062150

LSL LIMITED

environmental research associates • SUITE 333, 2453 BEACON AVENUE, SIDNEY, B.C. V8L 1X7
TELEPHONE (604) 656-0127
TELEX 049-7285

1 April 1981

Dr. W.J. Stephen
Environmental Coordinator
Pan Ocean Oil Ltd.
300 - 5th Avenue S.W.
Calgary, Alberta
T2P 3C4

Dear Bill,

Please find enclosed one copy of the final Bonnet Plume report, minus the plates. Since these plates form an integral portion of the vegetation analyses, I think it is best if they are presented in the text rather than in the map folio. I have therefore left a space for their eventual inclusion between pages 5 and 9. When the plates are available, we will bind three final copies of the report and submit them to you.

Best regards,

Jean Birdsall

for Dr. J.A. Taylor
Senior Limnologist

JAT/ew
Encl.

Received
Feb. 17, 1982.

AN OVERVIEW STUDY OF THE VEGETATION, WILDLIFE AND FISH RESOURCES OF THE BONNET PLUME LEASE, NORTHEASTERN YUKON TERRITORY

BY

LGL Limited
environmental research associates
Sidney, British Columbia

FOR

Pan Ocean Oil Ltd.
Calgary, Alberta

April 1981

ACKNOWLEDGEMENTS

The vegetation study was conducted by Dr. R. Brooke of Simon Fraser University. W. Griffiths of LGL Limited was instrumental in designing the fisheries program and directed the field program. Assistance in the field was provided by V. Buchwald (vegetation), S. Johnson (wildlife) and G. Kruzynski (fisheries).

We are grateful to the following members of the Yukon Game Branch for their cooperation and assistance: R. Archibald, R. Farnell, R. Hayes, M. Hoefs, D. Mossop and D. Russell. Thanks are also due to G. Zealand of Fisheries and Oceans.

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J. Kelsall reviewed and wrote portions of the wildlife section of the report. We are grateful to him and to the following members of LGL Limited who supplied technical and/or professional expertise to this study: K. Bruce, V. Buchwald, S. Fancy, W. Griffiths, S. Johnson, G. Kruzynski, J. Kruzynski, A. Sekerak, N. Stallard, L. White and J. Wright.

Weller Polygraph Consultants Ltd. drafted the figures which were printed by Superior Reproductions and Printing.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

1. INTRODUCTION

Pan Ocean Oil Ltd. is presently assessing the feasibility of developing a coal mine for production of power and for export of coal in the Wind River region of northeastern Yukon Territory (see Fig. 1*). Specific development plans have not been completed. Presently, an underground coal mine, ~ 200 megawatt capacity thermal power plant, transmission line, access road, and coal slurry pipeline are being considered; specific locations for the facilities have not been chosen. To date, only exploratory drilling from a camp at Kiwi Lake has been carried out on the lease area. No other industrial developments are located within the lease area.

In order to assess the feasibility of developing a coal mine and associated facilities and to predict the general types of impacts that are likely to occur if a mine development takes place, a Stage I overview study was commissioned with the following objectives.

a. Review the existing relevant biological information pertaining to the Bonnet Plume study area.

b. Supplement this information where necessary with overview field studies in order to provide a general description of the existing fish and wildlife resources and their use by humans.

c. Identify information gaps that remain after this study which will impair impact assessment.

d. Identify impacts on fish and wildlife resources that are likely to result from construction, operation, maintenance, and abandonment of a coal mine, thermal power plant, and ancillary facilities.

e. Recommend appropriate monitoring studies of fish and wildlife.

After discussion with Pan Ocean Oil Ltd., it was decided that Objective e, to develop a monitoring program, could be better accomplished after Stage II studies are complete. Similarly, because specific development plans are not yet available and present plans call for an underground mine, any recommendations for habitat rehabilitation were deemed to be premature. Therefore, no measures for habitat rehabilitation are included in this report.

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* Oversized figures have been placed in a map folio at the end of this report. Figures that appear in the map folio are indicated by an asterisk following the figure number (e.g., Fig. 9*).

2. STUDY AREA

The Bonnet Plume lease of Pan Ocean Oil Ltd. covers approximately 3960 km^2 in the northern Yukon Territory (Fig. 1*). The lease lies west of the Knorr Range and north of the Wernecke Mountains. It includes portions of the Wind and Bonnet Plume Rivers; both are major tributaries of the Peel River which bisects the northern portion of the lease.

The lease lies wholly within the Wernecke Mountains and Peel River eco-regions as described by Oswald and Senyk (1977) and the following description is largely based on this source. The lease is bordered on the east and south sides by mountains with peaks up to 1800 m ASL. Additionally, just north of the Wernecke Mountains is a small range of mountains called the Illtyd Range with peaks rising to 1200 m ASL. The region between these mountain ranges is hilly and incised by the Wind and Little Wind Rivers. Most of the remaining portions of the lease are relatively flat and slope from about 800 m ASL in the south to 300 m in the north.

The regional climate is largely influenced by the Arctic Ocean resulting in low winter temperatures and relatively small amounts of precipitation. The vegetation of the area reflects the northern climate; discontinuous permafrost is widespread. Treeline extends to about 750 m. The major vegetation types in the area are tundra and forest tundra. The forest consists largely of black spruce* often mixed with large amounts of larch. White spruce and paper birch are present on drier areas; aspen and balsam poplar are frequently encountered along river valleys. Typical understory consists of mosses and lichens with ericaceous shrubs and sedge tussocks growing on hummocks. Shrub birch and willow communities are common on protected slopes and above treeline. Scree slopes are abundant in the higher mountains.

The rivers and streams flowing through the lease are primarily swift flowing and braided. Hungry Creek, Illtyd Creek and the Little Wind River are large tributaries of the Wind River that have their confluences

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*Scientific nomenclature presented in Appendix 1.

within the lease area. Knorr Creek and Noisy Creek contribute their flow to the Bonnet Plume River within the lease.

Numerous small and intermediate-sized lakes are present on the flats south of the Peel River. Many appear to be shallow, thermokarst lakes. Additionally, two large lakes, Chappie and Margaret Lakes are present in the lease area.

3. VEGETATION

3.1 LITERATURE SUMMARY

Few detailed vegetation studies have been published for the north central Yukon. However, general accounts of comparable vegetation include the reports of Hettinger et al. (1973), the Forest Management Institute of the Canadian Forestry Service (1974), and of Kojima (1978). A brief, very general discussion of the characteristics of the area is included in Oswald and Senyk (1977).

3.2 METHODS

To assess the vegetation patterns present in the Bonnet Plume Project area, a map, based on photo-interpretation and limited on-site ground truthing, was prepared. Priority in the preparation of the map was given to the southern portion of the lease.

Prior to on-site ground truthing, preliminary boundaries of vegetation patterns were delineated on mylar overlays from 1968 black and white aerial photographs (A 20673, A 20637, A 20624 series, Canadian Department of Energy, Mines and Resources, taken at 30,000 ft ASL). On-site checking occurred from 16 to 18 August*. During the field work, numerous low level 35 mm color photographs were taken to assist in the ground truthing. Brief descriptions of approximately 100 ground locations were made either from direct ground surveys or more usually by hovering over the vegetation in a helicopter. Most attention was given in these descriptions to tree composition, estimates of tree height and crown coverage of the ground surface, dominant shrub species, most common understory species that could be recognized from the air, and an estimate of moss and lichen coverage of the ground surface. During the field surveys, an attempt was made to sample representatives of the range of habitats outlined in the preliminary overlays.

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* A schedule of field activities is presented in Appendix VI

3.3 RESULTS

A detailed vegetation map of portions of Pan Ocean Oil Ltd.'s lease was prepared. A simplified version of the vegetation map is presented in Plates 1, 2 and 3.

From the field surveys and 35 mm slides, extensive revisions to some of the preliminary patterns were necessary. These revisions and reassessments were due to the difficulty of separating small, moderately dense spruce from more open meadow-like vegetation from high altitude photographs, areas burned since 1968, and changes in the flood-plain since 1968. For these reasons and due to the limited ground checks which could be made, the vegetation patterns and categories mapped must be considered preliminary. Boundaries between the vegetation units are necessarily arbitrary and based on judgment so that normal precautions should be employed in using the vegetation map. The map was not corrected for aerial distortion.

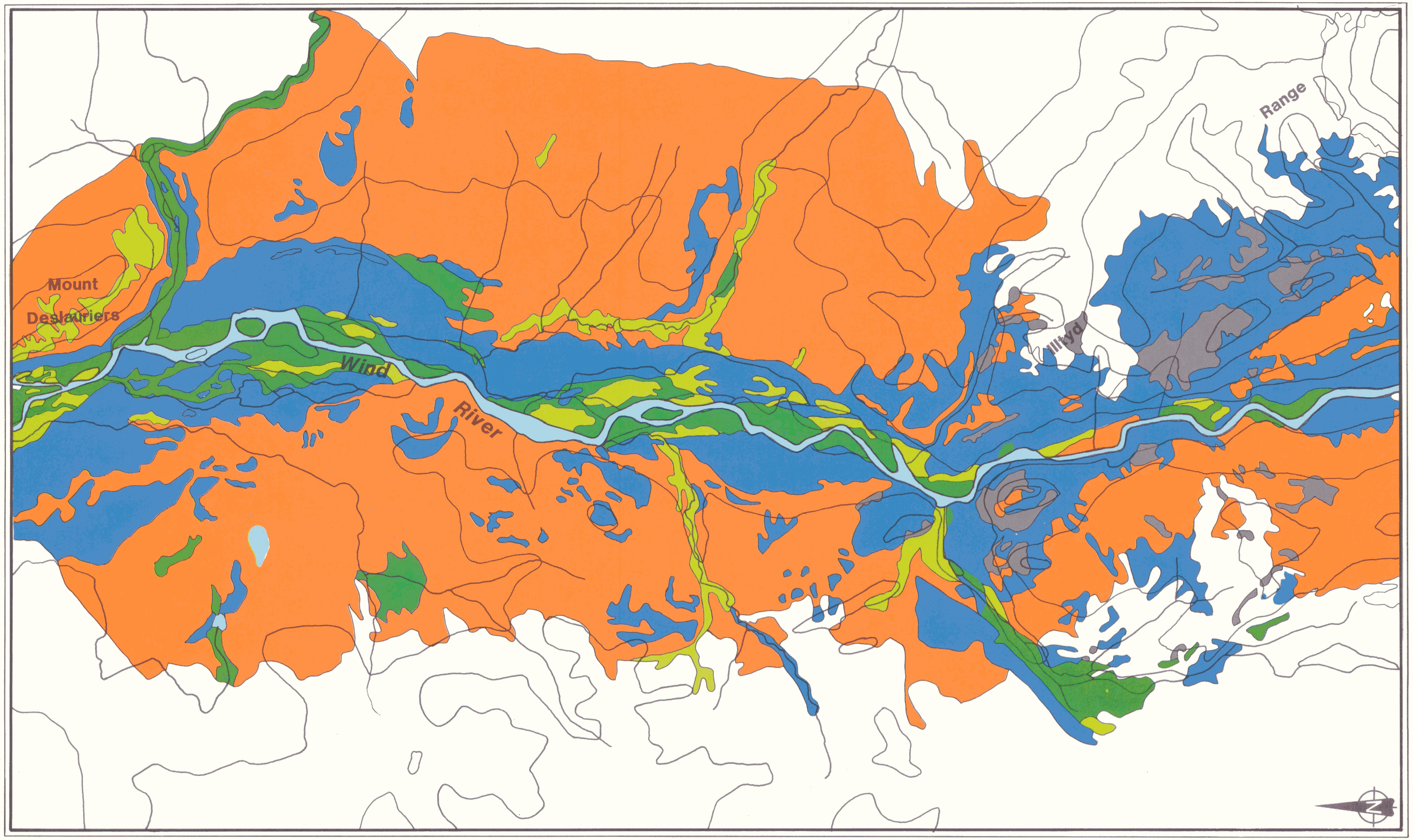
In concept, the vegetation classification and mapping that has resulted from this process is comparable to that developed by the Forest Management Institute, Canadian Forestry Service, for the Mackenzie Corridor. Distinctions between the units mapped are largely physiognomic, compositional and related to habitat differences. Sixteen categories are designated: 7 forest categories, 4 open transitional forest to tundra categories, and 5 non-forest categories. These categories are grouped into five major divisions which are presented in the summary vegetation maps. An outline of these divisions and categories follows.

a. Spruce-dominated forests

1. Spruce forests of alluvial floodplain and/or riparian habitats

   White spruce ranging in height from about 10-20 m is the most common and productive species in these alluvial habitats. Black spruce, larch (usually slightly taller than the spruce) and cottonwood (in wet areas) may be associated with white spruce. Shrubs in the understory are usually sparse and consist of alder and willow. Common smaller shrubs include dwarf birch and shrubby cinquefoil. Feather mosses are common mixed with herbaceous species in the ground cover. Lichens and sphagnum may be present but have low surface cover. These habitats are usually associated with good growth of spruce and may no longer be subjected to flooding.

Plates 1 - 3. Vegetation Maps of the Known Areas of Coal Occurrence, Bonnet Plume Lease.



Vegetation Units*

of

Southern Wind River and Illtyd Creek

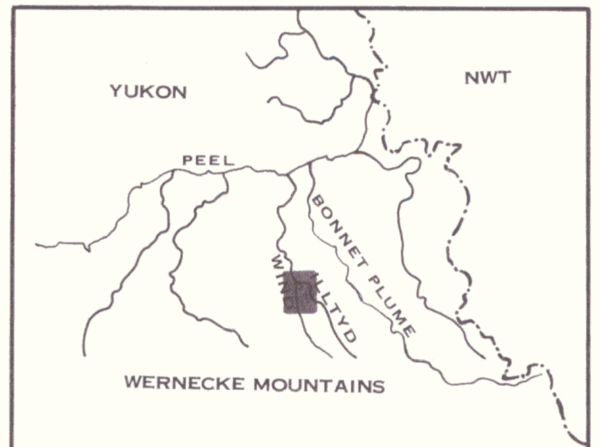
Yukon Territory

Map 1 of 3

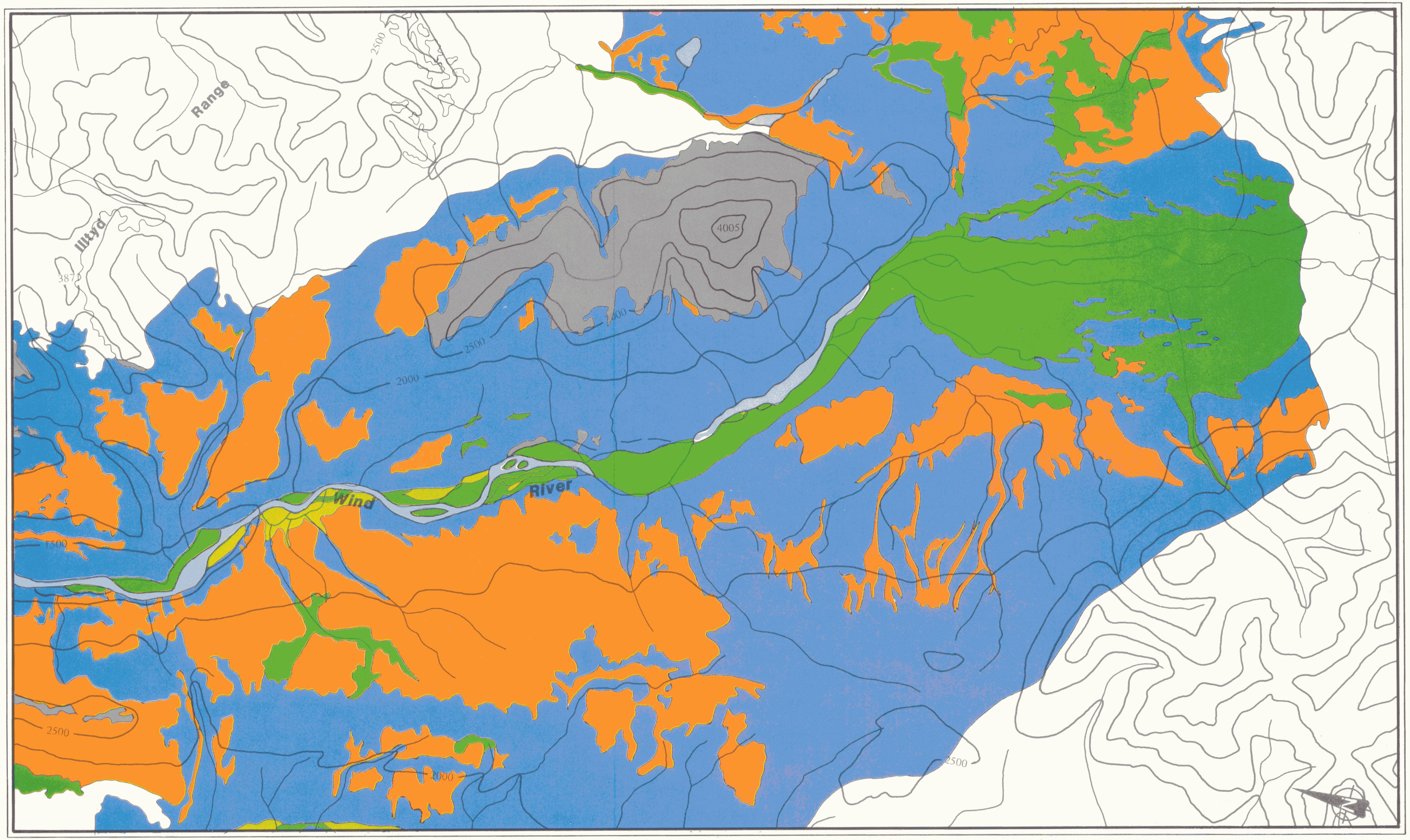
Kilometres · Miles

- Spruce dominated forest (includes vegetation units a1, a2, a3, a4 and transition between a2 and b1)
- Deciduous dominated forests (includes vegetation units a5, a6, a7)
- Muskeg or open forests (includes vegetation units b1, b2, b3, b4, c4 and transition between b1 and c4)
- Riparian vegetation (includes vegetation units c1, c2, c3)
- Montaine vegetation (includes vegetation unit c5, rock barrens and eroded surfaces)

*see text for vegetation units



approximate locations of maps



Vegetation Units*

of

Southern Wind River and Illtyd Creek

Yukon Territory

Map 2 of 3

0 1 2 Kilometres

0 2 Miles

Spruce dominated forest (includes vegetation units a1, a2, a3, a4 and transition between a2 and b1)

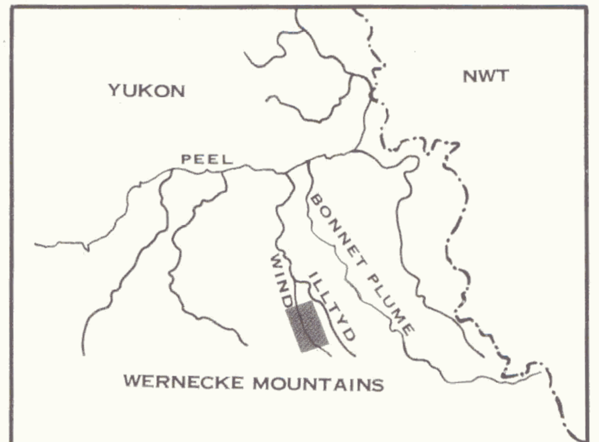
Deciduous dominated forests (includes vegetation units a5, a6, a7)

Muskeg or open forests (includes vegetation units b1, b2, b
b4, c4 and transition between b1 and c4)

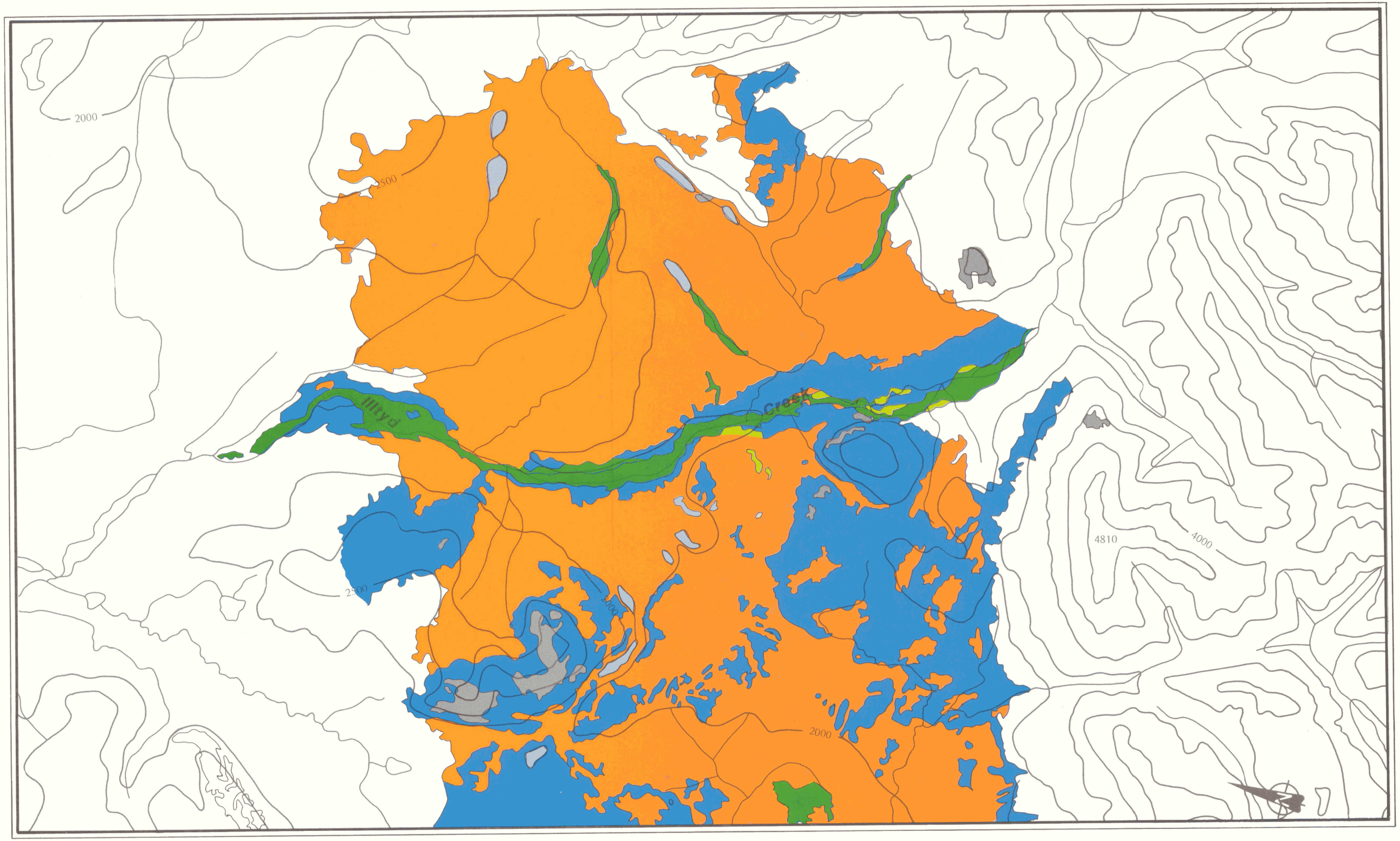
Riparian vegetation (includes vegetation units c1, c2, c3)

Montaine vegetation (includes vegetation unit c5, rock barrens and eroded surfaces)

*see text for vegetation units



approximate locations of maps



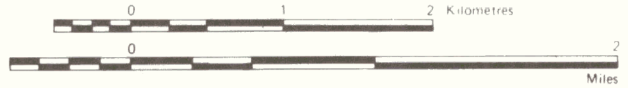
Vegetation Units*

of

Southern Wind River and Illtyd Creek

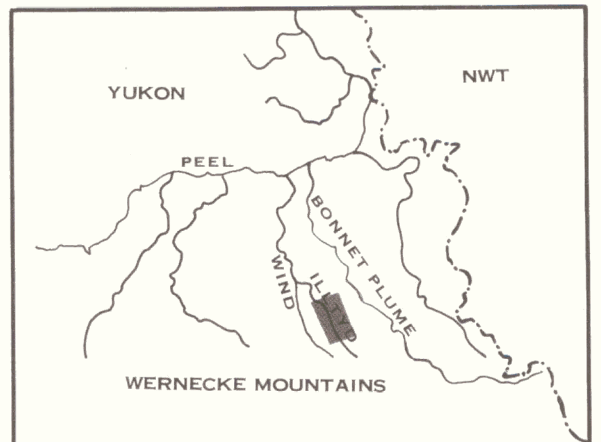
Yukon Territory

Map 3 of 3



- Spruce dominated forest (includes vegetation units a1, a2, a3, a4 and transition between a2 and b1)
- Deciduous dominated forests (includes vegetation units a5, a6, a7)
- Muskeg or open forests (includes vegetation units b1, b2, b b4, c4 and transition between b1 and c4)
- Riparian vegetation (includes vegetation units c1, c2, c3)
- Montaine vegetation (includes vegetation unit c5, rock barrens and eroded surfaces)

*see text for vegetation units



approximate locations of maps

2. Upland spruce forests of terraces above flood level or gentle slopes in the lowlands

   These forests may be largely white or black spruce or mixtures of the two; scattered larch represents up to about 20% of the tree cover. Trees range in height from about 3-10 m. Most common understory species include alder, dwarf birch, labrador tea, cinquefoil, blueberry, alpine bearberry. The habitats may be moderately to poorly drained. Lichens may be moderately abundant in the ground layer but are not dominant.

3. Spruce forests of moderately sloping to steep mountain slopes

   These forests are usually much more open and better drained than those in the previous category. A moderate to sparse shrub cover may be associated with this unit and may include dwarf birch and alder. Tree heights range from about 3-10 m. Ground cover may be dominated by herbaceous plants. This unit borders the subalpine/alpine, rock and barren areas.

4. Spruce and mixed forests of ravine and river banks

   These habitats support some of the densest and most productive forests in the area. White spruce is the most common conifer and may be 10-15 m tall, in some areas it is mixed with black spruce. Paper birch is the most common deciduous species with the occasional aspen or cottonwood. Deciduous dominated patches are usually small and isolated. Alder may occupy about 60 to 80% of the shrub cover in some areas and is the main tall shrub species. Lichens are essentially absent from the ground cover. Mosses and herbaceous species including coltsfoot dominate the ground cover. Many of these habitats are steep and unstable.

b. Deciduous-dominated forests

1. Deciduous dominated forests of warm exposures

   Paper birch and aspen dominate the tree cover of these moderately steep habitats. This vegetation unit was best developed on the slopes of Mt. Deslauriers and on a small promontory near the junction of Prongs Creek and the Wind River. Scattered spruce may occur with the deciduous species. Juniper, soapberry, bearberry, dwarf birch and alder may also be found.

2. Mixed deciduous/spruce forests of riparian habitats

Cottonwood and white spruce are the main tree species in the forest canopy. The shrub cover is variable in density and composition and includes soapberry, rose, cinquefoil, juniper, as well as alder and willow. Herbaceous species present include louseworts, *Anemone* sp., asters, comandra, orchids and graminoids. The habitats may still be subjected to periodic flooding.

3. Deciduous cover of riparian habitats

Although scattered spruce may be present, cottonwood ranging in height from about 3-10 m is the dominant tree with a moderately dense to dense cover of willow up to 3-5 m tall. These habitats are still frequently flooded and have a fairly rich ground cover that includes: avens, cinquefoil, alder, soapberry, rose, juniper, *Parnassia*, comandra, horsetail, lupine, and liquorice-root.

c. Muskeg or open forests

1. Spruce-sphagnum or spruce-sedge tussock vegetation

This vegetation unit is the most common throughout the area and is often described as a bog forest or muskeg type. Habitats are usually poorly drained where sphagnum mosses predominate and the trees are usually small and stunted. Black spruce and larch are the most common conifers present in this vegetation type, but white spruce may also occur. In some cases, larch may represent up to about 30% of the conifer cover. The shrub cover may be quite dense and usually includes dwarf birch, labrador tea, willow, lingenberry, blueberry, some cinquefoil and occasionally alder. Other species associated with the sphagnum in the ground cover include cloudberry, cranberry, coltsfoot, and alpine bearberry. In some areas, sedges dominate the ground cover giving the habitat an almost meadow-like appearance. Lichens in the ground layer may be sparse to about a 30-40% cover, but are rarely dominant in these habitats. Epiphytic lichens, however, may be abundant in the tree canopy.

2. Spruce-lichen or spruce-dwarf birch vegetation

This vegetation unit is usually associated with rock outcrops or areas with shallow and well-drained soils. Black spruce is the most common conifer although white spruce may also occur. Because of the absence of a dense low shrub cover, lichens are dominant in the ground layer and may occupy 60-70% or more of the surface. In some areas, however, shrubs dominate the surface cover. Prominent shrub species include dwarf birch, labrador tea, blueberry, lingenberry, and crowberry. The main lichen genera are *Cladonia* sp., *Cetraria* sp. and *Stereocaulon* sp.

3. Undifferentiated vegetation complexes of former burned areas

This vegetation type is encountered east of Illtyd creek. Trees killed by the fire are often still standing; dwarf birch and an occasional willow are the most common components of the shrub layer. Scattered alder may also be present. Areas mapped as this unit likely were represented by types b1 and b2 (above) previous to burning.

4. Drainage runnels supporting undifferentiated vegetation complexes

In some parts of the development areas, drainage runnels are prominent. This unit includes a wide range of vegetation forming a heterogeneous group. Dominant vegetation may range from willow and alder thickets, mixed forests, to forests dominated by spruces and/or larches. Shrub cover may form a dense canopy under the moderately dense to scattered tree cover.

5. Sedge meadow and/or low shrub vegetation

Sedges occupy up to about 80% of the ground surface and dominate this unit. They may form a tussock-like or meadow surface. The occasional conifer seedling may be found in the unit. Other important species include avens, reticulated willow, *Rhododendron lapponicum* and alpine bearberry. For areas essentially devoid of trees in the lowlands, it was not possible to separate the sedge-dominated vegetation from areas dominated by low shrubs such as dwarf birch. Habitats occupied by this vegetation complex range from moderately well-drained to wet.

d. Riparian vegetation

1. Pioneer floodplain vegetation

Vegetation cover in these floodplain habitats is usually not closed. Although cottonwood and willow seedlings may be present, dominants in the ground cover include *Dryas drummondii*, fireweed, and in some cases horsetail. Other species which may be present include bearberry, lousewort, cinquefoil, liquorice root, comandra, and false asphodel.

2. Riparian willow

Dense willow thickets of alluvial habitats are best developed along the Illtyd Creek. The cover of willows may be dense and essentially closed. Other components of this vegetation unit are similar to types a7 and c1, described previously.

3. Wetland complexes

Wetland complexes are a heterogeneous group associated with numerous small ponds and lakes, or consist of sphagnum moss and lichen cover in imperfectly drained habitats. Open water is usually surrounded by a narrow fen-like border consisting of sedges with low shrub cover and scattered trees on higher ground. Dwarf birch, willow and alder are common shrub species in the taller group with blueberry, labrador tea and lingenberry in the low shrub cover.

e. Montaine vegetation (includes rock barrens)

1. Undifferentiated alpine, subalpine or non-forest vegetation of upland mountain areas

This unit includes typical alpine tundra vegetation represented by species including *Saxifraga oppositifolia*, moss campion, and avens; white heather may occur in areas where snow remains well into spring. Also included in this vegetation type is subalpine parkland with scattered trees and shrub dominated areas of some steep mountain slopes. In most areas, sedges, grasses and herbaceous species are dominant in the ground cover.

3.4 EXISTING ENVIRONMENT

Vegetation of the Bonnet Plume lease area is characterized by closed to transitional open forests of white spruce, black spruce and larch in most lowland areas. Although mixtures of these species occur, white spruce is best developed along rivers and streams in alluvial habitats or upland habitats with good drainage; black spruce and larch are most common in poorly drained habitats such as bog forest areas. Other tree species represented in the area are aspen, paper birch and balsam poplar or cottonwood. Aspen and birch, as successional species have rather localized occurrence within the area, usually on warmer exposures that have experienced fire in the past. Cottonwood associated with willow thickets represents an early successional pattern on bars and margins of the active floodplain.

With increasing elevation from the lowlands, the forest cover thins, and dwarf birch often becomes an increasingly common understory species and may form dense thickets on well to moderately drained soils. Dwarf birch is a common component of the subalpine vegetation and may occur mixed with labrador tea, blueberry, crowberry and lingenberry. At upper elevations of the subalpine, dwarf birch may almost totally replace isolated and scattered clumps of trees to form extensive dense and almost pure thickets. At elevations above about 1000 m ASL, alpine tundra vegetation replaces the subalpine. This vegetation change may occur at lower elevations on northerly exposed slopes.

Within areas capable of supporting tree growth, there occur mosaic patterns of vegetation which differ in physiognomy, composition and successional development depending upon localized environmental and soil conditions as well as fire history. Poorly-drained surfaces usually support a peat or sedge-tussock ground cover with stunted black spruce that are darkened by epiphytic lichens. Well-drained shallow soils of rock outcrop areas have a ground cover dominated by lichens and heath or dwarf-shrub species including dwarf birch.

4. WILDLIFE

4.1 LITERATURE SUMMARY

Little specific information is available on wildlife in the lease area. The area is generally inaccessible except by aircraft and received little scientific attention until 1970. From 1970 to 1978, there were annual winter surveys of the Porcupine Caribou Herd and frequently spring and fall surveys, as well. Some of the resulting reports include mention of thinhorn sheep and other large mammals (Doll et al. 1974a; Jakimchuk 1974). More recently the Yukon Game Branch has initiated studies of raptorial birds and woodland caribou (*Rangifer tarandus caribou*). Their study area includes a portion in the lease area (D. Mossop, D. Russell, Yukon Game Branch, pers. comm. 1980). However, except for caribou, the literature presently provides little data that is specific to the lease area.

Some information on wildlife is available in regions considerably removed from the present study area--along the Canol Road to the south and east, along the Mackenzie River corridor to the north and east, and, more recently, along the Dempster Highway to the north and west. This information is incorporated into the following discussion whenever appropriate.

4.1.1 *Caribou*

Surveys of caribou wintering in the Bonnet Plume River-Wind River area have been conducted annually, with varying degrees of thoroughness, from 1970 to 1978. In addition, studies of spring and fall migration have been conducted in a number of those years (Calef 1974; Doll et al. 1974b; Jakimchuk 1974; Hoffman 1975; Roseneau and Curatolo 1976, n.d.; Surrendi and DeBock 1976; Foothills Pipe Lines (Yukon) Ltd. 1978a, b, 1979). Foothills Pipe Lines (Yukon) Ltd. (1978a, b, 1979) contain some original material, but are primarily summary or review documents that provide a complete chronological history of recent caribou use of the lease area. Another recent summary document by LeBlond (1979) is also of particular interest. It not only summarizes recent knowledge of the Porcupine

Caribou Herd, but also provides up-to-date insights on international agreements, native land claims, land use proposals and a host of other matters which bear on conservation in the northern Yukon.

Table 1 provides a summary of caribou observations in the Pan Ocean lease area in the period 1970-1978, as extracted from reports by Foothills Pipe Lines (Yukon) Ltd. (1978a, b, 1979). It is not always clear from these summary reports (or from original documents) whether a lack of observations indicates that caribou were absent or that no observations were made. It is also unclear, except in general terms, how many caribou were in the lease area at any given time because the total area occupied by caribou was in all cases larger than the lease and numbers were often given as a wide range. However, it is clear that some caribou were in the lease area during each of the eight winters between 1970 to 1978. During four of those winters (1970-71, 1971-72, 1973-74 and 1976-77) the numbers were described as 'large' or 'concentrated'.

In years when small numbers of caribou are present it might be suspected that the resident and relatively sedentary woodland caribou might have been involved, rather than the migratory barren ground caribou that comprise the Porcupine Caribou Herd (D. Russell, pers. comm. 1980). However, during two of the four winters where that might have been the case, migratory caribou were seen leaving the area to the north in spring and during three of those four years they were seen in or near the lease area during fall.

From the observations of 1970 to 1978, it must be concluded that the lease area is part of the usual winter range of the Porcupine Caribou Herd--lying on the southern extremity and toward the eastern margin of that range. According to the summary reports cited above it is part of the most important portion of traditionally occupied winter range. The caribou that occupy the lease area most commonly arrive and depart via a migration route along the Richardson Mountains.

Table 1. Summary of Information Relating to Use of the Pan Ocean Oil Ltd. Lease Area by Portions of the Porcupine Caribou Herd between 1970 and 1978. Data from Foothills Pipe Lines (Yukon) Ltd. (1978a, b, 1979).

YEAR	FALL MIGRATION[1]	WINTER DISTRIBUTION	SPRING MIGRATION[2]
1970-71	not surveyed	concentrated in lease area	vanguard at N end of lease May 13
1971-72	at N end of lease September 22	concentrated in lease area	vanguard at N end of lease
1972-73	nearing N end of lease September 17	'few' in lease area	vanguard at center of lease May 13
1973-74	not observed	'large numbers' across centre of lease	vanguard 70 km N of lease April 4
1974-75	moving both N and S in N end of lease November 20	'few to several 1000's' in lease area	vanguard just N of lease April 22
1975-76	in N end of lease moving E, date not given (November ?)	'scattered small groups' in lease	not observed
1976-77	nearing N end of lease late October	concentrated in lease area	not observed
1977-78	not observed	small numbers in lease area	not surveyed

[1] Movement southward unless otherwise specified

[2] Movement northward unless otherwise specified

4.1.2 *Other species*

Knowledge of birds in the lease area must be inferred from studies conducted elsewhere. Rand's (1946) list of birds of the Yukon and of the Canol Road is perhaps the most important source of information. Knowledge of the avifauna to 1966 has been summarized in range maps by Godfrey (1966).

Except for raptors, particularly the peregrine falcon and the gyrfalcon, the literature does not suggest the presence of rare or endangered birds. The lease area is theoretically within the historic breeding range of the rare trumpeter swan (Godfrey 1966). Although it is likely that swans present on the lease are whistling swans, it is possible that they may be trumpeter swans (R. McKelvey, Canadian Wildlife Service pers. comm. 1980).

The mammal fauna other than caribou present on the lease must also be largely determined by inference. Biological investigations by Preble (1908) and Porsild (1945), although old, are still useful in suggesting which mammals may range into the Peel, Bonnet Plume and Wind River areas from the Mackenzie River corridor. Of considerable interest is Youngman's (1975) Mammals of the Yukon Territory. The range maps and collection records which he provides clearly show the absence of biological investigations in the lease area. According to Youngman approximately 39 species of mammals are expected to occur on the Pan Ocean property, but none have actually been collected. It seems unlikely that the lease area is critical to any rare or endangered mammal. Youngman speculated that an uncommon subspecies of the varying lemming (*Dicrostonyx torquatus nunatakensis*) may be found in the Wernecke Mountains, but there is no data to support this hypothesis at present.

Environment Canada conducted surveys in February and August 1973 which provided a basis for Land Use Information Series (LUIS) maps. Fish and wildlife information from the LUIS maps are given in Fig. 4*.

4.2 METHODS

In addition to a review of relevant literature, limited aerial and ground surveys were used in gathering data for this report.†

4.2.1 Aerial Survey Design

Three aerial surveys were flown to obtain distributional information on wildlife. Because we lacked any *a priori* information on waterfowl and moose distribution on the lease, a systematic aerial survey design was proposed. Each survey would have consisted of four transect lines spaced at 10-km intervals across the study area. Additionally, transect lines spaced at 2-km intervals would have been flown over two 'development' areas* as designated by Pan Ocean Oil Ltd.

Changes in this systematic design were recommended by the Yukon Government and were based on their knowledge of animal distribution in the region of the study area. Among their recommendations were:

1. survey routes should include river valleys;
2. complete coverage of a number of quadrats in various habitat types should be conducted; and
3. the Chappie Lake wetlands and the wetlands southwest of Chappie Lake should be surveyed.

We altered our survey design to accommodate these recommendations in a practical way. Unfortunately, a large number of quadrats could not be surveyed because of time and cost constraints. The resultant survey routes that were flown during June and August 1980 are given in Figures 5* and 7*.

The October aerial survey was conducted according to a more systematic design than the previous surveys because the distribution of animals at this time of year was largely unknown, and the reasons for deviating from a systematic survey were no longer applicable (i.e., ungulates were not found in high numbers in river valleys, too few quadrats were able to be surveyed to permit density estimates, and most

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† A schedule of field activities is presented in Appendix VI
* These development areas encompass the known areas of coal occurrence (see Fig. 1*)

lakes and ponds were frozen and migrant waterfowl had left the area). Even during this survey, deviations from straight-line transects were inevitable because of the mountainous terrain.

Although more caution must be used in the interpretation of non-systematic or non-random sampling procedures, the results of the June and August surveys are adcquate for their intended purpose, i.e. to document the presence and distribution of selected wildlife species relative to the known areas of coal occurrence in the lease. Density estimates and distributional data from non-systematic surveys must be related to the areas surveyed; extrapolation, if conducted, must be done relative to the areas surveyed (e.g., by habitat type). Because of the low level of coverage (i.e., 5 to 10%), density estimates should not be extrapolated because they may not be representative*. Surveys with higher intensities of coverage permit a greater degree of confidence in the data (hence more freedom for extrapolation); however, such studies would have gone beyond the scope and budget of an overview study.

The first two surveys were primarily designed to obtain information on waterfowl and ungulates. Accordingly, flights were made at low elevation and a 400 m-wide transect (200 m on either side of the aircraft) was used. The third survey was primarily designed to survey caribou and moose. Therefore, the survey was flown at higher altitudes and the transect width was increased to 800 m (400 m on either side of the aircraft). The same two experienced observers were used for all surveys.

A brief description of each survey follows.

4.2.1.1 *Survey 1*

The first aerial survey was flown on 20 June 1980 using Hughes 500C and Bell 204 helicopters**. The route (see Fig. 5* and 6*) was designed to provide more intensive coverage of the area in which drilling activities are concentrated and to survey areas identified as important to wildlife by the Land Use Information Series maps (see Fig. 4*).

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* low levels of coverage do not allow extrapolation of densities whether the survey design is systematic or not.

** The Hughes 500C was unavailable for the portion of the survey down the Bonnet Plume River and up the Wind River. Therefore, the Bell 204 had to be used.

The survey was flown at approximately 30 m AGL and 150 kph. A third person occasionally assisted in making observations.

4.2.1.2 *Survey 2*

The second aerial survey was flown on 17-18 August using a Bell 206B helicopter. We attempted to fly the same route as was flown during Survey 1 with the exception of an additional flight line in the Illtyd Creek area (see Fig. 7* and 8*). Due to weather conditions and difficult navigational problems the route differed slightly from Survey 1.

The survey was flown at approximately 50 m AGL and 150 kph whenever weather conditions permitted. Because of extensive low clouds in the Bonnet Plume 'flats', altitudes and speeds were as low as 15-20 m and about 100 kph, respectively.

4.2.1.3. *Survey 3*

The third aerial survey was flown with a fixed-wing Cessna 206 on 14 October 1980. The route (see Fig. 9*) was designed to survey the entire lease area and the area immediately to the east of the lease. We attempted to survey the southern portion of the lease where most known coal reserves are located somewhat more intensively than the northern portion. The survey was flown at approximately 200 m AGL and 150 kph.

4.2.2 Ground Surveys

During mid-August 1980, a limited amount of work was conducted on the ground, south of the Illtyd Range. A small portion of the lease near the southern areas of coal occurrence (see Fig. 1*) was evaluated for its suitability as moose and caribou habitat according to the score sheet method of habitat evaluation (Flood et al. 1977; Stevens and Storey 1977). Score sheets, specifically modified for use in this study, are presented in Fig. 2 and 3. Each habitat characteristic within each area being evaluated was assigned a score representing the relative quality of the area for either moose or caribou. For example, herbaceous ground cover of 25% would receive a score of 4, 50%-8, and 100%-10. Each of the eleven characteristics were weighted according to their documented or perceived importance to moose and caribou. The score for each characteristic for

Area: ____________________

Site: ____________________

Rated for: __________ (season)

Date: ____________________

Characteristics

I. Tree Size Class and Canopy Closure(25)

Bare gravel	0
Gravels with < 10% tree cover	1
10-100% reproductive	1
70-100% mature	2
40- 70% mature	3
10- 40% mature	4
70-100% pole-sized	5
40- 70% pole-sized	6
10- 40% pole-sized	7
10- 40% mixed	8
47- 70% mixed	9
70-100% mixed	10

II. Tree Species Composition(25)

Newly worked or bare gravel	1
Softwoods (+70% wS, bS)	2
Pioneer saplings (wB, tA, bPo)	5
Mixedwoods (50-70% wB, tA, bPo)	8
Hardwoods (+70%, wB, tA, bPo)	10

III. Understory (Woody Vegetation < 5' High) % Ground Cover(20)

0-25%	1-3
25-50%	3-7
50-75%	7-10
75-100%	10-5

IV. Understory Species Composition(20)

No significant amount present	1
Only conifers present	2
Mixture of conifers and deciduous shrubs (no willow)	5
Deciduous shrubs (little willow)	8
Wide variety of deciduous shrubs (abundance of willow)	10

V. Herbaceous % Ground Cover(20)

0-25%	1-4
25-50%	4-8
50-100%	8-10

VI. Herbaceous Species Composition(20)

None present	1
Only forbs present	4
Mainly grasses, sedges and aquatics	7
Variety of terrestrial and aquatic forbs	10

VII. Preferred Food Plant Diversity(20)

No herbs or shrubs, only conifers or bare gravel	1
No shrubs, only herbs and mature trees	3
Some herbs and shrubs, no deciduous trees or aquatics	5
Some herbs and shrubs and deciduous trees	7
Variety of shrubs, herbs, forbs, aquatics and young deciduous trees	10

VIII. Food Availability(20)

No significant amount of food species	1
Insufficient food for season being rated	3
Sufficient food for season being rated	8
Sufficient food for all seasons	10

IX. Deadfall(5)

Impossible to walk	1
Difficult to walk	3
Some deadfall but presents no problem walking	8
No deadfall	10

X. Openings (area in forest with less than 10% canopy closure)(5)

No openings	1
Small openings	3
Small openings with some edge effect	6
Openings of sufficient size and location to allow good air movement and good edge effect	10

XI. External Edge(5)

Straight edge with no shrub development	1
Edge with developing shrub layer.	5
Meandering edge with dense vegetation	10

REMARKS: Location, Topograpy, Insects, Use (droppings, browsing activity, tracks).

Figure 2. Score Sheet Used to Evaluate the Habitat Suitability of Portions of the Lease for Moose. (Modified from Stevens and Storey 1977). Number in brackets after each habitat characteristic represents the weighting factor.

Area: ______________________

Site: ______________________

Rated for: __________ (season)

Date: ______________________

Characteristics

I. Tree Size Class and Canopy Closure (25)

10-100% reproductive	1
70-100% pole-sized	2
40- 70% pole-sized	3
10- 40% pole-sized	4
70-100% mature	5
70-100% mixed	6
40- 70% mature	7
10- 40% mature	8
40- 70% mixed	9
10- 40% mixed	10

II. Tree Species Composition (25)

Newly cleared land	1
Pioneer shrubs (wB, tA, bPo)	4
Hardwoods (+70%, wB, tA, bPo)	6
Mixedwoods	7
Softwoods (+70% Lx, wS, bS)	10
Mature forest	10

III. Understory (woody vegetation <5' high) % Ground Cover (20)

0-25%	1-3
25-50%	3-7
50-75%	7-10
75-100%	10-5

IV. Understory Species Composition (20)

No significant amount present	1
Only conifers present	2
Only deciduous shrubs present	4
One conifer mixed with deciduous shrubs	5
Labrador tea with some other evergreen/and deciduous shrubs.	9
Wide variety of deciduous and evergreen shrubs	10

V. Herbaceous % Ground Cover (20)

0-25%	1-4
25-50%	4-8
50-100%	8-10

VI. Herbaceous Species Composition (20)

No lichens or mosses, few forbs	1
Only forbs present	4
Only lichens and mosses	7
Lichens and mosses and a few forbs.	8
Lichens and mosses and wide variety of forbs	10

VII. Preferred Food Plant Diversity (20)

No herbaceous growth, only coniferous shrubs	1
Forbs and herbs	3
Mosses, grasslike plants and some deciduous shrubs	5
Mosses and terrestrial lichens	7
Labrador tea with lichens, some forbs.	8
Terrestrial and arboreal lichens, variety of forbs and deciduous shrubs	10

VIII. Food Availability (20)

No significant amount of food species	1
Insufficient food for season being rated	3
Sufficient food for season being rated	8
Sufficient food for all seasons	10

IX. Deadfall (5)

Impossible to walk	1
Difficult to walk	3
Some deadfall but presents no problem in walking	8
No deadfall	10

X. Openings (area in forest with less than 10% canopy closures) (5)

No openings	1
Small openings	3
Small openings with some edge effects	6
Openings of sufficient size and location to allow good air movement and good edge effect	10

XI. Topography (5)

Flat, regular	1
Gently sloping, regular	3
Gently sloping, irregular	5
Hillside, regular	8
Hilly, irregular	10

REMARKS:

Figure 3. Score Sheet Used to Evaluate the Habitat Suitability of Portions of the Lease for Caribou. (Modified from Stevens and Storey 1977). Number in brackets after each habitat characteristic represents the weighting factor.

each species was multiplied by its weighting factor, all scores were summed, and the resultant total was divided by 100. The final habitat score, therefore, could range between 0 (unsuitable) and 10 (excellent). It must be noted that a high habitat score does not necessarily mean that the area will receive high wildlife use. Furthermore, the habitat rating is based on our evaluation of habitat 'quality'; the animal may perceive the quality of habitats considerably differently.

4.3 RESULTS

4.3.1 1980 Aerial Surveys

Results of the three aerial surveys conducted between 20 June and 14 October 1980 are presented in Table 2 and Fig. 5*-9*. Both on- and off-transect sightings are plotted and tabulated, but estimated densities are calculated only for animals sighted on-transect. Except for waterbirds* and raptors, birds were not considered in this analysis.

About 5% of the lease area was surveyed during the June and August surveys and about 10% was surveyed during October. Low levels of coverage, lack of an adequate number of sightings in different habitat types (see below), and incomplete mapping of vegetation within the lease area prohibits extrapolation of density estimates to the entire lease to arrive at population estimates for any animal.

The habitat associations of birds or mammals were not evaluated in detail. During the August 1980 survey, 291 waterbodies were located wholly or partially within our transects. Waterfowl were present on about 59 (20%) of these waterbodies. Too few sightings of individual species of mammals were made to permit detailed analysis of habitat use. Table 3 presents a breakdown of sightings of moose by general habitat type. Moose clearly make considerable use of lakes and other wetlands during late summer.

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* Throughout this report, the term waterfowl refers to loons, grebes, ducks, geese and swans. The term waterbirds refers to other water-associated birds such as gulls, terns and shorebirds.

Table 2. Results of Aerial Survey Program of the Bonnet Plume Lease Area.

	Loons[1]	Ducks[1]	Geese[1]	Swans[1]	Other Water-Fowl[1,4]	Other Water Birds[2]	Raptors[2]	Moose[2]	Sheep[3]	Caribou[2]	Grizzly Bears[2]	Other Mammals
On Transect												
20 June												
No. observed	8	268	13	1	-	77	3	8	40	1	1	1 Red Fox 2 Arctic ground squirrels
Density (No./km^2)	0.05	1.6	0.08	0.01		0.4	0.01	0.04	1.1	0.01	0.01	
17-18 August												
No. observed	11	414	5	5	50	4	11	17	51	0	1	-
Density (No./km^2)	0.06	2.4	0.03	0.03	0.3	0.02	0.05	0.08	1.4	0.0	0.01	-
14 October												
No. observed	-	-	-	-	-	-	2	9	4	3	0	-
Density (No./km^2)							0.00	0.02	0.05	0.01	0.0	
Off Transect												
20 June												
No. observed	3	87	26	0	-	7	0	3	0	2	0	-
17-18 August												
No. observed	0	72	0	2	62	0	0	17	11	0	0	-
14 October												
No. observed	-	-	-	-	-	-	-	1	0	0	0	-

[1] density calculated on surveyed area of 165 km^2 for June survey; 187 km^2 for August survey; not calculated for October survey.
[2] density calculated on surveyed area of 202.5 km^2 for June surveys; 212.5 km^2 for August survey; and 405 km^2 for October survey.
[3] density calculated on surveyed area of 37.5 km^2 for June and August surveys; 75 km^2 for October survey.
[4] includes unidentified waterfowl.

Table 3. Number of Sightings of Moose by Habitat Type during 1980 Aerial Surveys. Number in brackets represents total number of animals seen both on- and off-transect.

General Habitat Type	June Survey	August Survey	October Survey
River/creek	4(6)	2(2)	6(6)
Lake/pond	--	16(24)	--
Muskeg	1(1)	5(7)	--
Upland open spruce	--	--	2(3)
Burn	--	1(1)	1(1)
Non-riparian willow	1(2)	--	--
Unrecorded	2(2)	--	--

The increase in the number of moose observed during August was apparently related to greatly increased visibility resulting from their increased use of waterbodies. When moose sighted in lakes and ponds are excluded, the numbers of sightings of moose and number of individual moose sighted during all three surveys are nearly identical (Fig. 10). It must be remembered, however, that the area surveyed during October was nearly twice the area surveyed during earlier surveys. Therefore, the number of sightings and number of individual moose sighted during October were only about half as many as those expected based on results of earlier surveys. The reduction in the number of sightings was probably the result of difficult survey conditions (see below) and to type of aircraft, survey width, survey height, and change in habitat selection by moose, all of which have been shown to affect the results of aerial surveys (e.g., Gasaway et al. 1979). The majority of the survey area during October was covered by a shallow layer of snow resulting in a mottled effect where snow cover was broken (e.g., little or no snow was present beneath coniferous trees, snow had often melted or blown from rocks and stumps, shrubs were only partially snow-covered). We believe that due to the combination of the above conditions, only a very small portion of the moose present on our survey lines were counted during October.

Present mining plans are for development in the southern portion of the lease. In order to evaluate moose and waterfowl distributions near the proposed mine developments vs those in the rest of the lease, a comparison was made of the surveyed portion of the lease north of about 65°33' with the surveyed portion of the lease lying south of this latitude (Table 4). No consistent differences were noted in either waterfowl or moose distributions within the portions of the lease that were compared.

Results and a brief discussion of the December 1980 wildlife survey are presented in Addendum 1 and Fig. 11*.

4.3.2 Habitat Evaluation

Nine different habitat types were rated for their suitability as moose and caribou habitat. Ratings were made at representative sites

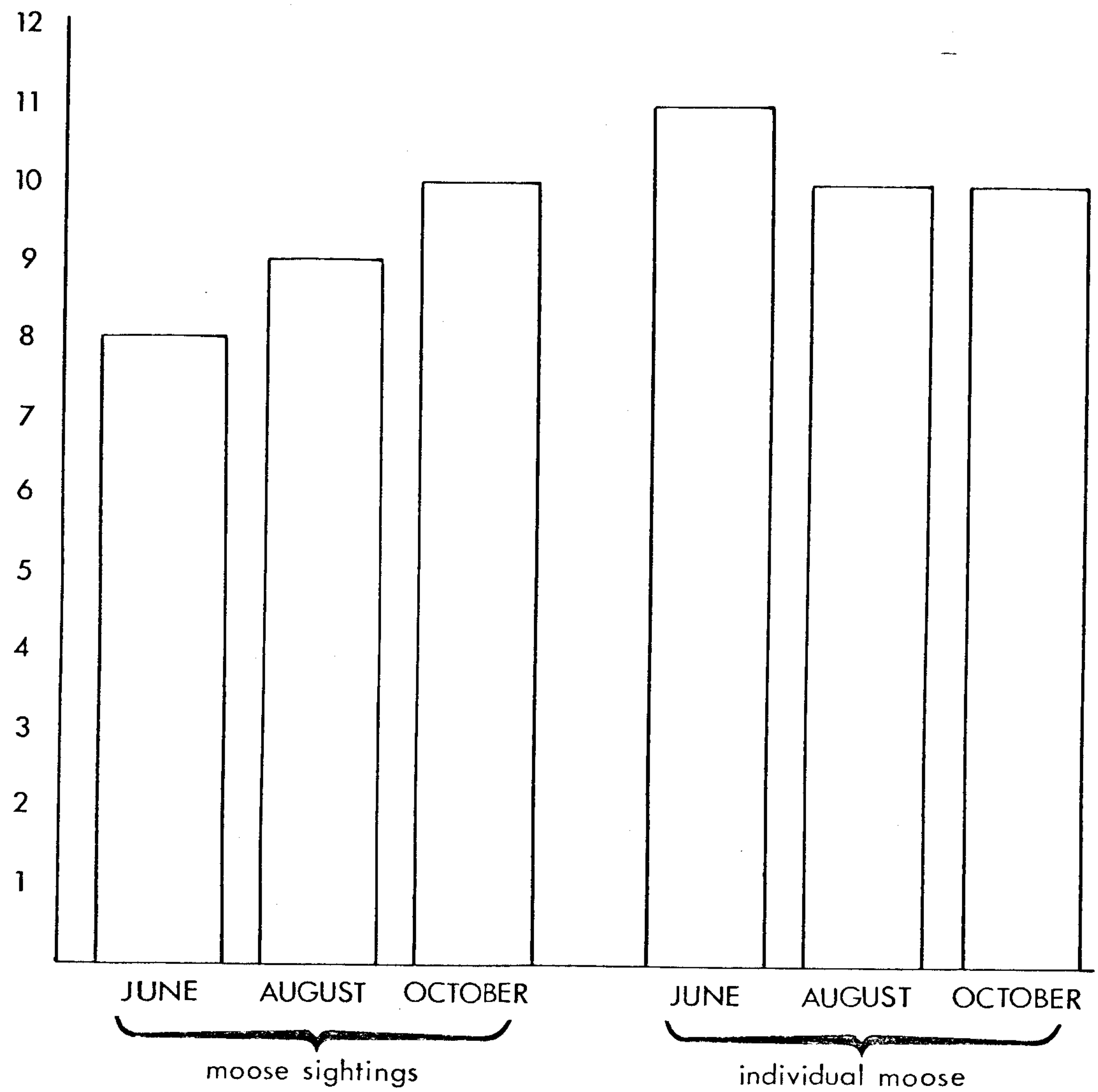

Figure 10. Number of sightings of moose and number of individual moose sighted during aerial surveys in June, August and October 1980.

Table 4. Comparison of Waterfowl and Moose Numbers Seen On-Transect North and South of 65°33'.

Wildlife Group	June		August		October	
	Northern Lease	Southern Lease	Northern Lease	Southern Lease	Northern Lease	Southern Lease
Ducks	89 (33)[1]	179 (67)	290 (70)	124 (30)	-	-
Geese	9 (69)	4 (31)	0 (0)	5 (100)	-	-
Swans	1 (100)	0 (0)	5 (100)	0 (0)	-	-
Loons	2 (25)	6 (75)	2 (18)	9 (82)	-	-
Total Waterfowl[2]	101 (35)	189 (65)	332 (68)	153 (32)	-	-
Moose	5 (63)	3 (37)	6 (35)	11 (65)	2 (22)	7 (78)
Area Surveyed[3]	64 (39)	101 (61)	64 (37)	111 (63)	150 (37)	255 (63)

[1]bracketed number represents percent of total group seen on lease on transect

[2]includes unidentified waterfowl

[3]km^2

within each forest type. The comparability of the habitat rating from one area to another within similar forest types is not known.

Habitat scores ranged from 4 to 8 for moose and 3 to 8 for caribou (Table 5). The following descriptive categories were used to interpret the numerical scores:

0	totally unsuitable habitat for species considered
1-3	poor habitat; does not fully meet any of the habitat requirements of the species considered and will usually be avoided
4-6	marginal habitat; meets one or two of the habitat requirements of the species considered, but will probably be used only in proportion to its occurrence (i.e. neither preferred nor avoided)
7-9	good habitat; is the preferred habitat of the species considered
10	excellent habitat; meets all of the known habitat requirements of the species considered

Most habitats evaluated were considered to be marginal moose habitat. Two areas, cottonwood/spruce forests and lichen woodland, constituted good moose habitat. Lichen woodland and a variety of spruce forest types were considered to be good caribou habitat. Wetland complexes were poor habitats for caribou. All other habitats evaluated were considered to be marginally adequate for caribou.

4.4 HUMAN USE OF WILDLIFE RESOURCES

4.4.1 *Trapping*

The lease area encompasses parts of four registered traplines and part of the Fort MacPherson group trapping area (see Fig. 4*). No information is available on trapping in the Fort MacPherson group trapping area. Two of the four registered traplines (No. 7 and 40) have not been trapped during the last 5 years and are presently 'open' (i.e. not registered by any individual). The remaining two traplines (No. 9 and 10) have been lightly trapped during 1 of the last 3 years (Table 6). The only trapping near the southern portion of Pan Ocean's lease that is actively being conducted during the 1980-81 winter is in the vicinity of Rapitan Creek.

Table 5. Habitat Capabilities of Selected Vegetation Types for Moose and Caribou.

Forest Type (see Vegetation Section)	Habitat Rating	
	Moose	Caribou
Spruce forest of alluvial floodplain and/or riparian habitats	6	7
Upland spruce forests of terraces above flood level or gentle slopes in the lowland	5	6
Spruce forests of moderately sloping to steep mountain slopes	6	8
Spruce and mixed forests of ravine and river banks	6	7
Mixed deciduous/spruce forests of riparian or floodplain habitats (cottonwood/spruce forests)	8	5
Spruce-sphagnum or spruce-sedge tussock vegetation of poorly drained habitats	5	5
Spruce-lichen or spruce-dwarf birch vegetation (lichen woodland)	7	8
Wetland complexes	5	3
Transition between upland spruce and spruce-sphagnum	4	5

Table 6. Trapline Returns on the Two Active Traplines that are Partially Within the Pan Ocean Oil Lease Area (data supplied by Yukon Game Branch).

Trapline No.	Year	Beaver	Fox	Marten	Mink	Muskrat	Squirrel	Wolverine
10	1977-78	18	1	27	2	29	13	1
9	1979-80	-	1	14	1	-	-	-

Marten appears to be the major fur species trapped in the lease area. A number of pelts of aquatic furbearer species (beaver and muskrat) are also taken where these animals are present.

4.4.2 *Guiding*

Two registered guiding areas are located partially within the lease area (See Fig. 4*). The major portion of the lease is not registered. Data on hunter harvests is shown in Table 7. Approximately 9% of all guided hunters in the Yukon hunted in Areas 4 or 5 during 1979. Based on analysis of the returns presented in Table 7, it appears that these areas provide especially good opportunities to hunt grizzly bears and thinhorn sheep. Much of the hunting, especially for bear, is centred along the Wind River (R. Furniss, Whitehorse resident, pers. comm. 1980).

4.5 EXISTING ENVIRONMENT

The following discussion is based primarily on results of 1980 field surveys and is supplemented with information from the literature. The purpose of this section is to describe the current wildlife conditions on the lease in order to assess the potential for impact from development in the Wind River-Bonnet Plume River area.

4.5.1 Caribou

From a review of the literature of caribou on the lease area, it is clear that a portion of the Porcupine Herd of barren-ground caribou make nearly annual use of the lease during winter. Because the data presented in the literature show occupation by caribou of broad areas only, and because the results from this study are based on the period June-October, it is not possible to depict specific portions of the lease (if any) that are used most frequently by wintering barren-ground caribou. Some information in this respect may be obtained from a field survey scheduled for December 1980 (report of this survey will be presented to Pan Ocean Oil Ltd. as an addendum to this report).

Few resident caribou were seen in the lease during surveys conducted in June, August and October 1980. A concurrent study of resident caribou conducted by the Yukon Game Branch found that most caribou

Table 7. Statistics of the 1979 Guiding Season in Areas 4 and 5 (data supplied by Yukon Game Branch).

Species	Area 4	Area 5	All Yukon Guide Areas	% of Yukon Guided Harvest*
No. of hunters	22	21	461	9
Thinhorn Sheep	14	11	212	12
Moose	4	4	177	5
Grizzly bear	3	3	48	13
Caribou	8	5	170	8
Mountain goat	0	0	11	0
Black bear	0	0	20	0
Wolverine	0	1	11	9
Wolf	1	2	24	13

* Represents the portion of the total Yukon guided harvest contributed by Guide Areas 4 and 5

residing in the vicinity occupied areas located further to the south and east of Pan Ocean's lease. It is possible that these caribou make more extensive use of the lease area during winter.

It appears, therefore, that the summer and early fall use of the lease area by caribou is minimal. However, this generalization must be tempered by the fact that detailed observations were conducted during only a portion of 1 year.

4.5.2 Moose

The only information on moose in the lease area comes from the surveys conducted during 1980. This information suggests that moose are distributed throughout the lease. The planned December survey may permit a preliminary estimate of abundance, within broad limits. Insufficient data are available to delineate distribution and abundance of moose by habitat type (and by season) on the lease.

4.5.3 Thinhorn Sheep

A total of 61 thinhorn sheep were counted on the Knorr Range during 1971 (Jakimchuk et al. 1974). The aerial surveys conducted during 1980 constituted the only other survey of sheep in the lease area. Only a portion of the Knorr Range was surveyed during each of three aerial surveys. Two sheep were seen in the Knorr Range in June, 49 in August, and none in October. The main 'spine' of the Illtyd Range was also surveyed three times during summer and fall 1980. Eleven sheep were seen there during June and an additional 27 were located nearby along the Wind River. Only two sheep were seen during the aerial survey in August, but 16 sheep were observed from the ground on 17 August. Four sheep were counted in the Illtyd Range during October. Only the north face of the Wernecke Mountains was surveyed; 11 sheep were seen from a considerable distance during the August survey.

A minimum of 78 sheep were seen during aerial surveys in the lease area; many more sheep are likely to reside there. From the presence of trails on ridges other than those on which sheep were seen, it is likely that many other mountain slopes in and near the lease are at times occupied by sheep. The frequency or duration of use, and patterns of movements between ranges are entirely unknown. On the basis of incomplete surveys during 1980, it appears that the area supports a relatively large sheep population.

4.5.4 Grizzly Bear

Although only two grizzly bears were seen during aerial surveys, three more were seen on the lease between surveys, and bears were reported to be seen frequently by personnel of Pan Ocean Oil's camp at Kiwi Lake. Most sightings were in the treeless areas in the southern portion of the lease. Pearson (1975), Miller (1977) and Miller and Barichello (1978) found that grizzly bears in the southern Yukon and Mackenzie Mountains used alpine habitats primarily during spring and fall. Bears gradually moved into subalpine habitats during late summer to feed on berries as they become ripe.

Land Use Information Series (LUIS) maps (see Fig. 4*) identify a ridge east of the Bonnet Plume River, north of Rapitan Creek and southwest of Knorr Creek as an area used by grizzly bears for denning. However, to our knowledge, this area has not been adequately surveyed to establish with certainty whether or not denning occurs there.

4.5.5 Other Mammals

As mentioned previously, no information is available on the presence or distribution of most mammals on the lease area. Trappers take beavers, muskrats, mink, martens, red squirrels, red foxes and wolverines from the lease area. During our field studies, we also observed pikas and arctic ground squirrels. In addition to the species already mentioned in this report, the lease area is also within the ranges of coyotes, wolves, black bears, ermine, least weasels, river otters, lynx, four species of shrews, two additional species of lagomorphs (rabbits, hares), and nine additional species of rodents.

4.5.6 Waterfowl

Previous to the 1980 surveys no information was available on waterfowl in the lease area. During August, waterfowl were found on 20% of the lakes surveyed, with an average of about eight birds per occupied waterbody. This density is probably an overestimate of the number of breeding waterfowl on the lease. Densities of waterfowl observed on transect averaged 1.8/km^2 during June, and 2.5/km^2 during August (a 40% increase). This increase was entirely due to more birds being present in the northern portion of the lease (primarily in the Chappie Lake area) -- in fact, fewer waterfowl were seen on the southern portion of the lease during August than during June. The increase in waterfowl in the Chappie Lake area probably represents a movement of fall staging waterfowl into the area.

Eight sightings of swans were made on the lease during surveys in 1980, but no swans could be reliably identified to species from the air. As mentioned previously in the literature review, there is a possibility that rare trumpeter swans may be present in the lease area.

4.5.7 Raptors

The Yukon Game Branch has plotted the locations of 14 raptor nests in or near the lease area (D. Mossop,pers. comm. 1980). No new raptor nests were located during our aerial surveys in 1980. However, a considerable number (up to 11) and variety (10 species) of raptors were seen during the aerial surveys (see Fig. 6*, 8* and 9*).

Most effort to locate raptor nests has been directed along the Peel River where five of the 14 nests have been located. The southern portion of the lease has not been well searched for raptor nests.

4.5.8 Other Birds

Appendix I presents a list of all species of birds that were seen during the limited amount of time spent in the study area during 1980. The total lack of information from the area on species of birds not specifically addressed in this report prevents any assessment of their status on the lease area.

5. FISH

5.1 LITERATURE SUMMARY

The present study has obtained almost all the available information of the fisheries resources of the study area. Probable species in the area were previously listed by the Department of Fisheries and Oceans, Whitehorse; some information is also available from LUIS maps (Fig. 4*).

5.2 MATERIALS AND METHODS

5.2.1 Fish

Fish surveys were conducted using a helicopter for access from 4-7 July and 8-11 September 1980*. These surveys concentrated on Illtyd Creek and the Wind River upstream of their confluences. Eight stations were sampled during the 4-7 July survey (four in the Wind River and four in Illtyd Creek (Fig. 12*). The same stations were sampled again in September, except for the uppermost station on Illtyd Creek.

During each of the surveys, fish and benthic macroinvertebrates were sampled and a series of physical measurements (e.g., temperature, oxygen, turbidity) were taken. In addition, water for chemical analysis was collected from each station on at least one occasion. Pan Ocean personnel also collected water samples from 17 stations on Illtyd Creek and 13 on the Wind River. The results of chemical analysis for these samples are included in this report in Appendix 3.

Fish samples were collected by four techniques. The methods and sampling efforts varied according to the specific habitat characteristics of each site.

a. Electrofishing was the major sampling method used during the September survey. A Coffelt backpack electroshocker (model BP-10), powered by a small gas driven generator, was primarily used in side channels, back channels, mainstream edges and shallow pools. Deeper pools, when accessible, were also sampled by this method. Electrofishing was performed over a distance of approximately 300 m at each site.

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* A schedule of field activities is presented in Appendix VI

b. A seine (15.4 m x 2.4 m) with a 0.4 cm stretch mesh was used in side channels, back channels and in some shallow pools. A relatively even substrate free of debris or snags was a prerequisite for this technique.

c. Gill netting was carried out in deep pools. Monofilament nets, 3.8 cm and 7.6 cm stretch mesh, 30 m in length and 2.4 m in height were used during both sampling periods. Nets were set for periods of up to 22 h.

d. Angling was employed on one occasion on Illtyd Creek.

During each field survey, representative specimens of fish were sacrificed to obtain life history data. Specimens were weighed to the nearest gram using Pesola scales, measured (total or fork length according to species) to the nearest mm and sexed. The reproductive condition of the fish was recorded (i.e. immature, green, ripe, or spent). Stomach contents were analyzed qualitatively and aging materials (otoliths and scales) were collected (Appendix II). The ages reported below were determined from otoliths only.

5.2.2 Benthic Macroinvertebrates

Benthic macroinvertebrates were collected using a Surber sampler with a frame of 930 cm^2. The collection bag had a mesh size of 150 µm. Samples were collected from Stations 4, 5, 6, 7 and 8 (Fig. 12*). The material was washed in the collection bag, preserved in 10% formalin and returned to the laboratory for identification and enumeration of the fauna.

5.2.3 Water Chemistry

Chemical and physical characteristics of water from the Wind River and Illtyd Creek, including dissolved oxygen concentration, pH, turbidity, temperature, and conductivity, were measured *in situ* using a Hach Kit for dissolved oxygen (± 0.5 mg/L), a Fisher model 109 digital pH meter (± 0.01), an HF Instruments Model DRT 15 turbidimeter (± 0.02 NTU) and a LaMotte Chemical model DA-1 conductivity meter (± 10 µmhos/cm). Water temperatures were measured with a mercury thermometer (± 0.5°C).

Water samples were collected from Stations 2, 4, 5 and 7 in July, and Stations 1, 3, 4, 5, 6, 7 and 8 in September, for the laboratory analysis of pH, alkalinity, suspended solids, dissolved solids, sulphate, chloride, nitrate plus nitrite, total Kjeldahl nitrogen, total phosphorus, total organic carbon, calcium, magnesium, sodium and potassium. Analyses methods were those of APHA Standard Methods (1976) and were conducted by Chemex Labs, Vancouver, B.C.

The physical characteristics of the watercourses, their substrates and characteristics of the banks were noted at each site. Water current measurements were made with a Gurley model 625 pygmy current meter at three stations (Stations 1, 3 and 4) in Illtyd Creek. Extensive braiding, swift currents and deep channels precluded these measurements at sites on the Wind River.

5.3 RESULTS

5.3.1 Water Chemistry

The results of laboratory analyses of water data collected *in situ* are presented in Table 8. The measurements determined for samples from Illtyd Creek and the Wind River illustrate the pre-development quality of waters in these rivers. The pH in both watercourses was alkaline; field measurements ranged from 7.23 to 8.01. Laboratory results of pH determination were higher than field measurements. Results ranged from 8.20 to 8.48, but were considered to be less accurate than field determinations due to delay before analysis.

Carbonate alkalinity ranged from 107 mg/L to 139 mg/L $CaCO_3$. Although this measurement does not directly indicate the buffering capacity of these watercourses, the capacity is expected to be moderately high. Water hardness, which stems principally from the presence of calcium and magnesium ions, is also moderately high. Calcium contributed most to water hardness; levels ranged from 26 mg/L to 44 mg/L. Magnesium ranged from 9 mg/L to 15 mg/L. Generally, the contribution of groundwater is important in determining hardness. As a result, water hardness normally varies because the contribution of groundwater to stream flow fluctuates on a seasonal basis.

Concentrations of sodium, potassium, sulphate, chloride, suspended solids, total organic carbon and nutrients were very low. These results are indicative of clear water with little organic or nutrient

Table 8. Water Quality of Illtyd Creek and the Wind River.

July 1980

Parameter	Sampling Station							
	Illtyd Creek				Wind River			
	1	2	3	4	5	6	7	8
pH[1]	7.23	7.54	8.01	7.46	7.57	7.47	7.45	7.67
Dissolved oxygen[1] (mgL^{-1})	10.0	9.0	8.0	8.0	9.0	9.0	8.0	8.0
Conductivity[1] (μmhos cm^{-1})	240	300	245	260	220	205	230	225
Turbidity[1] (NTU)	0.60	0.48	0.34	0.38	2.40	2.60	1.40	12.00
Temperature[1] (°C)	6	10	15	11	10	10	8	10
pH	-	8.20	-	8.29	8.22	8.20	8.23	-
Alkalinity ($mgCaCO_3L^{-1}$)	-	131	-	139	114	110	107	-
Suspended solids (mgL^{-1})	-	3	-	<1	6	3	3	-
Dissolved solids (mgL^{-1})	-	210	-	170	140	140	150	-
SO_4 (mgL^{-1})	-	36	-	9	11	11	12	-
Cl (mgL^{-1})	-	0.4	-	1.0	1.1	1.1	1.0	-
NO_3+NO_2 (mgL^{-1})	-	0.12	-	0.11	0.07	0.07	0.07	-
Total Kjeldahl Nitrogen (mgL^{-1})	-	0.05	-	0.19	0.09	0.05	0.19	-
Total PO_4 (mgL^{-1})	-	<0.01	-	<0.01	<0.01	<0.01	0.01	-
Total Organic Carbon (mgL^{-1})	-	6	-	2	16	15	10	-
Calcium (mgL^{-1})	-	36	-	35	29	26	27	-
Magnesium (mgL^{-1})	-	15	-	13	12	11	11	-
Sodium (mgL^{-1})	-	0.52	-	1.2	1.3	1.3	1.2	-
Potassium (mgL^{-1})	-	0.64	-	0.60	0.44	0.40	0.32	-

[1] Measured at the time of sampling.

Table 8. (cont'd)

September 1980

Parameter	Sampling Station							
	Illtyd Creek				Wind River			
	1	2	3	4	5	6	7	8
pH[1]	7.65	-	7.55	7.55	7.59	7.54	7.48	7.58
Dissolved oxygen[1] (mgL^{-1})	11.0	-	11.0	11.0	11.0	11.0	11.0	12.0
Conductivity[1] (μmhos cm^{-1})	300	-	310	240	270	270	260	300
Turbidity[1] (NTU)	0.56	-	0.34	0.68	0.64	1.10	0.36	5.05
Temperature[1] (°C)	2	-	2	3	2	2	2	2
pH	8.31	-	8.28	8.48	8.37	8.33	8.34	8.27
Alkalinity ($mgCaCO_3L^{-1}$)	130	-	124	134	125	118	115	130
Suspended solids (mgL^{-1})	<1	-	<1	<1	<1	<1	<1	6
Dissolved solids (mgL^{-1})	210	-	220	200	200	170	170	210
SO_4 (mgL^{-1})	12	-	16	9	13	13	12	8
Cl (mgL^{-1})	2	-	<0.1	<0.1	2	2	2	3
NO_3+NO_2 (mgL^{-1})	0.10	-	0.10	0.15	0.08	0.08	0.09	0.11
Total Kjeldahl Nitrogen (mgL^{-1})	0.16	-	0.06	<0.02	0.06	0.08	0.18	<0.02
Total PO_4 (mgL^{-1})	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Organic Carbon (mgL^{-1})	1	-	1	1	<1	<1	<1	1
Calcium (mgL^{-1})	44	-	37	35	33	29	27	35
Magnesium (mgL^{-1})	12	-	9	11	12	11	11	11
Sodium (mgL^{-1})	1.10	-	0.80	0.88	1.00	0.96	0.96	1.70
Potassium (mgL^{-1})	0.50	-	0.50	0.60	0.45	0.50	0.60	0.65

[1] Measured at the time of sampling.

content. The higher values for total organic carbon in July (range = 2 mg/L to 16 mg/L) compared with September (range = < 1 to 1 mg/L), likely reflect greater productivity during the warmer months (water temperatures ranged from 6.2°C in July and from 2.3°C in September).

Because of the low levels of suspended solids, turbidity was very low at most stations. It should be noted, however, that turbidity and suspended solids are not synonymous. Although the presence of suspended matter contributes to the turbidity of water, turbidity is also influenced by optical properties such as colour. The maximum value for turbidity occurred in July at Station 8 (12.0 NTU). During the September survey, Station 8 again had the highest level, 5.1 NTU. However, these values are not extreme in natural systems.

In summary, the water chemistry was similar in Illtyd Creek and the Wind River during the periods sampled. The majority of factors measured exhibited low concentrations. It is likely that during spring runoff, values of parameters such as suspended and dissolved solids, turbidity and nutrient levels increase substantially from land surface erosion and accumulated winter debris. Water chemistry data compiled by Pan Ocean from these rivers are generally similar to those presented here. (Appendix III). Notable exceptions were the greatly increased values of total suspended solids recorded from a majority of Wind River stations on 26 August. Similarly, a high value (71.2 mg/1) for SO_4 was recorded from station 10 on Illtyd Creek, on 16 October. Reasons for these deviations are not readily apparent.

5.3.2 Benthic Macroinvertebrates

Benthic sampling in the present study was preliminary and designed only to identify the major taxa of macroinvertebrates within the study area. Commonly used population statistics, such as species diversity and equitability have meaningful application only to studies that involve much greater effort and sampling replication; these statistics are inappropriate for the present overview study. The majority of organisms in the samples were not identified further than major group (e.g., class, order); related to difficulty of taxonomic separation. Groups, numbers and weights of organisms collected are presented in Tables 9 and 10.

The densities of macroinvertebrates varied among samples (3 to 94 organisms/sample) but were generally extremely low throughout the study area. The most productive site, in terms of both numbers and wet weight of organisms, was Station 4 on Illtyd Creek (Tables 9 and 10). Ephemeroptera (mayflies) were relatively abundant in the July samples at all stations except Station 7. Dipteran larvae and oligochaetes comprised a major part of most samples.

5.3.3 Fish

A summary of major habitat features and fish distribution of Illtyd Creek and the Wind River is presented in Table 11. Fish collection data, by sampling method, are given in Table 12. Lengths, weights and related statistics of fish are presented in Appendix IV.

5.3.3.1 *Habitat Characteristics*

Habitats in Illtyd Creek and the Wind River were generally similar at the stations visited. Within the study area, both watercourses display characteristics of moderately high energy streams. Both watercourses contain numerous braided areas of up to 30 channels (e.g., Station 5 on Wind River). Braided sections are interspersed with confined, irregularly meandering sections. Swift currents and clean, predominately gravel substrates were characteristic of most channels (Table 11). However, deeper channels (e.g., Station 5) and some side channels (e.g., Station 3 on Illtyd Creek) exhibited some silt deposition.

Large gravel bars occur throughout both stream channels. Pools were common in both braided and meandering reaches. In Illtyd Creek, pools are not large and most appear to be less than 2 m deep.

The wide flood plains of both watercourses precluded shading of the water by vegetation--an important component of rearing and feeding habitat. At Station 1, spruce trees along the east bank provided approximately 40% shading of the river. However, vegetation was minimal or absent at all other sites.

Table 9. Numbers and Total Weights of Benthic Macroinvertebrates Collected from Illtyd Creek and the Wind River, July 1980.

Location	Illtyd Creek	Wind River			
Station/Sample Number	4-1	7-1	8-1	8-2	8-3
Taxa					
Emphemeroptera					
Heptageniidae	18	0	22	21	15
Ephemerellidae	2	0	0	0	0
Baetidae	3	3	1	1	0
Plecoptera	5	1	3	2	1
Diptera					
Chironomidae	17	2	20	9	10
Deuterophlebiidae	1	0	0	0	0
Simuliidae	3	0	1	3	0
Acarina	3	1	0	0	0
Gastropoda	1	0	0	0	0
Bivalvia	1	0	0	0	0
Oligochaeta	40	0	0	0	0
Total individuals/sample	94	7	47	36	26
Total wet weight (mg)	64	≈5	43	33	39

Table 10. Numbers and Total Weights of Benthic Macroinvertebrates Collected from Illtyd Creek and the Wind River, September 1980.

Location	Illtyd Creek			Wind River					
Station/Sample Number	4-1	4-2	4-3	5-1	5-2	5-3	6-1	6-2	6-3
Taxa									
Ephemeroptera									
Heptageniidae	3	1	0	2	0	0	2	2	2
Baetidae	4	4	3	1	1	2	0	5	0
Leptophlebidae	2	4	1	4	0	4			
Plecoptera	1	1	5	1	1	1	1	0	1
Trichoptera	1	0	0	0	0	0	0	0	0
Diptera									
Chironomidae	15	23	21	17	20	18	0	1	0
Simuliidae	0	0	1	0	0	0	0	0	0
Tipuliidae	0	0	0	2	0	0	0	0	0
Acarina	3	1	0	1	0	0	0	0	0
Turbellaria	1	1	0	0	0	0	0	0	0
Oligochaeta	48	10	20	1	0	0	0	0	0
Coelenterata	0	0	0	0	0	0	0	1	0
Total individuals/sample	78	45	51	29	22	25	3	8	5
Total wet weight (mg)	90	41	58	22	11	17	1	13	12

Table 11. Selected Physical Characteristics of Aquatic Habitat and Fish Species Collected in Illtyd Creek and the Wind River.

Watercourse	Station	Channel Width (m)	Mean[1] Depth (cm)		Max.[1] Depth (cm)		Discharge[1] $m^3 sec^{-1}$		Bank Stability	% fines (<3 mm)	% gravel (3-75 mm)	% rubble (75-300 mm)	Flow[2] Character	Fish[3] Species
Illtyd Creek	1	15[a]	42[a]	51[b]	73[a]	95[b]	241[a]	474[b]	Poor	0	100	0	B/S	GR, SS
	2	10[a]	-[c]	-	-	-			Good	0	20	80	T/S	No fish collected
	3	6[a]	38[a]	35[b]	54[a]	110[b]	121[a]	231[b]	Good	30	60	10	B	GR, SS DV
	4	21[a]	28[a]	52[b]	50[a]	80[b]	346[a]	543[b]	Poor	0	20	80	T	GR, SS
Wind River	5	15[d]	-	-	-	-	-	-	Poor	50	40	10	S	GR, SS, DV
	6	25[d]	-	-	-	-	-	-	Poor	20	60	20	P	GR, SS RW, DV
	7	50[d]	-	-	-	-	-	-	Good	0	40	60	T/S	GR, SS DV
	8	50[d]	--	-	-	-	-	-	Good	5	15	80	T/S	GR, SS

[1] Information could not be collected at sites on the Wind River.
[2] Flow character: S - swirling, P - placid, B - broken, T - tumbling.
[3] Fish species: GR - Arctic grayling, SS - slimy sculpin, DV - Dolly Varden, RW - round whitefish.
a July survey
b September survey
c Information not collected. This site is located in an area of intermittent sub-surface flow.
d Estimated.

Table 12. Fish Species[1] Collected Within the Study Area, by Sampling Method.

Watercourse	Sampling Period	Electrofishing	Seining	Gill Netting	Angling
Illtyd Creek	July	NA[2]	24 GR, 11 SS	2 GR	3 GR
	September	5 GR, 42 SS	NA[2]	0[3]	NA[2]
Wind River	July	NA[2]	3 GR, 6 SS, 2 DV	20 GR, 3 DV, 1 RW	NA[2]
	September	6 GR, 39 SS, 1 DV		0[3]	NA[2]

[1] Fish species: GR - Arctic grayling, SS - slimy sculpin, DV - Dolly Varden, RW - round whitefish.
[2] NA - not attempted.
[3] 0 - method attempted, no fish captured.

During the July survey, three ice fields were found between Stations 1 and 2 on Illtyd Creek. The largest of these, approximately 3-km long and 2-km wide, occurred within the proposed mine area, just upstream of Station 3. Two ice fields were found on the Wind River between Stations 6 and 7. The presence of ice fields can indicate the occurrence of springs which flow throughout the winter. However, portions of Illtyd Creek remain open and flowing during the winter, which may account for the presence of the ice fields (D. Dodge, local trapper, pers. comm. 1980).

5.3.3.2 *Distribution*

a. Illtyd Creek

Three species of fish, Arctic grayling, Dolly Varden, and slimy sculpin were collected from Illtyd Creek during this study. Utilization of the upper reaches of Illtyd Creek appeared to be minimal. Station 2 is located above an area of sub-surface flow. During July it was isolated from the remainder of the stream by a dry section of channel. No fish were captured at this site and it was not revisited during September.

A total of 34 Arctic grayling, 1 Dolly Varden and 43 slimy sculpins were collected from Stations 1, 3 and 4 on Illtyd Creek. Fork lengths of Arctic grayling ranged from 18 to 395 mm; weights ranged from < 0.04 to 744 g. The calculation of length-weight and age-length relationships from the data is unjustified due to insufficient sample size. Five (2 females, 3 males) of the grayling were mature and ranged in age from 6 to 8 y. Mature grayling were captured only at Stations 1 and 4 during the July survey. These fish would very likely have spawned the following spring. (Egg size averaged 1.1 and 1.2 mm; those of ripe grayling are normally about 2.5 mm in diameter). The age at which grayling reach sexual maturity is highly variable. However, immature fish in the above age range (6 to 8 y) are not uncommon in northern drainages (Craig and Wells 1975).

During July, young-of-the-year grayling were captured at Stations 3 (18 individuals) and 4 (6 individuals). Both stations had riffles with gravel substrates suitable for spawning and backwater areas of negligible flow. It seems likely that these sites are used as spawning and nursery areas. However, no spent fish were collected.

No fish were captured at Station 1 during the September survey. At this time 5 juvenile grayling (fork lengths 54-164 mm, $\bar{x}$ = 92 mm; weight 1.3-46.5 g, $\bar{x}$ = 13.6 g) were collected at Stations 3 and 4. One immature female Dolly Varden (80 mm, 7.5 g) was captured at Station 3. A total of 42 slimy sculpin were also collected in Illtyd Creek.

b. Wind River

Arctic grayling, round whitefish, slimy sculpin and Dolly Varden are reported from the Wind River (Department of Fisheries and Oceans, unpublished data). Pike and various species of whitefish may also occur in the lower reaches. The first four of the above species were collected during the present study. The number of fish collected in the Wind River during the two surveys totalled 29 Arctic grayling, 45 slimy sculpin, 6 Dolly Varden and 1 round whitefish (see Table 12).

Detailed life history analyses of fish captured in the Wind River are precluded by insufficient sample sizes.

In July, 20 grayling representing three age classes (2, 3 and 4-5 y) were captured at Station 6. Seven of these fish were mature (fork length 153 to 231 mm, $\bar{x}$ = 197.9 mm; weights 44.6 to 118.4 g, $\bar{x}$ = 72.4 g) and appeared to have sufficient gonadal development to spawn in the spring of 1981. Thirteen immature grayling (fork lengths 159 to 235 mm, $\bar{x}$ = 197.5, n = 11; weights 40.0 to 138.6 g, $\bar{x}$ = 76.0, n = 11) were collected at this location. During the July survey one juvenile grayling was captured at Station 5 and two juveniles were collected at Station 8. Sampling during September resulted in the capture of three immature grayling at Stations 6 and 7 and three mature, green fish (fork lengths 279, 305 and 311 mm, weights 220, 330 and 340 g) at Station 8.

Dolly Varden char were captured at Stations 5, 6 and 7. Three mature females (fork lengths 211, 244 and 275 mm, weights 88.0, 116.9 and 191.7 g) were collected from Station 6. Three other Dolly Varden collected from Stations 5 and 7 were immature (fork lengths 80, 85, 95 mm, weights 5.8, 5.4 and 7.1 g).

Forty-five slimy sculpin were captured in the Wind River; sculpins were present at all stations sampled. This species occurred more abundantly in samples during the September survey (Table 12) than during the July survey. Sculpins may be a food source for predators such as Dolly Varden and large grayling; however, none occurred in the stomach contents of any fish that were sampled.

5.3.3.3 *Food Habits*

The stomach contents of 26 grayling, 3 Dolly Varden and 1 round whitefish, captured during the July survey, were examined qualitatively (Table 13). Three general categories of food items were identified.

a. bottom foods, primarily the pre-adult stages of aquatic insects (e.g., mayfly and stonefly nymphs and dipteran larvae and pupae);

b. surface foods which included terrestrial insects and the adult aerial stages of aquatic insects; and

c. plant material

Only one grayling stomach was less than 25% full ($\bar{x}$ = 53%). Three adults captured in Illtyd Creek each had 100% full stomachs which suggests that the two streams sampled in the study area may be important grayling feeding areas. Of the three Dolly Varden sampled, none had greater than a 5% full stomach.

The results of stomach content analysis illustrate the wide variety of food items used by grayling.

The frequencies of occurrence in grayling stomachs of a variety of bottom and surface foods are compared in Figure 13. Adult Diptera occurred most often, illustrating the importance of surface foods in the diets of grayling captured. Other surface foods frequently eaten were

Table 13. Qualitative Identification of Stomach Contents of Arctic grayling[1], round whitefish[2] and Dolly Varden[3].

Sampling Station	Illtyd 1			Illtyd 2		Wind 3									Wind 4		Wind 5	Wind 6												
Fish Number	1[1]	2[1]	3[1]	1[1]	2[1]	1[2]	2[1]	3[1]	4[1]	5[1]	6[1]	7[1]	8[1]	9[1]	1[1]	2[1]	1[1]	2[1]	3[1]	4[1]	5[1]	6[1]	7[1]	8[1]	10[1]	11[1]	12[1]	13[3]	14[3]	15[3]
Percent Full	100	100	100	75	75	25	50	75	75	50	10	50	50	25	25	25	25	25	75	25	75	50	25	25	75	50	50	1	5	5
Contents Weight (g)	14.0	15.8	10.3	12.1	2.8	.61	.62	.89	1.49	.77	.70	.97	.61	.53	.19	.12	.11	.35	.96	.33	.72	.96	.37	.39	.95	.73	.56	0	.34	.33
Wood		P								P	P																			
Seeds					C		C	A	A	P	C	F	A	C					P		F	C	C		A	A	C			
Gastropoda	P			P																										
Isopoda	P																													
Ephemeroptera-adult	C	C																												
nymphs-general	P		A		F		C					P			P	P		P		P	C									
Heptageniidae	F	C	C		F	P				P	F		P	P	F									P	C		P			
Leptophlebiidae						C					F															P	P		F	
Ephemerellidae				P	P																									
Odonata																				P										
Plecoptera-adult	C		P	P																										P
large nymph			C		C	P		P	C			P		F			P	P			C	P	P	P			C			
small nymph	A	A	A	C	C				C						F					P										
Hemiptera																														
Jassidae					P					P								P		P										
Membracidae					P																									
Lepidoptera-larvae				P																										
Trichoptera-adult																										P				
-larvae	C	P																												F
Diptera-adult	C	C	C		C		F	F	P	C	F	P		F	P	P	P		F	P	C	C	P	C	P	C				
Muscidae	P	P	P	F					P																					
Simuliidae			P		P					P																				
Culicidae			P																											
Syrphidae			P																											
larvae-																														
Simuliidae		P	P										P																	
Chironomidae				P	C	A	A		P	P	F	C	C		A		F	P	P		P	C		P	P		P			
pupae-																														
Simuliidae							F	C														P				P				
Chironomidae								F	P							C														
Hymenoptera-winged	P		P																											
Formicoidea	F	A	A	A	C			P	P			P							P								P			
Coleoptera (Terrestrial)	C	C	C	C	C			P		P	P	F	F	P			P	P	C		P	P	P	P	P	P	P			
Staphylinoidea																			P	P		P								
Curculionoidea		P						P												P		P								
Chrysomeloidea	P																													
Coleoptera (Aquatic)	P	C		C													P	C												
Arachinida																														
Aranea	P	P	P	P																		P						P		
Acarina										C			F	A				P	C		P	C	C	P		C				

P=Present (1 or 2) C=Common (>5 <10) F=Few (<5) A=Abundant (>10)

[1]Arctic grayling, 26 individuals
[2]round whitefish, 1 individual
[3]Dolly Varden, 3 individuals

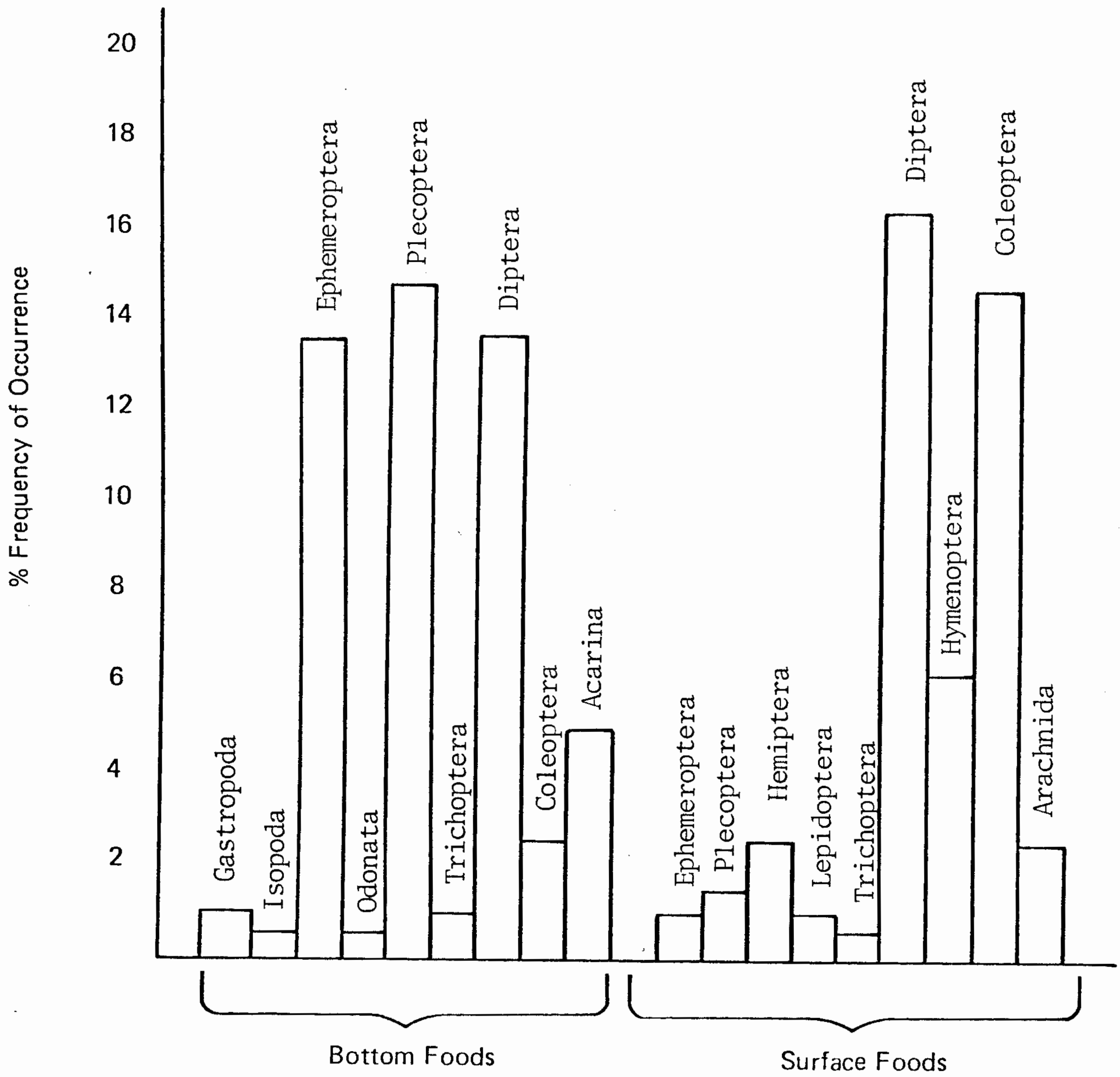

Figure 13. Comparison of the % Frequency of Occurrence of Various Bottom and Surface Foods in Grayling Stomachs. Winged (adult) stages of aquatic insects such as Ephemeroptera, Plecoptera and some Diptera are classified as surface foods.

terrestrial Coleoptera and Hymenoptera. The most frequently eaten bottom food organisms were Plecoptera nymphs, although Ephemeroptera and the aquatic stages of dipterans were also commonly encountered in the samples.

5.4 EXISTING ENVIRONMENT

Because Arctic grayling was the most numerous and widely distributed sports species encountered in the study area, the following section primarily concerns this species.

Spawning, by grayling, in Illtyd Creek may be inferred from the presence of young-of-the-year at two stations. At a majority of stations in both watercourses, substrates were suitable for spawning due to the presence of silt-free gravels. However, there was no evidence of spawning in the Wind River. The absence of spent fish in Illtyd Creek may have resulted from the downstream movement of fish after spawning. Both rivers were used to some extent as rearing habitat and nursery areas (i.e., by juveniles and young-of-the-year).

In general, summer fish habitat is relatively poor in both Illtyd Creek and the Wind River. A number of factors, including swift currents, lack of undercutting and lack of cover, contribute to reduce the quality of fish habitat. Benthic macroinvertebrate populations were present in low densities, perhaps reflecting the low nutrient concentrations in these streams. Primary production in the streams could also be low. Terrestrial insects tended to form a significant portion of the diet of Arctic grayling. Their availability is seasonal and is also related to the amount of overhanging vegetation. There was little overhanging vegetation along the stream.

The present study provides insufficient data to describe the seasonal movements of grayling within Illtyd Creek or the Wind River. However, it is likely that the general pattern of movement described by Craig and Poulin (1975) is applicable. In northern streams, they commonly found that adults and juveniles move upstream in the spring. Most adults move downstream shortly after spawning, whereas juveniles and young-of-the year remain in tributary streams. Prior to freeze-up, there is generally a large downstream movement of fry and juveniles from tributaries. During the September survey, juveniles occurred in low numbers at most stations. Adults, were found only at Station 8, the furthest downstream site on the Wind River.

Due to the possible presence of springs, some fish may overwinter in Illtyd Creek and the Wind River. It is unknown if groundwater discharges are sufficient for this purpose, although open water areas have been noted in both rivers during the winter (Fig. 4). Dolly Varden eggs are laid in the fall and incubate throughout the winter. Therefore, free water (i.e., either open water or water under ice) throughout the winter is critical to the spawning success of this species. Although few Dolly Varden were captured in the present study area, the apparent presence of flow in both streams throughout the winter could mean that potential spawning areas for Dolly Varden occur in the area. A field visit is planned prior to break-up in 1981 to establish the overwintering potential of these areas.

Although limited in scope, the present data suggest that grayling are the most abundant sportfish in the study area. Illtyd Creek perhaps harbours more grayling than the Wind River. Dolly Varden and round whitefish numbers appear to be low. Slimy sculpins were the only forage fish found; they were widespread and the most abundant fish species captured.

6. POTENTIAL IMPACTS

The plans for development of a coal mine and thermal power plant (and possible coal slurry pipeline) are still preliminary and incomplete; hence, it is not possible to discuss potential impacts that may result from development in detail. The following section treats potential impacts in general in accordance with the present level of development planning. Impacts associated with the anticipated mine development are discussed in most detail. Impacts that may arise from alternate mine development plans, power production and power and/or coal transportation are mentioned as topics that need to be considered if planning progresses in such a direction.

Impacts on fish and wildlife resources are considered below. Impacts on vegetation are considered to be coincident with wildlife habitat loss and will not be considered further until specific development plans are prepared. Large portions of the discussion of impacts to fish and wildlife were taken from Psutka and Sekerak (1979) and Sopuck et al. (1979), respectively. A second review of wildlife impact literature was also consulted (Shank 1979).

Aesthetic impacts are not considered but it should be noted that the Bonnet Plume-Wind River region is a spectacular wilderness area. There are no roads within more than 100 km of the area. Wilderness areas, especially one as scenic and diverse as this, are considered as valuable natural resources by a large number of Canadians.

6.1 MINE OPERATION

6.1.1 Wildlife

Present plans call for an underground coal mine. As such, habitat loss is likely to be minimal and arise primarily from construction of mine facilities, roads, airstrip, camp facilities, coal storage areas and, if needed, mine tailings ponds. Because of the complete removal of vegetation and the associated human disturbance, it must be considered that these areas will become uninhabitable for most wildlife species. With an underground mine, the total affected area is likely to be small. Should eventual plans call for an open pit mine, or a combination underground/ open pit mine, considerably more habitat will be lost for a long period of time. The ramifications of such a loss must be evaluated on an area by area basis if and when open pit mining plans are developed.

Loss of habitat may be incurred in ways other than by direct removal. A little studied, but potential local problem, is the dispersal of coal dust downwind of coal storage areas. A coating of coal dust on vegetation may make it temporarily unpalatable to herbivores. A second, more permanent type of habitat alteration may result from drainage changes caused by mining. Drainage of wetlands may result in a temporary increase in the growth of seral shrub communities. However, drainage of habitats that are already preferred by a species may be detrimental to local populations (see Berg and Phillips 1974).

The presence of a human population in the area will result in wildlife disturbance. Human presence, noise and vehicular traffic affects the behaviour of wildlife by causing them to avoid areas of activity. Disturbance may also result from above-ground mine equipment, service aircraft and deliberate human harrassment.

Disturbance associated with many human activities can affect wildlife populations directly, by causing a deterioration in their physical condition, and indirectly, by excluding them from portions of their habitat or reducing their efficiency in the use of the habitat. Both of these effects may lead to decreased survival and/or productivity of individuals and may thus lead to population declines (Moen 1973, 1976; Geist 1975; Hudson 1977). Most caribou are known to avoid areas with high levels of human activity (Cameron and Whitten 1976, 1977, 1978; Tracy 1977; Roby 1978). Although some information is contradictory, most data indicate that sheep appear to be sensitive to human disturbance (Nelson 1966; De Forge 1972). Although moose appear to be less sensitive to human disturbance than are caribou or sheep, they still appear to avoid areas of frequent human disturbance (Denniston 1956; Tracy 1977).

Little information is available on the effects of disturbance on furbearers. Weasels and river otters appear to avoid disturbed areas (Ferris et al. 1978; MacDonald et al. 1978). Marten apparently are less susceptible to disturbance (Clark and Campbell 1977; Soutiere 1978). Wolves are more sensitive to disturbance than are foxes. Prolonged human disturbance of wolves may result in avoidance behaviour leading to abandonment of traditional denning sites (Carbyn 1974; Chapman 1977). Foxes, in contrast, do not appear to avoid areas of frequent human activity; they often habituate to human disturbances (Neumann and Merriam 1972; Penner 1976; Tracy 1977; Ferris et al. 1978). Information on effects of human disturbance on bears is inadequate. Limited information suggests that bears avoid areas that are frequently used by humans (Craighead and Craighead 1972a; Chester 1976; Tracy 1977).

Human activity may also affect birds by causing desertion of nests and increased predation of eggs in nests (Hammond and Forward 1956). Perennial disturbance of waterfowl moulting areas may lead to decreased use or abandonment of moulting areas (Sterling and Dzubin 1967).

Little specific information is available on the effects of noise on wildlife. It is likely that the effects of noise will be most severe when associated with aircraft rather than with stationary or localized activity. Quantitative studies on the response of mammals to aircraft disturbance are limited mainly to barren-ground caribou. Bergerud (1971) and Miller (1974) have postulated that increased expenditures of energy that result from disturbance may be at the expense of energy that is required for survival or reproduction. Continued disturbance may lead to the abandonment of parts of the range and/or the disruption of migration patterns. Present information suggests that grizzly bears are even more sensitive to aircraft disturbance than are caribou (Klein 1974; McCourt et al. 1974).

Repeated use of lakes by floatplanes has been shown to result in a temporary decrease of waterbird densities (Schweinsburg 1974; Schweinsburg et al. 1974). Similarly, repeated overflights (i.e., 21 overflights in 2 days) by aircraft have been shown to affect the nesting and incubation behaviour of geese (Gollop et al. 1974a), the behaviour and dispersion of moulting ducks (Gollop et al. 1974b; Ward and Sharp 1974), and the behaviour of staging geese (Renewable Resources Consulting Services Ltd. 1972; Salter and Davis 1974; Davis and Wiseley 1974).

The effects of vehicular traffic and above-ground mine equipment are likely to be localized and similar to the types of disturbance arising from human activity.

Harrassment, or the intentional continued disturbance of wildlife, is a special type of disturbance that can have more severe and widespread impact than the above mentioned types of disturbance. Species such as grizzly bears, caribou, sheep and wolves are often targets of harrassment and, as mentioned earlier, are also highly sensitive to disturbance. Although harrassment is unnecessary, it is difficult to control and thus becomes an unfortunate consequence of northern development.

Another form of disturbance--in that the normal behaviour of animals is altered--is the establishment of garbage dumps and the feeding of wildlife. The distribution, abundance, social behaviour, food habits, movements and many other aspects of various species' ecology can be greatly altered by the presence of an abundant, readily accessible food supply such as a field camp or garbage dump. Foxes, wolves, bears, ravens and gulls are most susceptible to this alteration of behaviour. Oftentimes, because of the proximity of dumps to human dwellings and the association of man with food 'handouts', these species lose some of their fear of man and thus pose a threat to human life (Craighead and Craighead 1972b; Milke 1977). As a result a number of animals are killed to protect the camp population. Many of these problems can be minimized by adequately fencing garbage dumps before wildlife become attracted to them and an adequate program of education, regulations and enforcement (Mundy and Flook 1973; Milke 1977).

The presence of a coal conveyor system has the potential to interrupt wildlife movement. We assume that, discounting noise, the impacts of the physical presence of a conveyor system will be comparable to the impacts of an elevated pipeline on which some data are available. Of 6961 caribou that approached simulated pipelines raised 0.5 to 2.4 m off the ground, 78.3% either circumvented the simulation or turned back. Only 1.8% passed under the simulated pipeline (Child 1973). Cameron and Whitten (1976, 1977, 1978) provided data that indicated the average height of the pipeline at 49 successful caribou crossings was 2.9 ± 0.5 m and the average height at 12 unsuccessful crossings was 1.4 ± 0.7 m. Moose apparently selected pipeline heights greater than 1.8 m for crossing and may have been physically prevented from crossing pipelines elevated less than 1.2 m. However, where pipeline-to-ground clearances were adequate (greater than 1.8 m), 83% of crossing attempts by moose were successful (Van Ballenberghe 1978).

For a long, elevated conveyor system, it can be assumed that the degree of impact will be proportional to the length of the conveyor. A short conveyor will probably have little impact because ungulates can easily circumvent the conveyor system. However, the exact location relative to the traditional movement corridors of moose and caribou will affect the extent of impacts caused by the conveyor system (Klein 1971, 1979). Smaller mammals and birds will probably not be affected.

Presently, there are no plans for a tailings pond to be associated with the mine. However, in the event that one becomes necessary, the potential toxicity of the anticipated effluent should be assessed for its possible effects on waterbirds. A moderate number of waterbirds were located in lakes on the lease south of the Chappie Lake area (based on surveys during 1980), but few waterbirds would be likely to contact a tailings pond located in the mine areas. Therefore, the potential impacts of tailings ponds would likely be small.

6.1.2 Fish

In discussing impacts to fish resulting from coal extraction by either underground or surface methods, all aspects of the development must be considered. This includes the ancillary land use activities associated with construction of living quarters for workers, disposal of sewage and wastewater, construction of access roads within the site and construction of conveyor belt lines to transport coal to the thermal generating plant.

Open pit mining is of greater potential impact than underground mining because of the extensive loss of surface soils and vegetation which results in increased erosion, siltation and possible chemical alteration of streams. Underground mining affects a smaller surface area; however, it may result in subsidence, soil bank leaching and acid water drainage into streams following abandonment.

The most obvious disturbance during the construction phase is likely to be the increase of silt loads in aquatic systems. Extractive processes and intensive land use within the development both create a major source of sedimentation. This problem will be increased by coal dust dispersal from stock piles, coal handling at transfer points and conveyor transport routes. The detrimental effects of increased sediment loads on the aquatic habitat and fauna have been reviewed by Brown (1975), Cordone and Kelley (1961), Peters (1967) and Phillips (1971).

The severity of impact from sedimentation varies considerably with the timing and quantity of silt released into the waterbody, the duration of the disturbance and the affected habitat. In suspension, sediment reduces light transmission and hence photosynthesis, lowering primary production by algae and macrophytes. Thus less food is available to higher trophic levels. Many of the invertebrates upon which fish feed are sensitive to siltation and die if loads are too high. Increased silt loads may also damage the gill membranes of aquatic organisms such as mayflies and cause death if sediment concentrations are high and exposure is prolonged. All life history stages of fish species inhabiting a waterbody may be affected by siltation either directly (suffocation of individuals) or indirectly (changes in other components of the aquatic system). Herbert and Richards (1963, cited by Brown 1975) found growth was reduced in rainbow trout held in increasing concentrations (between 50 and 200 ppm) of wood fibre and coal washing solids. Early life history stages of fish are particularly sensitive to sedimentation because eggs may be covered, or fry may be incapable of avoiding heavy concentrations of silt.

Fish populations inhabiting overwintering areas could also be affected because suspended materials could cause increased oxygen demands. Also, silt may render spawning or nursery areas unsuitable for use. Migrations may also be blocked by high silt loads because some fish species avoid entering turbid waters.

Most of the silt load created by construction activities will settle short distances downstream of the area of disturbance. These sediments would be dispersed by natural stream scour; the majority of dispersal would likely occur during the next freshet. Fine materials in suspension that do not settle as fast will be deposited over longer distances downstream of the area of disturbance.

A variety of impacts, other than sedimentation, may result from road construction. Improper installation of culverts during road construction across streams may block fish passage. Debris may collect at the upstream sites of bridges and culverts and may physically block fish migrations. Fish may not be able to move past bridges or through culverts if the construction and alignment of these structures cause constriction of waterflow resulting in high current velocities. Improper installation of culverts could result in the creation of impassable vertical waterfalls at the downstream end of the crossing structure. In extreme cases, long term blockage of fish passage to critical habitat can result in elimination of the population. Structures which constrict flow may also result in ponding and subsequent sedimentation in upstream areas. High discharge rates through culverts or past bridges may also result in increased erosion of stream banks immediately downstream of these structures.

Effects such as the above can be minimized by using appropriate designs and installation procedures.

Some of the estimated 250 workers living on site will likely fish the newly accessible streams. The impact of overharvesting could be severe in localized areas since northern fish populations are easily over-exploited due to their slow growth. However, the upper reaches of Illtyd Creek in the vicinity of the proposed mine site do not appear to have a large sport fishing potential, since no adult fish were captured here.

A potential impact, especially during the construction phase of the project, is the accidental introduction of toxicants or pollutants into aquatic systems. Substances that, if used, are likely to cause adverse affects include fuels, domestic wastes and possibly herbicides and pesticides. The presence of any of these materials could result in mortality of aquatic organisms and in the deterioration of aquatic habitat.

Although habitat destruction and alteration are expected to be the primary cause of disturbance to fish fauna, the presence of men and/ or machinery may also affect fish. These disturbances may result in behavioural modifications and could be a concern during sensitive periods. Migrating adults, breeding adults, newly-hatched fry and fish inhabiting overwintering areas are likely to be most sensitive to disturbance.

6.2 THERMAL POWER GENERATION

6.2.1 Wildlife

The establishment of a thermal power plant on Illtyd Creek would likely have only moderate to minor impacts on wildlife. Most severe impacts would occur from human disturbance (effects of disturbance have been discussed above) and habitat loss both from plant facilities and the cooling pond (if a pond is necessary). During winter, if heated water were discharged into Illtyd Creek, open water which might result could present a hazard or barrier to certain mammals that were previously able to cross the frozen stream during winter. This effect is considered to be minor, but is largely undocumented. Another potentially minor but undocumented effect of thermal power generation in northern climates during winter, is the generation of ice fog/hoar frost and other local

6.3 TRANSPORTATION

6.3.1 Wildlife

Access will need to be provided in order to move equipment and supplies into the area and to move coal and electricity out. Present plans call for an access road into the mine area from Mayo, a power line from the proposed thermal power plant to Carmacks and a slurry pipeline from the mine to Skagway, Alaska.

The least significant impact will result from the presence and operation of a power transmission line. Some impacts of power lines include possible avoidance by mammals and birds, and bird mortality from collisions especially during migration (Klein 1971, Weir 1976; Avery 1978; Avery et al. 1978). This form of mortality is insignificant for most bird populations (Mayfield 1967; Stout and Cornwell 1976), but may be more serious for rare or endangered species.

Impacts from pipelines have been quantitatively documented primarily with moose, caribou and reindeer. The coal slurry pipeline may include segments of buried, ground-level and elevated pipelines. Elevated pipelines have the greatest potential for creating a barrier to movement of ungulates, particularly caribou; buried pipelines are least likely to restrict ungulate movement (Cameron and Whitten 1977; Van Ballenberghe 1978). However, some ungulates tend to avoid pipeline corridors with an associated road entirely (Cameron and Whitten 1978; Roby 1978). There is a concern that sensitive mammals such as wolves, grizzly bears and sheep may also avoid pipeline corridors (Mutch 1977). The height of the pipe above ground and types of wildlife crossing facilities can also affect the response of ungulates to raised pipelines.

Access roads will likely be associated with the proposed transmission line and slurry pipeline. Access roads may present physical or behavioural barriers to wildlife as a result of a raised roadbed, steep embankments, snowbanks, vehicular traffic, visual alteration of the corridor and human disturbance. Mortality caused by collisions with vehicles can be an important concern where animals occur in high density (e.g., during caribou migration), or when populations are considered to be endangered. Roads may also deflect normal movement patterns, thus delaying or disrupting migrations (for reviews see Geist 1975; Leedy 1975; Leedy et al. 1975; MacDonald 1977; Tracy and Dean 1978; Sopuck et al. 1979).

Although present plans are for the access road to be closed to the public, all northern roads built with government funds in the past have been opened to the public (e.g., Dempster Highway, Alaska Highway).

Legislation in Alaska is presently being prepared to open a private road--the Alaska Pipeline Haul Road--to the public. Thus it is likely that a road into the Wind River area would eventually be opened to the public. If this should happen, a significant amount of human disturbance from traffic, recreational activities and hunting will likely result.

Another impact associated with all forms of transport is real and effective habitat loss. 'Real' habitat loss refers to the amount of habitat altered by construction and operation activities to an unusable state by a given species. Effective habitat loss refers to the area that is no longer used by wildlife due to avoidance.

Disturbance during construction is an impact that will be associated with the transmission line, pipeline and access road. General types of disturbance have been discussed above.

6.3.2 Fisheries

Many impacts that are likely to result from linear developments (e.g., roads and pipelines) associated with the proposed mine and thermal power development are similar to the types of impacts that are anticipated with the mining development. Such impacts include increased erosion and stream siltation, blockage of fish movement, an increase in angling pressure resulting from improved access for fisherman, and contamination of surface waters by chemical spills.

The proposed slurry pipeline for the export of excess coal requires substantial quantities of water. Engineering design studies have not been conducted on this aspect of the development. In the absence of specific design plans, no comment can be made regarding the sufficiency of minimum flows in watercourses in the study area. However, substantial water requirements that result in reduced flows in the Wind River and Illtyd Creek could cause serious habitat loss and disruption. Greatly reduced water flows especially during migration, spawning and overwintering could have serious impacts on fish populations in the area.

6.4 SUMMARY

Because of the lack of specific development plans by Pan Ocean Oil Ltd., it is not possible to identify site specific impacts to the environment, which may result from the proposed coal development. This report has, therefore, addressed general categories of impacts which may be anticipated. Typical environmental impacts associated with the major aspects of the project, mining, thermal power generation and linear transportation facilities, are listed in Appendix V. The description of actions and anticipated effects is accompanied by appropriate mitigating measures. Construction, operation, maintenance and abandonment phases are addressed.

It is realistic to expect that a majority of impacts will be negative, resulting in the disruption or alienation of habitat. However, the severity of a given impact is determined by a variety of factors including duration, timing (seasonal), area affected and the numbers of susceptible organisms affected. In general, an impact may be considered to be negative if it results in a reduction of population size below the carrying capacity of the environment, increases population size above carrying capacity, or reduces the existing carrying capacity (Thompson 1977).

Potential impacts may be of short or long duration, affecting populations either directly, or indirectly. In addition, disturbance, the effects of which are often difficult to assess, may result from various construction or operation activities. The level and significance of these impacts are ascribed subjectively in Appendix V.

It should be noted that not all of the activities listed in this appendix will necessarily be associated with the proposed development. However, these have been included for completeness, since the information is intended as a general guide to potential effects, and as such may be of greater relevance at a later stage in design finalization.

7. DATA GAPS AND RECOMMENDED STUDIES

Overview studies of wildlife, fisheries and vegetation have resulted in a better understanding of the vegetation, wildlife and fish the Pan Ocean lease, and permit a general appraisal of the potential environmental impacts of development in the Wind River-Bonnet Plume River area. Continued studies are necessary because the overview studies were not designed to address site specific detailed environmental concerns of the proposed mining development. Below are recommendations for future wildlife, and vegetation studies that will provide information needed to adequately assess the specific environmental impacts.

In most instances, our recommendations for further studies are for investigations of smaller areas, but with more effort being applied. Most studies should be restricted to the southern portion of the lease (except for swan counts and winter caribou surveys, see below). The recommended studies for 1981 include the following major topics.

a. Completion of the vegetation map of the mine area.

Because wildlife studies hinge on vegetation, and because it will be necessary to assess potential impacts on special vegetation types, the present preliminary vegetation map needs to be completed, at least for the southern portion of the lease. There is also a need for additional ground-truthing of the preliminary vegetation map.

b. A study of the distribution, movements and numbers of sheep in the Wind River-Illtyd Creek area.

Thinhorn sheep are considered to be a major trophy animal in the Yukon Territory. Considerable numbers of sheep are located in the Illtyd Range, along the Wind River, and in the Wernecke Mountains (identified as a critical winter range by LUIS maps). Movements through and seasonal occupancy of parts of the mine area were documented during 1980 but further information is necessary to define possible impacts.

c. A study of moose and winter caribou use of the development area.

Moose are widely distributed in the proposed mine area and adjacent region. It is important to document the distribution and abundance of moose by habitat type and season. Caribou move through the area and are potentially abundant there during winter. We also need to know the distribution and use of the lease area by caribou of the Porcupine Herd during winter. The distribution of woodland caribou on the lease should also be monitored during other wildlife studies on the lease.

d. A study of furbearer abundance in the proposed mine area.

The overview study did not include investigations of furbearers. Because of the actual and potential revenue gained by the harvest of furbearers by both native and non-native trappers, some basic information on abundance is required. This study should also include work on the distribution, movements and denning areas of grizzly bears. Grizzly bears are a highly sensitive species. The effects of development on bears could extend beyond the development area.

e. A brief, but intensive, survey of waterfowl and raptors breeding in the Wind River and Illtyd Creek areas.

Moderate numbers of waterfowl and raptors were found in the study area during 1980. An intensive search for raptors should be made in the southern lease area to assess the abundance of breeding raptors.

An attempt should also be made to census river-nesting geese along the Wind River and Illtyd Creek. The swans resident on the lease should be identified and censused. These species are relatively high profile and their total populations are low enough to warrant special attention.

f. Documentation of fish habitat utilization.

To protect the fishery resource of the study area, particularly during vulnerable life history stages, a more complete documentation of habitat utilization is required. It should be clear from this report that site specific data will eventually be required for the formulation of sound mitigating procedures for the variety of impacts likely to be associated with the development. This is particularly relevant in the case of timing of stream crossings, particularly if Arctic grayling spawn or overwinter within the study site.

g. A study of the seasonal distribution and movements of Arctic grayling and Dolly Varden.

Because the most important fish species within the study area from a social perspective are Arctic grayling and Dolly Varden, it is recommended that a study of their seasonal distributions and movements be initiated in 1981. General emphasis should be placed on the southern portion of the present study area, with particular emphasis on that portion of Illtyd Creek lying within the proposed mine boundary.

h. A study of the benthic infauna of the Wind River and Illtyd Creek.

It is also recommended that studies be conducted on the benthic macroinvertebrate fauna of the Wind River and Illtyd Creek, for a minimum of two years prior to construction. This study should be designed to generate quantitative data on the abundance, species diversity and community structure of benthic fauna and enable strict comparisons of pre and post operational water quality to be made.

8 ADDENDUM 1. Report on December 1980 Aerial Wildlife Survey

Subsequent to the completion of the draft final report for Pan Ocean Oil Ltd. (LGL Limited 1980), an aerial wildlife survey (survey number four) was flown to determine the distribution of ungulates within the Bonnet Plume lease. The following summarizes the results of this aerial survey.

METHODS

The fourth aerial survey was primarily designed to obtain information on moose and caribou. The survey was flown using a fixed-wing Cessna 185, at approximately 100 m AGL and 150 kph, on 15-16 December 1980. An attempt was made to follow the same route as flown on 14 October 1980. However, due to several navigational errors made by an inexperienced pilot, equipment malfunction and periods of low ice fog, considerable deviation from the planned route resulted, particularly in the area east of the lease.

RESULTS AND DISCUSSION

The sightings made during the present survey are presented in Fig. 11 An area of about 340 km^2 was surveyed of which about 230 km^2 was within the lease boundaries. About 6% of the total area of the lease was surveyed. A total of 23 moose (15 sightings), 22 caribou (3 sightings), 5 wolves (2 sightings) and a goshawk were seen on-transect during the survey. Four moose (4 sightings) were seen off-transect. Of these sightings, 18 moose (including all four moose seen off-transect) four caribou and the goshawk were seen within the lease boundaries. Additionally, one wolf and one moose were seen very near the lease boundary.

Moose

The density of moose observed on the transect route during December was $0.07/km^2$, which is comparable to densities of moose noted during earlier surveys.

Although no attempt was made to determine the abundance of moose in the lease area, because of the similarity of results during aerial surveys conducted from June-December 1980 it can be said that moose apparently are distributed throughout the lease in low numbers. This distribution appears to shift slightly on a seasonal basis as a function of differential habitat use.

Of 25 moose for which habitat data were recorded, 16 (13 sightings) were sighted in open spruce muskeg, 8 (3 sightings) were found in riparian willow habitat and 1 was sighted at the edge of a lake. The sighting of most moose in open spruce muskeg is in marked contrast to the results of three previous surveys during 1980.

No evidence of large-scale migrations by moose was found during this study, but the level of effort was not sufficient to document this with certainty. Movements of moose out of the Bonnet-Plume area may have taken place after the December survey was conducted. Large scale seasonal movements of moose have been documented in North America by Le Resche (1974) and Van Ballenberghe (1977), in Europe by Pulliainen (1974), and in Siberia by Kistchinski (1974). Van Ballenberghe (1977) noted that considerable individual and annual variability exists in the timing and extent of moose movement in Alaska.

Caribou

Most caribou (18) were sighted immediately east of the Knorr Range. A large number of tracks were also present in this area indicating that a considerably larger number of animals had passed through this area prior to our survey. Unfortunately, bad weather and a series of navigational errors made by the pilot prevented us from surveying the Noisy Creek area to determine whether many Porcupine caribou were wintering near the lease.

Few caribou were seen on the lease. Four caribou and most of the identifiable caribou tracks were located east of Illtyd Creek about 3 km from the nearest area of known coal occurrence.

On the basis of tracks in snow, cratering and sightings of caribou within the lease, it can be said that few caribou appeared to be using the lease area during the early winter period. Additional surveys would be necessary to determine whether or not use is greater at other times during the winter (i.e. January-May).

Other Species

A large number of small mammal tracks were seen during the December aerial survey. Many of these appeared to be snowshoe hare tracks, but furbearer tracks were also seen. Most furbearer tracks were seen along the edges of lakes in the Chappie Lake area and along the west slopes of the Knorr Range.

Five wolves were seen during the survey in two widely different locations and habitat types. A single wolf was seen along the Peel River in mixed-wood forest near the edge of the lease. A pack of four wolves was observed in scattered spruce habitat east of the Knorr Range (outside of the lease area).

A single goshawk was the only bird sighted during the aerial survey.

SUMMARY

The results of the December survey generally agreed with those of earlier surveys. Moose were sighted throughout the lease in low numbers. Few caribou and little caribou sign were seen in the lease.

The December survey was our first opportunity to observe significant levels of terrestrial furbearer sign over a large area. Of the area surveyed, lake margins in the Chappie Lake area and the slopes along the west side of the Knorr Range appeared to have the most furbearer activity.

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APPENDICES

Appendix I. List of Common and Scientific Names Used in this Report.

Birds[1]

Common loon	*Gavia immer*
Arctic loon	*Gavia arctica*
Red-throated loon	*Gavia stellata*
Swan sp.*	*Olor* sp.
Canada goose	*Branta canadensis*
Pintail	*Anas acuta*
American widgeon	*Mareca americana*
Green-winged teal	*Anas carolinensis*
Greater scaup	*Aythya marila*
Bufflehead	*Bucephala albeola*
Black scoter	*Oidemia nigra*
Surf scoter	*Melanitta perspicillata*
Red-breasted merganser	*Mergus serrator*
Goshawk	*Accipiter gentilis*
Marsh hawk	*Circus cyaneus*
Red-tailed hawk	*Buteo jamaicensis*
Golden eagle	*Aquila chrysaetos*
Bald eagle	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
Gyrfalcon	*Falco rusticolus*
Peregrine falcon	*Falco peregrinus*
Kestrel	*Falco sparverius*
Spruce grouse	*Canachites canadensis*
Rock ptarmigan	*Lagopus mutus*
Upland sandpiper	*Bartramia longicauda*
Spotted sandpiper	*Actitis macularia*
Lesser yellowlegs	*Totanus flavipes*
Common snipe	*Capella gallinago*
Herring gull	*Larus argentatus*
Mew gull	*Larus canus*
Arctic tern	*Sterna paradisaea*
Short-eared owl	*Asio flammeus*
Snowy owl	*Nyctea scandiaca*
Hawk-owl	*Surnia ulula*
Common flicker	*Colaptes auratus*
Flycatcher sp.	*Empidonax* sp.
Cliff swallow	*Petrochelidon pyrrhonota*
Gray jay	*Perisoreus canadensis*
Black-billed magpie	*Pica pica*
Common raven	*Corvus corax*
American robin	*Turdus migratorius*
Townsend's solitaire	*Myadestes townsendi*
Swainson's thrush	*Hylocichla ustulata*

---

* Whistling swan (*Olor columbianus*) or trumpeter swan (*Olor buccinator*).

Appendix I. (Continued)

Birds (cont'd)

Water pipit	*Anthus spinoletta*
Bohemian waxwing	*Bombycilla garrulus*
Yellow-rumped warbler	*Dendroica coronata*
Northern waterthrush	*Seiurus noveboracensis*
Redpoll	*Acanthis* sp.
Savannah sparrow	*Passerculus sandwichensis*
Dark-eyed junco	*Junco hyemalis*
Tree sparrow	*Spizella arborea*
White-crowned sparrow	*Zonotrichia leucophrys*
Longspur sp.	*Calcarius sp.*

[1] All birds in this list were observed on the lease by us during 1980.

Mammals

Pika	*Ochotona princeps*
Snowshoe hare	*Lepus americanus*
Arctic ground squirrel	*Spermophilus parryii*
Red squirrel	*Tamiasciurus hudsonicus*
Beaver	*Castor canadensis*
Muskrat	*Ondatra zibethicus*
Collared lemming	*Dicrostonyx torquatus*
Coyote	*Canis latrans*
Gray wolf	*Canis lupus*
Red fox	*Vulpes vulpes*
Black bear	*Ursus americanus*
Grizzly bear	*Ursus arctos*
Marten	*Martes americana*
Ermine	*Mustela erminea*
Least weasel	*Mustela nivalis*
Mink	*Mustela vison*
Wolverine	*Gulo gulo*
River otter	*Lutra canadensis*
Lynx	*Felis lynx*
Moose	*Alces alces*
Caribou	*Rangifer tarandus*
Thinhorn sheep	*Ovis dalli*

Fish

Arctic grayling	*Thymallus arcticus*
Dolly Varden	*Salvelinus malma*
Round whitefish	*Prosopium cylindraceum*
Slimy sculpin	*Cottus cognatus*

Appendix I. (Continued)

Vegetation

Larch	*Larix laricina*
White spruce	*Picea glauca*
Black spruce	*Picea mariana*
Aspen	*Populus tremuloides*
Balsam poplar (Cottonwood)	*Populus balsamifera*
Paper birch	*Betula papyrifera*
Alder	*Alnus* sp.
Juniper	*Juniperus communis*
White heather	*Cassiope tetragona*
Crowberry	*Empetrum nigrum*
Soapberry	*Shepherdia canadensis*
Cloudberry	*Rubus chamaemorus*
Rose	*Rosa acicularis*
Shrubby cinquefoil	*Potentilla fruticosa*
Lingenberry	*Vaccinium vitis-idaea*
Lousewort	*Pedicularis* sp.
Cranberry	*Oxycoccus microcarpus*
Rhododendron	*Rhododendron lapponicum*
Bearberry (evergreen)	*Arctostaphylos uva-ursi*
Alpine bearberry	*Arctostaphylos alpina*
Willow	*Salix* sp.
Reticulated willow	*Salix reticulata*
Dwarf birch	*Betula glanulosa*
Bilberry	*Vaccinium uliginosum*
Blueberry	*Vaccinium* sp.
Labrador tea	*Ledum groenlandicum*
Commandra	*Geocaulon* sp.
Sedge sp.	*Carex* sp. and *Eriophorum* sp.
False asphodel	*Tofieldia pusilla*
Coltsfoot	*Petasites* sp.
Moss campion	*Silene acaulis*
Anemone	*Anemone*
Saxifrage	*Parnassia* sp.
Purple saxifrage	*Saxifraga oppositifolia*
Avens	*Dryas drummondii*
Liquorice-root	*Hedysarum* sp.
Lupine	*Lupinus* sp.
Fireweed	*Epilobium latifolium*
Horsetail	*Equisetum* sp.
Lichens	*Cladonia* sp., *Cetaria* sp., and *Stereocalon* sp.
Peat	*Sphagnum* sp.

Appendix II. Numbers and Disposition of Fish Specimens Collected in Illtyd Creek and the Wind River. 1980.

(a) Illtyd Creek

Sampling Period	Species	Number of Specimens Collected	Retained
July 1980	Arctic grayling	29	29
	slimy sculpin	11	11
September 1980	Arctic grayling	5	5
	slimy sculpin	42	16
	Dolly Varden	1	1

(b) Wind River

Sampling Period	Species	Number of Specimens Collected	Retained
July 1980	Arctic grayling	23	21
	slimy sculpin	6	2
	Dolly Varden	5	5
	round whitefish	1	1
September 1980	Arctic grayling	6	6
	slimy sculpin	39	19
	Dolly Varden	1	1

APPENDIX III

Water Quality Data Collected from Illtyd Creek
and the Wind River by Pan Ocean Personnel

CHEMEX

CALGARY 2021 - 41 AVE. N.E. CALGARY, CANADA T2E 6P2
TELEPHONE (403) 276-9627 TELEX 038-25541
EDMONTON 6112 DAVIES ROAD, EDMONTON, CANADA T6E 4M9
TELEPHONE (403) 465-9877 TELEX 037-41596

CERTIFICATE OF ANALYSIS

• MINERAL • GAS • WATER • OIL • SOILS • VEGETATION • ENVIRONMENTAL ANALYSIS

PAN OCEAN OIL LTD.

DATE June 26, 1980

DATE RECEIVED: JUNE 5, 1980

PROJECT NO. 9411-5-0569

WATER ANALYSIS

Page 1

#	pH	Total Alkal.	SO_4 (ppm)	Cl (ppm)	O-PO_4 (ppmP)	T-PO_4 (ppmP)	NO_2 (ppmN)	NO_3 (ppmN)	NH_3-N (ppmN)	SiO_2 (ppm)	Color	Turb. J.T.U.
1.	7.57	68.6	6.7	0.5	0.003	0.004	<.003	0.125	.02	0.9	15	0.8
2.	7.50	60.3	9.2	0.4	0.003	0.003	<.003	0.139	.02	1.9	10	0.9
3.	7.52	68.6	11.6	0.5	0.003	0.005	<.003	0.140	.03	2.3	<5	0.9
4.	7.61	83.2	11.4	0.5	0.004	0.004	<.003	0.145	.03	2.3	<5	0.7
5.	7.55	79.0	9.8	0.6	0.003	0.004	0.003	0.132	.03	2.2	15	1.4
6.	7.66	79.0	9.2	0.7	0.003	0.005	0.003	0.134	.02	2.2	5	0.8
7.	7.43	62.4	7.2	0.9	0.006	0.012	<.003	0.080	.02	2.0	40	4.2
8.	7.54	62.4	7.2	0.7	0.006	0.011	0.005	0.077	.02	2.0	35	5.6
9.	7.44	62.4	6.5	0.8	0.006	0.015	0.005	0.054	.02	2.0	45	6.8
10.	7.45	64.5	7.8	0.7	0.006	0.012	0.004	0.080	.02	2.2	35	7.2
11.	7.54	68.6	7.6	0.7	0.005	0.007	0.003	0.086	.02	2.2	35	4.2
12.	7.44	74.9	7.4	0.6	0.005	0.007	0.006	0.083	.02	2.2	35	7.4
13.	7.50	72.8	6.8	0.9	0.005	0.009	0.005	0.083	.02	2.4	40	6.6
14.	7.48	72.8	6.6	1.0	0.006	0.010	0.004	0.083	.02	2.4	45	6.8
15.	7.52	77.0	6.3	1.2	0.006	0.013	0.003	0.085	.01	2.4	45	5.4
16.	7.48	74.9	6.3	1.0	0.006	0.013	0.003	0.114	.01	2.4	60	6.6
17.	7.48	72.8	6.1	0.9	0.006	0.012	0.007	0.081	.01	2.4	60	7.6
		as ppm $CaCO_3$										

Certified by ....

CHEMEX

CALGARY 2021 - 41 AVE. N.E. CALGARY, CANADA T2E 6P2
TELEPHONE (403) 276-9627 TELEX 038-25541
EDMONTON 6112 DAVIES ROAD, EDMONTON, CANADA T6E 4M9
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CERTIFICATE OF ANALYSIS

• MINERAL • GAS • WATER • OIL • SOILS • VEGETATION • ENVIRONMENTAL ANALYSIS

PAN OCEAN OIL LTD.

DATE June 26, 1980

DATE RECEIVED: JUNE 5, 1980

PROJECT NO. 9411-5-0569

Page 2

WATER ANALYSIS

#	Cond. umho/cm	T.S.S. (mg/1)	T.D.S. (mg/1)
1.	156.	<0.4	103
2.	156.	<0.4	101
3.	172.	<0.4	107
4.	195.	<0.4	123
5.	183.	0.8	114
6.	183.	0.4	116
7.	150.	4.8	90
8.	156.	12.8	96
9.	150	20.4	92
10.	156.	7.6	100
11.	174.	4.0	107
12.	172.	4.8	109
13.	174.	6.0	111
14.	172.	12.4	106
15.	178	7.2	114
16.	184.	10.0	117
17.	172.	8.8	108

Certified by ....

CHEMEX

CALGARY 2021 - 41 AVE. N.E. CALGARY, CANADA T2E 6P2
TELEPHONE (403) 276-9627 TELEX 038-25541
EDMONTON 6112 DAVIES ROAD, EDMONTON, CANADA T6E 4M9
TELEPHONE (403) 465-9877 TELEX 037-41596

CERTIFICATE OF ANALYSIS

• MINERAL • GAS • WATER • OIL • SOILS • VEGETATION • ENVIRONMENTAL ANALYSIS

Pan Ocean
Kiwi Lake Project
Received: July 10/80
Water Analysis

DATE Aug. 11/80

PROJECT NO. 9411-5-0856

SAMPLE NO.	NH_3-N (ppm N)	SiO_2 (ppm)	Color	Turbidity (J.T.U.)	Conductivity (umho/cm)	T.S.S. (mg/l)	T.D.S. (mg/l)
1	<.01	1.4	<5	0.4	241.	<0.4	157.
2	<.01	2.7	<5	0.3	208.	<0.4	135.
3	<.01	2.8	<5	0.3	241.	<0.4	156.
4	<.01	2.8	<5	0.3	252.	<0.4	164.
5	<.01	2.9	<5	0.3	263.	<0.4	171.
6	<.01	2.9	<5	0.3	247.	<0.4	161.
7	<.01	2.8	<5	0.3	258.	<0.4	168.
8	<.01	2.9	<5	0.3	258.	<0.4	170.
9	<.01	3.3	<5	0.3	263.	<0.4	174.
10	<.01	3.1	<5	0.3	258.	<0.4	170.
11	<.01	3.2	<5	0.3	252.	<0.4	165.
12	<.01	3.1	<5	0.3	258.	<0.4	168.
13	<.01	3.6	<5	0.2	258.	<0.4	169.
14	<.01	3.6	<5	0.3	269.	<0.4	175.
15	<.01	3.5	<5	0.4	274.	<0.4	178.
16	<.01	3.5	<5	0.3	274.	<0.4	176.
17	<.01	3.3	<5	0.3	269.	<0.4	173.
1W	<.01	3.0	<5	0.5	225.	<0.4	146.
2W	<.01	3.2	<5	0.3	219.	<0.4	142.
3W	<.01	3.4	<5	0.4	219.	<0.4	140.
4W	<.01	3.3	<5	0.5	219.	<0.4	139.
5W	<.01	3.4	<5	0.6	219.	<0.4	142.
6W	<.01	3.4	<5	0.6	219.	<0.4	144.
7W	<.01	3.4	<5	0.5	236.	<0.4	153.
8W	<.01	3.4	<5	0.6	236.	<0.4	151.
9W	<.01	3.4	<5	1.2	236.	1.6	154.
10W	<.01	3.5	<5	0.9	247.	0.8	161.
11W	<.01	3.4	<5	0.9	247.	0.8	159.
12W	<.01	3.4	<5	1.1	258.	<0.4	168.
13W	<.01	3.5	5	1.2	269.	<0.4	177.

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CALGARY 2021 - 41 AVE. N.E. CALGARY, CANADA T2E 6P2
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EDMONTON 6112 DAVIES ROAD, EDMONTON, CANADA T6E 4M9
TELEPHONE (403) 465-9877 TELEX 037-41596

CERTIFICATE OF ANALYSIS

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Pan Ocean
Kiwi Lake Project
Received: July 10/80
Water Analysis

DATE Aug. 11/80

PROJECT NO. 9414-5-0856

SAMPLE NO.	pH	Total Alkalinity (as ppm $CaCO_3$)	SO_4 (ppm)	Cl (ppm)	O-PO_4 (ppm P)	T-PO_4 (ppm P)	NO_3 (ppm N)	NO_2 (ppm N)
1	8.11	95.7	26.0	0.4	<0.003	<0.003	0.192	<0.003
2	8.06	93.6	16.0	0.3	<0.003	<0.003	0.129	<0.003
3	8.10	114.	18.0	0.3	<0.003	<0.003	0.152	<0.003
4	8.26	119.	18.5	0.4	<0.003	<0.003	0.162	<0.003
5	8.20	127.	17.0	0.4	<0.003	<0.003	0.154	<0.003
6	8.32	123.	16.5	0.4	<0.003	<0.003	0.148	<0.003
7	8.46	127.	16.0	0.5	<0.003	<0.003	0.142	<0.003
8	8.34	127.	15.5	0.4	<0.003	<0.003	0.142	<0.003
9	8.20	129.	16.0	0.4	<0.003	<0.003	0.160	<0.003
10	8.31	129.	15.5	0.4	<0.003	<0.003	0.155	<0.003
11	8.16	127.	14.0	0.4	<0.003	<0.003	0.153	<0.003
12	8.34	127.	14.0	0.4	<0.003	<0.003	0.147	<0.003
13	8.16	131.	11.0	1.5	<0.003	<0.003	0.155	<0.003
14	8.29	133.	11.0	1.5	<0.003	<0.003	0.149	<0.003
15	8.35	137.	11.0	1.0	0.003	0.003	0.170	<0.003
16	8.28	139.	10.5	0.9	<0.003	<0.003	0.177	<0.003
17	8.47	137.	10.5	0.9	<0.003	<0.003	0.179	<0.003
1W	8.23	108.	12.0	0.9	<0.003	<0.003	0.109	<0.003
2W	8.29	108.	11.5	0.9	<0.003	<0.003	0.115	<0.003
3W	8.36	106.	11.5	0.9	<0.003	<0.003	0.109	<0.003
4W	8.30	108.	11.5	0.9	<0.003	<0.003	0.112	<0.003
5W	8.28	108.	11.5	1.5	<0.003	<0.003	0.110	<0.003
6W	8.27	108.	11.5	0.9	<0.003	<0.003	0.109	<0.003
7W	8.31	112.	12.0	1.0	<0.003	<0.003	0.112	0.003
8W	8.29	112.	12.5	0.9	<0.003	0.006	0.118	<0.003
9W	8.22	114.	12.5	0.9	<0.003	<0.003	0.129	0.003
10W	8.18	116.	12.5	1.0	<0.003	<0.003	0.121	0.003
11W	8.26	119.	12.5	0.7	<0.003	0.005	0.115	0.003
12W	8.22	121.	13.5	1.5	<0.003	0.003	0.112	<0.003
13W	8.27	114.	30.0	0.9	<0.003	0.005	0.071	0.003

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CALGARY 2021 - 41 AVE. N.E. CALGARY, CANADA T2E 6P2
TELEPHONE (403) 276-9627 TELEX 038-25541
EDMONTON 6112 DAVIES ROAD, EDMONTON, CANADA T6E 4M9
TELEPHONE (403) 465-9877 TELEX 037-41596

CERTIFICATE OF ANALYSIS

• MINERAL • GAS • WATER • OIL • SOILS • VEGETATION • ENVIRONMENTAL ANALYSIS

Pan Ocean Oil Limited
Kiwi Lake Project
Received: August 12/80
Water Analysis

DATE Aug. 26/80

PROJECT NO. 9411-5-1262

SAMPLE #	NH_3-N (ppm N)	SiO_2 (ppm)	Colour	Turbidity (J.T.U.)	Conductivity (umho/cm)	T.S.S. (mg/1)	T.D.S. (mg/1)
1	<.01	1.5	<5	0.3	291.	0.4	183
2	<.01	2.3	<5	0.4	228.	0.4	149
3	<.01	2.4	<5	0.4	235.	2.0	159
4	<.01	2.4	<5	0.4	233.	1.2	148
5	<.01	2.5	<5	0.6	246.	<0.4	159
6	<.01	2.5	<5	0.5	249.	0.8	167
7	<.01	2.5	<5	0.5	246.	4.0	160
8	<.01	2.6	<5	0.5	238.	2.0	159
9	<.01	2.7	<5	0.5	245.	0.8	159
10	<.01	2.7	<5	0.5	223.	2.0	148
11	<.01	2.8	<5	0.5	229.	1.2	151
12	<.01	2.8	<5	0.5	241.	1.6	163
13	<.01	3.0	15	0.5	219.	2.4	146
14	<.01	3.0	15	0.9	233.	2.0	148
15	<.01	3.1	15	0.7	241.	3.2	158
16	<.01	3.1	20	1.3	238.	2.8	150
17	<.01	3.0	20	0.6	233.	2.0	152
1W	<.01	2.5	<5	1.8	246.	4.4	161
2W	<.01	3.0	<5	0.9	219.	4.8	144
3W	<.01	3.2	<5	1.8	241.	6.0	153
4W	<.01	3.2	<5	2.5	223.	7.6	147
5W	<.01	3.2	<5	2.0	228.	5.2	151
6W	<.01	3.1	<5	3.7	217.	8.8	139
7W	<.01	3.2	<5	32.5	236.	45.2	156
8W	<.01	3.1	5	13.5	246.	13.6	160
9W	<.01	3.2	<5	24.0	241.	32.0	153
10W	<.01	3.2	<5	24.0	230.	25.2	149
11W	<.01	3.3	5	16.0	234.	23.2	155
12W	<.01	3.4	10	39.0	237.	57.2	156
13W	<.01	3.8	20	15.3	248.	19.6	164

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CHEMEX

CA' 'ARY 2021 - 41 AVE. N.E. CALGARY, CANADA T2E 6P2
TELEPHONE (403) 276-9627 TELEX 038-25541

ED''ONTON 6112 DAVIES ROAD, EDMONTON, CANADA T6E 4M9
TELEPHONE (403) 465-9877 TELEX 037-41596

CERTIFICATE OF ANALYSIS

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Pan Ocean Oil Ltd.
Kiwi Lake Project
Received: August 12/80
Water Analysis

DATE Aug. 26/80

PROJECT NO. 9411-5-1262

SAMPLE #	pH	TOTAL ALKALINITY (as ppm $CaCO_3$)	SO_4 (ppm)	Cl (ppm)	O-PO_4 (ppmP)	T-PO_4 (ppmP)	NO_3 (ppmN)	NO_2 (ppmN)
1	7.64	99.8	26.2	0.5	<0.003	<0.003	0.164	<0.003
2	7.48	89.4	20.9	0.5	<0.003	<0.003	0.130	<0.003
3	7.46	91.5	20.3	0.3	<0.003	<0.003	0.125	<0.003
4	7.54	99.8	19.3	0.3	<0.003	<0.003	0.140	<0.003
5	7.58	99.8	19.0	0.3	<0.003	<0.003	0.134	<0.003
6	7.66	99.8	18.5	0.3	<0.003	<0.003	0.133	<0.003
7	7.64	99.8	17.7	0.3	<0.003	<0.003	0.123	<0.003
8	7.66	99.8	17.4	0.4	<0.003	<0.003	0.120	<0.003
9	7.68	99.8	17.0	0.4	<0.003	<0.003	0.115	<0.003
10	7.68	99.8	16.7	0.5	<0.003	<0.003	0.118	<0.003
11	7.73	102.	16.3	0.4	<0.003	<0.003	0.117	<0.003
12	7.72	102.	15.3	0.5	<0.003	<0.003	0.113	<0.003
13	7.58	104.	12.5	0.7	<0.003	<0.003	0.113	<0.003
14	7.62	106.	12.1	0.8	<0.003	<0.003	0.113	<0.003
15	7.44	106.	11.7	0.8	<0.003	0.003	0.113	<0.003
16	7.46	106.	11.0	0.7	<0.003	<0.003	0.110	0.003
17	7.54	104.	10.8	0.7	<0.003	<0.003	0.110	0.003
1W	7.61	99.8	17.1	0.6	<0.003	<0.003	0.109	<0.003
2W	7.66	104.	13.3	1.0	<0.003	<0.003	0.106	<0.003
3W	7.52	99.8	11.8	1.0	<0.003	<0.003	0.100	0.003
4W	7.60	99.8	12.4	1.0	<0.003	<0.003	0.103	<0.003
5W	7.64	99.8	12.3	1.0	<0.003	<0.003	0.107	<0.003
6W	7.54	99.8	12.3	0.9	<0.003	0.005	0.105	<0.003
7W	7.61	102.	12.5	0.9	<0.003	0.005	0.106	<0.003
8W	7.58	104.	12.5	1.0	<0.003	0.008	0.104	<0.003
9W	7.72	106.	12.3	0.7	<0.003	0.006	0.110	<0.003
10W	7.64	106.	13.4	0.9	<0.003	0.011	0.104	<0.003
11W	7.60	102.	14.5	1.0	0.006	0.014	0.101	<0.003
12W	7.60	106.	15.0	1.0	0.009	0.017	0.094	<0.003
13W	7.55	95.7	34.5	1.0	0.009	0.018	0.084	<0.003

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CALGARY 2021 - 41 AVE. N.E. CALGARY, CANADA T2E 6P2
TELEPHONE (403) 276-9627 TELEX 038-25541
EDMONTON 6112 DAVIES ROAD, EDMONTON, CANADA T6E 4M9
TELEPHONE (403) 465-9877 TELEX 037-41596

CERTIFICATE OF ANALYSIS

• MINERAL • GAS • WATER • OIL • SOILS • VEGETATION • ENVIRONMENTAL ANALYSIS

PAN OIL LTD.

DATE OCT. 16, 1980.

WATER ANALYSIS
KIWI LAKE

PROJECT NO. 9411-5-1677

RECEIVED OCT 20 1980

SAMPLE NUMBER	NH3-N (PPM)	SiO2 (PPM)	COLOR UNITS	TURBIDITY J.T.U.	CONDUCTIVITY UMHO/CM	T.S.S. MG/ℓ	T.D.S. MG/ℓ
1	<0.01	1.6	<5	0.20	331.	<0.4	202.
2	<0.01	2.5	<5	0.20	233.	2.0	147.
3	<0.01	2.7	<5	0.20	244.	<0.4	159.
4	<0.01	2.6	<5	0.28	260.	<0.4	163.
5	<0.01	2.7	<5	0.12	249.	<0.4	162.
6	<0.01	2.6	<5	0.12	260.	<0.4	163.
7	.06	2.7	<5	0.22	260.	<0.4	169.
8	<0.01	2.6	<5	0.10	266.	<0.4	173.
9	<0.01	2.7	<5	0.22	260.	<0.4	163.
10	<0.01	2.8	<5	0.18	260.	1.2	165.
11	<0.01	2.8	<5	0.18	260.	1.6	169.
12	<0.01	3.1	<5	0.20	260.	1.2	171.
13	<0.01	3.2	<5	0.20	266.	1.2	170.
14	<0.01	3.3	<5	0.40	266.	1.6	169.
15	<0.01	3.2	<5	0.34	266.	1.6	173.
16	<0.01	3.2	<5	0.40	271.	0.8	173.
17	<0.01	3.2	<5	0.42	271.	2.0	179.
1W	.01	3.3	<5	0.40	244.	1.6	154.
2W	<0.01	3.1	<5	0.38	249.	0.8	149.
3W	<0.01	3.1	<5	0.48	246.	1.6	150.
4W	<0.01	3.1	<5	0.42	249.	1.6	151.
5W	<0.01	3.1	<5	0.42	249.	0.8	153.
6W	<0.01	3.0	<5	0.62	244.	1.6	159.
7W	<0.01	3.0	<5	0.46	255.	2.0	166.
8W	<0.01	3.0	<5	0.60	260.	1.6	164.
9W	<0.01	3.0	<5	0.58	260.	1.6	160.
10W	<0.01	3.0	<5	0.80	260.	2.4	163.
11W	<0.01	3.0	<5	2.4	266.	4.4	165.
12W	<0.01	3.1	<5	3.8	277.	5.2	163.
13W	.01	3.1	<5	2.6	315.	2.8	199.

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CHEMEX

CALGARY 2021 - 41 AVE. N.E. CALGARY, CANADA T2E 6P2
TELEPHONE (403) 276-9627 TELEX 038-25541
EDMONTON 6112 DAVIES ROAD, EDMONTON, CANADA T6E 4M9
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PAN OCEAN OIL LTD.
WATER ANALYSIS
KIWI ANALYSIS

DATE OCT. 16/80

PROJECT NO. 9411-5-1677

SAMPLE NO.	PH UNITS	TOTAL ALKALINITY PPM $CACO_3$	SO_4 PPM	CL PPM	OPO_4 PPM P	TBB_4 PPM P	NO_3 PPM N	NO_2 PPM N
1	7.85	81.1	47.0	0.1	<0.003	<0.003	0.184	0.004
2	7.91	66.6	21.8	0.1	<0.003	<0.003	0.135	0.005
3	7.93	70.7	22.5	0.1	<0.003	<0.003	0.136	0.004
4	8.02	77.0	21.0	0.1	<0.003	<0.003	0.154	0.004
5	8.26	79.0	20.0	0.1	<0.003	<0.003	0.151	0.005
6	8.00	79.0	19.0	0.1	<0.003	<0.003	0.153	0.005
7	8.17	81.1	18.5	0.1	<0.003	<0.003	0.136	0.004
8	8.02	81.1	18.0	0.1	<0.003	<0.003	0.128	0.005
9	8.01	83.2	17.2	0.1	<0.003	<0.003	0.134	0.004
10	8.03	83.2	71.2	0.1	<0.003	<0.003	0.135	0.005
11	7.86	83.2	16.0	0.1	<0.003	<0.003	0.135	0.004
12	8.26	85.3	12.5	0.5	<0.003	<0.003	0.188	0.005
13	8.13	87.4	12.0	0.5	<0.003	<0.003	0.135	0.004
14	8.22	89.4	11.5	0.5	<0.003	<0.003	0.135	0.005
15	8.18	91.5	11.0	0.5	<0.003	<0.003	0.140	0.004
16	8.18	89.4	10.0	0.5	<0.003	<0.003	0.149	0.004
17	8.21	93.6	10.0	0.5	<0.003	<0.003	0.149	0.004
1W	8.30	77.0	12.5	1.0	<0.003	<0.003	0.105	0.005
2W	8.20	79.0	13.5	1.0	<0.003	<0.003	0.105	0.005
3W	8.30	77.0	12.5	1.0	<0.003	<0.003	0.103	0.005
4W	8.27	77.0	12.5	1.0	<0.003	<0.003	0.105	0.004
5W	8.25	79.0	12.5	1.0	<0.003	<0.003	0.104	0.004
6W	8.30	79.0	12.5	1.0	<0.003	<0.003	0.109	0.006
7W	8.21	85.3	13.0	1.0	<0.003	<0.003	0.115	0.005
8W	8.20	85.3	13.5	1.0	<0.003	<0.003	0.106	0.005
9W	8.19	85.3	13.0	1.0	<0.003	<0.003	0.118	0.005
10W	8.26	85.3	24.0	1.0	<0.003	<0.003	0.111	0.007
11W	8.18	83.2	18.5	1.0	<0.003	<0.003	0.076	0.007
12W	8.22	87.4	18.5	1.0	<0.003	<0.003	0.093	0.007
13W	8.12	85.3	41.0	1.0	<0.003	<0.003	0.071	0.005

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Appendix IV. Summary of Physical Characteristics of Fish Species Collected from Illtyd Creek and the Wind River.

Illtyd Creek

Sampling Period	Sampling Station	Species	Length[1] (mm)	Weight (gm)	Sex[2]	Maturity[3]	Age[4] (yrs)
July 1980	1	Arctic grayling	388.0	740.00	F	M	7-8
			389.0	615.00	M	M	7-8
			372.0	696.20	F	M	8
		slimy sculpin[5]	35.0	0.41	Information not determined		
			28.5	0.25			
			26.5	0.21			
			25.0	0.17			
			23.5	0.15			
			24.0	0.15			
			22.0	0.13			
	3	Arctic grayling	24.0	0.10	U	y-o-y	
			22.5	0.09	U	y-o-y	
			23.0	0.10	U	y-o-y	
			22.5	0.08	U	y-o-y	
			25.5	0.09	U	y-o-y	
			22.0	0.07	U	y-o-y	
			24.5	0.11	U	y-o-y	
			24.0	0.10	U	y-o-y	
			22.5	0.08	U	y-o-y	
			22.5	0.08	U	y-o-y	
			21.0	0.07	U	y-o-y	
			24.5	0.11	U	y-o-y	
			18.0	0.04	U	y-o-y	
			21.5	0.07	U	y-o-y	
			23.0	0.10			
			24.0	0.11			
			22.0	0.08			
			22.0	0.08			
		slimy sculpin	22.0	0.11			
			23.0	0.12			
			26.5	0.23			
	4	Arctic grayling	25.5	0.16	U	y-o-y	
			22.5	0.10	U	y-o-y	
			23.0	0.12	U	y-o-y	
			24.0	0.12	U	y-o-y	
			21.0	0.07	U	y-o-y	
			26.0	0.15	U	y-o-y	

Appendix IV. (Continued)

Illtyd Creek

Sampling Period	Sampling Station	Species	Length[1] (mm)	Weight (gm)	Sex[2]	Maturity[3]	Age[4] (yrs)
July 1980	4	Arctic grayling	395.0	744.00	M	M	7-8
			308.0	345.00	M	M	6
		slimy sculpin	75.0	3.50			
September 1980	3	Arctic grayling	113.0	13.50	F	I	
			56.0	1.30	U	I	
		slimy sculpin	83.0	5.20	M	M	
			78.0	4.20	M	M	
			66.0	2.50	F	M	
			56.0	1.20	U	I	
			55.0	1.20	U	I	
			50.0	1.70	F	M	
			56.0	1.20	U	I	
			45.0	0.70	U	I	
			40.0	0.70	U	I	
			40.0	0.60	U	I	
			44.0	0.60	U	I	
			35.0	0.50	U	I	
			35.0	0.50	U	I	
		Dolly Varden	80.0	7.50	F	I	
	4	Arctic grayling	164.0	46.50	F	I	
			73.0	5.00	F	I	
			54.0	1.50	U	I	
		slimy sculpin	66.0	2.50	F	M	
			78.0	3.00	F	M	
			74.0	3.30	M	M	

Wind River

Sampling Period	Sampling Station	Species	Length[1] (mm)	Weight (gm)	Sex[2]	Maturity[3]	Age[4] (yrs)
July 1980	5	Arctic grayling	70.0	3.71	U	I	1
		slimy sculpin	52.0	1.28			
			36.0	0.50			
	6	Arctic grayling	190.0	62.70	F	M	3
			218.0	72.00	F	M	3
			153.0	44.60	F	M	2
			196.0	93.80	F	I	3
			204.0	74.80	F	M	2-3

Appendix IV. (Continued)

Wind River

Sampling Period	Sampling Station	Species	Length[1] (mm)	Weight (gm)	Sex[2]	Maturity[3]	Age[4] (yrs)
July 1980	6	Arctic grayling	183.0	53.10	U	I	3
			202.0	74.50	U	I	3
			193.0	65.40	F	M	3
			187.0	54.20	F	I	3
			198.0	70.00	F	I	3
			159.0	40.90	U	I	2
			201.0	75.30	U	I	3
			235.0	138.60	U	I	4-5
			202.0	74.90	F	I	3
			195.0	70.30	F	I	3
			214.0	89.80	U	I	3
			196.0	68.60	F	M	3
			231.0	118.40	F	M	3-4
		slimy sculpin	65.0	2.36			
			35.0	0.46			
		Dolly Varden	275.0	191.70	F	M	4
			244.0	116.90	F	M	4
			211.0	88.00	F	M	3-4
		round whitefish	214.0	76.90	U	I	3
	7	Dolly Varden	95.0	7.10	F	I	1-2
			85.0	5.36	U	I	1-2
	8	Arctic grayling	114.0	11.50	U	I	2
			34.0	0.40	U	I	
		slimy sculpin	37.0	0.53			
			27.0	0.20			
September 1980	5	Dolly Varden	80.0	5.75	U	I	
		slimy sculpin	76.0	5.07			
			64.0	2.77			
			50.0	1.37			
			42.0	0.70			
	6	Arctic grayling	106.0	9.50	M	I	
			56.0	1.50	U	I	

Appendix IV. (Continued)

Wind River

Sampling Period	Sampling Station	Species	Length[1] (mm)	Weight (gm)	Sex[2]	Maturity[3]	Age[4] (yrs)
September 1980	6	slimy sculpin	66.0	2.31			
			51.0	1.23			
			58.0	1.74			
			75.0	4.06			
			72.0	3.00			
			72.0	3.45			
			62.0	2.00			
			50.0	1.21			
			59.0	2.05			
			50.0	1.15			
			40.0	0.61			
			60.0	1.95			
			65.0	2.80			
			45.0	0.80			
			53.0	1.48			
	7	Arctic grayling	111.0	11.50	F	I	
	8	Arctic grayling	279.0	220.00	M	M	
			305.0	330.00	F	M	
			311.0	340.0	M	M	

[1] Total length measured for slimy sculpin, all others are fork lengths.
[2] F = female, M = male, U = unidentified.
[3] M = mature, I = immature, y-o-y = young-of-the-year.
[4] Due to small sample size ages were not determined for fish from the September survey.
[5] Sex, maturity and age were not determined for small forage fish.

Appendix V. General Description of Potential Impacts of Mining and Related Developments (Adapted from Psutka and Sekerak 1979).

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
GENERAL				
--Industrial development	Aesthetic	--loss of spectacular wilderness area	severe:permanent	--none
MINING				
Construction				
Mine				
--Water diversion	F	--habitat loss and direct mortality--diversion channel will result in a reduction of fisheries potential and mortality of benthos and aquatic macrophytes	high:long-term, irreversible,negative	--proper engineering design to maintain suitable seasonal flow regime
	W	--alteration of aquatic habitat	low:short-term, reversible, negative to neutral	--proper engineering design to maintain suitable seasonal flow regime
--Catchment ditches	F	--habitat degradation--increased sedimentation and increases of base flows	moderate:long-term, reversible, negative	--use of baffle structure (weirs) to reduce instantaneous runoff
--Settling ponds	F	--habitat degradation--increased erosion during construction phase	low:short-term, reversible, negative	--restabilization of dikes etc. by seeding
--Mine facilities	W	--habitat loss disturbance	low:long-term reversible, negative	--limit development to a small area away from sensitive wildlife habitats
Ancillary				
--Vegetation removal	F	--habitat degradation--increased erosion potential, increased flood peaks and reduced base flow to stream	low:long-term, reversible, negative	--retain buffer zones of vegetation near streams --settling basins --seasonal scheduling

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
--Site drainage and development	W	--habitat loss	med.-high:mid-term reversible, negative	--minimize area disturbed --immediate revegetation
	F	--habitat degradation--increased siltation	low:long-term, reversible, negative	--retain buffer zones of vegetation near streams --settling basins --seasonal scheduling
--Construction camp facilities	W	--habitat alteration	low:mid-long term irreversible; negative and positive	--avoid areas used by aquatic wildlife
a) Buildings	F	--none identified		
	W	--habitat loss	low:long-term reversible, negative	--avoid concentration areas or important areas for life history functions
b) Sewage and industrial waste disposal	F&W	--habitat degradation--careless disposal of toxic substances may contaminate aquatic habitats. Increased eutrophication near sewage outfalls.	low:long-term, reversible, negative	--provision of a suitable procedure for disposal of industrial wastes, particularly oil-based products and their containers. Supervision or enforcement may be required
--Vegetation removal for road construction	F	--habitat loss at crossing sites and degradation of streams and rivers from sedimentation --habitat degradation due to accumulation of organic debris in stream channels	moderate:long-term, reversible, negative	--rapid reclamation by re-seeding of right-of-way and placement of erosion control structures --clearing of debris from crossings --avoid steep slopes
	W	--habitat loss and alteration	low:mid-long term irreversible, negative and positive	--limit width of ROW

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
--Road high grading	F	--habitat loss at crossing sites and degradation of streams and rivers from sedimentation	moderate:long-term, reversible, negative	--rapid reclamation by re-seeding of right-of-way and placement of erosion control structures
		--habitat degradation due to accumulation of organic debris in stream channels		--clearing of debris from crossings --avoid steep slopes
	W	--disturbance to sensitive species	low:short-term, reversible, negative	--avoid areas when wildlife concentration present or during sensitive times of year
--Borrow pits	F	--habitat degradation caused by erosion during construction	low:short-term, reversible, negative	--rapid reclamation by re-seeding --settling ponds
	W	--habitat loss	low:long-term, irreversible, negative	--avoid important wildlife habitats
--Stream crossings	F	--disturbance of fish movements (spawning migrations, over-wintering movements)	high (blockage of movements), long-term, reversible, negative	--proper installation of culverts or the use of bridges --hand clearing only
		--habitat loss of stream bed riffle areas (spawning and feeding habitat)	low (habitat loss): short-term, reversible, negative	--scheduling of activities to avoid critical periods --control of beaver activity near crossings --divert or pump stream around crossing --utilize clean fill, silt screens, and settling basins
	W	--none identified		

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
Operation and Maintenance				
Mine				
--Vegetation removal	F	--habitat degradation--increased erosion potential increased flood peaks and reduce base flow to stream	moderate:long-term, reversible, negative	--retaining buffer zones of vegetation on steep slopes and near streams --settling basins, scheduling
	W	--habitat loss	moderate:long-term, reversible, negative	--minimize disturbed area and avoid important wildlife habitats
--Top soil stripping	F	--habitat degradation--increased erosion potential from the mining site will increase the sediment input into the surrounding watersheds	high:long-term, reversible, negative	--placement of erosion control structures to decrease the direct input of sediment into waterbodies --contouring and seeding --seasonal scheduling
	W	--habitat loss	moderate:long-term, reversible, negative	--minimize disturbed area and avoid important wildlife habitats
--Top soil stockpiles	F	--habitat degradation--increased erosion potential from the mining site will increase the sediment input into the surrounding watersheds	high:long-term, reversible, negative	--placement of erosion control structures to decrease the direct input of sediment into waterbodies --contouring and seeding --seasonal scheduling --containment of spoil piles with stable berms
	W	--habitat loss	low:long-term, reversible, negative	--minimize disturbed area and avoid important wildlife habitats

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impact	Mitigative Measures
--Overburden removal	F	--habitat degradation--increased erosion potential from the mining site will increase the sediment input into the surrounding watersheds	high:long-term, reversible, negative	--placement of erosion control structures to decrease the direct input of sediment into waterbodies --contouring and seeding --seasonal scheduling --containment of spoil piles with stable berms
	W	--habitat loss	moderate:long-term, reversible, negative	--minimize disturbed area and avoid important wildlife habitats
--Overburden stockpiles	F	--habitat degradation--increased erosion potential from the mining site will increase the sediment input into the surrounding watersheds	high:long-term, reversible, negative	--placement of erosion control structures to decrease the direct input of sediment into waterbodies --contouring and seeding --seasonal scheduling --containment of spoil piles with stable berms
	W	--habitat loss	low:long-term, reversible, negative	--minimize disturbed area and avoid important wildlife habitats
--Coal stripping	F	--habitat degradation--increased erosion potential from the mining site will increase the sediment input into the surrounding watersheds	high:long-term, reversible, negative	--placement of erosion control structures to decrease the direct input of sediment into waterbodies --contouring and seeding --seasonal scheduling --containment of spoil piles with stable berms

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impact	Mitigative Measures
	W	--habitat loss	moderate:long-term, reversible, negative	--minimize disturbed area and avoid important wildlife habitats
		--Possible blockage of ungulate movements by conveyor systems for coal transport to stock piles		--avoid movement corridors --elevate conveyor line >3 m
--Coal stockpiles	F	--habitat degradation--erosion of coal fines from stockpiles	low:long-term, reversible, negative	--containment of stockpiles to reduce wind and water erosion
	W	--habitat loss	low:short-term, reversible, negative	--minimize disturbed area and avoid important wildlife habitats --build windbreak to reduce dust dispersal
--Waste waters	F	--direct mortality--loss of aquatic biota due to toxicity of effluent	moderate:short-term to long-term, reversible negative	--water quality monitoring treatment of water to federal standards
		--habitat degradation--increase discharge in drainages receiving mine waters	low:long-term, reversible, positive and negative	--water quality monitoring treatment of water to federal standards
	W	--direct mortality to aquatic wildlife	low:short-term, reversible, negative	--water quality monitoring treatment of water to federal standards
--Catchment ditches	F	--habitat degradation--increase discharge in drainages receiving waste waters	moderate:long-term, reversible, negative	--use of surge ponds and settling ponds to control floods and sediments
		--increased flood peaks flows into sections of a watershed		--use of rip-rap and vegetation to stabilize ditch faces
	W	--none identified		

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impact	Mitigative Measures
Ancillary land use				
--Waste disposal	F	--careless disposal of toxic substances may contaminate aquatic habitats, particularly downstream of the development	moderate:long-term, reversible, negative	--proper disposal of industrial wastes, particularly oil-based products and their containers Supervision and enforcement may be required
		--air borne coal dust washed into streams	low:long-term, reversible, negative	--water sprays at transfer points --wind screens --spray stockpiles with pallatives --watering of haul roads
	W	--impacts from mine wastes as listed above	moderate:mid-term, reversible, negative	--proper disposal of industrial wastes
		--impacts from garbage disposal can alter normal behaviour of wildlife	low:mid-term, reversible, negative	--fence garbage dumps and provide sanitary landfill operation
--Drainage of site	F	--habitat degradation--increased siltation of receiving waters	low:long-term, reversible, negative	--direct runoff into vegetated buffer strips --locate surge ponds and settling ponds to control floods and sediments
	W	--reduction of habitat for aquatic wildlife	moderate:long-term, reversible, negative	--minimize area drained and avoid important wildlife habitat
--Snow removal from site		--none identified		
--Vehicle activity	F	--may create disturbance to migration, spawning, etc.	low:short-term, reversible, negative	--avoid areas of critical habitat
	W	--disturbance	moderate:short-term, reversible, negative	--avoid areas important to wildlife --limit amount and duration of vehicle activity
--Operation of loading facilities	F&W	--none identified		

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impact	Mitigative Measures
Reclamation and Abandonment				
Mine				
--Overburden placement (rehandling) if Open-Pit	F	--habitat degradation--increased erosion potential during recontouring of mining site	moderate:long-term, reversible, negative	--rapid reclamation and control of diversion channels
	W	--none identified		
--Top soil placement (rehandling)	F	--habitat degradation--increased erosion potential during recontouring of mining site	moderate:long-term reversible, negative	--rapid reclamation and control of diversion channels
	W	--none identified		
--Revegetation	F	--eutrophication of lakes due to use of fertilizers increased toxicity from petroleum products used in seeding	moderate:long-term, reversible, negative	--use of treated seeds in seeding --restrict runoff --adherence to federal reclamation guidelines
	W	--increased forage for herbivors	moderate:short-term, reversible, positive	--plant a diversity of preferably native species
--Removal of settling ponds	F	--habitat degradation--potential toxic chemicals leaching from pond site after removal--increased erosion potential during removal	low to moderate:long-term, reversible, negative	--rapid reclamation of site and control of surface drainage --infilling of ponds
	W	--none identified		
--Restoration of flow patterns	F	--habitat degradation--due to erosion and siltation	low:short-term, reversible, negative	--use of gabions and rip-rap to reduce erosion --seasonal scheduling --diversion channels
	W	--none identified		
Ancillary land use				
--Building removal	F&W	--none identified		
--Site preparation for revegetation	F	--habitat degradation--increased potentials for siltation from equipment used for site preparation	low:short-term, reversible, negative	--seasonal scheduling --direct runoff into vegetated buffer strips --sediment ponds
	W	--none identified		

Appendix V. (Continued)

Development Phase Activities	Resource	Potential Impact	Level and Significance of Impacts	Mitigative Measures
THERMAL POWER GENERATION				
Construction				
Power Plant				
--Water diversion				
	F	--habitat loss and direct mortality--diversion channel will result in a reduction of fisheries potential and mortality of benthos and aquatic macrophytes	high:long-term, irreversible,negative	--proper engineering design to maintain suitable seasonal flow regime
	W	--alteration of aquatic habitat	low:short-term, reversible, negative to neutral	--proper engineering design to maintain suitable seasonal flow regime
--Catchment ditches	F	--habitat degradation--increased sedimentation and increases of base flows	moderate:long-term, reversible, negative	--use of baffle structure (weirs) to reduce instantaneous runoff
--Settling ponds	F	--habitat degradation--increased erosion during construction phase	low:short-term, reversible, negative	--restabilization of dikes etc. by seeding
--Power Plant Facilities	W	--habitat loss disturbance	low:long-term reversible, negative	--limit development to a small area away from sensitive wildlife habitats
Ancillary				
--Vegetation removal	F	--habitat degradation--increased erosion potential, increased flood peaks and reduced base flow to stream	low:long-term, reversible, negative	--retain buffer zones of vegetation near streams --settling basins --seasonal scheduling

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
	W	--habitat loss	med.-high:mid-term reversible, negative	--minimize area disturbed --immediate revegetation
--Site drainage and development	F	--habitat degradation--increased siltation	low:long-term, reversible, negative	--retain buffer zones of vegetation near streams --settling basins --seasonal scheduling
--Construction camp facilities	W	--habitat alteration	low:mid-long term irreversible; negative and positive	--avoid areas used by aquatic wildlife
a) Buildings	F	--none identified		
	W	--habitat loss	low:long-term reversible, negative	--avoid concentration areas or important areas for life history functions
b) Sewage and industrial waste disposal	F&W	--habitat degradation--careless disposal of toxic substances may contaminate aquatic habitats. Increased eutrophication near sewage outfalls.	low:long-term, reversible, negative	--provision of a suitable procedure for disposal of industrial wastes, particularly oil-based products and their containers. Supervision or enforcement may be required
--Vegetation removal for Road construction	F	--habitat loss at crossing sites and degradation of streams and rivers from sedimentation	moderate:long-term, reversible, negative	--rapid reclamation by re-seeding of right-of-way and placement of erosion control structures
		--habitat degradation due to accumulation of organic debris in stream channels		--clearing of debris from crossings --avoid steep slopes
	W	--habitat loss and alteration	low:mid-long term irreversible, negative and positive	--limit width of ROW

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
--Road high grading	F	--habitat loss at crossing sites and degradation of streams and rivers from sedimentation	moderate:long-term, reversible, negative	--rapid reclamation by re-seeding of right-of-way and placement of erosion control structures
		--habitat degradation due to accumulation of organic debris in stream channels		--clearing of debris from crossings --avoid steep slopes
	W	--disturbance to sensitive species	low:short-term, reversible, negative	--avoid areas when wildlife concentration present or during sensitive times of year
--Borrow pits	F	--habitat degradation caused by erosion during construction	low:short-term, reversible, negative	--rapid reclamation by re-seeding --settling ponds
	W	--habitat loss	low:long-term, irreversible, negative	--avoid important wildlife habitats
--Stream crossings	F	--disturbance of fish movements (spawning migrations, over-wintering movements)	high (blockage of movements), long-term, reversible, negative	--proper installation of culverts or the use of bridges --hand clearing only
		--habitat loss of stream bed riffle areas (spawning and feeding habitat)	low (habitat loss): short-term, reversible, negative	--scheduling of activities to avoid critical periods --control of beaver activity near crossings --divert or pump stream around crossing --utilize clean fill, silt screens, and settling basins
	W	--none identified		

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impact	Mitigative Measures
Operation and Maintenance Power Plant --Water requirements for make-up	F	--habitat degradation due to altered stream flows	low to moderate:long-term, reversible, negative	--proper engineering design to maintain suitable seasonal flow regime
	W	--habitat alteration for aquatic wildlife	low:long-term, reversible, negative	--avoidance of timing conflict with migration and over-wintering --maintain natural or stable flow regime
--discharge of heated water during blow-down	F	--thermal shock	low:short-term, reversible, negative (depending on temperature difference between waste and receiving water)	
	W	--possible long stretches of open water	low:short-term, reversible, negative	--avoid 'thawing' large portions of watercourses
--disposal of treated wastes into make-up pond	F	--nutrient addition to Illtyd Creek during blow-down, increased productivity	low to moderate:short-term, reversible may be positive	--water quality monitoring
	W	--attraction of waterfowl to open ponds over winter	low:short-term, reversible, negative or positive	--avoid creating open water shortly after freeze-up or provide open water ponds at all times
--local climatic changes especially in winter	F	--none identified		
	W	--unknown		

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impact	Mitigative Measures
LINEAR FACILITIES				
Construction				
--Survey of rights of way for transmission line, road and slurry pipeline	F	--habitat degradation at stream crossings due to vehicle activity --habitat degradation due to altered drainage and allochthonous input (organic and inorganic) at stream crossings --alteration of existing water-courses creating erosion and loss of habitat	unknown: generally short-term, reversible, negative	--removal of slash from stream channels --right angle approach to streams --helicopter access only --seasonal scheduling --hand clearing only --avoid cut and fill procedure --avoid steep slopes
	W	--habitat alteration	low: moderate-term, reversible, negative or positive	--minimize width of right-of-way
Road and slurry pipeline				
--Vegetation removal	F	--habitat loss at crossing sites and degradation of streams and rivers from sedimentation --habitat degradation due to accumulation of organic debris in stream channels	unknown: generally long-term, reversible, negative	--rapid reclamation by reseeding of right-of-way and placement of erosion control structures --clearing of debris from crossings --avoid steep slopes
	W	--habitat loss	moderate: long-term, reversible, negative	--minimize width of right-of-way
--Road high grading	F	--habitat loss at crossing sites and degradation of streams and rivers from sedimentation --habitat degradation due to accumulation of organic debris in stream channels	unknown: generally long-term, reversible, negative	--rapid reclamation by reseeding of right-of-way and placement of erosion control structures --clearing of debris from crossings --avoid steep slopes
	W	--disturbance to sensitive species	low: short-term, reversible, negative	--avoid areas when wildlife concentration present or during sensitive time of year

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
--Borrow pits	F	--habitat degradation caused by erosion during construction	unknown:generally short-term, reversible, negative	--rapid reclamation by reseeding --settling ponds
	W	--habitat loss	low:long-term, irreversible, negative	--avoid important wildlife habitats
--Stream crossings	F	--disturbance of fish movements (spawning migrations, over-wintering movements) --habitat loss of stream bed riffle areas (spawning and feeding habitat)	unknown(blockage of movements), generally long-term, reversible, negative unknown (habitat loss): generally short-term, reversible, negative	--proper installation of culverts or the use of bridges --hand clearing only --scheduling of activities to avoid critical periods --control of beaver activity near crossings --divert or pump stream around crossing --utilize clean fill, silt screens, and settling basins
	W	--none identified		
Transmission Lines				
--Vegetation removal	F	--habitat degradation caused by increased erosion along line right-of-way, and sedimentation of streams	unknown:generally short-term, reversible, negative	--use of rock and gravel at stream approaches --maintain ground cover of vegetation, selective clearing
	W	--habitat loss	moderate:long-term, reversible, negative	--minimize width of right-of-way

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
--Line erection	F	--habitat degradation due to increased erosion from vehicle activity at stream crossings --accumulation of debris (timber) in stream channels	unknown:generally long-term, reversible, negative	--use of rock and gravel at stream approaches --removal of slash from stream channel --channelize run-off at streams
	W	--possible avoidance by wildlife --avian mortality from collisions	low:long-term, reversible, negative	--avoid wildlife use areas --design to minimize potential for collisions
Operation and Maintenance Roads and Slurry pipeline --Right-of-way maintenance	F	--habitat loss due to direct mortality of aquatic macrophytes if herbicides are used --habitat degradation caused by increased erosion potential during mechanical clearing or grading of roadways	unknown:generally short-term, reversible, negative	--limited use of herbicides on right-of-way --rapid reclamation by mechanical vegetation control --direct runoff into vegetated areas
	W	--disturbance	low-moderate:short-term, reversible, negative	--avoid sensitive times and areas
--Vehicle Use				
a) increased access	F	--increased fishing pressure due to access, direct mortality of sports species	unknown:generally long-term, reversible, negative	--restrict access --fishery management (catch limits, periodic stream closure) --increased enforcement of regulations
	W	--increased hunting mortality --increased disturbance --collision mortality	moderate:long-term, reversible, negative moderate-high:long-term, reversible, negative	--restrict acess --wildlife management (hunter draw, periodic closures) --increased enforcement

Appendix V. (Continued)

Development Phase Activities	Resource[1]	Potential Impact	Level and Significance of Impacts	Mitigative Measures
--Road and or Pipeline Presence	F	--none identified		
	W	--possible blockage of movements	moderate-high:long-term, reversible, negative	--raise (> 3 m) or bury pipeline --keep profile of road to a minimum --restrict movement of vehicles
Reclamation and Abandonment Roads and slurry pipeline --Removal	F	--habitat degradation due to sedimentation of streams during road reclamation	unknown:generally short-term, reversible, negative	--reclaim by:reseeding rights of way, erosion control structures, seasonal scheduling
	W	--none identified		
--Abandonment	F	--habitat loss due to potential migration blockage by beaver dams and debris at culverts and bridges	unknown:generally long-term, reversible, negative	--clearing of debris from crossings --proper road abandonment procedures (i.e. removal of culverts and grades)
		--habitat degradation caused by alteration of flow regime by blockages at road crossings		
	W	--none identified		
Transmission Lines --Line removal	F	--habitat degradation due to increased erosion potential during line removal	unknown:generally short-term reversible, negative	--direct runoff into vegetated areas --seeding, scheduling, helicopter access
	W	--none identified		

*Level of impact cannot be estimated due to lack of data on routes.

[1]F=Fisheries, W=Wildlife

Appendix VI. Schedule of Field Activities

Vegetation		
Ground Truthing	16-18 August	1980
Wildlife		
Survey 1	20 June	1980
Survey 2	17-18 August	1980
Survey 3	14 October	1980
Survey 4	15-16 December	1980
Ground-level studies	16-17 August	1980
Fisheries		
Field Trip 1	04-07 July	1980
Field Trip 2	08-11 September	1980
Field Trip 3	21 March	1980

MAP FOLIO

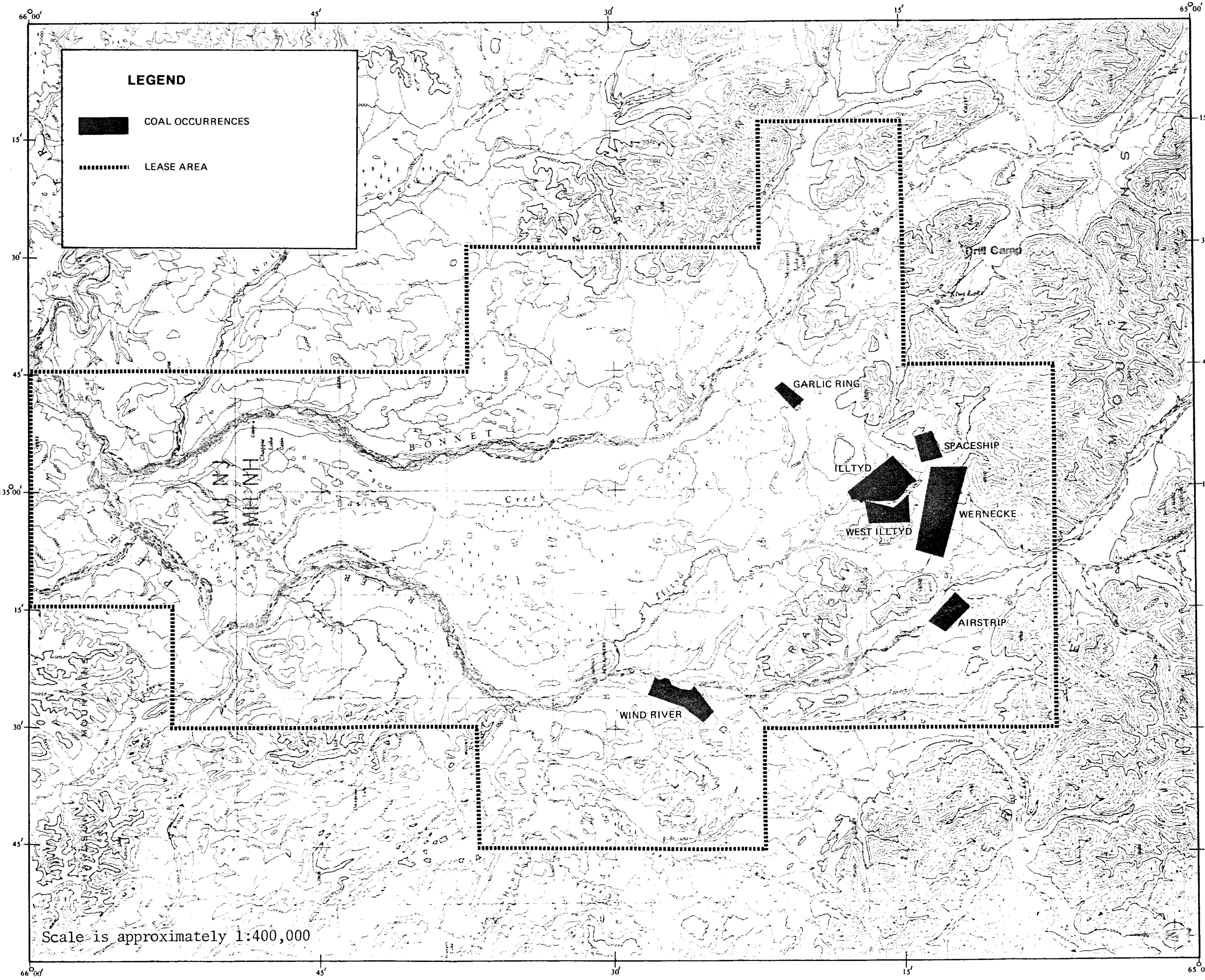


FIG. 1 MAP OF PAN OCEAN OIL LTD'S BONNET PLUME LEASE AND KNOWN AREAS OF COAL OCCURRENCE.

LEGEND

This legend summarizes symbols used on this map, in combination with the standard topographic symbols used on Canadian Topographic Maps.

WILDLIFE

Explanation of Symbol

1Wbs

- unit number — 1
- species eg: waterfowl — W
- habitat function eg: breeding — b
- seasonal use eg: summer — s

1Wns Vty Mty MSty This wildlife zone is generally flat and includes numerous muskegs and shallow lakes. The forest cover consists of black spruce and tamarack, with a lichen understory. Burns of various ages are found throughout the area. The section bounded by the Wind, Bonnet Plume, and Peel rivers, and the Wernecke Mountains is known as the Bonnet Plume Basin. From this area, the land rises in the west to the Porcupine Plateau and in the east to the Peel Plateau. A variety of animals inhabit this wildlife zone. Swans and several species of ducks nest on the deeper lakes that are found in the northern part of the Bonnet Plume Basin and in the region west of the Bonnet Plume River. All three species of the loon; the Arctic, common, and red-throated, are found in the zone. Beaver inhabit many of the streams and small lakes and are reported to be particularly plentiful in the northern part of the Bonnet Plume Basin. Muskrat are found in most of the ponds that do not freeze to the bottom in the winter. Moose are scattered throughout the zone

2Brw The entire area covered by this map sheet is important traditional winter range for barren-ground caribou of the Porcupine herd. However, not all parts of the range are used in any one year. Particularly good winter range is found to the north of the mountainous area. The caribou generally avoid burns and, in winter, usually concentrate in spruce forests which have a lichen understory. In spring, they migrate north through the Richardson Mountains to calving grounds which are located in the vicinity of the Arctic coast. In late fall, they return to wintering areas

3Bls Barren-ground caribou concentrate in the Knorr and Trevor ranges and other similar staging areas before migrating north through the Richardson Mountains in the spring.

4TSty In this wildlife zone, the Wernecke Mountains and the Knorr Range provide good summer range for sheep. These animals appear to be particularly abundant in the Knorr Range

5Gdw Grizzly bear spend the winter in dens near Rapitan Creek. This area should be considered critical

6TSrw These areas and possibly the west side of the Knorr Range are used as winter range by sheep. In winter, the Wernecke Mountains are uniformly covered with snow and sheep are found low on cliff rims or in the high timber. Those wintering areas known are outlined on the map. When located, other areas of sheep winter range should also be considered critical

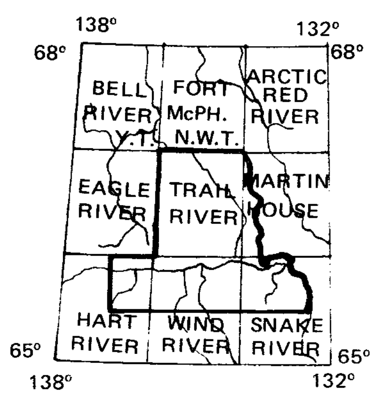
7TS Sheep use licks that are located within the area indicated on the map. These sites should be considered critical. Licks attract sheep from their normal alpine habitat to lowland areas where they are vulnerable to predation and disturbance by man. Summer is the peak period of use and ewes and lambs are particularly susceptible at this time

8TSty This high and isolated section of the Illtyd Range supports large numbers of sheep. The gentle slopes and flat tops are covered with abundant grasses and sedges, and the limestone cliffs provide excellent escape terrain

(**1Wbs**) Important wildlife area

Boundary of a registered group trapping area

10 Boundary of a hunting and/or trapping area. (trapping areas in the Yukon are registered).



Boundary of the Fort McPherson registered group trapping area

Barren-ground caribou

Grizzly bear

Thinhorn sheep

4 Boundary of an outfitter area and number

Common boundary of two outfitter areas

FISH RESOURCES AND FISHING

(M_1) Numerous Arctic cisco were taken from the Peel River in July, 1973. These fish were probably migrating from the Arctic Ocean to spawning grounds which have not been located as yet. Arctic char undertake a similar migration up the Peel River

(S_1) Pike spawn in Hungry Lake shortly after spring break-up

(S_2) The Little Wind River contains excellent spawning habitat for Arctic grayling and round whitefish

(1) Fish species permanently resident in the Peel River include Arctic grayling, inconnu, round whitefish, lake whitefish, pike, burbot, lake chub, flathead chub, longnose sucker, longnose dace, and slimy sculpin. Adult Arctic char and Arctic cisco are temporary residents

(2) The headwaters of tributary streams of the Peel River support populations of round whitefish, Arctic grayling, slimy sculpin, and dwarf, non-migratory dolly varden

(3) Margaret Lake, which contains very large pike that weigh up to 30 pounds, has some potential for controlled sport fishing. Smaller numbers of lake trout and lake whitefish are also present

(4) This chain of warm, shallow lakes contains pike and lake whitefish

(5) Open water has been noted at these locations in mid winter. In the northern Yukon, such ice-free areas are important to some fish species for spawning or overwintering. It is not known how the open-water areas shown in the area covered by this map sheet are used by local fish populations, but they should be viewed as potentially critical habitat for fish

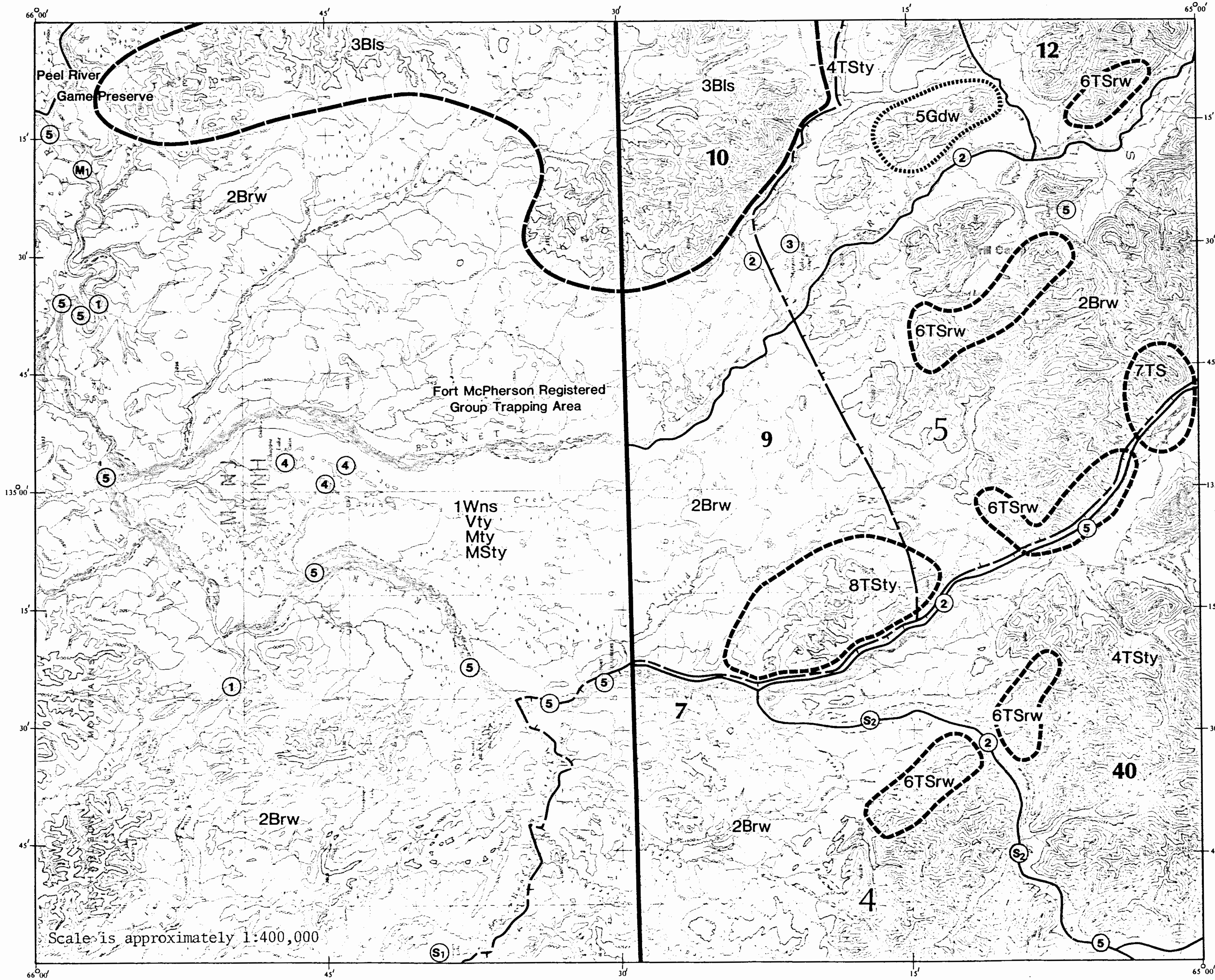


FIG. 4 FISH AND WILDLIFE DATA FROM LUIS MAPS, OUTFITTER GAME HUNTING AREAS AND REGISTERED TRAPPING AREAS.

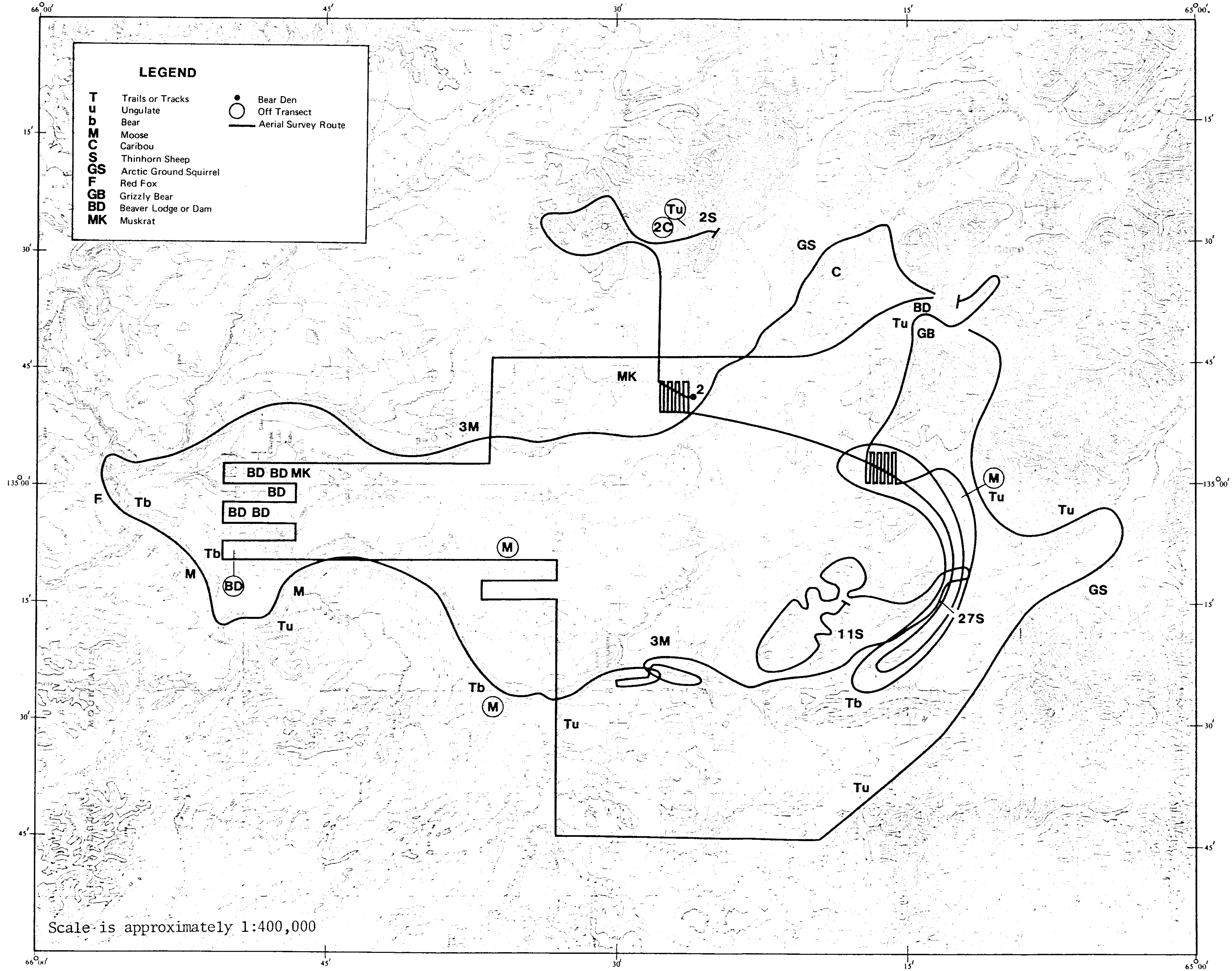


FIG. 5 SURVEY ROUTE AND MAMMAL OBSERVATIONS OF 20 JUNE 1980 AERIAL SURVEY.

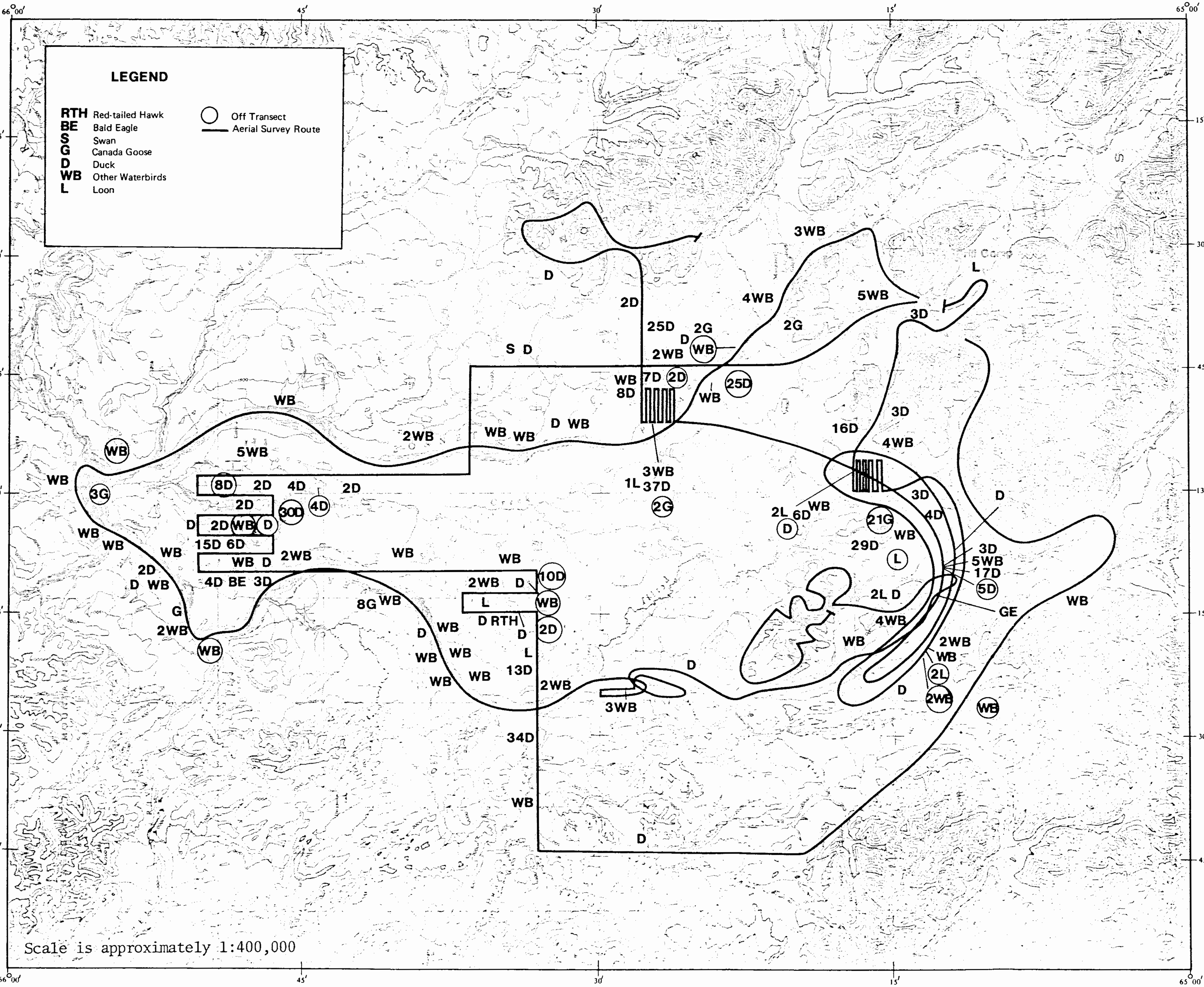


FIG. 6 SURVEY ROUTE AND BIRD OBSERVATIONS OF 20 JUNE 1980 AERIAL SURVEY.

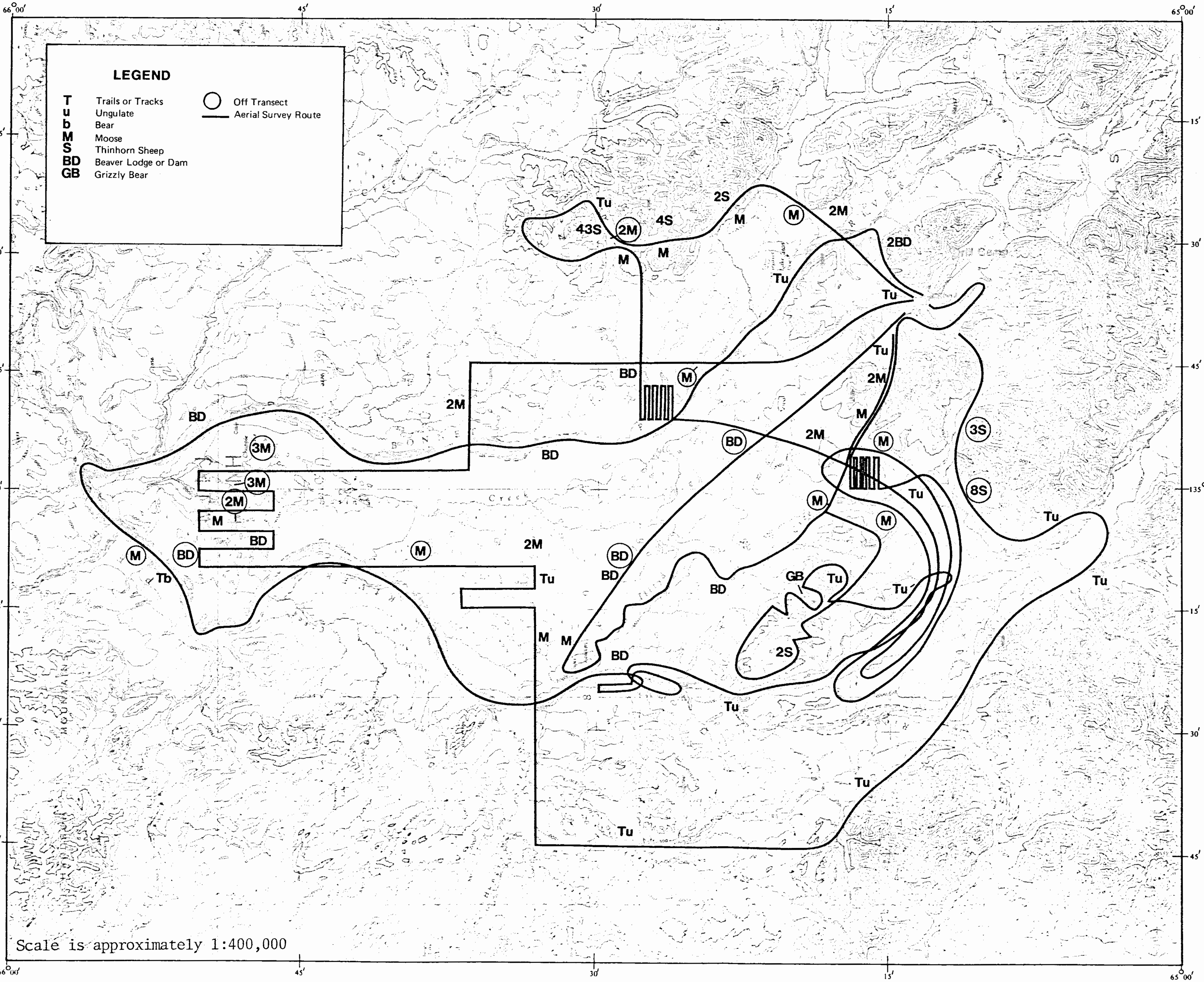


FIG. 7 SURVEY ROUTE AND MAMMAL OBSERVATIONS OF 17–18 AUGUST 1980 AERIAL SURVEY.

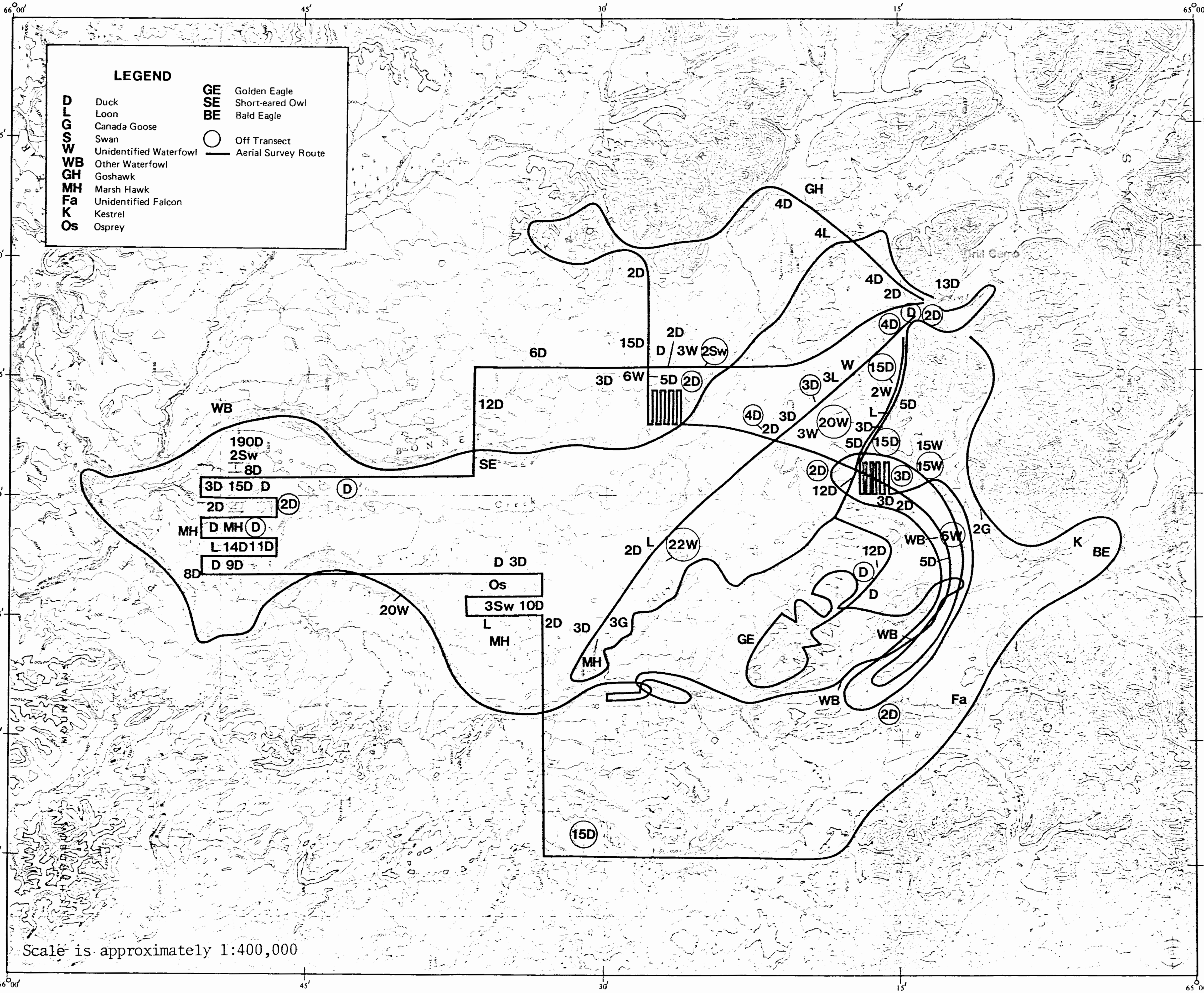


FIG. 8 SURVEY ROUTE AND BIRD OBSERVATIONS OF 17–18 AUGUST 1980 AERIAL SURVEY.

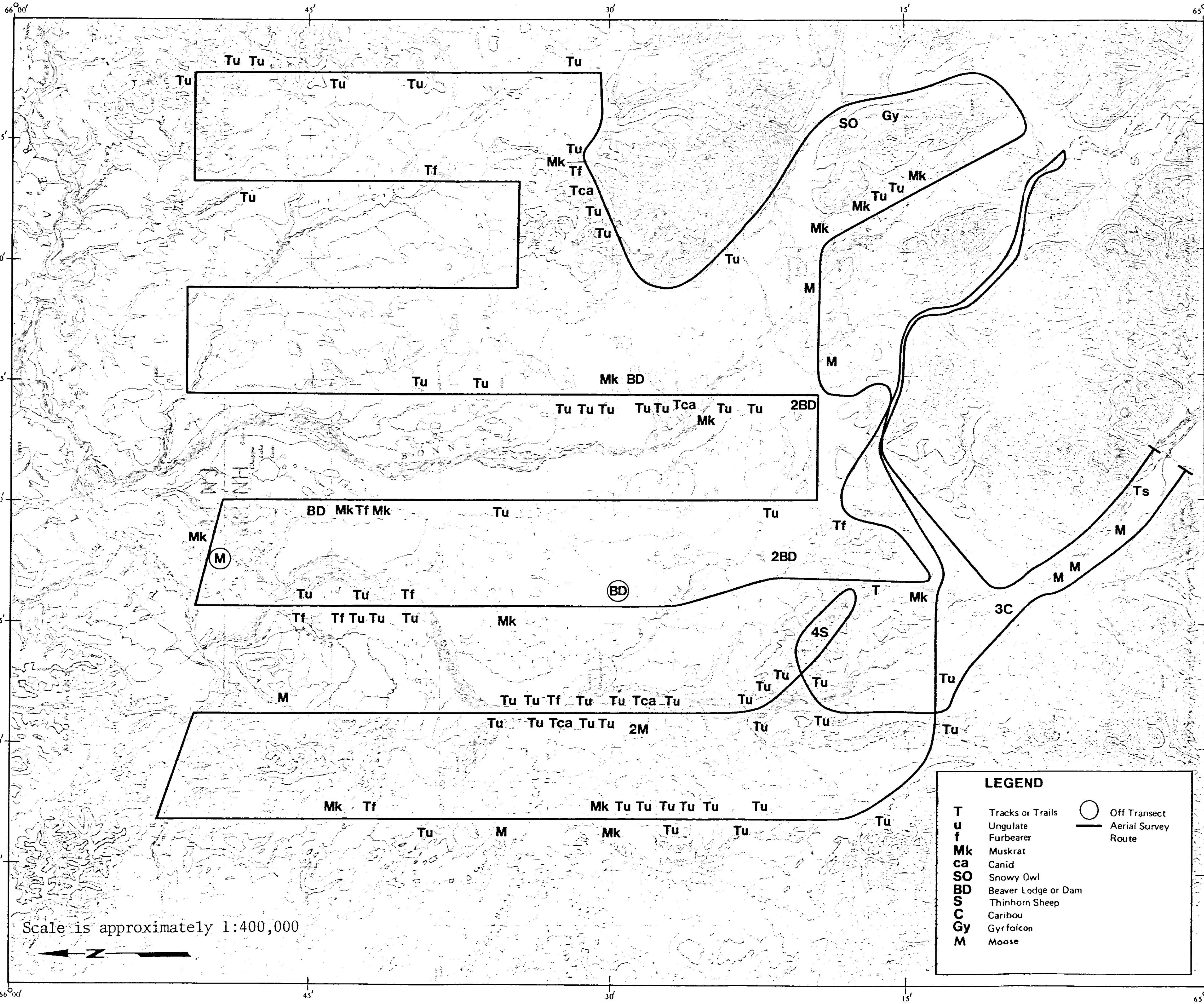


FIG. 9 SURVEY ROUTES AND RESULTS OF 14 OCTOBER 1980 AERIAL SURVEY.

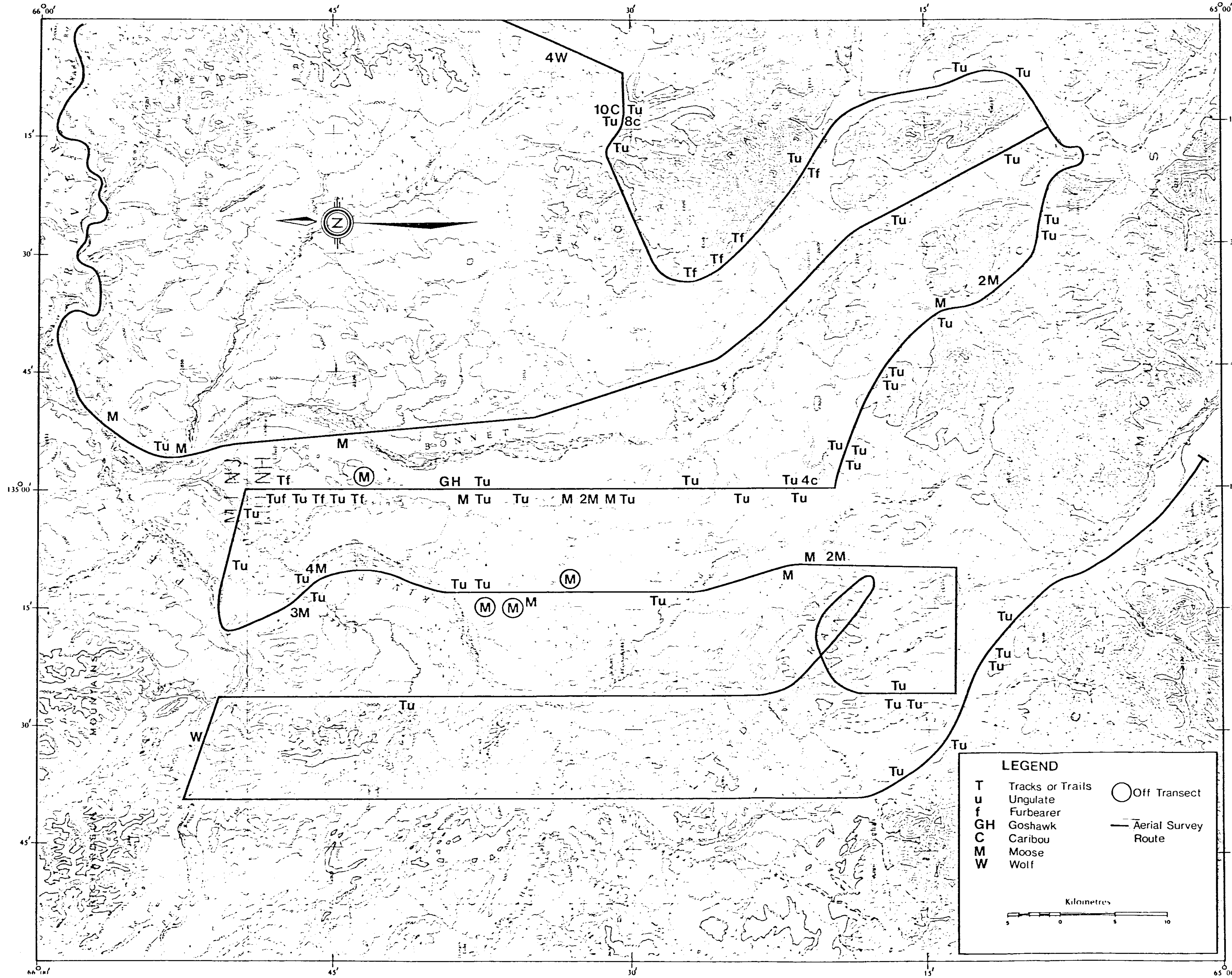


FIG. 11 SURVEY ROUTES AND RESULTS OF 15-16 DECEMBER 1980 AERIAL SURVEY

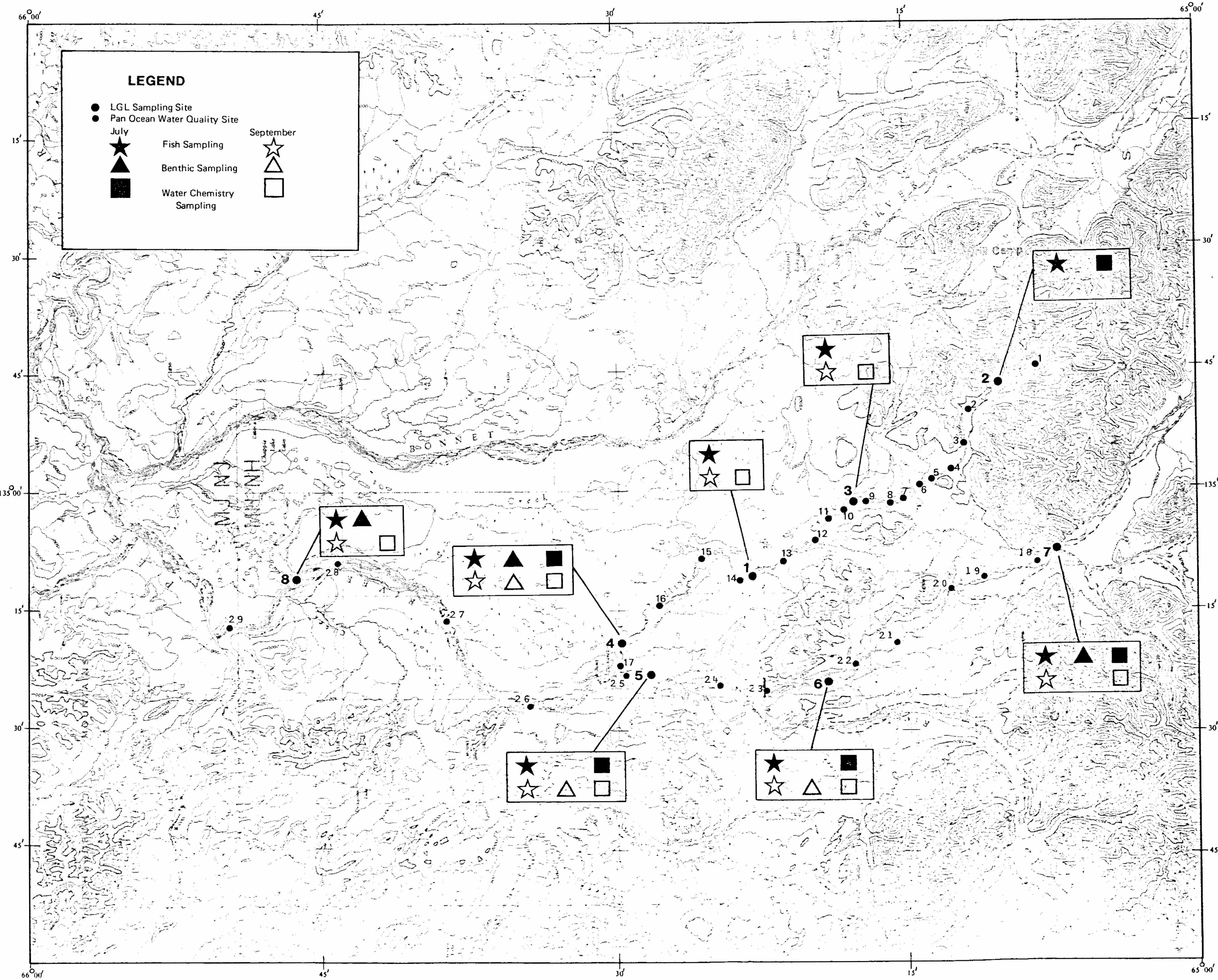


FIG. 12 SAMPLING LOCATIONS FOR FISH, BENTHIC MACROINVERTEBRATES AND WATER CHEMISTRY, ON ILLTYD CREEK AND THE WIND RIVER, 1980. ALSO SHOWN ARE PAN OCEAN WATER QUALITY SITES ON ILLTYD CREEK (NO. 1-17) AND WIND RIVER (NO. 18-29).

AN OVERVIEW STUDY OF THE
VEGETATION, WILDLIFE AND FISH RESOURCES
OF THE BONNET PLUME LEASE,
NORTHEASTERN YUKON TERRITORY

ADDENDUM RESULTS OF THE SURVEY TO DETERMINE OVERWINTERING POTENTIAL IN WIND RIVER AND ILLTYD CREEK

by

J.A. Taylor

INTRODUCTION

Following the completion of the overview study of the Bonnet Plume Lease (Searing and Taylor 1981), a winter survey of the Wind River and Illtyd Creek was conducted to determine their overwintering potential for fish. The survey covered all of the lease area, with emphasis on the southern portion where development is anticipated.

METHODS AND MATERIALS

An aerial reconnaissance of the Wind River and Illtyd Creek was conducted on 21 March 1981 using a Bell 206 helicopter, to locate areas of open water within the lease area. Sampling of selected sites was carried out using a Coffelt electroshocker (model BP-10). Selected physical and chemical parameters were recorded at each open water site visited. These included: dissolved oxygen, conductivity, turbidity, pH, water temperature, air temperature, water colour, maximum depth, mean depth and water velocity. Instruments and methods used were those of previous surveys (Searing and Taylor 1981). Water quality data are presented in Table 1.

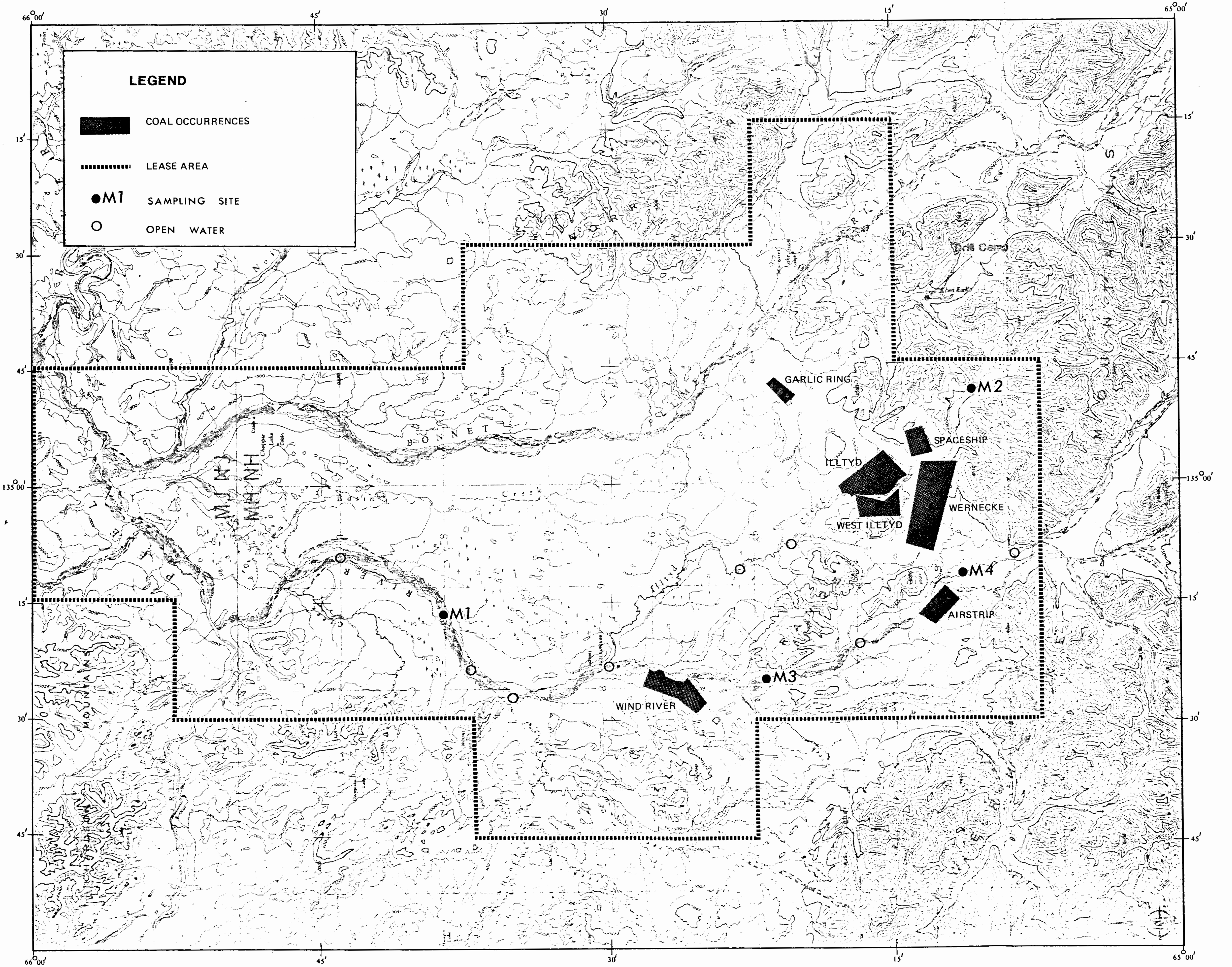


FIG. 1 MAP OF PAN OCEAN OIL LTD'S BONNET PLUME LEASE SHOWING OPEN WATER AREAS AND SAMPLING SITES IN RELATION TO KNOWN AREAS OF COAL OCCURRENCE.

Table 2. Summary of Fish Species Observed and Collected from the Wind River and Illtyd Creek March 1981.

Sample Site	Species	Length (mm)	Weight (g)	Comments
Wind River				
M1	slimy sculpin	41	0.7	not dissected
	slimy sculpin	61	2.2	not dissected
	Dolly Varden	33	0.6	juveniles
	Dolly Varden	41	0.3	juveniles
	Dolly Varden	41	0.6	juveniles
	Dolly Varden	41	0.6	juveniles
	2 Dolly Varden (observed)			
Illtyd Creek				
M2	slimy sculpin	105	13.5	ripe mature F*
	Dolly Varden	210	64.0	green mature F
	Dolly Varden	171	48.0	green mature F
	Dolly Varden	186	46.5	immature F
	Dolly Varden	158	37.5	green mature F
	Dolly Varden	126	19.0	immature M
M3	4 slimy sculpin (released)			
M4	1 slimy sculpin (released)			
	1 Dolly Varden (observed)			

* F = female, M = male

Illtyd Creek

Site M2: This was the only extensive open water area on Illtyd Creek. It was a small side channel with fast water flow (Table 1). The width of open water varied from 4 to 6 m and some side channel gravel bars were present. Substrate composition was predominately cobble (80%) with some gravel (20%). This channel was open for approximately 100 m and was mainly shallow riffles (70%). Pools were generally located in small backwater areas and were relatively deep (<75 cm) with some buildup of debris including fallen trees. However, water velocity in these pools was still fairly high.

Five Dolly Varden and one slimy sculpin were captured at this site.

REFERENCES

Searing, G.F. and J.A. Taylor. 1981. An Overview Study of the Vegetation, Wildlife and Fish resources of the Bonnet Plume Lease, Northeastern Yukon Territory. Unpubl. Rep. Prep. for Pan Ocean Oil Ltd. by LGL Limited, Sidney. 116 p.

COMMENTS

The results of the present survey confirm that overwintering of Dolly Varden and slimy sculpin occurs in areas of the Wind River and Illtyd Creek. Substantial amounts of free flowing water of high quality are present and habitat is good even in late winter. At the present time it is not known if Dolly Varden spawn in the area but successful incubation of eggs throughout the winter appears to be possible in this region.

The apparent absence of Arctic grayling in these streams in late winter and their presence in summer supports the theory that grayling probably overwinter in the Peel River and use streams in the area for spring spawning and rearing of young-of-the-year and juveniles (Searing and Taylor 1981).