.

In late October, two survey flights were made into eastern Alaska. On October 21 a flight was made through the Salmon Fork River drainage and up the Coleen River to the Firth River thence back to Old Crow. An estimated 2,000 caribou were found moving south from the Salmon Fork River area.

During this flight, many fresh caribou trails were seen crossing the Coleen River and leading east. Fresh trails and caribou observed on the Old Crow Flats suggested that as many as 2,500 - 3,000 animals may have returned from Alaska by October 21. The final survey flight of 1972 was carried out on October 30. Fresh caribou trails crossing into the Yukon and around Bilwaddy and Ammerman creeks as well as trails and feeding craters across the north edge of the Old Crow Flats and Timber Hill indicated that more caribou had returned to the Yukon from Alaska during the period from October 21 - 30. No estimate was possible on the numbers of returning caribou.

At the time the survey flights were ended, the majority of the Porcupine Caribou herd was in Alaska, with an estimated 15,000 animals in the Tatonduk River drainage. In addition to the above, approximately 2,000 caribou were in the Richardson Mountains and possibly as many as 5,000 caribou were dispersed from the British Mountains across the Old Crow Flats into the Old Crow Range.

The Variations of Caribou Movements

Data gathered on the Porcupine Caribou herd by various agencies over the past seasons provide some suggestion of the possible variations, both chronological and spatial, in the yearly cycle of migratory barren-ground caribou.

To deal with the potential variations of caribou in regards to movement patterns or usage of particular areas, it is necessary to distinguish between long and short term departures from "traditional" movements. Terms such as "traditional" migration routes, winter ranges, calving areas or river crossings are recurring throughout caribou literature. "Traditional" is accepted here as meaning an inherited unchanging pattern. Variations of traditional movement and behavior patterns must be separated from their short-term counterparts, in order to arrive at a correct concept of caribou movements.

Short-term Variations

As a result of two years observations, some remarks on yearly variations and their possible causes can be made. For the purpose of this discussion it has to be assumed that a short-term variation does not last more than five years. The field data available suggest that variations in time as well as in directions of movements are likely to occur from year to year. Such fluctuations in timing are probably closely correlated with weather and snow conditions, as are variations in movement patterns.

From field data available, the following conclusions are drawn. Chronology of spring movements during 1971 and 1972 for the various migration paths show variations of a week for the Old Crow Route and up to six weeks for the Richardson Migration Route. Summer movements began 10 days later in 1972 than in 1971 and ended a week later in 1972. Fall movements began approximately two weeks later in 1972 than 1971, although caribou reached the Ogilvie River on nearly the same date both years.

Basic spring migration patterns were nearly identical for both years, although there was a shift of winter ranges. Summer movement patterns during these two years were nearly exactly the same; although the number of animals involved was not.

Fall movements were entirely different for each of the two years for which data are available. Normally, caribou from the northern Yukon and northeast Alaska move southward to the area south of the Peel and Ogilvie rivers by way of the Richardson and Old Crow migration routes, which they did in 1971. In 1972 small segments of the Porcupine Caribou herd moved south of the Ogilvie River or into the Richardson Mountains. The bulk of the caribou herd moved northwest into Alaska to the Chandalar River near Arctic Village.

Long-term Variations

Historical documentation indicated that over long periods of time caribou movement patterns are relatively stable. Life-time residents of Old Crow report that there have been periods of up to several years when the caribou shifted their migration routes to such an extent that they completely bypassed Old Crow.

Several pieces of indirect evidence point to the long-term or traditional stability of caribou migration routes and movement patterns. Crossing points exist on the Porcupine River where the Loucheux Indians have ambushed caribou for untold generations. Hunting camps and settlements such as Old Crow have come into existence because of the dependability of such caribou movements through the area. The presence of eight caribou fences, most of which must be several hundred years old, all on migrational routes, testify to the long-term stability of caribou movements.

Within short time spans, up to several years, movement chronology can vary by months. Migration routes may or may not be used and movements may in fact not occur.

Over long periods of time, measured in human generations, it would appear that caribou movements are relatively dependable and in fact the term "traditional" is acceptable.

5.2.2.4 Speculations on Impact of the Pipeline

There are two specific periods during and after construction in which any pipeline could be expected to have an effect upon a herd of migratory barren-ground caribou. Pipeline impact on a caribou herd during the construction phase can take several forms.

Taking the variability of migration chronology and movement patterns into account, there are several possibilities for catastrophic pipeline effects on caribou. Caribou during their spring migration encountering several miles of open ditch, large construction camps, and continuous vehicular and air traffic may exhibit one or more of several reactions. Migrating caribou may simply retreat and move around construction activity ignoring the constant vehicular and air traffic. A caribou herd might also move through the construction zone, ignoring its activity, and continue on their way. Another equally plausible reaction is that caribou would simply refuse to move by or around construction. In effect, migration would halt, and caribou might return to the south. The effect of caribou going back to the south could be the loss of much of, or an entire cohort, as calves would be dropped under conditions precluding survival. This might also be true if a migration or subsequent migrations would be deflected from their traditional route. A fourth possibility is that caribou would blunder into construction activity, fail to cross open ditches and perish. The above speculations all assume that construction activity is taking place concurrently with widespread caribou migrations. Many deaths would occur if ditches were to be encounterd by the massed, close packed post-calving herds which may consist of 50,000 - 60,000 caribou in near body contact.

Air traffic in large volume may have an unsuspected impact on migrating or calving herds of caribou. Harassment by air traffic may disrupt caribou movements and behavior to such a degree as to cause abortion, exhaustion and death of parturient cows or abandonment of young.

The presence of large numbers of workers, many of whom will be hunters who may well try to take caribou against regulations, may also have seriously detrimental effects on the welfare of a migrating caribou herd.

Post-construction pipeline effects on migratory caribou are potentially as disastrous to caribou and their habitat as possible construction impacts. There are several potential effects on caribou or their habitat that an existing underground pipeline could have.

The effect of the presence of compressor and refrigerator stations and their concurrent disrupting noise on caribou is open to speculation. It is possible that such stations would attract, frighten or have no appreciable effect on caribou. Stations which would frighten caribou, could have a detrimental effect in key areas such as in the midst of calving areas, preferred staging areas, preferred migration routes or traditional river crossings.

Pipeline rights-of-way and berms of underground pipelines both have potential for deleterious impact on migratory caribou and their habitat. The following possibilities should be considered. An open pipeline right-of-way might attract caribou. They might prefer to travel on it, which might deflect migration movements with possible disaster to the herd. A right-of-way and a berm might act as a barrier which caribou refuse to cross. Assuming that caribou would cross a pipeline right-of-way and the probable berm, it remains to be seen how they would react to the presence of heavy growths of artificially seeded potential food species. Such potential food species might attract caribou causing migration deflection.

The presence of a pipeline right-of-way and/or artificially seeded vegetation might induce caribou to travel along the pipeline right-of-way. There are an estimated 70,000 to 140,000 caribou in the Porcupine Caribou herd; 70,000 animals travelling down a pipeline in an area where the insulation layer has already been damaged or destroyed may be disastrous. Thermokarst formations could result from habitual use of a pipeline right-of-way by large numbers of caribou.

A possibility which also has to be considered is that a pipeline right-of-way and access to such a right-of-way may result in increased harvest of caribou through increased accessibility.

The above are all speculative in nature at this time since there are insufficient data on caribou biology or behaviour to state with any certainty what pipeline impacts will be.

5.2.2.5 Recommendations

Preventative recommendations are difficult to crganize where data are insufficient. There are insufficient data on construction and post-construction aspects of proposed underground or above-ground pipelines. There are few data on caribou reactions to the speculative situations of the previous section.

The following recommendations will be based upon assumptions as to the conduct of pipeline construction. In all cases it will be assumed that caribou reaction will be negative.

It is assumed:

a. That construction will take place during winter except in mountainous areas where there may be summer construction.

b. That there will be three large construction camps each of 500 - 700 men.

c. That each camp will have approximately six miles of open pipeline trench at any one time.

d. That all trenches will be filled in during the summer.

e. That extensive use will be made of helicopters and fixed-wing aircraft.

f. That concerned authcritive environmental agencies will be able to exert scme measure of control over construction and chronology of construction.

With the above assumptions in mind it is reccmmended that:

a. All construction activity be halted prior to spring caribou migrations. This would entail maintaining an aerial surveillance of the caribcu from early February. Otherwise a tentative period for closing down construction activity would be from March 1 to November 15.

b. All construction camps, equipment, and any open trench be completely enclosed by snow fencing and abundant flagging so as to create a visual as well as a physical barrier at these points.

c. All pipeline trenches be closed by no later than March 1.

d. Minimum altitudes (2,000 feet above ground) and air corridors be designated for all air traffic.

e. Absolutely no firearms or private all-terrain vehicles be allowed amcngst construction crews.

f. Extensive impact and manipulative studies be carried out immediately, on caribou as well as other important species which may be affected by construction and existence of a pipeline. Such studies would allow the Canadian Wildlife Service to more effectively review consortia recommendations for the protection of caribou and other affected species.

Table 3. A summary of the expected effects upon caribou by the activities associated with the construction of a gas pipeline.

Activity	Potential Effects	Magnitude
Fire resulting from pipeline or highway construction	Destruction of climax forest wintering habitat for caribou	Moderate
Pipeline berm	Large numbers of caribou travelling on a berm might cause erosion of the berm with resultant exposure of pipe and interference with revegetation	Moderate
Pipeline construction	There is a need to time construction to avoid the caribou calving period and to avoid any construction procedures that would alter the environment critically at calving time	Moderate
Aircraft use on pipeline project	Although caribou can be disturbed by aircraft at any time during the year, disturbance would be particularly serious at calving time or in winter when the animals might be pressed by food shortages	Large
Harassment from any source	In mid-winter the daily energy expenditure of the harassed animals may exceed the energy present in the total forage available, thus placing the animal in a negative energy balance. If this is compensated for in increased food consumption by the animals there would be an overall increase in pressures of animals on their food resources with a reduction in carrying capacity of the habitat	Large
Buried pipeline or berm	Pipeline right-of-way would obstruct caribou migration resulting in alterations in patterns of range use and possible loss of caribou as a food source to the native people	Moderate

Table 3. Cont'd.

Activity	Potential Effects	Magnitude
Entire pipeline project	Interference with traditional migration routes, disturbance of animals on the calving grounds, creation of increased fire hazards, and opening of the country to hunters, would all adversely affect the caribou	Large
Buried pipeline in marshy areas of fine soil	The refilled ditch may remain unvegetated and in a fluid state for long periods of time, acting as a moat to block or entrap migratory animals	Small-moderate
Ditching phase of construction	A large open ditch confronted by migratory animals would act as potential trap or diversion	Moderate
Pipeline pumping	The noise level of the pumping stations may be intolerable to caribou	Moderate
Total pipeline development	The increased human population would result in an increase in harvest of caribou	Moderate
Oil spills	Oil spills would not be expected to have any important influence on caribou unless ingested	Small

5.3 DALL SHEEP

5.3.1 Introduction

Previous to this study, information on Dall sheep distribution within the study area was generally quite patchy. Dr. N. Simmons of the Canadian Wildlife Service had detailed information for the Carcajou Canyon and Norman Wells map areas, and some information on the Sans Sault Rapids and Fort McPherson map areas. Little or nothing was known about the remainder of the study area. Any existing information was used in outlining and establishing objectives and techniques for this study.

The first phase of the study was to map and classify Dall sheep range. Information on relative abundance of animals, and habitat preferences, as well as location and extent of winter ranges, was collected and used in delineating and classifying habitat units.

The study area was chosen to cover the region likely to be influenced by construction and operation of a gas pipeline. Aircraft harassment, disturbance by heavy equipment, and "blasting", as well as additional hunting pressure, are some of the problems which may be expected during the construction period. Noise from compressor stations and increased recreational and native hunting as a result of improved access are possible problems in the operation and maintenance stage.

The presently proposed pipeline route is, for the most part, well away from the mountains and thus avoids sheep range. However, in the Richardson Mountains, both proposed route alternatives pass very near known sheep ranges, and the coastal route passes directly below a major wintering area.

5.3.2 Methods

Preliminary Office Activity

Initial work on the project began in December, 1971, with a review of pertinent literature, and determination of possible sheep areas from aerial photographs. Further assistance was provided by Dr. N. Simmons, who has been studying Dall sheep in the Mackenzie Mountains for several years. His suggestions on distribution, habitat preference, survey tehcniques, and logistics were most beneficial to the study.

Field Activity

Aerial surveys were based on Fort Simpson, Norman Wells, Inuvik and Old Crow. Winter surveys were conducted from February 7, 1972 to March 30, 1972. Since all of the surveys were in precipitous mountain terrain, a Bell-206 helicopter was used most of the time. Survey personnel consisted of two observers (one on each side) equipped with 1:250,000 scale maps, tape recorder and cameras.

Individual sightings, tracks and areas of feeding activity were plotted on 1:250,000 scale maps, while descriptions and comments were tape recorded. Numerous photographs were taken of Dall sheep habitat.

All potential sheep range was investigated. Information on habitat preferences, winter range characteristics, distribution and relative abundance of sheep was collected. Dall sheep were classified as to age and sex; and attempts were made to correlate population figures with habitat types.

Summer aerial surveys were conducted in July to check marginal sheep areas, to note seasonal movements, and to determine population size and extent of summer ranges.

Habitat Classification

Dall sheep are strictly confined to the mountain portions of the study area, which can be separated into three main regions: the Mackenzie Mountains, the Richardson Mountains, and the British Mountains. Evaluation of an area was determined on a relative basis, considering the study area as a whole. Because sheep have specific habitat requirements, a great deal of difficulty was encountered in attempting to evaluate units on the basis of landform alone. Information on habitat requirements, habitat preference, distribution and relative abundance, was collected and correlated with physical units. As extrapolation of information from one area to another was impossible, all potential sheep areas were investigated individually.

Winter is the hardest time on sheep at northern latitudes, with survival most difficult: therefore areas of good wintering habitat were given the highest rating - Class 1. Heavily-used mineral licks and concentrated lambing areas were also given Class 1 ratings.

Summer use areas are often on higher slopes where sheep disperse over large areas of different habitat types. Units supporting moderate populations of Dall sheep year-round or large populations during the summer months were given a Class 2 rating.

Marginal areas supporting a few animals during the summer period were considered poor habitat (Class 3).

Class 1

A class 1 unit has no obvious limiting factors. Within the unit are good to excellent wintering areas critical to the survival of concentrated populations of sheep. Sheep may be found in Class 1 units throughout the year. Class 1 winter habitat has abundant amounts of food, limited snow cover, and scattered regions of escape terrain. In some cases, Class 1 also represents a concentrated lambing area or heavily used mineral lick.

Class 2

A class 2 area has minor factors limiting Dall sheep. These units often receive limited use as winter range; but are mainly used during the summer. Higher elevations, and more precipitous slopes with sparse vegetative cover are characteristic of Class 2 units. These summer ranges support moderate to high numbers of sheep, but animals tend to be more free-ranging and dispersed than on winter ranges.

Class 3

Class 3 units have moderate to severe limitations for Dall sheep and lack essential habitat components. These areas are marginal and receive only limited use during the summer.

Class 4

Class 4 areas have severe limitations for Dall sheep. Sheep use in these areas is uncommon.

5.3.3 Results and Discussion

A. Habitat

Dall sheep range within the outlined study area is all west of the Mackenzie River. Although the Franklin-McConnell Range appears to have suitable habitat, sheep have never been reported in this area. The study area includes cnly the periphery of sheep range in the Mackenzie Mountains, some of which is only marginal habitat.

Dall sheep range does not decrease in quality at higher latitudes. In fact, low precipitation and extreme cold helps to limit snow depth and crusting, permitting unrestricted movement in many areas during the winter months.

1. Winter Range

One of the main objectives was to locate and assess winter ranges of Dall sheep. Because northern winters are so severe, good wintering areas are critical. These wintering areas are only a small portion of the home range - usually ridges, slopes, cr plateaus where animals tend to concentrate. Because of this, these areas are considered most valuable, and were given the highest ratings.

A great diversity is found between winter ranges in different parts of the study area. All winter ranges are classed 1'S or 2'S, and fall into one of four major types.

Plateaus and gentle slopes. Well vegetated plateaus or gentle slopes with limited snow cover associated with deep canyons, steep slopes, or cliffs for escape terrain, are favored ranges and are heavily utilized. Many of these areas are on the periphery of mountain ranges where exposure to prevailing winds keeps snow depths minimal. Soil is relatively stable on these sites, and growing conditions for forage plants are good. Ranges of this type are almost always rated class 1.

Slopes and lateral spurs at treeline. Sheep were regularly observed utilizing slopes and lateral spurs near treeline. Snow depths are greater here than in the type previously described; however, these sites are not packed hard enough to hinder movement or feeding. Feeding craters were observed both above and below treeline in areas with escape terrain always close at hand and, even in the trees, visibility unobscured. Ranges of this type are rated class 1 or 2.

Slopes and spurs associated with eroded bluffs. Moderate numbers of sheep were observed wintering on slopes or lateral spurs in association with eroded rock bluffs. Snow depths on these sites are usually small due to exposure to wind. Slopes are steep and often unstable, giving some protection from predators. Habitat of this type can be seen in various situaticns - including along river valleys and high in alpine tundra basins. Small bluffs or benches sometimes created areas on these slopes where stable soil and better growing conditions resulted in better plant growth. Willow may also occur at the base of these outcrops, and is also utilized. Ranges of this type are class 1 or 2.

High ridges and slopes. This habitat type is the least common of the fcur. Reduced snow depths as a result of exposure to prevailing winds are always associated. Unstable slopes and sparse vegetative cover are characteristic. High elevations also tend tc restrict vegetative cover, thus reducing the number of sheep these areas are able to support. Most ranges of this type are class 2 with occasional areas of class 1.

2. Summer Range

Dall sheep summer range varies from high talus ridges to low cliffs along streams. Sheep disperse from winter ranges to areas not available to them in winter. Movement during the summer is unrestricted and animals utilize large areas limited only by proximity to escape terrain. Areas having all the qualities of good sheep habitat, except for the absence of escape terrain are not utilized.

Little is known about the location and characteristics of lambing areas, although two areas along steep river breaks in the Carcajou Canyon map area have been reported (Simmons, pers. ccmm.). Ewes are known to favor very rugged habitat, and occasionally concentrate during the lambing period.

The use of mineral licks is important, and ewe-lamb groups are commonly seen in proximity to these licks. Ram groups tend to use mineral licks somewhat less (Simmons, pers. comm.). Several licks have been located in the Carcajou Canyon map area, but nothing is available for other parts of the study area.

B. Populations

Four distinct populations of Dall sheep occur within the study area. Separated by geographical location, physical isolation from other sheep, or major habitat differences, the four areas are - the Nahanni, Ram and Yohin-Liard area; the Mackenzie Mountains; the Richardson Mountains; and the British Mountains.

1. Nahanni Range, Ram Plateau, Yohin-Liard Ranges

This area is the eastern limit of Dall sheep habitat. The Nahanni Range and Ram Plateau are physically isolated from other areas of Dall sheep. The Yohin-Liard ranges are somewhat removed from the main mountain complex; however, some movement is speculated. An estimated 50 animals occupy the Nahanni Range, with the bulk of the herd in the south-central portion of the area. Because of its precipitous nature, the Ram Plateau was difficult to survey, but a conservative estimate of the sheep population is 15-20 animals. Ten sheep were observed on the Yohin-Liard ranges during summer surveys.

The Nahanni and Yohin-Liard ranges are mainly of "slopes and lateral spurs at treeline" type winter range with lesser amounts of "high ridges and slopes" type. These habitat types were discussed in the previous section. The Ram Plateau is a "plateau and gentle slope" type with steep canyons falling away sharply from flat tops. Some small "lateral spurs", located on the north end of the plateau are also utilized during the winter. All of these winter ranges are exposed to wind, and are kept clear of snow.

2. Mackenzie Mountains

The Mackenzie Mountains are the most extensive range of mountains in the study area, and have the largest population of Dall sheep. Sheep inhabit areas varying from rough, barren, precipitous terrain in the Backbone Range, to gentle, well-vegetated plateaus in the Carcajou River area. All four types of wintering habitat are represented in this region. The best wintering areas are "plateaus and gentle slopes" and "slopes and lateral spurs at treeline" in the Carcajou Canyon, Norman Wells, and Sans Sault Rapids mapsheet areas. These sites are in a zone of light snowfall, and exposure to prevailing winds helps keep snow conditions shallow. The wintering areas within this region are actually more extensive than in other regions, and consequently larger groups of sheep inhabit them. In these areas of low snowfall or soft snow cover, the animals are able to feed and move freely.

The northwest portion of the Mackenzie Mountains (Arctic Red River area) has poorer habitat of the "slopes and spurs associated with eroded bluffs", "high ridges and slopes", and "slopes and lateral spurs at treeline" types. This area is much rougher, with unstable slope conditions, and sparce vegetative cover. Group sizes are smaller.

3. Richardson Mountains

Dall sheep are found in two areas in the Richardson Mountains. About 500 animals inhabit the McDougall Pass - Mount Goodenough area, and about 40 animals utilize river canyons in the Doll Creek area of the southern Richardsons.

The major wintering area for the Mount Goodenough group is in the eastern portion of the mountains north of McDougall Pass. "Plateaus and gentle slopes", and "slopes and lateral spurs at treeline" are the predominant winter range types. High winds keep exposed plateaus and slopes almost completely clear of snow. Feeding areas are in close proximity to steep lateral spurs and canyons which provide protection from predators. There is a general movement towards the west at least as far as Bell River during the summer. Many areas of suitable habitat are not used, however, due to lack of suitable escape terrain.

Limited information is available for the Doll Creek group, but preliminary surveys suggest habitat is limited, and is restricted to plateaus and slopes in close proximity to steep stream canyons. Nothing has been recorded of summer movements or distribution.

4. British Mountains

About 50 to 75 sheep, part of the herd which extends from the Brooks Range in Alaska, inhabit the British Mountains in the northern Yukon. The good wintering habitat, mostly of the "slopes and lateral spurs at treeline type", is on the west side of the Firth River. Strong winds are important in keeping small benches snow free, permitting winter use.

Records indicate movement of animals from this area to the Brooks Range, suggesting that this is the eastern limit of sheep in that region.

5.3.4 Conclusions

All Dall sheep habitat is situated west of the Mackenzie River. Habitat quality is not limited in the more northerly latitudes. Winter range is considered the most important habitat and sheep are often concentrated on these ranges. All wintering habitat was rated class 1 or 2 and may be broken into four major types; plateaus and gentle slopes, slopes and lateral spurs at treeline, slopes and spurs associated with eroded bluffs and high ridges and slopes. Sheep disperse during the summer. Lack of precipitous escape terrain in the Richardson Mountains seems to restrict summer distribution of sheep.

Two lambing areas as well as several mineral licks were reported on the Carcajou Canyon map area. Sheep, especially ewes and lambs, tend to concentrate around mineral licks during the spring and summer.

Four major populations of Dall sheep occur in the study area: the Nahanni, Ram, Yohin-Liard group; the Mackenzie Mountains group; the Richardson Mountains group; and the British Mountains group.

5.3.5 Speculations on Impact

Since most Dall sheep range is in the western part of the study area, well away from the actual proposed pipeline route, the effects of a pipeline should be minimal. However, in the Richardson Mountains, the proposed route passes very near some important wintering areas, and pipeline activities in this area could be very disturbing. Two phases of pipeline activity must be considered, the construction phase and the operation and maintenance phase.

A. Construction

Sheep fear both the sight and sound of aircraft, thus, heavy use of aircraft in support activities at the time of pipeline construction could have serious effects on the local Dall sheep populations. Low-flying aircraft are more disturbing than high-flying aircraft, and helicopters more than fixed-wing, probably because the rotor system of a helicopter emits higher and greater noise levels than does the propeller cf mcst fixed-wings. Aircraft disturbance is a problem with sheep at any time, but is especially so during the winter period and at lambing time.

Gravel or fill removal from or very near sheep ranges would likely have long-term effects on the population. The use of noisy equipment or explosives in close proximity to critical winter ranges or lambing areas could disturb the animals enough that they would be forced to vacate these ranges.

At present, sport and native hunting of sheep is light, due to the inaccessibility of sheep range within the study area. However, hunting by pipeline construction personnel, native or white, situated in large camps near sheep range, could result in disastrous overharvests.

B. Maintenance and Operation

The associated roads and cutlines that will be established during pipeline construction will provide greater access for native and sport hunters in the area. If Dall sheep populations in the area are small, this could rapidly result in an overharvest.

The noise from compressor stations may keep sheep away. If located on or near an important winter range or lambing area, abandonment of the area could occur with serious results.

5.3.6 Recommendations

The most important features of Dall sheep range are wintering areas, lambing areas, and mineral licks. Winter range is critical, and animals tend to congregate in these areas at that time. In the Richardson Mountains, sheep occupy their winter ranges from approximately November 1 to May 15. The winter period is slightly shorter in the Mackenzie Mountains. Lambing begins in early May and continues to mid-June, with the peak around late May. Use of mineral licks begins in late May and continues until late summer. Disturbance in these areas during their sensitive times could result in reduction of the Dall sheep population of the area.

1. Aircraft

It is recommended that the use of support aircraft during pipeline construction be closely regulated. Flight corridors and minimum elevations should be instituted, and low level flight over winter ranges, lambing areas, and mineral licks strictly prohibited. The construction and operation of major helicopter pads or airstrips in proximity to sheep range is not reccmmended. Low level flying for the purpose of picture-taking should be discouraged. This causes panic and stress in sheep, and can be extremely serious. Harassment of this sort should be strictly prevented.

2. Gravel and fill removal

The removal of granular material from areas of sheep winter range would result in long-term habitat destruction.

3. Blasting and heavy equipment

Whenever possible, the use of heavy equipment and blasting should be timed so as to minimize disturbance while sheep are on their winter ranges, mineral licks or lambing areas.

4. Compressor stations

Compressor stations should not be located in close proximity to winter ranges, mineral licks or lambing areas.

5. Hunting

It is recommended that regulations be established prohibiting hunting of sheep by personnel involved with pipeline construction.

Table 4. A summary of possible effects a gas pipeline may have on Dall sheep.

Activity	Potential Effects	Magnitude
Aircraft use in support of construction or operation of a pipeline	Harassment by aircraft, particularly helicopters, may cause animals to leave winter ranges, lambing areas or mineral licks. Low-level flights may cause sheep to expend additional energy during critical periods.	Large
Gravel or fill removal from or near important ranges	The removal of soil material from winter ranges could have destructive effects on this important habitat. Heavy equipment used in extracting material near winter ranges may force sheep to vacate this habitat.	Moderate
Operation of compressor stations near important ranges	The operation of a noisy compressor station on winter range, near lambing areas or mineral licks could cause abandonment to these habitat components.	Moderate
Blasting and use of heavy equipment during construction	The loud noise associated with construction equipment and blasting in close proximity to winter ranges, lambing areas and mineral licks, could force animals to abandon these areas.	Moderate
Total pipeline development	The increase in human population occurring from the pipeline could cause an increase in harvest of Dall sheep. Small, isolated sheep populations would be most vulnerable to overharvest.	Moderate
Sport and native hunting from construction camps	Hunting from camps located near sheep ranges would cause an increase in harvest. Smaller, isolated sheep populations could be seriously overharvested.	Large

Table 4. Cont'd.

Activity	Potential Effects	Magnitude
Increased access caused by pipeline construction and operation and additional hunting pressure	Roads and cutlines necessary in the construction and operation of a pipeline would create greater access to sheep ranges for sport and native hunters. Overharvest may result from excessive hunting.	Large
Destruction of habitat by constructing a pipeline across winter range	The loss of habitat incurred by constructing a pipeline on winter range could reduce the size of this habitat.	Moderate

5.4 GRIZZLY BEAR

5.4.1 Introduction

Except for a few scattered observations, and very general distribution maps, very little was known about grizzly bears within the study area. Since grizzly bears are not restricted to specific habitat types, information was collected on distribution, relative abundance, and location of den sites. This was then used to delineate, classify, and describe broad habitat units. Implications and recommendations were made giving the researchers' views on possible problems which may arise as a result of pipeline construction activity.

5.4.2 Methods

Preliminary Office Activity

Very limited information on grizzly bears was available for the study area. General distribution was determined from incidental sightings, and reports of den site locations. Numerous sightings and dens were recorded by Renewable Resources Consulting Services Ltd., while doing caribou surveys in the Northern Yukon in 1971. However, few or no data were available for the rest of the area.

Field Activities

Aerial surveys for grizzlies were based on Fort Simpson, Norman Wells, Inuvik, and Old Crow. Extensive aerial surveys were conducted April 18, 1972 to June 12, 1972, the approximate time bears emerge from winter dens. Aerial surveys were conducted to collect information on den site locations, relative abundance and distribution.

A Cessna-185 and a De Havilland Beaver were used for general reconnaissance flights. When fresh grizzly bear tracks or dens were located, a Bell-206 helicopter was chartered to back-track and observe den sites. Field notes were taped, and all observations were plotted on 1:250,000 scale maps. Incidental sightings from other wildlife surveys were also recorded.

Analysis and Final Mapping

Grizzly bear units are generally very large, determined mainly by general physical landforms, broad vegetation zones, and relative abundance of bears. Descriptive narratives of these units are, consequently, also general, outlining physical features, vegetation composition, and significant attractions or limitations.

Grizzly bear habitat is very difficult to classify, as bear distribution cannot be directly related to specific habitat type. General topography, landforms, and vegetation types were considered and correlated with population abundance and distribution as determined from past records and field surveys. Availability of good food sources was also considered. Delineation and classification of units was done on a relative basis, and in places information was taken from a known area and extrapolated to areas where little was known.

Due to the generalizations made in classifying grizzly bear habitat, this study cannot be considered a true detailed habitat evaluation. It does give a modified distribution map delineating broad habitat units, the relative abundance and densities of grizzly bear populations, important use areas, and brief discussions of habitat qualities and limitations.

Class 1

A class 1 unit has no obvious factors which may limit grizzly bears. These units possess the habitat requirements of good interspersion of landforms, suitable vegetation types, abundant food sources and especially, available denning habitat. Relatively high numbers of bears were recorded utilizing these areas.

Class 2

A class 2 unit has minor limitations for grizzly bears. These areas possess most of the requirements essential in supporting bears but lack one or more qualities, making them less than optimum. A moderate number of bears were observed in class 2 areas.

Class 3

A class 3 unit has moderate to severe limitations for grizzly bears. These units lack qualities essential to good grizzly bear habitat. Only occasional sightings were recorded in class 3 units.

Class 4

Class 4 units have severe limitations to grizzly bears and are considered poor habitat. Although there were no observations of bears in class 4 units, occasional transient animals may pass through these areas.

5.4.3 Results and Discussion

Spring surveys were conducted to obtain information on relative abundance of bears, and location of den sites. Concentrated effort at this time, when bears are emerging from their dens, proved successful, in that tracks as well as bears could be observed and recorded. Unless the bear had just recently emerged from its den, it was very difficult to re-trace tracks to the den site. The species of the bear cannot be determined from tracks; only by locating the individual can this be confirmed. Numerous grizzly and black bear sightings were recorded while conducting surveys for other species. This information assisted the program by giving a record of year-round distribution of bears.

Grizzly bears are omnivorous, with food preferences ranging from roots and berries to ground squirrels, fish, caribou and moose. The availability of food seems to determine grizzly bear distribution and abundance more so than does specific habitat types.

Preliminary studies in the northern Yukon suggest adult male bears have a very large home range, and appear to move with, or perhaps follow, the migrating barren-ground caribou. Grizzlies have also been reported preying on new-born calves on the caribou calving grounds. It is sometimes difficult to assess whether good food sources are available or not, but this is the major factor which may limit grizzly bears.

Landform, topography, vegetation type, and apparent food sources were factors used in describing grizzly bear habitat. Throughout the south and central portion of the study area, grizzly bears prefer rough, broken terrain as found in mountain regions, possibly as a result of the wide variety of vegetation types available. Areas of low relief, continuous bog or homogeneous forest cover offers a poor choice of food, and are little used. No doubt observer error would be greater in the forested regions as compared to the semi-open mountain areas, resulting in some bias in estimates of relative abundance. However, it is interesting to note that many black bears were observed in the Boreal Forest regions, whereas grizzlies were more common in the mountains, suggesting that they prefer these regions. In the northern portion of the study area, grizzlies utilize low-relief, open-tundra zones, such as the Yukon Coastal Plain, Richards Island, and the Tuktoyaktuk Peninsula. The taiga-tundra transition zone receives some use. The mountainous region of the northern section contains the highest number of grizzly bear sightings in the study area.

Denning areas are an important feature of grizzly bear habitat. Records of known sites in the Old Crow area indicate that bears tend to use the same dens year after year. This may be especially true in regions of shallow active layers.

Denning areas are difficult to locate, and small numbers of den sites have been recorded. Known sites are usually associated with mountain slopes, hills, or streambanks.

Because of the non-specific nature of grizzly bear habitat, habitat units are large and narrative descriptions very general.

5.4.4 Conclusions

Distribution and abundance of grizzly bear seems to depend more on availability of food than on specific habitat types. Information collected in the northern Yukon suggests that adult male bears have a very large home range, and appear to follow the migrating barren-ground caribou. Landform, topography, vegetative type and apparent food sources were considered in delineating and describing grizzly bear habitat.

Throughout the south and central portion of the study area, grizzlies prefer the rough, broken terrain of the mountains and hilly regions. Areas of low relief, continuous bog, or homogenous forest cover offer little choice of food and receive little use. Observer error was greater in heavily-forested regions. Black bears were sighted more frequently in the Boreal Forest regions.

Grizzly bear were more numerous in the northern portion of the study area, utilizing low relief tundra areas such as the Yukon Coastal Plain, Richards Island, and the Tuktoyaktuk Peninsula. Grizzly bear sightings were most numerous in the mountain regions of the northern Yukon.

Den sites are an important factor in considering grizzly bear habitat, and records indicate long-term use of individual dens. Dens are difficult to locate, and only a few dens have been recorded. Known sites were usually found associated with mountain slopes, hills or streambanks.

5.4.5 Speculations on Impact - Grizzly Bear

Grizzly bear distribution along the pipeline corridor varies from almost nil in some southern sections to high densities in the northern and mountainous regions. The amount of bear disturbance and the occurrence of man-bear interaction will probably increase as construction programs move into habitat supporting higher numbers of grizzlies.

In the past, improper garbage disposal has led to numerous problems with grizzlies, ranging from raided cookhouses to severe maulings. In most cases this has resulted in the destruction of the bear or bears. Effective garbage and sewage disposal systems are vital and should reduce the bear conflicts of this nature.

Denning sites are thought to be one of the most important parts of grizzly bear habitat, especially in zones of shallow active layers. Bears have been recorded using the same dens continually for many years. Disturbance or elimination of denning sites could have a drastic effect on the bear population in some locations.

The chance of man-bear confrontations could be large near den sites, as females with cubs reportedly have small home ranges and usually travel within 10 to 15 miles of their winter dens.

Pipeline construction activities near an abundant grizzly bear food source, such as a caribou calving ground, migration route, or a char stream, would also escalate the chances of man-bear interactions.

Grizzly bears are disturbed by low-flying aircraft, particularly by helicopters. The amount of harassment and the effect it has on grizzly bears can be variable and is largely unknown. Time of year, amount of cover, terrain, sex and age class of the bear, and type of aircraft are just some of the factors involved on the degree of such disturbance.

5.4.6 Speculations on Impact - Black Bear

Black bears are distributed in varying densities along the entire pipeline corridor, with the exception of tundra areas in the extreme northern sections. Although the black bear is not considered as ferocious or unpredictable as the grizzly, it can become a serious nuisance when attracted to construction camps. As with grizzlies, black bears are attracted to camps with poor garbage or sewage disposal. Little is known of denning requirements of the black bear in northern Canada. Since black bears are usually in or near forest cover, the effect of aircraft disturbance would not likely be as great as it would be for grizzlies.

5.4.7 Recommendations - Grizzly and Black Bears

Grizzly bears in the southern sections of the pipeline corridor have been reported to begin emerging from dens in late March. Adult bears were recorded "out" in northern areas as early as April, and most females and cubs are thought to have emerged by mid-June. The males are normally the last to den in the fall and are usually "in" by mid-November. During the period bears are out of their den, the following recommendations are suggested if bear problems are to be kept minimal:

1. Proper incineration or disposal of garbage and sewage is an absolute necessity. Oil or gas-fired incinerators should be installed in all camps and used daily.

2. Camps should not be located in close proximity to known dens during the period bears are "out". Information on den sites at present is limited, but there is suggestion that denning may be somewhat concentrated on specific landforms. Even a "clean camp" could be investigated by bears that normally frequent the area. Sows and cubs would very likely visit camps near dens because they tend to utilize a relatively small home range.

3. Camps should be equipped with some form of scaring devices such as exploding shotgun shells, or flare guns. These could be used to frighten bears that have approached camps. The development of a chemical that will effectively repel bears from camps would be invaluable.

4. A firearms restriction for all personnel involved in pipeline activities should be imposed, with the exception of one rifle per camp that would be used in cases of absolute emergency. This regulation would virtually eliminate any form of hunting from these camps.

5. Strict regulaticns concerning aircraft should be imposed in some locations of the pipeline route. Continuous and intense aircraft use involved in pipeline activities is certain to have some effect on grizzly bears, particularly in tundra regions supporting high populations.

With the influx of people expected with pipeline activities, the sport hunting of grizzly bear is likely to increase, especially in the northern portion of the corridor. Although there seems to be large numbers of bears in some areas, little is known about the productivity of these bear populations, and thus, an increase of sport hunting should be closely regulated to prevent an overharvest.

Table 5. A summary of possible effects a gas pipeline may have on grizzly bear.

Activity	Potential Effects	Magnitude
Improper garbage and sewage disposal at construction camps	Bears are attracted to camps with poor garbage or sewage disposal systems. Grizzly bears are potentially dangerous when feeding around garbage and as such are often shot.	Large
Location of camps in high density areas of grizzly bears and black bears	Bears are often attracted to camps out of pure curiosity and by strange odours.	Moderate
Firearms in construction camps	Grizzly bears have often been indiscriminately killed by personnel in camps for no justifiable reason. Hunting from large camps, particularly in high density areas on tundra zones may cause a drastic reduction in the bear population.	Large
Intensive low-level aircraft use in high density bear habitat	Intensive aircraft use on tundra areas could force bears to vacate the area.	Moderate
Camps located near grizzly bear dens	Camps located near den sites would increase the chance of man-bear conflicts as female-club groups have a small home range.	Moderate
Destruction of den sites during extraction of granular materials	Destruction of winter dens of grizzly bear could force these animals to locate in other areas of lesser quality habitat.	Large
Increased access and hunting of grizzly bears	Due to the increase in human population and sport hunting activities associated with pipeline development, overharvest of grizzly populations might occur. Roads and cutlines constructed by the pipeline would increase access for hunters.	Large

5.5 ARCTIC FOX

5.5.1 Introduction

Since arctic fox range throughout the Arctic tundra zone, and because fox populations are subject to cycles, the object of the study was to locate and evaluate important habitat units. Efforts were concentrated towards locating maternal den sites and correlating their abundance with general physical features and vegetation types. Consultation with trappers and fur dealers assisted in delineation of winter distribution and in habitat classification.

5.5.2 Methods

Preliminary Office Activity

Other than general distribution maps, very little scientific information was available on arctic foxes within the study area. Publication on other studies of arctic foxes were reviewed and assisted in outlining an effective field program.

Field Activities

Surveys were conducted out of Inuvik, N.W.T., and a field camp near the Firth River. A Cessna-185 and Bell-206 Jet Ranger were used with two observers (one on each side) equipped with 1:250,000 scale maps, tape recorders, and cameras. Selected areas were flown systematically at altitudes of 300 to 500 feet.

Two surveys were conducted. The first was in early May when female foxes prepare their dens for whelping. It was surmised that the re-digging or cleaning out of dens would leave soil materials on the surrounding snow, which could be observed from the air. The second and most successful survey using a Bell-206 helicopter was in early July, using the method described by Macpherson (1969).

Observers watched for lush, green patches of vegetation which occur around den sites. Once a potential site was located, the helicopter landed, and the site was investigated. Photographs were taken of each den, and a brief description made of site features. All locations were recorded on 1:250,000 scale maps.

In the Herschel Island and Tuktoyaktuk regions, local trappers assisted researchers in guiding them to den sites. Limited information was gathered from interviews with trappers and a local fur buyer at Tuktoyaktuk.

Analysis and Final Mapping

Since the entire Arctic tundra zone can be utilized by arctic foxes, it was decided that relative abundance of dens would be the main criterion used in classifying arctic fox habitat. Information from trappers, landforms, and vegetation types were used to delineate and describe habitat units.

Arctic fox range is restricted to the Arctic tundra regions of the study area. The tundra zone includes the Yukon Coastal Plain, the lower Mackenzie Delta, the Tuktoyaktuk Peninsula and a large area extending from the Eskimo Lakes to the lower Anderson River. In classifying arctic fox habitat, data combined from various sources were used. Basic landforms, vegetation types, distribution and trapping records were examined. These were correlated with observations on active dens and general habitat information collected during the 1972 field season. Due to the lack of past information and the difficulties encountered in evaluating arctic fox habitat, ratings were assigned on a relative basis. In some cases extrapolations were made to areas of limited information. Areas with a large number of active dens were given the highest rating; while inland areas used only occasionally by winter transients were considered poor.

Although difficult to assess on a land classification basis, the presence of good food sources is very important to arctic fox survival.

Class 1

A class 1 unit has no obvious factors limiting arctic foxes. These units possess the qualities of suitable soil composition necessary in denning, abundant food supplies, and preferred vegetative cover. High numbers of fox dens were recorded in class 1 areas.

Class 2

A class 2 unit has minor limitations for arctic foxes. These areas have most of the requirements important for foxes but lack quality, making them less than optimum. Dens were recorded in most of these units. A large number of foxes often winter in these areas during peak population years.

Class 3

A class 3 unit has moderate to severe limitations for arctic foxes. These areas lack qualities essential to good fox habitat. Only occasionally have foxes been recorded in these areas, usually during winters of peak populations.

Class 4

Class 4 units have severe limitations to arctic foxes. Some class 4 units, in clcse proximity to good habitat, may receive an occasional transient during high population years.

5.5.3 Results and Discussion

Evaluation of arctic fox habitat is difficult in that fox populations are cyclic, and the animal cannot be censused easily. The main criterion used in assessing arctic fox habitat in this study was the relative density of maternal dens on potential fox range. Den sites are re-used for many years. Areas which did not have a large number of dens, but are used during the winter period, were also evaluated.

Surveys in May were not successful and were terminated after a short trial period. Freshly excavated sites could not be located from the air, probably due to the high and drifting snow conditions which were common in open tundra areas.

The second set of surveys were conducted in July when the vegetation was mature and observations of den sites would be easiest. The lusher vegetation around den sites is due to added soil fertility as a result of fecal droppings and discarded food scraps.

Ground squirrel dens and fox dens are very similar in appearance, and clcse examination was required to positively identify sites. High populations of ground squirrels were encountered along the Yukon Coastal Plain and the Tuktoyaktuk Peninsula.

The greatest concentration of arctic fox dens was found in the Herschel Island mapsheet area. Dens occurred on a variety of sites, including sand dunes in river deltas, frost heaves, and the banks of rivers, lakes and streams.

Crests of low hills were also favored. On the Tuktoyaktuk Peninsula, all dens located were in sand dunes along the north coast. These were extremely difficult to observe due to the low fertility and poor vegetative growth which occurs in sand areas. Nearly all den sites were in a position to command a good view of the surrounding area, and all were near fresh water. Dens were usually dug in porous soil materials.

Colored or red foxes are common throughout much of the tundra region, and are most abundant in the shrub-tundra transition zones. Several colored fox dens were located, and a small overlap between the ranges of colored and arctic foxes was noted. Arctic foxes prefer to den in regions of low vegetation with little or no shrub thickets. All arctic fox dens were in the open on relatively low relief sites, whereas colored fox dens were often found on steep banks and hillsides.

Local trappers reported that in years of high population, arctic foxes come in off the sea ice to the coastal areas. Although large scale movements of arctic foxes have not been scientifically documented, cases of individual foxes moving several hundred miles have been recorded. Movement of this sort probably occurs only in the winter when food supplies are low. The Hudsons Bay Company fur-buyer in Tuktoyaktuk stated that the 1971-72 trapping season was the best in years. The coastal areas are favorite trapping sites for residents of Herschel and Tuktoykatuk.

5.5.4 Conclusions

The greatest concentration of arctic fox dens was found in the Herschel Island map area. Dens occurred on a variety of sites, including sand dunes, frost heaves, and the banks or rivers, lakes and streams. Nearly all den sites were in a position to command a good view of the surrounding area, and all were near fresh water. Dens were usually dug in porous soil materials.

Colored or red foxes inhabit tundra zones, but are most abundant in the shrub-tundra transition zones. Arctic foxes prefer to den in regions of low vegetation with little or no shrub thickets. Nearly all arctic fox dens were in the open on relatively low relief sites, whereas, colored fox dens were usually found on steep banks and hillsides.

5.5.5 Speculations in Impact

Arctic fox range extends over the whole Arctic tundra zone, of which the study area covers only a small part. The mapsheets which have arctic fox range are:

Demarcation Point (117C), Herschel Island (117 D), Blow River (117 A), Aklavik (107 B), Mackenzie Delta (107 C), Stanton (107 D), and Cape Dalhousie (107 E).

As the proposed pipeline route crosses several areas of good fox habitat, the possible effects of this development must be considered.

One of the most important requirements of arctic fox habitat is denning sites. Foxes prefer to den in areas of fine well-sorted silt, sand or gravel. Extraction of granular material for pipeline construction could result in habitat degradation by reduction of denning sites. High density denning areas, such as those on the Herschel Island mapsheet, would be particularly vulnerable. This is especially so, as it is known that dens are used for long periods of time. It has been estimated that some dens in the Eastern Arctic have been in continual use for over 200 years (Macpherson, 1969).

Harassment by aircraft, heavy equipment, or explosives could result in females abandoning their young, therefore caution should be exercised during the whelping and denning period from mid-May to early September. Arctic foxes often scavenge during winter periods and are easily drawn to raw garbage. During the winter, hungry foxes show little fear of man, and will most certainly be attracted to camps. This is not desirable, as foxes are known carriers of rabies.

5.5.6 Recommendations

1. Proper incineration or disposal of garbage and sewage is an absolute necessity if foxes are to be kept away from camps. Oil or gas incinerators should be installed in all camps and used daily.

2. The use of non-toxic chemicals to repel foxes from garbage disposal sites would be invaluable.

3. Restriction of firearms for all personnel involved in pipeline activities should be imposed. This should apply to native and white employees alike, thus eliminating hunting around the camps.

Extraction of gravel at or in close proximity to dens is not recommended. Destruction of den sites and disturbance of active dens would seriously limit foxes.

5. To minimize harassment by aircraft, it is recommended that air corridors be incorporated.

Table 6. A summary of possible effects a gas pipeline may have on arctic foxes.

Activity	Potential Effects	Magnitude
Improper garbage and sewage disposal at construction camps	Foxes are attracted to camps with poor garbage or sewage disposal systems. Foxes are known to be carriers of rabies.	Large
Location of camps in high density areas for arctic fox	Foxes are often attracted to camps out of pure curiosity and by strange odors.	Moderate
Intensive low-level aircraft use in high density fox habitat	Aircraft harassment in proximity to arctic fox maternal dens may cause abandonment of the young.	Moderate
Destruction of den sites for granular materials	Destruction of maternal den sites of arctic fox could force these animals to locate in other areas of lesser quality habitat.	Large

5.6 BEAVER AND MUSKRAT

5.6.1 Introduction

Justification

Within the framework of Northern Pipeline Studies, beaver and muskrat populations may be viewed in terms of two sets of interrelated values. Features that directly involve human interactions may be thought of as social values, while those relating to the interactions of each species with its natural surroundings are environmental values. Both sets of values are difficult to quantify but demanding of attention if wildlife is to be a part of land-use planning programs.

The role that beaver and muskrat populations play in shaping the life-style of northern peoples is quite diverse but influenced strongly by economic factors. On the fur market, beaver and muskrat compete locally with upland furbearers, mink, marten, and lynx. Although time of harvest differs for the two groups, the effort expended on harvesting either group is in part dependent on current market values. Of much greater significance is the tendency for beaver and muskrat populations to achieve high densities within suitable aquatic environments. Thus trappers are able to establish semi-permanent base camps and collect large numbers of furs within a short time period. Because beaver and muskrat achieve and retain pelt primeness through late winter and spring months, trappers may take advantage of the longer periods of daylight and higher temperatures to accomplish the harvest. Entire families may participate in the spring hunts which have become a tradition within northern communities. A further feature of beaver and muskrat harvest programs, which tends to de-emphasize market values, relates to food value of the animal carcass. Most newcomers to the rat camps are pleasantly surprised by the palatability of freshly caught muskrats which are so important in the diet of native trappers.

From an environmental standpoint, beaver and muskrat activity often has a readily-apparent influence in shaping and modifying aquatic ecosystems. Changes in plant succession that are evident above beaver dams are complemented by modified downstream flow regimes; in both instances the trend is toward more permanent aquatic habitat. Muskrats fall prey to one or more species of mammals, birds, or fish throughout the year. As such, their position on the food chain can be vital to the perpetuation of specific communities.

Objectives

This brief overview seeks to place in perspective the kinds of factors asscciated with beaver and muskrat populations within the study area. Certainly the range is far too broad tc allow extensive investigation of all relationships within the allotted time period. Identification of habitat and description of habitat types appears to be a logical starting point in providing information for land-use planning programs or setting the stage for more detailed research.

Preliminary identification of beaver and muskrat habitat within the Mackenzie Valley and northern Yukon was facilitated in part by recognition of current and traditional trapping areas throughout the corridor. Through aerial surveys of representative wetland and stream complexes, additicnal areas of occupation were located and delineated. Classification of habitat followed as an attempt to compare physical attributes of identified habitat in terms of known requirements of beaver and muskrat populations.

5.6.2 Methods

Literature Review

Literature searches were conducted during the fall and winter of 1971-72 to provide project personnel with some insight into the landscapes and communities present within the study area. Beaver surveys carried out by C.W.S. personnel after 1948 were particularly applicable to the furbearer program. Personal interviews were held with scientists who have been, or are, conducting research on aquatic species in the Mackenzie area. Field officers of the Northwest Territories Game Branch were contacted during preliminary field trips. Information requested during these interviews centered on beaver and muskrat population distribution, limiting factors, and intensity of harvest operations.

Preliminary Mapping

Major wetland regions and drainage systems were outlined on 1:250,000 National Topographic Series maps. These preliminary boundaries were established on a basis of geographic proximity, surface area and shoreline configuration of lakes or ponds, and size or channel form of stream systems.

Landscape components, particularly the resultant features of continental glaciation, were identified through reference to surficial geology maps supplied by the Geological Survey of Canada and the Canadian Forestry Service. Supplementary material included aerial photography and Forest Management Institute cover maps.

The next step was to group wetlands and stream systems into distinct units on the basis of gross outward similarities as dictated by their geologic origin and subsequent development. Units at that point were represented by geographically distinct groups of deltaic, oxbow, meltwater channel, glacial lacustrine, morainal plain, or bedrock lake basins and associated streams. Within these units sample sites were selected for field surveys.

Field Surveys

Immediately before spring breakup, muskrat pushup surveys were conducted from fixed-wing aircraft (Cessna-185, Beaver) to determine current distribution and relative abundance of the species within the various units. Efforts were concentrated in the higher density wetland areas where muskrat populations were generally known to occur. In this regard it was assumed that if construction activity impinged on wetlands there could be a much greater overall impact on muskrat populations in high density wetland complexes than in isolated and individual lakes and ponds. It should be noted that the same assumption does not necessarily hold true from a strictly environmental standpoint.

During the summer months aerial surveys were continued to obtain a more detailed picture of types of terrain, vegetative communities, lake and stream shoreline development, water depths, and evidence of muskrat or beaver populations. Whenever possible two observers accompanied each flight, although useful results were obtained by one observer assisted by the pilot. Flight altitude was kept as low as weather and terrain conditions allowed, usually 300-600 feet above ground level. Observers used portable tape recorders and flight-line checkpoints to document observations in flight.

In mid-September, beaver surveys were conducted within representative portions of the established units. Flight lines were generally established along stream systems and lakes to take advantage of readily apparent landmarks, but a few grid patterns were flown over high-density wetland units. Records were kept of all observations of current or past beaver activity, including lodges, food caches, or dams.

Classificaticn

After field notes and population data had been transcribed and compiled, unit boundaires were adjusted to accommodate specific habitat units. Each unit was given a classification based on its relative importance in terms of beaver and muskrat.

5.6.3 Results

An atlas* of topographic maps outlining beaver and muskrat habitat within the study area provides the basic results of 1972 field programs. Each landscape unit has been assigned a classification; the classification system has been explained, and a few illustrations of representative areas are included. A short summary is incorporated within this report to focus attention on geographic areas of better quality habitat.

5.6.4 Discussion

Limitations

Within the study area, beaver and muskrats can generally be found wherever the basic habitat requirements, including suitable food and shelter, are available. The success of each species, as judged by its ability to reach higher density levels, is a direct function of the degree to which these requirements are met. Optimum environments, imposing few stresses on the population, ultimately result in a harvestable surplus.

Classificaticn

Several factors must be kept in mind when examining, or attempting to extrapolate from, the habitat classification. Both species, but particularly muskrats, are known to exhibit marked fluctuations in population densities in more southern regions. Possibly the same factors responsible for these fluctuations influence populations within the study area. Management personnel are well aware of decimation of beaver populations in the Mackenzie region as a result of excessive harvest programs. Thus, populations observed within a specific area at any given time do not necessarily provide a reliable picture of habitat quality. This problem is compounded by the requirement that census programs are

*See note in Table of Contents

based on interpretation of secondary indicators. Lodges, bank dens, dams, food caches, pushups, runs, and vegetation cuttings are the observable indicators of beaver or muskrat activity, and each provides a degree of variability in numbers of animals involved.

From a positive standpoint, indications of current or past populations, as compared to no occupancy indicators, provide a base from which to continue evaluations of the physical components of a given aquatic environment. A few examples will serve to illustrate the use of population data in achieving a habitat classification.

Records from spring surveys on the Old Crow Flats showed two lakes, in close proximity, one having an abundance of muskrat pushups, the other apparently barren. Subsequent ground checks after breakup showed the barren lake to be very shallow, turbid, and nearly devoid of aquatics, while the lake supporting muskrats was deeper, clear, and producing an abundance of aquatics.

Within the Mackenzie Delta, very few active beaver colonies were recorded during the study period, yet many lakes and channels provide suitable banks for denning and there is an abundance of available food species. Harvest records and previous surveys indicate a good distribution of beaver through the Delta in past years. Contrary to current population indicators, potential habitat does indeed exist within this complex.

A third example is found in the many lakes occupying the northeast portion of the Arctic Red River mapsheet. The evident lack of beaver activity in this area can be related to shallow gravelly shorelines and extremely limited deciduous tree cover. Under those conditions it is probable that beaver could exist only on a temporary or transient basis.

In all cases the habitat value or class, attached to each landscape unit and denoted by a numerical scale from one through four, presents a subjective summary of available information. No rigid formulas were developed to reduce subjectivity because the vast majority of input from field studies is of a descriptive nature.

5.6.5 Potential Construction Impact

The Factors

Factors associated with construction programs, which may have a bearing on beaver and muskrat populations, fall into two broad categories. First there are the activities resulting in habitat modification which can have both direct and indirect influences on populations. A second category includes those factors initiating behavioral responses, and the influences of man, as the ultimate predator, on muskrat and beaver populations. The former encompasses alteration of water regimes (both timing and volumes), introduction of sediment loads, introduction of foreign substance, modification of forest fire effects and removal of riparian cover. The latter includes audio-visual disturbances and harvest programs subsequent to improved access to favorable locations.

The Environment

Stream complexes and standing water bodies within the study area are intimately associated, particularly so in terms of beaver and muskrat habitat; however, the two aquatic environments may respond quite differently to any particular landscape disturbance factor. Also, the extent to which a disturbance factor may exert its influence on each aquatic environment will depend largely on the position of such activity within any given drainage basin. It is unlikely that moderate alterations of downstream channels will have appreciable effects on headwater lakes; likewise, downstream lakes may serve as buffer zones to temporarily offset the influence of upstream activities. The measure of "uniqueness" inherent within the particular aquatic environment, or attributed to its location within the drainage basin, facilitates separation of standing water habitat and flowing water habitat in the following discussion.

The Relationship

A(1) Standing Water Bodies; Water Level Alterations

a. Complete Drainage.

Complete drainage of a lake or pond usually implies total loss of current populations of muskrats and beaver and available habitat.

b. Partial Drawdown.

Through much of the better quality standing water habitat, depth is a critical factor to overwintering beaver and muskrat populations. Drawdown could allow frost levels to penetrate to and into the substrate, effecting winter-kill. Drawdown in late fall, after overwintering dens and lodges are established, would invariably result in direct mortality. In specific instances reduction of water levels could be instrumental in promoting the establishment of emergent vegetation. This would apply primarily to deep lakes, with narrow poorly developed shorelines, such as occur within many glacial meltwater channels. The benefits gained in terms of increased emergent vegetation would vary directly with the surface area exposed by drawdown and the subsequent stability of water levels.

c. Flooding.

Temporary high water levels and resultant flooding of onshore communities is initially beneficial to many aquatic systems through addition of organic nutrients. However, if the timing and duration of flooding does not closely approximate natural seasonal fluctuations the over-all and long-term effects will likely result in poorly developed aquatic and shoreline plant communities. Edge effect, defined as the tendency toward greater variety and density of organisms in the boundary zone between communities, can be significantly modified by flooding. Landscapes exhibiting a high degree of interspersion of water and land provide a favorable edge effect in terms of beaver and muskrat populations (i.e. a high ratio of shoreline to surface area). Inundation of intervening land surfaces essentially reduces the shoreline-surface area ratio and results in a less favorable edge effect. The converse may be true for individual lakes or ponds within areas of low relief. Flooding of proximal, low-lying terrestrial sites can enhance the edge effect and create new habitat for aquatic species. Generally flood effects must be evaluated in terms of each individual set of landscape features.

A(2) Standing Water Bodies; Sediment Load Alterations

The influx of sediments into standing waters normally hastens the aging process through a simple filling-in of the basin. Since optimum habitat for both beaver and muskrats lies somewhere between the deep water lakes and the more eutrophic shallow lakes, the addition of sediment loads must be evaluated accordingly. For those lakes currently occupied by beaver and muskrat populations, sedimentation, on a large scale, probably implies alteration of aquatic plant communities and reduction of available overwintering habitat.

A(3) Standing Water Bodies; Introduction of Foreign

Substances

Within northern latitudes, under the influence of long periods of low temperature, aquatic systems must maintain a rather delicate balance. As such, the introduction of foreign substances presents a potential for extensive and long-lasting effects. Foreseeably those substances associated with construction activity and appearing detrimental to many aquatic systems, and consequently to muskrat and beaver populations, are fuel and lubricating oils, and water-borne toxic chemicals. It is beyond the scope of this paper to discuss the ramifications of oil spills with regards to aquatic systems at large. It is noteworthy that oil has a direct effect on aquatic furbearers in causing matting of the dense underfur with subsequent loss of buoyancy and insulation.

A(4) Standing Water Bodies; Changing Fire Regimes

Fire has historically played an important role in beaver ecology throughout the Mackenzie Valley. Inasmuch as construction activity will alter the potential for fire effect (i.e., improved access will increase potential for man-caused fires and alternately provide for better fire control), it must be included for consideration in any impact assessment. The greatest direct influence of fires on standing water habitat involves interruption of plant succession patterns on immediate uplands. Much greater indirect effects can be realized through the influence of fire on the drainage basin as a whole.

A(5) Standing Water Bodies; Removal of Riparian Cover

Vegetative communities along lake shorelines serve an extremely important function in fostering bank stability, protecting open waters from wind effect and retaining snow cover during winter months. Some terrestrial plants, particularly deciduous shrubs, are a major food source for resident beaver populations. While selective removal of mature trees can promote development of successional shrubby species, complete removal of riparian cover must be viewed as detrimental to the aquatic community.

B(1) Stream Complexes: Water Level Alterations

a. Complete Diversion of Flow.

On headwater streams complete diversion of flow will, of course, eliminate beaver habitat. The effect will be directly realized in downstream areas until optimum flows are regained through convergence of subsequent tributaries. It is important to note that stream systems tend toward a dynamic equilibrium with the landscape (i.e., channel form, vegetative associations), therefore alteration of flow regimes will be expressed in a variety of ways throughout the basin.

b. Partial Reduction of Flow or Change of Regime

Within the stream system, beaver attempt to obtain optimum and stable water levels through construction of dams. Any changes in volume or timing, beyond the capability of the dam to maintain optimum depths, will result in mortality or emigration. Stream flow regimes during the fall and winter are particularly critical to beaver and muskrat. Changes in water levels during that period could restrict access to critical winter food supplies.

c. Flooding

Again, timing becomes critical to beaver populations. Periodic spring flooding is tolerated and favored where it perpetuates the stream side willow-alder communities. At this time beaver are quite mobile and have sufficient time to repair dams or locate new overwintering sites. Exceptionally, or continuously, high waters resulting from diversion of drainage ditches into stream systems may not be tolerated by beaver populations.

B(2) Stream Complexes: Sediment Load Alterations

This is undoubtedly a most significant relationship in terms of both beaver and muskrat habitat, as the stream systems are ultimately reponsible for carrying sediment loads to all downstream aquatic environments. Some very fine habitat has been, and is, perpetuated through annual influxes of immeasurable sediment loads on the Mackenzie Delta; it is difficult to envision significant alterations of that regime. However, small headwater streams, originating on gentle slopes and carrying water through small lake complexes, present an environment that is most susceptible to the effects of siltation. Water depths within this environment, so critical to overwintering populations, can be seriously reduced by sediment deposition. Aquatic plant communities can be retarded through decreased light transmission accompanying turbid waters.

B(3) Stream Complexes: Introduction of Foreign Substances

Again, lubricating and fuel oil and toxic chemicals are of particular significance, with streams serving as very rapid dispersal agents. The effects of these pollutants on aquatic furbearers are discussed under standing water relationships.

B(4) Stream Complexes: Changing Fire Regimes

Emphasis has been placed on the role that fire has played in the past on beaver ecology within the study area. On a protracted time basis, small local burns that favor the seral stages of plant succession can enhance available beaver habitat, whereas burns that encompass whole watersheds, leave streams clogged with debris and susceptible to flash flooding and extensive erosion, will completely destroy beaver habitat.

B(5) Stream Complexes: Removal of Riparian Cover

Streamside vegetative communities play similar roles within the stream environment as within the standing water environment, but their function in furthering bank stability is greatly increased. Roots of nearly all plant species, and the litter layer of decaying vegetation, serve to bind soil particles against the erosive potential of high discharges. Removal of riparian cover favors bank degradation (in itself a loss of beaver habitat) increased silt loads and more rapid runoff with associated downstream flooding.

C(1) Aquatic Furbearers: Audio-Visual Disturbance

Experience with highway rights-of-way and pipeline operations in more southern regions indicates only limited negative response on the part of individual muskrats or beaver with regard to man's activity. There is some possibility of a positive response as evidence by muskrats building bank dens in levees or dykes, and beaver dams, associated with culverts and dykes where stream flow is confined.

C(2) Aquatic Furbearers: Increased Access Through Road Construction

The current lucrative fur market dictates a strong possibility of fur harvesting on local areas made more accessible through highway completion. Indications from past experiences are that beaver populations can be slow to recover from local overharvesting. Muskrat populations, showing a much more rapid turnover, seldom if ever suffer from overharvesting. In many areas productivity is enhanced by harvest programs. The economic importance of the fur resource to local residents should not be overlooked in the light of today's markets.

Table 7. Specific cause-effect relationships between pipeline construction activities and aquatic furbearers.

Construction Activity	Direct Effect	Aquatic Furbearer Habitat Most Directly Affected	Species Affected
Ditching	Drainage of standing waters redirection of runoff and alteration of normal flow regimes	Small headwater lakes within organic landscapes	Beaver, muskrat
		Thermokarst lakes within glacial lake basins	Muskrat, beaver
		Small meandering streams within low relief land-forms	Beaver
Berms, road grades	Increased runoff Obstruction and/or redirection of normal surface and sub-surface flows Introduction of sediment loads	Small meandering streams within low relief areas	Beaver
		Small headwater lakes within organic landscapes	Beaver, muskrat
		Deltaic lakes	Muskrat, beaver
Stream crossing	Introduction of sediment loads	Misfit streams within glacial meltwater channels	Beaver
		Deltaic lakes	Muskrat, beaver
Removal of riparian cover	Loss of bank stability and increased sediment loads	All habitat	Beaver, muskrat
	Loss of food supply	All habitat	Beaver
	Increased potential for downstream flooding	Headwater streams	
Introduction of pollutants including fuels, oils, toxic chemicals	Direct mortality within furbearer populations Destruction of vegetative communities	All habitat Potential damage may be greater within standing waters that lack the "flushing" action of stream systems	Beaver, muskrat

Table 7. Cont'd.

Construction Activity	Direct Effect	Aquatic Furbearer Habitat Most Directly Affected	Species Affected
Operation of engine-driven equipment such as earth movers, compressors, etc.	Noise	Minimal effect	Muskrat, beaver
Borrow pit construction	Degradation of permafrost regime, pot-hole formation	Possible creation of habitat	Muskrat
Roads, trails, landing strips	Increased access	All habitat, particularly high density wetland regions	Beaver, muskrat
	Increased frequency of forest fires Better forest fire control	Small headwater streams, meandering and convoluted mid-drainage streams	

5.7 WATERFOWL

5.7.1 Introduction

Very limited detailed information on the status of northern waterfowl and their habitat was known or available at the start of the study in late 1971. Therefore, study proposals focused on a program whereby, within the time span of approximately 13 months (including the 4-month field season of 1972), valuable information could be collected and used to supplement known or interpretative information. Further, it was intended such baseline information would set the stage for any more specific investigations. The objectives were:

1. Accumulate and compile available waterfowl data and relevant knowledge.

2. Identify waterfowl breeding habitats within regional landforms of the total Canadian Wildlife Service inventory study area, using a 1:250,000 National Topographic Series mapsheet basis.

3. Designate waterfowl habitat "types" based on physical characteristics, and formulate a meaningful class rating system.

4. Field check habitat types and record waterfowl species (ducks, geese, swans; and secondarily, cranes and loons) and presence of wetland vegetation.

5. Assimilate data, and on the basis of collective information available, assign class ratings to known units; apply extrapolation of facts, where necessary, to include all delineated waterfowl breeding habitat units within the study area.

6. Conduct aerial surveys of migrant waterfowl concentration and staging areas.

One point must be made very clear: even as pure inventory data, one year's observations leave much to be desired. Climatic conditions vary, as do the numbers of waterfowl which inhabit the north. Thus, the status of the actual conditions and waterfowl productivity of northern habitats is being assessed from what may in fact be a biased sampling. Further, while an attempt was made to visit a high percentage of habitat during the brief 4-month field season; some areas could not be observed with the time constraint and manpower available.

An assessment of the impact pipeline construction or a transportation corridor would have on waterfowl and their habitat was not planned for study in 1972. Consequently, the predictions herein are based on available knowledge, and are best described as an "educated guess" of conditions that may prevail with proposed development.

5.7.2 Methods

Basic Mapping Stage

Units vary in size to a minimum of less than 1 square mile; and they identify lakes, wetland-upland complexes, rivers, streams, bogs and fens. Wetlands which had similar characteristics and which were in close proximity were lumped into complex or combination units.

Mapping procedures were similar to those of the Canada Land Inventory (Benson, 1965); with less emphasis placed on contours, soils (information severely limited) and geologic landforms.

Air Photo Interpretation

Source data were compiled prior to the field season by a detailed evaluation cf defined waterfowl units using stereoscopic air photo coverage. Physical similarities on sample units were tabulated, noting: regularity and slope of shorelines, wetland densities, aquatic vegetation (presence, absence, distribution), upland vegetation adjacent to wetlands; and islands, bars, oxbows, and flowages of lotic (running-water) environments. Difficulties arose on occasion as segments of aerial photography had been taken up to several decades agc and/or during periods of ice cover on wetlands.

Class Rating System

The main objective of the waterfowl inventory has been to provide a set of maps as a basis whereby the 'relative' importance of waterfowl breeding areas can be compared. The basic 4-class rating system, that has been applied universally to the Canadian Wildlife Service wildlife inventory program, was inadequate for meaningful waterfowl habitat evaluations because excellent and very poor waterfowl breeding habitats were already known or easily defineable. Therefore three "sub-classes" were inserted and, consequently, ratings assigned to the present map series are: Class 1 - excellent breeding habitat: Class 2a - very good, Class 2b - good; Class 3a - fair, Class 3b - poor; Class 4a - marginal, Class 4b - of insignificant or nil value.

Accumulation of Available Information

Complementary to sources of information consulted for the inventory and mentioned earlier, additional sources were pursued. The U.S. Fish and Wildlife Service conducts an annual aerial waterfowl species survey in the Western Arctic to compile a rough index of breeding waterfowl populations. As approximately 1600 miles of flightline laterally segment the study area, unadjusted figures for 1970 and 1971 were obtained and were useful as a check of unit ratings once designated.

Field Investigations

Field checking of the waterfowl habitat units delineated on preliminary maps began in late May and extended to mid-August. A fixed-wing Cessna-185 aircraft was used for low-level surveys of habitat; and, on occasion, systematic population counts were made. Usually two observers accompanied the pilot: one observed general waterfowl species and numbers present, and the other noted bio-physical characteristics of wetlands.

With the onset of spring breakup, aerial surveys began in the southern region, and continued throughout the summer on the entire inventory corridor. Flights were selectively planned to intersect a maximum number of wetland units. Most areas were visited once; and some several times.

Representative and unique wetlands, selected on the basis of air photo interpretation, were visited on the ground. A Bell-206 helicopter was used to visit wetlands where other aircraft could not land.

Collected information focused on measured water depths of wetlands, species composition and abundance of aquatic plants, physical and biotic characteristics of shorelines and uplands, and species and approximate numbers of waterfowl.

Assimilation of Data

As a consequence of many recurring physical characteristics, the four main classes of waterfowl habitat have been considered in terms of the kinds of wetlands that comprise them, with subsequent incorporation of information on breeding waterfowl pairs and broods observed during spring and summer surveys.

Decisions for final unit ratings on the illustrated mapsheets were a result of consultation by at least two of the three waterfowl habitat investigators.

Migration and Staging Surveys

Aerial surveys from the Cessna-185 aircraft were generally flown at altitudes under 500 feet above ground level, and at speeds under 100 miles per hour. Routes were planned and flown to coincide with spring breakup or, at least, the first traces of meltwaters along the Mackenzie River where migrant waterfowl were known to congregate. Two separate return surveys along the corridor (from south to north to south) were flown in the month of May. In addition, localized counts were undertaken along the Mackenzie River and on large lakes and rivers where concentrations were suspected.

As breakup progressed, survey emphasis focused on assessing waterfowl breeding habitat. During July and August, breeding pair and brood production surveys encompassed the entire study area.

Migrant waterfowl using the Mackenzie River as a flyway route were monitored at Fort Simpson during late August and September. This undertaking was part of a concerted effort involving personnel from government and private wildlife investigation groups to study the fall migration of waterfowl from the western Arctic. Due to delays in computer processing, study results are not available as of April 1973.

5.7.3 Results and Discussion

Illustrated Waterfowl Habitat

A mapsheet series which consists of reduced copies of 1:250,000 National Topographic Series mapsheets depicting present waterfowl habitat values for the study area is contained within a booklet titled 'Atlas of Waterfowl Habitat Maps'.* The most significant information to be conveyed is the <u>relative</u> importance of areas to one another, consideration being given to physical features and the densities of waterfowl species inhabiting individual areas.

*See note in Table of Contents

It is important to point out here that northern waterfowl habitats produce fewer ducks than prairie wetlands on a per-acre basis; however, a number of waterfowl species depend on northern habitat for their very existence and the maintenance of present continental populations. Portions of the Arctic Tundra Biome are heavily utilized by major populations of geese and swans.

Wetland Descriptions

Wetland descriptions are provided in the Atlas to ensure that the reader gains an appreciation of characteristic aquatic environments which comprise the habitat for both waterfowl (including large water birds such as cranes and loons) and aquatic furbearers (beaver and muskrat). Further, they help to convey an understanding of delineated habitat units on the illustrated waterfowl maps.

5.7.4 Implications and Recommendations

Efforts to date have been oriented toward an inventory of waterfowl and waterfowl habitat within a vast study area, which includes all probably transportation routes Because of time limitations, it was not possible to undertake specific "impact" studies which would yield information concerning the effects of development activities on wetlands habitat or waterfowl species.

Basically, an impact study requires two separate sets of data before such a study can be undertaken. These are: (a) the sensitive components of given ecosystems, and (b) the actions which are expected to cause the impact. In the case of arctic waterfowl, the sensitive factors in habitat, behavior and population dynamics, are little known; and the expected actions are unknown to us either in magnitude or in exact geographic location.

With the information which is at our disposal now, it is possible only to speculate on the possible effect of pipeline construction in the study area, using inventory data, experience of habitat management, behavior of waterfowl, information on bird migrations, and whatever information cn pipeline construction that is available.

Discussion pertains to general speculations only. Detailed speculations or forecasts would require mile by mile investigations when the exact pipeline location and construction methods are known. In other words, the purpose of this section is to assess the general effects of pipeline construction on waterfowl and waterfowl habitat.

The following are factors of concern should construction plans materialize for any gas or oil line, or highway.

1. Loss and degradation of waterfowl habitat.
2. Disturbance of waterfcwl.
3. Excessive harvests of the waterfowl resource.

Loss and Degradation of Habitat

Loss of habitat will be caused by complete or partial drainage, drowning, or filling in with solid materials. Degradation of habitat can be caused by changing water levels, permanently or during certain periods; siltation; wildfires in the ecotone surrounding the habitat; or pollution of the water with foreign materials.

It is assumed that construction of a buried pipeline will use a six or seven-foot deep trench, which will be dug as straight and as level as terrain conditions permit. The effect of such a trench on water levels or nearby wetlands is not known. A further assumption is that such a pipeline will be buried in the bottom of shallow lakes, ponds and marshes; but that it will go around deep lakes.

A buried pipeline going through a shallow lake or marsh should have little lasting effect on the habitat quality - if the thermo-regime of the water near the pipe is not altered due to the heat loss of a hot oil pipeline, or the chilling effect of a chilled gasline. Insulation will reduce the rate of heat flow and effects are expected to be local and not generally degrading to the habitat. Gradient approaches of pipeline crossing lakes and marshes should, of necessity, be quickly restored to simulate natural conditions, thereby minimizing drainage alteration.

Where the submerged pipeline crosses a stream it is vital to restore the natural profile of the stream in order to avoid stream diversions and water-level changes in the watershed which could cause drainage or drowning of marshes. At stream crossings it is important to avoid the erosion of fill which could cause silting of marsh areas and the included aquatic vegetation.

Fires should be avoided, especially near wetlands. Although the vegetation of the edge of wetlands may seem unimportant to waterfowl, these sedges, grasses, ericaceous shrubs and willows provide vital nesting and escape habitat. It is expected that indirect degradation of wetland edges through exposure of permafrost, and consequent slumping of banks will occur, but it is not known that such slumping will continue or that the same plant communities will return and stabilize the bank or wetland's edge. Further, it is expected that the regeneration of the desirable plant species would be slow, and therefore the habitat would degrade in quality for several years to come. If a fire would occur in such habitat during the nesting season, nesting waterfowl would lose their clutches of eggs without an opportunity to re-nest successfully. One can expect more numerous man-caused wildfires with the proposed development; however, improved surveillance and access may facilitate better control of naturally-occurring wildfires.

It is of the greatest importance that gasoline, diesel fuel, other petroleum products, and toxic chemicals should be stored in such a place that, in case of a leak, such fluids do not flow into a drainage system. These fluids would cause disastrous effects on waterfowl; and even if the spills occurred in the absence of waterfowl, long lasting remnants of them could cause serious mortality during later use of affected wetlands by waterfowl. It is assumed that an oil-line will be designed to be leakproof, but the disastrous lasting effects of oil in waterfowl habitat cannot be over-emphasized.

In the spring, the islands in the Mackenzie River serve as resting areas for large numbers of migrating geese and swans. At the peak of migration more than 100,000 birds may concentrate on favorable resting areas such as sandy bars and island fringes. It is expected that the removal of sand and gravel from these areas will change the ecosystem and would make these areas unsuitable as resting and feeding sites. For instance, it may be expected that the removal of sand and gravel will change the profile of the shoals which in turn will have a detrimental effect on the aquatic vegetation and invertebrate organisms, both of which may be used as food for waterfowl. Also, removal of sand bars and spits may result in exposure to wind and wave action of formerly sheltered resting areas. To sum up, it is expected that removal of sand and gravel from sand bars and island fringes will result in degradation of migration habitat, which could seriously affect migrant geese and swans.

Outlets of tributaries to the Mackenzie River are, following break-up, frequented by large concentrations of waterfowl such as scaup, oldsquaw, scoters, and loons. These migrants use these water areas because they provide open waters early, and likely have a richer food supply than the main river. It is expected that any restriction of stream flow upstream from such outlets will result in degradation of these resting and feeding habitats.

The coastal zone of the Beaufort Sea, which consists of large bays such as Shallow, Kugmallit and Liverpool bays, is especially important to arctic waterfowl. The shallow waters along the ocean foreshore, especially those protected from the open sea by barrier beaches, provide moulting and staging areas for an important part of the continental waterfowl population. For instance, from mid-August until freeze-up (mid-September) practically the entire continental population of lesser snow geese utilize the coastal zone usually along the North Slope of the Yukon. Geese, Brant, swans, and ducks (including sea ducks) may total 300,000 and more birds in this area.

It is expected that physical changes to the coastal zone, e.g. through removal of sand and gravel, or a transportation system using causeways to connect sand bars, would be detrimental to this type of habitat because a change in currents and a resultant reduction in the production of biomass of aquatic food species are distinct possibilities.

In this type of habitat, where bio-degradation is slow, the spectre of oil pollution looms large. Even in the case where oil would not be transported by pipe through this area, the danger of pollution of this fragile habitat by oil used by shipping or land-based activities is a constant threat.

A short summary of expected effects upon waterfowl habitat which may be incurred by major development is presented in Table 8.

Disturbance of Waterfowl

Waterfowl are sensitive to disturbance by man and machinery. Reactions to disturbance vary among species of ducks, geese, and swans, but the first reaction to a possible threat is flight. Because waterfowl are extremely mobile, disturbance and harassment (including excessive noise and irresponsible shooting) can cause them to desert favorable resting, feeding or nesting habitat and thus lessen the chance of survival of the species.

The Waterfowl Atlas shows critical waterfowl migration habitat. Part of the Mackenzie River complex of islands, outlets of tributaries, and marshes adjacent to the River make up a portion of this critical habitat. Large numbers of migrants, such as 100,000 geese and tens of thousands of scaup, scoters, oldsquaw and other species, use the Mackenzie River and its associated wetlands when the first sign of break-up appears; and move northward with ice break-up and rising waters. This migration period spans all of May and sometime extends into June, depending on seasonal variations. These species are very intolerant to disturbance and it is expected that human activity within close proximity of such areas will harass the birds. Furthermore, it is expected that the effects of blasting as far as several miles away may cause the birds to leave preferred habitat. Overflights of low-flying aircraft can be expected to disturb birds beyond the threshold of tolerance; large helicopters in particular should avoid over-flights of critical waterfowl areas.

Nesting waterfowl are extremely intolerant to disturbance. An extended period of such disturbance may cause the incubating bird to desert the clutch altogether, or to leave the nest, subjecting the eggs to low temperatures and to attacks by avian and terrestrial predators.

It is expected that disturbance by man and/or aircraft of breeding swans and geese during the period from May 20 to July 1 will cause a serious loss of production.

In early August, waterfowl begin to concentrate along the coastal zone until the total populations have built up to 300,000 or more birds. Geese feed on sedges and berries on the upland slopes and, in doing so, condition themselves for the long flight southward.

It is expected that disturbance by man or by aircraft of waterfowl on the staging areas and feeding grounds from approximately August 10 to freeze-up will cause unnatural mortality due to displacement of birds from their critical traditional feeding, loafing and resting areas.

Results from a study on the outer Mackenzie Delta, near the Kendall Island Migratory Bird Sanctuary, by Barry and Spencer (1972) indicated that overall waterfowl production declined and populations of snow geese were markedly reduced in proximity (1 1/2 miles) to an area of major activity (a drill rig site). Also, in July, family groups or flocks of flightless moulting birds moved to a distance of several miles distant, avoiding the habitat they had used in past. A most important inference resulting from that study is that any development camps, settlements, and major supply routes, should be located at least 3 miles distant from critical waterfowl areas.

A short summary of expected disturbances to waterfowl which may be incurred by major construction activities is presented in Table 9.

Excessive Harvest of the Waterfowl Resource

It may be expected that construction activities and the presence of the pipeline with its facilities for access will increase the present low waterfowl harvest through hunting. During the construction stage, if regulations concerning the restriction of firearms are observed, a slight increase in harvest other than by natives can be expected. However, as areas become more accessible, adventurous "outsiders" will take advantage of the large concentrations of waterfowl, particularly in the coastal areas where one presently would have the opportunity to kill several hundred geese per day. In order to prevent excessive kills, strict enforcement of regulations and inspection of hunting camps would be required.

Table 8. A summary of expected effects upon waterfowl habitat which a pipeline or highway construction may produce.

Waterfowl
Expected Effects

I Loss and Degradation of Habitat

Cause	Possible Effects	Magnitude
Trenching in wetlands without proper grade	Change of drainage; redirection of runoff; channelling of surface and sub-surface drainage	Small-large depending on topography
Creation of berms, road base	Disturbance of runoff and normal drainage	Small-moderate
Construction of borrow pits	Habitat creation	Moderate (favorable) consult Biologist
Heat loss or chilling incurred by buried pipe	Change of thermo-regime	Small-moderate
Stream crossing of pipeline	Drainage or drowning	Small-moderate
Stream crossing of pipeline	Erosion of fill; sedimentation and filling in of basins; succession of vegetation species	Small-moderate
Wild fires	Loss of nesting and escape habitat	Moderate
Pollution by oil, petroleum products, or other toxic chemicals	Serious degradation of habitat, damage lasting for years (direct mortality to local birds)	Large
Removal of sand and gravel from river islands, bars, etc.	Serious degradation of habitat possibly lasting	Moderate
Diversion of tributaries to Mackenzie River	Serious lasting degradation of habitat	Moderate
Removal of sand and gravel from coastal formations or change of such formations	Serious lasting degradation of habitat	Large

Table 8. Cont'd.

Cause	Possible Effects	Magnitude
Oil or toxic chemical pollution of coastal waters	Serious lasting degradation of habitat (direct mortality to local birds)	Large-disastrous

Table 9. A short summary of expected disturbances to waterfowl which may be incurred during pipeline or highway construction.

Waterfowl Expected Effects II Disturbance		
Cause	Possible Effect	Magnitude
Construction, and particularly blasting within two miles of designated areas of Mackenzie River May 1 - June 15	Disruption of migration pattern	Large
Overflight of aircraft less than 2,000 feet altitude over designated areas May 10 - July 1	Disruption of migration pattern	Large
Disturbance by man or aircraft of designated waterfowl breeding areas May 20 - July 1	Serious disruption of breeding and abnormal mortality	Large
Disturbance by man or aircraft of designated staging areas August 10 - September 21	Serious disruption of staging, possible premature migration; abnormal mortality	Large

5.8 RARE AND ENDANGERED SPECIES - RAPTORS

The raptors referred to in this section are the peregrine falcon, gyrfalcon, osprey, bald eagle and golden eagle. Although all five species are not equally as rare or endangered, they may all be influenced by the construction of a pipeline. In order to protect the more valuable and more eagerly sought after species, they will all be discussed as a group of birds of prey and referred to under the one general heading, raptors.

Many sightings and eyrie locations were made during the 1972 surveys, and many more were gathered from other Canadian Wildlife Service, consortia, and interested industrial personnel. To protect the remaining known nesting sites of endangered species, such as the peregrine falcon, the locations of these will be kept strictly confidential within the Canadian Wildlife Service. Pertinent information will only be released to an agency which has jurisdiction over future land use if it is felt that the release is necessary to protect the species or location involved.

The reason for this restriction on information release is obvious. Peregrine falcons and gyrfalcons are fervently sought after for use as hunting birds. These birds bring a handsome price, sometimes as much as $3,000 to $5,000. As they become more rare, they become more valuable, and more sought after. Some provinces and states have put tight restrictions on the keeping of wild animals in captivity but many have not. Foreign countries also present a considerable demand. Since raptors traditionally use the same nesting territories year after year, any public release of exact locations would immediately place that nest in jeopardy through disturbance by curious tourists, photographers, egg collectors or falconers.

The following report was prepared with the above in mind. Only those locations where direct conflicts are expected have been noted and they have been referred to as raptor nests. Any change in route location should be accompanied by a re-examination of the raptor information for additional conflicts.

The construction phase of the proposed pipeline should not seriously affect raptors in general; however, it will contribute to the ever-increasing reduction of their numbers. For every 28 to 30 miles of pipeline, 1 square mile of land will be directly 'lost' through construction activities. Whether this will include raptor nesting habitat will depend on its location. Since raptors are wilderness species, the area actually affected may be much greater than that directly affected by the pipeline construction. Nesting sites as far away as two or three miles on each side of any construction activity, including camps, airports, haul roads, blasting, etc., may be influenced. All nest sites along the proposed route have not been located, so the actual number of raptors that will be involved is not known.

Although the disturbance due to construction will likely be temporary, the effects may be permanent. At least two of the raptor species, the peregrine falcon and the bald eagle, are known to be declining in numbers. Once displaced from traditional nesting sites there is no assurance that they will return.

The anticipated increased human pressures will also extend the area that will be affected. The effect of human presence and activities on raptors varies with season. Disturbance during the establishment of territories in early April or May may lead to desertion of the site. Later disturbances of very short duration, even for an hour, during the egg-laying and incubation period (May to June) may lead to loss of the eggs and young. Disturbance during the flightless period of the young from June to August may lead to abandonment or increased predation of the young.

The threat of illegal egg collecting, irresponsible shooting of young and adult raptors, and the robbing of young from nests for falconry will accompany any increased human access and activity associated with the construction and operation of the pipeline. This problem is inevitable and can only be partially controlled by limiting access and increased publicity and enforcement of game regulations.

The increased introduction of pollutants and chemicals into the northern environment could seriously affect these birds. Already detectable amounts of many pesticides are being found in the northern ecosystem. Falcons and eagles are known to be seriously affected by some of these chemicals. Any use of pesticides and herbicides should occur only after consultation with Canadian Wildlife Service biologists.

Since all but the bald eagle and osprey are traditionally cliff nesters, the areas of potential nest sites can be narrowed considerably. Known and potential sites can be found throughout the Yukon and the mountainous regions of the western Northwest Territories.

Along the proposed pipeline routes the major areas of concern are the Franklin Mountains, some areas along the banks of the Mackenzie, the Richardson Mountains, the British Mountains, and the Porcupine River. Many of the major and minor rivers draining the mountainous regions flow through deeply eroded valleys. The exposed rock faces provide excellent nesting sites. Many still remain to be investigated.

The osprey and bald eagle nests are generally found in forested lowland areas in close association with lakes and ponds. Peregrine falcons are usually restricted to cliffs in forested areas quite often overlooking water. The gyrfalcon prefers the more open cliffs above treeline. Golden eagles are more widespread, although they too prefer the mountain cliffs. Golden eagles are particularly abundant in the British Mountains where the Porcupine Caribou herd fcrms an abundant food supply.

There are only two known areas where the presently proposed pipeline route will result in direct raptor - pipeline conflicts.

1. Arctic Red River

There are several raptor nest sites across and downstream from Arctic Red River on the steep banks of the Mackenzie River. These have been present and active for some time. Already development has caused the destruction and abandonment of several, and there is some doubt as to the possibility of saving the remaining few. If the pipeline is to cross the Mackenzie River at this point, every effort should be made to use the same approaches to the river as were constructed fcr the Dempster Highway. This will help keep the destruction of nesting sites at a minimum. Blasting and other construction activity should be completely restricted during the nesting season from April to August for at least 2 miles on either side of the cliff area.

2. Porcupine River Drainage

This river valley is known for the raptor nests located along it (de Belle, et al. 1972). The presently proposed pipeline route will destrcy or severely disturb at least two nest sites located near the mouth of the Driftwood River. The route should be kept at least 1 mile from the river at these spots to avoid nest destruction, and construction should not take place during the nesting season which is from April to August.

There are alsc at least seven additional kncwn and potential nesting areas where disturbances associated with pipeline construction and activity should be restricted during the nesting season. These are:

1. The sections of the route that pass particularly close to the exposed rock cliffs of the McConnell Range and the Norman Range;

2. The Mackenzie River banks at the Ramparts and Fort Good Hope;

3. The exposed rock cliffs around Campbell Lake south of Inuvik;

4. The McDougall Pass area;

5. The Porcupine River;

6. The Old Crow River; and

7. The exposed rock cliffs of the Old Crow Range.

There are several other likely nesting areas along the route, but most are located outside the 2-mile limit of major disturbance. These are being thoroughly investigated during 1973. Any suggested re-routing of the pipeline should take these locations into account. Concern is also expressed over selection of campsites, air strips and haul roads; each of these could easily have as serious an impact as the route itself. The exposed cliffs favored as nest sites by raptors may be sought as sources of gravel and rock. The positioning of compressor stations may cause disturbance, if not through noise then through associated human activities. Provisions should be established so that before decisions on the locations of any development are made, raptor information should be obtained and reviewed. Raptors are very sensitive to disturbance and have the potential of becoming the wildlife species most seriously affected by northern development. Careful selection of route and associated development location can keep the influence of pipeline construction at a minimum.

5.9 RARE AND ENDANGERED SPECIES - POLAR BEARS

5.9.1 Introduction

The area under discussion extends along the coast of the Beaufort Sea from the west of Herschel Island, Y.T. to about Baillie Island, N.W.T.

In any conflict between exploration or development and bears there are several types of potential problems. In planning for such development activities, the interests of both the bears and the activity should be considered.

5.9.2 Discussion

Polar Bear Denning Areas

Apparently little maternal denning of polar bears occurs on the mainland coast or associated offshore islands of the Yukon and western N.W.T. The only sites known to have been used within living memory are Herschel Island, Y.T., Pullen Island, N.W.T., and Nuvorak Point, N.W.T. Thus, there is probably little potential for damage to the species through interference with denning areas. Nevertheless, some vigilance and care should still be recommended when operating near drifted banks or streambeds near the sea, points of land, or offshore islands.

Polar Bear Feeding Areas

During the period of open water along the mainland coast, the occurrence of polar bears on land is rare. However, in the fall when the polar pack ice moves south and the newly formed sea ice joins the pack to the mainland, the bears move south and are abundant near the coast. All through the winter and spring until breakup, there are working leads in the sea ice that run in an east-west direction parallel to the coast. This is where the seal hunting is best and, consequently, is also the area in which polar bears concentrate. The points of land where these leads occur closest to shore are Herschel Island and Baillie Island. Because these two islands are offshore of natural headlands, it is likely that the effect of coastal currents and ice movements on the maintenance of broken ice areas is greatest there. Polar bears tend to concentrate near both these islands during winter.

Excessive activity by men and machines could alter the movements of these bears, resulting in a shift of distribution away from these points. The effect on the bears of such a shift might not be too serious because they could likely obtain seals elsewhere, although possibly under less favorable hunting circumstances. However, Eskimos that depend on hunting polar bears (as well as trapping white foxes) at Herschel and Baillie islands for part of their livelihood, could be seriously affected.

In 1970 and 1971 at Herschel Island, large numbers of bears were reported near the settlement in late October and early November. In the fall of 1972, there was excessive aircraft movement, land vehicle activity, and construction of an airstrip. Several fuel storage tanks and a barge were also positioned during the summer of 1972. Few polar bears were seen. Observations over sea ice between Banks Island and the Alaska border in late October and early November revealed many tracks and 22 bears. Thus, bears were again abundant in the area, yet scarce at Herschel Island where the noise of mechanical activity may be responsible for their absence.

5.9.3 Implications

It is expected that -

a. The excessive noise of vehicular activity, from late fall to early spring, is likely to be disruptive to coastal wildlife movements; in particular to polar bears, and possibly to white foxes as well.

b. Fuel storage tanks right by the edge of the sea raise the threat of an oil spill which could cause great damage to the marine ecosystem upon which the seals, polar bears, and beluga whales depend. This threat is intolerable.

5.9.4 Recommendations

To date, no effective chemical bear repellent is known. The best defence for any camps is absolute cleanliness, and this cannot be over-emphasized. Garbage should be incinerated and back-hauled. Materials such as frozen meat should be kept enclosed. Sewage should be containerized and back-hauled or incinerated.

Even with the best of precautions some bears will approach a camp or even a vehicle out of curiosity. Camps should be equipped with some of, or all of, the following scaring devices for use as deterrents:

1. Thunderflash, CIAI (Thrown by hand)
   Dept. of National Defence

Ammunition Group
Base Supply Section
Canadian Forces Base
Shilo, Manitoba

2. Teleshot, 12 gauge (Bird Control Cartridge; shot from standard 12 gauge shotgun)
   Colt Industries
   Colt Firearms Division
   U.S.A.

3. Twinshots (same as no. 2)
   Maison D'Armes
   181 Rue Ste. Paul
   Quebec, P.Q.

4. Bird Bombs
   W. V. Clow Seed Co.
   1107 Abbott Street
   Salinas, California 93901
   U.S.A.

   Also available from Ketchum Mfg.
   Sales Ltd.,
   396 Berkeley Ave.
   Ottawa 13, Ontario

6. GENERAL DISCUSSION

The relationships between the studies described in this report and other studies presently undertaken, such as the Mackenzie Valley Highway Study, and those contemplated of the Arctic Islands, are obvious, but at the same time not clear in detail. In order to explore these relationships, it is necessary to investigate at least three separate areas: those of design, analysis and extrapolation of results.

The design to present information in the form of an inventory map series, is applicable to almost any land-use planning task. Similar designs were used by the Canada Land Inventory, the original "Arctic Ecology" map series, and very recently the ALUR Land-use information map series. An inventory map series showing wildlife habitat units can be used to identify important habitat in the vicinity or in the path of the pipeline or highway. Maps of the scale of 1:250,000 are useful for general planning purposes. However, for detailed assessments of river crossings, and marsh crossings they do not provide enough detail. Our experience, so far, has been that detailed engineering designs are not available at the right moment, and once they are available there is not sufficient time to study their exact location, let alone to study their effects on the environment. For instance, it is not possible to assess the effects of a 20 to 30 mile stretch of highway in one week, never having seen the terrain on the ground in detail nor the habitat or the animals involved.

Until the proposed locations of pipeline routes are finalized, there seems little point in doing detailed habitat investigations along routes currently shown on maps or photo mosaics prepared by the gas pipeline study consortium. Further wildlife-pipeline investigations will be limited by the amount of advance information available on proposed engineering methods and by the relative lack of precise details of proposed locations for construction camps, access roads, storage areas and all other activities associated with construction of a large-diameter pipeline. Once such details are known, much more specific wildlife investigations can be undertaken, providing there is time to do so. Detailed habitat investigations would require at least one field season, and with selections of sites on air photos and final preparation on maps, will take a full year from the date that detailed design perhaps would become available.

The analysis of information obtained from the present wildlife habitat inventory is simple in one aspect - the delineation of important wildlife areas; it presents great difficulties in others, such as the "social" evaluation of habitat values and the estimation of "impact".

The maps which are part of this report show wildlife units in classes of quality, and at a glance their position relative to a proposed construction location can be found. Consequently, areas of possible conflict can be easily identified.

The estimation of "impact" can only be general, because the engineering techniques are not known to us and the exact location of the structures: highway - pipeline - campsites - bridges - underwater crossings, are not known either. Therefore, the speculations on effects of construction have to be of a very general nature.

The evaluation of habitat units and the wildlife they support from a social point of view is outside the scope of this report. The relative importance of one wildlife species compared with that of another is a hazy subject. Are mallards more "important" than shorebirds? Are grizzly bears more "important" than moose?

The extrapolation of results, for use in similar studies, is possible to a limited degree. For instance, behavior of a certain species of waterfowl subjected to disturbance might be expected to be the same on the Arctic Islands as on the coastal zone of the Beaufort Sea. In general, species which occur in the present study area are expected to have the same sensitivity to disturbance and habitat degradation as the same species of wildlife which inhabit the Arctic Islands. Due to different terrain, habitat units are expected to be different from those of the present study area.

7. GENERAL CONCLUSIONS

The purpose of this chapter is to summarize the main conclusions and assemble this information for all species in one chapter.

7.1 Moose

Moose are widespread throughout the Mackenzie River Valley and northern Yukon. While in summer their movements are almost unrestricted, in winter they confine themselves to three main habitat types which are river valleys, wetland complexes and upland slopes.

Moose wintering in river valleys are vulnerable to disturbance or hunting because the topography and possibly snow depth could hamper their escape movements and the animals are concentrated in large numbers. Moose are very dependent on natural habitat disturbance for their existence. Flooding of the floodplains of fast-flowing mountain rivers and wild fires create most of the habitat in the upstream reaches of the Mackenzie River, while in the north the shallow active layers over the permafrost restricts the growth of browse species to the river channels.

7.2 Caribou

7.2.1 Caribou, other than the Porcupine herd

There are two, or probably three sub-species of caribou in the Mackenzie Valley; woodland caribou, barren-ground caribou, and reindeer (originally escaped from the Reindeer Project). The woodland caribou are common throughout the study area from the Alberta border to south of Inuvik along both sides of the Mackenzie River, while most of the barren-ground caribou belong to the Bluenose herd, which has been estimated to consist of 20,000 to 150,000 animals. The escaped reindeer or offspring of escaped reindeer may possibly contribute to a group that ranges between the Eskimo Lakes in summer and the Travaillant Lake-Iroquois rivers area in winter.

Woodland caribou west of the Mackenzie River are restricted to the Mackenzie Mountains and the adjacent foothills and lowlands; large groups were observed along the headwaters of the Keele, Redstone, Carcajou and Arctic Red rivers. Woodland caribou east of the Mackenzie River are seldom concentrated, but radiate out from their summer ranges into suitable winter habitat.

Groups belonging to the Bluenose herd of barren-ground caribou may winter as far south as the Horn Plateau, and some animals spend at least part of the winter along the Willow Lake, Blackwater and Great Bear rivers.

The group that seems to summer just south of the Eskimo Lakes and winter in the Travaillant Lake area numbers about 1,000 to 2,000 animals and does not concentrate but stays in small groups of 2 to 20.

7.2.2 The Porcupine herd of Barren-Ground Caribou

Data collected by various agencies suggest that variations, both chronological and spatial, exist in the yearly cycle of the migratory barren-ground caribou. Variations may be either short-term or long-term, where it is assumed that a short-term variation does not last more than five years. Chronology of spring movements during 1971 and 1972 for the various migration paths show variations of a week for the Old Crow Route and up to six weeks for the Richardson Route. It may be concluded then that within a short time span up to several years, movement chronology can vary by months and movement may or may not occur. Over long periods of time measured in human generations, it would appear that caribou movements are relatively dependable.

7.3 Dall Sheep

All important Dall sheep habitat is situated west of the Mackenzie River. Winter habitat consists of four major types: plateaus and gentle slopes; slopes and lateral spurs at treeline slopes; spurs associated with eroded bluffs; and high ridges and slopes.

Four major Dall sheep populations are known in the study area; the Nahanni, Ram, Yohin-Liard group; the Mackenzie Mountains group, the Richardson Mountains group and the British Mountains group.

7.4 Grizzly Bears

Surveys were conducted in the early spring when the bears are first emerging from their winter dens. It proved very difficult to retrace tracks to the den site, unless the bear had just recently emerged. From the observations it seems that grizzly bears depend more on availability of food than on specific habitat types. Adult male bears have a very large home range, while females with cubs travel in a small radius from their den. Although availability of food and not habitat seems to influence the presence of bears, large habitat units can be identified.

There is a definite preference by grizzly bears for the rough, broken terrain of the mountains and hilly regions over the flat densely forested areas of the south and central portion of the study area. Grizzly bear sightings were most numerous in the mountain regions of the northern Yukon. The Yukon coastal plain, Richards Island and the Tuktoyaktuk Peninsula support good bear populations.

7.5 Arctic Fox

Delineation of habitat types for arctic fox is difficult due to the cyclic nature of the animal. Habitat quality was determined by several factors, of which the relative density of maternal dens was one. The greatest concentration of arctic fox dens was found in the Herschel Island mapsheet area. Dens were found on sand dunes, frost heaves, and on banks of watercourses and lakes, usually in porous soil materials.

7.6 Beaver and Muskrat

Within the study area, beaver and muskrat can generally be found wherever the basic habitat requirements, including suitable food and shelter, are available. However, it is possible to indicate some areas which are of special importance.

The most extensive areas of better quality beaver and muskrat habitat occur in the deltaic complex of the lower Mackenzie River and the thermokarst lakes within glacial lacustrine basins along the Ramparts River west of Fort Good Hope, the Brackett River northeast of Fort Norman, MacKay Creek south of Fort Norman, and west of the Mackenzie River at Camsell Bend.

Lakes of the Old Crow Flats and several less extensive basins along the Porcupine River provide very favorable muskrat habitat but are of only minor importance to beaver.

Drumlinized till deposits, between Fort McPherson and Martin House, provide a combination of drainage confinement and shoreline stability that beaver prefer for dam construction.

In the more southern regions, good beaver habitat is found within stream systems on the gently sloping flanks of several large plateaus. Very extensive organic overburden in the headwaters and excellent deciduous shrub cover along the meandering mainstem channels contribute to the overall value of these systems. Harris Creek north of Fort Simpson, the south fork of the Martin River and the Matou River near Sibbeston Lake, and the unnamed stream emptying into the northwest side of Trout Lake, all fall within the above category.

Two other areas of good quality beaver habitat worthy of mention are the Tetcela River, occupying a broad U-shaped intermontane basin on the west side of the Sibbeston Lake mapsheet and the deltaic region on the lower Kakisa River.

7.7 Waterfowl

Waterfowl use the study area annually from May until September.

The Mackenzie River, its islands and mouths of tributaries, is a major migration pathway along which many thousands of waterfowl travel, rest, wait for open water and gradually move northward during spring. The Boreal and Tundra regions provide thousands of lakes, ponds and streams suitable as nesting habitat, while later on in midsummer, the coastal waters and large inland lakes are used by flocks of moulting adult birds. In early fall, several hundred thousand birds concentrate on the North Slope and estuarine areas of the Mackenzie Delta where they condition themselves for their southward migration.

The waterfowl involved are geese, ducks and swans; some reference is made to loons. The inventory has identified the following extensive areas of good waterfowl breeding habitat: the Old Crow Flats, the Mackenzie Delta, the Tuktoyaktuk Peninsula and adjacent lowlands, the Ramparts Flats, the Brackett Lakes and the wetlands adjacent to the Kakisa River. Less extensive areas, such as basins situated in alluvial sediments on floodplains and deltas, provide habitat of equal importance.

7.8 Raptors

The falcons, osprey and eagles are discussed as one group of birds of prey. All but the bald eagle and osprey are traditionally cliff nesters, therefore the areas of potential nest sites can be narrowed down. Known and potential sites can be found through the Yukon and the mountains of the western Northwest Territories, such as the Franklin Mountains, the Richardson Mountains, and the British Mountains. Some sites also exist along the eroded banks of the Mackenzie and Porcupine rivers as well as along the deeply eroded valleys of many of the major and minor rivers draining mountainous regions.

It was found that the osprey and bald eagle generally nest in forested lowlands close to lakes and ponds. Peregrine falcons are usually found on cliffs in forested areas, while gyrfalcons prefer open cliffs above treeline. Golden eagles are abundant in the British Mountains.

7.9 Polar Bears

The only maternal denning sites known to have been used by polar bears in the study area are on Herschel Island, Y.T., Pullen Island, N.W.T., and Nuvorak Point, N.W.T.

During the period of open water along the mainland coast the occurrence of polar bears on land is rare. However, in the fall, when the polar pack ice moves south and the newly formed sea ice joins the pack to the mainland, the bears move south and are abundant near the coast. All through the winter and spring until breakup, there are working leads in the sea ice that run in an east-west direction parallel to the coast. This is where the seal hunting is best and, consequently, is also the area in which polar bears concentrate.

8. IMPLICATIONS AND RECOMMENDATIONS

The relationships between wildlife populations and habitat and the construction of an underground gas pipeline are at best vague. Lacking specific and detailed information on location, design, and techniques of construction, speculations on impact become necessarily very general.

An attempt to bring the various impact speculations presented in the individual "chapters" together is given in Appendix III. In most cases a pessimistic view has been taken of the magnitude and duration, indicating what may happen under the worst situations. Realistically, most construction activities will have a wide variety of effects, and many may be beneficial under certain circumstances. For example, the creation of water bodies through obstruction of drainage or borrow pit excavation can, through proper management, create satisfactory waterfowl and muskrat habitat. Sedimentation has in many places enhanced lakes and estuaries, creating deltas and delta-like situations extensively used as waterfowl and muskrat habitat. Wildfires over the long-term are beneficial to moose and in fact may be the major reason for widespread occurrence of this species in the North.

The table in Appendix III does not reveal possible remedial measures that may alleviate construction impacts. Summarized briefly these are:

1. Disruption of behavioral patterns by construction activities on almost all species would be lessened considerably if construction took place during the winter, November 15 to April 15. This would avoid most major migrational, nesting or reproductive periods, and represents the inactive period for grizzly and black bears. Increased human activity and associated noises, aircraft activity, and fires can be included as influxes that may be lessened by proper timing.

2. The impact of destruction of sheep and moose habitats by construction activities can be lessened by avoiding the more important and sensitive habitat types and carrying out revegetation procedures on the disturbed right-of-way as soon as possible.

3. The location of camps, compressor stations, air strips and supply and maintenance roads can be selected to avoid adverse impacts. If possible they should be placed away from critical wildlife areas. Increased human activity such as low-level aircraft flying, people on foot, off-road

vehicle travel, hunting and trapping may have to be strictly controlled within some sensitive areas.

4. All construction activities that may affect drainage through obstructing, increasing or re-directing normal surface and sub-surface water flows require great caution in order to avoid adverse affects. Every attempt should be made to know, understand and maintain the present situation. Drainage structures must be adequate. Bridges are preferred over culverts. Drainage in ditches should be avoided.

5. The removal of gravel and sand from streambeds should be avoided. If allowed, it should be conducted so as to miminize damage to the riparian vegetation. Removal of any material from the coastal sand bars should be strictly prohibited.

6. The introduction of chemicals into the environment in any form must be carefully reviewed and controlled. Contingency plans must be devised that will allow quick discovery and control of problem situations.

7. The handling and disposal of garbage and sewage may develop into a problem if inadequately carried out. Present land-use regulations and highway campsite stipulations should be closely followed.

8. The tundra and muskeg areas are all very sensitive to damage from tracked construction equipment and all-terrain vehicles. Excess damage can be avoided by restricting their use to the construction right-of-way.

Long-term damage to wildlife populations and habitat will not likely result from most construction activities except for man-made fires, the removal of large gravel material sources, and the establishment of large permanent settlements in sensitive areas. If drainage conditions are not seriously affected, little impact should be felt by most inland waterfowl and aquatic furbearers.

Route selection will be the first and most important step in alleviating impact on wildlife. If some sensitive wildlife areas cannot be economically or physically avoided, closer liaison between design engineers and biologists should help lead to a reduction of most disturbance features of pipeline construction.

9. NEEDS FOR FURTHER STUDY

The current demand for appraisals of the impact that development activity will impose on wildlife resources within the pipeline corridor emphasizes the need for more detailed documentation of population-habitat relationships. Both social and environmental values should be given consideration in selecting the species that will be the focus of further efforts.

9.1 Moose

Present inventory information should prove adequate for the prediction of pipeline construction impact on moose. More data would be helpful along the Mackenzie River itself, particularly about the moose that winter on the islands. Knowledge of their movement to and from these islands would be useful.

9.2. Caribou

A sudden departure, in the fall of 1972, of the barren-ground caribou of the Porcupine herd from the fairly stable seasonal movement pattern documented during the previous two years indicates the extreme variability and unpredictability of caribou movements. Movements and chronology of movements have been documented in detail for the Porcupine herd but not for the other groups and sub-species. Better knowledge of where and when these movements take place is necessary before accurate predictions can be made on impact.

The effect of low-flying aircraft has not been clearly enough documented to allow effective and reasonable guidelines to be drawn up.

Reaction of migrating and non-migrating caribou to the pipeline right-of-way, berms, roads, seismic lines, camps and compressor stations requires more documentation.

In some cases, particularly during pipeline construction, it may be advantageous to be able to control or direct the movements of caribou around areas of potential conflict. No work has been done on developing economical and effective techniques for this purpose.

In view of the above, the following aspects of caribou population and behavior are being documented during the 1973 field season:

1. The size and composition of the various groups

2. The seasonal movement behavior and distribution delineating wintering areas, calving areas, staging areas, and mineral licks whenever possible

3. The productivity for 1973

4. The 1973 mortality and causes of death

5. The behavior to various disturbance sources, particularly low-flying aircraft

6. Reaction to man-made deflection devices with the aim of making recommendations for methods enabling the small-scale manipulation of migration movements.

9.3 Dall Sheep

Since most Dall sheep are restricted to the mountainous regions in the western part of the study area, they will be well away from the proposed pipeline route and the effects of construction should be minimal. However, in the Richardson Mountains, the proposed route passes very near some important wintering areas of the Mount Goodenough sheep population. Pipeline construction activities in this area could be very disturbing.

Much more detailed information is needed on habitat requirements and behavior. The following information should be documented:

1. The numbers and distribution of Dall sheep in the Mount Goodenough area, particularly on the eastern slopes

2. Seasonal use of various parts of the range, especially in the winter period and during lambing.

3. The location and use made of all mineral licks in the Mount Goodenough area.

4. More detailed descriptive data of the physical and vegetational characteristics of the areas showing highest use, especially the wintering areas, lambing areas and mineral licks.

5. A systematic assessment of the reaction of Dall sheep to aircraft. Low-flying aircraft represent one of the most serious potential disturbance factors to sheep. Some

aircraft are more disturbing than others and the amount of reaction varies with the time of year. In order to set adequate stipulaticns more data are required.

9.4 Grizzly Bears

Preliminary surveys indicate that grizzly bears are widely distributed throughout the study areas but are mainly concentrated in the rough broken terrain of the mountains and hilly regions and the northern tundra. Sightings were most numerous in the mcuntainous regions of the northern Yukon. The suspected large home range of adult male grizzlies and their asscciation with migrating caribou suggests that a large numter of bears, through their wide movements, may ccme in close contact with the pipeline and pipeline activities.

Den sites are an important aspect of grizzly bear habitat. Very few dens were located and little is known about their physical characteristics.

In view of the potential interrelationships between grizzly bears and the proposed gas pipeline, it is recommended that the following be documented:

1. The home range and movement behavior of sex and age groups of grizzly bears in the northern Yukon.

2. The association or relationship of grizzlies and their movements with the Porcupine Caribou herd.

3. The location and ecological characteristics of denning sites.

4. Population numbers and composition, productivity, annual cycle, food habits and bio-energetics of the grizzly bears in the northern Yukcn.

9.5 Arctic Fox

There is little need for further inventory work on arctic foxes at this time. The widespread distribution of maternal den sites and other important features of arctic fox habitat requirements throughout the tundra areas of the pipeline route indicate few direct problems. A ground inspection of the pipeline right-of-way and material sources once these locations are proposed in detail should help reduce most disturbance problems.

9.6 Beaver and Muskrat

Preliminary habitat inventories indicate the more important areas for muskrat populations are high-density wetlands, areas that are generally avoided in the proposed pipeline alignment. Conversely, drainages that are occupied by beaver populations are frequently crossed by the same alignment. Further indications of the need to place emphasis on beaver habitat studies are found in the greater influence that beaver impose on the environment through their efforts to control water levels. Finally, it is probable that beaver populations will be much more sensitive than muskrat to accelerated harvest programs that may accompany increased access.

During the current field season, the following aspects of beaver populations and habitat, within the immediate pipeline corridor, should be documented through both aerial and ground surveys:

1. Intensity of beaver activity on individual streams and stream systems directly in line with current pipeline alignment.

2. More details of the physical and vegetational characteristics of those areas showing highest use-density. Physical features could include stream size and gradient, channel form, bank stability and substrate materials. Vegetational features to be documented include composition of woody plant communities in close proximity to stream channels, and species composition of the plants utilized by beaver within the range of available habitat types.

3. The influence that beaver exert on landscapes, as seen in the gross aspects of vegetational communities above and below dam-sites.

4. The use of beaver habitat by other species, such as muskrats, waterfowl, mink, moose, etc.

Further understanding of these relationships will be beneficial not only from the standpoint of impact prediction but also as input into continued management programs.

9.7 Waterfowl

The present inventory of waterfowl habitat delineates the location of individual wetlands and wetland complexes in the detail believed to be required to pinpoint most potential areas of conflict with proposed major developments. Nevertheless, for more detailed assessments, it will be necessary to upgrade and obtain additional information to formulate more conclusive "values" - both qualitative and quantitative - for specific localized areas.

It will be practical to focus attention on a very limited portion of the inventory study area - the proposed pipeline corridor. Additional studies in 1973 are being confined to wetlands within what may be termed a 'zone of influence' of the tentative gas pipeline right-of-way.

Some inventory ratings have, of necessity, been made with information of a general nature. Studies should now focus on details such as species and densities of birds utilizing individual units; and specific criteria, such as favored vegetation species, which may influence use. Results of such studies will support the present inventory and they may be extrapolated to provide insight for similar areas within the 1972 study area.

Aerial and ground support equipment for pipeline construction and monitoring will, if used at random, harass some waterfowl causing loss of production. Restrictions are necessary to minimize machinery - waterfowl encounters. Presently, several short-term studies provide superficial results of waterfowl reaction to such disturbance. However, as wildlife behavioral responses depend on reactions to complex internal and external stimuli and physiological condition, long-term research is needed to fully understand the problems. Such studies would be too late to employ in advance of pipeline developments. To better understand how large flocks of birds react to aircraft, a study is planned for the North Slope where flocks of snow geese will be subjected to aircraft over-flights and reactions will be documented under varied conditions.

A very important factor which could be used in predicting change or "impact" on waterfowl habitat is adequate insight into the status of hydrological regimes prior to disturbance. If at least some such information can be made available from other environmental and engineering specialists, detailed impact assessments should reflect in accuracy of forecasts.

9.8 Raptors

Few raptors should be directly influenced by the presence of a gas pipeline. It will be the indirect wide-ranging influences such as human presence, noise, and the use of open cliff faces for material sources that will have the most impact on this species. Nesting sites as far away as 2 or 3 miles on each side of any pipeline activity may be influenced.

The efforts expended in locating raptor nest sites during the past season were insufficient to give more than an indication of the potential problems. More information is needed on nest locations, critical breeding periods and types of prey species utilized before speculations on the effects of human activity can be provided.

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11. APPENDICES

11.1 Appendix I

List of Scientific Names of Plants Referred to in this Report, Including Accompanying Atlases (Hulten, E. 1968).

Common Name	Scientific Name
Alder	*Alnus crispa*
Aquatic Moss	*Musci* spp.
Aspen Poplar	*Populus tremuloides*
Balsam Poplar	*Populus balsamifera*
Black Spruce	*Picea mariana*
Bog Bilberry	*Vaccinium uliginosum*
Bog or Dwarf Birch	*Betula glandulosa*
Bog Cranberry	*Vaccinium vitis - idaea*
Buffalo berry	*Shepherdia canadensis*
Bulrush	*Scirpus* spp.
Bur Reed	*Sparganium angustifolium*
Cattail	*Typha latifolia*
Cloudberry	*Rubus acaulis* *Rubus chamaemorus*
Coontail	*Ceratophyllum demersum*
Cottongrass	*Eriophorium angustifolium*
Dewberry	*Rubus pubescens*
Duckweed	*Lemna* spp.
Dwarf Birch	*Betula nana*
Horsetail	*Equisetum* spp.
Jack Pine	*Pinus banksiana*

Common Name	Scientific Name
Juniper	*Juniperus* spp.
Labrador Tea	*Ledum decumbens*, *L. groenlandicum*
Larch	*Larix laricina*
Marestail	*Hippuris vulgaris*
Marsh Cinquefoil	*Potentilla palustris*
Mountain Aven	*Dryas* spp.
Pondweeds	*Potamogeton* spp.
Red Osier Dogwood	*Cornus stolonifera*
Rose	*Rosa acicularis*
Saskatoon	*Amelanchier alnifolia*
Sedge	*Carex* spp.
Spike rush	*Eleocharis palustris*
Snowberry	*Symphoricarpos albus*
Water Arum	*Calla palustris*
Water Lily	*Nuphar variegatum*
Water Milfoil	*Myriophyllum exalbescens*
Water Smartweed	*Polygonum* spp.
White Birch	*Betula papyrifera*
White Spruce	*Picea glauca*
Wild Red Raspberry	*Rubus idaeus*
Willow	*Salix* spp.

11.2 Appendix II

Table 1. The potential effects of the proposed Mackenzie Valley Gas Pipeline construction activities.

Construction Activity	Potential Effect	Species Affected	Magnitude	Duration
Habitat Destruction or Loss				
Pipeline right-of-way	Destruction of habitat	Sheep	Severe	Short
		Moose	Light	Short
Buried refrigerated gas lines	Change in aquatic thermal regime	Beaver	Variable	-
		Muskrat	Variable	-
		Waterfowl	Moderate	Long
Camp locations	Loss of habitat	Moose	Light	Long
		Raptors	Severe	Short
Borrow pit construction locations	Loss of habitat	Bear	Light	Long
		Fox	Light	Long
		Sheep	Light	Long
Removal of sand and gravel along water bodies and streams	Removal of riparian vegetation	Beaver	Variable	-
		Muskrat	Variable	-
		Waterfowl	Severe	Long
		Moose	Severe	Long
	Sedimentation	Muskrat	Light	Short
Removal of coastal sand bars	Loss of habitat	Waterfowl	Severe	Long
Stream crossings	Introduction of sediment loads and erosion of stream banks	Beaver	Moderate	Long
		Muskrat	Moderate	Long
		Waterfowl	Moderate	Moderate
	Drainage of adjacent ponds	Muskrat	Severe	Long
		Waterfowl	Severe	Long
Berms and road grades	Obstruction and/or redirection of normal surface and sub-surface water flows	Beaver	Variable	-
		Muskrat	Variable	-
		Waterfowl	Moderate	Long
	Changes in sediment loads	Beaver	Variable	-
		Muskrat	Variable	-
		Waterfowl	Severe	Long

11.2 Cont'd.

Table 1. Cont'd.

Construction Activity	Potential Effect	Species Affected	Magnitude	Duration
Ditching	Changes in normal surface or sub-surface water flow	Beaver	Variable	-
		Muskrat	Variable	-
		Waterfowl	Severe	Long
Increased fires	Loss of habitat	Beaver	Moderate	Moderate
		Waterfowl	Moderate	Short
		Caribou	Severe	Long
		Moose	Severe	Short
Use of all-terrain vehicles	Terrain damage	Caribou	Light	Long
<u>Disruption of Normal Behavior Patterns</u>				
Berms and road grades	Creating travel lanes changing direction and resulting in damage to berm and surrounding terrain	Caribou	Moderate	Long
		Moose	Light	Long
	Creates snow drifting obstructs movement	Caribou	Moderate	Long
		Moose	Light	Long
Borrow pit construction	Activity, blasting noise	Bear	Light	Short
		Sheep	Moderate	Moderate
		Waterfowl	Moderate	Short
		Caribou	Moderate	Short
		Moose	Light	Short
		Raptors	Severe	Moderate
Ditching	Open ditch during construction	Caribou	Severe	Short
		Moose	Light	Short
Reclamation procedures	Attract animals to areas where they are more vulnerable and away from traditional habitat	Moose	Light	Long
Operation of engine driven equipment	Noise	Beaver	Light	Short
		Muskrat	Light	Short
		Sheep	Severe	Short
		Waterfowl	Severe	Short
		Caribou	Moderate	Short
		Raptors	Severe	Short

11.2 Cont'd.

Table 1 Cont'd.

Construction Activity	Potential Effect	Species Affected	Magnitude	Duration
Garbage and sewage disposal	Attraction of animals	Bears	Severe	Moderate
		Foxes	Moderate	Short
<u>Increased Human Activity</u>				
Aircraft support	Aerial harassment	Bear	Moderate	Short
		Sheep	Severe	Moderate
		Waterfowl	Severe	Short
		Caribou	Severe	Moderate
		Moose	Moderate	Short
Use of all-terrain vehicles	Harassment	Bear	Moderate	Short
		Fox	Light	Short
		Sheep	Severe	Moderate
		Waterfowl	Moderate	Short
		Caribou	Severe	Short
		Moose	Light	Short
Human activity (camps, etc.)	Disturbance due to human presence	Sheep	Moderate	Short
		Caribou	Light	Short
		Moose	Light	Short
		Raptors	Severe	Long
(Roads, trails, airstrips)	Increased hunting and trapping (variable with all species depending on the regulatory control of harvest)	Beaver	Variable	-
		Muskrat	Variable	-
		Bears	Severe	Long
		Foxes	Moderate	Moderate
		Sheep	Severe	Moderate
		Waterfowl	Light	Short
		Caribou	Moderate	Moderate
		Moose	Moderate	Moderate
		Raptors	Severe	Long
Introduction of pollutants, fuels, oils, toxic chemicals	Direct and indirect poisoning	Beaver	Moderate	Short
		Muskrat	Severe	Short
		Waterfowl	Severe	Short
		Raptors	Severe	Long