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Effects of Exploration and Development in the Baker Lake Area

Volume 1 - Study Report

Interdisciplinary Systems

EFFECTS OF EXPLORATION AND DEVELOPMENT IN THE BAKER LAKE AREA
VOLUME 1 - STUDY REPORT

Prepared for:

Department of Indian Affairs
and Northern Development
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This report comprises two volumes: the text in this volume and eleven maps in an accompanying supplement

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EXECUTIVE SUMMARY

Since 1969, Baker Lake residents have expressed concern about the effects of mineral exploration activities on renewable resources, particularly caribou, sustaining their community. Responding to these concerns, the Minister of Indian and Northern Affairs in March 1977 issued a temporary "halt" on land-use activities in a 78,000 km^2 (30,000 mi^2) area around Baker Lake and announced that a study into the potential effects of exploration activities in the area would be undertaken.

This report presents the results of that study. It examines renewable resource harvest, biological characteristics of fish and wildlife species supporting this harvest, industrial exploration and development, and potential impacts of industrial activities on harvested species. It also identifies areas regarded as critical for maintaining traditionally harvested populations and presents recommendations on special controls or prohibitions for industrial activities in each critical area.

Renewable Resource Harvest

Data collected through interviews with 43 randomly selected Baker Lake heads of household reveal that caribou hunters currently use at least 80 percent of the study area and fox trappers at least 45 percent. Domestic fishing is a wide-ranging activity, occurring throughout the study area, whereas wildfowl hunting is mostly confined to areas close to the hamlet. Land-use patterns appear not to have changed much in recent years. Recent changes that we have identified relate primarily to changes in animal distribution and behaviour (e.g. caribou wintering areas and migration routes) and to the movement of people from camps into Baker Lake.

Harvest occurs through the year. Early and late winter and summer appear to be the most important times for caribou hunting, early and late winter for fox trapping, and spring and early winter for fishing. Geese and ducks are hunted in late spring and early summer and most ptarmigan are taken in fall.

Through data collected during study interviews, we estimate the current caribou harvest at 4100, the current wildfowl harvest at 400 geese and 2800 ptarmigan, and the current consumption of fish at 140,000 lbs (65,000 kg). We also estimate the current arctic fox harvest at 790, based on NWT Government Fish and Wildlife Service fur records.

The total value of this harvest, including cash income from sales of furs and replacement cost (imputed income) of country food, is just over $1 million. This represents an income of about $6400 for each Inuit family in Baker Lake. Approximately two-thirds of this value is derived from consumption of caribou meat. We estimate that the replacement cost of this red meat alone is $683,000, or $4350 per family.

Various strategies for enhancing benefits of renewable resource harvest were examined. The feasibility of relocating the fish cannery from Rankin Inlet to Baker Lake was considered. We concluded that this would be an inefficient allocation of funds since the costs of production greatly exceed the market value of the product. An alternative worthy of further examination would be the development of a tourist sport fishery based in Baker Lake. We examined recently initiated trappers assistance programs, including the Outpost Camp Program, trappers' assistance loans, trappers' incentive grants, and the Fur Marketing Service. We concluded that these programs were adequate but that communication with trappers and program implementation could be improved. We also briefly outlined a scheme to purchase caribou hides and manufacture quality handcrafted leather goods. We consider such an enterprise worthy of further examination.

Biological Characteristics of Harvested Species

Barren-ground caribou occur throughout most of the study area. Spring migration, calving, post-calving aggregations, summer movements, and fall migration all occur there. Some caribou may rut within the study area and variable numbers winter there in different years. These caribou belong primarily to the Beverly and Kaminuriak populations. Recent estimates of these populations are 124,000 and 41,000, respectively.

Arctic foxes are permanent residents of the study area. They have large home ranges much of the year but are restricted to more specific areas during the denning period. There appears to be an abundance of suitable denning habitat in much of the study area.

Productivity of waters in the study area is low, resulting in slow fish growth rates. The standing crop of fish in unexploited waters is usually large, but local populations are readily susceptible to overharvest. Fourteen species of fish are reported to occur within the study area; of these only lake trout, arctic char, lake whitefish, and lake cisco are currently important for domestic or commercial harvest.

Several species of waterfowl nest and moult in the study area. The most common of these are Canada, lesser snow, and white-fronted geese and oldsquaw ducks. Many species occur extensively throughout the region but no extremely large aggregations of waterfowl are known to occur anywhere in the study area.

Industrial Land Use

Mineral exploration, primarily for uranium, has been the most widespread industrial land-use activity in the study area and the major focus of local concern. A great deal of interest was first shown in the area in 1969, when prospecting permits were issued for about one-third of the study area. To date, exploration activity has not proceeded beyond a preliminary level over much of the area. The most intensive activity has been diamond drilling on claims near Kazan Falls.

In December 1977, Polar Gas made initial filings to the National Energy Board pursuant to an application to construct a pipeline to transport natural gas from the Arctic Islands to southern markets. The proposed routing crosses the study area west of Baker Lake.

Facilities and activities associated with mineral exploration and development (uranium) and natural gas pipeline construction and operation are regarded as the most likely sources of industrial impact in the study area.

Caribou Critical Areas

Four types of critical areas were identified for caribou: major migration corridors to calving grounds, calving grounds, areas where post-calving aggregations and movements occur, and important water crossings.

The major concerns identified for migration corridors, calving grounds, and areas used for post-calving aggregations and movements are similar. They include: development of roads or other facilities which could impede movements of caribou to, on, or from calving grounds and post-calving areas; low-flying aircraft; intensive human or construction activity; heavy traffic; and habitat destruction due to emissions of sulphur oxides. Specific favoured calving areas could also be occupied by industrial facilities.

Recommended controls to mitigate these concerns include restrictions on the location of facilities and facility design, regulation of aircraft overflight altitudes, timing of activities, and possible outright prohibition of industrial facilities in certain favoured calving sites.

Major concerns and recommendations regarding important caribou water-crossing sites are similar to those outlined above, with one major exception. We recommend that no permanent above-ground developments involving noise, human presence, visual or physical impediments to caribou movement, or habitat destruction be permitted within 4.8 km (3 mi) of important water crossings. Further, we recommend that temporary exploration and development activities not be allowed within 4.8 km (3 mi) of these crossings. If such activities must be located within this "prohibited zone", we recommend that all activities be shut down and all readily removable facilities and non-essential manpower be withdrawn when caribou are in the area.

Fish Critical Areas

Four general areas have been identified as critical for fish: Baker Lake and its tributary rivers; large lakes currently important for domestic fishing (Pitz, Schultz, and Whitehills Lakes); smaller lakes throughout the study area inhabited by lake trout; and Quoich River. We believe that fish populations in these waterbodies are vulnerable to either direct or indirect impact from industrial activities. Further, they either support domestic harvest or serve as habitat for fish species favoured by Baker Lake residents (lake trout, arctic char, and lake whitefish).

Major concerns relative to industrial activities in these areas are siltation, toxic spills, accumulation of toxic substances, acidification, habitat destruction, blockage of flow and dewatering, and overharvest. Recommended controls to mitigate these concerns include restrictions on the location of rights-of-way and facilities and on construction design; contingency plans for containment and cleanup of spills; enforcement of emission standards for sulphur oxides; restrictions on the location of borrow operations; and enforcement of existing fishing regulations or development of special restrictions if necessary.

Arctic Fox Critical Areas

No critical areas have been identified for arctic fox. The only concern relative to industrial activities is destruction of dens and denning habitat due to borrow activities. Destruction of dens can be prevented, however, by conducting surveys of borrow sites prior to extraction and avoiding actual den sites during borrow operations. Destruction of scarce denning habitat is unlikely as there appear to be ample supplies of gravel in much of the study area.

Waterfowl Critical Areas

Two critical waterfowl areas were identified: the south shore of Baker Lake and an area around and northeast of Pitz Lake, and the islands area between Beverly and Aberdeen Lakes. The former area is a snow goose nesting and moulting area as well as the area where most goose hunting by Baker Lake residents occurs. The latter area is a moulting area for an estimated 10,000 large-race Canada geese.

Major concerns relative to industrial activities in the two areas relate to destruction of nesting and moulting habitat by borrow activities and facilities construction, excessive disturbance of nesting and moulting geese by human and industrial activities and low aircraft overflights, and fuel and chemical spills in areas where nesting or moulting waterfowl are concentrated. Controls recommended for both areas include restrictions on the location of facilities, regulation of aircraft overflight altitudes, timing of activities, and contingency plans for containment and cleanup of fuel and chemical spills.

Land Use Regulations - General Considerations

In recommending controls to protect fish and wildlife species, we encountered significant data gaps with respect to the biological characteristics of harvested species and the behavioural responses of these species to various industrial activities. To remedy these data gaps, we recommend that a program of intensive monitoring be undertaken whenever long-term activities identified as having potentially adverse impacts on fish and wildlife species supporting harvest are permitted in any area identified as critical. The resulting data would then be applicable to subsequent industrial activities.

Most controls that we have recommended can be implemented within the existing regulatory framework. Exceptions are aircraft operation and exploratory activities, which due to their scale, duration, or character, do not require land-use permits.

With respect to aircraft operation, we recommend that areas identified as caribou calving grounds, post-calving areas, or water-crossing sites and possibly other sensitive wildlife areas should be designated by Territorial Ordinance as areas where aircraft operation is restricted during critical periods. We further recommend that aircraft activities within critical areas be monitored to ensure satisfactory compliance, that land-use permits could be withdrawn as a punitive measure, and that industry incorporate penalty clauses into contracts with companies supplying air support services.

With respect to exploratory activities that do not require land-use permits, we recommend that holders of mineral prospecting permits be required to advise communities of details regarding all proposed field activities and that subsequent programs be tailored with community concerns in mind. We also recommend consultation between the mining industry, government, NWT residents, and other affected parties to amend the regulatory framework under which mineral exploration activities are undertaken. Finally, while we recognize that development activities arising out of a successful exploration program are subject to control under the Federal Environmental Assessment and Review Process, we recommend that the public hearing phase of that process be extensive and be undertaken at a time when local residents most affected are best able to participate.

To overcome problems in the process by which land-use permit applications are reviewed with local communities and to make community review of those applications more meaningful, the present system for permit application and community review requires modification. We recommend that regular review periods be scheduled to ensure that communities are given a realistic opportunity to review and comment on land-use permit applications. During these review periods, a representative of DIAND should be present in the community to meet with the community council, Hunters and Trappers Association, or other groups. We further recommend that information on permit applications submitted to communities should be comprehensive.

COMMENTS OF THE ADVISORY COMMITTEE

On 4 and 6 February 1978, Interdisciplinary Systems Ltd. staff met with the study advisory committee of Louis Tapatai, Peter Kaluraq, William Anautalik, Moses Nagyugalik, Francis Kalurag, and Jonah Amitnaaq to review the draft final report. During these meetings discussion focussed mainly on those areas identified as critical and on controls recommended to mitigate adverse environmental impacts. A number of comments and concerns were expressed by advisory committee members at these meetings, and are summarized below:

The point was made that caribou and fish are more important to people of Baker Lake than to people in coastal communities who can rely on seals for food. The advisory committee also noted that when caribou are scarce, Baker Lake people depend more on meat purchased from the Bay.

The committee pointed out that caribou follow different migration routes in different years, and that hunting areas must vary because of these yearly changes in distribution of the herds. The sensitivity of caribou to disturbance at water crossings was reiterated, and concern expressed about industrial activities in these areas. The difficulty of enforcing such controls as minimum altitudes for aircraft overflights not only at water crossings but throughout the area was recognized.

It was the feeling of the advisory committee that many other lakes are as important for fish harvest to some people as the large lakes identified as critical areas. They thought the same controls recommended for the latter should be applied to the former as well. They expressed concern about wastage of fish caught by sport-fishing workers at exploration camps, but again the difficulty of control was recognized.

In relation to fish harvest estimates, they mentioned their difficulty in estimating how much of the harvest is consumed by people and how much is used for dog food.

The advisory committee favoured use of local monitors used to help enforce fishing regulations and minimum altitudes of aircraft overflights. They perceived difficulties because of the language difference between monitors and industrial workers.

Finally, they made special note of the need to control industrial activity outside study area boundaries as well as within. They emphasized that caribou harvested by Baker Lake hunters rely on an area much larger than that encompassed by the study area, making it essential that recommended controls be applied throughout their entire range.

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CHAPTER 1

PROPOSED BAKER LAKE LAND FREEZE - PROBLEM REVIEW

Since 1969, Baker Lake residents have repeatedly expressed concern about the effects of mineral exploration activities on the renewable resources that sustain their community, particularly caribou.

This concern came to a head in March 1974 when the Department of Indian and Northern Affairs (DINA) notified residents of the settlement that mineral exploration activities had been scheduled that summer for the Baker Lake area. The residents responded to this announcement the following month with a formal complaint and petition to the Federal and Territorial Governments signed by about 300 Baker Lake residents. Taking the basic position that they rejected continued exploration "on Inuit-occupied lands", the residents protested the lack of prior consultation about proposed industrial activities. They asserted that exploration activities would only be acceptable after a land-claims settlement -- and then only if Baker Lake residents approved of proposed activities.

Concern was focussed on three areas regarded as most important for traditional land-use activities, particularly caribou hunting: Kazan Falls, Christopher Island, and the Aberdeen-Beverly Lakes region. A more general concern expressed was the encroachment of industry on Inuit economy and life-style.

About the same time (1974), the Baker Lake Settlement Council also expressed concern about the District of Keewatin not being subject to the Territorial Lands Act and hence the Land Use Regulations. In June 1974, DINA informed the Baker Lake Council that the eastern Arctic, and thus Baker Lake, would be incorporated into this regulatory scheme by 1 January 1975. They indicated that the lengthy consultative process for amending the Territorial Lands Act would involve governments, native groups and industry. DINA further indicated that under the proposed new Regulations, advance information about land-use permit applications would be made available to local residents, and local residents would be consulted about proposed activities. Although the Inuit Tapirisat of Canada (ITC) was subsequently consulted during this amendment process, the Baker Lake Council was not. This only served to reinforce the skepticism of Baker Lake residents.

Shortly after learning that they had been overlooked during preparation and review of proposed new Regulations, the Baker Lake Council advised DINA that they could not accept delays while changes were made to the Land Use Regulations, and requested an immediate "freeze" on all exploration activities in the Baker Lake area until such time as the new Regulations were made official. But by 24 March 1975, the Council had received no reply to this request, so they resolved to contact their Member of Parliament and the ITC in Ottawa.

DINA had in the meantime contacted ITC regarding protection for territories involved in Inuit land claims. Although DINA had in the past insisted that a total "freeze" or moratorium on development in such lands was unacceptable, the Minister had indicated (28 November 1974) that there might be "some places of special significance" for cultural, historical or local reasons for which "special protection" could be arranged in order "that disturbance would not occur without full prior consultation". DINA's policy was thus one under which individual parcels of land could be protected, but not large land areas simply because they might be used for hunting or trapping, or for environmental reasons.

In March 1975, DINA advised Baker Lake residents of impending summer exploration programs. The settlement again expressed concern about delays in the promised amendments to the Territorial Lands Act. By late June 1975, however, DINA officials were anticipating that these amendments would be accomplished by the following summer. Although the changes desired by the Baker Lake Council had not as yet been put into effect, the settlement's concerns had been brought to the attention of the Land Use Advisory Committee and DINA. In addition, the Canadian Wildlife Service and the Ministry of Transport had contacted mineral exploration companies about special flying precautions that should be taken on flights over caribou calving grounds between 25 May and 10 June.

On 2 June 1975, the Baker Lake Council asked ITC to prepare the necessary documentation towards obtaining a "land freeze" for the Baker Lake area; and on 24 June, ITC presented the "Baker Lake Land Freeze Proposal" to the Federal Government on behalf of the settlement (ITC 1975). The proposal outlined the settlement's concerns, especially the effects of aircraft on caribou, emphasized the "cultural value" attached to the land, and requested a "freeze" on six areas pending a land-claims settlement.

On 13 August 1975, the Minister informed ITC that the "land freeze" proposal had been rejected, citing again the department's philosophy that controlled industrial activity could proceed without excessive environmental damage. The Minister also stated that Keewatin would be incorporated into the area under the Territorial Lands Act by October 1975, and that an adequate framework for dealing with the community's concern would then be in place.

In March 1976, DINA approved 68 applications for prospecting permits in the NWT, including several within the proposed Baker Lake "freeze" zone. ITC immediately expressed their lack of confidence in the Minister, charging lack of consultation and concern for northern people. In response, the Minister re-asserted his faith in the permit-review process, and later confirmed that exploration would be allowed to continue. In February 1977, DINA indicated in an internal communication that new prospecting permits would soon be issued, but suggested that departmental review should be made of permit areas relative to current Inuit land use and biologically sensitive areas. It was also suggested that ITC be informed of DINA's criteria for issuing prospecting permits. Both ITC and the Baker Lake Council again called for a "freeze", rejecting the permit-review process as an adequate means of controlling environmental damage, particularly harassment of caribou.

On 25 March 1977, the Minister of DINA imposed a temporary "halt" on land-use activities in a 78,000-km^2 (30,000-mi^2) area around Baker Lake by instructing that all land-use permit applications for operations in the area be rejected. Three current land-use permits were unaffected, but three prospecting and four land-use permit applications (including two by Federal Government agencies) were affected. The halt on issuance of land-use permits was to last until 1 March 1978, during which time a study would be undertaken of the effects of exploration activity on hunting and trapping, and in a later enlargement of the terms of reference, on fishing. Prospecting permits for other areas of the NWT would continue to be issued, with exploration subject to the land-use permit system. DINA again expressed faith in the ability of the permit-review process to bring about awareness of local concerns. DINA thus continues to reject a total "freeze" while land claims are negotiated, although they remain committed to reviewing and considering the requests and concerns of specific communities on their "individual merit".

CHAPTER 2

STUDY OBJECTIVES AND APPROACH

OBJECTIVES

The objectives of this study as outlined in the initial terms of reference are six-fold:

1. to identify areas critical for, areas supporting and areas of no significance to, current hunting and trapping.

2. to define the nature and extent of past, present and anticipated non-renewable resource exploration and development.

3. to identify areas and periods within which:

    a) non-renewable resource-related activities will not conflict with current hunting and trapping and in which normal regulatory procedures may be followed.

    b) minor conflicts might exist but non-renewable resource-related activities could continue under special regulation.

    c) non-renewable resource-related activities should not be allowed because regulatory measures could not be devised that would prevent a major impact on hunting and trapping as currently practiced.

4. to recommend regulatory terms and conditions for non-renewable resource-related activities in areas defined under 3(b) above, in order to ensure that hunting and trapping may continue.

5. to determine the current value of hunting and trapping to the Inuit of Baker Lake as a source of food and income.

6. to assess the feasibility and practicability of enhancing the use of caribou and furbearers as the basis of a local renewable resource business enterprise.

The above objectives were subsequently broadened to include fisheries considerations.

The study area, shown on Map 1, was defined as follows:

In the Northwest Territories;

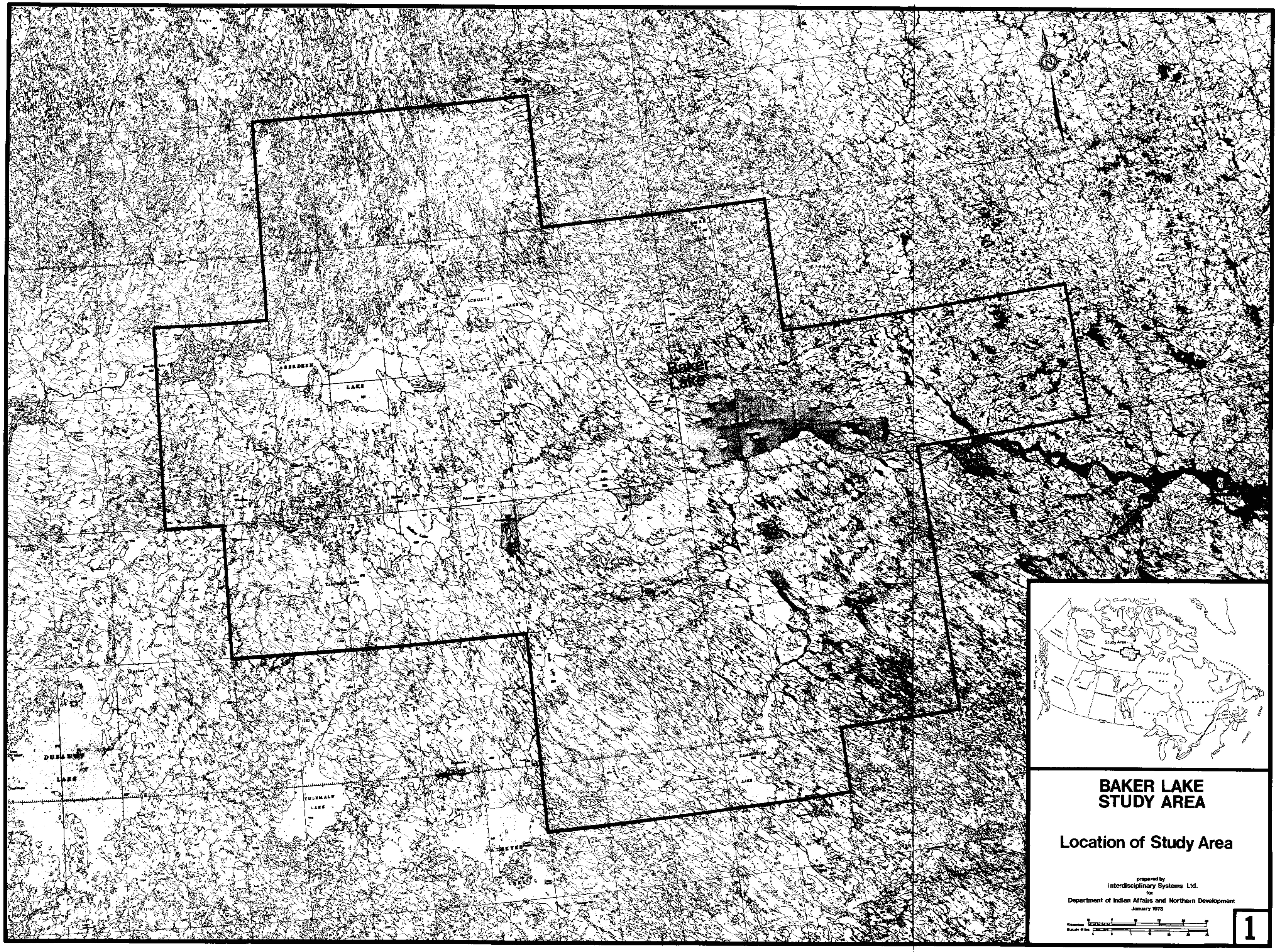
in the District of Keewatin,

all that tract of land being more particularly described as follows:

Commencing at a point on the right bank of the Dubawnt River at approximate latitude 63°50'30" and longitude 100°00';

thence due south to latitude 63°30';
thence due east to longitude 97°30';
thence due south to latitude 62°45';
thence due east to longitude 95°00';
thence due north of latitude 63°00';
thence due east to longitude 94°00';
thence due north to latitude 64°00';
thence due east to longitude 92°30';
thence due north to latitude 64°30';
thence due west to longitude 95°00';
thence due north to latitude 65°00';
thence due west to longitude 97°00';
thence due north to latitude 65°30';
thence due west to longtiude 99°30';
thence due south to latitude 64°45';
thence due west to longitude 100°30';
thence due south to latitude 64°00';
thence due east to longitude 100°00';
thence due south to the point of commencement.

Saving, excepting, and reserving thereout and therefrom all lands lying within the boundaries of the Thelon Game Sanctuary;



BAKER LAKE STUDY AREA

Location of Study Area

prepared by
Interdisciplinary Systems Ltd.
for
Department of Indian Affairs and Northern Development
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Saving, excepting, and reserving thereout and therefrom all lands lying within a radius of twenty-five (25) miles from the northeast corner of Lot 196 in the Settlement of Baker Lake as said Lot 196 is shown on plan of survey of record number 55826 in the Canada Lands Surveys Records at Ottawa, a copy of which is filed in the Land Titles Office for the Northwest Territories Land Registration District at Yellowknife under number 567.

APPROACH

The approach adopted for this study involved: documenting recent renewable resource land-use patterns, estimating renewable resource harvest, computing the value of renewable resource harvest, describing biological characteristics of harvested species, documenting recent industrial land use, describing potential industrial land use, identifying potential impacts of industrial facilities and activities on harvested species, delineating areas regarded critical for sustaining harvested populations, and recommending industrial land-use controls.

These various aspects of our approach as well as the community consultation and interview process used are briefly discussed below. Additional detail is presented in appropriate sections of the report.

Land Use - Renewable Resources

Information on extent and seasonality of land use by Baker Lake hunters, trappers, and domestic fishermen, as well as the relative importance of particular areas within the study area for hunting, trapping, and fishing, was compiled from two main sources: Inuit Land Use and Occupancy Project (I.L.U.O.P.) maps and supporting commentary, and interviews with local residents conducted as part of this study.

The relative importance of particular areas currently used for hunting, trapping, or fishing and recent changes in land-use patterns were determined by analyzing individual I.L.U.O.P. map biographies and maps prepared by Baker Lake residents interviewed during this study.

Renewable Resource Harvest - Quantity and Value

Information from several sources was used in estimating current game, fur, and fish harvest by Baker Lake residents. Game harvest was estimated using kill estimates reported by 43 randomly selected heads of household we interviewed as part of this study. Current fur harvest estimates were taken from fur records maintained by the N.W.T. Government Fish and Wildlife Service.

Reliable data on domestic fish harvest were lacking and impossible to acquire. Through our interviews, however, we were able to acquire insight into the proportion of various country foods comprising the average Baker Lake resident's diet. Using this information, it was possible to estimate the quantity of fish consumed.

After estimating harvest we calculated the value of harvest. This required imputing a value for non-marketed resources. The importance of renewable resource harvest to the economy of Baker Lake was determined by comparing this value with income earned from other sources.

Biological Characteristics

Biological characteristics of caribou, waterfowl, arctic fox, and fish in the study area were determined from a review of relevant literature and interviews with Baker Lake residents. General features of the biology of the two main caribou populations occupying the study area (Beverly and Kaminuriak populations) are outlined. This is followed by a more detailed discussion of distribution, numbers, behaviour and other features of each population under the following life-history phase headings: spring migration, calving areas, post-calving aggregations and summer movements, fall movements, and wintering ranges.

Biology and distribution of several species of waterfowl, namely Canada, lesser snow, and white-fronted geese, and oldsquaw ducks are summarized. Nesting and moulting are emphasized, and six areas of greatest importance to nesting and moulting waterfowl are presented.

Distribution and behaviour of arctic foxes are described, with emphasis on denning.

Fish in various watersheds of the study area are discussed as are physical characteristics of the watersheds. Distribution of fish species was determined from general literature, area-specific studies, and local information. Biological information on northern fish populations was gleaned from the literature. Information about mercury contamination of fish from specific lakes in the study area was provided by Environment Canada.

Industrial Land Use

Recent and ongoing mineral exploration activity is described from information provided by Department of Indian and Northern Affairs, Geological Survey of Canada and industry. This information shows the general location and extent of recent activity and provides some insight into probable areas for future development of uranium mines. Since considerable uncertainty about mineral potential still exists, however, we are obliged, for purposes of this study, to assume that mineral discovery and development could occur almost anywhere within the study area.

The proposed Polar Gas pipeline project is described using information provided by Polar Gas.

Potential Impact of Industrial Development

Scenarios describing the facilities and activities characteristic of: uranium exploration and development, up to and including an operating mine, and, construction, operation, and maintenance of a natural gas pipeline were prepared (Appendix A). Potential impacts of these industrial facilities and activities on harvested species are portrayed within a matrix.

Areas regarded critical for sustaining harvested fish and wildlife populations are identified. The relevance to each critical area of potential impacts portrayed in the matrix is then appraised and controls are recommended.

Community Consultation and Interview Process

To ensure that Baker Lake residents understood study objectives, were informed of progress, and were consulted about strategic aspects of the study, a local Advisory Committee was established. This committee of six, structured in accordance with the wishes of Baker Lake residents, was comprised of two persons each from the Hamlet Council, Land Claims Committee, and Hunters and Trappers Association. A resident co-ordinator, selected by the Advisory Committee, was employed for the duration of the study. The co-ordinator communicated study findings to committee members on an ongoing basis.

Interviews were an important source of information on land use, renewable resource harvest, and biological characteristics. Sixty male heads of households were randomly selected as prospective interviewees from a community list of Inuit families. Family units with no male members

16 years of age or older were excluded from the sample population since interviews focussed on hunting, trapping, and fishing; activities generally pursued by adult males.

For a variety of reasons it proved impossible to arrange interviews with 17 of the 60 prospective respondents identified. Of the 17 prospective respondents with whom interviews could not be arranged, 1 was deceased, 2 had disabilities rendering an interview impossible, 7 were temporarily residing or visiting elsewhere, and 7 were unavailable to respond because of other commitments. Although the work and education commitments of some of these non-respondents may have affected their opportunity to pursue traditional hunting, trapping and fishing, we do not believe that their inclusion in the interview sample would have greatly changed our overall conclusions.

The resident co-ordinator contacted each respondent to explain the purpose and general nature of the interview and to arrange interview times. All interviews were conducted in the home of the respondent with both an IDS staff member and an interpreter present.

A predesigned form was used for all interviews. Since there was no opportunity to pretest the questionnaire, however, some flexibility was required and the form was modified somewhat as interviewing progressed. In order to ensure consistent interpretation of questions, the co-ordinator and interpreters were fully briefed on the questionnaire, and the reasons for asking each question were explained.

The co-ordinator and interpreters then undertook to translate the questions into Inuktituk to ensure consistent interpretation.

Each respondent was asked to mark on a map of the study area where he had hunted, trapped, and fished since 1970. Information on when hunting, trapping, and fishing occurred, and how much was harvested, was recorded, as was income and employment information for the previous 12 months. The latter was required for purposes of evaluating the significance of income derived from traditional pursuits relative to total earned income.

CHAPTER 3

LAND USE - RENEWABLE RESOURCES

Baker Lake residents hunt, trap, and fish over most of the study area. This chapter documents specific areas used for caribou, goose, and ptarmigan hunting, fox trapping, and, domestic and commercial fishing. It also discusses the relative importance of areas used by hunters, trappers, and fishermen, apparent recent changes in use of these areas, and seasonality of use.

Maps 2, 4, and 6 show areas of high, moderate, and low relative importance for caribou hunting, fox trapping, and domestic fishing. Maps 3, 5, and 7 identify ten caribou hunting areas, seven fox trapping areas, and eight domestic fishing areas, respectively, for which data on recent changes in the relative intensity and seasonality of use are presented. Map 8 shows areas of high, moderate, and low relative importance for goose hunting and indicates study area lakes which were available for commercial fishing in 1976-77.

PREPARATION OF LAND USE MAPS

Two main information sources were used in analyzing and depicting traditional land-use information: individual map biographies compiled by the I.L.U.O.P., together with supporting text (Welland 1976), and individual maps and supporting documentation compiled during our study interviews in Baker Lake. In addition, land-use information from Stager (1977) was reviewed and compared with information from our study interviews.

I.L.U.O.P. Data

Individual map biographies[1] were compiled by I.L.U.O.P. field workers in Baker Lake during interviews with 101 hunters and trappers in March, April, and May 1974. These individual map biographies were used to compile composite maps[1] showing the extent of land use by Baker Lake hunters and trappers. Volume Three of the I.L.U.O.P. report (Freeman 1976) presents generalized reproductions of these composite maps.

I.L.U.O.P. maps show the extent of land use during three time periods. Period III, the most recent, covers land use by Baker Lake residents from 1956 to 1974. Since 1956, land-use activities by most Baker Lake hunters and trappers have been primarily settlement-based, although a long transition period to settlement-based life lasted well into the 1960's. We compiled information from individual I.L.U.O.P. map biographies since composite maps, with the exception of the trapping composite, provide little insight

[1]deposited at the National Map Collection, Public Archives, Ottawa.

into how many hunters used particular areas. Volume One of the I.L.U.O.P. report (Welland 1976) does, however, provide some information on the relative importance of hunting, trapping, and fishing areas and on seasonality of land use.

Interview Data

During this study, individual land-use maps and supporting documentation were compiled during interviews with heads of 43 households. Nine active caribou hunters, not included among households we sampled, were also surveyed to determine if there were additional caribou hunting areas used by them and not reported by hunters in sampled households.

In compiling individual land-use maps, we attempted to record all important hunting, trapping, and fishing areas used by respondents during the period 1970 to 1977. Respondents were also asked about time spent and seasonality of hunting and fishing.

Map Preparation

To analyze land-use information, the study area was divided into 945 grid squares. This grid square pattern was superimposed on each individual I.L.U.O.P. map biography and each map prepared during study interviews. Counts were made of total numbers of respondents who indicated hunting, trapping, and fishing in each grid square.

These counts provide insight into the relative importance of areas for hunting, trapping, and fishing. While these numbers do not indicate what portion of the harvest came from a particular area or how much time was spent there by hunters, they do indicate the number of hunters reporting use of the area during the time period specified.

In this study, "use class" is a measure of the relative importance of an area and refers to the number of hunters, trappers, or fishermen who indicated use within a particular grid square during the time period specified. The "use class" of a particular grid square was judged "high" when more than two-thirds of respondents indicated use within that square, "moderate" when one-third to two-thirds indicated use, and "low" when less than one-third indicated use.

Comparison of I.L.U.O.P. and Study Interview Maps

Maps 2, 4, and 6 show caribou hunting, fox trapping, and domestic fishing patterns determined from individual I.L.U.O.P. maps and study interview maps. They enable comparison of I.L.U.O.P. and study interview data and illustrate recent changes in land use. Some apparent changes in land use are probably attributable to differences in method and approach between the I.L.U.O.P. study and this study rather than to actual changes in land use. Major differences in land-use mapping methods employed in these two studies are:

1. I.L.U.O.P. maps cover a longer time period (1956-1974) than study interview maps (1970-1977). Therefore, greater variation in areas used, reflecting variation in animal distribution (e.g. caribou migratory and wintering patterns), can be expected.

2. I.L.U.O.P. maps include land-use activities by hunters and trappers who lived in camps, particularly during the early part of Period III (1956-1974), whereas almost all activities shown on study interview maps are settlement-based. Thus, I.L.U.O.P. maps would tend to show a greater use of outlying areas than study interview maps.

3. The I.L.U.O.P. study attempted to establish only the extent of land use during a particular period. As a result, general areas indicated by lines joining outer limits of hunting areas were shown on many I.L.U.O.P. maps. Consequently, regions between hunting areas where no hunting actually took place may be included in the individual's general hunting area. This occurred less on study interview maps, since lines were drawn to include only those areas respondents regarded most important for hunting or trapping.

4. I.L.U.O.P. maps include travel routes to hunting and trapping areas to a much greater extent than do study interview maps. Thus, intensity of use would appear to be greater along well-used travel routes (e.g. Thelon and Kazan Rivers) on I.L.U.O.P. maps than on study interview maps.

5. The I.L.U.O.P. sample size was 101, whereas our sample size was 43. Our sample was randomly chosen; thus, it should accurately represent current land use by Baker Lake residents. However, outlying areas, which may be used by only one or two hunters who were not included in the sample, may be missed.

CARIBOU HUNTING

Caribou hunting is probably more important to Baker Lake Inuit than to Inuit of other settlements. Caribou are their primary source of country food in a region where seals, walruses, whales, and geese -- important foods in other Inuit settlements -- are relatively scarce or absent.

Almost every adult male in Baker Lake hunts caribou. Of the 101 Baker Lake hunters who completed I.L.U.O.P. maps, 99 indicated that they had hunted caribou during the period from 1956 to 1974 and the other 2 indicated that they had hunted caribou during earlier periods. Of 43 heads of households we interviewed, 39 indicated that they had hunted caribou during the past few years. The remaining 4 indicated that, although they had not hunted during the past few years, they had hunted prior to 1974.

Seasonality of Caribou Hunting

Caribou hunting is virtually a year-round activity for Baker Lake residents, except for brief periods during spring breakup, usually in June, and fall freezeup, usually in October, when travel is virtually impossible. During the last two years, winter has been the most important hunting season since large numbers of caribou wintered north of Baker Lake. Based on study interviews, about 64 percent of the caribou harvest over the past year (winter 1976-77 to fall 1977) was in winter, 17 percent in summer, 10 percent in fall, and 9 percent in spring. In contrast, 5 to 10 years ago most caribou were harvested in summer and fall (Welland 1976; E. Land, NWT Fish and Wildlife Service, personal communication).

Winter hunting generally starts in late October or early November, as soon as snow and ice conditions allow overland travel by snowmobile. Hunting peaks in early winter but continues throughout the winter depending on family food requirements. Kabloona (1977:125 in Stager 1977) reports that hunters try to bring in enough meat in November to last through December and January. Hunting drops to a low level from late December to early February -- the coldest, darkest period.

Most winter hunting trips are relatively short, generally one to three days (including weekend trips). Very few hunters go on extended hunting trips in winter; those who do usually trap at the same time. Generally, winter hunting trips during the past couple of years, when caribou wintered north of Baker Lake, have been more frequent, shorter, and more successful.

Spring hunting generally occurs from April to breakup in June. Although there is no clear break between winter and spring hunting, spring marks the return of warmer weather, days are longer, and travel is more comfortable. Consequently, although caribou harvest is relatively low during this season, many people are on the land hunting caribou in association with fishing and goose hunting.

Spring hunting trips, particularly those undertaken by employed people, are often weekend trips. Many families go for holidays in spring, often spending two weeks or more at favourite hunting and fishing spots.

Summer hunting starts in July when major water travel routes such as Thelon and Kazan Rivers are relatively free of ice and safe for travel. Wage employment is highest during summer and consequently many people are obliged to hunt on weekends. Those who are not employed generally spend more time on the land, going on longer hunting trips up Thelon and Kazan Rivers and down Baker Lake and Chesterfield Inlet.

Fall hunting generally starts with the advent of cooler weather in early September and continues until freeze-up in mid to late October or early November. Traditionally, fall hunting was much more important than it has been in the past two years. Hunters would cache meat which they could not bring back, retrieving it during winter. Recently, fall hunting patterns have apparently been a continuation of summer hunting patterns, characterized by weekend hunting trips by employed people and longer trips along water travel routes by others.

Extent of Caribou Hunting

Caribou hunting occurs over most of the study area. I.L.U.O.P. maps for 1956 to 1974 show that caribou were hunted in 98 percent of the study area. Maps compiled during our study interviews show at least 80 percent of the study area currently being used by caribou hunters in the 43 households we sampled. When responses of the nine additional active caribou hunters we surveyed are included, at least 85 percent of the study area appears to be currently used by Baker Lake caribou hunters.

Map 2 shows the extent of caribou hunting and areas of high, moderate, and low use, based on I.L.U.O.P. maps (1956 to 1976) and study interview maps (1970 to 1977). Generally, I.L.U.O.P. maps indicate a higher use class than do study interview maps. I.L.U.O.P. information indicated high use in 4 percent of the study area, moderate in 20 percent, low in 74 percent, and no use in 2 percent of the study area. Study interview information indicates high use in 1 percent of the study area, moderate in 13 percent, low in 66 percent, and no use in 20 percent of the study area.

Some apparent differences between hunting patterns shown by I.L.U.O.P. maps and study interview maps are due to differences in method and approach described earlier. Perhaps the most significant of these differences is the inclusion of travel routes used by hunters to a greater extent on I.L.U.O.P. maps than on study interview maps.

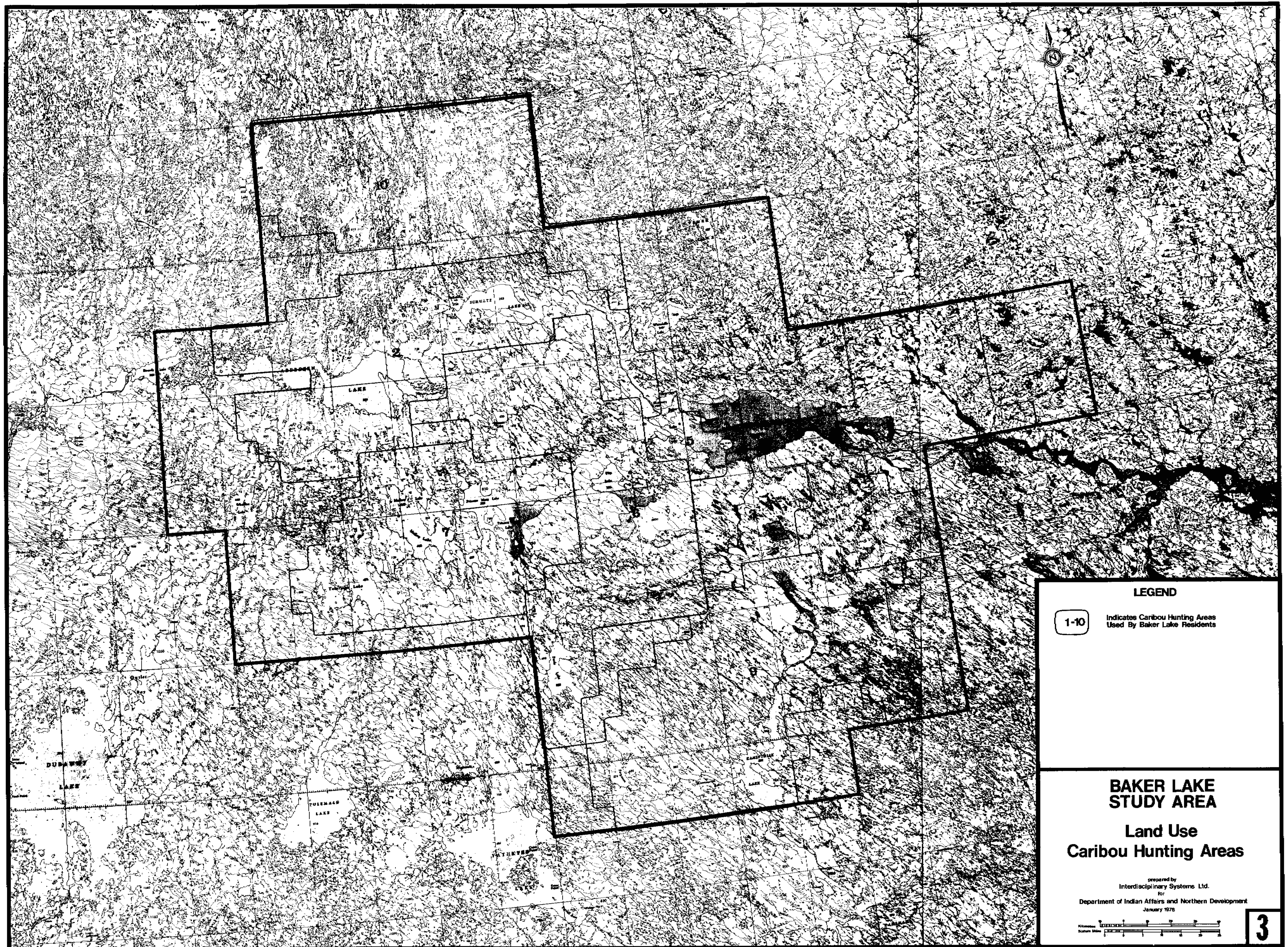
Patterns of use shown on I.L.U.O.P. maps and study interview maps are nonetheless similar. Use of areas to the northwest, north, and east of Baker Lake hamlet is similar, while use of areas to the southwest, south, and southeast of the hamlet is shown as generally lower on study interview maps, suggesting some decline in hunting in these areas during recent years.

Most hunting by the nine additional active caribou hunters we surveyed was within those caribou hunting areas described by hunters in sampled households. The only exceptions were an area between Aberdeen and Beverly Lakes and along lower Dubawnt River extending south to northwestern Wharton Lake, and a small area north of western Aberdeen Lake. These areas, comprising about five percent of the study area, were used by two of the nine additional caribou hunters surveyed.

From a sample of 49 households in Baker Lake in 1975, Stager (1977) presents one map showing caribou hunting by Baker Lake residents from winter 1974-75 to fall 1975 and one map showing caribou hunting from 1970 to 1974. Hunting patterns on Stager's maps generally agree with patterns shown on our study interview maps. Stager's maps indicate that the Thelon River and Schultz Lake, Quoich River, Kazan River, Whitehills Lake, and Pitz Lake areas were well used by caribou hunters. They do not, however, indicate the concentration of hunting north of Baker Lake which appears on study interview maps. Undoubtedly this is because caribou did not winter there in large numbers prior to 1975.

Caribou Hunting Areas

Map 3 shows ten areas where hunters we interviewed indicated recent caribou hunting. During the past two


LEGEND
1-10
Indicates Caribou Hunting Areas Used By Baker Lake Residents
BAKER LAKE STUDY AREA
Land Use
Caribou Hunting Areas
prepared by
Interdisciplinary Systems Ltd.
for
Department of Indian Affairs and Northern Development
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years, the area north of Baker Lake (Area 1) appears to have been the most important caribou hunting area. Other important hunting areas are Thelon River and Schultz and Aberdeen Lakes (Area 2), Kazan River and Martell and Bissett Lakes (Area 3), and east of Baker Lake (Area 4). Based on study interview data, most other hunting areas appear less important, and any importance they may once have had appears to have declined in recent years.

The caribou hunting areas shown on Map 3 are listed in order of relative importance, based on the number of hunters we interviewed reporting use of each area.

Area 1: North of Baker Lake. Current use of this area by caribou hunters ranges from high along the north shore of Baker Lake between the mouths of Akutuak and Ketyet Rivers; moderate around Whitehills Lake and lower Prince, Akutuak, and Ketyet Rivers; to low around Tehek Lake.

Use in most of this area appears not to have changed much in recent years, with the exception that winter hunting has been concentrated here in the last two years. There has also been an apparent shift in the relative importance of hunting sites within this area. Hunting appears to have increased to the east around Akutuak and Ketyet Rivers and decreased to the west around Prince River. This is presumably due to the location of caribou wintering concentrations. Hunting close to the hamlet also appears to have declined, although this is probably attributable to inclusion of travel routes to a greater extent on I.L.U.O.P. maps than on study interview maps.

Hunting in Area 1 is primarily in winter. Some hunting occurs in spring before breakup but very little occurs in summer and fall (Table 3.1).

Area 2: Thelon River, Schultz and Aberdeen Lakes, and Marjorie Hills. Current use of this area by caribou hunters ranges from moderate along Thelon River and the shores of Schultz and Aberdeen Lakes to low in more inland areas such as Marjorie Hills. The highest concentrations of use occur close to Thelon River mouth, around the outlet of Schultz Lake, at the eastern narrows between Schultz and Aberdeen Lakes, and at the narrows between central and eastern Aberdeen Lake. These sites, with the exception of Thelon River near its mouth, have also been identified as important caribou river-crossing sites (see Map 14, Critical Areas - Caribou).

Use appears to have declined somewhat in recent years along lower Thelon River and Schultz Lake, remained about the same around eastern Aberdeen Lake, and increased slightly around central Aberdeen Lake. The apparent decline in use along lower Thelon River and Schultz Lake, however, may be largely attributable to inclusion of travel routes to a greater extent on I.L.U.O.P. maps than on study interview maps. It may also be partly attributable to the recent reduction in the success of summer and fall hunting.

Table 3.1 Seasonality of hunting in Baker Lake caribou hunting areas.[1]

Area	Location	Seasonal use reported by hunters using area			
		Winter	Spring	Summer	Fall
1.	North of Baker Lake	91%	23%	6%	6%
2.	Thelon River, Schultz and Aberdeen Lakes, and Marjorie Hills	19%	13%	78%	31%
3.	Kazan River, Martell and Bissett Lakes	23%	13%	60%	30%
4.	East of Baker Lake	88%	8%	23%	12%
5.	Western Baker Lake	38%	13%	50%	25%
6.	Sissons, Pitz, Thirty Mile, and Forde Lakes	42%	5%	47%	32%
7.	Princess Mary, Mallery, and Tebesjuak Lakes	93%	7%	7%	0%
8.	Southern Baker Lake, Andrews and Brown Lakes	58%	8%	25%	8%
9.	MacQuoid, Banks, Parker, Kaminuriak and Ferguson Lakes	50%	40%	10%	10%
10.	North of Aberdeen and Schultz Lakes	67%	33%	0%	0%

[1]based on study interviews.

Most hunting in Area 2 is during summer and fall when travel by canoe is possible (Table 3.1). There is some winter and spring hunting, however, particularly around Aberdeen Lake, which has been identified as a wintering area for some caribou (see Caribou Biology, Chapter 5).

Area 3: Kazan River, Martell and Bissett Lakes. Current use of this area by caribou hunters ranges from moderate along Kazan River to low in more inland areas. There appears to be a small high-use zone along Kazan River northeast of Kazan Falls.

Use appears not to have changed much in recent years along Kazan River. It appears to have declined around Martell and Bissett Lakes and to the west of Kazan River. Use also appears to have declined somewhat around the mouth of Kazan River, although this is probably attributable in part to inclusion of travel routes to a greater extent on I.L.U.O.P. maps than on study interview maps.

Hunting along Kazan River is mainly in summer and fall when travel by canoe is possible. Hunting around Martell and Bissett Lakes is largely in winter although some summer hunting occurs there as well (Table 3.1).

Area 4: East of Baker Lake. Current use of this area by caribou hunters ranges from moderate around Christopher Island and along lower Quoich River to low around Bowell Islands and northeast of Quoich River. The highest concentrations of use occur in the North Channel area and around St. Clair Falls on Quoich River.

Use appears to have declined in recent years around Christopher and Bowell Islands but increased along Quoich River. Part of the apparent decline around Christopher and Bowell Islands is probably attributable to hunters who indicated travel routes down Chesterfield Inlet to a greater extent on I.L.U.O.P. maps than on study interview maps. There also appear to have been fewer hunters travelling down Chesterfield Inlet in recent summers, corroborated by interview data indicating that most recent hunting in the area is in winter. The apparent increase in hunting along Quoich River is probably attributable to large numbers of caribou recently wintering north of Baker Lake.

Hunting in Area 4 is primarily in winter. Some summer and fall hunting occurs around Christopher and Bowell Islands and along Quoich River below St. Clair Falls. Very little spring hunting occurs in this area (Table 3.1).

Area 5: Western Baker Lake. Current use of this area by caribou hunters ranges from moderate between the hamlet and Fish Camp and around Gull Lake to low around Nunagiak and Big Hips Islands and northwest of Gull Lake.

Hunting appears to have declined substantially in this area in recent years. This is probably attributable in part to inclusion of travel routes to a greater extent on I.L.U.O.P. maps than on study interview maps.

Hunting in Area 5 occurs year-round since it is close to the hamlet and easily accessible (Table 3.1). Caribou are often hunted here in conjunction with trapping and fishing.

Area 6: Sissons, Pitz, Thirty Mile, and Forde Lakes. Current use of this area by caribou hunters appears low, although there is a small moderate-use zone around northern Pitz Lake. Use is relatively higher around Pitz and Thirty Mile Lakes and lower around Sissons and Forde Lakes.

The number of hunters using the area appears to have declined slightly in recent years, again probably due to the recent concentration of winter hunting north of Baker Lake and movement of people who formerly lived on the land into the settlement of Baker Lake.

Hunting in Area 6 occurs year-round, although there seems to be very little spring hunting (Table 3.1). Hunting around Thirty Mile, Forde, and Sissons Lakes is primarily confined to winter, while around Pitz Lake there is considerable hunting during summer and fall.

Area 7: Princess Mary, Mallery, and Tebesjuak Lakes. Current use of this area by caribou hunters is low. Generally, most hunting which occurs here is around Princess Mary Lake. Less hunting occurs around Mallery Lake and less still occurs around Tebesjuak Lake. Highest concentrations of use occur around northeastern and western Princess Mary Lake and in the vicinity of Mallery Lake outlet.

Hunting around Princess Mary and Mallery Lakes appears to have declined somewhat in recent years, while around Tebesjuak Lake it appears to have remained about the same.

Almost all hunting in Area 7 is in winter, when overland travel by snowmobile is possible (Table 3.1).

Area 8: Southern Baker Lake, Andrews and Brown Lakes. Current use of this area by caribou hunters appears low. It is highest along the shore of Baker Lake and south to Andrews Lake and very low around Tanataluk Islands to the northwest and Brown Lake to the southeast.

Hunting appears to have declined substantially over much of this area in recent years. This is probably attributable to inclusion of travel routes to a greater extent on I.L.U.O.P. maps than on study interview maps, to a decline in summer hunting trips along Baker Lake and down Chesterfield Inlet, and to a shift in winter hunting to the area north of Baker Lake.

Winter is the main hunting season in Area 8, particularly around Andrews and Brown Lakes. Summer hunting occurs primarily along the shore of Baker Lake. Very little spring or fall hunting occurs in this area (Table 3.1).

Area 9: MacQuoid, Banks, Parker, Kaminuriak, and Ferguson Lakes. Current use of this area by caribou hunters is very low and appears to have declined in recent years, partly due to changes in caribou migratory patterns and wintering areas and relocation to Baker Lake of Inuit who formerly lived in this area. Use is generally higher around Parker and Kaminuriak Lakes and lower around MacQuoid, Banks, and Ferguson Lakes.

Hunting in Area 9 is primarily in winter and spring when overland travel by snowmobile is possible (Table 3.1).

Area 10: North of Aberdeen and Schultz Lakes. Current use of this area by caribou hunters is very low and appears to have declined somewhat in recent years probably due to the recent concentration of winter hunting north of Baker Lake and movement of people who formerly lived on the land into the settlement of Baker Lake.

Hunting in Area 10 occurs in winter and spring when overland travel by snowmobile is possible (Table 3.1).

FOX TRAPPING

The majority of adult males in Baker Lake are, to some extent, involved in fox trapping. Most are casual trappers, however, trapping close to the hamlet and taking few foxes. Of the 43 heads of household we interviewed, 29 had trapped in the past few years and 4 others, although not currently trapping, had trapped prior to 1974. Based on a survey of 30 households in 1975, Stager (1977:149) reported that someone in 44 percent of households trapped, but that 76 percent of these usually set less than 15 traps.

The majority of foxes trapped are taken by those few trappers who travel to outlying areas. Almost all foxes taken are arctic foxes; coloured (red) foxes account for less than one percent of the harvest.

Seasonality of Fox Trapping

Under the NWT Wildlife Regulations, the trapping season is from November 1 to April 15. Much of the trapping during the early part of the season occurs close to the hamlet. Pelts taken at this time are usually not in prime condition and consequently pelt prices are low. Nonetheless, early season trapping effort by "casual" trappers is high since travel is easy and still relatively comfortable. Further, if they wish to have any success, these trappers cannot afford to wait too long because the area around the settlement is quickly "trapped out".

Most foxes are harvested in December and late winter (March to April) from outlying areas. Very little trapping occurs between late December and early February.

Trappers who travel to outlying areas usually fish and hunt in conjunction with trapping, often using fish or caribou offal for bait.

Extent of Trapping

Fox trapping currently occurs over about half of the study area. I.L.U.O.P. maps indicate that trapping occurred in about 60 percent of the study area from 1956 to 1974, while maps compiled during study interviews indicate that about 45 percent of the area was used for trapping from 1970 to 1977.

Map 4 shows trapping patterns based on I.L.U.O.P. maps and study interview maps. It enables comparison of these two patterns and provides insight into recent changes in land use by trappers. The trapping pattern based on study interview maps shows areas used by moderate and low numbers of trappers and areas where little or no trapping occurs. No differentiation between areas used by high, moderate, and low numbers of trappers is possible for the pattern based on I.L.U.O.P. maps. Instead, this pattern is a composite of individual traplines and trapping areas. In our opinion, however, it is adequate to show extent and concentration of land use by trappers during the period 1956 to 1974.

Generally, the extent and concentration of land use shown by I.L.U.O.P. maps and study interview maps are similar, suggesting no major changes in land use by trappers in recent years. The number of trappers using areas to the north and east of the hamlet appears to have increased slightly in recent years while the number of trappers using areas to the south, west, and northwest has remained about the same or decreased slightly. A greater concentration of use around the hamlet is shown on I.L.U.O.P. maps than on study interview maps, largely due to inclusion of travel routes to a greater extent on I.L.U.O.P. maps than on study interview maps.

Fox Trapping Areas

Map 5 shows seven areas where trappers we interviewed indicated recent fox trapping. The area around the west end of Baker Lake and towards Pitz Lake (Area 1) is currently used by the highest number of trappers. Use of this area is, to a large extent, by casual trappers who generally harvest less than 10 foxes per year. Relatively well-used outlying areas lie to the north and east along the north shore of Baker Lake and toward Whitehills Lake (Area 2) and to the south, along Kazan River (Area 3). Other outlying areas are used by very few trappers.

Fox trapping areas shown on Map 5 are listed in order of relative importance, based on numbers of trappers we interviewed reporting use of each area.

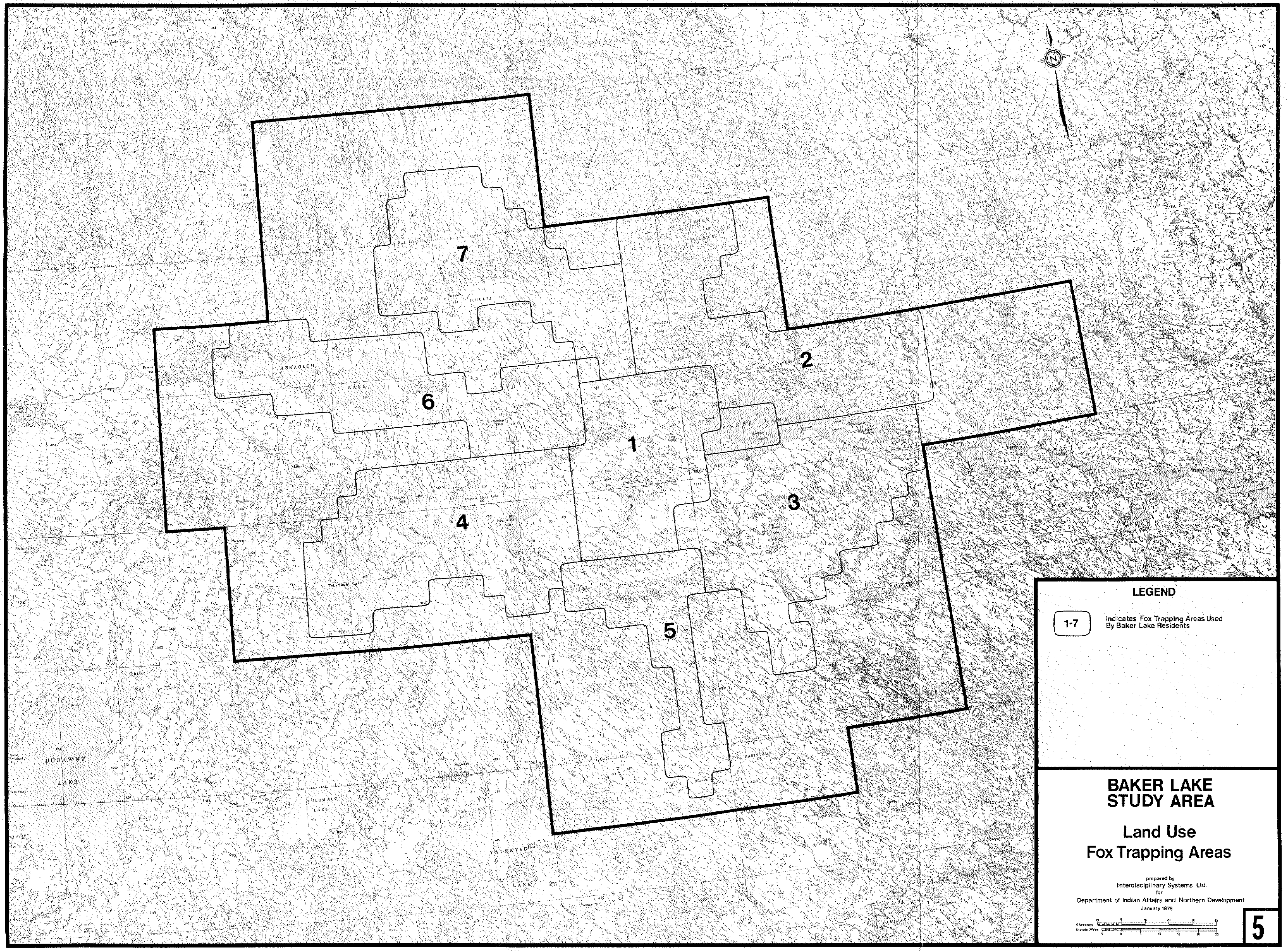
It should be noted that the number of trappers reporting use of an area is not necessarily an accurate measure of the relative importance of that area for fox harvest since a substantial portion of the harvest may be from outlying areas used by very few trappers.

Area 1: Pitz Lake and west end of Baker Lake. More trappers indicated use of this area than any other trapping area. While much of this area is currently used by relatively few trappers, a moderate number of trappers reported use of areas close to the hamlet and southwest towards Pitz Lake. Use appears not to have changed much in recent years. Most trapping occurs in November, largely by casual trappers.

Area 2: North and northeast of Baker Lake. Few trappers currently use this area. The north shore of Baker Lake, near the mouth of Ketyet River, and Whitehills Lake were used by more trappers than other parts of this area. Trapping in Area 2 appears to have increased in recent years, possibly because of increased winter caribou hunting in the area. Most trapping occurs in early and late winter.

Area 3: South and southeast of Baker Lake. Few trappers currently use most of this area, although a moderate number reported use of a small area just east of Kazan Falls. Generally, more trappers reported use around Kazan River than in other parts of this area. Use appears not to have changed significantly in recent years. Most trapping occurs in early and late winter.

Area 4: Princess Mary, Mallery, and Tebesjuak Lakes. Few trappers currently use this area. More reported use around eastern Princess Mary Lake and the narrows between Mallery and Princess Mary Lakes than in other parts of this area. In recent years use appears to have decreased somewhat around Princess Mary Lake, remained the same around Mallery Lake, and increased somewhat around Tebesjuak Lake. Most trapping occurs in early and late winter.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ABERDEEN LAKE
BAKER LAKE
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LEGEND
1-7
Indicates Fox Trapping Areas Used By Baker Lake Residents
BAKER LAKE STUDY AREA
Land Use
Fox Trapping Areas
prepared by
Interdisciplinary Systems Ltd.
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Area 5: Thirty Mile Lake to western Kaminuriak Lake. Very few trappers currently use this area. More trappers reported use around Thirty Mile Lake than in other parts of this area. Use appears not to have changed much in recent years. Most trapping occurs in early and late winter.

Area 6: Sissons Lake to Aberdeen Lake. Very few trappers currently use this area. Trappers reported more use around Sissons Lake than around Aberdeen Lake. Use appears not to have changed much in recent years. Most trapping occurs in early and late winter.

Area 7: Thelon River, Schultz Lake, and north of Schultz Lake. Fewer trappers reported use of this area than of any other trapping area. Use is uniformly low throughout the area and appears not to have changed much in recent years. Most trapping occurs in early and late winter.

DOMESTIC FISHING

At least one member of almost all families in Baker Lake fishes for food. Of 43 heads of household we interviewed, 41 are involved in domestic fishing to some extent every year and many said that their wives and children also fish. Of the 101 individuals in Baker Lake who completed I.L.U.O.P. maps in 1974, about 80 indicated fishing areas on their map biographies. A few more probably fished while hunting or trapping, although they did not indicate fishing areas on maps. From a sample of 30 households in 1975, Stager (1977:155) reported domestic fishing by members of 84 percent of these households.

Based on information offered by persons we interviewed, lake trout appear to account for about half of the domestic fish harvest. Arctic char and lake whitefish account for the remainder of the harvest, while lake cisco and grayling are caught only incidentally.

Seasonality of Domestic Fishing

Domestic fishing by Baker Lake residents is a year-round activity, although it is limited during freezeup and breakup. From a sample of 30 households in 1975, Stager (1977:155) reports that 84 percent indicated spring fishing, 63 percent summer fishing, 63 percent fall fishing, and 75 percent winter fishing.

More people go fishing in spring than in other seasons. The return of longer days and warmer weather makes travel more comfortable and many families go on holidays to fish camps at mouths of rivers along Baker Lake. Weekend fishing trips, particularly by employed residents, are common in spring. Jigging is the predominant fishing method, although there is also some casting and net fishing, particularly in late spring. Whitehills, Pitz, and Gull Lakes are important spring jigging sites.

Summer, which is characterized by family holidays, long trips to hunting areas, and weekend trips by employed residents, is also an important fishing season. Casting is the predominant fishing method and occurs along Thelon and Kazan Rivers and in Baker Lake. Some people also set nets in Baker Lake in summer.

The intensity of summer fishing drops off considerably as fall approaches, although fall fishing patterns are similar to summer fishing patterns. Fall casting is done along Thelon and Kazan Rivers and some nets are set in Baker Lake.

Winter fishing is important for hunters and trappers who fish for food and bait. Jigging is the predominant fishing method in outlying areas, although nets are sometimes set as well. Nets are also set in early winter in Baker Lake near the hamlet. Some of these are fished throughout the winter.

Extent of Land Use by Domestic Fishermen

Domestic fishing occurs over much of the study area. Most fishing occurs relatively close to the hamlet, but outlying areas are used by hunters and trappers fishing for food and bait. Fishermen we interviewed indicated that domestic fishing within the study area currently extends to Tehek Lake in the north, Bowell Islands in the east, southern Parker and Forde Lakes in the south, Princess Mary and Mallery Lakes in the southwest, and Schultz and Aberdeen

Lakes in the northwest. Map 6 shows the extent and concentration of land use by domestic fishermen we interviewed and by domestic fishermen who specifically indicated fishing sites on I.L.U.O.P. maps.

Domestic fishermen who completed I.L.U.O.P. maps indicated fishing farther east (to Quoich River), farther south (to northern Kaminuriak Lake), and farther west (to Wharton Lake) than did fishermen we interviewed. Nonetheless the general pattern derived from I.L.U.O.P. maps and study interviews corresponds remarkably well.

Domestic fishermen we interviewed indicated use of the west end of Baker Lake and Whitehills Lake to a greater extent, and the mouth of Kazan River to a lesser extent, than those who completed I.L.U.O.P. maps. Apparent changes in importance of areas may, however, be due to differences in the ways in which those we interviewed and those who completed I.L.U.O.P. maps defined fishing areas. For instance, many domestic fishermen who completed I.L.U.O.P. maps did not indicate specific areas where they casually fished while hunting or trapping, whereas most fishermen we interviewed did.

The apparent difference in the importance of western Baker Lake near the hamlet is probably almost entirely due to differences in interpretation of fishing areas. Many who completed I.L.U.O.P. maps may not have indicated this as a specific fishing area because of the casual nature of fishing there, much of which is done by women and children. During study interviews, however, we encouraged fishermen to indicate all areas where they or their families fished.

Based on a 1975 sampling of 30 Baker Lake households, Stager (1977) prepared maps showing domestic fishing areas used in 1975, fishing areas used from 1970 to 1974, and locations of spring fishing camps. Fishing patterns on Stager's maps generally agree with those based on our study interviews (Map 6). Stager's maps indicate that Fish Camp, the mouths of Thelon, Prince, and Kazan Rivers, and western Baker Lake are the most important fishing areas and that Pitz, Whitehills and Schultz Lakes and lower Thelon River are also well used.

Domestic Fishing Areas

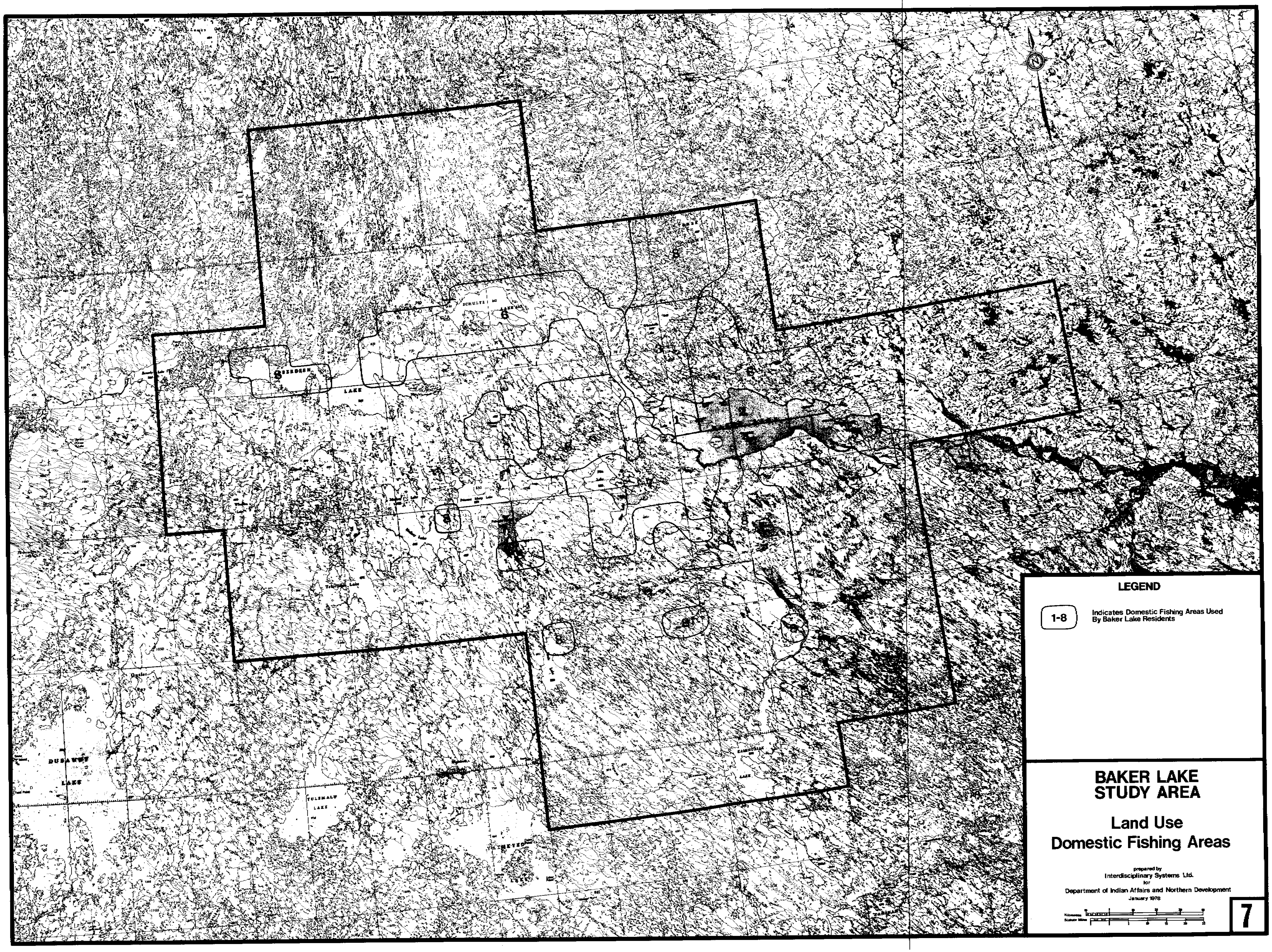
Map 7 shows eight areas where persons we interviewed indicated recent domestic fishing activity. The most important fishing sites in the study area appear to be: western Baker Lake, particularly around the hamlet and Fish Camp (Area 1); northern Baker Lake, particularly around the mouths of Prince and Akutuak Rivers (Area 2); Whitehills Lake (Area 3); and southern Baker Lake, particularly around the mouth of Kazan River (Area 4). Other relatively well used areas are eastern Baker Lake, particularly around western Christopher Island (Area 5); lower Thelon River, particularly around the outlet of Schultz Lake (Area 6); and Pitz Lake (Area 7). Other sites, used by very few fishermen we interviewed, primarily in conjunction with hunting or trapping, are also indicated (Area 8).

The domestic fishing areas shown on Map 7 are listed in order of their relative importance, based on the number of fishermen we interviewed who reported use of each area.

Area 1: Western Baker Lake. Use of this area by domestic fishermen currently ranges from moderate around the hamlet and Nunagiak Island to high around Fish Camp. A much higher percentage of fishermen we interviewed indicated use of this area than did fishermen who completed I.L.U.O.P. maps. This is probably due mainly to differences in approach between this study and the I.L.U.O.P. study, rather than an actual change in use. However, some increase in use may have occurred in recent years due to increases in the hamlet population.

Domestic fishing occurs year-round in this area, although it is limited during breakup and freezeup. Spring and summer are the most important seasons; there is also considerable fishing in early winter but relatively little in fall. Nets are used primarily in winter and summer, although jigging and casting also occur. Most spring fishing is by jigging while casting and net fishing are done in fall.

Area 2: Northern Baker Lake. Current use of this area by domestic fishermen is moderate along the shore


LEGEND
1-8
Indicates Domestic Fishing Areas Used By Baker Lake Residents
BAKER LAKE STUDY AREA
Land Use
Domestic Fishing Areas
prepared by
Interdisciplinary Systems Ltd.
for
Department of Indian Affairs and Northern Development
January 1978
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of Baker Lake from the mouth of Prince River to the mouth of Akutuak River and low over the remainder of the area. The highest concentration of use occurs around the mouth of Prince River. Fishing appears to have increased somewhat in Area 2 in recent years. This is probably attributable to both the recent concentration of winter caribou hunting north of Baker Lake and inclusion of fishing associated with hunting and trapping to a greater extent on study interview maps than on I.L.U.O.P. maps.

Spring is the most important fishing season in Area 2. There is also some fishing in winter, summer, and fall. Most fishing is done by jigging, although there is some casting and net fishing.

Area 3: Whitehills Lake and lower Prince River.

Use of this area by domestic fishermen currently ranges from moderate around Whitehills Lake to low along lower Prince River. Fishing in Area 3 appears to have increased somewhat in recent years, probably due to the recent concentration of winter caribou hunting north of Baker Lake and the inclusion of fishing associated with hunting and trapping to a greater extent on study interview maps than on I.L.U.O.P. maps.

Spring is the main fishing season in Area 3. Whitehills Lake is a favourite spring jigging area for many Baker Lake residents. There is also some winter jigging and net fishing here.

Area 4: Southern Baker Lake. Use of this area by domestic fishermen currently ranges from moderate around the Kazan River mouth to low over the remainder of the area.

Domestic fishing in Area 4 appears to have declined somewhat in recent years, particularly around the Kazan River mouth. This may be attributable to the closing of the Kazan River domestic fishing project in 1972.

Most fishing is in spring and summer with jigging and casting the most common methods. There is very little fall and winter fishing. When the Kazan River domestic fishing project operated, there was considerable net fishing along the south shore near Kazan River mouth during summer.

Area 5: Eastern Baker Lake. Current use of this area by domestic fishermen is low, with highest concentrations around western Christopher Island. Use appears to have increased somewhat in recent years although this could be largely due to inclusion of fishing associated with hunting to a greater extent on study interview maps than on I.L.U.O.P. maps.

Spring is the most important fishing season, although there is some winter fishing. Most fishing is done by jigging.

Area 6: Thelon River and Schultz Lake. Current use of this area by domestic fishermen is low. Highest concentrations of use occur around the outlet of Schultz

Lake. Domestic fishing here appears to have increased somewhat in recent years, although this could be largely attributable to inclusion of fishing associated with hunting and trapping to a greater extent on study interview maps than on I.L.U.O.P. maps.

Most fishing occurs in summer and fall when travel by canoe is possible and is done by casting. There is some jigging in spring but very little in winter.

Area 7: West of Baker Lake to Pitz Lake. Current use of this area by domestic fishermen is low. Highest concentrations of use occur around Pitz and Gull Lakes. Domestic fishing activity in Area 7 appears to have increased slightly in recent years although this could be largely attributable to inclusion of fishing associated with hunting and trapping to a greater extent on study interview maps than on I.L.U.O.P. maps.

Winter and spring are the most important fishing seasons around Pitz Lake, while spring is the main season around Gull Lake. Most fishing is done by jigging, although there is some winter net fishing in Pitz Lake.

Area 8: Lakes and streams throughout the study area. Domestic fishing sites comprising Area 8 are used by hunters and trappers fishing for food or bait. Although very few people we interviewed indicated they use fishing sites in Area 8, these sites are probably important to hunters or trappers using those areas. Fishing by hunters and trappers is not restricted to sites comprising Area 8 and can occur in lakes and rivers throughout the study area. For instance, hunters and trappers who completed I.L.U.O.P. maps indicated they fished in Quoich River, Kaminuriak, Mallery, and Wharton Lakes, and lakes and rivers north of Aberdeen and Schultz Lakes.

Use of Area 8 fishing sites has probably declined in recent years with the decline in use of dog teams and movement of people who formerly lived on the land into Baker Lake settlement. Almost all fishing in outlying lakes and rivers (Area 8) is in winter and spring when overland travel by snowmobile is possible. Some summer and fall fishing occurs along water travel routes such as Kazan River. Most fishing is done by jigging, although nets are sometimes set in lakes. Casting occurs in summer and fall along water travel routes.

COMMERCIAL FISHING

All commercial fishing done in the study area was to supply the recently closed cannery at Rankin Inlet. Several lakes in the study area were commercially fished for lake trout and lake whitefish, and lake cisco were commercially harvested on an experimental basis in Baker, Kaminuriak, and Parker Lakes.

A number of Baker Lake residents were engaged in commercial fishing operations. During the past three winters, between 5 and 11 commercial fishermen from Baker Lake were licensed and during the past four summers between 4 and 12 were licensed (G. LeGal, former field supervisor, commercial fishing, personal communication). However, more Baker Lake residents participated in commercial fishing than is suggested by the number of licensed fishermen, since families often accompanied commercial fishermen, particularly in summer.

Baker Lake residents commercially fished both within and outside study area boundaries. Many also fished for arctic char along Chesterfield Inlet.

Seasonality of Commercial Fishing

Commercial fishing in the study area occurred in both summer and winter. Preparation for summer fishing usually started by the third week of July with actual fishing operations beginning in the fourth week of July. Fish were dressed, iced, and flown to Rankin Inlet -- usually by Twin Otter. Summer fishing was usually over by the first week of September, often because the fishermen wanted to go caribou hunting. Fishing was done with gill nets.

Winter commercial fishing operations started on first good ice -- usually about mid-October -- and lasted until December. Lake whitefish were the dominant species caught. Gill nets were set under the ice, and fish were stored in igloos until they could be picked up and flown to Rankin Inlet by Twin Otter or DC-3.

Generally, inland lakes were not fished for more than two consecutive years to minimize the chance of over-harvest. The success of commercial fishing was greatly influenced by weather and ice conditions.

Commercial Fishing Areas

Map 8 shows all waterbodies presently available for commercial fishing within the study area. Those which have been commercially fished from 1970 to 1977, along with the number of years they were fished are as follows: Kaminuriak Lake - 3 years; Baker, Parker, Pitz, and Schultz Lakes - 1 year. Almost all fish harvested in these lakes were lake trout and lake whitefish. Commercial catches on some of these lakes were very low because they were only test netted to evaluate potential for future commercial operations.

Waterbodies in the study area for which there are lake trout and lake whitefish quotas, but which have not been commercially fished in recent years, are: Banks, Blakely, MacQuoid, Mallery, Princess Mary, Tebesjuak, Tehek, and Whitehills Lakes.

GOOSE HUNTING

Nesting goose populations in the study area are relatively low and goose hunting does not appear to be a preferred activity by Baker Lake Inuit. Of 43 heads of household we interviewed, 23 said they had recently hunted geese. Only 3 of these reported taking more than 10 geese last year, however. Of 101 Baker Lake residents who completed I.L.U.O.P. maps in 1974, only 3 identified goose hunting areas, suggesting that they did not regard goose hunting important enough to note it specifically.

Goose Hunting Areas and Seasons

Map 8 shows goose hunting areas for Baker Lake hunters. The only source of information used in identifying these areas was study interviews; information from I.L.U.O.P. maps was too limited to be of value.

Geese are hunted by Baker Lake residents in June and July when geese are nesting. Hunting areas are along the western shore of Baker Lake, extending inland to eastern Pitz Lake; around the mouth of Kazan River; and around the mouth of Prince River. The area around Fish Camp at the west end of Baker Lake appears to be the most popular area for goose hunting.

The goose hunting areas identified coincide with well-used domestic fishing areas, indicating that goose hunting probably occurs in association with late spring and early summer fishing. Egg collecting and duck hunting also occur in these areas. Welland (1976) reported that geese and ducks are hunted on shores and islands in the Aberdeen Lake area. However, no hunters we interviewed reported goose hunting in these areas. Based on a 1975 sampling of 49 Baker Lake households, Stager (1977) prepared a map indicating goose hunting areas used in 1975. The pattern on Stager's map is similar to that based on our study interviews (Map 8) and shows that the western shore of Baker Lake, in the vicinity of Fish Camp, and the mouths of Kazan and Prince Rivers are goose hunting areas.

PTARMIGAN HUNTING

Many Baker Lake residents hunt ptarmigan -- some occasionally, others frequently. Of 43 heads of household we interviewed, 27 had taken ptarmigan last year and another 6 had hunted ptarmigan at some time since 1970. Many said that their wives or children often hunted ptarmigan.

Most ptarmigan hunting occurs near the hamlet; Blueberry Hill was mentioned frequently. Other ptarmigan hunting areas mentioned by hunters we interviewed include Fish Camp and the Thelon and Kazan River mouths. Based on a 1975 sampling of 49 Baker Lake households, Stager (1977) reports ptarmigan hunting areas around Fish Camp, Pitz Lake, Prince River mouth, and Thelon River near the outlet of Schultz Lake. Ptarmigan are ubiquitous, however, and may be hunted throughout the study area. Those hunted farther from the hamlet are usually taken by caribou hunters or fishermen when they happen to see them.

Fall is the season when most hunters we interviewed reported hunting ptarmigan. Spring was the second most common hunting season, followed by winter. No one reported hunting ptarmigan in summer.

USE OF THE STUDY AREA BY RESIDENTS OF COMMUNITIES OTHER THAN BAKER LAKE

Parts of the study area are used by residents of Eskimo Point, Whale Cove, and Rankin Inlet as remote caribou hunting and fox trapping areas. The I.L.U.O.P. summary maps (Freeman 1976) show caribou hunting and fox trapping by residents of these three communities in the Banks, MacQuoid, Parker, and Kaminuriak Lakes area and by Rankin Inlet residents in the Quoich River and Bowell Islands area. They also show areas used by Eskimo Point trappers extending to Forde Lake and then north towards Baker Lake. Harvests within the study area by residents of these three communities undoubtedly represent a very small portion of their total community harvests since core hunting and trapping areas for these communities lie outside study area boundaries.

Caribou Hunting

Caribou hunters from Rankin Inlet probably use parts of the study area as remote hunting areas to a greater extent than do Whale Cove or Eskimo Point hunters. Areas around Kaminuriak and Banks Lakes, and Quoich River and Bowell Islands are used by Rankin Inlet caribou hunters if caribou cannot be found closer to that settlement (Welland 1976). The Quoich River and Bowell Islands area may have become more important in recent years when Kaminuriak caribou wintered in large numbers north of Baker Lake.

The Kaminuriak, Banks, MacQuoid, and Parker Lakes area is used by Whale Cove caribou hunters when they have to go farther afield to find caribou. This area was formerly important to Eskimo Point caribou hunters who lived inland, but they now seldom return there to hunt (Welland 1976).

Fox Trapping

Trappers from Rankin Inlet probably use parts of the study area as remote trapping areas to a greater extent than do Whale Cove and Eskimo Point trappers. One of Rankin Inlet's important trapping areas runs from that settlement west to Banks Lake. The Quoich River area is used only occasionally by Rankin Inlet trappers. Banks Lake is also located at the northwestern end of an area that is intensively trapped by Whale Cove trappers (Welland 1976).

Eskimo Point trappers now make only occasional trips into the study area. The I.L.U.O.P. map summarizing the extent of land use by Eskimo Point trappers from 1959 to 1974 (Freeman 1976) shows one or two individual trapping areas extending past Kaminuriak Lake to Forde Lake and north towards Baker Lake. However, this likely reflects occasional trapping trips by Eskimo Point trappers who used to live inland rather than a concerted trapping effort.

SUMMARY

Residents of Baker Lake hunt caribou, trap foxes, and fish for lake trout, lake whitefish, and arctic char over much of the study area. Based on our interviews with 43 heads of household in Baker Lake, caribou hunting is the most wide-ranging harvest activity and currently occurs over at least 80 percent of the study area. Caribou meat is the single most important food source for Baker Lake residents; consequently, when caribou are not available in sufficient numbers close to the hamlet, hunters travel long distances -- up to 320 kilometres (200 miles) -- to hunt (Welland 1976).

Fox trapping occurs over about half of the study area. Much trapping occurs close to the hamlet, but because this area is "trapped out" early in the season, those trappers who depend on income from sales of furs have to travel considerable distances from the hamlet to find good trapping areas (Welland 1976).

Domestic fishing, primarily for lake trout, lake whitefish, and arctic char, occurs throughout the study area. The most intensive fishing occurs relatively close to the hamlet, although hunters and trappers fish for food and bait in numerous lakes and rivers throughout the study area. Some larger lakes in the study area have been commercially fished.

Goose and duck hunting by Baker Lake residents is primarily confined to three relatively small areas close to the hamlet. Ptarmigan are also mostly taken near the hamlet, although they may be taken throughout the study area. Wolves, and a few polar bears, grizzly bears, wolverines, and seals are also taken in the study area. However, these species are generally taken coincidentally during caribou hunting or fox trapping, and therefore no specific harvest areas have been delineated for them on land-use maps.

Most hunting, trapping, and fishing by Baker Lake residents now appears to be within study area boundaries. Caribou hunters we interviewed reported some hunting outside the study area around Tehek Lake to the north, upper Quoich River to the northeast, Cross Bay to the east, and along Kaminuriak Lake to the south. Trappers we interviewed reported trapping outside of the study area north of Tehek Lake. However, areas outside study area boundaries were used by a very small percentage of hunters and trappers we interviewed.

Baker Lake hunters, trappers, and fishermen are on the land during all seasons. The only times when almost no harvest activity occurs are during spring breakup and fall freezeup when travel is restricted and people are largely confined to the hamlet. Harvest activity is also minimal from late December to early February -- the coldest, darkest period.

For the past two years, winter has been the most important season for caribou hunting since caribou have wintered in large numbers north of Baker Lake. Previously, summer and fall were the most important hunting seasons and may again become most important if caribou wintering patterns revert to those which prevailed historically. Summer and fall hunting trips now are largely along Thelon and Kazan Rivers.

Spring is also an important hunting season, not necessarily in terms of numbers of caribou harvested, but for intensity of land use. Spring marks the return of longer and warmer days, and travel on the land is pleasant; consequently, large numbers of people are on the land fishing and hunting caribou and geese.

Trapping occurs from November 1 to April 15, although early and late winter are the times of greatest participation and harvest. Geese and ducks are hunted in late spring and early summer; most ptarmigan are taken in fall. Domestic fishing occurs throughout the year, but spring and early winter are the seasons of greatest participation and harvest.

CHAPTER 4

RENEWABLE RESOURCE HARVEST

Caribou, fish, and arctic fox are the primary renewable resources harvested by Baker Lake Inuit. Geese, ducks, ptarmigan, arctic hares, and a few coloured (red) foxes, wolves, wolverines, polar bears, grizzly bears, and seals are also harvested. Almost all harvest, with the exception of a limited amount of caribou hunting, fox trapping, and domestic fishing, occurs within the study area.

In this chapter, sources of harvest data are discussed, harvest data for 1970 to 1977 are presented, and estimates of current harvest are made. Given current harvest estimates, the relative importance of renewable resource harvest to the economy of Baker Lake is then assessed.

HARVEST ESTIMATES

In order to determine the importance of renewable resource harvest to the economy of Baker Lake, it is first necessary to estimate current harvest of fur, game, and fish. Fur and game harvest records maintained by the NWT Government are commonly used for this purpose since they are the only continuous data source available for NWT settlements.

In our opinion, the fur harvest records are reliable and we have used them in this study. Because of the unreliable and incomplete nature of the game harvest records, however, we felt it necessary to determine current game harvest ourselves. This we did through interviews with 43 randomly selected heads of household in Baker Lake.

No records are maintained for domestic fish harvest in the NWT. Various authors have attempted to estimate this harvest for some settlements, but their estimates were generally made for one year or one season and we do not regard them as being particularly accurate. We did not attempt to directly estimate current domestic fish harvest for Baker Lake. Rather we estimated fish consumption, based on study interview data. Having estimated fish consumption, we then estimated the quantity of harvest necessary to enable this consumption. Because of limited data and the number of assumptions involved, our estimate should be regarded at best as a general indicator of fish harvest.

Caribou Harvest

Recent estimates for caribou harvest by Baker Lake residents are available from NWT Government Fish and Wildlife Service records, for 1970 to 1977; from a socio-economic study of Baker Lake by Stager (1977), for 1974-75; and from information collected from Baker Lake residents we interviewed, for 1976-77.

General Hunting License (GHL) returns are the source of harvest estimates from the NWT Fish and Wildlife Service. They are compiled by Fish and Wildlife Officers from licenses returned by hunters seeking new licenses.

GHL records for the period 1970 to 1977 indicate an annual caribou harvest ranging from 494 to 2378 (Table 4.1). We do not regard these data as accurate, however, for the following reasons:

a) Not all licenses are returned and some are returned too late to be included in the records. This is not judged to be a major source of error from 1969-70 to 1973-74 when a Fish and Wildlife Officer was present in Baker Lake. The average return of licenses in this period was a very high 91 percent. In 1974-75 and 1975-76, however, no Fish and Wildlife Officer was present in Baker Lake and numbers of licenses issued and returned were very low.

b) Declarations of harvest by hunters are made from memory at the time the license is returned. Errors are caused by the impracticality of trying to remember accurately numbers of animals killed over the past year, especially numbers of small animals such as ducks, geese, and ptarmigan. In addition, many hunters may not realize the importance of maintaining accurate harvest records and thus may not be concerned about recording precise numbers of animals killed. This is judged to be a major source of error in GHL data.

c) Individuals may deliberately underestimate or overestimate their harvest. Underestimating is likely the more common error and may be done in fear of imposition of quotas or other restrictive actions.

Table 4.1. Annual game and fur harvests from NWT Government records for 1969-70 to 1976-77 – Baker Lake.

	69-70	70-71	71-72	72-73	73-74	74-75	75-76	76-77	Total	Average
Caribou[1]	2030	1763	1586	2378	2000	1346[2]	494[2]	1078[3]	12,675	1584
Wildfowl[1]										
Geese	23	41	28	127	136	66[2]	34[2]	85[3]	540	67.5
Ducks	1	2	46	38	17	0[2]	12[2]	13[3]	129	16.1
Ptarmigan	499	792	984	849	1525	33[2]	110[2]	207[3]	4999	625
Furbearers[4]										
Arctic fox	281	1194	703	389	2284	361	436	674	6322	790
Coloured (red) fox	4	7	9	3	9	2	0	3	37	4.6
Wolf										
Fur	N.D.	10	9	8	9	7	1	9	53	7.6
Bounty	13	12	27	20	34	23[5]			129	21.5

[1]Data for caribou and wildfowl harvest are from General Hunting License (GHL) returns. These returns have many sources of error which generally result in underestimation of harvest (Usher 1975).

[2]There was no Fish and Wildlife Officer in Baker Lake in 1974-75 and 1975-76 and GHL returns for those years are very incomplete.

[3]GHL returns for 1976-77 were obtained from the Fish and Wildlife Officer in Baker Lake (D. Stewart, personal communication). They are incomplete as not all GHLs had been returned.

[4]Fur harvest data are from Fur Export Tax Returns (FETR) for 1969-70 to 1974-1975. Traders Fur Record Book data were used for 1975-76 and 1976-77 because FETR data were not available.

[5]The wolf bounty was discontinued in 1975.

N.D. = No data.

The precise degree of error in GHL returns is difficult to estimate. Usher (1975:22) considers them to be serious underestimates, suggesting that the "degree of underestimation is in general irregular and unpredictable". We concur with this assessment of GHL returns.

Stager (1977:145) reported that 49 Baker Lake households sampled in 1975 harvested 917 caribou from winter 1974 to fall 1975; 40 percent of this harvest was in winter, 24 percent in spring, 22 percent in summer, and 14 percent in fall. Stager extrapolated this harvest to the entire native community to obtain a total estimated harvest of 2600 caribou. We chose not to rely on this estimate because of our uncertainty about the sampling procedure employed.

Caribou harvest reported for 1976-77 by heads of households we interviewed was 1329 (Table 4.2). If we assume that the one head of household who would not provide an estimate of his harvest except to report that he had taken "some" caribou took at least 10, then total estimated caribou harvest by sampled households is 1339.

An accurate extrapolation of this harvest estimate to the entire community requires current census information. Unfortunately, such information was not available. The most recent settlement list, compiled in April 1975 and updated to some extent, shows a total Inuit population of 725, comprised of 146 families with an average family size of 4.97. Based on the number of young children in households we sampled who were not included on the settlement list, we estimated the natural increase in the Baker Lake Inuit

Table 4.2 Harvest reported by 43 sampled households in Baker Lake — winter 1976/77 to fall 1977.

Reported Harvest[1]

Number of People in Household	Caribou	Geese	Ptarmigan	Fish
10	32	0	0	some
8	17	0	20	some
8	40	0	some *(20)*	some
1	54	5	0	some
6	0	0	20	some
5	100	5	0	some
4	0	0	0	some
14	1	0	some *(20)*	some
6	15	0	0	some
8	17	0	0	some
6	40	2	200	some
7	50	some *(5)*	6	some
6	15	0	10	some
5	53	0	9	some
7	9	10	50	100
5	10	3	40	some
5	7	0	0	50–100
6	13	5	0	some
5	6	0	some *(20)*	some
6	40	0	some *(20)*	0
3	4	some *(5)*	some *(20)*	some
4	0	0	0	some
2	30	0	10	some
7	160	2	some *(20)*	some
4	30	0	12	0
7	50	0	0	some
8	35	30	50	some
3	80	20	some *(20)*	some
4	29	10	100	some
8	28	0	9	some
6	30	0	some *(20)*	some
3	22	0	10	570
5	6	0	9	some
6	37	0	24	some
5	40	0	some *(20)*	some
3	some *(10)*	some *(5)*	0	some
7	40	4	26	some
7	30	some *(5)*	some *(20)*	some
8	30	0	0	some
3	11	2	20	30
5	35	15	70	some
2	43	2	20	some
8	40	0	0	some
246	1329 *(1339)*	115 *(135)*	715 *(915)*	
Total number of households reporting harvest	40	18	30	41

[1] Numbers in parentheses are our interpretation.

population, since the settlement list was last updated, at about eight percent. Applying this increase to the population of 725 indicated on the settlement list, we estimate the current Inuit population of Baker Lake at about 785.[1]

In extrapolating estimated harvest by sampled households to the entire Inuit population, one must assume that all Baker Lake families have hunters who are as active, on average, as those in sampled households. This is obviously not the case for families comprised of single women and widows, with or without young children. These families were excluded from the sampled population (see Community Consultation and Interview Process, Chapter 2) and thus must be excluded when extrapolating harvest. The population of the 130 "hunter-families" from which the sampled households were chosen was 702 on the updated 1975 settlement list. Increasing this value by eight percent to account for natural increases since the settlement list was updated, we estimated the current population of these "hunter-families" to be about 760.

Current caribou harvest is calculated by multiplying the number of caribou harvested by sampled households (1339) by the ratio of the estimated population of "hunter-families" (760) to the population of sampled households

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[1]Recent census information, not available during preparation of this report, indicates a substantial in-migration and a present Baker Lake Inuit population of about 985. This could appreciably increase estimates of total harvest.

(246). Using this calculation, and rounding to the nearest 100, our "best estimate" of current annual caribou harvest by Baker Lake Inuit is 4100.[1]

(1339 x 760/246 = 4137 → 4100)

Information from study interviews indicates that about 64 percent of this harvest was in winter, 9 percent in spring, 17 percent in summer, and 10 percent in fall.

There is considerable variation between our estimate of 4100, Stager's (1977) estimate of 2600, and annual harvests from GHL records which range from 494 to 2378 (Table 4.1). It could be argued that caribou harvest has increased considerably in the past couple of years because large numbers of caribou have recently wintered north of Baker Lake. About three-quarters of the heads of household we interviewed, however, said they took less or about the same number of caribou during the past year than they did in previous years and only about one-quarter said they took more caribou than usual. Thus, it appears that local residents perceive no substantial increase in the last year or two.

Some increase in caribou harvest can undoubtedly be anticipated in response to increased needs of a growing population, but the variation between our harvest estimate and harvest data from GHL records appears to be mainly attributable to the degree of underestimation in GHL re-

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[1] 4100± 374 at 95% confidence limits.

turns. There is no readily apparent explanation for the difference between our estimate and that of Stager (1977).

Fur Harvest

Data sources for fur harvest are Fur Export Tax Returns and Traders Fur Record Books. Fur Export Tax Returns (FETR) are community summaries compiled from records submitted by those exporting fur from the NWT. Annual permit returns are filed by each exporter, specifying number and species exported and the origin and destination of the fur. Traders Fur Record Books (TFRB) are ledgers maintained by all fur traders in which transactions with individual trappers are recorded.

FETR records are the most accurate records of fur harvest because they account for pelts exported directly to southern markets by trappers while TFRB records do not. In addition, TFRB records for Baker Lake prior to 1973-74 did not include fur sales through the NWT Fish and Wildlife Service. Neither FETR nor TFRB records account for domestic use of furs, which Usher (1975:11) estimated as 10 to 15 percent for foxes and much higher for wolves.

Table 4.1 shows annual fur harvest for Baker Lake from FETR records for 1969-70 to 1974-75 and TFRB records for 1975-76 and 1976-77. (FETR records were not yet available for 1975-76 and 1976-77.) The average annual harvest over this eight-year period was arctic fox 790, coloured (red) fox 4.6, and wolf 7.6. Wolf bounties were paid on an average of 21.5 wolves per year until the bounty was discontinued in 1975. These wolves were taken mostly in summer when pelts were in poor condition and could not be sold.

Very low numbers of other fur species are taken by Baker Lake residents. FETR records indicate that the skins of 3 wolverines, 2 polar bears, 6 grizzly or black bears, and 7 ringed seals were sold from 1969-70 to 1976-77. Actual harvest is probably higher, however, because of domestic use of most of these species.

There is great variability in fox harvest between individual years. This variability is probably related more to fox population cycles, which peak about every three years (Macpherson 1969), than to trapping effort. It would be misleading to consider fox harvest for the most recent year (1976-77) as being representative of current harvest. Rather, we regard it more reasonable to use average annual fox harvest for the period 1970 to 1977 as indicative of current harvest. We thus use the average annual harvest of 790 fox (Table 4.1) as our basis for estimating current fox harvest. This may underestimate the harvest by about 10 to 15 percent since it does not account for domestic use of furs (Usher 1975).

We have not derived current harvest estimates for other furbearers such as coloured (red) foxes, wolves, wolverines, bears, and seals since numbers harvested are very low and these species do not contribute significantly to income from fur sales.

Wildfowl Harvest

Estimates for 1970-1971 wildfowl harvest by Baker Lake residents are available from NWT Government Fish and Wildlife Service records; from a socio-economic study of Baker Lake by Stager (1977), for 1974-75; and from information collected from Baker Lake residents we interviewed, for 1976-77.

General Hunting License (GHL) returns are the source of harvest estimates from the NWT Government Fish and Wildlife Service. These returns, described earlier, show annual harvest for the period 1970 to 1977 ranging from 23 to 136 for geese, 33 to 1525 for ptarmigan, and 0 to 46 for ducks (Table 4.1). These records suffer from the same inaccuracies discussed in the caribou harvest section and consequently cannot be used to accurately estimate current wildfowl harvest.

Based on a 1975 sample of 49 households, Stager (1977:83) estimated the 1974-1975 goose harvest at 150. We chose not to rely on this estimate, however, because its derivation is not documented.

Goose harvest reported for 1976-77 by heads of households we interviewed was 115 (Table 4.2). If we assume that the 4 heads of household who reported harvesting "some" geese took at least 5 each, then total estimated goose harvest by households we sampled would be 135.

Ptarmigan harvest reported by heads of households we interviewed was 715 (Table 4.2). If we assume that the

10 heads of household who reported harvesting "some" ptarmigan took at least 20 each, then estimated ptarmigan harvest by households we sampled would be 915. We did not ask hunters to estimate their duck harvest since very few are harvested and they are not an important source of country food.

We have estimated current goose and ptarmigan harvest by the per capita extrapolation method used to estimate caribou harvest. Extrapolating goose and ptarmigan harvest estimates (135 and 915 respectively) from the population of sampled households (246) to the estimated current population of "hunter-families" (760) results in estimates for current annual harvest of about 400 geese and 2800 ptarmigan.

$$(135 \times 760/246 = 417 \rightarrow 400)$$

$$(915 \times 760/246 = 2827 \rightarrow 2800)$$

We do not regard these estimates as reliable as our caribou harvest estimates because heads of household had considerably greater difficulty remembering how many geese and ptarmigan they, and in particular their wives and children, had taken over the past year.

Domestic Fish Harvest

No records of domestic fish harvest in the NWT are maintained, but some estimates have been made for Baker Lake

(Stager 1977, R. Green in Stager 1977). Because of the difficulty of collecting fish harvest data and the inability of people to recollect previous catches, these estimates are only tentative.

Stager (1977:152) sampled 30 Baker Lake households in 1975, asking respondents what fishing methods they used, the number of nets they checked, and the quantity of fish taken each time they fished or checked their nets. This process yielded a harvest estimate of 346,900 lbs (157,400 kg) which Stager (1977:85) divided into approximately 200,000 lbs (90,000 kg) eaten by people and 140,000 lbs (64,000 kg) fed to dogs.

Stager (1977:154) also presents an estimate of 15,000 lbs (6800 kg) for the Baker Lake domestic fish harvest given by R. Green (a former Economic Development Officer in Baker Lake in charge of commercial fishing) and adds that "it is not possible to reconcile the two estimates". This estimate by R. Green, however, was for fish netted in Baker Lake only (G. LeGal, personal communication).

Only 4 of 43 heads of household we interviewed were able to estimate the amount of fish caught over the last year (Table 4.2). Therefore, we were unable to estimate domestic fish harvest from these data.

We chose instead to estimate consumption of fish. Study interview data indicate that fish comprise about 20 percent of the meat diet in Baker Lake. Consequently, given an estimate of the total quantity of meat consumed, we can estimate fish consumption.

There are no estimates available for the quantity of meat consumed specifically by Baker Lake Inuit. Estimates are available for other communities, however. Usher (1970:73), reporting on Sachs Harbour, estimated that a man on the trail requires about 3 to 5 lbs (1.4 to 2.3 kg) of meat per day while a family at home requires over 10 pounds (4.5 kg) of meat per day. Stager (1974:75), reporting on Old Crow, estimated that an adult would consume 5 lbs (2.3 kg) of meat per day and a child would consume 1.5 to 2 lbs (0.7 to 0.9 kg) of meat per day.

Based on these estimates, it would seem reasonable to assume that an adult in Baker Lake consumes about 4 lbs (1.8 kg) of meat per day and a child consumes about 1.75 lbs (0.8 kg) per day. Based on the 1975 settlement list, adults (age 16 or older) comprise 55 percent of the population and children 45 percent. Thus, the average per capita consumption of meat would be about 2.5 lbs (1.2 kg) per day, calculated as follows:

$$(4 \text{ lbs} \times .55 + 1.75 \text{ lbs} \times .45 = 2.54 \text{ lbs} \rightarrow 2.5 \text{ lbs})$$

Multiplying the average estimated per capita meat consumption by the estimated current Inuit population (785), the estimated amount of meat consumed annually is 720,000 lbs (330,000 kg). Using the estimate from study interviews that fish comprise about 20 percent of the meat diet, we estimate total fish consumption at about 140,000 lbs (65,000 kg), calculated as follows:

(2.5 lbs/day x 365 days x 785 x .20 = 143,000 lbs)

To compare fish harvest estimates, we must convert this estimate into round weight. Assuming that about 60 percent of a fish is edible, then a fish harvest of about 230,000 lbs (110,000 kg) would be required to yield 140,000 lbs (65,000 kg) of edible fish. This current estimate is about 15 percent higher than Stager's (1977) estimate for 1974-75 of a 200,000 lb (90,000 kg) fish harvest for human consumption. We did not attempt to estimate the quantity of fish currently fed to dogs.

ECONOMIC IMPORTANCE OF RENEWABLE RESOURCE HARVEST

Economic importance of renewable resource harvest can be evaluated by determining cash income from fur harvest and imputing income from game and fish harvest.

Cash Income from Fur Harvest

Our estimate for current annual arctic fox harvest is 790. Since the harvest of other furbearers is small and does not contribute significantly to trapping income, it is not accounted for in our determination of cash income from the sale of furs.

The average 1976-77 price paid to Baker Lake trappers for an arctic fox pelt was $29.04 (TFRB records, NWT

Government). Based on this price, we estimate current cash income from sales of fox pelts at $23,000 annually.

Imputed Value of Game and Fish Harvest

In virtually all economic analyses, imputed value has been used to represent monetary value of country food, while "cultural value" has generally been discussed in terms of importance of the harvest to lifestyle and culture. Our approach is no different. While we recognize that the harvest has an important cultural value, we make no pretense of being able to assign a monetary value to it. The imputed value of country food that we derive is thus underestimated since it does not include any measure of the cultural value attributable to harvesting and consuming country food.

Determining substitution cost for a country food is one of several ways available for imputing its value. A substitute for a country food such as caribou meat is identified and the value of the substitute food serves as its "shadow price". A major drawback of this method is that a one-to-one relationship between the country food and its substitute is assumed. We recognize that this is not totally valid when substituting a good valued by one culture for a good valued by another culture (e.g. substituting beef for caribou meat). There are no useful analytical methods available to overcome this problem, however, and we have therefore chosen the substitution cost method as the best available.

Imputed values of the principal sources of country food in Baker Lake -- caribou, fish, and wildfowl are established in the sections which follow.

Imputed Value of Caribou Harvest. Although other studies have used retail prices of beef products available in various northern communities as substitute values for caribou meat (Usher 1976a, 1976b), we believe it would be misleading to use retail prices of beef products available in Baker Lake. This is because the limited demand by Inuit for retailed meat in Baker Lake has never indicated a preference for a range of retailed meat. It would therefore be erroneous to impute value on the basis of this restricted market.

The most appropriate substitute value for caribou meat, in our opinion, is the cost of providing a side of beef in Baker Lake. Since proportions of various cuts of meat from a side of caribou are comparable to cuts from a side of beef, it should be reasonable to use the average price of a side of beef as determined in southern markets, plus transport and other costs of distribution, as a legitimate substitute value for caribou meat.

The Winnipeg price of a side of beef is approximately \$2.20/kg (\$1.00/lb) cut and wrapped (November 1977). Transportation costs for meat, according to information provided by Hudson's Bay Company officials, are approximately \$0.90/kg (\$0.41/lb) between Winnipeg and Baker Lake. Adding transportation costs and a markup to cover other costs of distribution, assumed to be about 20 percent, the final price of a side of beef in Baker Lake would be about $3.70/kg ($1.68/lb). This then is our imputed value of caribou meat.

Our estimate of current caribou harvest is about 4100 (Table 4.3). If the dressed weight of a caribou is assumed to be 45 kg (100 lbs), the total imputed value of this harvest is about $680,000 (Table 4.4).

Other studies, however, have suggested that substitution of beef for caribou meat on a one-to-one basis may not be valid because of significant nutritional differences between the two foods. Usher (1976a:115) suggests that "if one assumes that the chief element of scarcity from which meat derives its value is in its protein content rather than its fat content", then the imputed value of caribou meat would have to be increased by about 60 percent to account for the difference in protein content between a kilogram of beef and a kilogram of caribou meat.

We have chosen not to adjust the imputed value of caribou meat to account for nutritional differences between caribou meat and beef, however, because of the large number of uncertainties involved. For example, it is impossible to arrive at a precise figure for difference in protein content between beef and caribou meat. While beef generally has a higher fat content and hence lower protein content per kilogram than caribou meat, the protein content of lean beef is nearly as great as that of caribou meat (Usher 1976a). The protein content of caribou meat and, to a lesser extent,

Table 4.3 Estimated current annual game and domestic fish harvest by Baker Lake Inuit and dressed weight of country food from game and domestic fish harvest, 1976-77.

	Current Annual Harvest [1]	Average Dressed Weight per Animal [2] (kg)	Total Dressed Weight (kg)	Percentage of Total Dressed Weight of Country Food
Game				
Caribou	4100	45	184,500	73.4
Geese	400	1.7	700	0.3
Ptarmigan	2800	0.4	1100	0.4
Domestic Fish	110,000 kg	60%	65,000	25.9
Total Dressed Weight of Country Food			251,300	100

[1] Current annual harvest estimates are based on data from study interviews in Baker Lake.

[2] Data on average dressed weight per animal are from Kelsall (1968), Bissett (1974), Asch (1976), and Usher (1976b), except for fish. We assumed that 60% of a fish is edible.

Table 4.4 Estimated total cash and imputed incomes from fur, game, and fish harvest – Baker Lake.

	Harvest (Fur) or Dressed Weight (Game, Fish) 1	Fur Price 2 or Imputed Value 3	Cash or Imputed Income	Per Family Income 4
Fur				
Arctic fox	790	$29.04	$23,000	$ 150
Subtotal – Cash Income			$23,000	$ 150
Game				
Caribou	184,500 kg	$3.70/kg	$683,000	$4350
Geese	700 kg	$6.10/kg	$ 4,000	$ 30
Ptarmigan	1100 kg	$3.70/kg	$ 4,000	$ 30
Domestic Fish	65,000 kg	$4.54/kg5	$295,000	$1880
Subtotal – Imputed Income			$986,000	$6280
Total – Cash and Imputed Income			$1,009,000	$6430

1 Current fur harvest estimates are derived in this chapter; dressed weight of game and fish harvest is from Table 4.3.

2 1976-77 average fur prices paid to Baker Lake trappers, from NWT Government TFRB records.

3 Derived in this section, based on prices of substitute foods.

4 Based on an estimated current Inuit population of 785, comprised of 157 families with an average family size of 5.

5 Composite price assuming a harvest of 50% lake trout, 25% lake whitefish, and 25% arctic char.

beef is also dependent upon condition of the animals and hence varies from season to season and year to year.

Further, there is some question of the relative importance of protein and fat in the Inuit diet. The source of calories in the traditional, all-meat diet of Alaskan Eskimos has been estimated to be 66 percent fat, 32 percent protein, and 2 percent carbohydrate, thus indicating the importance of fats as well as protein as essential features of the diet (Draper 1977). Other authors (Stefansson 1913, Lawrie 1948 in Kelsall 1968) have also commented on the importance of fat in the traditional Inuit diet. The relative absence of carbohydrates in the traditional diet necessitated a high consumption of protein in order to furnish amino acids required for glucose synthesis (Draper 1977). There is some question as to whether such high concentrations of protein are necessary in the modern Inuit diet which has a much higher carbohydrate content due to availability of store-bought foods.

Even with increased consumption of carbohydrates, however, meat remains a very important food for Inuit. Based on our estimate of current caribou harvest of 4100, with a dressed weight of 184,500 kg (407,000 lb), the current annual per capita consumption of caribou meat by Baker Lake Inuit is approximately 235 kg (520 lbs). The national per capita consumption of all of beef, veal, mutton, pork, and offal during 1976 was 79.1 kg (174.4 lbs) (Statistics Canada 1976). Therefore, per capita consumption of red meat in Baker Lake, from caribou alone, appears to be about three times the national average. This illustrates the importance of caribou meat to Baker Lake Inuit.

<u>Imputed Value of Fish Harvest.</u> The imputed value we applied to fish is based on Winnipeg prices of lake trout, lake whitefish, and arctic char. Transportation costs of $0.90/kg ($0.41/lb) and other costs for distribution, assumed to be 20 percent, were added to these prices.

The current estimate of fish consumed by Baker Lake residents is 65,000 kg (140,000 lbs) (Table 4.3). Data from study interviews suggest that proportions of fish species harvested were roughly one-half lake trout, one-quarter lake whitefish, and one-quarter arctic char. Winnipeg prices of these fish species are $2.10/kg ($0.95/lb) for lake trout, $1.80/kg ($0.80/lb) for lake whitefish (Class A), and $5.05/kg ($2.50/lb) for arctic char (A. Drobot, Freshwater Fish Marketing Corporation, personal communication). Adding transportation and other distribution costs, these prices become $3.60/kg ($1.65/lb) for lake trout, $3.25/kg ($1.45/lb) for lake whitefish, and $7.70/kg ($3.50/lb) for arctic char. Applying these prices to the proportions of fish species currently harvested and to the current estimate of fish consumption, the imputed value of fish harvest to Baker Lake Inuit is $295,000 (Table 4.4), calculated as follows:

(65,000 kg x ($3.60/kg x 1/2 + $3.25/kg x 1/4 + $7.70/kg x 1/4) = $295,000)

Imputed Value of Wildfowl Harvest. Wildfowl, principally geese and ptarmigan, provide a much smaller proportion of the country food eaten by Baker Lake Inuit than do caribou or fish (Table 4.3). Winnipeg prices of geese and uncut chicken are used as substitute values for goose and ptarmigan meat. These values are $4.17/kg ($1.89/lb) and $2.20/kg ($1.00/lb), respectively. When the same transportation cost as well as an estimated twenty percent markup to cover other distribution costs is added, these prices become $6.10/kg ($2.76/lb) and $3.70/kg ($1.70/lb).

The estimated total dressed weight of the current annual goose and ptarmigan harvest is 700 kg (1500 lbs) and 1100 kg (2400 lbs) respectively (Table 4.3). Based on the above estimates of substitute values, the total imputed value of this harvest is about $8000 (Table 4.4).

Total Income. Cash and imputed incomes from fur, game, and fish harvest are summarized in Table 4.4. Cash incomes from fur sales are very low in relation to imputed incomes from game and fish harvests. This is to be expected, however, since few trappers depend on fur sales for a majority of their cash income while caribou and fish are important sources of food, and thus imputed income, for most Inuit families in Baker Lake.

Our estimate of total cash income from current fur harvest is $23,000. If divided equally among the estimated 157 Inuit families, the annual per family income from fur harvest would be about $150. Cash income from fur harvest is obviously not divided equally among all families, however. Based on TFRB records (1970-1977), 8 percent of the trappers were responsible for 50 percent of the fur harvest and 22 percent were responsible for 75 percent of the harvest.

Our estimate of total imputed value of country food is $986,000 (Table 4.4). This value, if divided evenly among the estimated 157 Inuit families, would yield an imputed annual income of $6280 per family, comprised of $4350 (69 percent) from caribou harvest, $1880 (30 percent) from fish harvest, and $60 (1 percent) from goose and ptarmigan harvest.

Game and fish harvest is not divided equally among all families, however. Based on GHL records (1970-1977), 15 percent of caribou hunters, 13 percent of goose hunters, and 13 percent of ptarmigan hunters were responsible for 50 percent of the reported caribou, goose, and ptarmigan harvest, respectively, and 31 percent of caribou hunters, 31 percent of goose hunters, and 33 percent of ptarmigan hunters were responsible for 75 percent of the reported caribou, goose, and ptarmigan harvest, repectively.

To determine relative importance of cash and imputed income from renewable resource harvest, the 43 heads of household we interviewed were asked to estimate how much income from full-time and casual employment they had earned between November 1976 and October 1977. Some were able to provide us with precise figures but many were able to give only rough estimates. In particular, carvers were not able to estimate income from sales of carvings. We were able to obtain carvers' incomes from the Sanavik Co-op and Nunamiut Company, however. Similarly, the four commercial fishermen we interviewed were not able to estimate their incomes and in this instance we were unable to obtain income figures; thus, income from commercial fishing is omitted from the income profile of heads of household.

In constructing an income profile for heads of households, incomes from fur, game, and fish harvest are based on the portion of the harvest taken by heads of household themselves. Harvest by other family members is not included. Since data on fish harvest were limited, we assumed that half the fish harvested by sampled households were caught by heads of household and half by other family members. Imputed income from game and fish harvested by heads of households was calculated according to methods discussed previously (Tables 4.3, 4.4).

Table 4.5 presents an income profile for an average head of household in Baker Lake for the period November 1976 to October 1977. Transfer payments and income from commercial fishing are excluded. Data presented show that cash and imputed income from renewable resource harvest is the most important source of income, accounting

Table 4.5 Income profile – Baker Lake heads of households.[1]

Income Source	Income Per Head of Household	Percent of Total Income
Fur sales [2]	$ 250	2.4
Caribou harvest [3]	$ 4480	42.3
Goose and ptarmigan harvest [3]	$ 50	0.5
Domestic fish harvest [4]	$ 940	8.9
Subtotal – Income from fur, game, and fish harvest	$ 5720	54.1
Wages and salaries [5]	$ 4420	41.7
Sale of carvings[6]	$ 450	4.2
Subtotal – Employment Income	$ 4870	45.9
Total Income	$10,590	100

[1]These data describe incomes for heads of 43 randomly sampled households in Baker Lake for the period November 1976 to October 1977. Transfer payments and income from commercial fishing are excluded.

[2]From TFRB records, NWT Government.

[3]Harvests by 43 heads of household were: caribou 1156, geese 114, ptarmigan 766. Imputed values were calculated as per Tables 4.3, 4.4.

[4]Based on a per family fish consumption of 410 kg, the assumption that a head of household harvested half of the fish caught by a family, and the price per kilogram from Table 4.4.

[5]From estimates of wages and salaries earned by heads of households we interviewed.

[6]From Sanavik Co-op and Nunamiut Company.

for about 54 percent of total income, with income from wages and salaries accounting for the remainder.

We recognize that an income profile for heads of households perhaps overestimates the importance of renewable resource harvest and underestimates the importance of income from wages and salaries in the total Inuit economy because heads of household take a greater portion of the total fur and game harvest than do other family members. For example, in 43 sampled households, heads of household accounted for 87 percent of the caribou harvest and 84 percent of the goose and ptarmigan harvest reported (see Table 4.5). It is not likely that heads of household would account for a similar portion of total income from wages and salaries, however, since wives, sons, and daughters are often employed.

The income profile for Baker Lake Inuit families presented in Table 4.6 tends to support this conclusion. It shows that income from wages and salaries accounts for about 55 percent of total income, and income from renewable resource harvest accounts for about 45 percent of total income. The estimate of wages and salaries in Table 4.6 is from Stager (1977:64-71). He estimates total employment income earned by Baker Lake Inuit in 1975 at $1,134,500, comprised of $534,500 from full-time employment (totally government salaries) and $600,000 from casual employment (including wages paid by government and private enterprise and income from carving, printmaking, and handicrafts). This was equivalent to a per family income of $7930 in 1975.

Table 4.6 Income profile — Baker Lake Inuit families.[1]

Income Source	Income Per Family	Percent of Total Income
Fur sales[2]	$ 150	1.0
Caribou harvest[2]	$ 4350	30.3
Goose and ptarmigan harvest[2]	$ 60	0.4
Domestic fish harvest[2]	$ 1880	13.1
Subtotal — Income from fur, game, and fish harvest	$ 6440	44.8
Wages and salaries[3]	$ 7930	55.2
Total Income	$14,370	100

[1]For the period November 1976 to October 1977, excluding transfer payments and income from commercial fishing.

[2]From Table 4.4.

[3]Stager (1977:64-71) estimated 1975 income from full time and casual employment, for 143 Inuit families, at $1,134,500.

Since employment levels can fluctuate significantly from year to year, however, the income profile in Table 4.6 is valid only if employment conditions in 1976-77 were similar to those in 1975.

While the income profiles presented in Tables 4.5 and 4.6 contain some inaccuracies, they indicate that renewable resource harvest is an important sector of the Baker Lake economy. We conclude that cash and imputed income from renewable resource harvest account for between 45 and 55 percent of total earned income for Baker Lake Inuit.

CHAPTER 5

BIOLOGICAL CHARACTERISTICS OF HARVESTED FISH AND WILDLIFE SPECIES

This chapter presents, by way of maps and supporting commentary, information on the biological characteristics of study area caribou, arctic fox, fish and waterfowl populations. Caribou biology is discussed in greatest detail since this species has been studied most and is of greatest concern to Baker Lake residents. Discussion of caribou is organized under life-history phase headings and the two major study area populations are discussed separately.

Arctic fox are discussed in general terms with most attention focussed on denning.

Study area fish resources are poorly documented in the available literature; therefore, the discussion presented here simply reviews the limited information available on major drainage systems and characteristics of fish species occurring in them. Information on background levels of mercury is also presented.

Biological characteristics of the more common waterfowl occurring in the study area are presented under species headings. Areas of noteworthy waterfowl concentrations are identified and the species and life-history phase activities occurring there are documented.

CARIBOU

Caribou Biology - General

Barren-ground caribou occur throughout most of the study area. Spring migration, calving, post-calving aggregation, summer movements and fall migration all occur here. Some caribou may rut within the study area, and variable numbers winter here in different years.

Caribou within the study area are assigned primarily to two groups, the Beverly and Kaminuriak populations. These names are derived from the general locations of their main calving grounds near Beverly and Kaminuriak Lakes, respectively. Each population apparently consists of several "herds" occupying relatively discrete portions of the total population's range for part of each year (Thomas 1967, Kelsall 1968, Parker 1972a).

Caribou other than those comprising the aforementioned populations may utilize more northern portions of the study area. Current information on ranges, movements and numbers of these more northern caribou and their possible inter-relationships with Kaminuriak and Beverly caribou is inadequate to offer any detailed discussion of them (Kelsall 1968; Fischer et al. 1977; G. Calef, NWT Fish and Wildlife Service, personal communication).

Estimates of the size of the Kaminuriak population include the following: 120,000 in 1950 (Banfield 1954 *in* Parker 1972a); 40,000 in winter 1957-58 (Kelsall 1968);

63,000 prior to calving in 1968 (Parker 1972a); 61,500 on wintering grounds in 1974-75 (Robertson 1975 in Fischer et al. 1977); and 42,000 adults in June 1976 (Fischer et al. 1977). Parker (1972a) suggests that although Banfield's 1954 estimate has been accepted as the norm for this population, it was in fact made at a time of unusually high numbers and greatly expanded winter range. Historical data reviewed by Parker (1972a) suggest that his population estimate (63,000) and description of winter range and distribution closely resemble those of early historical records.

Recent changes in range and apparent population decline have stimulated concern regarding the future viability of the Kaminuriak population (Gimmer 1977; Robertson 1977; D. Stewart, Fish and Wildlife Officer, Baker Lake, personal communication).

Thomas (1967) estimated the Beverly population at 159,000 caribou. Rippin (1971, in Moshenko 1974) and Moshenko (1974) estimated the population at 167,000 and 124,000 caribou, respectively.

Most Kaminuriak and Beverly caribou traditionally winter in northern Manitoba and Saskatchewan, and east of Great Slave Lake. Variable numbers do winter on the tundra, however (Kelsall 1968, Parker 1972a, Miller 1976, Robertson 1977). Although winter ranges of the Kaminuriak and Beverly populations have overlapped, there is no evidence of extensive interchange between the two populations (Miller and Robertson 1967, Parker 1972b).

Spring migration north from the taiga (and south from recent Kaminuriak population wintering grounds north of Baker Lake) generally starts in late April or early May when cows and yearlings gradually begin to drift toward their calving grounds in small bands. These bands coalesce into larger groups, and are followed later by males that wintered further south (Parker 1972a). Yearlings, immature males and non-pregnant females drop out of these groups before reaching the calving grounds (Parker 1972a, Kelsall 1968). Fischer et al. (1977) observed that the spring migration from winter ranges north of Baker Lake was apparently underway by late March 1976.

Spring migrations are usually about 480 to 800 km (300 to 500 mi). Caribou travel 21 to 51 km (13 to 32 mi) per day, accelerating as they approach the calving grounds (Skoog 1968, Kelsall 1968, Parker 1972a). Migration routes are variable, depending on locations of pre-migratory concentrations (Kelsall 1968, Parker 1972a).

Calving generally takes place in rocky terrain at the highest, locally-available elevations. Although Kelsall (1968) considers such areas to be the least hospitable locations within the general region in which they are found, Parker (1972a) asserts that elevated, rocky terrain provides the driest possible conditions and maximum shelter from high winds and sudden rain and snow storms. Of all areas used by barren-ground caribou, perhaps the greatest fidelity is toward calving areas, some of which are known to have been used regularly since formal observations began about thirty years ago (Skoog 1968, Kelsall 1968, Calef 1975).

Calving occurs in June, peaking in the second week of that month (Kelsall 1968, Parker 1972a). Caribou calves are precocious, following their mothers at all times from the age of about one day. Most calves commence grazing within a few days of birth, and are probably weaned within a month. Despite their precocity, caribou have not developed a consistent method of dealing with postnatal danger, and separation of newborn calves from their mothers undoubtedly results in a high rate of calf mortality (Kelsall 1968).

The female's energy demands are greatest during late pregnancy (McEwan and Whitehead 1972, Dauphine 1976). Disposition of the female's available energy is a significant factor affecting calf survival in different years. Malnutrition probably causes direct death of relatively few calves (Miller 1974), but may render calves more vulnerable to other forms of mortality (Dauphine 1976).

Following calving, females and calves aggregate and are joined by non-calving population segments. Reasons for post-calving aggregations are unclear, but they may reflect a "natural tendency" for cows and calves to aggregate, or they be a reaction to insect harassment, and in some cases are due to bunching at rivers too swollen to cross (Kelsall 1958, 1968). Miller (1974) proposed that post-calving groupings were critical for resocialization of various herd components.

In August, caribou tend to disperse widely in small groups while generally drifting south over poorly-defined routes (Kelsall 1968, Parker 1972a). Summer grazing is critical for growth, winter survival and reproduction of caribou. Females in particular must recover from reproductive stresses, while serious insect harassment may have weakened males and females. Rapid growth and fat accumulation by calves is imperative. Caribou are adapted to marginal subsistence in winter, but full nutrition during summer is essential (Dauphine 1976).

By mid August caribou are usually near the treeline, and the rut probably occurs somewhere north of the treeline in early October (Kelsall 1968, Parker 1972a, Dauphine and McClure 1974). Following the rut, caribou move to traditional taiga winter ranges (Kelsall 1968, Parker 1972a).

Caribou Biology - Kaminuriak Population

CWS intensively studied the Kaminuriak population between 1966 and 1970 and more recently the NWT Fish and Wildlife Service has conducted surveys. Much of the following is based on this research. Movements described here are primarily those to and from "traditional" winter ranges in northern Manitoba and Saskatchewan and on the Hudson Bay coast between Whale Cove and Eskimo Point. Since much or perhaps all of this population has shifted winter range in recent years, however, (Robertson 1977; Fischer et al. 1977;

local interviews; G. Calef, personal communication) it is not known what extent this information is only of historical interest. The aforementioned shifts are relatively recent and apparently quite variable; therefore, one cannot predict future movements of this population.

Some information obtained during our interviews with Baker Lake residents confirms observations made by the CWS and NWT Fish and Wildlife Service, whereas other information provided by local residents does not. In compiling maps and accompanying narratives information from both sources is presented, but sources can be readily identified.

Information from interviews with Baker Lake residents presented here is a summary of observations offered by many individuals with long experience on the land. It should not be concluded that all movements described by local residents necessarily take place regularly or even that they have occurred recently. Rather, they should be considered as alternative routes or areas which variable numbers of caribou may follow or use each year or in different years.

There are several possible reasons for apparent discrepancies between information from local residents and that in published, scientific accounts. These include the following:

1. Government (CWS and NWT Fish and Wildlife Service) surveys were conducted over relatively short periods of time, whereas caribou movements may be

sufficiently variable that significant patterns could have been missed in intervening years. Data from local residents cover a long period and a large area, and may be expected to include some of these other movements.

2. Data from local interviews may reflect some minor movements which could easily have been missed or discounted as relatively unimportant when the whole population picture was presented by CWS and NWT Fish and Wildlife Service biologists.

3. On-ground observation is difficult, and some movements reported by local residents may be based on incomplete information. Several groups of caribou could be present in an area, resulting in confusion over movements of any one group. Accurate observations over large areas are much more easily made by air-borne observers.

Discussions which follow are organized under life-history headings and referenced to the accompanying map.

Spring Migration (Map 9). Most of the Kaminuriak population has historically migrated north or northeast from taiga wintering ranges in spring, while others have moved north or northwest to calving grounds from wintering areas on the Hudson Bay coast. Non-calving population segments generally drop out of the migration before reaching the calving grounds. In general, migrating caribou enter calving grounds in the study area in late May or early June. Caribou that winter in the Eskimo Point-Whale Cove area could reach calving grounds a few days earlier than those migrating further from taiga ranges (Parker 1972a).

Parker (1972a) found spring migration by calving caribou (about 27,000 animals) was complete by 12 June in 1967 and 1968. He found no evidence that migrating caribou seek specific geographic landmarks during migration. In spring 1967, caribou were located far northwest of their usual winter ranges but took a straight-line course to traditional calving areas. In addition to pregnant females, an estimated 6800 non-calving caribou were also found in the calving ground in early June 1968.

The 36,000 non-calving caribou generally move north later than the pregnant females, although many yearlings and non-pregnant females move out of the taiga with the pregnant females in late May, some dropping out of the migration as the pregnant females move towards the calving ground. Most adult males leave taiga winter ranges by mid-June, closely following the northward progress of melting snow. Many males do not reach as far north as Baker Lake, but join aggregated caribou moving south from that area in late July and early August.

Non-calving caribou move slowly north in small groups, primarily along the west side of Kaminuriak Lake. Others move across the calving ground east of that lake, joining post-calving groups south of Baker Lake. In general, non-calving caribou are very scattered during June and early July. By the third week of July, about one-third of the adult males and yearlings (about 8000 animals) are south of Baker Lake, with the remainder (16,000 caribou) scattered south to the treeline or along a coastal tundra strip. A further 5500 2-year old males and non-calving females (2 years and older) join post-calving aggregations south of

Baker Lake, while 6000 of these age and sex classes are scattered south of the post-calving area (Parker 1972a).

Fischer et al. (1977) found caribou moving south and east from winter ranges somewhere north of Baker Lake by 20 March 1976. Large groups were found on Bowell and Christopher Islands and north and south of Chesterfield Inlet. By late April, large numbers were found south of Brown and Gibson Lakes. By mid May, these animals were widely dispersed through traditional calving grounds.

Historical spring movements of Kaminuriak caribou described by Baker Lake residents are generally similar to those described by Parker (1972a). Local residents indicate that these caribou enter the study area from the south or southeast, although some are said to enter the area from the southwest (Yathkyed Lake area). There was little certainty about spring migration routes of those caribou recently wintering north of Baker Lake, although migration routes around or across the eastern end of Baker Lake were mentioned.

<u>Calving (Map 10).</u> Parker (1972a) describes the Kaminuriak population's calving area as near the west shore of Hudson Bay, between Rankin Inlet and Kaminuriak Lake, and between Maguse and Kaminak Lakes in the south and Brown and Gibson Lakes in the north. Elevations of major waterbodies in this area are up to 110 m (370 ft) above sea level. Elevations on the calving range extend to slightly over 180 m (600 ft) above sea level, thus constituting heights of

land between Kazan River, the Hudson Bay coast, and the Chesterfield Inlet-Baker Lake complex (Kelsall 1968).

Calving may occur over the entire calving area or be concentrated in a particular region, apparently depending on climatic conditions during spring migration and areas occupied at winter's end. In 1966 and 1967, north-south length of the actual calving area was about 135 km (85 mi), and total area used was about 6500 sq km (2500 sq mi). In 1968, total length was about 210 km (130 mi), and total area used was about 6065 sq km (2333 sq mi). In 1968, caribou density on the calving ground averaged 5 to 6 adults per sq km (12 to 14 per sq mi), with extremes of from 0 to 20 per sq km (0 to 50 per sq mi) at the time of peak calving (Parker 1972a).

If pregnant females are to reach calving grounds on time, they must do so before breakup has advanced too far in order to avoid flooding streams and deep slush near lake shores. When travel conditions are good, females may arrive early and move to more northerly areas of the calving range (Parker 1972a).

The first calves are usually born in late May or early June while the caribou are still moving to calving grounds. Calving peaks between 10 and 15 June. Calving by Kaminuriak caribou is essentially complete by 20 June.

After calving, females and calves form small nursery bands. They then move about locally, nursing and grazing on newly-emergent plant growth. Small groups of non-breeders may be found on the peripheries of these nursery bands (Parker 1972a).

Approximately 60 percent of the estimated 27,000 calves born in 1968 did not survive the first 4 or 5 weeks of life (Parker 1972a). Miller and Broughton (1974) attributed these losses, in order of decreasing importance, to: excessive wolf predation; abandonment of new-born young, primarily by young females giving birth to their first calves; still-births, and physiological and pathological disorders; injuries, pneumonia and malnutrition; and unknown natural causes. This high mortality is regarded as a "principal factor" limiting growth of the Kaminuriak population (Miller and Broughton 1974).

The Kaminuriak population shows considerable fidelity to a general calving range; it used a relatively consistent area during CWS surveys in the late 1960's (Parker 1972a, Miller and Broughton 1974) and NWT Fish and Wildlife Service surveys in the early 1970's (e.g. Bowden and Timmerman 1972, Land and Hawkins 1973). Despite marked changes in winter range and thus in spring and fall migration routes, these caribou have continued to calve in the same general area in the past two years (Fischer et al. 1977; G. Calef, D. Stewart, and D. Heard, NWT Fish and Wildlife Service, personal communications).

The Kaminuriak calving area identified by Baker Lake residents is located, for the most part, west of the area indicated by CWS and NWT Fish and Wildlife Service studies. Information gathered in our interviews in Baker Lake was provided by people with long-term familiarity with that area, and differences between patterns they described and those described by government studies cannot be dismissed out-of-hand. There are, however, several possible explanations for these differences. These include:

1. The area outlined by Baker Lake residents is an aggregate of many separate, smaller areas indicated by individual respondents, some of which may be more accurate than others.

2. Some outlying areas may be where scattered caribou have been observed to calve, but outside a "core" calving area. There may also have been a shift in calving ground, or at least a greater variability in area used than that indicated by government studies. Such areas may have been located by local residents as a result of observations over a much longer period. The elevation west of Kaminuriak Lake is similar to that east of the lake, and that area may also be suitable calving habitat.

3. Calving occurs at about the time of breakup, when travel is very difficult. This could be expected to decrease familiarity of local residents with caribou spring movements.

4. The "core" calving area identified by government studies is beyond the regular hunting area for most Baker Lake residents, possibly decreasing their familiarity with caribou movements in that region. Other respondents, however, do have long-term familiarity with the areas involved.

5. Some information provided by local residents may represent areas occupied by caribou after calving, and not calving areas *per se*.

When one combines calving areas described by Parker (1972a) with those indicated by local residents, a very large area falls within the designation "calving grounds", reducing an assumed average density of calving females over the entire area to a low level. Such an "average" density figure may be misleading, however, as calving caribou are believed to concentrate in certain, more favourable sites. Besides the general region where Parker (1972a) indicated most of the calving segment of the population concentrated, location or even existence of certain consistently favoured, local sites is unknown.

Post-Calving Aggregations and Summer Movements (Map 10). After calving, females and calves form small "nursery bands" that by late June begin to move northward and coalesce until several large herds move slowly north across the calving ground, gathering other nursery bands as they go. By early July there may be up to 10 or 12 such herds of 1000 to 5000 caribou, comprised almost entirely of females with calves and some calfless adult females and yearlings, but very few males over 1 year of age, approaching the northern end of the calving ground (Parker 1972a). In the first half of July, these post-calving aggregations are joined by scattered, non-calving animals moving north across the calving grounds. By mid July the post-calving herds are usually between the north end of the calving ground and Chesterfield Inlet. Coincidentally, about 15 July, herds of non-calving caribou have moved slowly up the west side of Kaminuriak Lake in herds of 50 to several hundred, and are approaching the area east of the Kazan River near Bissett and Martell Lakes, where they aggregate into herds of up to several thousand each.

In mid July several primarily cow and calf post-calving groups move west toward Kazan River and join the non-calving segments already there. Other cow and calf aggregations remain relatively stationary near the northern tip of the calving grounds south of Chesterfield Inlet. Thus, by 20 July, there are usually two main areas containing large caribou concentrations: one area from northwest of Kaminuriak Lake north to Kazan River delta, the other east and northeast of Kaminuriak Lake north to Chesterfield Inlet. Exact locations may vary, but the pattern of geographically separate aggregations is believed to be relatively constant (Parker 1972a). Thirty-two post-calving aggregations were photographed south of Baker Lake on 17 July 1968, and a subsequent count showed 51,000 caribou in the area (Parker 1972a).

Although forces motivating this post-calving behaviour are unknown, these aggregations may allow grouping of the caribou into maternal social units, and permit sorting into groups that will move to several distinct summer ranges (Parker 1972a). These aggregations may also provide favourable situations for regrouping of bands from the previous winter (Miller 1974).

Baker Lake residents had little specific information on post-calving aggregations *per se*, but did refer repeatedly to large herds of caribou making early summer movements (study interviews). Some of these movements were confined to a circulation in the area south of Baker Lake and east of Kazan River. Another commonly mentioned movement was west across Kazan River, and then west and northwest toward and past Pitz and Schultz Lakes.

As post-calving female and calf groups move into areas occupied by juveniles, non-calving females, and bulls, the groups merge and move off on the mid-summer migration. In the period 1966 to 1969 studied by Parker (1972a), the mid-summer migration of those caribou within the post-calving range began in the third week of July. Before southward migration begins, the many post-calving aggregations show erratic, local movements. On windy days the groups spread out and are stationary, whereas on calm, warm days insects are bad and the aggregations are in tight formation, rapidly moving about.

Besides these local movements, there is generally a premigratory east-west shift of those calves and cows which remained northeast of Kaminuriak Lake to the lower Kazan River where the non-calving aggregations previously described are located. Southward movement then begins, generally as several large herds with smaller groups straggling behind. Rates of movement during mid-summer migration vary, but appear to average 15 to 25 km (10 to 15 mi) per day (Parker 1972a). In different years the bulk of this summer movement may be either east or west of Kaminuriak Lake. After moving south about 160 km (100 mi), these larger groups begin to disperse and the migration route broadens. By the time they reach the southern end of Kaminuriak Lake, they are usually following three main routes. These separate concentrations proceed to three geographically distinct summering areas south of the study area, and migratory momentum gives way to erratic local movements by early August. Sex and age composition of caribou in each of these herds is different (Parker 1972a). Midsummer migration routes are not as precise as spring routes, and accurate delineation is difficult. Main summer routes can be described, but small bands and solitary caribou are widely dispersed and move south on a very wide front from Kazan River to the Hudson Bay coast.

Some midsummer movements described by Baker Lake residents differed considerably from those reported by Parker (1972a). For example, Baker Lake residents describe a general circulation of caribou south of Baker Lake and east of the Kazan River followed by an exodus to the south. Another general summer movement west and northwest was also detailed by local residents. One such course takes caribou in a westerly direction south of Thirty Mile Lake and across Kazan River north of Forde Lake. These caribou may go north and then west to the north of Princess Mary Lake or continue north up to or across Thelon River east of Schultz Lake. The other westward summer movement described by Baker Lake residents was across Kazan River in the Kazan Falls region, and several important crossings were identified. They believed this movement continued around Pitz Lake and then north to or beyond the Thelon east of Schultz Lake.

The number of caribou reportedly making these westward movements is unknown, although Baker Lake residents describe large, rapidly moving herds. They further report that these caribou scatter and spread out in August south of

Schultz Lake and Thelon River. Thus, while CWS studies found caribou moving south out of the study area in late July and August, Baker Lake residents describe additional summer movements west and north into the central part of the study area.

Fall Movements (Map 9). There is little published information regarding fall caribou movements in the study area. Parker (1972a) found that most caribou moved south out of the study area in August.

Information gathered by Parker predated recent large-scale movement of Kaminuriak caribou to wintering areas around Baker Lake, however. Routes to this area from summer ranges farther south or west remain unclear. Several local residents report that caribou return to the study area in fall from the south and southeast, moving across or around the east end of Baker Lake in late fall or early winter.

There may also be a fall movement from areas north and northeast of the study area to the region north of Baker Lake and along Quoich River. It is not entirely clear, however, to which population these latter caribou belong, how many there are, or to what extent they use the study area.

Recent studies have not documented large-scale summer movements west across Kazan River. Baker Lake hunters report that those caribou which move west and north to the vicinity of Schultz Lake and Thelon River in July either return south in August or September by approximately the same routes, or else move southeast through the study area, passing west of the south end of Kaminuriak Lake, en route to winter ranges. During these movements their pace is reportedly leisurely, caribou are widely dispersed in small groups, and routes followed are less predictable than during spring migration.

Wintering (Map 10). When intensive government-sponsored studies were undertaken, large numbers of Kaminuriak caribou were not known to winter on tundra ranges within the study area, although variable numbers frequently wintered on Hudson Bay coastal tundra (Parker 1972a). Clarke (1940) indicated that scattered caribou wintered immediately south of Baker Lake, both east and west of Kazan River, in about 1850, however, and Kelsall (1968) comments that in virtually all of the mainland tundra there are few areas where caribou have not been observed or reported in one winter or another since 1949.

Fischer et al. (1977) report that in winter 1975-1976 about 20,000 caribou of the Kaminuriak population wintered north of Baker Lake, although the actual extent of wintering areas was unknown. The remainder of the populations (20,000 or more caribou) must also have wintered somewhere on the tundra, most likely in the Eskimo Point area. In general, snow conditions exert a strong influence on winter range location (Pruitt 1959), and caribou tundra winter ranges are on the most snow-free highlands (Kelsall 1968).

Within the generally accepted range of the Kaminuriak population, Baker Lake residents identified consistently-used winter ranges in the vicinity of Thirty Mile Lake, west of Kazan River, in Parker Lake area, around Banks and MacQuoid Lakes and in the vicinity of southern Kaminuriak Lake (study interviews). An area along Quoich River was also frequently mentioned, although it is not known to which population these caribou belong. The territory north of Baker Lake, extending at least as far north as Whitehills and Tehek Lakes, has been used by large numbers of caribou during the last two winters (study interviews). Many of these caribou are presumably Kaminuriak caribou, but it is not known if caribou from other population(s) also winter here.

Caribou Biology - Beverly Population

Beverly caribou were studied by CWS biologists, primarily in the late 1950's and early 1960's. Periodic, short-term research projects such as calving ground surveys have since been conducted by NWT Fish and Wildlife Service. This population has been less intensively studied than the Kaminuriak population, and correspondingly less data on movements are available. Our interviews with Baker Lake residents largely confirm published observations, and in other cases supplement them. In compiling maps and supporting narratives, information from both sources is presented, but sources can be readily identified.

Information from interviews in Baker Lake is, as in preceding discussions of the Kaminuriak population, a summary of observations by many individuals with lengthy experience on the land. One should not conclude that all such movements or areas described necessarily occur or are used regularly now, or have been used or occurred recently. Rather, they should be considered as alternate routes or areas which varying numbers of caribou may follow or use each year or in different years.

There are several possible reasons for apparent discrepancies between information sources. These have been discussed in the preceding section on biology of the Kaminuriak population and apply equally here.

Spring Migration (Map 9). Spring migration of the Beverly population within study area boundaries is poorly known, but behavioural aspects discussed for spring migration of the Kaminuriak population also apply here. Pregnant females and accompanying juveniles and non-pregnant females are often funnelled along higher land between valleys of Thelon and Dubawnt Rivers, or may move northeast along ridges between Thelon and Back Rivers toward calving grounds north and south of Beverly Lake (Kelsall 1958, 1968). Moshenko (1974) described a northeasterly movement along eskers by more than 10,000 caribou, about 85 percent adult females, northwest of Deep Rose Lake on 1 June 1974. Caribou "had long since" passed through the calving ground south of Beverly Lake by 31 May 1974, heading for the calving ground north of Beverly Lake (Moshenko 1974).

Topographic features thus concentrate migrating caribou from vast winter ranges onto relatively localized calving grounds (Kelsall 1968). If spring snow cover is heavy, caribou may not reach traditional calving areas. In 1958 some caribou, unable to reach northern calving grounds, returned to the calving area they had just crossed south of Beverly Lake (Kelsall 1968).

Non-calving population segments lag behind pregnant females. Some may remain south of calving ranges or catch up to and pass the females after calving. Males may cross through calving grounds, but are more likely to bypass them, staying on lower ground where forage is better, such as Thelon and Dubawnt Valleys (Kelsall 1968).

Baker Lake residents indicate that Beverly caribou migrate into the study area in spring over a broad front, virtually anywhere from south of Princess Mary Lake to Sand Lake (study interviews). Although local residents could offer little information on numbers of caribou following any particular route and consistency with which any particular route is used, they identified important river and lake crossing sites. These are summarized as follows:

1. There are several very important crossings through the islands area of Thelon River between Beverly and Aberdeen Lakes. This includes the Box Crossing described by Thomas (1960), Hawkins (1973) and others.

2. The western "fingers" of Aberdeen Lake.

3. The three "fingers" between Aberdeen and Schultz Lakes.

4. Several crossing points were identified on Thelon River east of Schultz Lake. According to movement patterns described by Baker Lake residents, this crossing region may be utilized by some Kaminuriak caribou as well. Such movements by Kaminuriak caribou are not documented in published accounts.

Calving (Map 10). The Beverly population traditionally calves north and south of Beverly and Aberdeen Lakes, in areas of highest local elevation. Exceptions to use of these areas appear due to unusual snow conditions retarding movement to high elevations (Kelsall 1968).

Kelsall (1968) cites several reports indicating that most Beverly population calves are born in the second week of June, with calving ending by 3 July or earlier. Moshenko (1974) found calving about 50 percent complete on the northern calving ground by 2 June 1974.

Numbers of caribou using calving grounds north and south of Beverly and Aberdeen Lakes vary in different years. Moshenko (1974) estimated about 71,000, 2-year or older cows, 7000 yearlings and 50,000 new-born calves on calving grounds in June 1974. Most of these calves were born on the northern grounds, females having first crossed calving grounds south of Beverly Lake. He believes that caribou observed on the southern calving area on 3 June were primarily non-calving animals. Kelsall (1958) reported most calving occurred south of Beverly Lake in 1957, whereas in

1958 many caribou, possibly the majority, crossed Thelon River-Beverly Lake system to calve a few kilometres north of Beverly Lake.

Baker Lake hunters describe larger calving areas north and south of both Beverly and Aberdeen Lakes than are indicated in published accounts (study interviews). North of Thelon River they report calving areas extending east to the area north of Schultz Lake while south of the Thelon they report calving groups south and east to Mallery and Tebesjuak Lakes. Differences between patterns described by local residents and by government studies cannot be dismissed out-of-hand, however. Several possible explanations for these differences were discussed in the preceding section on the Kaminuriak population and apply equally here.

When one combines calving areas described in government studies with those indicated by local residents, a very large area north and south of Beverly and Aberdeen Lakes is classified as "calving grounds", reducing an assumed average density of pregnant females over the entire area to a relatively low level. Such an "average" density figure may be misleading, however, as calving caribou are believed to concentrate in certain, more favourable sites. Location or even existance of such consistently favoured sites is presently unknown.

<u>Post-Calving Aggregations and Summer Movements (Map 10).</u> Behavioural details on formation of post-calving

aggregations by Beverly caribou are lacking, but are presumed similar to those previously outlined for the Kaminuriak population. Following calving, females, calves and yearlings move to lower, greener areas, often along the general line of spring migration. Thus, in 1957, many caribou moved north across the Thelon west of Beverly Lake, but most bunched against Dubawnt River where unseasonally high water levels and drifting ice blocked their crossing. About 80,000 to 100,000 caribou crowded into a 65-km (40-mi) long area on the west side of the Dubawnt between Marjorie and Beverly Lakes before crossing the river between 12 and 17 July. Leading herd elements were within 26 to 32 km (16-20 mi) of Baker Lake settlement on 18 July when they suddenly reversed their direction, apparently due to heavy insect harassment. For the next two weeks they grouped in large, closely massed herds, moving rapidly and erratically in the area south of Thelon River (Kelsall 1958, 1968).

Following calving in 1958, however, most caribou moved northeast, without massive formations along Dubawnt River. Less than a quarter of the caribou stayed south of the Thelon, moving east toward Baker Lake. Those north of the Thelon formed large aggregations in mid July, apparently moving north to the height of land between Thelon and Back Rivers before moving quickly southwest in late July. They then moved rapidly west along the north shore of Aberdeen Lake, and by 3 August at least 63,000 caribou had crossed Thelon River west of Beverly Lake (Kelsall 1958).

Baker Lake residents report several areas where Beverly caribou traditionally winter. These include highlands around Marjorie, Wharton, Tebesjuak, Mallery and Princess Mary Lakes, Sissons Lake area and a large area extending from south of Aberdeen Lake north toward Garry Lake and Back River. They are unable to provide information on numbers of caribou wintering in these areas in recent years, however.

ARCTIC FOX

Arctic Fox Biology - General

Arctic fox are year-round residents of the study area, although certain regions are believed to support larger populations than others. Arctic fox are highly mobile, with large home ranges much of the year, and they may move long distances on or from tundra areas during certain winters (Chesemore 1968, Wrigley and Hatch 1976). Arctic foxes are restricted to more specific areas during the denning period (Macpherson 1969, Speller 1972).

Increased availability of nutrients around dens results in the presence of a patch of brilliant, yellow-green vegetation (Danilov 1961, Macpherson 1969, Chesemore 1969), making dens somewhat conspicuous, particularly from the air.

Foxes in the study area tend to den in well-vegetated areas of gentle slope, frequently eskers or moraines overlooking valleys. Stable surface deposits are necessary for denning, and depth of active layer is an important factor determining whether or not foxes can den in any particular area (Chesemore 1969, Macpherson 1969). Foxes favor fine, well-sorted silt and sand for denning, avoiding talus slopes and areas of rocky debris (Macpherson 1969) and uniformly flat areas far from valleys (Danilov 1961). There is an apparent abundance of suitable denning habitat in much of the study area.

Large dens in the study area may consist of up to 100 burrow entrances, many of which may have collapsed. Over time, a series of dens may "move" slowly along a ridge crest. Not all dens in one area are used in any one year, and the proportion of dens occupied in different years may differ. Of 203 dens examined over a 5-year period, 154 were occupied in at least one year. New dens are infrequently constructed (the increment rate is about 0.3 percent per year). If the long-term breeding population is assumed to be about the same, average lifespan of study area dens is about 330 years. Dens are thus intermittently in use over a long period, rarely being replaced and rarely becoming uninhabitable (Macpherson 1969).

Macpherson (1969) found the mean density of dens in 3 good denning regions in or near the study area to be at least 1 den per 36 sq km (14 sq mi). The minimum distance between occupied dens was about 1.6 km (1 mi) suggesting a "distinct tendency" for denning foxes to keep their distance from each other (Macpherson 1969, Speller 1972).

Arctic foxes mate and occupy breeding dens in late winter. They cannot dig new dens at this time, and must use existing structures for whelping. Each pair has one litter (mean litter size is 10.6), born in late May and weaned by the third week of July. The male provides much of the food, particularly when the pups are young and after weaning (Speller 1972). The young disperse after mid August.

The primary food of arctic foxes in the study area is lemmings, supplemented by birds, caribou carrion and incidental items (Macpherson 1969, Speller 1972). Lemming populations fluctuate widely with a periodicity of about three years (Krebs 1963), with important repercussions on fox population levels. Fox populations in the study area at the start of the trapping season have varied four-to-five fold in successive years (Macpherson 1969, Speller 1972).

FISH

Watershed and Biological Characteristics - General

The open water period of lakes in the Baker Lake region is short (mid July to mid October for larger lakes). Because of current and surface run-off, rivers freeze later and break up earlier than lakes. Initial snowmelt run-off occurs quickly, generally starting in late May, but peak river discharges are often modified by the reservoir effect of upstream lakes. The character of peak flow discharge thus varies considerably between the drainage systems.

Because of low water temperature and limited dissolved solids, productivity of waters here is low. This results in slow fish growth rates, but fish live longer and mature later than at more southern latitudes. Mature individuals of most species probably do not spawn every year in this area (McLeod et al. 1976).

The standing crop of fish in unexploited northern waters is usually large, but local populations are readily susceptible to over-harvest. When overfished such populations are slow to recover. This does not necessarily mean the fish populations are unstable (Johnson 1975), but compensatory adaptability to exploitation appears to vary between species (Healey 1975). Fish species indicated in the study area are listed in Table 5.1. Species distribution maps (Scott and Crossman 1973) indicate that arctic char, lake trout, lake whitefish, lake cisco, round whitefish, grayling, northern pike, lake chub, longnose sucker, burbot, ninespine stickleback, slimy sculpin, spoonhead sculpin, and possibly threespine stickleback would be found in the study area. Fish collected for Polar Gas (McLeod et al. 1976) included the marine four-horned sculpin in the west end of Baker Lake. McLeod et al. (1976) also sampled fish along the proposed Polar Gas pipeline route in the study area, but did not collect northern pike, lake chub, spoonhead sculpin or threespine stickleback. Lawrence et al. (in prep.), in sampling the Kazan, Pitz and Whitehills drainages, also did not collect northern pike, but did record lake chub and spoonhead sculpin south of the Thelon

Table 5.1 Fish species of the Baker Lake Study Area.

Arctic char	–	*Salvelinus alpinus* (Linnaeus)
Grayling	–	*Thymallus arcticus* (Pallas)
*Blackfin cisco	–	*Coregonus nigripinnis* (Gill)
Burbot	–	*Lota lota* (Linnaeus)
Lake chub	–	*Couesius plumbeus* (Agassiz)
Lake cisco	–	*Coregonus artedii* (Le Sueur)
Lake trout	–	*Salvelinus namaycush* (Walbaum)
Lake whitefish	–	*Coregonus clupeaformis* (Mitchell)
Longnose sucker	–	*Catostomus catostomus* (Forster)
Ninespine stickleback	–	*Pungitius pungitius* (Linnaeus)
Round whitefish	–	*Prosopium cylindraceum* (Pallas)
Slimy sculpin	–	*Cottus cognatus* (Richardson)
Spoonhead sculpin	–	*Cottus ricei* (Nelson)
Four-horned sculpin	–	*Myoxocephalus quadricornis* (Linnaeus)

*tentative identification

River. They also collected what has tenatively been identified as blackfin cisco. Hatfield et al. (1977) report northern pike in the Kazan drainage, but Lawrence et al. (in prep.) suggest that the limit of pike distribution in this region is south of the study area. It is also probable that the study area is near the northeastern limit of distribution of longnose sucker, burbot, and lake chub (McLeod et al. 1976, Hatfield et al. 1977, Lawrence et al. in prep.).

Fewer spring spawning fish species are to be found in the study area than in areas farther south. This is probably because the short period of flowing water in many small streams made conditions unsuitable for spring spawning.

Lake trout, lake whitefish, and lake cisco are usually resident in lakes and spawn there in fall or early winter. Their eggs incubate overwinter and hatch in spring. At times these fish, especially lake cisco, use larger rivers for feeding and rearing (McLeod et al. 1976), but they are thought to overwinter mainly in deeper lakes. Grayling usually overwinter in lakes, but migrate to small streams during spring breakup for spawning. These small streams provide nursery habitat for young grayling, but the fish return to deeper water in fall. Arctic char are probably present in the study area as both anadromous and freshwater forms. Although migration patterns of anadromous char are not well understood in this area, spawning always occurs in freshwater during fall, and the eggs hatch in spring.

Back River Drainage

Waters in this drainage flow east and then north from west-central Keewatin to enter the Arctic Ocean at Chantrey Inlet. Within the study area this system is limited to headwaters of a few northerly flowing tributary streams and rivers, the largest of which is the Meadowbank River. There are no large lakes in that part of the Back River drainage included in the study area. Because these are headwater streams and rivers, and because there are no lakes to buffer flow, stream and river discharge in this system has great annual extremes.

Scott and Crossman (1973) indicate presence of arctic char, lake trout, lake whitefish, lake cisco, round whitefish, grayling, northern pike, burbot, ninespine stickleback, slimy sculpin, and possibly longnose suckers within the Back River drainage in the study area. Hatfield et al. (1977) report probable occurrence of arctic char, lake whitefish, and lake cisco, and confirmed occurrences of lake trout, round whitefish, and grayling in the Meadowbank River near Nanau Lake. Arctic char probably do not ascend to headwaters within the study area, but lake trout, nine-spine stickleback, and slimy sculpin were collected from the headwaters of Meadowbank River (McLeod et al. 1976).

No mercury testing has been done of lake trout from the Back River drainage within the study area. Tests done on lake trout from Garry Lakes, however, indicate moderate levels of mercury (G.W.G. McGregor, Fisheries and Marine Service, personal communication).

Dubawnt River Drainage

Waters in this drainage flow north from south-central Keewatin, entering the Thelon River between Beverly and Aberdeen Lakes. Wharton and Marjorie Lakes are part of this system, as is Dubawnt Lake which is southwest of the study area. The reservoir effect of these lakes evens out annual flow to the point that maximum discharge is one of the lowest for the major drainages in the study area, yet minimum discharge is one of the greatest.

Scott and Crossman (1973) indicate presence of lake trout, lake whitefish, lake cisco, round whitefish, grayling, lake chub, northern pike, longnose sucker, burbot, ninespine stickleback, slimy sculpin, and spoonhead sculpin in the Dubawnt drainage. Arctic char are absent from the drainage. Few fisheries investigations, other than mercury testing, have been done in this drainage, and little is known about spawning areas or fish distribution and movement. Mercury testing of lake trout from Dubawnt Lake shows lower levels of mercury than for other lakes tested in the Baker Lake region (G.W.G. McGregor, personal communication).

Thelon River Drainage

Waters in this main drainage flow east through Aberdeen, Schultz, and Baker Lakes and into Chesterfield Inlet. Other large lakes in this area drain directly into Baker Lake; Whitehills Lake from the north and Pitz Lake from the southwest. Wind tides apparently push sea water from Chesterfield Inlet into Baker Lake, forming a bottom layer of saline water in the east end of the lake (Johnson 1965). The reservoir effect of large lakes in this drainage modifies extremes in seasonal discharge. Ice scour in the Thelon River near Baker Lake is considerable during breakup. Freezeup of Chesterfield Inlet occurs later than for Baker Lake because of water currents and increased salinity.

Scott and Crossman (1973) indicate presence of arctic char, lake trout, lake whitefish, lake cisco, round whitefish, grayling, northern pike, longnose sucker, burbot, ninespine stickleback, slimy sculpin, and spoonhead sculpin in this drainage. Aberdeen, Schultz, and Baker Lakes contain sizeable populations of lake trout, lake whitefish, lake cisco, and round whitefish (McLeod et al. 1976; study interviews). Arctic char are common but not abundant in parts of Baker Lake, and present but not common in Schultz and Aberdeen Lakes. Spoonhead sculpin are apparently present in Aberdeen Lake (Scott and Crossman 1973), and have been found in Pitz Lake (Lawrence et al. in prep.). Four-horned sculpin, a marine species, are found in Baker Lake (McLeod et al. 1976). Hatfield et al. (1977) report the presence of arctic char, lake trout, lake whitefish, round whitefish, grayling, lake cisco, longnose sucker, and burbot in this drainage near the proposed pipeline route.

Investigations by McLeod et al. (1976) indicate year-round residence for several fish species in the west end of Baker Lake, and possible spawning of lake trout, lake whitefish, and lake cisco near the mouth of Thelon River. Spawning areas may, however, be more widespread and general.

Limited testing of Schultz and Pitz Lakes show lake trout there to be relatively low in mercury (G.W. G. McGregor, personal communication).

Kazan River Drainage

Waters in this drainage flow north and east from southern Keewatin to enter Baker Lake on its south shore. Three major lakes (Tebesjuak, Mallery, and Princess Mary) drain via the Kunwak River into the Kazan River at the west end of Thirty Mile Lake. Yathkyed Lake, located just south of the study area, and Forde Lake drain into Thirty Mile Lake via the Kazan River. Some river rapids (e.g. the outlet of Princess Mary Lake) remain open throughout the winter (study interviews).

Scott and Crossman (1973) indicate presence of lake trout, lake whitefish, lake cisco, round whitefish, grayling, northern pike, longnose sucker, burbot, ninespine stickleback, and slimy sculpin in this drainage. Lake chub were collected by Lawrence et al. (in prep.) from the Thirty Mile Lake area, but not north of there. Hatfield et al. (1977) report lake trout, lake whitefish, round whitefish, grayling, lake cisco, longnose sucker, burbot, and northern pike from this drainage. There is no record of arctic char in this drainage, but some may ascend to Kazan Falls from

Baker Lake. Upstream movement of all fish is apparently blocked by Kazan Falls. Seasonal fish movements in this drainage are not well understood, but fish movement at the outlet of Princess Mary Lake is suggested by traditional winter and spring harvest there (study interviews).

Yathkyed Lake is the only lake in this drainage from which lake trout have been tested for mercury. Limited samples suggest moderate levels of mercury in trout from this lake (G.W.G. McGregor, personal communication).

Ferguson River Drainage

Ferguson, Parker, and Banks Lakes flow into Kaminuriak Lake and hence southeast via the Ferguson River into Hudson Bay south of Chesterfield Inlet.

Scott and Crossman (1973) indicate presence of arctic char, lake trout, lake whitefish, lake cisco, round whitefish, grayling, northern pike, longnose sucker, burbot, ninespine stickleback, and slimy sculpin in this drainage. The presence of lake trout, lake whitefish, lake cisco, longnose sucker, grayling, arctic char, and burbot has been confirmed by Bond (1975). Lake trout and lake whitefish are the main, large species in the lakes. Arctic char are found occasionally in this drainage within the study area. Growth rates of Kaminuriak Lake whitefish appear moderately high while growth rates of lake trout from this lake appear low compared to other northern lakes (Bond 1975).

On the basis of limited samples, lake trout from Kaminuriak Lake appear to have moderate mercury levels, while trout from Parker and Ferguson Lakes appear quite high in mercury. In Kaminak Lake, south of the study area, mercury levels in trout also appear high (G.W.G. McGregor, personal communication). This drainage may have the highest levels of background mercury in the Baker Lake region.

Quoich River

The Quoich River, draining Tehek Lake, flows southeast into Chesterfield Inlet. St. Clair Falls is about 25 kilometres (15 miles) upriver from Chesterfield Inlet. Quoich River is the smallest of the major rivers in the study area and exhibits a great difference between maximum and minimum daily discharges (Environment Canada 1976a). This is a result of there being no large lakes, other than Tehek Lake, to impart a reservoir effect on river discharge.

Fish presence and distribution in this drainage are poorly understood, but distribution maps from Scott and Crossman (1973) indicate that arctic char, lake trout, lake whitefish, lake cisco, round whitefish, grayling, northern pike, longnose sucker, burbot, ninespine stickleback, and slimy sculpin may be found here. Information from local residents indicates that arctic char migrate in the Quoich River, and lake trout and lake whitefish are present in the drainage.

No mercury testing of lake trout has been done in this drainage (G.W.G. McGregor, personal communication).

WATERFOWL

Waterfowl Biology - General

Several species of waterfowl breed and/or moult in the study area. The most significant of these for harvest are Canada, lesser snow and white-fronted geese. Oldsquaw are the most common ducks and other ducks, though present, occur in lesser numbers. Although several species of waterfowl occur extensively throughout the region, no extremely large aggregations are known anywhere in the study area.

Canada Geese. Nesting Canada geese in the Baker Lake area are of the tallgrass prairie population of lesser (small-race) Canada geese. This population has the largest range of any Canada goose population (Bellrose 1976). Nesting pairs are widely distributed in Keewatin south of the Thelon River (McLaren et al. 1976, 1977).

Breeding Canadas arrive in Keewatin in late May and early June, but numbers are low in most areas (McLaren et al. 1976, 1977). They nest in relative isolation from each other in a wide variety of sites, including marshes, tundra and on islands (Bellrose 1976). Preferred sites at

McConnell River (MacInnes 1962) were hummocky, sphagnum-covered sites less than 0.45 m (1.5 ft) above summer water level. The same nest sites are apparently used in succeeding years, but they will go to nearby sites if preferred ones are unavailable (Bellrose 1976). MacInnes (1962) found nest densities at McConnell River as high as 8 per sq km (20 per sq mi), with a mean of 2.5 nests per sq km (6.5 per sq mi). Most nests were over 90 m (100 yd) from their nearest neighbor.

Canada geese are among the earliest waterfowl to nest in spring, as soon as favoured sites are clear of snow. In the McConnell River area, egg laying begins in late May or early June (MacInnes et al. 1974), and hatching occurs about four weeks later. There is no evidence of renesting in the arctic (MacInnes et al. 1974). Young attain flight within 52 to 60 days. In the Hudson Bay area peak numbers of Canada geese migrate south about 1 September (MacInnes 1963, Bellrose 1976), and most have left central Keewatin by early September (McLaren et al. 1977).

Non-breeding individuals of several races of Canada geese make an annual moult migration to specific northern areas, one of which is the Beverly-Aberdeen Lakes region. Moulters here between mid June and late July or mid August include males, subadults, and non-breeding and unsuccessful-breeder females of the giant and western races which have migrated 1600 to 3000 km (1000 to 2000 mi) from breeding ranges in the northern U.S.A. and southern Canada

(Kuyt 1966, Sterling and Dzubin 1967). Canada geese actually nesting in the arctic begin the moult one or two weeks after hatching has occurred. During the moult, body fat reserves are consumed (Kuyt 1966).

Moulters are believed to show strong fidelity to specific moulting sites. Major systems of rivers and connected lakes are particularly attractive to moulters which are generally restricted to stream and lake shores. Tributary streams and lakes are rarely used, and then only by groups of 20 or less on any lake. In early moult phases moulters are believed to spend most of their time on water in flocks of 3 to 2,000 (Sterling and Dzubin 1967).

Lesser Snow Geese. The breeding range of lesser snow geese has changed dramatically in the last two decades, with rapid growth of new colonies on the western side of Hudson Bay (Kerbes 1975). They arrive in the eastern and central arctic in mid to late May and leave in mid to late September (Bellrose 1976, McLaren et al. 1977). Snow geese generally breed in dense colonies of up to 160,000 nests (Kerbes 1975). Although no major breeding colonies are known in the Keewatin interior, small nesting colonies of snow geese are locally distributed throughout Keewatin (McLaren et al. 1976, 1977). McLaren et al. (1977) suggested the existence of a snow goose migration corridor across central Keewatin from the Hudson Bay coast to more northerly nesting areas. Local watercourses serve as stopover points in both spring and fall migration.

Nesting colonies are located in low, grassy tundra plains; along broad, shallow rivers; and on islands in shallow lakes within about 130 km (80 mi) of the coast. Nest sites are built up over a period of years. Egg-laying begins in early June. Although delayed nesting results in smaller clutches, only one clutch is initiated. Moult begins in early July, with a flightless period of three to four weeks (Bellrose 1976).

White-fronted Geese. Small numbers of white-fronted geese breed locally in Keewatin. They arrive on breeding grounds in mid to late May. Favoured nesting sites for these non-colonial nesters are tidal sloughs and sedge marshes, and less often margins of tundra hummocks. Shortly after hatching, they leave the nest and move to water. Fall migration occurs in late August or early September (Bellrose 1976).

Oldsquaw Ducks. Oldsquaw are sea ducks, and there are about 1.5 million of these circumpolar breeders in eastern arctic tundra areas. They arrive in coastal areas in late May and on the tundra by mid June. They are common nesters in coastal regions and inland wherever tundra-like conditions exist. They prefer islands or uplands near lakes, never far from water. Nests may be grouped, particularly on islands. There is no evidence of renesting. Shortly after hatching the broods go to water, either staying inland until fall or travelling down rivers to the sea. Males leave breeding areas to moult by mid July, and breeding grounds are deserted by mid September (Bellrose 1976).

Areas of Particular Importance to Waterfowl (Map 12)

Area 1: Shore of Baker Lake, including delta of Kazan River. McLaren et al. (1976) found moulting and breeding Canada geese around Baker Lake on 21-23 July 1975, mostly around Kazan River mouth and the east end of Baker Lake. Moulters were also common along the north shore of Baker Lake. Snow geese were common near the mouth of the Kazan in late summer in both 1975 and 1976, while Canadas were more common between Thelon and Kazan Rivers (McLaren et al. 1976, 1977). Snow and Canada goose numbers increased around Baker Lake in the latter half of August 1976, with several hundred brood-rearing snows and brood-rearing and moulting Canadas present until about mid September. Canadas may use the eastern end of Baker Lake for late-summer staging (McLaren et al. 1976, 1977).

McLaren et al. (1976) reported small numbers of oldsquaws and eiders near the mouth of Kazan River in late August. Mowat and Lawrie (1955) reported the eider as the most common breeding duck in Baker Lake. Clarke (1940) reports Porsild's observations of large flocks of Canadas, and lesser numbers of moulting snow geese around Baker Lake on 29 August 1930. Oldsquaw ducks were common.

Baker Lake residents reported that the mouth of the Kazan is a nesting area for Canada and snow geese (study interviews), and much of the area was identified as important for goose nesting on the I.L.U.O.P. ecological composite map and by ITC (1975).

Area 2: Central and western Aberdeen Lake and islands between Beverly and Aberdeen Lakes. About 10,000 large-race Canada geese moult in the islands area between Beverly and Aberdeen Lakes between mid June and late July or mid August (Kuyt 1966, Sterling and Dzubin 1967). Sterling and Dzubin (1967) describe an important moulting area at the east end of Beverly Lake, and report that since 1955 moulting populations had been increasing in this area. Moulting Canadas are restricted to streams and lakeshores, occupying sand beaches and sedge meadows that flood in spring; few moult on upland tributary streams and lakes (Sterling and Dzubin 1967).

At least 30 white-fronted geese were nesting between Beverly and Aberdeen Lakes in August 1960 (T. Barry, personal communication to Kuyt 1962), and Mowat and Lawrie (1955) recorded white-fronts at Beverly Lake in July 1949. Thelon River may have become more important for breeding white-fronts in recent years (Kuyt 1962). Clarke (1940) reported Canada geese were abundant along Thelon River between Thelon Game Sanctuary and Baker Lake, although Sterling and Dzubin (1967) reported the Thelon system was unimportant for breeding, small-race Canadas. Clarke

(1940) reported oldsquaws were common in this area. Snow geese also nest and moult here, although numbers are unknown (CWS 1972). Hawkins (1973) described nesting snow geese, a few Canadas and an oldsquaw nest on Goose Islands near the entry of the Thelon into Aberdeen Lake.

Several Baker Lake residents reported geese nesting in western Aberdeen Lake and the islands area, but estimates of numbers were unavailable (study interviews). They were unable to provide information on moulting geese in this area.

Area 3: Kazan River, Thirty Mile Lake and Kunwak River. McLaren et al. (1976, 1977) found Canada and snow geese common on rivers in the area. They observed 3.7 snow geese per sq km (9.7 per sq mi) in early June 1976, and at least 121 non-breeding, flightless Canadas and 11 broods along Kazan River on 21 to 23 July 1975. Snow geese were locally common along the Kazan between Forde and Baker Lakes. They also found moderate numbers of breeding and moulting Canadas east of the Kazan between 18 June and 11 July 1975, and observed Canadas along the river in early September. They observed nesting snow geese along Kazan River and Thirty Mile Lake and saw 56 at the east end of Thirty Mile Lake on 21-23 July.

Miller (1972) recorded 21 snow geese nesting on the cliff top at Kazan Falls in mid July 1970 and isolated Canada goose nests along Kazan River. Clarke (1940) reported observations of Canada geese along the Kazan although oldsquaw were the only common duck in the Kazan River area.

McLaren et al. (1977) postulated a snow goose migration corridor through interior Keewatin to nesting areas further north, and Kazan River area may be an important stopover point in spring and fall. Ducks also stage here prior to dispersal to nesting areas.

There were several reports by Baker Lake residents of Canada and snow geese nesting along Kazan River and Thirty Mile Lake (study interviews).

Area 4: Between Ferguson and Forde Lakes.

McLaren et al. (1976) reported 22 birds per sq km (57 per sq mi) northwest of Ferguson Lake in late June 1975. Of these, about half were waterfowl, with Canada geese, green-wing teal, pintail and greater scaup most common. They reported 19.8 birds per sq km (51.6 per sq mi) south of Forde Lake in late June 1975, of which only moderate numbers (5.6 per sq km or 14.6 per sq mi) were waterfowl. Snow geese were common (132 per sq km or 342 per sq mi) west of Ferguson Lake in early June 1976 (McLaren et al. 1977). Shores of Thirty Mile Lake are important staging areas for hundreds of geese and ducks prior to dispersal to nesting grounds (McLaren et al. 1977).

Baker Lake hunters were unable to supplement published information on waterfowl in this area (study interviews).

Area 5: Around and northeast of Pitz Lake.

McLaren et al. (1976) reported 15.1 birds per sq km (39.3 per sq mi) south of Pitz Lake in late June 1975, about one-fourth of which were waterfowl, primarily oldsquaws and snow geese. Nesting Canada geese were not abundant between 18 June and 11 July 1975 (3.0 per sq km or 7.7 per sq mi).

In late June 1975, McLaren et al. (1976) found high waterfowl densities (24.2 per sq km or 62.8 per sq mi) northeast of Pitz Lake, an area with numerous lakes, ponds, streams and sedge marshes. Common species included old-squaws, snow and Canada geese, green-wing teal and pintail. They reported this to be the richest waterfowl region along the proposed Polar Gas alignment within the current study area.

In spring, Pitz Lake is a staging area for hundreds of geese and ducks, and snow geese may stop here along a possible spring migration corridor across central Keewatin. Thousands of snow geese stop here during fall migration, during which McLaren et al. (1977) observed 34 snow geese per sq km (88 per sq mi) west of Pitz Lake.

Many Baker Lake residents reported nesting Canada and snow geese in this area, particularly northeast of Pitz Lake (study interviews). The Baker Lake Land Freeze Proposal (ITC 1975) also indicated the area's importance for nesting waterfowl.

Area 6: Quoich River. McLaren et al. (1976) observed about 750 waterfowl along Quoich River in late August 1975. Ninety-five percent of these were Canada geese, three-quarters of which were within 80 km (50 mi) of Chesterfield Inlet. In late August, these authors observed 10.0 post-moulting waterfowl per sq km (26.1 per sq mi) in 31 flocks.

CHAPTER 6

RECENT INDUSTRIAL LAND USE IN BAKER LAKE STUDY AREA

This chapter reviews recent industrial activity in the Baker Lake study area, and presents a brief overview of the framework regulating mineral exploration activity. Attention is focussed on mineral exploration, primarily for uranium which has been the most widespread activity and the focus of local concern. Activity associated with the development of an application to construct the proposed Polar Gas natural gas pipeline through the study area is briefly outlined.

REGULATORY FRAMEWORK FOR MINERAL EXPLORATION

Canada Mining Regulations pursuant to the Territorial Lands Act and the Public Lands Grants Act, and Land Use Regulations pursuant to the Territorial Lands Act comprise the main framework regulating mineral exploration and development.

The relevant aspects of the Canada Mining Regulations are as follows.

Persons or companies may apply for prospecting permits for the exclusive right to explore and develop minerals within an area. North of 60° latitude, permits cover areas defined by mineral claim staking sheets which are defined as areas bounded by 15 minutes latitude and 30 minutes longitude. During the three-year term of a permit, a permit-holder must spend specified sums of money on exploration.

At the end of the first year, a permit holder must relinquish at least one-quarter of his original permit area. At the end of the second year the holder must relinquish an area which, together with that already released, makes up one-half of his original permit area. Before the end of the three-year permit term, the holder must stake mineral claims or relinquish all rights in the area.

Individual claims are limited to a maximum of 51.65 acres (20.90 ha). The number of claims which a permit holder may stake are:

First Year	-	up to 90 claims
Second Year	-	up to a total of 270 claims for first and second year.
Third Year	-	up to a total of 450 claims for 3 years.

A claim may be held for a maximum of 10 years providing that work to the value of $100 is done on the claim each year <u>or</u> $100 is paid to the Mine Recorder. Work in excess of $100 may be considered as work done in subsequent years.

At the end of the 10-year claim period, a holder must apply for a lease to the claim or lose all rights. He may also apply for a lease before the end of the 10-year term if: the claim has been kept in good standing for 5 years, or the claim is producing at least 5 tons of ore per day.

Leases are valid for 21 years and may be renewed if the lease is kept in good standing. Lease rentals are nominal and are reduced by the amount of royalties paid. Leases for producing mines are renewed automatically on expiry.

Various activities associated with mineral exploration and development require a land-use permit. Activities such as airborne surveys and ground surveys using small, mobile camps would not require a land-use permit. A land-use permit and conditions pursuant to same would apply, however, to any exploration activity characterized by fuel caches of over 4000 l (880 gal), camps of 2000 or more man-days occupancy, or use of power-driven drilling equipment of more than 500 kg (1100 lbs). Many activities, particularly those undertaken during earlier stages of exploration, are normally of a duration and scale, or can be so organized, as to not require a land-use permit.

RECENT MINERAL EXPLORATION ACTIVITY

Map 13 shows mineral claim-staking sheet areas fully or partially under permit at present, permit areas that have been relinquished, claim-staking sheet areas within which claims have been filed, and claim-staking sheet areas where permits have not been issued.

A great deal of interest was first shown in the area in 1969 when prospecting permits were issued for 35 mineral claim-staking sheets, or one-third of the total area. Activity was concentrated in the central and northern parts of the study area (a broad band of land generally running east from Princess Mary Lake, south of Baker Lake to Bowell Islands, and a broad north-south area generally bounded on the south by a line joining Marjorie and Sissons Lakes and on the north by the study area boundary). Aquitaine Company of Canada Ltd., with 12 permit areas, was the most active company. Most of these permits were relinquished or they lapsed in the following three years with only four leading to claims.

Only seven more permits were issued in the following four years, all of these in the central parts of the study area (generally in two broad bands, one parallel to Thirty Mile Lake, the other between the Akutuak and Quoich Rivers north of Baker Lake). New Continental Oil Ltd. was the most active company. All seven permits were later relinguished or allowed to lapse.

There was renewed interest in the area in 1974 when 7 permits were issued for staking sheets not previously explored and 17 permits were issued for staking sheets previously under permit and subsequently relinquished. Of these, Pan Ocean Oil Ltd. held 9, Metallgesellschaft Canada

Ltd. 11, and Shell Canada Ltd. 4. Most of these permits were located in the south-central and north-central parts of the study area (generally a large block of land in the Wharton-Tebesjuak Lakes area, and a broad band of land trending east from Princess Mary Lake, straddling Thirty Mile Lake and terminating south of South Channel; and a broad north-south band stretching from Mallery-Princess Mary Lakes in the south to the northern boundary of the study area). Some of these permits were later relinquished, including all four areas held by Shell Canada. As a result of this exploration, eight claims were filed by Pan Ocean and six by Metallgesellschaft.

More recently a number of new, second, and third permits have been issued, mainly to Urangesellschaft. This company holds permits in 10 staking sheet areas, mostly in the northern section of the study area, and exploration is in progress.

At the present time approximately 6.8 percent of the study area (510,120 ha or 1,260,000 acres) is covered by permit and approximately 1.4 percent (108,900 ha or 269,000 acres) is claimed. To date, permits have never been issued for 48 of the 105 mineral claim-staking sheets in the study area. Permit holdings for the remaining 57 sheets were largely confined to the central and northwestern portions of the study area, with some holdings in the southwest. Eighteen of these permit areas have been relinquished with no claim staking activity. The majority of these relinquished permit areas lie in an east-west strip through the centre of the study area, and in two small blocks in the western and southwestern portions of the study area.

The location of recent claims provides some insight into the areas of highest probability for development of a uranium mine should suffucient reserves be discovered.

To date, exploration activity has not proceeded beyond a preliminary level over much of the area. The most intensive activity has been diamond drilling on claims in the Kazan Falls area.

A brief description of the sequence of events which characterize the mineral exploration and development process, from preliminary airborne radiometric surveys through development of an operating mine is presented in Appendix A.

POLAR GAS PROJECT

In December 1977, Polar Gas made initial filings and application to the National Energy Board (NEB) to construct a natural gas pipeline from the Arctic Islands to southern markets. The routing of the proposed pipeline, shown on Map 13, crosses the Baker Lake study area. The alignment crosses the northern study area boundary west of Tehek Lake, crosses Thelon River between Baker and Schultz Lakes, skirts the west side of Pitz Lake, crosses Kazan River at the western end of Thirty Mile Lake, and crosses the southern boundary of the study area west of Ferguson Lake.

Polar Gas has undertaken biological and geotechnical studies to establish alignment, and to assess potential environmental impacts of the proposed pipeline. Many of these studies have been relatively small scale and consequently did not require land-use permits. Some field programs requiring land-use permits were not undertaken in the Baker Lake area in 1977-78 due to the restraint on industrial land-use activities.

A brief description of pipeline activities, from preconstruction surveys to operation and maintenance, is presented in Appendix A.

CHAPTER 7

POTENTIAL IMPACTS AND CRITICAL AREAS

This chapter presents a matrix portraying potential impact on traditionally harvested fish and wildlife populations of the study area due to various facilities and activities associated with uranium exploration and development and pipeline construction, operation and maintenance. Areas regarded as critical for sustaining these populations are identified using biological criteria, and potential impacts identified in the matrix are addressed for these critical areas. Land-use controls for each critical area are subsequently recommended.

Before proceeding with a discussion of the potential impact matrix and critical areas, however, a brief overview of facilities and activities associated with the types of industrial development envisaged is presented.

POTENTIAL INDUSTRIAL DEVELOPMENT

Mineral Exploration and Development

Recent exploration activity in the Baker Lake study area has resulted in some claim staking and raises the possibility of mining operations in the foreseeable future.

While claims have been staked for ore bodies containing a variety of minerals, the most likely mineral to be economically developed is uranium.

Mineral exploration leading to mine development is a staged process. Airborne surveys to detect promising areas are followed by ground surveys to ascertain presence of an ore body. This is followed by diamond drilling to sample and determine the extent of the ore body. If sufficient ore of acceptable grade is found, mine development may be initiated.

If a mine were to be developed in the Baker Lake area it is likely that materials, fuel, and equipment would be barged into Baker Lake and transported overland by winter road to the mine site. Yearly resupply of large amounts of chemicals and fuel for mine and mill operation would follow the same route. Construction of a wharf on Baker Lake would undoubtedly be required.

Milling of uranium ore requires large amounts of chemical reagents. Sulphuric acid or sulphur (for the manufacture of acid), sodium chlorate, and lime are used in considerable quantities in uranium recovery and are stockpiled on site. Many other reagents are also used in smaller quantities.

Mill tailings are discharged in a slurry to a natural basin or man-made pond where heavy materials settle out. To precipitate heavy metals in the pond before discharge, tailings pH is adjusted from acidic to alkaline.

Secondary treatment of tailings liquids by addition of barium chloride causes precipitation of radium in a secondary pond. After a suitable retention period effluents are discharged to surface waters.

Jet aircraft are likely to be used to transport recovered uranium from the mine sites and backhaul supplies, requiring construction of a suitable airstrip.

A more detailed description of activities and facilities which are likely to characterize uranium exploration and development is presented in Appendix A.

Polar Gas Pipeline

The proposed Polar Gas pipeline is intended to carry natural gas from the Arctic Islands southward to the existing TransCanada pipeline in Ontario, a distance of 3700 km (2300 mi). Chilled through areas of continuous permafrost, the proposed pipeline would carry an estimated 87 million m^3 (3 billion ft^3) of gas per day. Proposed routing of the 107-cm (42-in) diameter, fully-buried pipeline crosses the study area in a north-south direction passing west of Baker Lake hamlet.

Central transfer facilities will be on Chesterfield Inlet. Materials, equipment, and fuel for pipeline construction will be offloaded from ocean-going vessels for barging to a staging site at the west end of Baker Lake. Wharves, warehouses, other storage facilities, accommodations, and an airstrip will be required at the staging site, and a gravel access road will be constructed to the pipeline right-of-way.

Some 930 km (580 mi) of pipeline will be constructed from the Baker Lake base over a four-year period. Pipeline construction will be suspended from mid November to March, although compressor station construction will continue year round. Initially one compressor station will be constructed within the study area, with two others to be completed in the future. A gravel road will be constructed along the right-of-way to provide access during construction and for repair.

A more detailed description of the activities and facilities likely to characterize pipeline construction, operation and maintenance is presented in Appendix A.

Other Developments

Other industrial activities could occur within the study area in the future, including base-metal mining and hydro-electric developments. Noteworthy base metal discoveries have been made in the area (e.g. Ferguson Lake) and the hydro potential of study area rivers has been appraised and potential development sites identified. We regard the possibility that these developments will occur in the foreseeable future as unlikely, and have as a consequence not addressed them in this study.

POTENTIAL IMPACT MATRIX

The vertical axis of the potential impact matrix (Fig. 7.1) lists those facilities and activities which characterize mineral exploration and development, and pipeline construction and operation. These facilities and activities were briefly described in the preceding discussion.

The horizontal axis of the potential impact matrix lists life-history phases for the most important traditionally harvested species with the exception of fish, which are addressed on the basis of general habitats. For other species, namely caribou, snow geese, Canada geese, and arctic fox, those life-history phases important for sustaining populations or particularly susceptible to adverse impacts are considered.

Within the matrix, potential impacts are portrayed in terms of severity (moderate and high) and duration (short-term and long-term). For purposes of this appraisal, moderate severity is defined as a perceptible change in species population or distribution pattern. High severity is defined as a readily noticeable change in species population or distribution pattern.

Judgements of severity are of necessity subjective. Data are not sufficient to determine whether populations are being harvested at or near capacity, if populations are at or near the carrying capacity of their habitat, or what effects environmental factors (e.g. climate) have had or are currently having on population levels and distribution patterns. Similarly, facility- and activity-related impacts on fish and wildlife populations are poorly understood, and opinions on the potential for various facilities and activities to affect wildlife populations and distributions vary.

When the severity of a potential impact was regarded moderate or high, an "M" or an "H" respectively was recorded in the appropriate matrix cell. A blank matrix cell indicates that potential impact was judged to be either insignificant or of low severity.

For purposes of this study we have regarded as short-term any change in population or distribution pattern which reverts to pre-impact levels in less than three years. Conversely, changes which persist beyond three years are regarded long-term. Judgements respecting duration of potential impacts are also subjective.

Duration of impact is portrayed in the matrix only for potential impacts assigned a moderate and high severity rating. This is done by placing an asterisk(*) in any cell where impact is regarded long-term.

The potential impact matrix simply signifies the level and duration of impact that is regarded as possible if the facility or activity in question were to be located in a sensitive (critical) area, improperly designed, or inappropriately timed. The presence of "M" or "H", with or without an asterisk, in a particular matrix cell does not

LEGEND: IMPACTS
M = Moderate, short-term impacts
M* = Moderate, long-term impacts
H = High, short-term impacts
H* = High, long-term impacts

EXPLORATION & DEVELOPMENT ACTIVITIES			WATERFOWL		CARIBOU							Arctic Fox	FISH		
			Snow Geese (nest and moult)	Canada Geese (moult)	spring migration	calving	post-calving	summering	fall migration	wintering	river crossings	dens	rivers	small lakes	large lakes
URANIUM EXPLORATION AND DEVELOPMENT	Airborne Surveys	CAMPS									M				
		AIRCRAFT	H	M	M	H	H	M	M		H				
		FUEL STORAGE AND HANDLING													
	GROUND SURVEYS	CAMPS									M				
		AIRCRAFT	H	M	M	H	H				H				
		FUEL STORAGE AND HANDLING													
		SURVEY ACTIVITIES									M				
	DETAILED EXPLOR-ATION	CAMPS									M				
		AIRCRAFT	H	M	M	H	H				H				
		FUEL STORAGE AND HANDLING												M	
		DRILLING AND BLASTING	H	M	M	H	H				H				
	MINE AND MILL CONSTRUCTION	BARGING AND STAGING													
		WINTER ROADS			M						M		H		
		PERMANENT ROADS	H	M	H	H	H	M	M	M	H		M		
		AIRCRAFT	H	M	M	H	H				H				
		FUEL STORAGE AND HANDLING	H	M							M		M	H	M
		CAMP	H	M		M	M				H		M	H	M
		SITE PREPARATION (including tailings ponds)	H	M		M	M				H			M	
		BORROW AREAS	H*	M*		M	M				H	M*	M	M	
		FACILITY CONSTRUCTION (including water and sewage facilities)	H	M		M	M				H				
	MINE AND MILL OPERATION	PRESENCE OF FACILITY	H*	M*		M*	M*				H*				
		CAMP	M*			M*	M*				H*		M*	H*	M*
		WINTER ROADS			M*						M*		H*		
		PERMANENT ROADS	H*	M*	H*	H*	H*	M*	M*	M*	H*				
		AIRCRAFT	H*	M*	M*	H*	H*			M*	H*				
		FUEL/CHEMICAL STORAGE/HANDLING	H	M							M*		M	H	M
		ACID PLANT				M*	M*	M*	M*	M*				M*	
		WATER SUPPLY									H*		M*	M*	
		TAILINGS AND WASTES											M*	H*	M*
NATURAL GAS PIPELINE	Pre-Construct. Surveys	CAMPS									M				
		AIRCRAFT	H	M	M	H	H				H				
		FUEL STORAGE AND HANDLING													
		SURVEY ACTIVITIES									M				
	SUPPORT FACILITIES CONSTRUCTION	CAMPS	H	M		M	M				H		M	H	M
		FUEL STORAGE AND HANDLING	H	M							M		M	H	M
		BARGING AND STAGING							H		H				
		BORROW AREAS	H*	M*		M	M				H	M*	M	M	
		ROADS AND PADS	H	M	H	H	H	M	M	M	H		M		
		AIRCRAFT	H	M	M	H	H				H				
		COMMUNICATION TOWERS	H	M		M	M				H				
	PIPELINE AND STATION CONSTRUCTION	BORROW AREAS	H*	M*		M	M				H	M*	M	M	
		MAINLINE CONSTRUCTION	H	M	H	H	H	M	M	M	H		H	M	
		TESTING											M	H	
		COMPRESSOR STATIONS	H	M		M	M				H				
		ROADS	H	M	H	H	H	M	M	M	H		M		
		CAMPS	H	M		M	M				H		M	H	M
		FUEL STORAGE AND HANDLING	H	M							M			H	M
		AIRCRAFT	H	M	M	H	H				H				
	Operations and Maintenance	GROUND TRAFFIC AND ROAD	H*	M*	H*	H*	H*	M*	M*	M*	H*				
		AIRCRAFT	H*	M*		M*	M*				M*				
		PIPELINE (buried)											H*		
		COMPRESSOR STATIONS	H*	M*		M*	M*				H*				

Fig. 7.1 POTENTIAL IMPACT MATRIX

necessarily mean that particular facility or activity will always have the severity and duration of impact indicated on the species or species life-history phase addressed.

CRITICAL AREAS: CARIBOU

Beverly and Kaminuriak caribou are believed to account for essentially all caribou meat obtained by Baker Lake residents. Consequently, protection of these populations from serious, development-related conflicts is considered essential. Four types of areas have been identified as critical for sustaining these populations: spring migration routes, calving grounds, post-calving ranges, and main water-crossing sites (Map 14). It is in these areas that industrial development could have the most serious effects, both immediate and long-term, on caribou populations and distribution, and thus on resource harvest. Long-term fidelity by caribou to most of these areas indicates their importance as focal points in the caribou annual cycle.

The critical areas may be described briefly as follows:

Area 1 covers two broad corridors used by calving segments of the Beverly and Kaminuriak populations during migration to respective calving grounds.

Area 2 encompasses broadly-defined calving grounds of the Beverly and Kaminuriak populations.

Area 3 is comprised of two broad, incompletely-defined zones where post-calving re-aggregations and movements of the Beverly and Kaminuriak populations are believed to occur.

Area 4 consists of several discrete river- and lake-crossing sites traditionally used by Beverly and Kaminuriak populations during spring, summer and fall movements.

Although only four critical areas related to particular caribou life-history phases are identified, this does not imply that potential for impact does not exist elsewhere or that there are no concerns relative to caribou during other life-history phases. Examination of the potential impact matrix (Fig. 7.1) reveals that many concerns identified for late summer, fall and winter life-history phases are identical to those identified for spring migration, calving and post-calving phases on critical areas. Generally, however, potential conflicts at those times not defined as "critical" are believed to be less damaging than those during spring and early summer. In some instances, these other life-history phases occur primarily outside study area boundaries.

During late summer and fall caribou are widely dispersed in small groups (Parker 1972a). This decreases the chance of large numbers being seriously or repeatedly disturbed or having their movements blocked by the presence of any particular industrial facility or activity. Because summer foraging is critical for subsequent reproduction, growth and winter survival, however, any disturbance decreasing feeding time or increasing energy demands or any feature decreasing habitat quality is detrimental (Dauphine 1976).

With regard to winter, the majority of both the Kaminuriak and Beverly populations have traditionally wintered well south of the study area in northern Manitoba and Saskatchewan and along Hudson Bay coast; and in northern

Saskatchewan and Great Slave Lake regions respectively. Large segments of the Kaminuriak population have recently wintered within the study area. Disturbance or blockage of movements on winter ranges could weaken caribou, hasten starvation and contribute to injuries.

DATA GAPS AND GENERAL CONCERNS -- AN OVERVIEW

A complete appraisal of the potential for industrial facilities and activities to adversely affect caribou numbers and distribution cannot be made at this time given the shortage of detailed biological information on these populations and the limited understanding of effects of industrial facilities and related activities on caribou. Currently, spring migration routes used by the Kaminuriak and Beverly populations en route to calving grounds are only generally understood, and areas used during post-calving aggregations are inadequately known. Recent shifts in winter range by the Kaminuriak population have resulted in changes in spring migration routes. Early summer movement of this population west across the Kazan River is mentioned by local residents but not formally documented.

Available data currently enable only a broad definition of calving grounds, a problem further complicated by marked variation between areas described by CWS and NWT Fish and Wildlife Service studies, and those described by Baker Lake residents. A more precise definition of even the broadly-defined calving grounds is thus required, and apparent inconsistencies in boundaries of calving areas described by government studies and Baker Lake residents require resolution. The possible presence of and degree of fidelity to preferred local sites within calving grounds as presently defined is unknown. Before importance of any local area to calving caribou can be determined, further studies are required. These should seek not only to determine geographic boundaries of favoured sites but to determine characteristics which make such sites desirable to enhance our capability to predict other areas important to calving caribou.

The number of caribou wintering in the study area and extent of their winter ranges are presently unknown. In recent years the Kaminuriak population has repeatedly shifted winter range. Caribou winter movements may be quite extensive, at least in the taiga, but there is no information on winter movements on mainland tundra ranges.

A number of researchers have described caribou response to industrial facilities. Observations and opinions regarding effects of elevated pipeline structures, permanent and winter roads, other man-made features, and human activities on caribou behaviour and movements have been recorded by Kelsall (1968), Espmark (1970), Klein (1971), Miller et al. (1972), Skrobov (1972 in Calef 1974), Urquhart (1973), Child (1973, 1974, 1975), Bergerud (1974), McCourt et al. (1974), Banfield (1974), Geist (1975), Surrendi and deBock (1976), Cameron and Whitten (1976, 1977) and Johnson and

Todd (1977). There is no unanimity among these researchers, however, as to potential short- and long-term effects of such features and activities on caribou. A review of available literature thus inevitably leads one to conclude that further research is required to accurately assess effects of bermed roads and other aboveground installations or features on or traversing caribou ranges and in particular their migration routes. Similarly, research is required to ascertain whether there are ways of constructing and operating such facilities so as not to impede caribou movements.

A number of researchers have also observed or offered opinions on caribou response to human-related disturbance factors such as aircraft, ground traffic, construction activity, and noise: deVos (1960), Lent (1966), Geist (1971a,b), Calef and Lortie (1973), Calef (1974), Bergerud (1974), McCourt et al. (1974), McCourt and Horstman (1974), Jakimchuk et al. (1974), Miller and Broughton (1974), Surrendi and deBock (1976), Calef et al. (1976), Fischer et al. (1977), and Johnson and Todd (1977). A review of their observations and opinions again leads to the conclusion that there is still much to be learned before effects of human-related disturbance on caribou can be predicted and controlled.

In the absence of definitive data, therefore, all industrial facilities and activities which could conceivably interfere with caribou migration, impede access to caribou ranges or otherwise interfere with critical life-history phases must be regarded with concern. With few exceptions, potential impacts envisaged and addressed in the critical area discussions which follow are concerned with location and design of industrial facilities, and scale, location, and timing of construction and operation of these facilities in areas regarded as critical to caribou.

Concern with respect to caribou habitat is limited to consideration of the potential for emission of sulphur oxides from a uranium mill's acid-production plant to affect lichens. Chronic concentrations of sulphur dioxide as low as 0.05 ppm can adversely affect lichens, a major component of caribou diet, over a wide area (Schofield and Hamilton 1970).

CRITICAL AREA 1A: Caribou Spring Migration Route - Kaminuriak Population

CRITICAL AREA 1B: Caribou Spring Migration Route - Beverly Population

Biological Description

Barren-ground caribou tend to follow traditional routes during spring migration from wintering areas to traditional calving grounds (Map 14). Despite local exceptions, they follow the most easily travelled routes, often along major watersheds and eskers (Pruitt 1958, 1959, Kelsall 1968, Skoog 1968, Parker 1972a). Pregnant females (together with some non-breeding females and juveniles) precede other components of the population, arriving on calving grounds in late May and early June (Kelsall 1968, Parker 1972a). When moving from winter ranges north of Baker Lake, the Kaminuriak spring migration had commenced by late March (Fischer et al. 1977).

Caribou of the Kaminuriak population traditionally migrate from northern Saskatchewan and Manitoba and the Hudson Bay coast to calve around Kaminuriak Lake (Parker 1972a). Many of these caribou have recently wintered around and north of Baker Lake (Fischer et al. 1977, study interviews) and consequently have followed different spring migration routes.

Caribou of the Beverly population move from northern Saskatchewan and east of Great Slave Lake to calving grounds in the Beverly Lake area (Kelsall 1968).

Pregnant females on spring migration may be more strongly motivated to travel than during other times of the year due to their "need" to reach calving grounds on time (Skoog 1968, Kelsall 1968, Miller et al. 1972), although bad weather can halt or temporarily reverse spring migrations.

Concerns

Caribou may react in either of two ways when confronted with impenetrable barriers during spring migration. They may wait until conditions allow them to cross the barrier, or they may attempt to move around the obstruction. Results of either reaction can be unfavorable. Critical energy reserves can be depleted (Geist 1975), or they may fail to reach traditional calving grounds in time for calving (Miller et al. 1972, Calef 1974).

Effects of a delay in reaching calving grounds are unclear even though there are instances on record where natural conditions have delayed or prevented caribou from reaching traditional calving grounds on time (Kelsall 1968, Skoog 1968, Bergerud 1974, Gavin 1975, Surrendi and deBock 1976). Should cows of necessity calve before reaching traditional calving grounds, continuation of migration shortly after birth of the calves could result in high calf mortality and failure to form important cow-calf bonds (Bergerud 1974). Skoog (1968), however, found that migration to traditional calving grounds can be halted if a majority of the females calve en route. Miller et al. (1972) pointed out that if Kaminuriak caribou calved south of traditional areas they would be in a wolf denning area. This could increase wolf predation, particularly if the migration was not later resumed (Miller et al. 1972, Calef 1974). Wolf predation on calves is already regarded by some as an important limiting factor on the Kaminuriak population (Miller and Broughton 1974).

Cameron and Whitten (1976, 1977) observed a possible increase in sensitivity of pregnant females to Alyeska pipeline facilities as calving approached, although other authors have not observed such increased sensitivity (McCourt et al. 1974, McCourt and Horstman 1974). Fischer et al. (1977) reported that caribou were more reactive to aircraft disturbance in March and early April, when spring migration could be starting, than in late spring and early summer.

There are several aspects of mineral exploration and development, and natural gas pipeline construction and operation which could prevent or hinder migration of pregnant caribou to traditional calving grounds. These were identified in the matrix (Fig. 7.1), and only major concerns are highlighted here.

Concerns relative to mining exploration and development relate primarily to blockage or diversion of caribou movements by permanent, and to a lesser extent, winter roads across migration corridors. Disturbance by low-flying aircraft or blasting is also a major concern. Developments involving intensive human activity, noise or large excavations are of particular concern at main river-crossing sites, as discussed in Critical Area 4.

There are fewer concerns relative to construction, operation, and maintenance of the proposed Polar Gas pipeline. The proposed alignment is east of spring migration routes of the Beverly population, and west of those sections of the study area generally crossed by most or all Kaminuriak caribou during recent and historically recorded spring migrations. It is not impossible, however, given that caribou may shift seasonal ranges, as was recently the case for the Kaminuriak population, that part or all of either population could winter in a location where they would have to cross the proposed pipeline right-of-way in order to migrate to calving grounds. Re-occupation of traditional taiga winter ranges by Kaminuriak caribou and subsequent use of traditional migration routes would result in this crossing taking place outside the study area. If such right-of-way crossings should occur, the scale, location, timing and mode of pipeline, road and facility construction and operation would be of major concern.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Areas 1A and 1B are reiterated below, together with recommended control measures.

POTENTIAL IMPACTS — CARIBOU SPRING MIGRATION ROUTES

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS				
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
GROUND SURVEYS				
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
DETAILED EXPLORATION				
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
Drilling & blasting	Disturbance	Moderate	Short-term	Timing
MINE AND MILL CONSTRUCTION				
Winter roads	Block movements	Moderate	Short-term	Design
Permanent roads	Block movements, Disturbance	High	Short-term	Timing, techniques, design
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
MINE AND MILL OPERATION				
Winter roads	Block movements	Moderate	Long-term	Design
Permanent roads	Block movements	High	Long-term	Possibly by design, traffic control
Aircraft	Disturbance	Moderate	Long-term	Altitude, timing
NATURAL GAS PIPELINE				
PRECONSTRUCTION SURVEYS				
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
SUPPORT FACILITIES CONSTRUCTION				
Roads and pads	Block movements, Disturbance	High	Short-term	Location, timing, techniques, design
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
PIPELINE AND STATION CONSTRUCTION				
Mainline construction	Block movements, Disturbance	High	Short-term	Timing, techniques
Roads	Block movements, Disturbance	High	Short-term	Timing, techniques, design
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
OPERATIONS AND MAINTENANCE				
Ground traffic and road	Block movements, Disturbance	High	Long-term	Possibly by design, traffic control

Controls

Current spring migration patterns in the study area require further clarification, particularly definition of any preferred routes to which caribou may exhibit fidelity within these broad corridors. Further, though historic Kaminuriak population migration patterns are generally documented, recent patterns, given the marked shifts in wintering areas, are not. As a consequence, one cannot reliably specify exclusive areas where special precautions and controls are required every year. Further studies are required to resolve these inconsistencies and identify possible preferred migration routes. To increase local credibility of these studies, they should be conducted in cooperation with Baker Lake residents. Until such time as our understanding of migration patterns and routes is much more precise we recommend the following:

1. Any proposal to construct a road or other extensive aboveground facility across spring migration corridors should be subject to scrutiny. Permission to construct should be denied if it is concluded that location or design of a proposed road or other facility would divert caribou movement by more than 4.8 km (3 mi).

2. Any extensive aboveground facilities that are permitted should be constructed with effective crossing devices at all points where migrating caribou are traditionally funnelled by natural features. If such devices cannot be designed and implemented permission to construct in such sensitive areas should be denied.

3. Permission to undertake any major exploration or construction program in migration corridors between mid May and mid June should be contingent upon maintaining a regular surveillance of caribou movements. Should caribou be found migrating toward an area where potentially disruptive activity is underway the following precautions should be instituted:

   a) all aircraft flights over migrating caribou should be restricted to at least 300 m (1000 ft) aboveground within 4.8 km (3 mi) of the migrating caribou. No aircraft should land or take off within 4.8 km (3 mi) of migrating caribou. These restrictions should apply insofar as they are consistent with safe flying practice.

   b) all construction-related activity within 4.8 km (3 mi) of migrating caribou should be curtailed and limited to discrete areas until the caribou have passed. Rights-of-way should be left in a condition so as not to impede caribou. At main river-crossing sites all construction-related activity should cease and if possible be removed when migrating caribou are in the area (Critical Area 4).

   c) all blasting within 8 km (5 mi) of migrating caribou should cease.

4. Ground traffic in any rights-of-way which may be established across migration corridors should be curtailed during the normal period of migration (May 15 to June 15).

CRITICAL AREA 2A: Caribou Calving Grounds - Kaminuriak Population

CRITICAL AREA 2B: Caribou Calving Grounds - Beverly Population

Biological Description

Calving grounds are regarded as among the most critical and restricted parts of caribou habitat (Kelsall 1968, Skoog 1968, Calef 1975). Caribou in the Kaminuriak population traditionally calve around Kaminuriak Lake (Parker 1972a, study interviews) while those in the Beverly population calve north and south of Beverly and perhaps Aberdeen Lakes (Kelsall 1968, Moshenko 1974, study interviews). Calving normally occurs in the first half of June, generally in rocky terrain at the highest regional elevations (Kelsall 1968). Barren-ground caribou are believed to exhibit strong, long-term fidelity to traditional calving grounds. Calving grounds illustrated in Critical Areas Map 14 are very general, combining areas indicated by CWS and NWT Fish and Wildlife Service studies and local residents. This is not to suggest that the entire area is "core" calving habitat or that the entire area is utilized each year other than by, perhaps, very small numbers of caribou. The current level of information does not enable identification of local, most consistently-used calving sites if such exist.

Concerns

Given that "core" caribou calving grounds are believed to be among the most critical and restricted parts of caribou habitat, maintaining integrity of these areas is believed essential for long-term well-being of a caribou population. Much of the area shown as critical calving habitat on Map 14 may in fact be infrequently used for calving.

Recent observations of some researchers (Child 1973, 1974, 1975; Cameron and Whitten 1976, 1977) suggest that caribou calves and pregnant cows are particularly sensitive to, and consequently avoid, man-made facilities. They further suggest that this sensitivity to and avoidance of man-made facilities by pregnant cows heightens as calving approaches. Therefore, man-made features on or cutting across calving grounds are of particular concern. Although caribou might approach and cross such features at other times of year, they may constitute more serious impediments for cows near time of calving. Such impediments could bar access to favoured areas of the calving ground.

Some researchers have suggested that pregnant cows and young on calving grounds are generally more sensitive to human presence, aircraft and other factors than at other times of the year (deVos 1960, Lent 1966, Surrendi and deBock 1976, Fischer et al. 1977), further suggesting that disturbance on the calving grounds could break up cow-calf pairs, hence increasing already-high calf mortality. Other researchers are not in agreement, however, suggesting that except for cases of extreme and purposeful harassment, cows with calves may be no more sensitive to aircraft, for example, than are other adult caribou (Calef and Lortie 1973, McCourt and Horstman 1974, Calef et al. 1976). Cows just before birth and young calves are particularly susceptible to injuries sustained as a result of running (Calef and Lortie 1973, Calef et al. 1976). McCourt et al. (1974) observed that caribou avoided only local areas on calving grounds due to noise from a simulated compressor station installation.

Until such time as the above divergence of opinion can be reconciled, the nature, extent and timing of activities on calving grounds must, in our opinion, remain a matter of concern. The impact matrix (Fig. 7.1) indicates a number of concerns related to pipeline construction, operation, and maintenance. These would apply if a pipeline were to be constructed through calving grounds, but are not considered here since the proposed Polar Gas pipeline does not pass through or near known traditional calving grounds in the study area.

Concerns related to mineral exploration and development on calving grounds remain, however. Of particular concern are location of roads and other facilities and the nature, extent, and timing of other activities, particularly aircraft overflights but also including facilities construction and operation, and blasting, on or near occupied calving grounds.

Long-term emission of sulphur oxides can affect lichens, a major component of caribou diet, over a wide area (Schofield and Hamilton 1970), thus potentially affecting quality of calving habitat.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Areas 2A and 2B are reiterated below, together with recommended control measures.

POTENTIAL IMPACTS – CARIBOU CALVING GROUNDS

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS				
Aircraft	Disturbance	High	Short-term	Altitude, timing
GROUND SURVEYS				
Aircraft	Disturbance	High	Short-term	Altitude, timing
DETAILED EXPLORATION				
Aircraft	Disturbance	High	Short-term	Altitude, timing
Drilling and blasting	Disturbance	High	Short-term	Timing
MINE AND MILL CONSTRUCTION				
Permanent roads	Block movements, Disturbance	High	Short-term	Timing, techniques, design
Aircraft	Disturbance	High	Short-term	Altitude, timing
Camp	Disturbance	Moderate	Short-term	Location, timing
Site preparation	Disturbance	Moderate	Short-term	Location, timing
Borrow areas	Disturbance	Moderate	Short-term	Location, timing
Facility construction	Disturbance	Moderate	Short-term	Location, timing
MINE AND MILL OPERATION				
Presence of facility	Disturbance	Moderate	Long-term	Location
Camp	Disturbance	Moderate	Long-term	Location
Permanent roads	Block movements	High	Long-term	Possibly by design, traffic control
Aircraft	Disturbance	High	Long-term	Altitude, timing
Acid plant	SO_2 emission	Moderate	Long-term	Emission controls

NATURAL GAS PIPELINE

If a pipeline were to be built in this area the potential impacts identified in the potential impact matrix (Fig. 7.1) would be of concern. These potential impacts are not considered here, however, because there is no pipeline presently proposed in this critical area.

Controls

As previously indicated, additional research is required within the broad zones currently identified as calving grounds to ascertain whether or not there are precisely definable locations which are more favoured and consistently used. To enhance local credibility of these studies, they should be conducted in cooperation with Baker Lake residents. Until such time as the existence and location of any such discrete calving areas can be identified, we recommend the following controls on industrial activity and development within the broadly-defined calving ground critical areas:

1. Facilities such as roads extending over long distances and located so that they might impede movement within traditional calving grounds should not be permitted until more is known about the response of pregnant cows to such features. If such features are considered likely to impede free caribou movement they should not be permitted unless they can be modified in a manner so as to allow free movement by adult and new-born caribou. In no case should caribou be forced to divert more than 4.8 km (3 mi) to circumvent such a facility.

2. No facility should be located or constructed on calving grounds without careful prior assessment to determine whether the desired facility lies within or near a favoured, local calving area. The period between preliminary location of a potentially exploitable mineral body and initiation of mining preparations should be used to maximum advantage to ascertain significance of that local and surrounding area to caribou. Should any detailed exploration program or facility be proposed for an area which is a heavily-used calving site, these industrial undertakings should be allowed to proceed only if subject to the following restrictions during the calving period (the last week of May until the end of June):

a) a minimum altitude of 300 m (1000 ft) above-ground should apply to all aircraft flights within 4.8 km (3 mi) of caribou anywhere on the calving ground. No aircraft should land or take off within 4.8 km (3 mi) of calving caribou. These restrictions should apply insofar as they are consistent with safe flying practice.

b) all construction and operation of facilities involving large human presence, intensive activity and loud noise should be curtailed within 4.8 km (3 mi) of a favoured calving area occupied by calving caribou. No blasting should be allowed within 8 km (5 mi) of a favoured calving area occupied by caribou.

c) all traffic on any road which may ultimately be constructed on calving grounds should be curtailed on preferred calving areas occupied by calving caribou.

If calving is found not to occur on consistently-preferred local areas, these restrictions should apply to facilities located in any part of the calving ground to which large numbers of caribou come to calve in any particular year.

3. Any acid plant associated with a uranium mill should have emission-control devices such that emissions of sulphur oxides and other materials will not damage vegetation of surrounding areas.

CRITICAL AREA 3A: Caribou Post-calving Movements - Kaminuriak Population

CRITICAL AREA 3B: Caribou Post-calving Movements - Beverly Population

Biological Description

Following calving, females and calves gradually converge into large groupings in late June, and non-calving segments of the population may later join these groupings. In July these large, dense aggregations may make rapid, directional movements or mill in relatively local areas prior to leaving these post-calving areas and dispersing in August (Kelsall 1968, Parker 1972a).

Boundaries of post-calving areas on the accompanying critical areas map (Map 14) cannot be precisely defined. Post-calving areas which Parker (1972a) reported for the Kaminuriak population were relatively consistent in different years. A movement of indeterminate size, however, reportedly crosses the Kazan River going west and northwest (study interviews), crossing the proposed Polar Gas alignment. The extent of Kaminuriak population post-calving movements and boundaries of the area properly defined as being used during post-calving movements are thus unclear.

Post-calving areas used by Beverly caribou are also incompletely known. Although they are known to range both north and south of Beverly and Aberdeen Lakes following calving (Kelsall 1968, study interviews), the extent to which post-calving caribou move north and east out of the study area north of Aberdeen and Schultz Lakes is unknown.

Post-calving ranges shown as critical on Map 14 are very general, combining areas indicated by CWS studies and local residents. This is not to suggest that the entire area is "core" post-calving habitat, or that the entire area outlined is utilized each year by large, post-calving aggregations. The current level of information does not enable prediction of local, most consistently used post-calving areas (if any).

Concerns

Several aspects of developing and operating either a mining complex or a natural gas pipeline could affect post-calving caribou in early to mid summer (see the matrix, Fig. 7.1). Concerns relate primarily to potential blockage of movements by such man-made features as permanent roads and aboveground or bermed pipeline installations, and disturbance by aircraft or other activities involving a major human presence.

Concern with man-made features such as roads and aboveground or bermed pipelines, except as absolute physical barriers, depends on different responses caribou of various age and sex groups may have to these features. Observations in Alaska have led some researchers to suggest that calves and cows may be more sensitive to such features in early summer and consequently be more reluctant to cross or venture close to them than at other times of the year (Child 1973, 1974, 1975; Cameron and Whitten 1976, 1977). Although it is not known how various components of large, post-calving aggregations would react to such facilities, they could prevent normal movements of caribou and even impede formation of normal, post-calving aggregations. This would have adverse repercussions, including effects on resocializaton of various herd components, which Miller (1974) suggests occurs at that time. Sensitivity of cows and calves to pipeline structures may decrease by fall and during periods of intense insect harassment.

DeVos (1960) reported that during the early post-calving period (mid to late June) cows with calves are restless and are the most easily alarmed segment of the population. Pruitt (1958) noted that the most reactive caribou in late July were females with calves, while Fischer et al. (1977) observed that caribou with calves were more reactive to aircraft than those without calves. Observations by McCourt and Horstman (1974) suggest that caribou in large, post-calving aggregations are more sensitive to low-flying aircraft than during any other life-history phase. Calef et al. (1976) observed that large groups of caribou could be herded in a given direction in July by circling at altitudes of 215 to 610 m (700 to 2000 ft). Harassment of post-calving aggregations can be particularly serious because of the likelihood of injury due to stampedes, and because of stresses already placed on the animals by insects.

Despite observations by other researchers (Surrendi and deBock 1976) suggesting that caribou were relatively tolerant of aircraft in July, the possibility that caribou are more susceptible to harassment at this time cannot be readily dismissed.

Long-term emission of sulphur oxides can affect lichens, a major component of caribou diet, over a wide area (Schofield and Hamilton 1970). Consequently, the presence of facilities emitting such pollutants is a concern on ranges where post-calving aggregations occur.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Areas 3A and 3B are reiterated below, together with recommended control measures.

POTENTIAL IMPACTS – CARIBOU POST-CALVING MOVEMENTS

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS				
Aircraft	Disturbance	High	Short-term	Altitude, timing
GROUND SURVEYS				
Aircraft	Disturbance	High	Short-term	Altitude, timing
DETAILED EXPLORATION				
Aircraft	Disturbance	High	Short-term	Altitude, timing
Drilling and blasting	Disturbance	High	Short-term	Timing
MINE AND MILL CONSTRUCTION				
Permanent roads	Block movements, Disturbance	High	Short-term	Timing, techniques, design
Aircraft	Disturbance	High	Short-term	Altitude, timing
Camp	Disturbance	Moderate	Short-term	Location, timing
Site preparation	Disturbance	Moderate	Short-term	Location, timing
Borrow areas	Disturbance	Moderate	Short-term	Location, timing
Facility construction	Disturbance	Moderate	Short-term	Location, timing
MINE AND MILL OPERATION				
Presence of facility	Disturbance	Moderate	Long-term	Location
Camp	Disturbance	Moderate	Long-term	Location
Permanent roads	Block movements	High	Long-term	Possibly by design, traffic control
Aircraft	Disturbance	High	Long-term	Altitude, timing
Acid plant	SO_2 emission	Moderate	Long-term	Emission controls
NATURAL GAS PIPELINE				
PRECONSTRUCTION SURVEYS				
Aircraft	Disturbance	High	Short-term	Altitude, timing
SUPPORT FACILITIES CONSTRUCTION				
Camps	Disturbance	Moderate	Short-term	Location, timing
Borrow areas	Disturbance	Moderate	Short-term	Location, timing
Roads and pads	Disturbance, Block movements	High	Short-term	Location, timing, techniques, design
Aircraft	Disturbance	High	Short-term	Altitude, timing
Communication towers	Disturbance	Moderate	Short-term	Location, timing
PIPELINE AND STATION CONSTRUCTION				
Borrow areas	Disturbance	Moderate	Short-term	Location, timing
Mainline construction	Disturbance, Block movements	High	Short-term	Timing, techniques
Compressor stations	Disturbance	Moderate	Short-term	Location, timing
Roads	Disturbance, Block movements	High	Short-term	Timing, techniques, design
Camps	Disturbance	Moderate	Short-term	Location, timing
Aircraft	Disturbance	High	Short-term	Altitude, timing
OPERATIONS AND MAINTENANCE				
Ground traffic and road	Disturbance, Block movements	High	Long-term	Possibly by design, traffic control
Aircraft	Disturbance	Moderate	Long-term	Altitude, timing
Compressor stations	Disturbance	Moderate	Long-term	Location, noise muffling

Controls

Data gaps mentioned previously as well as apparent variability in areas used for post-calving aggregations in different years render impossible identification of precise locations where sources of disturbance and man-made impediments to caribou movement should be prohibited. Further studies are required to provide the necessary information and identify possible existence of preferred areas for post-calving aggregations and routes for post-calving movements. To enhance local credibility of these studies, they should be conducted in cooperation with Baker Lake residents.

Until such time as our understanding of post-calving behaviour and movements is much more precise, we recommend the following controls on industrial activity and development within the broadly-defined post-calving critical areas:

1. Aboveground facilities such as roads extending over long distances and located so that they might impede movement within post-calving ranges should not be permitted until more is known about responses of adult and newborn caribou to such features. If such features are considered likely to impede free caribou movement by more than 4.8 km (3 mi), they should not be permitted unless it can be demonstrated that they can be modified in a manner so as to allow free movement by all caribou. In no case should caribou be forced to divert more than 4.8 km (3 mi) to circumvent such facilities.

2. No facility should be located or constructed on post-calving ranges without careful prior assessment to determine whether the desired facility site lies within or near a consistently-used post-calving area. The period between preliminary location of a potentially exploitable mineral body

and initiation of mining preparations should be used to maximum advantage to ascertain significance of the location to caribou. Should any exploration program or facility be proposed for an area which is a consistently-used post-calving range, these industrial undertakings should be allowed to proceed only if subject to the following restrictions during the post-calving period (late June and July):

a) a minimum altitude of 600 m (2000 ft) above-ground should apply to all aircraft flights within 4.8 km (3 mi) of caribou anywhere on post-calving ranges. No aircraft should take off or land within 4.8 km (3 mi) of post-calving aggregations. These regulations should apply insofar as they are consistent with safe flying practice.

b) all construction and operation of facilities involving large human presence, intensive activity and loud noise should be curtailed within 4.8 km (3 mi) of an area occupied by caribou post-calving aggregations. No blasting should be permitted within 8 km (5 mi) of caribou post-calving aggregations.

c) all traffic on any road which may ultimately be constructed on post-calving ranges should be curtailed when post-calving aggregations are occupying the area.

If post-calving movements are found to not occur on consistently-preferred areas, the above restrictions should apply to facilities located in any part of the range where caribou post-calving aggregations are found in any particular year.

3. Any acid plant associated with a uranium mill facility should have emission-control devices such that emissions of sulphur oxides and other materials will not damage vegetation of surrounding areas.

Biological Description

Caribou tend to use specific, traditional points to cross major rivers and other waterbodies (Kelsall 1968, Jakimchuk et al. 1974, Surrendi and deBock 1976), and are known to have crossed lakes and rivers at specific sites for generations, despite long-term hunting by natives at or near these points (Miller and Robertson 1967, Kelsall 1968, Surrendi and deBock 1976). Continued use of the crossing at Old Crow is an example of long-term fidelity of caribou to a crossing area, although they have been hunted there for at least 30,000 years (Surrendi and deBock 1976).

Caribou funnel into crossing points from wide fronts and may move along river banks for long distances to preferred, traditionally-used crossing sites (Jakimchuk et al. 1974).

Crossings are usually initiated by cows, particularly those with calves (Surrendi and deBock 1976). Swimming cows are usually closely followed by their calves (Skoog 1968, Jakimchuk et al. 1974, Surrendi and deBock 1976). Caribou behaviour while crossing rivers indicates that this may be a stressful activity for them (Surrendi and deBock 1976). Surrendi and deBock (1974) and Jakimchuk et al. (1974) found caribou apparently unconcerned with quietly hidden men and boats at a crossing site, however, and once swimming they would closely approach operating motor boats. Calef and Lortie (1973) and Calef et al. (1976), however, noted caribou were apparently more reactive to aircraft while at river crossings than while travelling or feeding.

Information on location of important crossing sites in the study area was obtained primarily from interviews with Baker Lake residents. Published materials (e.g. Kelsall 1958, 1968) refer to crossing points on rivers such as the Thelon and Dubawnt. Although not recorded in the recent literature, Baker Lake residents also report several sites where numerous caribou cross the Kazan River during westward, post-calving movements.

Concerns

Caribou appear to exhibit considerable fidelity to certain river- and lake-crossing sites. Since large numbers of caribou are funnelled into small, local areas, maintaining integrity of such places becomes of particular concern.

The main concern with man-made features such as roads or other extensive aboveground facilities at river crossings is blockage or diversion of caribou movements. Disturbance by aircraft, blasting and drilling, or other activities or facilities involving a large human presence or noise could also prevent caribou from using traditional crossing sites. Even short-term blockage or diversion could be critical, particularly during spring migration to calving grounds or during post-calving movements. Reaction of caribou to such barriers and sources of disturbance may vary between different sex and age groups and in different seasons.

Effects of camps and exploration activities on caribou at river crossings are of particular concern to Baker Lake hunters. Effects of low-flying aircraft in deterring caribou from using traditional crossing sites near Kazan Falls were repeatedly emphasized during our interviews in Baker Lake. Aircraft and activity around exploration camps at Kazan Falls and the west end of Schultz Lake were also mentioned in the Baker Lake Land Freeze Proposal (ITC 1975). This document and our interviews highlight Inuit concerns that these disturbances have changed caribou behaviour and migration routes.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Area 4 are reiterated below, together with recommended control measures.

POTENTIAL IMPACTS – MAIN CARIBOU WATER-CROSSING SITES

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS				
Camps	Divert or block movements	Moderate	Short-term	Timing
Aircraft	Divert movements	High	Short-term	Altitude, timing
GROUND SURVEYS				
Camps	Divert or block movements	Moderate	Short-term	Timing
Aircraft	Divert movements	High	Short-term	Altitude, timing
Survey activities	Divert or block movements	Moderate	Short-term	Timing
DETAILED EXPLORATION				
Camps	Divert or block movements	Moderate	Short-term	Timing
Aircraft	Divert movements	High	Short-term	Altitude, timing
Drilling and blasting	Divert or block movements	High	Short-term	Timing
MINE AND MILL CONSTRUCTION				
Winter roads	Divert or block movements	Moderate	Short-term	Design
Permanent roads	Divert or block movements	High	Short-term	Timing, techniques, design
Aircraft	Divert movements	High	Short-term	Altitude, timing
Fuel storage and handling	Divert or block movements	Moderate	Short-term	Timing, techniques, contingency plans
Camp	Divert or block movements	High	Short-term	Timing
Site preparation	Divert or block movements	High	Short-term	Timing
Borrow areas	Divert or block movements	High	Short-term	Avoid crossing sites
Facility construction	Divert or block movements	High	Short-term	Timing
MINE AND MILL OPERATION				
Presence of facility	Divert or block movements	High	Long-term	Avoid crossing sites
Camp	Divert or block movements	High	Long-term	Avoid crossing sites
Winter roads	Divert or block movements	Moderate	Long-term	Design
Permanent roads	Divert or block movements	High	Long-term	Possibly by design, traffic control
Aircraft	Divert movements	High	Long-term	Altitude, timing
Fuel and chemical storage and handling	Divert or block movements	Moderate	Long-term	Timing, techniques, contingency plans
Water supply	Divert or block movements (pipeline)	High	Long-term	Avoid crossing sites

POTENTIAL IMPACTS – MAIN CARIBOU WATER-CROSSING SITES (Cont'd.)

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
NATURAL GAS PIPELINE				
PRECONSTRUCTION SURVEYS				
Camps	Divert or block movements	Moderate	Short-term	Timing
Aircraft	Divert movements	High	Short-term	Altitude, timing
Survey activities	Divert or block movements	Moderate	Short-term	Timing
SUPPORT FACILITIES CONSTRUCTION				
Camps	Divert or block movements	High	Short-term	Timing
Fuel storage and handling	Divert or block movements	Moderate	Short-term	Timing, techniques, contingency plans
Barging and staging	Block movements	High	Short-term	Avoid use of icebreakers in Baker Lake
Borrow areas	Divert or block movements	High	Short-term	Avoid crossing sites
Roads and pads	Divert or block movements	High	Short-term	Timing
Aircraft	Divert movements	High	Short-term	Altitude, timing
Communication towers	Divert or block movements	High	Short-term	Timing
PIPELINE AND STATION CONSTRUCTION				
Borrow areas	Divert or block movements	High	Short-term	Avoid crossing sites
Mainline construction	Divert or block movements	High	Short-term	Timing, techniques, design
Compressor stations	Divert or block movements	High	Short-term	Avoid crossing sites
Roads	Divert or block movements	High	Short-term	Timing, techniques, design
Camps	Divert or block movements	High	Short-term	Timing
Fuel storage and handling	Divert or block movements	Moderate	Short-term	Timing, techniques, contingency plans
Aircraft	Divert movements	High	Short-term	Altitude, timing
OPERATIONS AND MAINTENANCE				
Ground traffic and road	Divert or block movements	High	Long-term	Possibly by design, traffic control
Aircraft	Divert movements	Moderate	Long-term	Altitude, timing
Compressor stations	Divert or block movements	High	Long-term	Avoid crossing sites

Controls

Variability in annual and seasonal use of river crossings and uncertainty regarding movement of Kaminuriak caribou west across Kazan River and to and from recent winter ranges north of Baker Lake preclude precise definition of all main crossing points and dates when they are used. Further studies are required to resolve these inadequacies. To enhance local credibility, these studies should be conducted in cooperation with Baker Lake residents. Until such time as location, significance, and season of use of main crossings are more precisely known, we recommend the following controls be applied on industrial land use in proximity to those crossing sites identified on the caribou critical areas map (Map 14) or at other such sites which may subsequently be identified.

1. Any proposal to locate industrial facilities in the immediate vicinity of a known crossing site should be subject to rigorous scrutiny. If it is felt that the proposed installation could possibly deter caribou from using the crossing site, permission to locate there should be denied. As a guideline we suggest that no long-term activity or structure judged to constitute a physical, visual or noise barrier should be permitted within a minimum of 4.8 km (3 mi) of any important crossing site.

2. Permission to locate a temporary facility (e.g. camp, fuel cache), or carry out any short-term construction or exploration within 4.8 km (3 mi) of a main crossing site should be contingent upon maintaining a regular surveillance of caribou movements. Should there be an indication of caribou movement toward the crossing area the following controls should be implemented:

a) all readily-removable, temporary facilities and non-essential manpower within 4.8 km (3 mi) of the crossing should be removed, and construction or other industrial activity at other sites should cease until caribou have passed.

b) a minimum altitude of 600 m (2000 ft) should be maintained by aircraft during overflights within 4.8 km (3 mi) of crossing sites. Aircraft take offs and landings within a minimum of 4.8 km (3 mi) of the crossing site should be prohibited, and airstrips oriented so that landing and take off paths avoid flight over crossing areas at less than 600 m (2000 ft) altitude. These restrictions should apply insofar as they are consistent with safe flying practice.

c) any road or pipeline construction activity within 4.8 km (3 mi) of the crossing should be halted, and the right-of-way left in such a condition as to pose no barrier to caribou movements.

d) ground traffic on any rights-of-way which might ultimately be constructed in the vicinity of main crossing sites should be curtailed until caribou have moved out of the area.

e) blasting should not be permitted within 8 km (5 mi) of water-crossing sites.

4. Extension of the shipping season in eastern Baker Lake or Chesterfield Inlet by using ice breakers should not be permitted.

CRITICAL AREAS: FISH

Fish, particularly lake trout, arctic char, and lake whitefish, are an important subsistence resource to Baker Lake residents. We have estimated that fish account for about one quarter of country food harvested in the area (Table 4.3). Fish become a primary source of country food when caribou are scarce.

Four areas (Map 15) have been designated as "critical" because we believe harvested fish populations here are vulnerable to either direct or indirect impact from industrial activities. Many other waterbodies are just as vulnerable to these disturbances but are not identified as "critical", either because they have experienced less domestic fish harvest recently, or because they do not appear to serve as habitat for fish species favoured by Baker Lake residents. Potentially adverse effects from industrial activity on the fishes of these waterbodies are indicated in the impact matrix (Fig. 7.1). Land-use controls that should apply are then recommended.

The areas designated as "critical" are: Baker Lake and its tributary rivers; larger, currently-harvested lakes (Pitz, Schultz, and Whitehills Lakes); smaller, lake trout-inhabited lakes throughout the study area; and Quoich River.

Area 5 - Baker Lake is the main fishing area for Baker Lake residents. Favoured fishing sites are located at the west end of the lake near the hamlet and at the mouths of and upstream along some tributary rivers. Lake trout are most commonly caught, but considerable numbers of arctic char and lake whitefish are also taken. Lake cisco are of lesser importance and are caught mainly near the hamlet.

Area 6 - Pitz, Schultz and Whitehills Lakes are well used seasonally. Schultz Lake is fished in summer and fall, usually in conjunction with caribou hunting. Lake trout, arctic char, and lake whitefish are taken here. Pitz Lake and Whitehills Lake are popular trout fishing areas in spring, and some winter fishing is done in both lakes.

Area 7 - Many smaller study area lakes, i.e. lakes less than 50 km^2 (20 mi^2), contain overwintering populations of lake trout. These are usually fished by jigging, but occasionally by gill-nets. Harvest is almost exclusively restricted to winter and spring. Use of the lakes is highly variable from year to year, depending on the location of hunting and trapping and the success of caribou hunting.

Area 8 - The Quoich River may be a major arctic char water within the study area. Arctic char are found downstream of St. Clair Falls while lake trout predominate above the falls.

DATA GAPS AND GENERAL CONCERNS -- AN OVERVIEW

Prediction of impact to fish by industrial activities is limited by lack of biological information concerning the study area. For most waterbodies there are only preliminary inventory data, and for some waterbodies even this level of information is lacking. There is more biological information available on specific lakes, such as Kaminuriak, Thirty Mile, and Pitz Lakes, and the west end of Baker Lake, as a result of commercial fishing and pipeline investigations (Bond 1975, McLeod et al. 1976, Lawrence et al. in prep.). Data are generally lacking on distribution and abundance of fish species in most lakes and rivers. Locations, extent, and timing of fish movements and migrations are not known, nor are specific spawning times or specific spawning and nursery locations. Overwintering areas and overwintering capacities in waters other than large lakes are not presently known. Finally, mercury contamination of fish in the various drainages has not been adequately analyzed and is not well understood. Nonetheless, fish response to industrial disturbance can be generalized in many cases from impact studies in other northern areas.

We feel the following causes of impact to fish are of greatest concern: siltation, toxic spills, accumulation of toxic substances, acidification, habitat loss, blockage of flow and dewatering, and overharvest. Anticipated industrial sources of impacts, biological effects relating to these impacts, locations where they are of greatest concern, and their predicted duration are discussed below.

Siltation. Silt will originate primarily from unstable surface soils disturbed by development and operation of borrow sites; clearing and grading required at mine and pipeline facilities; clearing, grading, trenching, and backfilling associated with pipeline construction; and erosion and drainage from permanent roads. The inherent instability of fine-grained, ice-rich soils worsen this potential problem.

Deposition of silt in waterbodies can harm fish directly by degrading spawning habitat and smothering fish eggs (Rosenberg and Snow 1975). This is particularly true of fish species requiring clean substrate for successful spawning and for those species whose eggs incubate over winter, e.g. lake trout, arctic char, and lake whitefish. Siltation can also adversely affect fish by altering the substrate habitat of aquatic invertebrates (Hynes 1973, Rosenberg and Snow 1975) which are often an essential food source for fish (McLeod et al. 1976, Lawrence et al. in prep.).

Siltation is of greatest concern in quiet-water areas such as lakes, river pools, and mouths of rivers where current is insufficient to flush out silt. Small lakes would experience greater damage than large lakes because a higher percentage of the area in small lakes would be affected by introduction of a given amount of silt. River pools and river mouths are particularly sensitive because of their importance for fish feeding (McLeod et al. 1976) and, in the case of river pools, because some serve as isolated winter habitat for fish.

Siltation is expected to be short-term if disturbed source areas are soon stabilized. This requires special attention in areas of unstable, ice-rich soils.

<u>Toxic spills.</u> Spills are a likely occurrence during pipeline construction and mine development and operation because of the great amounts of fuels or chemicals

required during these phases. The greatest potential for serious spills would be associated with barging of fuel or chemicals into Baker Lake and subsequent storage in large tanks or bladders. Methanol, which may be used for hydrostatic pipeline testing, could be spilled from storage areas or during pipe testing.

The direct lethal effects of fuels and chemicals on aquatic fauna depend on type and quantity spilled, ambient temperatures (Eedy 1974), and ice cover. Refined petroleum products such as gasoline and diesel fuel are more toxic than crude petroleum, but are volatile and will more quickly evaporate. Spills of chlorinated hydrocarbons (e.g. insecticides) can be immediately lethal to aquatic fauna, or if diluted may accumulate and concentrate in fish through their food chain. Smaller, less mobile aquatic fauna will be affected more than fish by a spill.

Concentration of toxic materials would make spills more damaging to fish in small lakes than in large lakes. Spills under ice or in flowing water are of special concern because of the difficulty of containment and cleanup (Pimlott et al. 1976, Lau and Kirchhefer 1974). In large lakes effects of spills would depend on toxicity of the material, spread or concentration of the spill by wind, and the particular use of the immediate area by fish.

Because spills are generally infrequent, accidental events, their effects are considered short-term and non-continuous. The duration and magnitude of effects will largely depend on design of safeguards and effectiveness of contingency procedures employed.

Accumulated toxic substances. Tailings ponds effluent can be the source of toxic substances that may accumulate in downstream quiet-water areas. Seepage from tailings ponds is also of concern as a source of toxic substances because of difficulties in building dikes in permafrost (Imperial Oil Ltd. 1974), and because of the great yearly variability in climatic conditions in the arctic (Eedy 1974). It is thus possible that even abandoned tailings ponds may be a continuing source of pollution.

Experience at some northern mines suggests that gradual accumulation of toxic substances is more likely to occur than concentrations of acute toxicity (Falk et al. 1973, Clarke 1974); therefore we deal mainly with the former here. Acute doses of toxic substances can be considered similar to spills discussed earlier.

In high concentration effluent from tailings ponds can be directly lethal to fish and fish food organisms. In lower concentrations toxic substances can accumulate and become a chronic source of pollution. Sublethal dosages can concentrate in fish through the food chain until fatal or physiologically-damaging concentrations have accumulated. This process varies with different substances; some chemicals can be metabolically eliminated by fish (Hynes 1966), and effects are influenced by physical, chemical, and biological characteristics of receiving water (Lee 1970, Hatfield and Williams 1976).

Greater accumulation of toxic substances will occur in quiet water, downstream areas such as river mouths or in small lakes. Because of the possibility of continuous leaching from areas of accumulation, they are considered sources of long-term impact.

Acidification. Acidification of water will be caused by fallout of sulphur oxides from stack emissions of acid plants associated with milling facilities. The effects of acidification on fish, like those of accumulated toxic substances, will be gradual, but chronic. Acidic water will arrest fish reproduction and perhaps reduce longevity much before it is acutely toxic (Beamish et al. 1975). Beamish et al. (1975) found lake trout were more readily affected by acidification than lake cisco.

Problems of acidification are expected to be restricted to small lakes with low flushing capacities, particularly those surrounded by granitic soils which often have inefficient neutralizing capacity (Beamish et al. 1975).

Acidification is considered to be a source of long-term impact because acidity will increase gradually over the duration of acid plant operation. Water quality will gradually improve through flushing, however, when acid plants cease operation.

Habitat loss. Spawning habitat can be destroyed by removal of river or lakeshore substrate for use as borrow material. Blockage of river flow or excessive withdrawl of water from limited sources can cause loss of fish habitat in small lakes or downstream river areas.

Removal of river or lakeshore substrate could destroy fish spawning areas and alter water flow through adjacent spawning areas (USDI 1976). This would reduce spawning success which in turn would reduce fish populations. River flow could be blocked by channel diversions, ice dams resulting from ice bridges, or by pipeline-induced frostbulbs at river crossings. Blockage of flow would temporarily eliminate habitat in downstream areas. Excessive withdrawl of water from rivers would cause similar effects, and if taken from small lakes could diminish the capacity of a lake as winter habitat.

River and lake substrate may be used as borrow material where upland sources are limited. Impact would be greatest if the water-based borrow areas were important spawning areas. Frostbulb-induced ice dams on rivers could result from improperly designed, buried river crossings of a chilled pipeline. Ice damming could also result from ice bridges over shallow water areas of low-discharge rivers.

Damage to fish habitat caused by gravel removal from lakes and rivers can be drastic and long-term, for the duration of effect is dependent on hydraulic and geologic forces replacing gravel and reforming spawning beds (USDI 1976). Ice damming could continue as long as the source of the problem is present. Disruption of habitat caused by excessive water withdrawl would continue for as long as withdrawl is excessive.

<u>Overharvest.</u> Overharvest of fish would most likely occur near large construction and mining camps of 200 or more men.

Limited dissolved nutrients from the precambrian shield and low temperature results in low productivity of northern waters, and fish here grow very slowly (Doran 1974). In addition, individual mature fish apparently do not spawn every year (McLeod et al. 1976) increasing the time required for fish populations to return to pre-exploitation levels. Thus, even relatively low fishing effort can overexploit northern fish populations. An apparent demonstration of this is the smaller average size of lake trout and lake whitefish caught from the most heavily fished areas around the Baker Lake hamlet compared to those caught in remote lakes (NWT Govt. files; McLeod et al. 1976). Similarly, Healey (1975) has pointed out that lake trout in northern waters are vulnerable to overfishing and their populations are slow to recover from overharvest. Overharvest of fish would occur most quickly in small lakes and in local areas of large lakes, and would be most severe near mining camps because of their duration of operation. This is of major concern where sport fishing by industrial workers would be in competition with domestic fishing. Lake trout and arctic char are likely to be the species most actively sought by southern anglers, as they are by Baker Lake residents.

Potential for overharvest will continue as long as there are large numbers of workers in a local area, and because of slow fish growth, recovery to pre-exploitation levels may take 10 or more years.

Biological Description

Eleven fish species, including lake trout, arctic char, and lake whitefish were collected by McLeod et al. (1976) in the western portion of Baker Lake.

Lake trout inhabit Baker Lake throughout the year, but some ascend tributary rivers in summer for feeding, and some may spawn and overwinter in deeper water areas of the Thelon River (McLeod et al. 1976). Life-history phases of lake trout most sensitive to disturbance are spawning, overwinter egg incubation, and overwintering.

In summer, arctic char migrate into northern Baker Lake for feeding. In fall, they apparently migrate back up tributary rivers along the north shore of Baker Lake to spawn and overwinter in small lakes. It is not known if arctic char undertake migrations in the Thelon River (McLeod et al. 1976). Life-history phases of arctic char most sensitive to disturbance are spawning, overwinter egg incubation, overwintering, and migration.

Lake whitefish are primarily lake-dwellers. McLeod et al. (1976) did not collect them in Thelon River, but speculated that they may use the river mouth at Baker Lake for feeding. Life-history phases of lake whitefish most sensitive to disturbance are spawning and overwinter egg incubation.

Concerns

Silt may originate from activities such as road construction, borrow areas, and pipeline right-of-way clearing, trenching, and backfilling. Effects of siltation will be greater at river mouths and quiet-water areas of rivers where lack of flow allows silt to accumulate. Spring flood will flush most silt from river channels, and the size of Baker Lake should allow most of it to remain relatively unaffected by silt. Therefore, the area of greatest concern is at river mouths where siltation may degrade spawning and rearing habitat. Siltation will be primarily restricted to the construction period, and is judged to be a short-term impact.

Spills of fuel during construction of a mine site or pipeline, chemicals during mine operation, and methanol during pressure testing of a pipeline are of greatest concern when large volumes are handled and stored. The greatest danger of spills is at staging areas on Baker Lake and near river mouths. Effects of spills within rivers will be transitory because of flowing water, but containment and cleanup will be difficult (Imperial Oil Ltd. 1974). Spills in lakeshore areas used for spawning and rearing may be more damaging, but less difficult to contain and cleanup.

Toxic substances, including radioactive wastes, can accumulate downstream of mine tailings ponds, primarily at river mouths and in quiet areas of rivers. Tailings ponds and areas of accumulated toxic substances could be a continuing source of contamination to aquatic fauna even after mine abandonment.

Important fish habitat may be destroyed in the Thelon River by trenching and backfilling of a buried pipeline across the river. At present specific areas of important fish habitat have not been identified, but habitat loss would probably be confined to the local area of pipeline crossing.

If industrial workers from large camps sport fish, overharvest of lake trout and arctic char may occur in local areas of Baker Lake and in areas of fish concentration, such as downstream of Kazan Falls. This harvest is of concern if in competition with domestic fishing.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Area 5 are summarized below together with recommended control measures.

POTENTIAL IMPACTS – FISH IN BAKER LAKE AND TRIBUTARY RIVERS

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS	None anticipated			
GROUND SURVEYS	None anticipated			
DETAILED EXPLORATION	None anticipated			
MINE AND MILL CONSTRUCTION				
Permanent roads	Siltation	Moderate	Short-term	Location, design,
Fuel storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
Camp	Overharvest	Moderate	Short-term	Harvest regulation
Borrow areas	Siltation	Moderate	Short-term	Location, design
MINE AND MILL OPERATION				
Camp	Overharvest	Moderate	Long-term	Harvest regulation
Fuel and chemical storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
Tailings and wastes	Accumulated toxins	Moderate	Long-term	Design, monitoring
NATURAL GAS PIPELINE				
PRECONSTRUCTION SURVEYS	None anticipated			
SUPPORT FACILITIES CONSTRUCTION				
Camps	Overharvest	Moderate	Short-term	Harvest, regulation
Fuel storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
Borrow areas	Siltation	Moderate	Short-term	Location, design
Roads and pads	Siltation	Moderate	Short-term	Location, design
PIPELINE AND STATION CONSTRUCTION				
Borrow areas	Siltation	Moderate	Short-term	Location, design
Mainline construction	Siltation, Habitat loss	High, Moderate	Short-term	Method, design, location
Testing	Spills	Moderate	Short-term	Method, location, design, contingency plans
Roads	Siltation	Moderate	Short-term	Location, design
Camps	Overharvest	Moderate	Short-term	Harvest regulation
Fuel storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
OPERATIONS AND MAINTENANCE	None anticipated			

Controls

1. Control of siltation is best accomplished by locating rights-of-way and facilities away from erosion susceptible soils, and by construction design and revegetation that will minimize erosion.

2. To minimize fuel and chemical spills, storage facilities should not be located in areas which drain directly into sensitive fish areas, and all bulk storage tanks and bladders should be adequately diked to provide surface and subsurface containment of spills. Handling procedures should be developed to minimize the chance of spills, and contingency procedures should be developed for detection, containment, and cleanup of spills.

3. Accumulation of toxic substances from mill process wastes can be controlled by designing and constructing tailings ponds to accommodate process effluent from the mill, and ensuring that pond effluent quality is within levels allowed by Metal Mining Liquid Effluent Regulations (EPS 1977). Tailings pond effluents must not be allowed to enter sensitive fish habitat. Impervious materials must be used in construction of ponds to prevent seepage. Monitoring of downstream areas should continue during mine operation. At abandonment, ponds must be left in a physically and chemically stable condition.

4. To avoid loss of important fish habitat, areas of potential industrial activity should be surveyed to identify such habitat. Construction activity should be precluded if these areas are especially important to fish.

5. Overharvest may be controlled by enforcement of existing sport fish catch and possession limits. If subsequent monitoring of sport fishing harvest indicates overfishing or conflict with domestic fishing, special harvest restrictions or closure of sport fishing may be warranted.

CRITICAL AREA 6: Pitz, Schultz, and Whitehills Lakes

Biological Description

Pitz Lake is fished during spring and summer for lake trout and lake whitefish. Both species probably use Pitz Lake for all life-history phases, but some may move into rivers and small lakes for feeding during summer.

Schultz Lake is fished during summer and fall for lake trout, arctic char, and lake whitefish. The trout and whitefish are primarily lake-resident, but the char probably migrate between Schultz and Baker Lakes, or between Schultz Lake and its tributary lakes.

Whitehills Lake is intensively fished during spring when lake trout are taken by jigging. Lawrence et al. (in prep) reported arctic char here, and McLeod et al. (1976) reported them in Prince River which drains Whitehills Lake into Baker Lake. The extent of char migration and locations of spawning areas are not known.

Life-history phases of lake trout, arctic char, and lake whitefish most sensitive to disturbance are fall spawning, overwinter egg incubation, and overwintering. Arctic char are also sensitive during migration.

Concerns

If large camps are located near these lakes, sport fishing by industrial workers may cause local overharvest. This is of particular concern at the outlet of Schultz Lake, and at traditional domestic fishing areas on Whitehills and Pitz Lakes.

Fuel spills during pipeline construction and mine construction and operation, chemical spills during mill operation, and methanol spills during pressure testing of a pipeline are of greatest concern when large volumes are handled and stored. Spills are of greatest danger to fish in spawning and rearing areas, but locations of such areas are presently unknown. Outlets and inlets to lakes are of primary concern because these areas often contain concentrations of fish.

Toxic substances, including radioactive wastes, can accumulate downstream of mine tailings ponds, primarily at river mouths. Tailings ponds and areas of accumulated toxic substances could be a continuing source of contamination to aquatic fauna even after mine abandonment.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Area 6 are summarized below together with recommended control measures.

POTENTIAL IMPACTS – FISH IN LARGE LAKES

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS	None anticipated			
GROUND SURVEYS	None anticipated			
DETAILED EXPLORATION	None anticipated			
MINE AND MILL CONSTRUCTION				
Fuel storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
Camp	Overharvest	Moderate	Short-term	Harvest regulation
MINE AND MILL OPERATION				
Camp	Overharvest	Moderate	Long-term	Harvest regulation
Fuel and chemical storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
Tailings and wastes	Accumulated toxins	Moderate	Long-term	Design, monitoring
NATURAL GAS PIPELINE				
PRECONSTRUCTION SURVEYS	None anticipated			
SUPPORT FACILITIES CONSTRUCTION				
Camps	Overharvest	Moderate	Short-term	Harvest regulation
Fuel storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
PIPELINE AND STATION CONSTRUCTION				
Camps	Overharvest	Moderate	Short-term	Harvest regulation
Fuel storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
OPERATIONS AND MAINTENANCE	None anticipated			

Controls

1. Overharvest can be controlled by enforcement of existing sport fish catch and possession limits. If subsequent monitoring of sport fishing harvest indicates overfishing or conflict with domestic fishing, special harvest restrictions or closure of sport fishing may be warranted.

2. To limit spills, fuel and chemicals should not be stored in areas that drain directly to sensitive fish habitat, and all bulk storage should be adequately diked to provide surface and subsurface containment of spills. Handling procedures should be developed to minimize the chance of spills, and contingency procedures should be developed for detection, containment, and cleanup of spills.

3. Accumulation of toxic substances from mill process wastes can be controlled by designing and constructing tailings ponds to accommodate process effluent from the mill, and ensuring that pond effluent quality is within levels allowed by Metal Mining Liquid Effluent Regulations (EPS 1977). Tailings pond effluents must not be allowed to enter sensitive fish habitat. Impervious materials must be used in construction of ponds to prevent seepage. Monitoring of downstream areas should continue during mine operation. At abandonment, ponds must be left in a physically and chemically stable condition.

CRITICAL AREA 7: Small Lakes

Biological Description

There are many small lakes, i.e. less than 50 km^2 (20 mi^2), throughout the study area that contain lake trout, and some lakes that contain either anadromous or land-locked char. Because oxygen may be limited in shallower lakes, they may provide only marginal winter habitat to fish. Fish movement to and from some of these lakes may be possible only during a relatively short period in summer. Fish may thus be restricted to these small lakes for a major part of each year, rendering them more vulnerable to disturbance than fish in larger lakes.

Concerns

Specific lakes are not identified in this category; rather any small lakes that support either lake trout or arctic char are included since they potentially provide subsistence to individual hunters and trappers. In most cases, expressed concerns relate to each individual lake which by itself does not contain the large numbers of fish that may be found in major rivers and lakes. Generally, impacts of greater magnitude are expected in small lakes because of limited opportunity of fish to escape and the concentration of impact effect.

Eroded silt from land-based activities would have long-term effects because cleansing of the lake bottom is limited by lack of currents.

Dilution of pollutants in small lakes is limited and large fuel or chemical spills could destroy or greatly deplete fish populations. Because dilution in small lakes is limited, concern about spills has been extended to smaller-scale project activities.

If natural lakes with fish populations are used as tailings ponds they would be destroyed as fish habitat. Excessive withdrawl of water from small lakes may limit their capacity to allow overwintering of fish. Toxic substances in tailings pond effluent can accumulate in small lakes and become a continuing source of contamination even after a mine has ceased operation.

Acidification of lakes can result from fallout of sulphur oxides emitted from acid plants at mine sites. Acidification would be gradual, but continuous, throughout mine operation. Fish reproduction would be adversely affected before lake water becomes acutely toxic to fish.

Because of low fish productivity of waters in the study area, sport fishing by industrial workers may lead to overharvest of isolated or semi-isolated fish populations in small lakes. The effects of overharvest would not be permanent, but could be continuous for the duration of a camp. Though irregularly used, these lakes are important to hunters and trappers, particularly when they are unsuccessful at caribou hunting.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Area 7 are summarized below together with recommended control measures.

POTENTIAL IMPACTS – FISH IN SMALL LAKES

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS	None anticipated			
GROUND SURVEYS	None anticipated			
DETAILED EXPLORATION				
Fuel storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
MINE AND MILL CONSTRUCTION				
Fuel storage and handling	Spills	High	Short-term	Location, design, contingency plans
Camp	Overharvest	High	Short-term	Harvest regulation
Site preparation	Siltation	Moderate	Short-term	Location, design
Borrow sites	Siltation	Moderate	Short-term.	Location, design
MINE AND MILL OPERATION				
Camp	Overharvest	High	Long-term	Harvest regulation
Fuel and chemical storage and handling	Spills	High	Short-term	Location, design, contingency plans
Acid plant	Acidification	Moderate	Long-term	Emission controls
Water supply	Habitat disturbance	Moderate	Long-term	Location
Tailings and wastes	Accumulated toxins, habitat loss	High	Long-term	Design, monitoring, method
NATURAL GAS PIPELINE				
PRECONSTRUCTION SURVEYS	None anticipated			
SUPPORT FACILITIES CONSTRUCTION				
Camps	Overharvest	High	Short-term	Harvest regulation
Fuel storage and handling	Spills	High	Short-term	Location, design, contingency plans
Borrow areas	Siltation	Moderate	Short-term	Location, design
PIPELINE AND STATION CONSTRUCTION				
Borrow areas	Siltation	Moderate	Short-term	Location, design
Mainline construction	Siltation	Moderate	Short-term	Location, design
Testing	Spills	High	Short-term	Location, method
Camps	Overharvest	High	Short-term	Harvest regulation
Fuel storage and handling	Spills	High	Short-term	Location, design, contingency plans
OPERATIONS AND MAINTENANCE	None anticipated			

Controls

1. Siltation can be most effectively controlled by locating rights-of-way and project facilities on non-erosive soils and away from areas that drain directly to small lakes. Project activities should be planned and designed to limit erosion.

2. Fuel and chemical storage and handling areas should be located away from small lakes. When large tanks and bladders are used for storage they should be adequately diked. Storage areas should be designed and contingency procedures developed to restrict spills from entering waterbodies. Contingency procedures should also be developed to contain and clean up spills.

3. Use of natural lakes as tailings ponds should only be allowed if engineered structures are not feasible, and if the natural lakes do not contain harvested fish species. Water should not be withdrawn from lakes if this would jeopardize overwintering of fish.

4. Accumulation of toxic substances from mill process wastes can be controlled by designing and constructing tailings ponds to accommodate process effluent from the mill, and ensuring that pond effluent quality is within levels allowed by Metal Mining Liquid Effluent Regulations (EPS 1977). Monitoring of downstream areas should continue during mine operation. Tailings pond effluents must not be allowed to enter sensitive fish habitat. Impervious materials must be used in construction of ponds to prevent seepage. At abandonment, ponds must be left in a physically and chemically stable condition.

5. Emission of sulphur oxides can be controlled by the use of emission control devices in stacks of acid plants.

6. Overharvest can be controlled by enforcement of existing sport fish catch and possession limits. If subsequent monitoring of sport fishing harvest indicates overfishing or conflict with domestic fishing, special harvest restrictions or closure of sport fishing may be warranted.

Biological Description

Biological information on this river drainage is very limited, but information from Baker Lake residents indicates that lake trout and arctic char have been harvested from this river. Lake trout are found predominantly above St. Clair Falls while arctic char may be restricted to below the falls. Spawning and overwintering areas of both species are not known, nor is it known whether fish ascend St. Clair Falls. The Quoich River estuary may be an important feeding area for arctic char.

Concerns

The Quoich River is designated as a critical area for fish because of its very low winter discharge, usually less than 3 m^3/s (100 ft^3/s) (Environment Canada 1976a).

Spills during storage and handling of bulk fuels and chemicals are of greatest concern particularly in winter, when discharge is low and most of the river is ice-covered.

Fish spawning habitat could be destroyed if river gravel is used as borrow material (USDI 1976). The likelihood of this depends on availability of upland sources of gravel. Overwintering fish habitat and incubating eggs could be jeopardized by excessive withdrawal of water from the river during late winter when discharge is low.

Ice damming, that could stop flow to downstream areas, could be caused by ice bridges for winter roads across shallow areas of the river. This would eliminate downstream areas as winter habitat for fish.

If industrial workers from large camps sport fish, overharvest of lake trout and arctic char may occur in areas of fish concentration such as downstream of St. Clair Falls. This harvest is of concern if in competition with domestic fishing.

Toxic substances in tailings pond effluent could accumulate in the Quoich River estaury and become a continuing source of contamination to fish, even after a mine has ceased operation.

Silt, from land-based activities or borrow activity within the floodplain, would accumulate in quiet-water areas of the river and degrade fish habitat.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Area 8 are summarized below, together with recommended control measures.

POTENTIAL IMPACTS – FISH IN QUOICH RIVER

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS	None anticipated			
GROUND SURVEYS	None anticipated			
DETAILED EXPLORATION	None anticipated			
MINE AND MILL CONSTRUCTION				
Camp	Overharvest	Moderate	Short-term	Harvest regulation
Winter roads	Habitat loss	High	Short-term	Location
Fuel storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
Borrow sites	Habitat loss, siltation	Moderate	Short-term	Location, design
MINE AND MILL OPERATION				
Camp	Overharvest	Moderate	Long-term	Harvest regulation
Winter roads	Habitat loss	High	Long-term	Location
Fuel and chemical storage and handling	Spills	Moderate	Short-term	Location, design, contingency plans
Water supply	Habitat disturbance	Moderate	Long-term	Location, timing
Tailings and wastes	Accumulated toxins	Moderate	Long-term	Design, method

NATURAL GAS PIPELINE

If a pipeline were to be built in this area the potential impacts identified in the potential impact matrix (Fig. 7.1) would be of concern. These potential impacts are not considered here, however, because there is no pipeline presently proposed in this critical area.

Controls

1. Fuel and chemical storage and handling areas should be located away from the river and areas that drain directly to the Quoich River. Tanks and bladders should be adequately diked, and safe procedures for handling fuels and chemicals should be developed. Contingency procedures for containment and cleanup of spills should be developed because present technology is inadequate for containment and cleanup of spills in flowing water and under ice.

2. To limit the release of toxic substances, adequate design and capacity of tailings ponds and consideration of natural drainage patterns in the mine area are essential. Impervious materials must be used in construction of ponds to prevent seepage. Effluents from tailings ponds should meet the requirements of the Metal Mining Liquid Effluent Regulations (EPS 1977) and monitoring of downstream areas should continue during operation of mines. At abandonment, ponds must be left in a physically and chemically stable condition.

3. Borrow areas or facility sites should not be allowed in the floodplain of the river.

4. Withdrawl of water during winter should be controlled to prevent dewatering of downstream fish habitat. This requires identification of fish wintering areas and of industrial and biological water requirements. Ice bridges should not be located where they may cause freezedown of the river.

5. Overharvest can be controlled by enforcement of existing sport fish catch and possession limits. If subsequent monitoring indicates overfishing or conflict with domestic fishing, special harvest restrictions or closure of sport fishing may be warranted.

CRITICAL AREAS: WATERFOWL

Although waterfowl account for a relatively minor part of the country food harvested by Baker Lake residents, we feel it is essential that those waterfowl populations actually or potentially harvested by Baker Lake hunters be protected from serious, development-related conflicts. Concentrated nesting and moulting areas have been identified as critical for sustaining these populations (Map 15). It is here that industrial development could have the most serious immediate and long-term effects on these waterfowl populations.

The critical areas may be described as follows:

Area 9 - comprised of the south shore of Baker Lake and an area around and northeast of Pitz Lake, it supports nesting and moulting waterfowl of several species, but colonially-nesting snow geese are the primary concern.

Area 10 - comprised of the islands area between Beverly and Aberdeen Lakes, it supports the moult of several thousand non-breeding, large-race Canada geese.

The fact that only two critical areas are described for waterfowl relates to the sensitivity of nesting and moulting snow geese and of moulting Canada geese to disturbance. The colonial aspect of their moulting and nesting increases the probability of significant impacts from a variety of relatively local events, as outlined in the potential impact matrix (Fig. 7.1). Nesting and moulting habitats of other waterfowl species in the study area have not been included as critical areas as these areas tend to be more widespread and less likely to be affected seriously by local disturbances. Further, harvest of waterfowl other than snow and Canada geese by Baker Lake residents is negligible, reducing probable effects of industrial impacts on local harvest.

DATA GAPS AND GENERAL CONCERNS: AN OVERVIEW

The current shortage of detailed biological information on snow and Canada goose populations in the study area precludes a complete appraisal of potential for industrial facilities and activities to affect waterfowl reproductive and moulting activities. At present, information is available primarily for those waterfowl populations along Thelon River and proposed Polar Gas pipeline route, but even here data are incomplete. Baker Lake residents were able to provide little additional information on waterfowl distribution, possibly reflecting difficulty of overland travel in summer, or a virtual absence of concentrated waterfowl nesting and moulting habitat throughout much of the study area. Thus, we are able only to define critical nesting and moulting areas along Thelon River and the proposed Polar Gas alignment, although we cannot rule out existance of nesting and moulting colonies in other parts of the study area.

A number of researchers have described responses of snow geese to industrial activities and facilities. Effects of noise from simulated compressor stations and aircraft were recorded by Gollop and Davis (1974), Wiseley (1974), Davis and Wiseley (1974), Salter and Davis (1974) and Barry and Spencer (1976). There is general concensus that nesting, moulting and staging snow geese are extremely sensitive to disturbance, particularly by low-flying aircraft. Habituation to, and long-term effects of, repeated disturbance remain speculative, however, although concern has been expressed regarding effects of repeated disturbance on fat storage, possibly resulting in reduced migratory success, particularly in poor years (Salter and Davis 1974, Davis and Wiseley 1974).

Human or aircraft disturbance of nesting geese can decrease nesting success through predation and exposure, and hasten starvation of brooding geese and thus increase nest abandonment (MacInnes 1962, Harvey 1971, MacInnes and Misra 1972, Jacobson 1974, Barry and Spencer 1976).

In general, effects of disturbance on moulting Canada geese are poorly known. They are believed to display strong fidelity to specific sites, but continued human disturbance can result in abandonment of specific areas (Sterling and Dzubin 1967).

Oil causes extensive matting of feathers, decreasing insulative value and necessitating metabolic rate increases by both moulters and nesters (Hartung 1967). Oils may be toxic if ingested (Hartung and Hunt 1966) and also inhibit egg laying and decrease hatching success of at least some waterfowl species (Hartung 1965).

In the absence of precise data on long-term effects of industrial activities on nesting and moulting waterfowl, we believe that all activities and facilities that could disturb waterfowl or destroy local areas of habitat supporting critical life-history phases must be regarded with concern. Most potential impacts discussed in the following critical area sheets are concerned with location of industrial facilities, and timing and techniques used in industrial activities in areas critical to waterfowl. The primary concern with respect to habitat relates to spills of oil or other toxic materials adjacent to nesting or moulting areas, and extensive excavations (borrow activities, open-pit mining) in nesting or moulting areas.

CRITICAL AREA 9: Snow Geese Nesting and Moulting Areas at Pitz and Baker Lakes.

Biological Description

Several waterfowl species nest and moult here in summer, including the lesser snow goose. Snow geese nest in compact colonies near water in June, and breeding snow geese moult in the same areas after mid July (Bellrose 1976). Snow geese may use this area as a stopover on spring migration, and thousands stop here during fall migration (McLaren et al. 1977). Numbers of snow geese actually nesting in this critical area are believed to be small (Map 15).

Concerns

Snow goose nesting and moulting areas are among the most critical and limited parts of their habitat, and maintaining integrity of these areas is believed essential for well-being of the population. Several aspects of mineral exploration and development and natural gas pipeline construction and operation may prevent or hinder nesting and moulting on traditional areas (Fig. 7.1).

Concerns relative to mining and pipelines are primarily those of disturbance and habitat destruction during exploration, construction, and operation. Snow geese are extremely sensitive to noise. Thus any activity involving intensive human or industrial presence, including low-flying aircraft, on or near the snow goose colony could cause evacuation of the colony, or disruption of nesting to such an extent that nesting success would be very greatly reduced. Similarly, human presence or industrial activity could interfere with moulting.

Habitat destruction or degradation is also of concern. Fuel and chemical spills, extensive excavations (borrow activities, open-pit mining) and occupation of critical sites by major project facilities would all reduce quality or area of habitat. Fuel and chemical spills in particular could result in a high rate of mortality and much-decreased nesting and moulting success.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Area 9 are reiterated below, together with recommended control measures.

POTENTIAL IMPACTS – SNOW GEESE NESTING AND MOULTING AREAS AT PITZ AND BAKER LAKES

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS				
Aircraft	Disturbance	High	Short-term	Altitude, timing
GROUND SURVEYS				
Aircraft	Disturbance	High	Short-term	Altitude, timing
DETAILED EXPLORATION				
Aircraft	Disturbance	High	Short-term	Altitude, timing
Drilling and blasting	Disturbance	High	Short-term	Timing
MINE AND MILL CONSTRUCTION				
Permanent roads	Disturbance, Habitat destruction	High	Short-term	Timing
Aircraft	Disturbance	High	Short-term	Altitude, timing
Fuel storage and handling	Spills	High	Short-term	Location, techniques, contingency plans
Camp	Disturbance	High	Short-term	Timing
Site preparation	Disturbance, Habitat destruction	High	Short-term	Timing
Borrow areas	Disturbance, Habitat destruction	High	Long-term	Avoid critical area
Facility construction	Disturbance, Habitat destruction	High	Short-term	Timing
MINE AND MILL OPERATION				
Presence of facility	Disturbance	High	Long-term	Avoid critical areas
Camp	Disturbance	Moderate	Long-term	Avoid critical area
Permanent roads	Disturbance	High	Long-term	Traffic controls
Aircraft	Disturbance	High	Long-term	Altitude, timing
Fuel and chemical storage and handling	Spills	High	Short-term	Location, techniques, contingency plans

POTENTIAL IMPACTS – SNOW GEESE NESTING AND MOULTING AREAS AT PITZ AND BAKER LAKES (Cont'd.)

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
NATURAL GAS PIPELINE				
PRECONSTRUCTION SURVEYS				
Aircraft	Disturbance	High	Short-term	Altitude, timing
SUPPORT FACILITIES CONSTRUCTION				
Camps	Disturbance	High	Short-term	Timing
Fuel storage and handling	Spills	High	Short-term	Location, techniques, contingency plans
Borrow areas	Disturbance, Habitat destruction	High	Long-term	Avoid critical area
Roads and pads	Disturbance, Habitat destruction	High	Short-term	Timing
Aircraft	Disturbance	High	Short-term	Altitude, timing
Communication towers	Disturbance	High	Short-term	Timing
PIPELINE AND STATION CONSTRUCTION				
Borrow areas	Disturbance, Habitat destruction	High	Long-term	Avoid critical area
Mainline construction	Disturbance, Habitat destruction	High	Short-term	Timing
Compressor stations	Disturbance	High	Short-term	Timing
Roads	Disturbance, Habitat destruction	High	Short-term	Timing
Camps	Disturbance	High	Short-term	Timing
Fuel storage and handling	Spills	High	Short-term	Location, techniques, contingency plans
Aircraft	Disturbance	High	Short-term	Altitude, timing
OPERATIONS AND MAINTENANCE				
Ground traffic and road	Disturbance	High	Long-term	Traffic controls
Aircraft	Disturbance	High	Long-term	Altitude, timing
Compressor stations	Disturbance	High	Long-term	Avoid critical area

Controls

At present, shortages of information may have precluded precise definition of all main snow goose nesting and moulting colonies in the study area. Until precise boundaries and significance of area(s) used by snow geese are more precisely known we recommend the following controls be applied on industrial land use in or near the snow goose nesting and moulting area identified on Map 15, or at other sites or within boundaries that may subsequently be identified:

1. Any proposal to locate permanent industrial facilities near a snow goose nesting or moulting area should be subject to scrutiny. If it is felt that operation of the proposed facility would deter snow geese from using that area, permission to locate there should be denied. We suggest that no permanent industrial structure, airstrip, camp, compressor station or major excavation be permitted within 3.2 km (2 mi) of snow goose nesting colonies.

2. Location of any temporary facility and initiation of any short-term construction or exploration activity judged potentially capable of deterring snow geese from using nesting colonies should not be permitted within 3.2 km (2 mi) of snow goose colonies during the late May-August period.

3. No aircraft should be operated within 3.2 km (2 mi) of, or lower than 600 m (2000 ft) over, snow goose colonies, between late May and August. Aircraft landings or take offs should not be permitted within 3.2 km (2 mi) of snow goose colonies in this same period. These restrictions should apply insofar as they are consistent with safe flying practice.

4. No blasting should be allowed within 8 km (5 mi) of snow goose colonies between late May and August.

5. Traffic on any road that may ultimately be constructed through or near snow geese colonies should be forbidden in the late May-August period.

6. Fuel and chemical storage sites should not be located where spills could pollute critical nesting and moulting areas. All bulk storage tanks and bladders should be adequately diked to provide surface and subsurface containment of spills. Handling procedures should be developed to minimize the chance of spills, and contingency procedures developed for detection, containment and cleanup of spills.

CRITICAL AREA 10: Canada Geese Moulting Area Between Beverly and Aberdeen Lakes.

Biological Description

The islands region between Beverly and Aberdeen Lakes is a moulting area for about 10,000 non-nesting, large-race Canada geese which migrate from more southerly areas in order to moult (Map 15). Moulting Canada geese are in the area between mid June and mid August. Major river systems and connected lakes are particularly attractive to moulters, which are generally restricted to stream and lake shores. Tributary streams and lakes are rarely used and then only by groups of 20 or less on any lake (Sterling and Dzubin 1967). Snow, white-fronted and Canada geese also nest in the area, in unknown numbers. At present it is not known if there are other Canada goose moulting colonies in central Keewatin (Sterling and Dzubin 1967).

Concerns

Canada goose moulting areas may be among the most sensitive parts of their habitat, and maintaining integrity of these areas is believed essential for well-being of the population concerned. Several aspects of mineral exploration and development, and natural gas pipeline construction and operation may prevent or hinder moulting on traditional areas (Fig. 7.1). At present the proposed Polar Gas pipeline is located east of this critical area, and concerns relative to the pipeline are not elaborated here.

Concerns relative to mining relate primarily to disturbance and habitat destruction. Moulting Canada geese are believed to be sensitive to noise and disturbance. Any industrial activity involving a large human or industrial presence on or near the colony could cause abandonment of the area or otherwise interfere with moulting. Depletion of limited energy reserves could also be hastened.

Habitat destruction or degradation is also of concern. Fuel and chemical spills, extensive excavations (borrow activities, open-pit mining) and occupation of important sites by major project facilities could all reduce quality or amount of habitat. Fuel or oil spills could result in a high rate of mortality due to oiling and associated thermoregulatory problems.

Potential impacts shown in the matrix (Fig. 7.1) and regarded relevant to Critical Area 10 are reiterated below, together with recommended control measures.

POTENTIAL IMPACTS – CANADA GEESE MOULTING AREA BETWEEN BEVERLY AND ABERDEEN LAKES

PROJECT ACTIVITY	MAJOR CONCERNS	SEVERITY	DURATION	CONTROLS
URANIUM EXPLORATION AND DEVELOPMENT				
AIRBORNE SURVEYS				
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
GROUND SURVEYS				
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
DETAILED EXPLORATION				
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
Drilling and blasting	Disturbance	Moderate	Short-term	Timing
MINE AND MILL CONSTRUCTION				
Permanent roads	Disturbance, Habitat destruction	Moderate	Short-term	Timing
Aircraft	Disturbance	Moderate	Short-term	Altitude, timing
Fuel storage and handling	Spills	Moderate	Short-term	Location, techniques, contingency plans
Camp	Disturbance	Moderate	Short-term	Timing
Site preparation	Disturbance, Habitat destruction	Moderate	Short-term	Timing
Borrow areas	Disturbance, Habitat destruction	Moderate	Long-term	Avoid critical area
Facility construction	Disturbance, Habitat destruction	Moderate	Short-term	Timing
MINE AND MILL OPERATION				
Presence of facility	Disturbance	Moderate	Long-term	Avoid critical area
Permanent roads	Disturbance	Moderate	Long-term	Traffic controls
Aircraft	Disturbance	Moderate	Long-term	Altitude, timing
Fuel and chemical storage and handling	Spills	Moderate	Short-term	Location, techniques, contingency plans

NATURAL GAS PIPELINE

If a pipeline were to be built in this area the potential impacts identified in the potential impact matrix (*Fig. 7.1*) would be of concern. These potential impacts are not considered here, however, because there is no pipeline presently proposed in this critical area.

Controls

At present, a shortage of information may have precluded precise definition of all Canada goose moulting colonies in the study area. Until precise boundaries and significance of areas used by Canada geese for moulting are known, we recommend the following controls be applied on industrial land use in and near the Canada goose moulting area identified on Map 15, or at other sites or within boundaries that may subsequently be identified.

1. Any proposal to locate permanent industrial facilities near the Canada goose moulting colony should be subject to scrutiny. If it is felt that operation of the proposed facility would deter Canada geese from moulting in that area, permission to locate there should be denied. We suggest that no permanent industrial structure, airstrip, compressor station, camp or major excavation be permitted within 3.2 km (2 mi) of Canada goose moulting colonies.

2. Location of any temporary facility, or initiation of any short-term construction or exploration activity judged potentially capable of deterring Canada geese from using moulting areas should not be permitted within 3.2 km (2 mi) of the colony between mid June and mid August.

3. No aircraft should be operated within 3.2 km (2 mi) of, or lower than 300 m (1000 ft) over, Canada goose moulting colonies between mid June and mid August. Aircraft landings and take offs should not be permitted within 3.2 km (2 mi) of moulting colonies in the same period. These restrictions should apply insofar as they are consistent with safe flying practice.

4. No blasting should be allowed within 8 km (5 mi) of the Canada goose moulting colony between mid June and mid August.

5. Traffic on any road that may ultimately be constructed on the moulting colony should be forbidden between mid June and mid August.

6. Fuel and chemical storage sites should not be located where spills could pollute critical moulting habitat. All bulk storage tanks and bladders should be adequately diked to provide surface and subsurface containment of spills. Handling procedures should be developed to minimize the chance of spills, and contingency procedures developed for containment and cleanup of spills.

CRITICAL AREAS: ARCTIC FOX

No critical areas have been identified for arctic fox. The most serious industrial threat to study area fox populations is loss of dens and denning habitat due to borrow activities. Although several areas are said to have a relatively high density of arctic fox dens, none of these areas are known to be specifically threatened by project-related activities.

In general, loss of dens and denning habitat in regions where denning habitat is limited could adversely affect a region's ability to produce arctic foxes. If supplies of aggregate materials are limited in an area, land-forms of the type used by denning foxes could comprise much of the sand and gravel required for development of a mining or pipeline infrastructure. There would appear, however, to be ample supplies of these materials in much of the study area, reducing likelihood of the need to destroy fox denning habitat there. Despite apparently ample denning habitat, one should not assume a large excess of available dens. Existing dens are used for long periods. New dens cannot be dug in spring and existing structures must be used for whelping at that time (Macpherson 1969). Fox dens are identifiable in summer, particularly from the air, making avoidance of den sites and surrounding areas a feasible and necessary restriction to borrow operations.

Disturbance of denning foxes can cause den abandonment (Macpherson 1969, Ruttan 1974, Ruttan and Wooley 1974), but this is not believed to present a serious threat to fox populations. Ruttan (1974) found arctic foxes did not react strongly to human presence if the observer did not approach closer than 150 m (500 ft), but at distances of less than 40 m (125 ft) some foxes retreated into burrows. They may attempt to avoid aircraft above 300 m (1000 ft), or may simply show watchful curiosity (Ruttan 1974). Operation of heavy equipment or use of explosives near dens could cause den abandonment (Watson et al. 1973). The high mobility of arctic foxes at times other than late winter, spring and early summer reduces their susceptibility to disturbance for much of the year.

CHAPTER 8

LAND-USE REGULATION - GENERAL CONSIDERATIONS

In this section several land-use issues not specifically related to particular critical areas are discussed. More specifically these issues relate to: the strategy which should be adopted in permitting any industrial development within critical areas, regulation of aircraft altitudes, procedures for ensuring that exploration activities which fall outside current land-use regulations are reviewed, and, improving consultation with local residents.

IMPLEMENTATION OF CONTROLS

In formulating land-use control recommendations presented in the Critical Areas section of this report (Chapter 7), we encountered data gaps in the distribution, movements, and specific, local habitat requirements of key harvested species (caribou, arctic fox, fish and wildfowl). Similarly, behavioural responses of these species to various industrial activities are incompletely documented. It was thus possible to specify only very broadly-defined critical areas in most instances. Controls for each critical area were recommended fully recognizing that the "critical" designation may not apply to the entire area, at least at particular times of the year.

In making our recommendations, we have adopted the stance that industrial development within most of the study area is probably acceptable with appropriate, and in some instances stringent, regulation. In this study all industrial facilities which, in our opinion, could have unacceptable effects on harvested species were regarded with concern. Our approach has been one of recommending controls on location and design of industrial facilities and on scale, location, techniques and timing of exploration, construction, and operation activities.

In an attempt to remedy shortages of information that necessitated establishment of such broad critical areas, we recommend further research. More data are required on distribution, movement patterns and other basic, life-history aspects. In addition to area-wide research, we recommend a program of intensive monitoring to determine the significance of local areas to affected species and also behavioural responses to the activity in question. This monitoring should be undertaken whenever long-term industrial activities identified in the potential impacts matrix as having the potential to adversely affect harvested species (Fig. 7.1) are permitted in any area identified as critical. This monitoring would record in detail the effects of industrial activities, and these data would then be applicable to subsequent industrial activities in these or other areas. Industrial activities initiated in conjunction with monitoring in these critical areas should be undertaken on the understanding that the monitoring program could result in implementation of more restrictive controls.

Most controls we have recommended can be implemented within existing Land Use Regulations under the Territorial Lands Act (1977). Some exploration activities are not adequately controlled by the existing Regulations, however; they include aircraft operations and activities which, due to scale, duration or character, do not require a land-use permit.

Baker Lake hunters have expressed serious concern that aircarft overflights have affected caribou populations in the study area. Of particular concern to us are intensive, low-level flights associated with radiometric surveys, frequent resupply and support flights associated with exploration activity, and construction and operation of future facilities. Consequently, we believe there is a definite need to find some means whereby aircraft activity can be effectively monitored and regulated.

The Ministry of Transport (MOT) has power to establish flight corridors and altitude restrictions and has done so for aircraft safety and protection of property and persons on the ground. Other restrictions have been placed by various authorities on air traffic over specific areas such as DEW line sites and wildlife sanctuaries. There are at present no specific legal restrictions on aircraft overflights of critical wildlife areas (in the sense of Chapter 7) in the NWT except insofar as they are located within bird sanctuaries.

To date, the approach of MOT to aircraft control over certain sensitive wildlife areas has been to request pilots to avoid flights below 600 m (2000 ft) where potential for conflict between wildlife and air traffic exists. This is done by means of a Notice to Airmen (NOTAM), mailed to all licensed pilots in Canada. NOTAM's are merely advisory, however, and violation does not carry a penalty. In addition to NOTAM's, DIAND may attach operating restrictions to land-use permits, specifying places and dates to avoid. In general, however, they only prohibit prolonged operation by aircraft below 450 m (1500 ft) in sensitive areas. The difficulty of monitoring to ensure that these conditions are obeyed, and subsequent enforcement if they are not, is regarded as a major problem by all parties involved.

We envisage several means by which aircraft overflight altitudes might be regulated so as to avoid adversely affecting wildlife, particularly caribou. First, areas identified as traditional calving grounds should be designated by Territorial Ordinance as areas where overflight altitudes are to be controlled at not less than 300 m (1000 ft) during the calving period (May 20 to June 30). Special permission to land aircarft or service any ground-based activity by aircraft in these areas between these dates should only be granted if details of flight timing, frequency, and aircraft type are reviewed as part of the land-use permit application process, including that phase wherein local residents are consulted (see following discussion), and found acceptable. Radiometric surveys and other extensive, low-level flying should be curtailed over calving grounds during this period. These restrictions should be in effect only insofar as they are consistent with safe flying practices.

Similarly, a Territorial Ordinance should prohibit aircraft overflights under 600 m (2000 ft) altitude on all areas where post-calving aggregations are located between 15 June and 31 July. Regulations, including those governing special permission to land or service any activity as well as low-level radiometric or other surveys, should be applied as detailed above for the calving period.

A Territorial Ordinance should also prohibit aircraft activity under 600 m (2000 ft) altitude within 4.8 km (3 mi) of any important river- or lake-crossing site when large numbers of caribou are using the crossing during spring migration (15 May to 15 June), post-calving movements (15 June to 31 July), and late summer or fall migration (August or September).

A Territorial Ordinance should also be used to regulate aircraft overflights of other critical areas, such as colonial waterfowl nesting and molting habitat, during sensitive periods.

Second, aircraft activity within critical areas should be monitored to ensure satisfactory compliance with altitude and timing regulations. The only punitive measure we regard as practical at this time is withdrawal of a land-use permit if aircraft operating conditions pursuant to the permit are violated, except insofar as the violations were necessary for reasons of safety.

Local residents recognize the difficulties involved in monitoring aircraft, but concur with our opinion that effective enforcement of aircraft restrictions is essential. They also envisage a role for local monitors. A procedure should be established and communicated to all local residents so that apparent infractions of permit conditions, regulations, or the Territorial Ordinance(s) proposed above can be reported to the proper authority. To ensure that such complaints are investigated, the complainant should, if he so desires, be informed in writing within a reasonable time as to the outcome of his complaint.

Third, in addition to initiatives government might take to achieve an acceptable level of compliance with aircraft regulations, industry could demonstrate a genuine commitment to control by incorporating penalty clauses into contracts with companies supplying air support services. If these clauses were enforced, a carrier who violated overflight conditions would suffer financial loss. This punative measure would hopefully contribute to greater compliance and more responsible behaviour.

With respect to exploration programs not of sufficient scale, duration, or character to require land-use permits, we propose that holders of mineral prospecting permits be required to advise affected communities and the Land Use Advisory Committee (LUAC) of details regarding all proposed field activities. This would encourage companies to take community concerns into account when planning the location and timing of their activities. This would no doubt require closer liaison between the companies involved, community councils, and other local groups such as Hunters and Trappers Associations. For companies to prepare their programs without this consultation would be irresponsible and harmful to long-term relationships.

In addition to this expanded liaison with local groups, consultation is required between government, the mining industry, NWT residents, and other affected parties to amend the regulatory framework under which mineral exploration activities are currently undertaken. At present, the Land Use Regulations are not adequate to control these activities. Because of this inadequacy, much regional prospecting and even detailed exploration has been conducted without reference to the Land Use Regulations, and subject primarily to the Canada Mining Regulations, the main specifications of which were summarized in Chapter 6.

We believe that the Land Use Regulations should be amended in such a way that all mineral prospecting and exploration involving power-driven equipment or aircraft would fall within their purview. These activities would thus require appropriate land-use permits in the same manner as petroleum-exploration activities do now, and thus bring proposed mineral exploration and development activities under the scrutiny of local community councils, the LUAC, and that section of DIAND responsible for issuing land-use permits.

All development activity arising out of a successful exploration program, although not subject to land-use regulations, is subject to control through the Federal Environmental Assessment and Review Process (EARP). The public hearing phase of this process, wherein the Environmental Assessment Panel undertakes hearings in each affected community, should be as extensive as necessary, and undertaken when those local residents most affected and most qualified to contribute, by virtue of long experience on the land, can be present. If necessary, public funding should be available to enable local groups to provide proper documentation of their presentations. That phase of the EARP proceedings wherein public concerns are voiced should be considered critical when determining the significance of adverse environmental impacts and when recommending on project acceptability, future research, controls, surveillance, and monitoring.

LOCAL REVIEW OF INDUSTRIAL LAND-USE

Various northern communities, including Baker Lake, as well as DIAND officials have expressed concern that the process by which land-use permit applications are reviewed with local communities is at times less effective than desired. Such consultation is not required under existing land-use regulations, but as a matter of government policy an application for industrial land use within the harvest area of a hamlet or settlement is sent to that community for review and comment. The applications are usually sent to local community Councils, who in turn may refer them to local Hunters and Trappers Associations or other community groups.

In some instances, community comments on land-use applications are returned to DIAND in Yellowknife too late to affect permit issuance or influence operating conditions attached to permits. In other cases Yellowknife receives no input at all from the communities involved.

There are several reasons for these situations. Community responses to land-use permit applications are often tardy or absent because time limitations for processing applications may not always be understood by local councils, and time limitations are, in many cases, too short for effective response. Further, companies and government often do not understand the true sequence of decision-making within communities and hence impose unrealistic scheduling.

Local people who have the best knowledge of the area for which a permit is requested are often absent from the community when applications are received by council; and information given on applications is frequently either insufficient to allow judgment of possible effects, or of such a technical nature that it means little to local people.

Local concerns forwarded to Yellowknife within specified time limits rarely result in denial of a permit and may not even be expressed in the operating conditions attached to a land-use permit because government officials apparently feel that the concerns expressed do not represent real problems, or because there is no appropriate control available to deal with the concerns.

To overcome some of these problems and to make community review of land-use applications more meaningful, the system for permit application and community review requires modification. With this in mind we recommend several reforms.

To ensure that communities are given a realistic opportunity to review and comment on land-use permit applications, regular review periods should be scheduled. They should occur when appropriate local people will be available to comment on them. We suggest that at least two review periods per year be established and their scheduling be determined in consultation with local Councils. Advantageous times for this process, at least in some communities, would be during spring breakup, to deal with applications for land use during the following winter, and in early January to deal with applications for land use during the following summer.

At these times a representative from the Land Use Section of DIAND should meet in the community with the local Council, Hunters and Trappers Association, or other group(s) that may be designated by Council, to review applications and receive local recommendations. Applications could be in one of two forms: a "preliminary" form, basically expressions of intent by industry to conduct certain land-use activities, or a final application.

Information on the preliminary or final applications should include: a general discussion of the purpose of the proposed activity, characteristics of that activity, the expected duration of activities, and a general but complete description of where camps and activities will be located. This would include detail on the size and nature of the operation and types of equipment, including aircraft to be used.

If a preliminary application is endorsed by the community Council and the final application is not appreciably different, final referral need not be made to the community Council. A copy of the land-use permit issued by DIAND, with operating conditions attached, should nonetheless be sent to the Hamlet or Settlement Council as a means of notification. If preliminary applications are not endorsed by the community Council, or if the final application differs significantly from the preliminary one, the final application should be sent to the community Council for review and comment as outlined above for preliminary applications.

This process of consultation involving local Community Councils, together with their designated agents, only grants communities a chance to voice their views regarding the overall acceptability of a proposed land-use and the conditions which should be attached. This procedure does not confer a legal power of veto or acceptance to the local Council; the ultimate decision and responsibility for permit issuance remains with DIAND.

The foregoing procedure would, however, require industry to anticipate their land-use activities well in advance of their present practice, and would obviously restrict issuance of land-use permits to specific periods each year. Applications could nonetheless be received by government and forwarded to communities throughout the year as long as they were available for review during one of the two periods designated for review.

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APPENDIX A

EXPLORATION AND DEVELOPMENT SCENARIOS

This appendix details the activities which would characterize mineral (uranium) exploration and development up to and including development and operation of a mine, and, construction, operation and maintenance of a natural gas pipeline. Activities are discussed chronologically, and information on their nature, timing, duration, and other characteristics is presented. In addition, facilities which are likely to be constructed are identified and briefly described.

URANIUM EXPLORATION, MINING, AND PROCESSING -- PROJECT DESCRIPTION

Recent exploration activity in the study area has resulted in some claim staking and a definite possibility of future mining operations. While claims have been staked for ore bodies containing various minerals, the most likely mineral to be developed in the near future is uranium. Several companies are presently engaged in uranium exploration and some large blocks of land have been claimed.

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Design and Planning

Logistics. Logistics of initiating and supplying a uranium mining and milling operation in the Baker Lake area are not difficult. All equipment and materials for facilities construction and mining and milling could be barged into Baker Lake during the three-month shipping season and offloaded at a small wharf. Wharf construction might precede shipping by one year. Access to the mine site would initially be by snow road in winter.

Large amounts of fuel and chemicals could be resupplied annually by barge and stockpiled. Transport of men, food, and refined uranium could be accomplished by aircraft.

The uranium exploration process can generally be divided into three stages: airborne surveys, ground follow-up surveys, and detailed exploration. The entire exploration process to prove an ore body may span several years, after which development of a mine and mill facility would be required.

Airborne Surveys

Airborne surveys with radiometric instruments are used in reconnaissance of large areas to detect geophysical anomalies associated with ore bodies.

Camps. Camps used for airborne survey crews vary in size depending on intensity and operating schedule of the survey. Tents are generally used as a high degree of mobility is required. Camps may be supplied by small, fixed-wing aircraft.

Aircraft. Airborne surveys are initially carried out over very large areas. Permit areas in the Baker Lake area can be as large as 72,845 ha (180,000 acres). In surveying a region, instrument-equipped aircraft fly grid patterns varying in size from 0.2 to 1.6 km (0.1 to 1 mi) at altitudes of 45 to 60 m (100 to 200 ft). Small helicopters or light, fixed-wing aircraft are suitable for this purpose. Flying time averages about 5 hours per day at a speed of 95 km per hour (60 mi per hour).

Fuel Storage and Handling. Prior to the start of surveys, fuel is usually deposited in caches near lakes large enough to land aircraft carrying drums of fuel. Size and number of caches vary with the type and number of aircraft used in the survey.

Ground Surveys

Ground follow-up surveys are undertaken to confirm existence of an ore body. They include radiometric surveys, hand augering, and geochemical analyses.

Camps. Base camps for ground surveys, which may remain in place for several years, would house 6 to 15 men and operate from June to mid-September. Fly camps based from these base camps and housing two or more men would be relocated several times a season.

Aircraft. Base camps and fuel are transported to campsite locations in winter by ski-equipped DC-3 aircraft for use the following summer. Campsites are located near lakes large enough to land these aircraft. Once in operation, base camps are re-supplied by air using Twin Otters on floats every 10 to 14 days. Helicopters would be used to locate and supply fly camps operating from the base camps. Empty fuel drums would be removed the following winter by DC-3.

Fuel Storage and Handling. Large fuel caches would be located at base camps, with smaller caches distributed later from this cache by helicopter. Base camp caches would be located near lakes.

Fuel requirements for a summer's operations would be 23,000 to 68,000 litres (5000 to 15,000 gal) depending on aircraft useage.

Survey Activities. Survey activities could be based from a number of small fly camps. Small teams intensively sample local areas using radiometric surveys, hand augering, and geochemical analyses.

Detailed Exploration

To determine the feasibility of mine development in a specific location, detailed examination of an ore body is required. This is largely accomplished by diamond drilling which recovers ore samples and thus defines the ore body size. Small drills weighing about 450 kg (1000 lbs) and capable of penetrating to a depth of over 100 m (several hundred feet) are used for this purpose.

Camps. Camps would consist of about 10 aluminum-framed tents and would house 20 men. They would be in place from early spring to late fall.

Aircraft. Equipment, materials, fuel, and camps are usually flown in by DC-3 during the previous winter. There is weekly supply during drilling by Twin Otter. Helicopters are used to move materials and fuel locally, and to move drills between drill sites.

Fuel Storage and Handling. Fuel would be transported to the drill site by DC-3 in winter and placed in large caches for use the next summer. Additional supplies would be brought in as required. Fuel requirements for a summer's operations would be 68,000 to 91,000 litres (15,000 to 20,000 gal).

Drilling and Blasting. Drilling to establish the size of an ore body is generally done on a grid pattern, with grid lines spaced as little as 15 m (50 ft) apart. Drilling continues until satisfactory information on size, shape, and orientation of the ore body has been obtained. Core samples from drilling are retained for later analysis.

Light, diesel-powered drills are transported to the site and moved between drill holes by helicopter. Water required during drilling to wash and cool the diamond bit is usually obtained from a nearby lake or stream. Water is forced down the hollow centre of the drill rods to pass across the bit and returns to the surface between the drill rods and the casing or borehole wall carrying cuttings from the bit. Such cuttings may be collected at the surface as sludge and retained for later analysis with cores. Where sludge is not retained, water and sludge may be allowed to simply drain away from the drill hole. Where water is scarce, it may be recirculated after passing through a drill water reclaimer. Water requirements vary from 7 to 32 litres (1.5 to 13 gal) per minute when water is not recirculated.

In permafrost overburden, antifreeze may be added to drilling water to permit circulation of a colder fluid and reduce melting of permafrost cores. Other fluids such as kerosene may also be used. These fluids are recirculated after passing through a reclaimer.

When drilling through highly permeable materials, additivies such as drilling muds may be mixed with the drilling fluid to seal off the drill hole and prevent fluid loss. In such cases the fluids used are recirculated. Badly fractured rock is usually sealed by cementing.

In some areas blasting may be a necessary part of detailed exploration activities.

Mine and Mill Construction

Following location of a feasibly exploitable mineral body and the decision to proceed with the operation, mine and mill facilities would be required at the site of the ore body.

Barging and Staging. Equipment and materials for facilities construction would be barged into Baker Lake during summer. They would be offloaded and stockpiled there until the following winter.

Winter Roads. Materials and fuel stockpiled at Baker Lake would be transported over winter roads to the mine site.

Permanent Roads. Permanent gravel roads would be constructed between landing strips and borrow sources and the mining complex. Uranium ore bodies of mineable grade often occur in scattered deposits several kilometres apart.

Although one such deposit may not be sufficient to support a mining operation, several similar deposits would; and they may be mined in succession, with ore hauled to a centrally-located processing plant. This method of operation results in a network of roads connecting individual mine sites with the processing plant.

Aircraft. Aircraft would be required to supply the mine site regularly during the construction period. A 1500 m (5000 ft) airstrip capable of handling jet aircraft would be required.

Fuel Storage and Handling. Fuel for construction would be barged to Baker Lake in the summer and stockpiled for later transport to the site by winter road. On-site storage would also be required.

Camps. Approximately 200 men would be engaged in site preparation work for a one and a half year period and would be housed in a trailer complex.

Site Preparation. Site preparation would be scheduled for summer and would consist of clearing the site area and constructing building foundations and buildings, the adit collar, accommodations, access roads, and an airstrip. Waste material mined from the adit would be used as fill for road and pad construction. Installation of plant and equipment would continue through the winter.

Tailings ponds are required to retain process mill effluent so that discharge of the effluent will not adversely affect the natural environment. They may be constructed either by excavation of a non-watered area or they may be developed from a small, natural waterbody.

Borrow Areas. Some granular material would be required for preparation of mine and mill facilities. If extensive roads are built, large quantities would be required. Airstrip preparation may also require considerable volumes, but no estimates of total requirements are available. While borrow sources have not been identified, nearby eskers may be a logical source.

Facility Construction. Construction of the facility would require about one and a half years. The basic mining and milling compound would be about 10 ha (25 acres) in size and contain the mine entrance, crusher and concentrator building, storage area, miners' change house, compressor house, machine shops, warehouse, office, and ore storage, loading, and shipping facilities.

Mine and Mill Operation

A uranium mining and milling operation in the Baker Lake area is likely to process 910 tonnes (1000 tons) of uranium ore per day. The milling process is designed to recover uranium from the ore in concentrations suitable for shipping. Producing uranium mines in Canada typically mine ores containing 0.4 to 0.6 percent U_3O_8. There are a number of uranium-bearing minerals, including oxides, titanates, and silicates of uranium. Recovery processes vary somewhat, depending on the particular ore.

Presence of Facility. The basic mine and mill compound is about 10 ha (25 acres) in size, and would contain the mine entrance, mill (crusher and concentrator), compressor house, machine shops, warehouse, office, and storage, loading, and shipping facilities.

Before the ore can be chemically processed in the mill, it must be crushed to a suitable size. Crushers reduce the ore to a fine consistency, generating considerable dust. Fans draw this dust-laden air out of the building and exhaust it outside, although filters may be used to trap dust particles in the exhaust before it passes out of the building. A certain amount of noise will be associated with the processing facilities.

The crushed ore then passes through a series of chemical and mechanical processes to recover the uranium. While the exact processes are tailored to each specific ore, reagents used in a typical acid-leach process include the following: sulphuric acid for leaching, sodium chlorate or chlorite as an oxidizing agent, lime as a neutralizer, sodium hydroxide or magnesia as a precipitator, salt for ion exchange, and other reagents in small amounts.

A mill processing 910 tonnes (1000 tons) of ore per day might use 14,500 tonnes (16,000 tons) of chemicals annually, including sulphur for acid making.

Communications will be established through an on-site satellite earth station.

<u>Camps.</u> A total of 250 to 300 men may be employed in a mine-mill operation processing 910 tonnes (1000 tons) of ore per day. It is anticipated that the camp would be included within the mine and mill compound.

<u>Winter Roads.</u> Materials and fuel stockpiled at Baker Lake may be transported over winter roads to the mine site.

<u>Permanent Roads.</u> Permanent roads would be used to transport ore between scattered mining facilities and the mill if the mining operation required development in that manner. If a permanent road joined the Baker Lake staging area and a mine, materials and fuel would be transported on it.

<u>Aircraft.</u> Jet aircraft (Boeing 737 or equivalent) would be scheduled weekly to rotate crews, transport supplies, and transport the concentrated ore or "yellowcake" to Baker Lake or elsewhere.

Fuel and Chemical Storage and Handling. Fuel would be required for power generation at the mine and mill site and to operate mining equipment. A 5000 kW generator on site consumes about 9 million litres (2 million gal) of fuel yearly, while equipment may consume an additional 4.5 million litres (1 million gal) yearly. Storage facilities would be required for these amounts of fuel. Storage facilities would also be required for the considerable quantities of chemicals and sulphur used in the milling and refining processes.

Acid Plant. Large quantities of sulphuric acid are used in uranium recovery. As an example, processing 910 tonnes (1000 tons) of ore per day using 5 kg of acid per tonne (10 lb per ton) would require 45 tonnes (50 tons) of acid per day (assuming no acid reclamation). Rather than stockpile such large quantities of acid, many operations manufacture acid from sulphur in a contact acid plant. Emissions from this process include heat, which is sometimes used to heat buildings and produce steam, and sulphur dioxide. Emission control devices are required if sulphur dioxide is to be prevented from escaping to the atmosphere. A stockpile of sulphur would be required if an acid plant were used.

Water Supply. Ore processing for the proposed mill operation may require approximately 2300 litres (500 gal) of water per minute. Some of this may be drawn from the tailings pond as clarified effluent with the remainder being fresh water. Depending on the location of the mine, mill, and camp relative to the source of fresh water, an aboveground pipeline may be required to bring the water to the facility compound.

Tailings and Wastes. The pH of tailings from typical plants is raised, usually to a range of 8 to 10, before discharge to a tailings pond by using slaked lime and ground limestone. A high alkalinity is necessary to precipitate heavy metals from the tailings. The tailings liquids normally contain high concentrations of dissolved minerals.

Clarification of tailings effluents is obtained by passing them through one or more secondary ponds for settlement. Barium chloride, added as the effluent is passed to the secondary stage, causes radium to precipitate in the secondary pond. Many operations discharge secondarily-treated effluents to nearby surface waters, although some of the treated effluents may be re-used in the mill.

Tailings ponds vary in size depending on the amount of tailings discharged per day and the total amount of solids the pond must eventually contain. A typical, long-term operation may require a pond 240 ha (600 acres) or more in size. Seepage of tailings effluents may be a problem if pond dikes are permeable. Many operations rely on ore slimes discharged into the pond to seal dikes.

It is anticipated that sewage will be discharged into tailings ponds. Combustible garbage will be burned and non-combustible garbage will be buried or flown out of the mine site.

POLAR GAS PROJECT DESCRIPTION

The proposed Polar Gas pipeline will carry natural gas from the Arctic Islands south about 3700 km (2300 mi) to connect with the existing TransCanada Pipelines transmission system. The gas will be chilled through areas of continuous permafrost. The route of the 107-cm (42-inch) diameter, fully-buried pipeline crosses the Baker Lake study area in a north-south direction, passing just west of the Baker Lake hamlet. (Location of the proposed route is shown on Map 13.)

Design and Planning

Logistics. Construction of a gas pipeline down the west side of Hudson Bay presents problems in logistics and construction planning. Limited access to the proposed route and a short marine shipping season complicate movement of materials and construction scheduling.

Virtually all materials, equipment, and fuel required for construction of 930 km (580 miles) of pipeline in the Baker Lake region will be transported to a staging point on Baker Lake. The Hudson Bay shipping season for unstrengthened vessels is about three months, although use of vessels with ice-breaking capability would extend it somewhat. The navigation season for Baker Lake is about the same as for Hudson Bay.

Chesterfield Inlet provides some restrictions on vessel draught (Regina Narrows is 7 m (23 ft) deep) and presents numerous hazards to shipping. For this reason, Polar Gas has elected to construct central transfer facilities at the settlement of Chesterfield Inlet where large ocean-going ships and barges will offload their cargoes for later transport by barge through Chesterfield Inlet to Baker Lake. At present, neither Chesterfield Inlet nor Baker Lake has a suitable wharf, and incoming ships must anchor offshore and lighter freight ashore. Construction of wharves will be required, with start of wharf construction preceding arrival of freight by at least one and possibly two years.

Polar Gas will construct barge offloading and staging facilities at the western end of Baker Lake to receive and store materials barged from the Chesterfield Inlet central transfer point. A permanent gravel road will be constructed from the stockpile site to the pipeline right-of-way for year-round movement of materials. Access along the pipeline right-of-way will also be by permanent gravel road.

The northern Hudson Bay region in which the study area is located will receive most of the required pipe, fuel, and other material (estimated at 595,000 tonnes (655,000 tons)) in the second, third, and fourth years of construction. In addition, large amounts of equipment will be required in all five years in which construction is scheduled.

Schedule. The proposed construction schedule has been formulated around prevailing climatic conditions for each construction spread. During the coldest time of year, Polar Gas proposes to cease construction, resuming with the return of warmer weather. For the Baker Lake area, operations will be suspended from mid-November until the end of March. There are three sections of two construction spreads located within the study area.

Most pipeline project activities will be conducted during the June to September period, although timing of given project activities will vary somewhat within different spread sections. Right-of-way grading and work pad preparation are the only activities scheduled for before (April and May) and after (October and November) the main construction season. The Kazan River crossing will be built between June and October, while work on the Thelon crossing is scheduled for July to November.

The potential impact matrix (Fig. 7.1) provides a break-down of activities comprising construction and operation of the proposed Polar Gas pipeline. Each of these activities is briefly discussed in the following section.

Preconstruction Surveys

Various surveys will precede construction of support facilities and the pipeline in order that information for final design may be obtained.

Camps. Camps housing preconstruction crews will vary in size depending on intensity of work. Crews of 10 to 50 men involved in location surveys and exploratory drilling will be housed in portable camps to allow them to move along the right-of-way.

Aircraft. Aircraft, particularly helicopters, will be used extensively by survey and exploration crews to transport men and supplies. At least one helicopter will be based in each camp.

Fuel Storage and Handling. The limited fuel required for surveys and drilling activities will generally be transported in small quantities in drums.

Survey Activities. In the study area, absence of the need to prepare a cut line may speed survey activities, but location of the survey line on the ground can be a problem. Monuments or tripods will have to be constructed at survey points to allow location of survey lines. Such markers must be of sturdy construction to withstand weather extremes. As no right-of-way definition is required for clearing, surveys will only be run to establish the pipeline centre line and ascertain terrain features.

Surveys will also be required to determine location and site layout of the following facilities: access roads, stockpile sites, camps, sewer and water systems, and buildings. Surveys to determine the location of boreholes for subsurface investigations will also be required.

Subsurface investigations are necessary to determine soil type and ice content for design of buildings and the pipeline, and to determine available quantities and grades of potential borrow material.

Where bedrock is near the surface and ample supplies of granular material are available, exploratory drilling may be minimal. Areas of deep overburden with high ice content and scarce borrow material, however, will require more extensive drilling.

Support Facilities Construction

Pipeline construction will be preceded by construction of support facilities, including storage areas, warehouses, wharves, fuel tanks, airstrips, roads, and main construction camps and offices.

Camps. Camps housing support facilities construction crews will be considerably larger than those for preconstruction crews. Housing 100 to 600 men, these camps will generally remain in place for at least one. Some, such as the one required for wharf construction at the Baker Lake staging site, will remain in place until the pipeline is completed. That camp will house 600 men during facilities construction and 250 during receipt of pipeline materials.

Borrow operations and road construction crews will be housed in camps of up to 100 men. Generally two such camps will be located in each spread section. These camps will be in operation one year before pipelaying begins in a spread section, and move to the next spread section the following year.

Fuel Storage and Handling. Fuel requirements for support facilities construction will be greatly increased over those for pre-construction. Storage facilities for much larger amounts of fuel (up to 9 million litres or 2 million gallons) will be constructed at the Baker Lake staging site.

Barging and Staging. Materials will be barged from the central transfer point on Chesterfield Inlet to the western end of Baker Lake. There is a possibility that icebreakers will be used to lengthen the shipping season. A storage yard, warehouse, and wharves will be constructed at the Baker Lake staging site.

Borrow Areas. Granular material will be required for building access roads, station pads, and airstrips and for manufacturing foundation concrete and pipe weights. While borrow sources have not yet been identified, nearby eskers may be a logical choice. No estimates of borrow requirements are yet available.

Roads and Pads. Virtually all access roads will be constructed of granular material. There will be roads from borrow areas to station sites; from station sites to airstrips, garbage dumps, and sewage lagoons; and from the Baker Lake staging area to the right-of-way and along the right-of-way.

Compressor stations will require construction of built-up gravel pads. Size of these pads is not known at present, although it is anticipated that they may be fairly large and require large amounts of granular material.

Aircraft. Aircraft will be used to transport men and supplies to the sites where support facilities will be constructed. Two airstrips will be constructed within the study area, one at the compressor station site west of Pitz Lake and one at the Baker Lake staging site. Each airstrip will be 1800 m (6000 ft) long, and capable of handling jet aircraft.

Communication Towers. Communication towers will be erected at each compressor station site and at several intermediate sites to facilitate communication during construction and operation. Size of the towers is not presently known.

Pipeline and Station Construction

Borrow Areas. At present, borrow requirements for pipeline construction have not been defined nor have borrow sources. Material from large eskers, common in much of the study area, may be used. Where large amounts of borrow material are required, borrow operations and stockpiling may start well in advance of construction.

Mainline Construction. Mainline construction consists of a variety of separate activities, outlined below.

The work area of the right-of-way will be levelled using a cut and fill method to provide a level surface for movement of equipment. Rock outcrops will be removed by ripping or blasting. The levelled surface will receive a final grading.

Pipe will be transported from stockpiles to the right-of-way where it will be unloaded and strung out alongside the centreline.

In areas where the pipeline is to be ditched and fully buried, the ditch will be excavated to a depth of about 2.1 m (7 ft) and a width of 1.5 to 1.8 m (5 to 6 ft). Ditching methods will vary -- ditching machines will be used in areas of fine-grained soils and backhoes in dense, boulder-strewn soils. Solid rock areas will be blasted, and the broken rock excavated by backhoe. Ice-rich, permafrost soils may be difficult to excavate without blasting.

Where the ditch is excavated in solid rock or where the ditch bottom is irregular, a layer of bedding material will be placed in the bottom of the ditch prior to pipelaying.

After the pipe is bent to conform to the shape of the ditch bottom, it will be aligned and welded together. A cleaning and priming operation followed by coating and wrapping will complete the assembly process and the pipe will be lowered into the ditch by crawler tractors equipped with side booms.

Where the material is suitable, native backfill will generally be used with some select backfill used initially to provide protection for the pipe coating. Where native material is totally unsuitable, select material will be used exclusively. Rockshield will be used where necessary.

Concrete will be required for building foundations and floors, machine bases, and pipeline weights. Ideally, the batch plant would be located close to a borrow source and close to the area where the concrete will be used. Since most of the concrete used will be for casting pipeline weights, the weight-casting area will be located near the batch plant. In addition to granular material, a source of water is required for concrete batching.

Major river crossings are normally installed by specially equipped crews separate from mainline construction, whereas minor river crossings are installed as encountered by mainline crews. In general, both types of crossing involve trenching of the river bed, installation of a weighted pipe, and subsequent backfilling.

Trenching and pipelaying across major rivers may be accomplished by various means depending on the river bottom material and the time of year pipelaying takes place. Crossings installed in summer may be constructed from berms built in the river to provide a working surface for equipment. Dredges may be used for trench excavation where river bottom materials permit. Pipe may be placed in the trench by barge or by pulling from the opposite bank. All river crossings in the study area are scheduled for summer construction. Dual pipe crossings will be constructed on Thelon and Kazan Rivers, with single crossings at all others.

Because the gas will be chilled, an insulating sleeve may be required on underwater pipe sections to limit formation of icings on river bottoms and on lake crossings.

At the conclusion of pipeline construction, construction forces and equipment will be demobilized. As construction crews will be completing the spreads farthest from their original staging points, demobilization routes may not be the same as the original route of entry. It is expected that some demobilization may still occur through Baker Lake.

<u>Testing.</u> Following backfilling, the pipeline will be pressure tested, using air, water, or a water-methanol mixture. Water is often preferred, with heated water or a water-methanol mixture used to prevent freezing where the ground temperature is below $0^{\circ}C$ ($32^{\circ}F$).

The pipeline will be tested in short sections of 16 km (10 mi) or less. The liquid test medium can be recovered to be used again on the next section, although only the water-methanol mixture is normally re-used. Water is normally discharged into the nearest watercourse.

The volume of water required for testing is approximately 900,000 litres per km (320,000 gal per mi) of pipeline.

<u>Compressor Stations.</u> Compressor stations will be constructed at locations which will allow maximum efficiency of the system as a whole. Situated 80 to 100 km (50 to 60 mi) apart, these stations compress and chill the gas using compressors and chilling units fueled by natural gas.

There are three compressor stations proposed within the study area. Only one, west of Pitz Lake, will be constructed prior to system startup, and the others at some time in the future.

Station construction will continue year-round and require supply by aircraft. All-weather access roads will be constructed to transport equipment and fuel to the sites.

Roads and Pads. Polar Gas proposes to construct a gravel access road along the right-of-way. Road crews working in advance of pipeline construction will construct the road required for the next season's pipelaying operations. While road designs are unavailable, a typical 7-m (24-ft) wide gravel road with an average thickness of 0.6 m (2 ft) will require about 5000 m^3 per km (10,500 yd^3 per mi) of gravel.

A permanent bridge across the Thelon River is planned to carry year-round traffic.

Camps. Pipeline construction camps will house up to 900 men and generally be located near the centre of a spread section. Since this location may not coincide with the location of the compressor station in that spread section, a separate 150-man camp could be required for compressor station construction. Two 100-man camps will be required for borrow operations and road building.

Fuel Storage and Handling. Up to 45 million litres (10 million gal) of fuel will be stored at the Baker Lake staging site. Tankage will be required for storage along with wharf facilities for offloading barges.

Aircraft. A total of about 30 aircraft will be in use along the entire pipeline route to transport men, supplies, and food during construction. Gravel airstrips 1800 m (6000 ft) in length will be constructed at each compressor station site and some staging sites for jet aircraft. Airstrips will be equipped with the necessary beacons and lights to permit Instrument Flight Rating (IFR) operations.

Operations and Maintenance

It is assumed that the Polar Gas pipeline system will be operated from a remote control centre.

Ground Traffic and Road. Ground patrols by four-wheel drive vehicles will carry out close inspections on an annual basis. Road designs are not yet available; neither is information on whether this road will be used by non-pipeline-related traffic.

Aircraft. Routine pipeline inspections will be carried out by low-flying aircraft once or twice a month. These inspections will be of both the right-of-way and the compressor stations.

Pipeline. The pipeline will be buried for its entire length, with the possible exception of an overhead crossing of Thelon River.

Compressor Stations. Compressor stations will function automatically without supervisory personnel. A sufficient supply of spare parts, materials, and adequate equipment will be available at compressor station sites and other strategic places to allow for rapid station and pipeline repairs.

Operating compressor stations will generate noise, emissions and heat. Operating noise levels will be in the range of 60 to 70 dbA at the station fence line. Station blowdown noise may be as high as 140 dbA, although silencing may reduce this intensity to about 80 dbA.

Station emissions will include unburned hydrocarbons; oxides of nitrogen, carbon and sulphur; and water vapour.

Heat produced by a number of pieces of equipment in the stations (such as turbines, chilling units, and compressors will probably be exhausted to the air.

APPENDIX B

ENHANCEMENT OF BENEFITS FROM RENEWABLE RESOURCE HARVEST

Study terms of reference, incorporated at the request of local residents, required that we examine means whereby benefits from renewable resource harvest might be enhanced. Inquiries were made of local residents to ascertain more precisely the types of enhancement envisaged.

Relocation of the Rankin Inlet fish cannery to Baker Lake and assistance to trappers were the only means of enhancement identified by local residents and our attention is focussed primarily on these two issues. We do, however, offer suggestions about two other means of enhancement which may merit examination: developing tourist sport fisheries and using caribou hides for manufacturing fine quality leather goods.

ANALYSIS OF FISH CANNERY

Until recently a fish cannery was operated in Rankin Inlet. This section presents an analysis of the potential for a similar project in Baker Lake.

Little information was available regarding marketing experience of the Rankin Inlet cannery. Therefore, while we did consider the limited information that was indicative of the potential for marketing fish products from Baker Lake, this analysis gives greater emphasis to costs of production.

We assume that production would involve the canning of lake trout and whitefish in 7 3/4 oz (220g) cans. We further assume that capital equipment and other methods of production that were employed in the Rankin Inlet cannery would also be employed in a Baker Lake cannery. Initially, our appraisal is made in a private accounting framework, which implies that the project must at least break even in terms of revenues and costs. We also offer a brief appraisal within a public accounting framework.

Production Costs

Table B.1 presents a summary of estimated costs for producting canned fish in Baker Lake. Fixed and variable cost data were compiled in the manner described below.

Fixed Costs

Fixed cost estimates are based on estimates of current replacement costs for a building and machinery similar to that of the Rankin Inlet cannery. In calculating capital costs for this project, we assumed the building and machinery to be fully depreciated after 20 years and 10 years respectively. The average fixed cost per unit of

Table B.1. Projected costs for a Baker Lake fish cannery.

A. Fixed Costs	per annum	Per unit of output 200,000 #	250,000 #
1. building depreciation @ 5% [1] (includes maintenance	$ 4,200	$ 0.021	$ 0.017
2. equipment depreciation @ 10% [1] (includes maintenance and repairs)	14,600	0.073	0.058
3. equipment leasing (capping machines)	7,000	0.035	0.028
4. management and administration	25,000	0.125	0.1
5. annual startup and closedown of plant	5,000	0.025	0.02
Totals	$ 55,800	$ 0.28	$ 0.23

B. Variable Costs	Per unit of output [2]
1. payment to fishermen	$ 0.55
2. transportation (fish camp to plant)	0.13
3. plant labour	0.35
4. packaging materials	0.08
5. other production costs (fuel, ingredients, etc.)	0.05
Total	$ 1.16

[1] See Table B.2 for details.

[2] Assumes that 1 lb. (.45 kg) of fish (round weight) is equivalent to one 7 ¾ oz (220 g) can of product.

product was calculated for two levels of output -- 200,000 and 250,000 cans per annum. These two levels of output reflect the average annual output of the Rankin Inlet cannery (NWT Government, Department of Economic Development files). Because we are not aware of any detailed marketing and production surveys that may have been done, we have assumed that output from a Baker Lake cannery would not be significantly higher than that on the Rankin Inlet cannery. Besides, it is doubtful that fish could be harvested economically in sufficient quantities to expand output significantly beyond the level of 250,000 cans per annum.

Building. The minimum size of building required for a cannery project would be about 2400 square feet (220 square metres). The initial outlay for a building would be about $84,000 assuming construction costs in Baker Lake are approximately $35 per square foot ($380 per square metre) (W. Dilk, Fisheries and Marine Service, personal communication). If this is fully depreciated after 20 years, the annual depreciation allowance (which includes maintenance) would be about $4200 annually (Table B.1).

Equipment and Other Fixed Costs. An itemized list of required equipment is presented in Table B.2 (NWT Government, Department of Economic Development files). The cost of purchased equipment (W. Dilk, personal communication) plus a 10 percent allowance for miscellaneous equipment and

Table B.2. Building and equipment costs for a Baker Lake fish cannery.

A.	Building		$ 84,000
B.	Equipment		
	1.	smoke house	15,000
	2.	steam boiler progress	18,000
	3.	retort	13,000
	4.	labeling machine	6,000
	5.	stainless steel table	5,000
	6.	thawing table	2,000
	7.	stainless steel soup kettle	3,000
	8.	air compressor	1,000
	9.	mixer	4,500
	10.	steamer	2,500
	11.	spread filler	7,000
	12.	conveyor belt	4,400
	13.	speed scales	4,500
	14.	can washers	5,500
	15.	skinning machine	3,500
	16.	filleting machine	6,000
	17.	clothes washer	500
	18.	clothes dryer	500
	19.	steamer	300
	20.	stainless steel wheel tub	500
	21.	freezing units	30,000
	22.	miscellaneous	13,000
		TOTAL	$ 230,000

contingencies totals about $146,000. If this equipment is fully depreciated after 10 years, the annual depreciation (and maintenance) allowance is about $14,600. Equipment leasing and management costs about $7000 and $25,000 each year. A conservative estimate for plant startup and closedown cost is about $5000 (Table B.1).

Variable Costs

Payment to fishermen. It has been indicated to us that payments to fishermen would be approximately $0.35/lb ($0.75/kg) round weight, if the government supplied all equipment, or $0.55/lb ($1.20/kg) round weight, if the fishermen supplied their own equipment (G. LeGal, personal communication). Since this analysis attempts to account for all costs of production, the latter figure, $0.55/lb, is the appropriate choice here.

Transportation. The freight rate for a Twin Otter aircraft is currently $2.40/mi ($1.50/km) (Lambair, personal communication). If we assume an average load of 2800 lbs (1300 kg) and an average round trip distance of 150 mi (95 km) between Baker Lake and potential outlying fish camps, average transportation costs would be about $0.13/lb ($0.29/kg) round weight.

The above estimates of costs for payments to fishermen and transportation total $0.68/lb ($1.05/kg) round weight. Since 1 lb (454 g) round weight yields about one

7 3/4 oz (220 g) can of product (NWT Government, personal communication), the cost of obtaining fish would be about $0.68 per can.

Other Variable Costs. The costs for plant labour, packaging materials, and other production costs listed in Table B.1 were determined from finanacial statements provided by the Department of Economic Development, NWT Government.

Economic Appraisal. We can calculate from Table B.1 that production costs for a 7 3/4 oz (220 g) can of fish would be in the order of $1.39 if total output is 250,000 cans, or $1.44 if total output is 2000,000 cans.

These estimates are given f.o.b. Baker Lake. Other costs which would be added in order to determine the price to the final consumer are transportation to southern Canada and wholesale and retail markups.

Having established rough estimates of production costs for canned fish products from Baker Lake, marketing is examined to determine the attractiveness of such a project for private investment.

The limited information that is available suggests that attempts to market canned fish from Rankin Inlet were not particularly successful. After 3 years of steady decline, the price paid by a Vancouver wholesaler for a 7 3/4 oz can f.o.b. Rankin Inlet, reached a bottom of $0.78 per can in 1977 (A. Normand, International Importers Limited, Vancouver, personal communication). If a Baker Lake cannery were to sell all that it produced at this price, there would be a substantial deficit incurred by the operation.

Recalling our earlier estimates of production costs ranging from $1.39 to $1.44 per unit, we can estimate the deficit incurred (or the subsidy which would be necessary) per can. This would be approximately $0.61 to $0.66 per 7 3/4 oz can. The total deficit or necessary subsidy would range from approximately $132,000 to $152,500 per annum.

Further, if transportation costs to a southern market average $0.05 per unit, and a 15 percent markup is applied at both the wholesale and retail levels, the final price to consumers could range from $1.90 to $1.97. This does not compare favourably with a substitute such as tinned salmon which has a current price range from $1.00 to $1.40 for a 7 3/4 oz can.

Discussion

At the outset we stated that our choice of accounting methods was that of a private accounting stance. In such a case, only those monetary costs incurred by the business and those monetary benefits received are valid criteria to apply when evaluating a project. It is evident from the preceding analysis that a fish cannery at Baker Lake would not attract investment funds using these criteria.

While the choice of a public accounting framework would not alter our opinion of this project, we note that such a framework would permit one to estimate the true opportunity costs for inputs from a public point of view. One could adjust labour costs to reflect the high unemployment in the region, for example. In other words, it could be deemed socially desireable to subsidize labour costs if the region experiences chronic unemployment. In such a case, the total wage bill would be of lesser importance. Rather, the opportunity cost, or the income foregone by labour (including other wage income, transfer payments, or imputed income) in order to work on a public project, would become the relevant cost for inputs.

This issue has more than an academic interest since the choice of accounting framework can ultimately determine two different, but correct, solutions to the same problem. We emphasize the differences between these two accounting methods here because the extent of government involvement in the Rankin Inlet cannery suggests that the correct accounting system should be from a public, rather than private, perspective.

We suggest that in an analysis of a Baker Lake fish cannery, the costs for fishing effort and plant labour are the single most important items which should be adjusted to reflect true (or "social") opportunity cost. The prices of other inputs are determined in fairly well structured markets, and hence discrepancies between private and social costs would be far less significant. A fair adjustment factor for the costs of fishing effort and plant labour might be in the order of 50 percent of the payments, although a more precise estimate could only be determined after substantial study. If 50 percent is assumed to be reasonably accurate, payments to fishermen (exclusive of equipment costs) and the plant labour component of our cost estimate would be reduced by about $0.45 per unit of output. This would reduce the social opportunity cost of production to a range from about $0.94 to $0.99. These social opportunity costs still exceed the perceived market value of the product ($0.78).

The above estimates do not augur well for a fish cannery at Baker Lake. It is readily apparent that a 50 percent subsidy to plant labour's and fishermen's share of production costs would not reduce production costs enough to yield a positive benefit. This further suggests that the production costs are far more heavily weighted toward factors which are imported from other regions, such as some transportation, capital, wholesale, and retail services -- hardly what one would expect of a project intended to stimulate northern development.

Conclusion

On the basis of the information available we conclude that a fish cannery at Baker Lake (or at Rankin Inlet) would be an ineffient allocation of public funds, insofar as the expenditure is intended to stimulate economic development of this area. We suggest that a more worthwhile project should be much more intensive in local, rather than imported, factors of production.

ANALYSIS OF SPORT FISHERY POTENTIAL

One alternative to a fish cannery could be to encourage development of a tourist sport fishery. Such an endeavour would offer the advantages of being intensive in the use of local resources while at the same time requiring little in the way of heavy capital investment (at least compared to a fish cannery). There are indications that recreational fishing could be developed, as evidenced by the fact that more than 10,000 angling licenses were sold in the NWT during 1974-75, and about 60 percent of these were sold to non-residents.

Given that Baker Lake presently has a well equipped, locally-owned hotel, a potential base of operations exists. Outcamp fishing, using tent camps, could be organized at relatively small cost. Given that many older local residents do not possess a working knowledge of English, guiding and service opportunities associated with a tourist sport fishery would of necessity fall to younger members of the community. We note that access to char fishing is possible from Baker Lake. This constitutes a noteworthy marketing advantage as few outfitters are in a position to provide access to char fishing opportunities.

TRAPPER ASSISTANCE PROGRAMS

Several programs recently initiated by the NWT Government could prove beneficial to Baker Lake trappers.

Outpost Camp Program

The Outpost Camp Program provides an incentive to those who wish to live on the land for part or all of the year. Anyone entitled to hold a General Hunting License qualifies for assistance under this program. The assistance available can include funding for transportation of residents and supplies to an outpost camp at the beginning of a hunting or trapping season, and return to the community at the end of the season. Materials for a one-room cabin are made available and heating fuel is provided. Loans can be obtained for buying supplies. In addition, a first aid kit and a transceiver radio may be made available. A Fish and Wildlife Officer and nurse make periodic visits to outpost camps.

Trappers' Assistance Loans

Another program undertaken by the NWT Government is one which provides trappers' assistance loans. These are interest-free loans, negotiated through the Fish and Wildlife

Officer, to a maximum of $700. Loans are repayable within 12 months with provision being made for uncontrollable circumstances.

Trappers' Incentive Grants

A third incentive to trappers takes the form of a grant which is based on a percentage of the previous years trapping income to a maximum limit of $3000. The minimum requirement for application is that trapping income must have been greater than $600 during the previous year. The current subsidy rate is 15 percent which would give a maximum of $450 per trapper. Since fur sales can be shared among family members and partners, however, it is possible that more than the $450 maximum might be obtained by an individual trapper. Outstanding trapper's loans, as well as overpayments from the Fur Marketing Service (described below), are deducted from the subsidy.

Fur Marketing Service

The Fur Marketing Service was established by the NWT Government to enable trappers to obtain a greater return from fur sales than could be obtained from traditional outlets. Currently, the two major purchasers of furs in the NWT are the Fur Marketing Service (FMS) and the Hudson's Bay Company (HBC). To a lesser extent trappers sell to independent fur buyers, or send their furs directly to southern fur auctions.

In the NWT Fur Marketing Service, a Fish and Wildlife Officer can issue immediate payment of up to 75 percent of his estimated value of a trapper's pelts to a maximum payment of $1000. The pelts are then sent to auction which claims 7 percent of total value after sale. The remainder (93 percent of auction value) is remitted to the NWT Government. The trapper is then paid the balance owing him. Should the initial advance exceed the auction value, the trapper must reimburse the NWT Government. Overpayments made by the Fur Marketing Service are deducted from trappers' incentive grants to be received the following year.

The distinct advantage of the Fur Marketing Service is that it generally offers a higher return to trappers for their pelts. Average prices for arctic fox pelts in Baker Lake during 1976-77 were $27.99 from the HBC, $28.79 from independent fur buyers, and $49.38 from the FMS. Despite the higher return possible through the FMS, about 90 percent of the furs sold by Baker Lake trappers in 1976-1977 were sold to the HBC (NWT Fish and Wildlife Service fur records).

Several reasons have been offered to explain why the FMS is being underutilized:

a) While the HBC offers full (but less) payment immediately, the FMS can only offer up to 75 percent of the estimated pelt value, to a maximum of $1000 per trapper. The remainder is paid out after the fur auction, a process which can take up to two months, given current fur auction schedules. Some trappers feel that this is too long to wait for full payment.

b) The HBC is more convenient than the FMS since the Fish and Wildlife Officer may not be on hand when a trapper wishes to sell furs. The FMS apparently also discourages the sale of less than six pelts at any one time whereas the HBC will accept any quantity.

c) The NWT Government established the FMS as an alternate to the HBC and use of the service within a community may depend to a considerable extent on local promotion and other local variables.

d) Many trappers apparently do not realize the difference in prices offered by FMS and HBC. Several trappers we interviewed in Baker Lake were under the impression that the HBC offered a better price for their pelts.

e) Other reasons which are more difficult to deal with include a feeling of tradition associated with selling furs to the HBC and obligation to the HBC for offering credit for pre-season trapping preparations (E. Land, personal communication; study interviews).

Conclusion

It is our overall assessment that programs already in place to assist trappers are adequate. The fact that trappers have not availed themselves of these programs perhaps reflects on the effectiveness of communications with them and the manner in which they are implemented.

CARIBOU HIDES FOR QUALITY LEATHER GOODS

Converting hides into fine quality leather goods is the only opportunity we envisage for potential enhancement of the already substantial benefits Baker Lake residents derive from caribou harvest. The concept is only outlined briefly here, time constraints having rendered a thorough analysis impossible.

Basically, we envisage purchase of warble-free side panels of hides from local hunters. These would be received and stored in Baker Lake until such time as there were enough on hand to justify shipping them south to be tanned into quality leathers. The tanned leathers could then be shipped back to Baker Lake for manufacture of handcrafted leather goods. We do not advocate establishing local tanning facilities for the following reasons: a tannery would generate little employment while requiring considerable capital investment; it would be difficult to achieve the quality control and standards required if the final product is to command a premium price (we are informed that very few established tanners in North America can achieve the desired quality standards); and disposal of effluent from the process could cause environmental problems.

The merits of the concept are four-fold: it affords a market for a by-product of the caribou harvest; capital requirements for establishing a facility to manufacture quality handcrafted leather goods are relatively small; quality leather goods can be shipped at a relatively economical cost; and the product has a high market value relative to size and weight.

Potential problems to be overcome include storage and handling of raw hides from warm weather harvest, transport costs for shipping raw hides to southern tanners and shipping tanned hides back to Baker Lake, finding experienced persons who could impart the necessary skills to local residents, and establishing markets. Further, the concept assumes that there is currently a surplus of suitable quality hides which could be offered for sale without increasing current caribou harvest and reducing availability of hides for local use.