

# Environmental Overview Howard's Pass Access Road for Canex Placer Limited

prepared by

**envirocon Ltd.**

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**Cover Photo**

Downstream view of Placer Creek to its  
confluence with Lidia Creek.

## ACKNOWLEDGEMENT

We wish to thank Canex Placer Ltd., and in particular the people of Howard's Pass, for the kind assistance they provided during our field studies.

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## 1.0 INTRODUCTION

In 1972, Canex, a wholly owned exploration division of Placer Development Limited, discovered a large zinc-lead deposit in the Howard's Pass area of the Selwyn Mountains near the Yukon-Northwest Territories border (Figure 1-1). This deposit has the potential of being the largest zinc and lead deposit discovered to date in this region, and accordingly, Canex-Placer will have expended more than three million dollars on exploration and development by the end of 1976.

The Selwyn Mountains have an excellent potential for further discoveries of base metal deposits of lead and zinc in the area between Tungsten, N.W.T. and MacMillan Pass on the North Canal Road. A similar potential for copper deposits exists in the Backbone Ranges of the Mackenzie Mountains to the east of the Selwyn Mountains. There is a good possibility for locating tungsten deposits, similar to the relatively high-grade deposit at Tungsten, N.W.T. or the very large tonnage Mac Tung deposit developed by AMAX at MacMillan Pass.

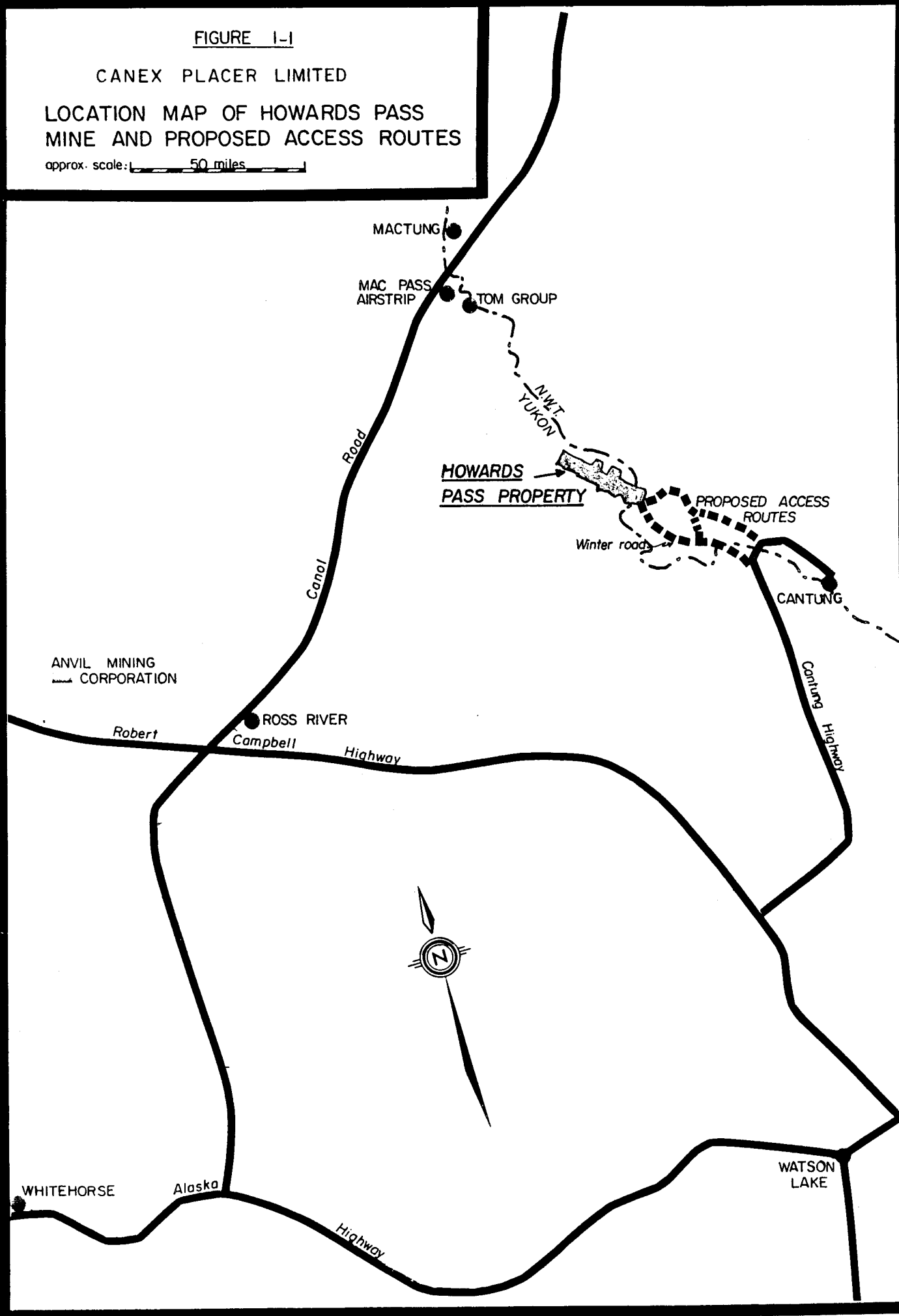
The announcement of the Canex discovery in 1972 sparked the interest of other mining companies in the base metal potential of the area immediately around Howard's Pass. Cominco, Noranda, Dynasty, Welcome North and a host of junior mining companies acquired claims and commenced geologic investigations. Cominco and Dynasty diamond-drilled mineral prospects on claims adjoining Canex mineral claims in 1973 and 1974. Tri Control Oils (Canada)

FIGURE 1-1

CANEX PLACER LIMITED

LOCATION MAP OF HOWARDS PASS  
MINE AND PROPOSED ACCESS ROUTES

approx. scale:  50 miles



Limited in 1976 conducted a drilling investigation of a lead-zinc prospect 14.4 kilometers south of Howard's Pass. Shell Canada Limited has commenced an extensive exploration program northwest of Howard's Pass in the Redstone Mines-Coates Lake area. Since 1972, Canada Tungsten Mining Corp. has developed a second ore body of tungsten minerals at Tungsten, N.W.T. Union Carbide, Serem and Noranda are prospecting for base metals in the Howard's Pass-Tungsten area during the present year.

Servicing and supplies to the exploration activities in this region have been maintained using chartered aircraft either to Summit Lake, 19 kilometers south of Howard's Pass, or to an 800 meter temporary airstrip at the Canex exploration campsite. Canex Placer has proposed an 80 kilometer (50 mile) initial access road to be constructed between the community of Tungsten, N.W.T., and the Howard's Pass minesite. To comply with the environmental requirements of the Department of Indian and Northern Affairs and the Territorial Government, Canex Placer commissioned Envirocon Ltd. to conduct an overview impact assessment of the proposed routes.

The scope of this study was to evaluate the proposed access routes and to identify any major resource concerns associated with each. This report provides that evaluation with emphasis on the preferred route and also presents recommendations with respect to opportunities for minimizing environmental disturbances.

## 2.0 DESCRIPTION OF THE PROJECT

### 2.1 Requirement for Access Route

The immediate need for an access route by land to Howard's Pass is dictated by the current stage of development of the local mineral deposits. The next phase of development is a program of underground exploration requiring the installation of 1,500 tons of surface plant, storage, and service facilities at the site. In addition to this, there is a continuing supply of expendables presently being transported at excessive cost by aircraft.

Canex Placer's utilization of the road in the initial year following completion of construction is estimated at 100 tons of supplies transported each month. An equally important benefit will be achieved when Tungsten and Howard's Pass are connected by road. It will provide inter-communication between two mining camps with opportunities for cultural exchange and competitive sports. Indirect benefits would include a more stable labour force when the isolated nature of single community living is removed by a road connecting the two sites.

An access road from the Nahanni Range Road utilizing good road engineering practice can provide the first segment of a link road connecting with the North Canol road in the vicinity of MacMillan Pass. When developed to area road standards and extended to the North Canol Road, it will complete one more of the "loop-road" concepts actively endorsed by the Federal Government in its Northern Road Program.

## 2.2 Requirements for Construction

The proposed road will be built to initial access road standards. The Department of Indian and Northern Affairs describes an access road as a road "designed to provide access to a resource project which is in the exploration or development stage." Briefly, road specification would be as follows:

- 1) Design speed of 25 m.p.h.
- 2) Clearing of a 50-foot right-of-way
- 3) Skim-grade construction with 12-foot minimum travel surface
- 4) No road shoulders and maximum grade of 14%
- 5) Maximum curvature of 35°
- 6) Bridge loading of H<sub>20</sub>-516 and deck width of 12 feet.
- 7) A 300-foot minimum separation from the river channel.

Further, the route selected will be one that can easily be upgraded to the standards of a resource road. Based on this criteria and results from construction feasibility and environmental studies, the proposed corridor route is described as route "D" in the engineering report. This report, prepared by Al Wright and Associates, is provided "in total" in Appendix 1.

### 3.0 PHYSICAL RESOURCES ALONG THE PROPOSED ROUTE

The engineering report prepared by A.A. Wright and Associates has suggested the development of the access route start at the Tungsten side of Harrison Pass and continue up the Little Nahanni River valley. The following is a brief description of the physical resources along the proposed route, although the climatology data provides a more general indication of temperatures and precipitation for the overall area.

The surficial geology for the various routes being considered is described in detail on the photo mosaics provided by the Department of Indian and Northern Affairs through the services of the Department of Public Works. Ground checks substantiated the description of surficial geology made by the air photo interpreter.

#### 3.1 Climatology

The best available source of climatic information for the area of the proposed route is a seven year record of conditions at Tungsten, N.W.T., supplied through the courtesy of the Manager of Canada Tungsten Mining Corporation. This seven year record of temperatures, snowfall and rainfall is shown in Table 3-1. The weather station is in the same valley system as the route identified as Route "D", and is located at approximately 1,036 meters ASL at Tungsten, N.W.T. Since 69 kilometers of this route traverses the valley system between 1,260 meters ASL and 990 meters ASL, little variation from the Tungsten weather station records is to be expected.

Table 3-1. Climatic data taken at the Tungsten weather station

<u>Year</u>	<u>Min Temp.</u> (°F)	<u>Max Temp.</u> (°F)	<u>Snow Fall</u> (Units)	<u>Rain Fall</u> (Units)	<u>Total Per.</u> (Units)
1960	-48	+83	-	-	-
1970	-45	+73	118.2	13.55	25.37
1971	-58	+80	108.75	8.43	19.305
1972	-38	+74	181.8	12.84	31.02
1973	-35	+72	99.55	10.19	20.145
1974	-49	+76	128.5	13.12	25.97
1975	-58	+80	93.1	14.5	23.81
Average			121.65	12.105	24.27

At Howard's Pass, approximately mile 50 of the proposed route, weather observations have been made at regular intervals since March 1973 at 1,500 meter elevations. The following general observations are recorded.

1. The "wet" season is approximately June 16th to August 20th. The "dry" season, August 20th to June 15th.
2. Sub-zero night temperatures are likely to occur from September 15th to June 30th.
3. The ground is snow covered from about October 1st to June 30th except where windswept.
4. The maximum depth of snow occurred in March 1973 when depths of 2.1 meters to 3.0 meters were observed in non-drifted areas. The minimum depth of snow in place was observed in 1976 when 1.35 meters of snow-depth was observed.
5. Temperature ranges in winter are estimated to be similar to recorded observations at Tungsten (Table 3-1) based on readings taken at Howard's Pass between October to March in 1973/74.
6. Humidity percentages are low except during brief periods of days in June and for a period of up to 3 weeks in August when ground fog is common between 1,050 meters and 1,650 meters A.S.L.

### 3.2 Surficial - Geotechnical Data

This section is an abstract of the engineering report and briefly describes the geotechnical characteristics of the selected route. This access road originates at approximately mile 106 of the Cantung Road, which, for this description, will correspond to mile 0 + 00 of the access route. The proposed road will begin by following a bench that parallels the Flat Lake - Little Nahanni valley. The first 6 miles of this route are on sand, or sand and gravel exposures. Beyond mile 6 the bench begins to pinch out and side hill construction will be necessary for the next 20 miles. The soil of this section is predominantly shallow till, although pockets of sand, or sand and gravel are periodically encountered. There are a number of stream crossings along this portion of the route, which will require 1 meter (36 inch) minimum diameter C.I.P. culverts with random rip-rap for additional protection. Between mile 20.5 and 21.1 a low, swampy area will be crossed by using borrowed materials from the sand plain and sand ridges found in close proximity to this area. At mile 21.1, Mac Creek will be crossed by the standard 7.8 meter (26 foot) trestle with side abutments. A similar trestle is required at mile 23.2, mile 26.4 and mile 34.

From mile 23.2 to approximately mile 33, the road again follows the Little Nahanni River and once more is primarily side hill construction involving terrain which is predominantly shallow till underlain by shale. The side hill becomes generally steeper between mile 24.5 and mile 26 as

the meanders of the river press tightly against its edge. At this point, a 300-foot separation from the active river channel is not possible. Between mile 33 and 34 the river flows through a deep canyon, which is avoided by cutting across a knob terrain left in this area by glacial moraine. Some cutting and filling using the sand and gravel material in the area will be required. At mile 34, a fourth trestle will cross March Creek and at this point the road turns up Lidia Creek for a further 5 miles. This 5-mile stretch will pass well up the valley wall where construction will require 500 to 1000 feet of rockwork. The section will involve a climb at maximum grade entering the valley and at minimum grade before leaving it before turning up Placer Creek. Lidia Creek is the largest tributary of the Little Nahanni and therefore must be crossed by an approximately 100-foot span Bailey Bridge.

Due to slide conditions, the route will follow along west of Placer Creek Valley for the first 3 miles. The road then crosses Placer Creek at approximately mile 43, above the slide area, and continues along the east side of the valley for the final climb to Howard's Pass. This valley is V-shaped and therefore only side hill construction is possible along this section of the route. At about mile 46, the route breaks out of the valley at an elevation of approximately 4800 feet. At this point of the route to the present campsite, the terrain is less steep; however, side hill construction will continue through glacial till with some clay and sand, and fragments of shale and limestone.

#### 4.0 BIOLOGICAL RESOURCES

This section of the report describes the terrestrial and aquatic communities of the project area, and for the most part, emphasizes the valley side-slopes and watercourses associated with the Little Nahanni River. The more detailed investigation of the Flat Lake - Little Nahanni valley area was primarily due to the suggested use of this route for the proposed access road; however, the discontinuous exploitation by animal populations of specific habitat types in the other project areas also influenced the level of effort in particular sites. Available literature describing the biotic communities of this general area is very limited and therefore much of the information has been gathered from air and ground reconnaissance, and personal communication with federal and territorial fish and wildlife personnel, as well as local residents. Field studies began on June 16th in the Howard's Pass minesite area, and subsequent work was carried out along the proposed routes until completion in the Flat Lake area on June 26th.

#### 4.1 Vegetation

##### General Description

The Howard's Pass area is generally classified as tundra by Rowe (1972), but no descriptive material is provided. It lies between the Eastern Yukon Boreal Forest and the Alpine Forest-Tundra as classified by Rowe, and parts of the

descriptive material for these areas are applicable to the study area. The Alpine Forest-Tundra, which most closely describes the study area, is an altitudinal transition from forest to tundra. Open stands of white spruce alternate with grass or shrub vegetation, or with rocky barrens. Sub-alpine fir is usual at the treeline on northern and eastern exposures. Alaska birch is found with white spruce on the more fertile sites.

The biogeoclimatic zones of Krajina (1969) are described in considerable detail for British Columbia (B.C.), and some of this material can be extrapolated to cover our study area. Krajina's descriptions of the interior alpine tundra for northern B.C. would appear to apply equally well to the higher elevations in our study area. Climatic data for this zone (Krajina, 1969) are compared with other pertinent zones and with data from Tungsten, N.W.T. (Table 4-1). The alpine tundra zone is characterized by an absence of trees, but dwarf birch and sub-alpine fir appear in Krummholz form (Plate 6) at the lower portions of this zone. This zone begins at elevations of 1,650 meters in northeastern B.C.

The Boreal White and Black Spruce Zone of Krajina (1969) most closely matches the lower elevations of our study area, and climatic data are listed in Table 4-1. White spruce, black spruce and sub-alpine fir are the main conifers present. White birch, trembling aspen, and balsam poplar are also present.

TABLE 4-1 - CLIMATIC DATA OF THE BIOGEOCLIMATIC ZONES (KROJINA 1969)

Climatic Characteristic	Biogeoclimatic Zone	Biogeoclimatic Zone	Study Area	
	<u>Engelmann Spruce - Sub-Alpine Fir</u>	<u>Boreal White and Black Spruce</u>	<u>Alpine Tundra</u>	<u>Tungsten</u>
Accumulated day degrees over 6° C.	1,000-2,000	1,500 maximum	40-600	
Number of frost-free days	50-100	20-150	25	
Mean annual temperature (° C.)	1 to 4	-3 to +3	-4 to -1.5	-5
January mean monthly temp. (° C.)	-18 to -7	-11 to +6	-18 to -7	-26
July mean monthly temp. (° C.)	12 to 16	12 to 17	7 to 11	+11
Number of months above 10° C.	2-4	2-5	0	1
Number of months below 0° C.	5-6	5-7	7-8	7
Absolute maximum temp. (° C.)	32 to 37	30 to 41	21 to 28	28.5
Absolute minimum temp. (° C.)	-56 to -35	-59 to -42	-45 to -33	-50.0
Annual total precipitation (cm.)	40-183	30-58	71-279	58
Annual snowfall (cm.)	175-1,016	119-312	530-1,956	279
Snowfall in % of total ppt. (cm.)	43-72	36-54	72-74	50
Driest month precipitation (cm.)	1.5-6.6	0.7-2.5	2.5-12.2	2.3
Wettest month precipitation (cm.)	6.4-25.4	4.6-8.9	7.6-35.6	7.6
Seasonal occurrence of ppt.: <u>wet</u>	evenly	S, A, W	summer	summer, A, W
<u>dry</u>	spring	spring	A or spring	spring
Clouds	common	common	common	common
Elevation (meters)	1,050-1,650	165-840	above 1,650	1,200
Latitude	to 60°	above 54° 40'	above 49°	62°
Tree species:	Sub-alpine fir	white spruce	sub-alpine fir	*white spruce
	lodgepole pine	black spruce	dwarf birch	black spruce
	green alder	lodgepole pine		sub-alpine fir
	dwarf birch	tamarack		aspen
	(white spruce absent)	sub-alpine fir		balsam poplar
		aspen		*dwarf birch
		balsam poplar		willows
		white birch		Alaska (white)
		green alder		birch

\* Dominant species

(EA 1802)

13

ENVIROCON

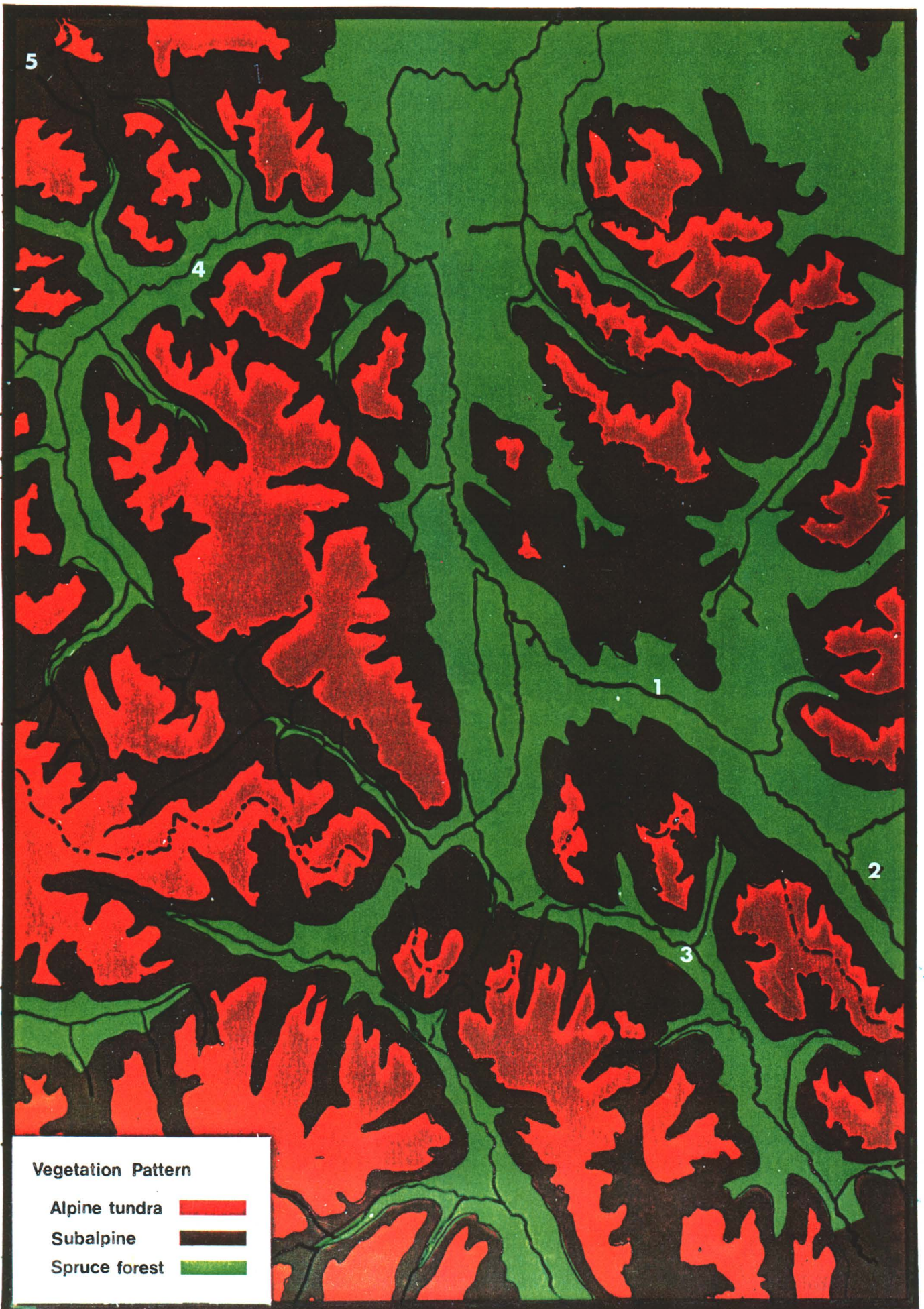
The northern sub-zone of the Engelmann Spruce - Sub-alpine Fir Zone (Krajina, 1969) has some similarities to our study area. Several of the biogeocoenoses listed for this zone seem to describe the vegetation of the study area better than those listed for the Boreal White and Black Spruce Zone. In particular, the groupings that include the lichens and those that include the sphagnum and dwarf birch are applicable. Trees tend to grow in colonies or clumps where the snow remains longer and supplies additional moisture. Semi-arid plant communities develop where snow melts early. The Engelmann Spruce does not occur in the northern sub-zone, and it is not replaced by white spruce. White spruce remains below the sub-alpine zone in the montane zones. The sub-alpine is represented by sub-alpine fir and dwarf birch.

The topography in the study area varies in altitude from 1,000 to 2,100 meters and includes various altitudinal vegetation zones. In general, we may describe it as lying within the Boreal White and Black Spruce Zone, but including vegetation elements representative of the Engelmann Spruce - Sub-alpine Fir northern sub-zone and the Alpine Tundra Zone. At the lowest elevations, the vegetation is dominated by white spruce with sphagnum bogs in depressions. Willows occupy riparian locations and snowslide slopes. Fruticose lichens and dwarf birch form a dense growth in open areas and under the relatively open white spruce canopy. Dwarf birch is also abundant on the sphagnum bogs, with labrador tea and some willows. The white spruce extends up the slopes to treeline at about 1,350 meters. Spruce extends to its highest elevation in long, finger-like extensions in small ravines or in broader patches where snow remains.

longer and provides moisture. Black spruce is not abundant, but does occur on some bog sites. The sub-alpine zone is characterized by sub-alpine fir and dwarf birch with willow in more moist areas. The alpine zone has scattered Krummholz sub-alpine fir with a relatively sparse ground cover of heather, grasses and forbs. These areas are described separately in more detail in the following sections of this report. Figure 4-1 shows the approximate distribution of the various vegetation zones. Scotler and Cod (1974) have prepared a list of vascular plants that is relevant for this area.

#### Valley Bottoms

Many of the streams are braided or meandering in relatively wide, U-shaped valleys. The vegetation along the streams is invariably willow with up to 90% cover in the more moist sites often accompanied by immature balsam poplar (Plates 1 and 2). The vegetation changes to dwarf birch with 50%-80% cover within a few meters of the stream as the site becomes more dry. White spruce is usually present near streams, but the major forest cover is confined to the lower slopes. A hummocky muskeg is usually present on the old flood plain and white spruce is not present. The muskeg type habitat, of variable width, separates the riparian zone from the birch-lichen or white spruce areas (Plate 3). Vegetation in the muskeg consists of sphagnum mosses providing about 90% cover with dwarf birch forming about 50% cover in the shrub layer. There is no overstory in the muskeg type although black spruce might be expected to occur.



**Vegetation Pattern**

- Alpine tundra
- Subalpine
- Spruce forest



Plate 1 Woodland cariboo observed at Mac Creek.  
Willow dominates the shoreline vegetation.



Plate 2 Willow shrubs on muskeg in valley bottom.



Plate 3 Spruce forest with birch-lichen understory in valley floor.



Plate 4 Heavy lichen growth with dwarf birch shrub layer and spruce overstory. This is typical of vegetation some distance from the valley bottoms.

Rowe (1972) mentions that the area has been strongly glaciated and the surface mantle consists of glacial drift, much of it calcareous. Krajina (1969) describes black spruce as a calciphobe, which could explain its absence from the muskeg type. Fruticose lichens are usually present in the muskeg.

#### Spruce Forest-Lower Slopes

The white spruce forest extends from the valley bottoms at 900 to 1,050 meters up to timberline at 1,350 meters (Plates 4 and 5). On the more xeric south and west exposures, the spruce forest reaches timberline 1,350 meters only as finger-like extensions in small ravines where moisture is available. These timbered extensions are separated by dwarf birch with 75%-90% cover. Spruce also extends to treeline in finger-like extensions adjacent to avalanche slopes, but the reason for this probably is physical disturbance rather than lack of moisture. Willow occurs in small isolated patches adjacent to spruce forest where moisture is more abundant. Spruce cover varies with moisture and exposure, but is generally open with about 50% maximum cover. The cover decreases to about 10% on more xeric sites. Understory shrub vegetation is dwarf birch (20%-50% cover), willow (10%-20%), and labrador tea (5%-10%). Fruticose lichens form a dense cover of 40%-70% throughout most of the spruce forest. On north exposures, this is sometimes accompanied by sphagnum. Black arboreal lichen were moderately abundant on white spruce on north exposures. Grouseberry occurs in the



Plate 5 Spruce and fir with birch-lichen understory near timberline.



Plate 6 Krummholz growth near timberline with sub-alpine spruce.

spruce forest, but is not abundant. Although trembling aspen and Alaska birch occur in the area, they are widely scattered and do not appear to form a significant part of the plant community.

The shade tolerance of white spruce is low, which means it will not grow well in dense stands or reproduce well under a well-developed canopy. This is particularly true on the less dry sites. Black spruce is much more shade-tolerant and would replace white spruce in the boreal spruce zone if there were no intervention. Fire plays a major role in opening up the forest stands and permitting white spruce to regenerate. This general relationship is modified by the nutritional and moisture requirements of the two species. White spruce requires calcium, magnesium, and potassium, as well as moderately moist conditions, in order to achieve its best growth. The late melting of snow and the relative abundance of rain in the summer growing season partially determine the distribution of white spruce. The inability of white spruce to grow in very moist, but oligotrophic (infertile) soils explains its absence from many sub-alpine areas. By contrast, black spruce attains its best growth on moist, but infertile areas, since it does not require as large a supply of nutrients. However, black spruce grows very poorly on high calcium soils. Growth is also poor on very dry sites. The nutritional and moisture requirements of the two species probably explains, to a large extent, their distribution and abundance in the study area.

### Sub-alpine

A narrow but distinctive zone of vegetation lies between the white spruce forest of the lower elevations and the alpine tundra of the higher elevations. In the regions farther south, this zone is dominated by Engelmann spruce, but this species does not extend north as far as our study area. White spruce does not replace it in this zone (although the two species are closely related and interbreed) because the higher nutritional requirements of white spruce are not met in the sub-alpine. Thus, the only tree species in the sub-alpine zone of our study area is the sub-alpine fir (Plate 6). Sub-alpine fir grows from about 1,500 meters down to the spruce timberline at about 1,350 meters. However, sub-alpine fir is not distributed evenly through the zone. It is often clumped in areas where snow lies longer and melts slowly, creating very moist conditions throughout the summer. Generally, sub-alpine fir is not abundant, nor does it show good growth in this zone. The nutritional requirements of this tree are generally even higher than those of white spruce, so it is not surprising to find relatively poor growth in areas where the white spruce does not grow. Sub-alpine fir has a high shade-tolerance and succeeds as the climax tree in those areas where it grows with Engelmann spruce. It may be that it requires shade for establishment on the relatively infertile and dry sites. This shade is lacking in our area because neither Engelmann spruce or white spruce are present in the sub-alpine zone. Other plants which are found in this zone are willow, dwarf birch, and Labrador tea. This is typical "high moor" vegetation

and indicates an oligotrophic situation in which sub-alpine fir grows poorly or not at all. Thus, much of the sub-alpine zone is characterized by the presence of a shrub layer with about 50% cover, scattered clumps of sub-alpine fir, and the absence of white spruce.

### Alpine Tundra

The alpine tundra occupies those areas above 1,500 meters (Plate 7). Although no trees occur in these areas, low-growing willows are present in clumped distribution and provide up to 10% cover. Since the ground often remains frozen here after snow melts, the conditions are actually quite arid. Consequently, a grassland community develops here with clumped grasses forming about 10-50% cover (Plate 8). The vegetative cover is interrupted frequently by rock barrens. Fruticose lichens develop up to 50% cover on some sites. Various members of the heath family, such as Rhododendron lapponicum and Cassiope sp., may form 10-60% cover. Vaccinium sp. is also present. Various forbs are present in abundance although many were not sufficiently developed for identification at the time of our field reconnaissance (mid-June). Those that could be identified were Silene acaulis, Lupinus nootkatensis, Pedicularis lanata, Anemone sp., and Sedum rosea.



Plate 7 Boundary between alpine and sub-alpine zones.



Plate 8 Alpine area with heather and sedge.



Plate 9 Rhododendron growing in alpine zone.



Plate 10 Woolly lousewort and anemone in alpine zone.

## 4.2 Wildlife

The wildlife species of major interest to man are generally those which humans utilize for food, fur or recreation, or those which are in danger of extinction as a result of human activities. The larger carnivores such as bears and wolves; the large ungulates such as caribou, moose, sheep, and goats; furbearers such as beaver and wolverine; and birds such as the peregrine falcon, ducks, and geese are the species which attract the most attention. While these animals are certainly important, they do not encompass the full range of relevant ecological processes which are required to sustain the total biological system. Therefore, other aspects must also be considered when estimating an impact, such as the proposed road, on the principal species. Each "major" species will be discussed separately in this report, but will include the relevant ecological relationships with respect to the proposed development.

### Grizzly Bear (Ursus arctos)

#### Description, Life History, and Ecological Relationships

The grizzly is the largest omnivore of the study area, ranging in weight from about 68.1 to 226.5 kg. The most pertinent reference work on this species is the monograph by Pearson (1975) based on extensive research in the western Yukon.

The female grizzly breeds first at about 7.5 years of age and may reproduce at 3 year intervals thereafter. Average

litter size is 2-3 cubs, but juvenile mortality reduces the litter to 1-2 at 1 year of age. Breeding occurs in June-July and cubs are born in February or March. Due to the relatively low reproduction rate, this species cannot sustain a high annual harvest.

The grizzly has a large home range. The average minimum home range was 52.8 sq. kilometers for females and 176 sq. kilometers for adult males in southwestern Yukon, and the density of bears is about 1 per 16 sq. kilometers (Pearson, 1975). Their movements through the home range are largely in response to changing food sources. The early spring movements are usually restricted to snow-free slopes near the winter den areas, often at elevations of 900 to 1,500 meters. At this time, the bears feed heavily on vegetation. In southwestern Yukon the bears often remained in the alpine and sub-alpine terrain during May, feeding on roots, willow catkins, or grasses. During June and July the bears concentrated on sub-alpine willow areas. Toward the end of July, bears began utilizing the lower timbered slopes and alluvial flats, feeding on berries and roots. Bears tend to move back up-slope in late summer and fall to utilize the later berry crops at the high altitudes. After snowfall in the alpine zones, bears dig out ground squirrels. The grizzly appears to be an opportunist in food habits, taking those foods which are available. Thus, we cannot be certain that bears in our study area will exhibit the same movement pattern that was found in southwestern Yukon. One important difference is the absence of dense berry patches, such as the soapberry, in our study area. Daily activity patterns

show a relatively intense activity in early morning with a decrease from late morning to mid-afternoon, and increased activity from late afternoon to dusk.

Bears exhibit their omnivorous characteristics by being largely vegetarians; however, they do utilize animal foods whenever available. They will take ground squirrels, marmots, moose calves, and beaver. They consume carrion and will frequent garbage dumps if they are available. Thus, the grizzly serves both as a scavenger and as a predator on other mammals. Given the low density of bears, it is not likely that they exert excessive predatory pressure on their prey species. Their only real competitor, and their chief predator, is man. Bears most often conflict with humans when developments encroach on wilderness areas or when man-made food supplies attract the bears.

#### Presence in Study Area

No grizzlies were sighted by us during most of our field reconnaissance, but tracks were observed throughout the study area. Specifically, tracks were noted near beaver lodges at the confluence of Lidia Creek and the Little Nahanni River, in the vicinity of beaver lodges upstream on the Little Nahanni, near the confluence of Canex and Lidia Creeks, and in most alpine areas. Employees of Canex Placer reported a sow and yearling a few miles from Howard's Pass in the Don Creek valley, and also reported two winter dens in the same valley. In addition, several bears have been

reported, and one was observed during this study utilizing the garbage available at the Tungsten dump. Thus, we may assume that grizzlies are distributed throughout the study area and may come into conflict with the proposed developments at Howard's Pass.

#### Possible Impacts and Mitigation Opportunities

The proposed route passes through grizzly habitat for its entire length. Since the road will separate some alpine areas from alluvial flats, it is safe to assume that bears will cross the road at some point as they move from one food area to another. If succulent green vegetation becomes established along the roadway, this may become an attractant for bears, particularly in the early summer. The road will bring increasing numbers of humans into this otherwise inaccessible area, and this human activity rather than habitat destruction by the road per se, represents the real impact on the grizzly.

Perhaps the most important mitigation possibility is the installation of proper incineration facilities for camp garbage. This should minimize the attraction of bears to the camp sites. Although the grizzly will probably avoid encounters with humans in natural circumstances, "garbage" bears frequently become severe problems. We recommend that all garbage from road-work camps be collected and burned daily, and the charred refuse buried.

Despite the numerous scare stories about grizzlies, they usually avoid people (Mundy and Flook, 1973). Herrero (1970) calculated the injury rate in all North American national parks at 1 per 2 million visitors and the death rate at 1 per 30 million. However, it is wise to avoid interaction with grizzlies if possible. Most of the attacks on humans seem to be by adult females with young, and most persons either disturb the animals at a rich food source (garbage dump, carrion, berry patch) or come too close to the bear by making a silent approach. Thus, workers can do much to increase their safety by the following:

1. See the bear first and avoid it.
2. Do not travel with a dog.
3. Carry bells on your pack, whistle, or make other noise so the bear can avoid you.
4. Exercise extreme care when approaching concentrated food areas.

#### Wolf (*Canis lupus*)

##### Description, Life History, and Ecology

Although the wolf is not the largest carnivore, it is probably the most capable predator in the study area. The adults range in weight from 29.5 to 79.5 kilograms. Wolves form a family pack which often hunts as a unit. The pack occupies a fixed home range of 260-650 sq. kilometers around the den (Banfield, 1974), but home ranges can overlap those of other packs. Much has been written about the wolf, and it is difficult at times to separate fact from fiction.

this area supports a dense population of wolves since prey species do not appear to be abundant. The wolves may, in fact, follow the seasonal movements of the caribou and not remain in the area during the severe winter months.

#### Possible Impacts

Wolves will undoubtedly come in contact with the road, but no major impacts are likely due to habitat alteration. The road will probably result in increased trapping of wolves from the area. This may have a small, but beneficial, economic effect and should not constitute a threat to the population if conducted by professional trappers on a sustained yield basis. The road could constitute a threat to the wolves if it caused a reduction in the populations of the prey species. Although we can only speculate on the actual predator-prey relationships, we do not think the road is likely to exert a significant effect due to the diversity of prey species available and the expected low density of the wolf population.

With regard to mitigation, it is felt that the Northwest Territories Fish and Wildlife Service, having jurisdiction in the area, are well-aware of the consequences of increased access to wilderness areas. If wildlife populations suffer due to increased recreational-economic utilization, the government agencies would be expected to act very quickly and place restriction on these activities.

Beaver (Castor canadensis)

Description, Life History, and Ecology

The beaver is a large aquatic rodent weighing about 18 kilograms. It has a highly social behaviour based on the family unit. All members of the group work cooperatively in constructing and maintaining lodges, dams, and canals. Each lodge will usually contain a female, male, and 2-4 juveniles. Breeding occurs in January-February and about 4 kits are born in April-May. The male leaves the lodge before birth of the kits. When the juveniles mature at 2 years of age, they are driven from the lodge. These 2-year old beaver travel widely seeking suitable habitat. They are preyed upon extensively at this time by wolves and bear.

Beaver often build dams and lodges but may live in bank burrows if water levels are fairly stable. Since the beaver depends on having a dry nest chamber above water levels and a safe entrance below water, it is essential that water levels be relatively stable.

Beavers live on a diet of young twigs and the cambium layer of the bark of larger trees. They favour aspen, willow, birch and poplar. They will utilize spruce but this is probably not an adequate diet. They are most active at night, but are often observed during the long daylight hours of the more northern areas. Since beavers do not hibernate, they must store food for the winter when ice prevents their reaching the surface. In autumn they cut large quantities of material and make a cache by jamming the butt ends of the

branches into the bottom of the pond. Beaver cannot colonize areas where streams and ponds freeze solid, since they must maintain underwater access to their cache.

#### Presence in Study Area

Beaver were observed in the meandering or braided sections of the Little Nahanni River, Lidia Creek, and in most small lakes. Active beaver lodges were abundant in the Little Hyland River. There is very little aspen in the study area and the beaver depend on willow for their major food supply. Some spruce had been cut but these may have been used for construction rather than food. Bank burrows were more common than lodges in the Nahanni system, but lodges seemed more prevalent in the Little Hyland. Bank heights in the latter are probably not great enough to permit construction of safe burrows. Beaver are maintaining the early successional stages by their concentrated utilization of willows on the alluvial areas, and beaver productivity should remain unchanged.

#### Possible Impacts

Since the road will follow a route at least 90 meters removed from the active stream channel, it is unlikely that it will pass near or through beaver habitat. Increased trapping of beaver resultant for improved access may reduce the numbers of this species available to predators.

It is suggested that the effects on beaver can be partially mitigated by avoiding areas containing their food resources. Generally speaking, good beaver habitat and preferred road corridors are not compatible and since use of an area by beaver is easily identified, they should be avoided.

Moose (Alces alces)

Description, Life History and Ecology

The moose is the largest member of the deer family. Bulls may weigh up to 453 kilograms and stand 2 meters at the shoulder, but cows weigh only about 340 kilograms. Moose are not gregarious and usually occur singly or in very small groups, such as a cow and yearling.

Moose breed from September to November and calves are born in May-June. The calf usually remains with the cow until the next calving season. Moose will utilize a wide variety of foods, but depend most heavily on willow and aspen browse during the critical winter months. Moose will often remain within a small area for extensive periods if food and shelter are available. The main environmental components limiting moose are food availability and snow depths in winter.

Kelsall and Prescott (1971) found that moose were severely hampered by snow depths in excess of 0.75 meters. Deep snow becomes even more limiting if crusting occurs. Such conditions leave moose extremely vulnerable to wolf predation.

The most recent comprehensive publication on this species is by Bedard (1975).

### Presence in Study Area

Moose were observed in alluvial areas throughout the study area. Moose tracks and pellet groups were present in all areas, including the alpine, but were most abundant in the willow areas along streams and lakes. Pellet groups characteristic of moose feeding on winter browse (Murie, 1963) were present in most areas. It is not possible at the time of the reconnaissance to determine whether or not these pellet groups were from early winter and early spring or whether the moose remained in the area throughout the winter. Snow can reach a depth of 2 meters in areas near Tungsten (Herbison, pers. comm.) and such depth would prohibit successful wintering even if snow remained soft and uncrusted. Kelsall and Prescott (1971) recorded 45 percent greater snow depth in open areas than under a spruce-fir canopy in New Brunswick. It is possible that the overstory could provide some degree of reduction in snow depth. However, as described in the previous section on vegetation, the white spruce zone is generally open with about 50 percent maximum cover.

The general condition of the area with respect to abundance of pellet groups, extreme hedging of the willows and the presence of shed antlers suggests that this habitat is used by moose until very late in the winter. Moose antlers are generally dropped in January; however, there are a large number of occurrences where antlers are dropped in December with the earliest date noted as December 10th. Further, it has been reported that moose generally move out of valleys

having elevations above 750 meters, and into the lower elevation river bottoms (Len Mychasiw, pers. comm.) Since the elevation of the Little Nahanni and surrounding valleys approximates 960 to 1200 meters and these areas are most often subjected to heavy rainfalls and deep snow conditions, it is therefore unlikely that moose overwinter in the study area. However, moose have been seen during January and February in the Nahanni Range road area (Herbison, pers. comm.) and this is directly adjacent to the project area.

#### Possible Impact

If the moose do not overwinter in the study sites, then consideration for this particular period of increased physiological stress is unnecessary. However, during the early winter season, these large mammals are storing energy for utilization during critical periods and therefore disturbances to moose habitat should be kept to a minimum.

Many of the potential adverse effects can be mitigated by proper road location and winter maintenance practices, and intelligent behaviour by those using the road. To minimize the effects on moose, the road should avoid willow areas whenever possible since these are necessary food for moose. Also, a buffer of forest should be left between the road and willow areas to reduce harrassment of the moose and to allow the moose to obtain shelter. Such buffer strips should be at least 100 meters wide. Plowing in winter could create an impenetrable snow bern, and this would then prevent animals reaching otherwise available food supplies.

Also, it could make it very difficult for any animal that reaches the road to get off. Plow-outs should be constructed and maintained on both sides of the roadway at 0.8 kilometer intervals to permit animals in the area to cross the road.

Observation during the early winter period will indicate those areas that require more plow-outs and those areas where frequency of plow-outs can be reduced. Harrassment by travellers is probably the most serious impact and the most difficult to mitigate. If the road is a private road, presumably the developer can require users to conform to appropriate behaviour. We suggest that all regular users of the road be instructed that any disturbance of wintering moose might cause mortality and request their cooperation in avoiding such impacts.

Woodland Caribou (Rangifer tarandus caribou)  
Description, Life History, Ecology

Many references exist on the barren-ground sub-species of caribou, but few deal specifically with the woodland caribou. Banfield (1974) provides generalized descriptive information for the species.

Caribou are medium-sized deer weighing from about 68-144 kilograms. Males grow antlers from March-September and shed them by December. Females grow antlers from June-October but carry them until after calving in April-May.

### Presence in Study Area

Caribou were sighted regularly throughout the study area (Plate 1), and caribou trails and pellet groups were obvious in all areas examined. From our observations during the field reconnaissance, it appears that caribou are the most abundant and most evenly distributed species of game animal. Caribou were sighted in all drainages and at all elevations, but it appeared that the general trend was a movement into the high ridges and bowls above timberline. All calves observed were above timberline. The types of pellets found indicated both summer and winter use of the area, but the winter pellets might have been from early winter prior to migration. The Land Use Information Series of maps indicates that caribou use the lower areas along the Little Nahanni for winter range and the higher country to the west for summer range. However, there is some question as to the use of this area for winter range. The snow depths, as discussed previously, are considerable (69 cm on April 1st, Highland Airstrip -elevation 750 meters) since the elevation of the Little Nahanni valley exceeds 1,000 meters. This area very likely serves as a travel corridor; however, its utilization as a winter range is doubtful (Grant Lortie and Herbison, pers. comm.) Game surveys conducted in March by the Canadian Wildlife Service (C.W.S.) (Simmons, 1969) indicated that caribou travelled along stream drainages in loose groups of 7-200 animals. The C.W.S. report indicated that in summer, caribou were scattered from the eastern edge of the Mackenzie Mountains to the Yukon border. By September,

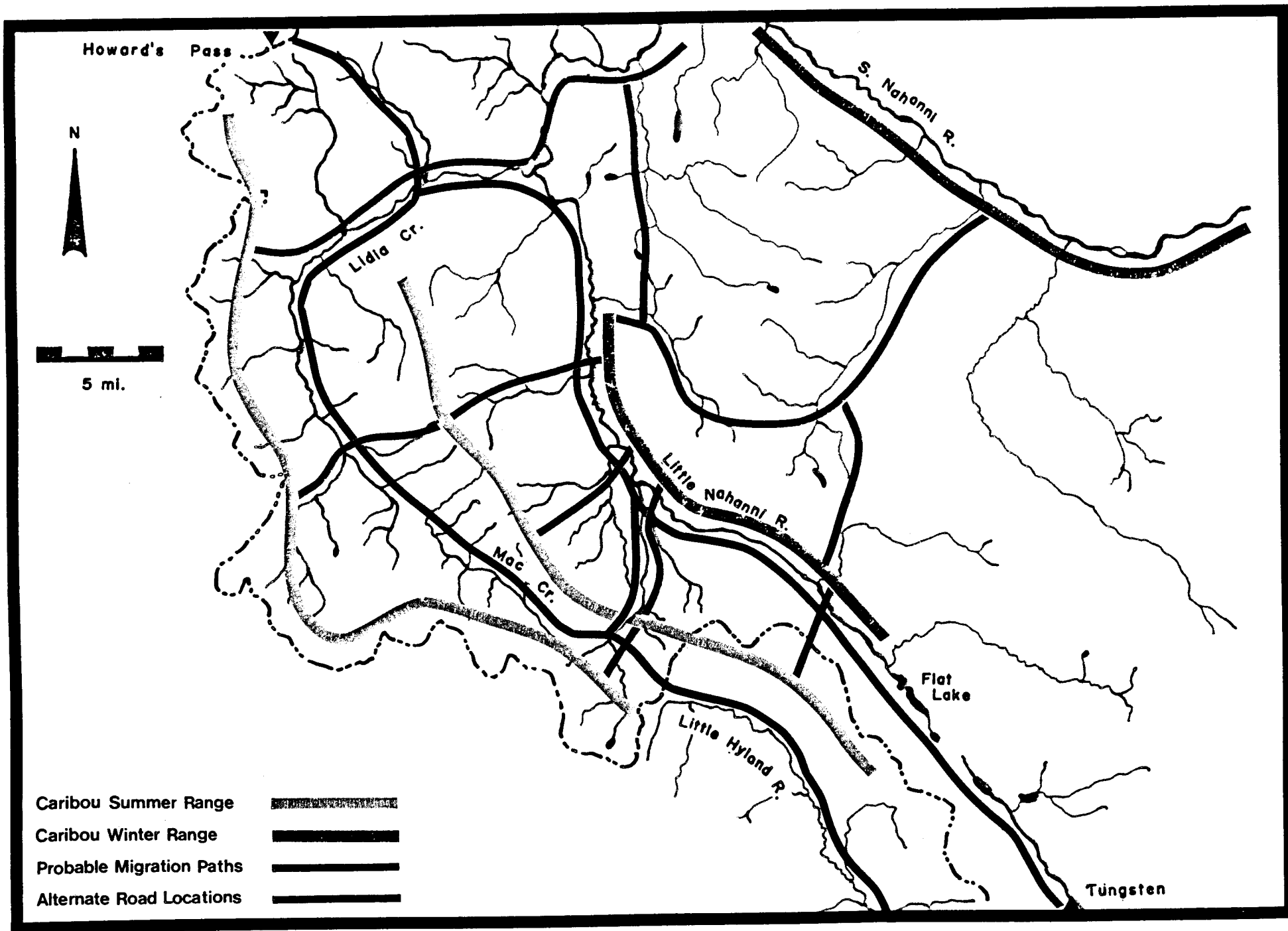
they began to move back down from the alpine tundra following major drainages. Fig. 4-2 shows our estimation of probable migration routes and seasonal ranges. Herbison (pers. comm.) described essentially the same migration patterns as the C.W.S. report.

#### Possible Impacts and Mitigation

The proposed road will be perpendicular to the probable migration paths of the caribou using the summer range west of the Little Nahanni. In addition, it will pass through possible winter range in the valley of the Little Nahanni. The road may disturb the usual movements of the animals in one of two ways:

1. It may create an interference with normal east-west migration and decrease use of the summer range or cause animals to remain too long on the summer range.
2. It may create an easy travel lane, especially in winter, and divert animals south towards Tungsten rather than east to winter ranges.

It is impossible to predict more precisely the effect of the road. In Norway, well-travelled highways and railways have obstructed the movements of wild reindeer. In some cases, the cuts and fills created physical barriers but the traffic along the route also created a barrier. This resulted in over-utilization of some range and under-utilization of the rest (Klein, 1971). In other cases, caribou have been



killed by trains when they got onto the tracks and used them as travel corridors in deep snow conditions. Preliminary results from pipeline studies in Alaska have indicated that the pipeline does interfere with movements of caribou and the behaviour of the caribou is disturbed by encounters with the pipeline (Cameron and Whitten, 1976). Studies have been conducted in Alaska to design gravel ramps for caribou to cross the pipeline; however, these have been generally unsuccessful (Discussion following paper by Child, 1975). It should be noted that an above-ground pipeline can be a much more formidable barrier than a roadway.

These results all indicate that roads and pipelines do alter caribou behaviour and movements, and that no final solutions to the problems are yet available. However, caribou regularly cross the airstrip at Howard's Pass during the fall migration, and they may show a similar willingness to cross the proposed road. The experience in Norway indicates that traffic rather than the road, per se, was the prime disturbance factor. The proposed road would have very little official traffic as described by Canex (Macrae, pers. comm.) and should, therefore, not create a severe impediment to caribou movements. The unknown factor, of course, is the amount of unofficial traffic by hunters, tourists, etc., that the road will receive, both now and in the future. The Department of Indian and Northern Affairs (D.I.N.A.) is reported to be interested in developing the road to form a circle route with the Canol Road to the north. If this occurs, careful scientific studies should be conducted annually to determine whether or not the road is creating a

disturbance. If so, then the developers and the appropriate government agencies could work together to reduce the problems. More significantly, C.W.S. and D.I.N.A. should evaluate the situation following construction before reaching any decision to maintain and up-grade the road beyond the requirements outlined in the project description (Section 2.0).

In the short-run, we see the major impact on caribou being the use of the road by hunters. Barring this interference, we think that the road and its low-level of use need not form a serious barrier to caribou movements. This, of course, assumes that the road will be constructed in a manner that will not form a physical barrier.

In terms of mitigation, we recommend the following:

1. In cooperation with the appropriate wildlife agency, regulate use of the road to prohibit hunting of caribou within 1 kilometer of the road.
2. Construct the road in such a manner that steep cuts and fills do not occupy more than 25% of the road length. Maintain the general slope of the land along as much of the roadway as possible. Steep banks should not occupy continuous segments of more than 1 kilometer.
3. Maintain plow-outs on both sides of the road at 1 kilometer intervals to permit animals to cross the snow berms. Locations for the plow-outs should be selected by a wildlife biologist after completion of the road.

4. Remove tangles of slash along the route, preferably by burning. Caribou may be injured while travelling through this type of barrier.

Dall Sheep (Ovis dalli)

Description, Life History, and Ecology

The white dall sheep inhabits the mountains of the Yukon Territory and the N.W.T. Banfield (1974) describes the physical characteristics and natural history of the species. Geist (1971) describes and discusses the behaviour of the various species of sheep.

Dall sheep utilize the higher alpine areas in summer but move to lower elevations in fall. Grasses, sedges, and forbs predominate in their diet. Nolan and Kelsall (1975) describe the winter ranges of Dall sheep. The sheep favour slopes, ridges and plateaux where the prevailing winds keep the ground relatively clear of snow. Such areas are well-vegetated and have escape cover nearby in the form of steep rocky areas. The intermediate elevations between 540 and 900 meters are most often used, probably to take advantage of temperature inversions which often keep such elevations warmer than the lower slopes. Grasses, sedges, ericaceous shrubs, willow, birch, and cottongrass are common vegetative elements on sheep ranges.

The common predators of Dall sheep include lynx, wolverine, grizzly bear, and wolf.

### Presence in Study Area

No indication of Dall sheep was found during our field survey. Helicopter searches along ridges and south-facing slopes above timberline revealed some goats but no sheep. We conclude that the study area does not have a significant population of sheep, although it is possible that a few small bands may be present.

### Mountain Goats (*Oreamnos americanus*) Description, Life History, and Ecology

This white, shaggy, mountain antelope weighs from 45-114 kilograms. They are fairly gregarious, although groups are generally segregated by sex for most of the year. Goats feed throughout the day with activity peaks at dawn and dusk, and their summer diet consists of grasses, sedges, and forbs (Banfield, 1974). In winter, conifers such as sub-alpine fir become important dietary components. Aspen, dwarf birch, and willow may also be important in the winter diet (Cowan, 1944; quoted in Brandborg, 1955). The animals may travel several miles in movements between summer ranges in the higher alpine areas and winter ranges at lower elevations near or below treeline.

Mountain goats breed in November and 1 or 2 kids are born in May-June. The main predators are grizzlies, cougars, wolves, and eagles. Goats rely on access to steep, rocky, cliff areas for protection from most predators.

### Presence in Study Area

We observed bands of goats on three mountains in the vicinity of Howard's Pass, and trails were evident on several other high ridges although no goats were seen there. All the animals observed were above timberline (1,350 meters) and were feeding in the alpine or sub-alpine regions. We conclude that a moderate population of goats is present in the study area. They inhabit the more rugged terrain where sharp ridges and rocky cliff areas are adjacent to sizable alpine and sub-alpine areas. All such areas can be presumed to have goats at some time during the year. These animals may remain at the higher elevations all year or may descend into the timber during winter. In view of the deep snow reported for the area, it is not likely that the spruce forest would provide sufficient reduction in depth of snow to make the forest habitable. It is more likely that the animals remain on high wind-swept ridges during winter. However, it is likely that the animals do move from one mountain to another by crossing the valley floors.

### Possible Impact and Mitigation

Since the road will be as low as possible in the valleys, we do not anticipate significant interaction with goats or destruction of habitat. The road could affect the goats if they do cross the valleys or if they winter at the lower elevations. Studies should be conducted in autumn and winter to determine the movement patterns and wintering areas of these animals. The greatest impact is likely to be

increased hunting pressure. This could cause high impact if they were hunted on low elevation wintering areas. We do not suggest any specific mitigation at this time, since we do not think the impact will be great. However, the type of impacts that we described can be mitigated by controlling hunting along the road and by maintaining adequate plow-outs along the road in winter, if the recommended studies indicate a need for such mitigative actions.

Birds - all species  
Presence in the area

Our reconnaissance survey did not include intensive studies of any particular species, but special observations were made of habitats that might be used by endangered species. A list was made of all bird species actually identified by us (Table 4-2).

Although we made special observations of steep, cliff areas that appeared to be suitable nesting habitat for peregrine falcon, we did not find any indication that they might be present. The avifauna of the area is rather sparse and the scarcity of prey species may explain its absence from the study area. Scotter et al. (1971) did not include the peregrine on their "expected" or "observed" lists for the South Nahanni.

TABLE 4-2

## BIRDS IDENTIFIED IN THE STUDY AREA.

<u>Group</u>	<u>Species</u>	<u>Habitat</u>
Ducks	Greater scaup	Marshy pond
	Oldsquaw	Marshy pond
Raptors	Golden eagle	High alpine ridges
Grouse	Rock or willow ptarmigan	Alpine areas
Shorebirds	Semi-palmated plover	River shorelines
	Spotted sandpiper	River shorelines
	Greater yellowlegs	Marshy ponds or sloughs
	Northern phalarope	Marshy ponds
	Mew gull	Marshy sloughs; garbage
	Arctic tern	Rivers
Passerine Birds	Raven	Garbage dump
	Chipping sparrow	Dwarf birch - spruce forest

### Possible Impact

In view of the small number of species which are present, the absence of rare or endangered species, and the fact that no species appears abundant, we do not envisage any large impact on the avifauna of the area. There may be an increase in hunting of ptarmigan, but we do not think such an impact would be large. Most of the birds were concentrated along the margins of streams, lakes, and marshy ponds. These important habitats should be avoided by the road, but we expect such areas will be avoided anyway for engineering reasons. No special mitigation is indicated for birds.

### Economic Use of Wildlife Resources

#### Hunting

Very little hunting takes place in the study area due to inaccessibility, except for the areas that can be reached from the Flat Lake access road and the Nahanni Range Road. Our information indicates that the majority of hunting is by local residents, mostly from Tungsten. Commercial guides have operated in this area in the past, but the area is not currently utilized. Big game management plans for the Mackenzie Mountains show the area from Tungsten north to the Canol Road as unassigned (Simmons, 1970) in 1970, and local residents indicated that it was not being used at present. Presumably, the area is not used by commercial outfitters because of the relatively sparse distribution of game and the high cost of access.

With construction of the road, we would expect a rather large increase in hunting by residents of Tungsten, who are severely limited in hunting opportunities within the N.W.T. at present. Also, we expect that the prospect of cheap road access will cause a renewed interest by commercial outfitters. If acceptable management of game requirements are not provided, we anticipate relatively large impacts on the wildlife populations of the area, especially moose, caribou, and grizzly. It may be important to intensify management of this area to ensure that game harvests do not exceed net productivity.

#### Trapping

The Canada Land Inventory for the area indicates that no commercial trapping is conducted in the study area, but some recreational trapping is carried out by residents of Tungsten. Due to the difficult access, it is doubtful if such trapping extends much farther north than Flat Lake.

Some portions of the Little Nahanni and its tributaries, and the Little Hyland system, have beaver populations which are not easily accessible at present. The proposed road will provide ready access to the beaver and wolf populations. This will provide benefits in the form of recreation and modest revenue for the trappers. Since most species produce a harvestable surplus, the impact of the trapping need not be adverse. There will, however, be considerable impact if trapping is not managed on a sustained-yield basis. Beaver, in particular, could be severely reduced through unrestricted trapping.

### 4.3 FISHERIES

Fisheries investigations were conducted from June 15 to June 26, 1976. Since little information on the fishery resources of the Little Nahanni and Little Hyland Rivers was available, the objective of the field work was to determine major fish species inhabiting the drainages of the project area and to qualitatively assess fish habitat.

#### 4.3.1 Stream Surveys

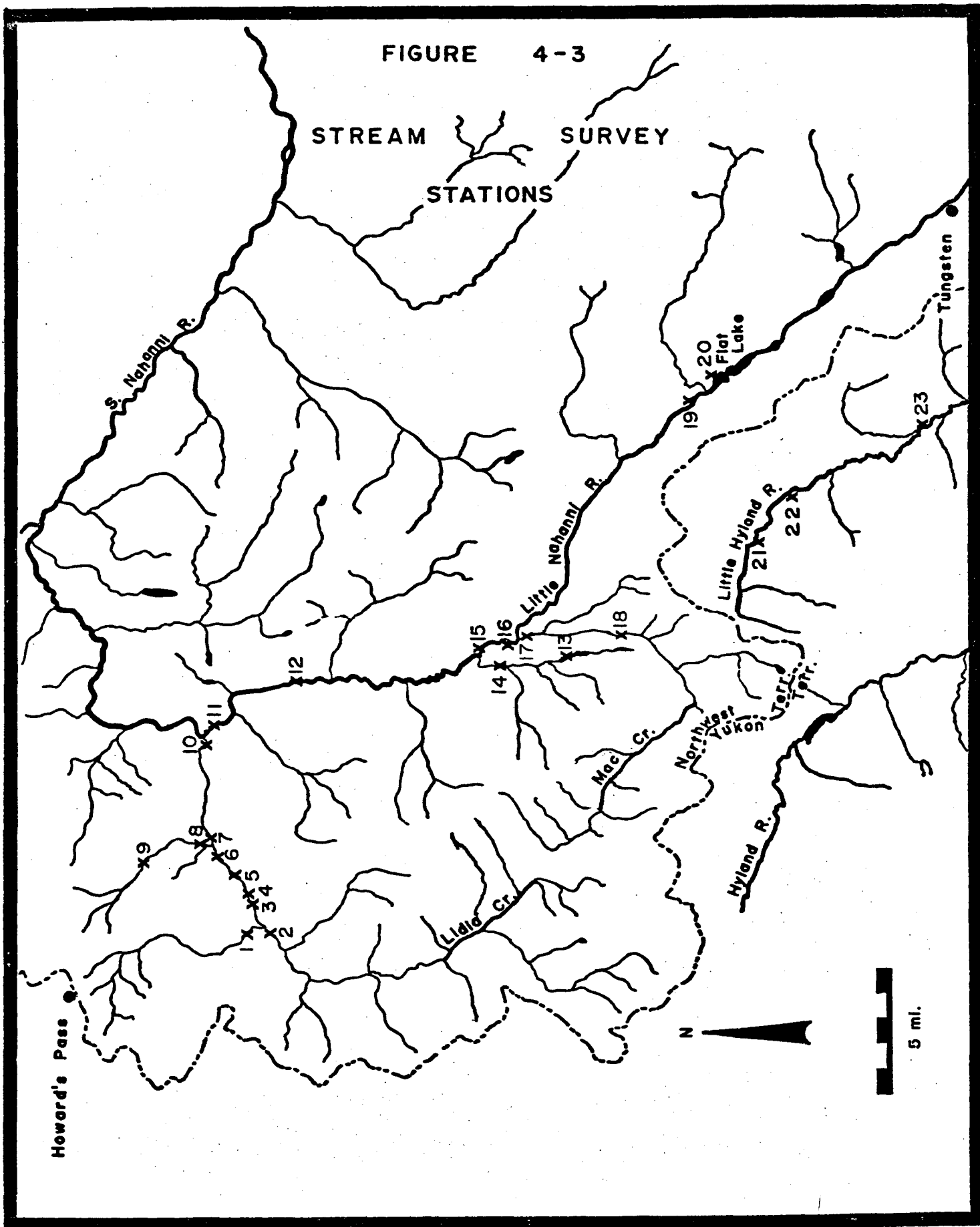
Both aerial and ground reconnaissance were used to assess stream characteristics and a brief description of the major streams in the project area are presented below. Stream measurements at selected stations are included in Appendix 2 Table 1 and the reader is referred to Figure 4-3 for the location of streams and sample sites. It should be noted that the stream descriptions which follow are based on observations and measurements taken during the peak flow period.

##### Little Nahanni River

The Little Nahanni River, the major stream in the project area, is part of the Mackenzie River drainage, flowing via the South Nahanni and Liard Rivers. It originates at Flat Lake, north of Tungsten, N.W.T., and drains an area of

FIGURE 4-3

STREAM SURVEY STATIONS



approximately 1,670 square kilometers.<sup>1</sup> It flows in a moderately wide U-shaped valley and shows the characteristics of both a braided and meandering stream. Channel width averages about 30 meters and the depth is generally less than 2 meters, although this depth may be exceeded due to scouring of meander bends. Substrate composition is predominantly rubble<sup>2</sup> and gravel, with numerous exposed gravel bars (Plate 11). Where the gradient is low, for example at the outlet of Flat Lake and in the vicinity of Mac and Guthrie Creeks, the river meanders strongly with old stream courses creating backwater channels and pools (Plate 12). The substrate in these channels consists of silt, but the water was extremely clear and grayling were observed on several occasions feeding at the surface. Beaver activity is common in these areas.

The stream banks of the Little Nahanni are generally low (less than 1 meter) and well-vegetated, the dominant species being dwarf birch, willow, some balsam poplar and spruce. As a result of the vegetative cover, the banks are generally stable although some undercutting on the outside of river bends and slumping is evident in localized areas. About 3 kilometers upstream from the confluence of Lidia Creek, the river becomes a series of rapids flowing in a steep, rock-faced canyon.

- 
1. The drainage area of this stream and those which follow were estimated by planimetry and are approximate only.
  2. Based on the classification of Lagler (1956), rubble refers to bottom materials ranging in size from 8 to 15 cm.



Plate 11 Typical view of the Little Nahanni River, showing gravel bars.



Plate 12 Meandering channel of the Little Nahanni River near the outlet of Flat Lake.

Flow records are not available for the Little Nahanni River, but maximum flows occur in June as a result of snowmelt. Water velocities measured in June averaged between 1.5 and 1.8 meters per second. During the field survey, the water was extremely clear, though several days of warm weather resulted in rapid run-off and very turbid conditions on June 25.

### Tributary Streams

The tributary streams of the Little Nahanni River drain the surrounding mountains originating at an elevation of 1,800 to 2,100 meters and join the Little Nahanni River between 900 and 1,200 meters. The tributary streams were typically clear and substrate composition ranged from coarse gravel to boulders, the size generally increasing with stream gradient. Vegetation in the valley bottoms consisted primarily of willow and birch at the lower elevations. For comparative purposes, these streams have been classified using a system developed by Strahler (1951) where streams with no tributaries are designated first-order streams. Two first-order streams join to form a second-order stream; two second-order streams join to form a third-order stream, and so on. The major tributary streams are described below in order of their occurrence along the preferred access route as outlined in Section 3.2.

The first major tributary at mile 21.1 is Mac Creek, a third-order stream draining an area of approximately 212 square kilometers. The upper reaches of this stream flow in a narrow V-shaped valley and are characterized by many small

canyons, rapids and braided stretches (Plate 13). Downstream reaches, on the other hand, exhibit a meandering pattern and old meander scars are evident. The valley is relatively wide and marshy in this area and several pothole lakes are present about 1,100 meters upstream of its confluence with the Little Nahanni River. Stream widths in the lower sections average 20 meters, stream depths between 60 and 120 centimeters and surface velocities were estimated to be 1.5 to 1.8 meters per second.

Two small elongated lakes are the source of Guthrie Creek which flows parallel to Mac Creek on the west side of a prominent ridge separating these two valleys. This third-order creek drains an area of approximately 52 square kilometers. The stream is braided and riffles predominate flowing over a rubble substrate (Plate 14). Stream measurements taken in the downstream reaches indicated an average width of about 6 meters, an average depth of 30 centimeters and surface velocities between 1.2 and 1.5 meters per second.

The two remaining third-order tributaries of the Little Nahanni River, Fork and March Creeks, were surveyed by air only. Drainage areas for these two streams were calculated to be about 62 and 52 square kilometers respectively. The nature of these creeks differs considerably from Mac and Guthrie Creeks. These streams flow in narrow, V-shaped valleys and are characterized by a steep gradient and torrential flows over a substrate of rubble and boulders.



Plate 13 Small canyons and rapids typical of the headwaters of Mac and Lidia Creeks.



Plate 14 Braided downstream reaches of Guthrie Creek.

Lidia Creek, a fourth-order stream, is the largest tributary of the Little Nahanni River, draining an area of approximately 497 square kilometers. The upstream areas of this stream are similar to the headwaters of Mac Creek. The stream is typically braided, flowing around vegetated gravel bars. This is interspersed with short stretches of rapids flowing through small canyons. Downstream of Canex Creek, the valley widens, the stream meanders, and backwater areas similar to those described for the Little Nahanni River are formed in old stream channels (Plate 15). Stream widths in this reach averaged 18 to 23 meters and velocities ranged from 1.2 to 2.1 meters per second. About 1.5 kilometers from its confluence with the Little Nahanni River, Lidia Creek enters a steep, rocky, canyon where it flows in a series of rapids and over a waterfall estimated between 2 and 3 meters high (Plate 16). This probably presents an unsurpassable barrier to the upstream movement of fish into Lidia Creek.

From Lidia Creek to Howard's Pass, the proposed access route will follow either Placer or Canex Creeks. These creeks are characterized by narrow V-shaped valleys, a relatively steep gradient and a rubble and boulder substrate. Riffles and rapids predominate (Plate 17). Canex Creek, a third-order stream, drains an area of about 91 square kilometers. Measurements near the stream mouth indicated a width of approximately 12 meters, average depth between 30 and 60 centimeters, and surface velocities as high as 2.4 meters per second. Placer Creek is a smaller second-order stream



Plate 15 Backwater pool formed in old stream channel of Lidia Creek.



Plate 16 Canyon and rapids at lower end of Lidia Creek.

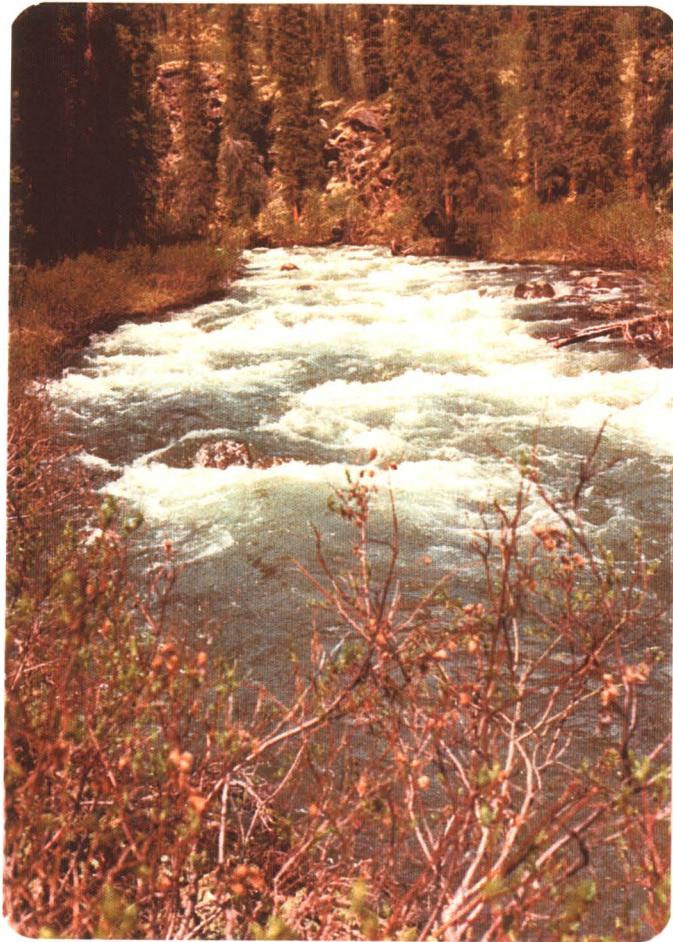


Plate 17 Rapids in Placer Creek, a  
third order stream.



Plate 18 Southeast view of Flat Lake.

with a drainage area of 39 square kilometers. Stream width in the lower sections averaged about 4 meters, surface velocity was 1.8 meters per second and average stream depth was similar to Placer Creek.

The smaller first-order and second-order streams in the project areas were not considered individually in this study. Most of these streams are noted as intermittent on the maps of the National Topographic Series. These streams are typically less than 3 or 4 meters wide, have a steep gradient and a stony bottom. Fluctuation in discharges are likely to be pronounced in these run-off streams, dependent upon precipitation.

#### Little Hyland River

As three of the alternate routes proposed for the access road will follow the Little Hyland River, this drainage is also described. The Little Hyland River flows into the Liard via the Hyland River. It drains an area of about 803 square kilometers, although only the headwaters are in the project area. The Little Hyland flows in a wide, flat valley. The headwaters are clear, shallow, and flow rapidly in a braided channel over a rubble-gravel bottom. Further downstream, water velocities decrease and the river is deeper and more turbid, and meanders in a wide, marshy floodplain dotted with oxbow lakes and shallow silted backwater areas. Streamside vegetation consists of willow and some birch, and aquatic vegetation, including sedges and mosses, is abundant in the backwaters and ponds.

#### 4.3.2 Lake Survey

Only two streams in the project area are associated with lakes. Flat Lake, the source of the Little Nahanni River, is the largest with a surface area of about 24 hectares (Plate 18). Flat Lake is approximately 1.6 kilometers in length, with a maximum width of 0.2 kilometers. It consists of two relatively deep basins joined by a shallow gravel stretch where the lake width is constricted to approximately 10 meters. The lake, which lies in a steep-sided, SE-NW valley, is fed by small, intermittent streams and drains two small upstream lakes. The shoreline is regular and vegetation surrounding the lake consists of birch, willow and spruce. Aquatic vegetation is present only in the shallow upper end of Flat Lake and emergent and submergent vegetation, in particular sedges and mosses, are abundant in the shallow, upstream lakes.

When Flat Lake was sampled (June 26), the surface water had a temperature of 12°C and a pH of 8. The water was relatively clear with a secchi disc visibility of 4 meters and conductivity of 160  $\mu\text{mhos cm}^{-1}$ . Conductivity, which is correlated with the total dissolved solids (TDS) and/or the nutrient content of water (Anderson, 1975) was equivalent to a TDS value of less than 100 ppm. According to Northcote and Larkin (1956) this would indicate low productivity during this period. However, other factors, particularly climate and lake morphometry, may significantly influence the relationship between TDS and biological production.

The headwater lakes of Guthrie Creek occupy 2 small elongated basins. The lower lake is the larger, with a length of about 0.8 kilometers. The surrounding vegetation was predominantly willow and there was little shoreline development. Aquatic vegetation, including sedges and submergent mosses, were present in shallow areas near the lake outlet. Beaver were observed in this area and the outlet of the lake has been partially dammed. Surface temperatures in the lake shallows were as high as 21°C and conductivity was similar to that of Flat Lake (188 umhos. cm.<sup>-1</sup>).

#### 4.3.3 Fish Species Present And Resource Use

Fish were collected from the Little Nahanni system and the Little Hyland River during the period from June 20 to June 26. The purpose of the sampling program was to determine the species of fish inhabiting the stream and estimate the effects of the proposed access road. The sampling methods used included gill netting, angling, and visual observations. Gill netting in the river was limited to the availability of deep backwater pools created in old meander channels. As a result, sampling effort was concentrated in the Little Nahanni River and its largest tributary, and the Little Hyland where suitable sites were found. Fish were also sampled in Flat Lake and the headwater lake of Guthrie Creek. The high water discharge rates during the survey did not allow sampling of fish in many of the smaller and swift-flowing tributary streams.

Fish sampling stations are shown in Fig. 4-3 and fish catch data presented in Table 4-3 and Appendix 2, Table 2.

From Table 4-3, it can be seen that the arctic grayling (Thymallus arcticus) is the most common species in both the Little Nahanni system and the headwaters of the Little Hyland River. In addition to grayling, lake trout (Salvelinus namaycush) were present in the Little Nahanni at Flat Lake, and mountain whitefish (Prosopium williamsoni) occurred in the Little Hyland River. The distribution of these species and some aspects of their biology are presented in the following sections.

#### Arctic Grayling (Thymallus arcticus)

##### Species Description

The arctic grayling is a widely-distributed species in northern freshwater drainages, preferring the clear, cold waters of large rivers, rocky creeks and lakes (Scott and Crossman, 1975). Although studies of grayling are available for exploited populations in large lakes of the Northwest Territories (Great Slave and Great Bear Lakes) little is known of their biology and movements in small sub-arctic and arctic streams (Craig and Poulin, 1975). A general description of the life history of arctic grayling is provided by Scott and Crossman (1973) and McPhail and Lindsey (1970).

TABLE 4-3

Species and numbers of fish caught in the Little Nahanni drainage and the Little Hyland River, 1976.

<u>Sample Station</u>	<u>Date</u>	<u>Sampling Method</u>	<u>Fish Catch</u>
Little Nahanni			
3	June 20	gill net	0 catch
4	June 19	angling	0 catch
5	June 20	gill net	0 catch
6	June 22	gill net	0 catch
10	June 21	gill net	7 grayling
11	June 17	angling	0 catch
12	June 22	gill net	1 grayling
13	June 25	angling	2 grayling
15	June 16	angling	5 grayling
15	June 22	gill net	8 grayling
			1 lake trout
16	June 22	observation	1 grayling
17	June 22	angling	0 catch
19	June 25	gill net	33 grayling
20	June 26	gill net	12 lake trout
Little Hyland			
22	June 25	gill net	4 grayling
23	June 25	gill net	22 grayling
			5 mountain whitefish

The spawning season of grayling in its northern range occurs usually in May or early June immediately prior to or during ice break-up. Grayling generally migrate from lakes and rivers to small tributaries, and spawn over a gravel or rocky substrate, returning to the lakes and rivers after spawning. Eggs usually hatch within 16 to 18 days at temperatures near 9°C and the young may emigrate shortly afterwards or rear in the spawning stream for the duration of the summer. In ice-locked streams a second migration of both adults and juveniles occurs in the fall to suitable overwintering areas in deep lakes or larger rivers.

#### Distribution In the Project Area

Arctic grayling were found to inhabit both the Little Nahanni and the Little Hyland Rivers. In all gill net sets in backwater pools and channels, arctic grayling was the sole or most abundant species caught. Largest grayling catches occurred in the Little Nahanni River near the outlet of Flat Lake and at the downstream station in the Little Hyland River. Although grayling were not sampled in Flat Lake, they were abundant and could be observed feeding at the surface and distributed throughout the lake. Grayling were also present in the smaller, shallow lakes draining into Flat Lake.

Although Lidia Creek appears to provide good grayling habitat, similar to that in the Little Nahanni River, gill netting, angling and visual observations at several locations between Placer and Canex Creeks did not indicate the

presence of fish. Grayling were, however, caught in Lidia Creek at a downstream site close to its confluence with the Little Nahanni River. It appears that the falls located approximately 1.5 kilometers above the mouth of Lidia Creek presents an obstruction to fish movements. The absence of fish in upstream sections would thus preclude their existence in tributary streams including Canex and Placer Creeks.

The absence of suitable gill netting sites in the remaining tributaries of the Little Nahanni River did not permit the documentation of fish presence or absence in these streams; however, some qualitative observations on potential stream utilization can be made. Based on stream characteristics, such as stream gradient, water depth, and substrate composition, it would appear that both Mac and Guthrie Creeks, two third-order streams, may be used by grayling although angling and visual observations during the field survey did not reveal any fish. It should be noted that grayling were found in the lower headwater lake of Guthrie Creek, feeding at the surface near the lake outlet. However, access to the lake, may be blocked by a small beaver dam.

Aerial reconnaissance of March and Fork Creeks, also third-order streams, indicated that the steep gradient and rapid flow over boulders would provide limited habitat potential. Similarly, small tributary streams classified as first and second order are unlikely to be of major importance from a fisheries standpoint as they are characterized by a very steep gradient, shallow depth and intermittent flows.

It should be emphasized here that the distribution of grayling in the study area as discussed in the previous section is based on reconnaissance survey of adult grayling during a two-week period in June. Their distribution during the spawning season or in summer and fall when flows have decreased may be quite different. For example, although the availability of suitable spawning habitat appears extensive in the Little Nahanni mainstem and in Mac and Guthrie Creeks, the relative importance of these streams for spawning purposes would have to be determined directly by observations during the spawning season. In addition, no information has been obtained on fry rearing areas.

#### Biological Data

##### Age and Growth

The 56 Grayling collected from the Little Nahanni system ranged from 23.1 cm. to 38.5 cm. in length. The 26 grayling from the Little Hyland were a similar size ranging from 20.2 to 41.0 cm. The relationship between fork length and weight for grayling from both systems is comparable and is shown in Fig. 4-4. Age classes between 2 and 8 years were represented and growth curves are shown in Fig. 4-5; superimposed on results obtained from other areas in northern Canada and Alaska. The growth rate for grayling in the study area is slightly above average in comparison with these other populations though sizes tend to decrease at the higher age classes. It should be noted, however, that the relatively small sample size and the difficulty of accurate age deter-

Fig. 4-4. Length/weight relationship for arctic grayling from the Little Nahanni River (●) and the Little Hyland River (x), 1976.

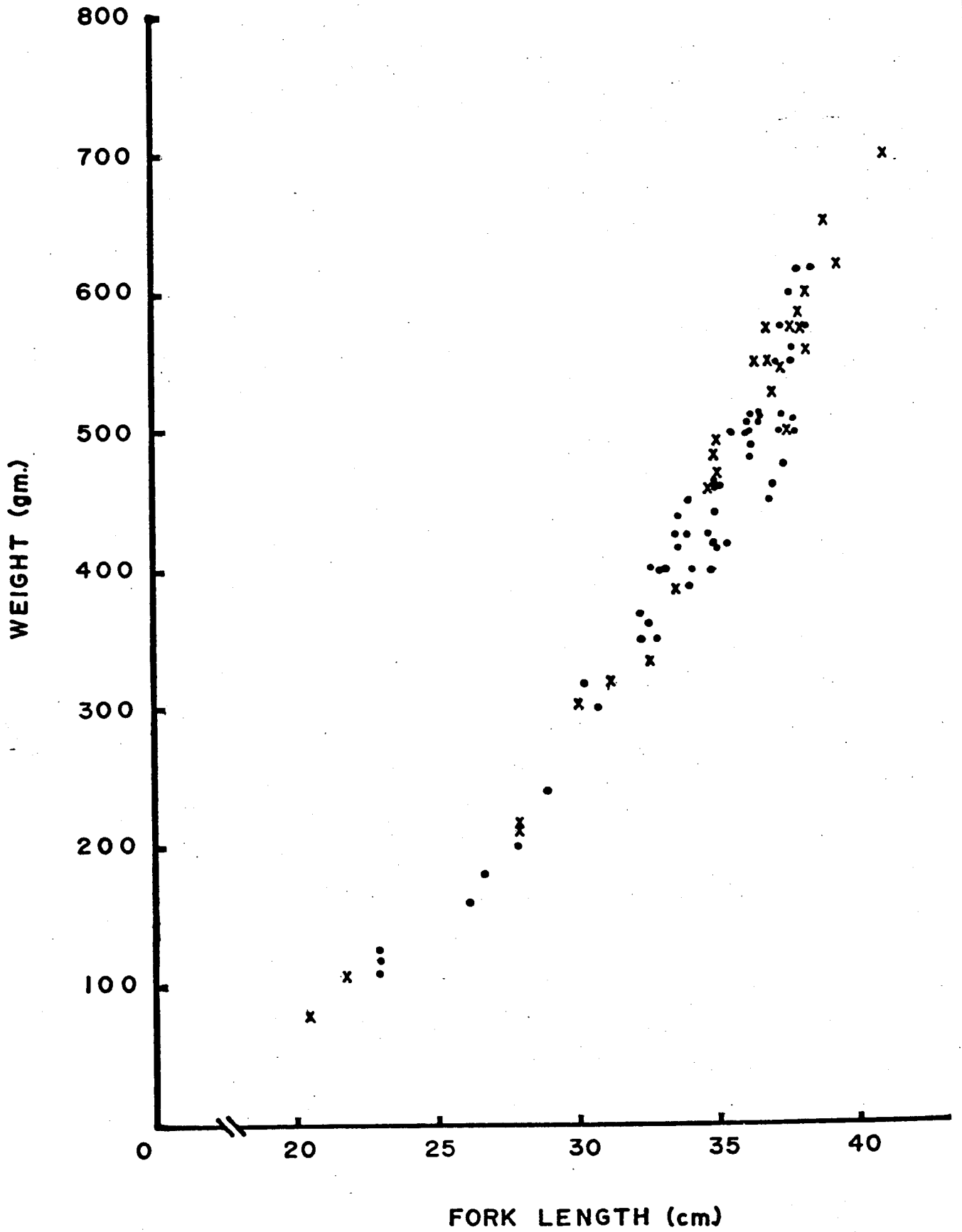
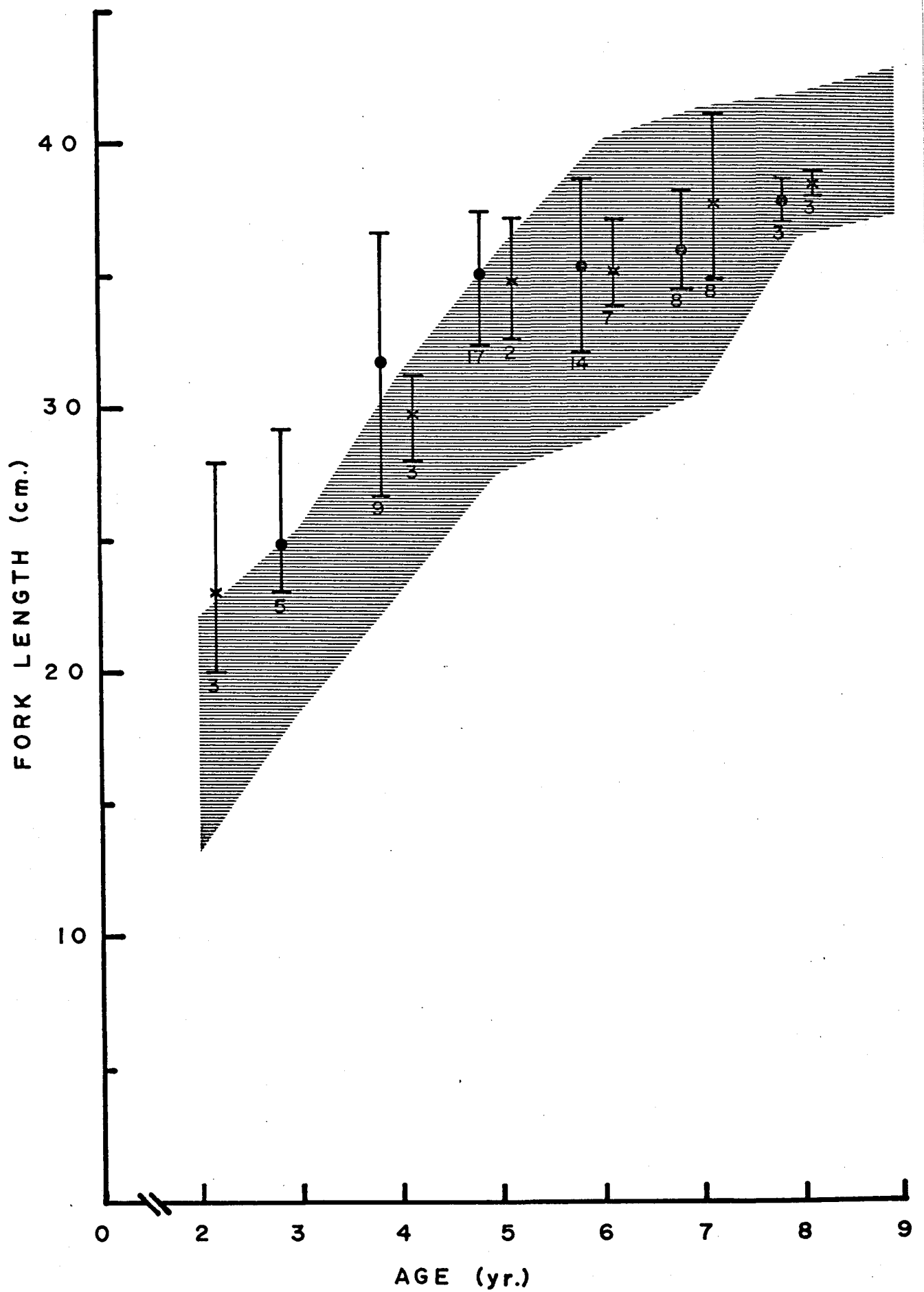


Fig. 4-5. Growth in the length of arctic grayling from the Little Nahanni River (●) and the Little Hyland River (x). For each age class, the range in lengths and the number of samples are shown. The shaded area represents growth curves for arctic grayling from other northern lakes and rivers including Great Bear Lake, N.W.T.; Lake Athabasca, Sask.; Little Salcha River, Alaska (Scott and Crossman, 1973); Weir Creek and Kavik River, Alaska (Craig and Poulin, 1975); and Great Slave Lake, N.W.T. (Falk and Gillman, 1974).



mination may influence the growth curve. Such analysis can often underestimate ages due to a missing first annulus or "growth ring." Aging of older fish is also difficult as the yearly growth increment may be so small that the annuli are difficult to identify (Craig and Poulin, 1975).

Age at maturity was not determined as sampling was conducted after the spawning season when all fish had developing gonads. Although all females over 2 years of age had developing eggs, it was not possible to determine which ones would spawn next spring. According to Scott and Crossman (1973), the age at maturity is generally between 5-9 years for northern populations.

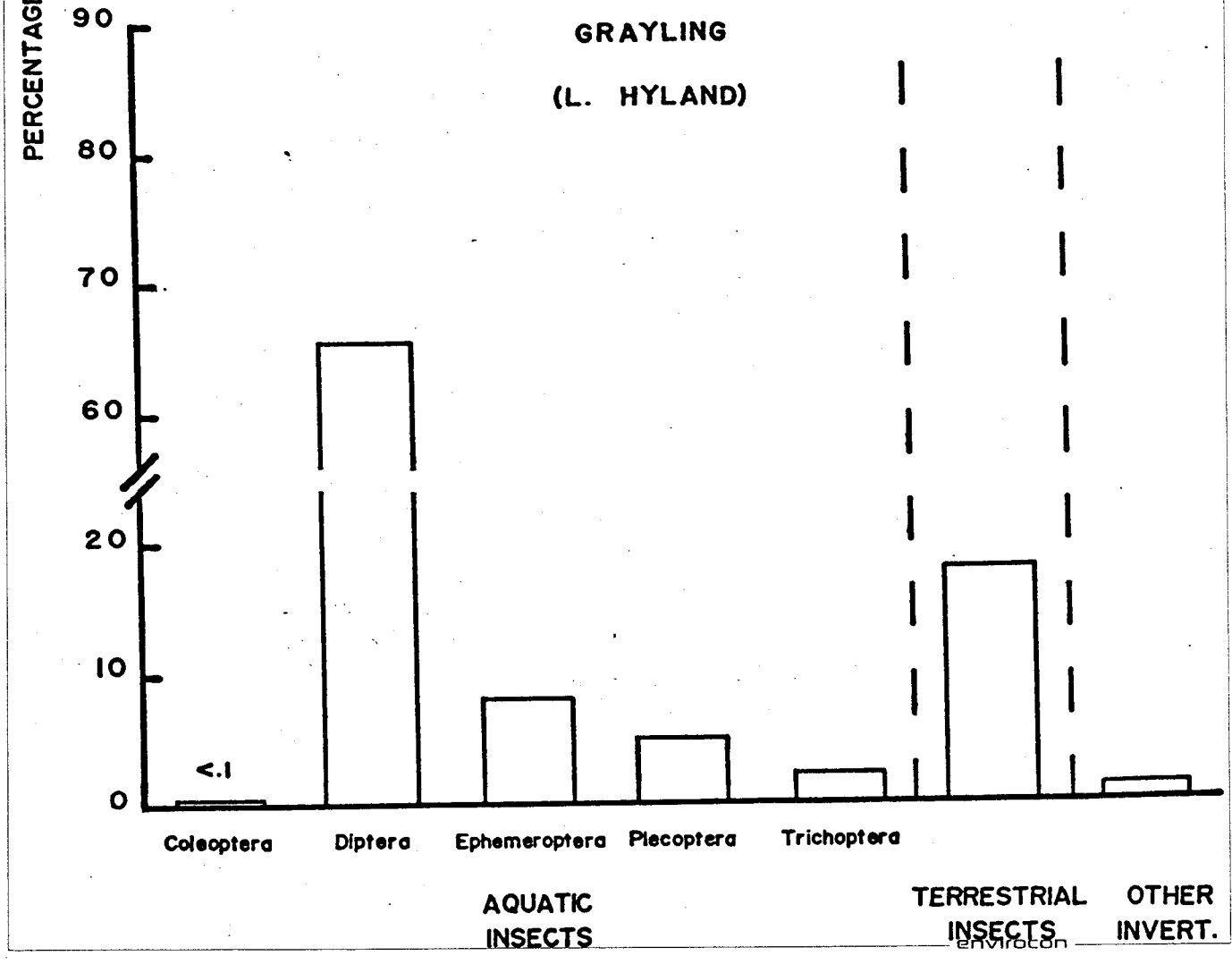
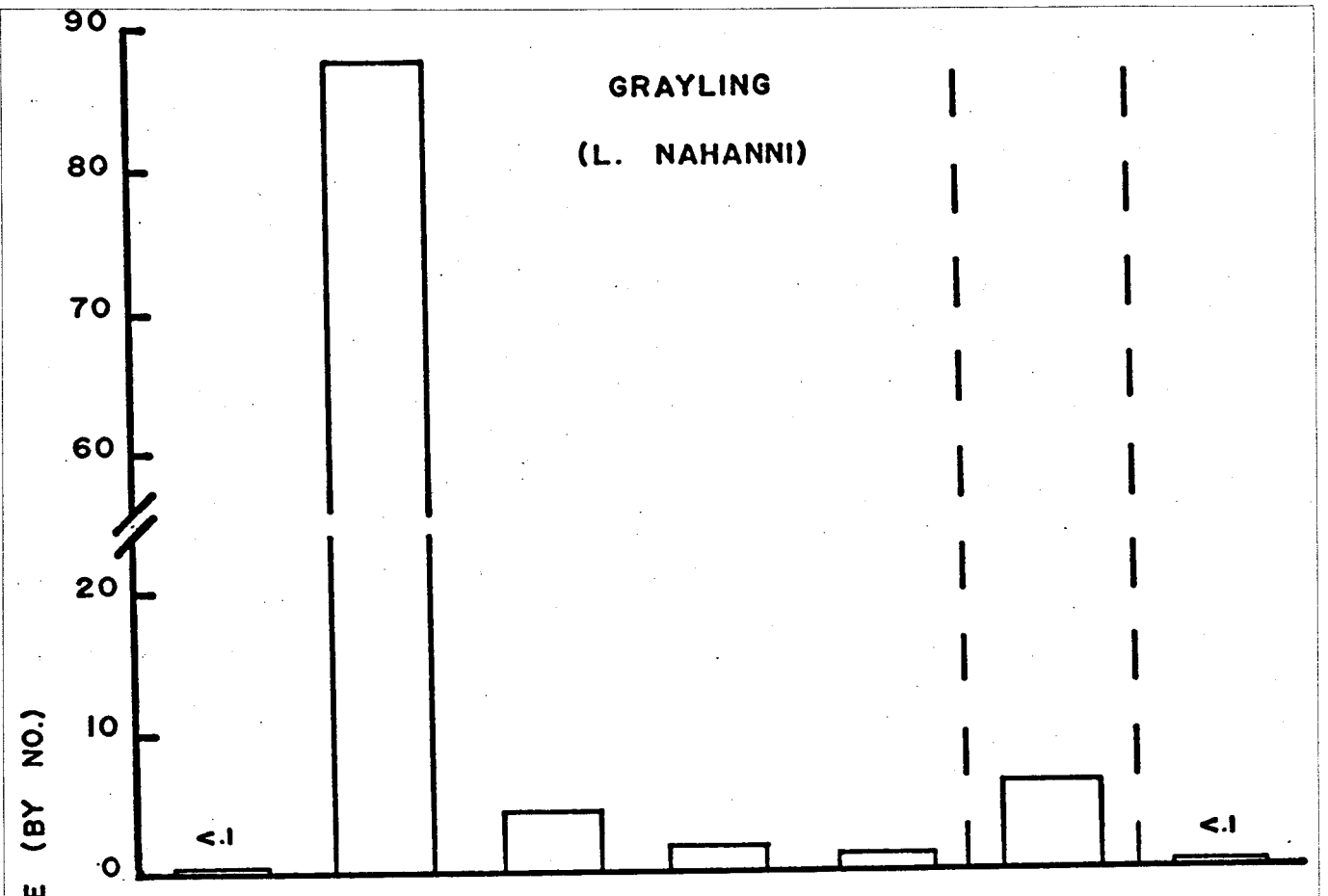
#### Feeding Habits

The results of stomach content analysis of arctic grayling from the Little Nahanni and Little Hyland Rivers are presented in Figs. 4-6 and 4-7 and a more detailed analysis is included in Appendix 2, Tables 3 and 4. Results are expressed in terms of the relative abundance of various food organisms and their frequency of occurrence in fish stomachs. By comparing these values, the relative importance of prey species can be assessed. In general, the components of the diet were similar to those reported for other grayling populations.

The diet of arctic grayling, which was similar for both the Little Nahanni and Little Hyland systems, consisted almost entirely of aquatic and terrestrial insects. In terms of

Fig. 4-6. Percentage occurrence of food organisms in arctic grayling stomach samples from the Little Nahanni River, 1976.

Fig. 4-7. Percentage occurrence of food organisms in arctic grayling stomach samples from the Little Hyland River, 1976



AQUATIC  
INSECTS

TERRESTRIAL  
INSECTS

OTHER  
INVERT.

Environment

numbers, the aquatic forms predominated, represented by five insect orders including Diptera (fly larvae and pupae); Trichoptera (caddisfly larvae); Ephemeroptera (mayfly nymphs); Plecoptera (stonefly nymphs) and Coleoptera (beetle larvae). Of these groups, the dipterans were the most numerous, in particular the aquatic developmental stages of Tendipedidae (midges). Percentage composition of midge larvae and pupae in stomach samples was 86% and 59% for grayling from the Little Nahanni and Little Hyland Rivers respectively. It should be noted, however, that the variability among samples was high ranging from 0 to over 1,000 larvae in individual stomachs.

Mayflies, caddisflies and stoneflies each had a high frequency of occurrence in fish stomachs, but were present only in moderate numbers. Terrestrial insects were also common in the grayling diet, occurring in over 90% of the stomachs examined. For grayling from both the Little Nahanni and Little Hyland Rivers, the number of aquatic insects excluding dipterans, was similar to the number of terrestrial forms. Other components of the grayling diet including Coleoptera, Gastropoda (snails) and Nematoda (round worms) were of minor importance.

Many of the aquatic insect species comprising the arctic grayling diet were represented in the benthic samples collected from the stream bottom in the Little Nahanni River and some of the major streams. The small number of samples, however, did not permit any conclusions to be drawn regarding the availability of specific food organisms and their

relative use by fish. In general, the abundance of stream insects was low, with densities usually less than 15 organisms per square meter. Since sampling was conducted during peak flows, the abundance of aquatic insects would be expected to be at low levels. Results of the benthic sampling are presented in Appendix 2, Table 5.

#### Lake Trout (*Salvelinus namaycush*)

The lake trout is a widely distributed species in lakes and rivers throughout northern Canada. Lake trout are fall spawners and although the exact spawning times vary with different lakes, spawning occurs mainly in October. Spawning generally occurs over a rubble or boulder substrate in lake shallows, although river spawning is known to occur (McPhail and Lindsay, 1970). Incubation lasts 4 to 5 months and the young emerge in early spring. Lake trout movements can be limited to a particular lake or they may disperse many kilometers throughout small and medium-sized lakes. (Scott and Crossman, 1973).

#### Distribution In the Study Area

Lake trout occur in Flat Lake and are a valued sports fish for local anglers. They are apparently more abundant in the lower end of the lake and a gill net set overnight at a depth of 9 to 12 m. yielded 12 specimens. Lake trout may also occur in the Little Nahanni River as indicated by the capture of one trout downstream of Guthrie Creek. Although their presence in the headwater lake of this tributary

stream was not determined in the present study, lake trout may utilize this small lake as well.

### Biological Data

#### Age and Growth

The fork lengths of the lake trout sampled ranged from about 24 to 41 cm. and the relationship between fork length and weight is presented in Fig. 4-8. Age ranged from 3 to 9 years and growth rate curves for lake trout in Flat Lake are presented in Fig. 4-9. The shaded area of the graph represents data from lake trout populations in other areas of northern Canada and indicates a relatively slow growth rate for the lake trout population in Flat Lake. This may be due to the apparent absence or unavailability of fish forage species in Flat Lake. Although lake trout feed on a variety of organisms including fish, plankton, benthic invertebrates and terrestrial insects, growth rates are generally greater for piscivorous populations.

The lake trout aged 7, 8 and 9 were all mature females which would likely spawn in the fall. The fish in age classes 5 and under, however, all had immature gonads. This corresponds with the average age at maturity of 6 or 7 years indicated by Scott and Crossman (1973).

#### Feeding Habits

The percentage composition of food items in the twelve lake trout stomachs examined is presented in Figure 4-10 and

Fig.4-8. Length/weight relationship for  
lake trout from Flat Lake, 1976

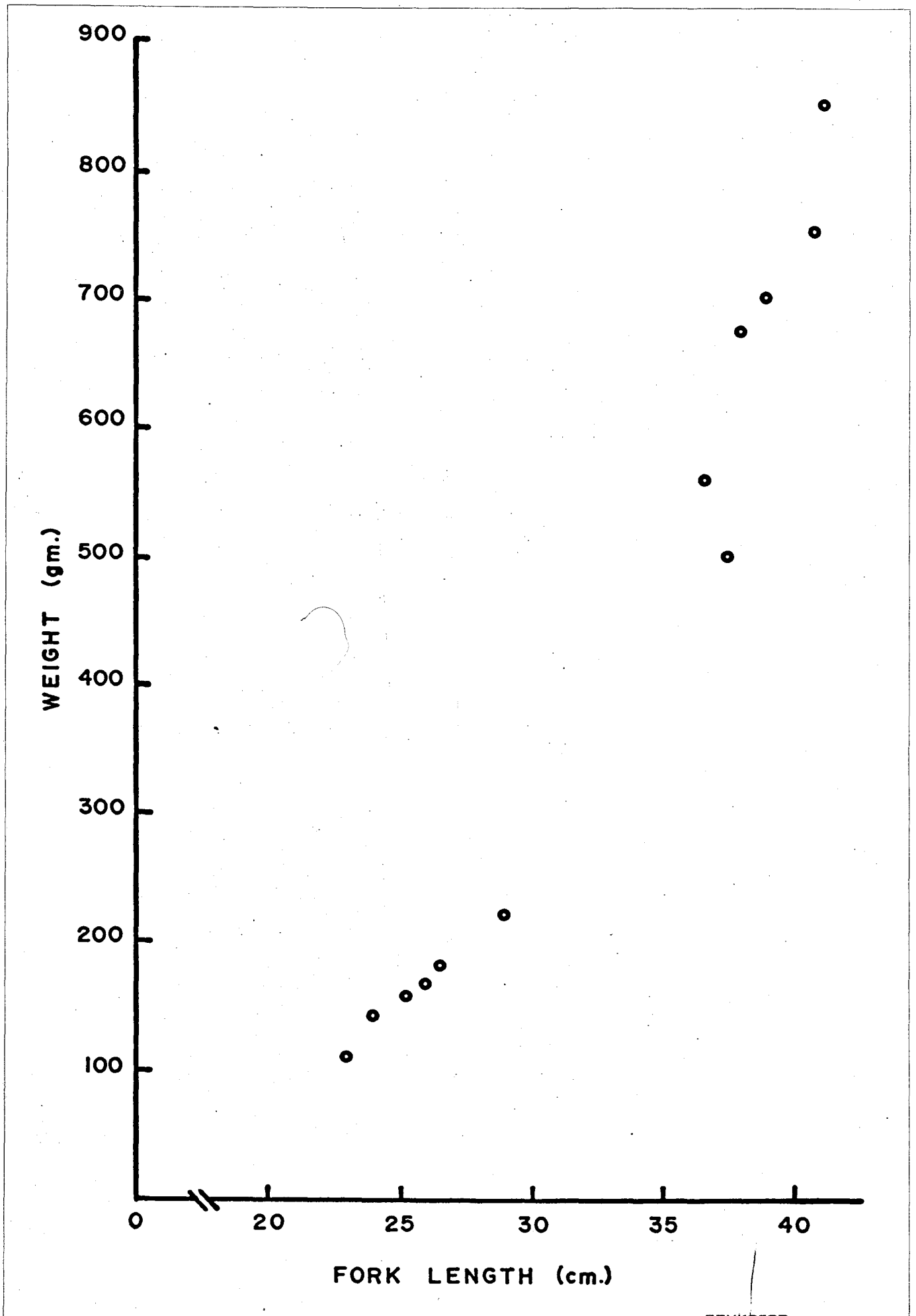


Fig. 4-9. Growth in length of lake trout from Flat Lake, 1976. Shaded area represents growth curves for lake trout from lakes in northern Canada including Teslin Lake, Yukon (Clemens et al. 1968); Hottah Lake, N.W.T. (Wong and Williams, 1973); Great Slave Lake, N.W.T. and Lac la Ronge, Sask. (Scott and Crossman, 1973).

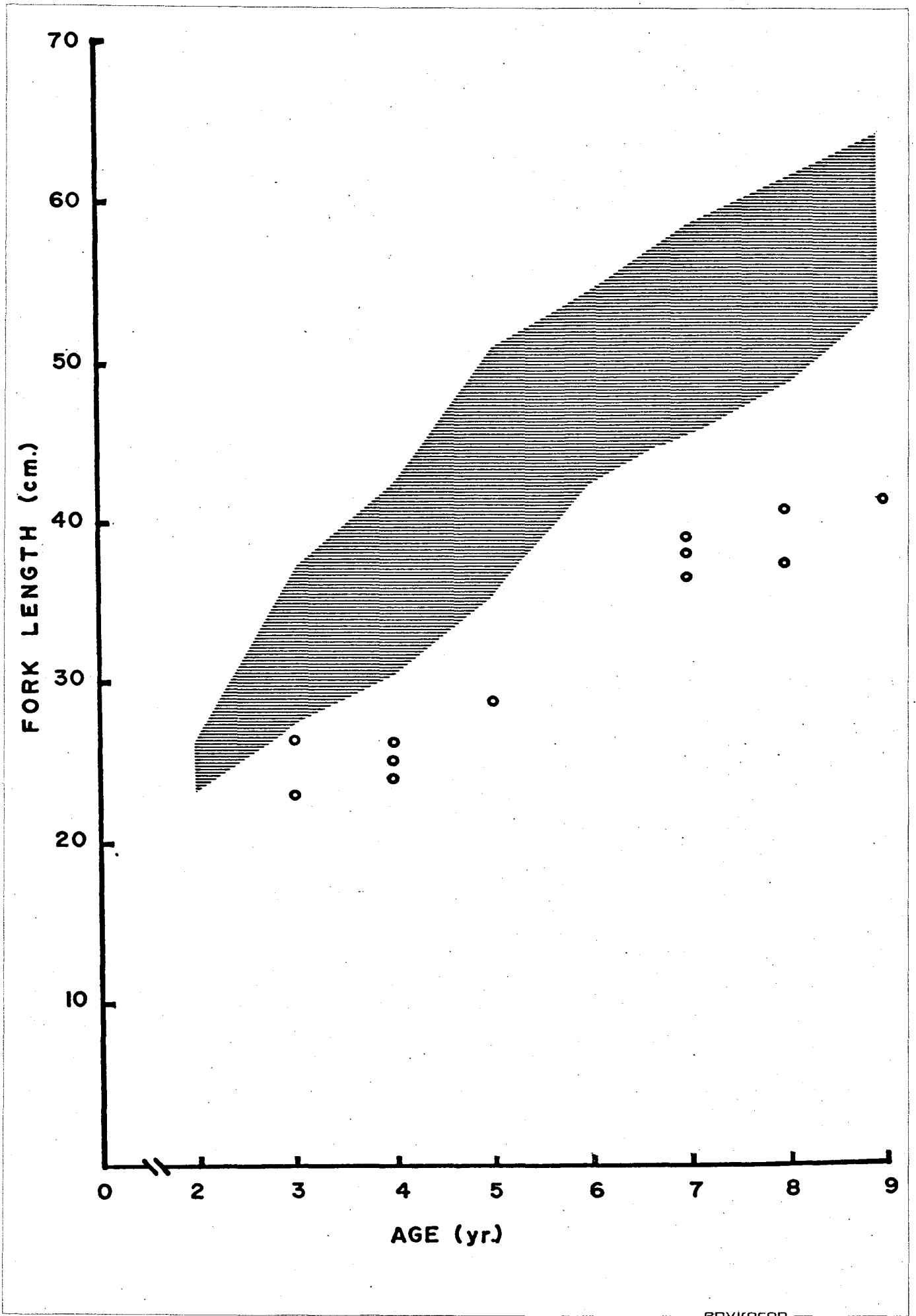
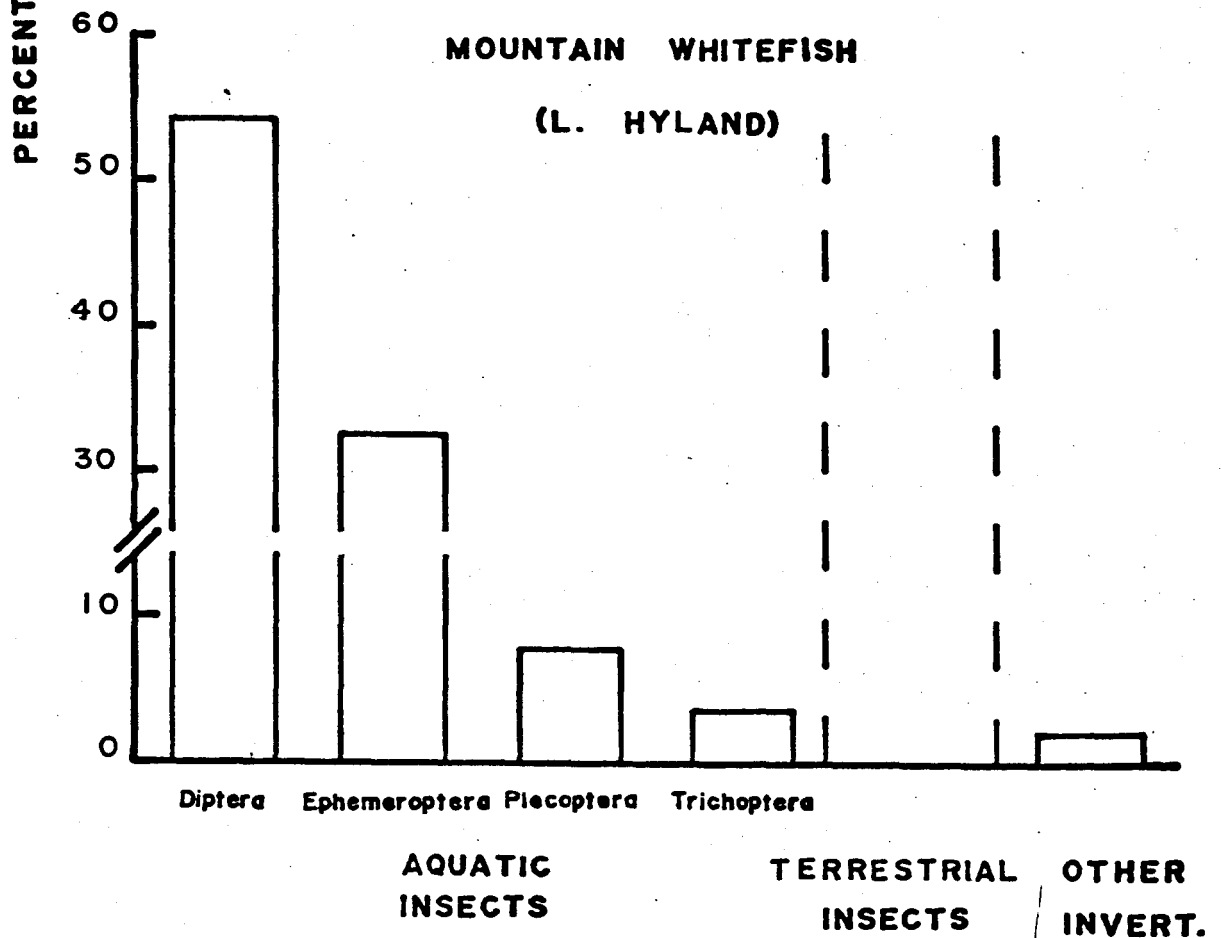
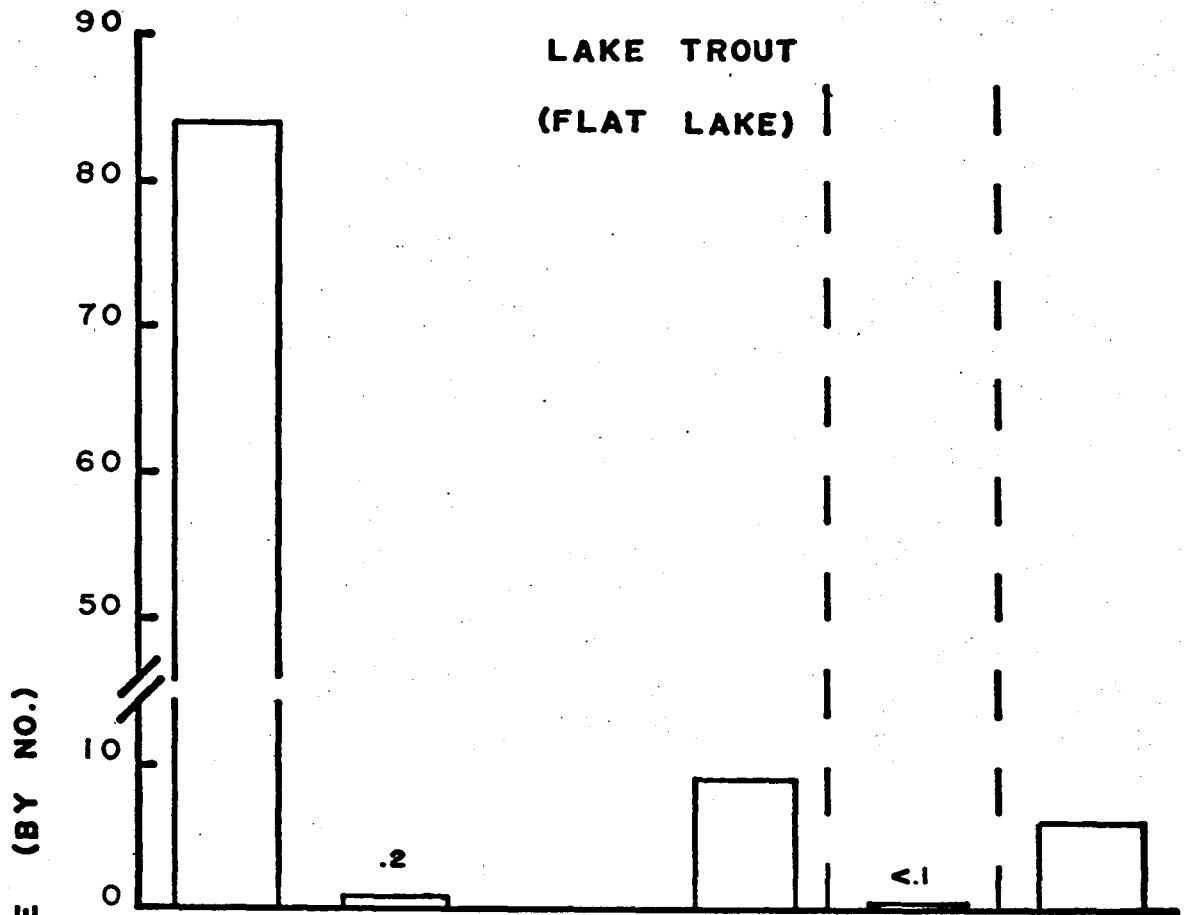


Fig.4-10. Percentage occurrence of food organisms in lake trout stomach samples from Flat Lake, 1976.

Fig.4-11. Percentage occurrence of food organisms in mountain whitefish stomach samples from the Little Hyland River, 1976.



detailed results in Appendix 2, Table 7. The major food items for lake trout were Tendipedidae (midge) larvae and pupae, the same group which were heavily utilized by grayling. Percentage composition by numbers was 84% and it occurred in all stomachs examined. Other food organisms included the aquatic insect orders, Ephemeroptera (may flies) and Trichoptera (caddisflies) as well as other invertebrate groups such as Acarina (water mites), Mollusca (snails and clams) and Oligochaeta (segmented worms). In general, the frequency of occurrence of these groups was low. Although caddisfly larvae and clams were relatively abundant, these numbers are based almost entirely on a single stomach sample for each. Fish remains were not found in any of the samples.

Mountain Whitefish (Prosopium williamsoni)

Species Description

The mountain whitefish is common in lakes and rivers of western Canada, attaining its northern limit in the Liard system. The mountain whitefish has a wide range of habitats, including deep cold lakes, shallow eutrophic ponds, and clear or silty streams. Spawning occurs in the fall over gravel or rubble substrate in the shallow waters of streams. On occasion gravel shoals in lakes also provide a spawning bed. The young usually emerge in the spring and can be found along stream edges and in backwater areas.

### Distribution In the Study Area

The presence of mountain whitefish has not been reported for the Little Nahanni system and this species was not observed in this drainage during the present study. Mountain whitefish were, however, present in the Little Hyland River. Five whitefish were caught at station 23 which was downstream of the project area. The river in this section could be described as strongly meandering in a wide marshy floodplain. As a general comparison with the Little Nahanni, the Little Hyland was characterized by a lower gradient, less rapid flows, and more turbid water conditions, consistent with the habitat preferences of mountain whitefish. Shallow, backwater areas with abundant aquatic vegetation were extensive in this area and may provide good rearing habitat for fry.

The headwaters of the Little Hyland River, which were swiftly flowing, fairly shallow and lacking the backwater areas characteristic of downstream sections, may support few fish. Mountain whitefish were not caught at the upstream station although grayling were present. Good spawning gravel is available, however, and the upstream reaches may be utilized as spawning habitat.

## Biological Data

### Age and Growth

As only 5 mountain whitefish were sampled, an analysis of growth rate is not possible. The fish ranged from 32.1 to 42.9 cm. fork length and weighed from 320 to 750 grams. Age classes 6, 7 and 9 years were represented; however, the age of the largest fish was not determined due to a regenerated scale sample. The fork lengths for each age class were within the middle range of average lengths for mountain whitefish populations in B.C., Alberta and the western states (reported in Scott and Crossman, 1973). Sexual maturity is usually attained at age 3 or 4, and all specimens examined were mature.

### Feeding Habits

Stomach content analysis for mountain whitefish is presented in Fig. 4-11 and Appendix 2, Table 8. It should be noted, however, that the small sample size may bias the results. Similar to both the grayling and lake trout diet, it appears that midge larvae are extremely important to the mountain whitefish. Other food items included mayflies, stoneflies and caddis flies. Freshwater snails (Gastropoda) were also utilized to a small degree.

### Other Species

As the timing and duration of the field studies did not allow extensive fish sampling, other species may be present

in the project area, but were not detected. However, the wide-spread occurrence of grayling indicate it is the most common inhabitant of the waters in the study area. Although published information is not available for the drainages sampled, local residents indicated that small numbers of burbot (Lota lota) are present in Flat Lake.

Limited seining in the Little Hyland River indicated the presence of the slimy sculpin (Cottus cognatus). The slimy sculpin, a small species common to northern streams, is often an important food resource of piscivorous fishes, such as lake trout. As seining was considered impractical due to high water velocities in most streams of the Little Nahanni drainage, the presence of small fish species was not documented.

According to the Land Use Information Series map, non-migratory dolly varden (Salvelinus malma) and round whitefish (Prosopium cylindraceum) are present in the lower reaches of the Hyland River, although their presence in the Little Hyland River has not been documented.

#### Resource Use

As there is no road access along the Little Nahanni River or its tributaries, sportfishing is restricted mainly to Flat Lake. Both Flat Lake and the smaller shallow lakes upstream are popular fishing areas for the residents of Tungsten. Fishing for grayling is probably the most popular since they can be taken from shore or boat, and their intensive surface

feeding is indicative of their large numbers. Lake trout are also angled and, according to one resident who has lived intermittently in the area for the past ten years, the numbers and size of lake trout have decreased appreciably due to the increased fishing pressure accompanying the growth of Tungsten. Fishing in the Hyland River system is primarily for dolly varden char inhabiting a small lake downstream of the project area.

#### 4.3.4 Impact on Fisheries

From a fisheries viewpoint, Route A which parallels the headwaters of the Little Hyland River, Mac Creek and Lidia Creek then reaches Howard's Pass via Canex Creek, would have the least impact. The Little Hyland River contains arctic grayling and mountain whitefish populations so consideration would have to be given to minimizing stream disturbances in this area. The route follows this river for a relatively short distance and will be a continuation of an existing road in the Little Hyland Valley. The largest portion of the route, however, will follow streams which are unlikely to contain fish. Although the downstream portions of Mac Creek appear to provide good grayling habitat, the headwaters of this creek, characterized by small canyons with rapids and shallow riffles sections are not expected to support this species. The presence of a waterfall in the lower sections of Lidia Creek coupled with the results of fish sampling efforts in this stream also indicated that grayling were not present in this drainage.

The three other proposed routes, on the other hand, all run parallel for some distance to the Little Nahanni River and therefore would have an increased potential impact on arctic grayling and lake trout which were found in this drainage area. As the preferred access road based on engineering evaluation is Route D, the potential impact of this route is examined in more detail.

The effects of road construction and operation on the fisheries resources of the Northwest Territories have been reviewed by Dryden and Stein (1975). The major concerns described by these authors include the following:

1. fish blockage due to improper culvert design and installation or accumulation of debris.
2. increased siltation due to riverbank and bed erosion at permanent or temporary stream crossings. In addition, clearing activities, cut and fill slopes and gravel removal may increase sediment loads.
3. removal of streambed gravels used as spawning and rearing substrate.
4. introduction of waste materials into watercourses.

In addition to the above, the effects of increased access to the area should also be considered. These potential impacts are reviewed and evaluated in relation to the proposed project and ways to minimize any adverse environmental effects are presented.

### Fish Migration

Because of the seasonal habitat requirements of many northern fish species including arctic grayling, access to spawning, rearing, feeding and overwintering areas is vital for the survival of fish populations. Any obstruction to fish movement whether temporary or permanent may therefore have serious consequences. The severity of the impact will, however, vary, depending on the number of species utilizing the stream and/or its relative use by a particular fish population. For example, since spawning requirements are often fairly specific in terms of substrate composition, water depth and velocities, suitable areas may be limited to specific streams or portions of streams, resulting in a heavy concentration of fish during the spawning season. Blockage of such a stream could have a major impact on the fish.

These considerations are important with respect to the movements of arctic grayling population in the project area. Although the timing of the field studies did not permit the documentation of grayling spawning areas, observations on physical stream characteristics indicated potential spawning habitat abounded in the Little Nahanni River and in some of the larger permanent streams such as Mac and Guthrie Creeks. Unrestricted movement in these waters should therefore be maintained. In addition, as most of the Little Nahanni drainage is ice-locked during the winter, the migration of adults and juveniles to the deeper pools and to Flat Lake, which likely provide overwintering habitat, should also be unobstructed.

Since the proposed access Route D parallels the Little Nahanni River, and bridge crossings are proposed instead of simple culverts for all major tributary streams including Mac, Guthrie, Fork and March Creeks, the effect of the project on grayling movements is expected to be negligible. This statement is based on the assumption that good engineering practices will be followed and bridge crossings will not alter the natural river regimes and riverbanks at the crossing site will be stabilized. Since accumulation of debris in the river channel may also impede the passage of fish it should be prevented. Although culverts will be required for the smaller first and second-order stream crossings, access to these waters for fish may be unimportant since reconnaissance surveys indicated that the steep gradient, swift velocities and intermittent nature of these streams do not provide suitable fish habitat.

#### Erosion and Siltation

Cummins (1966) indicated that after water quality no single factor has greater biological significance in the stream than the physical nature of the channel substrate. Consequently, alterations of stream substrate due to road construction can have a major impact on aquatic resources. Stream bank erosion, scouring and increased siltation of streams are most often associated with stream crossings which may affect fish populations in a number of ways. An increased sediment load is unlikely to affect adult fish directly. Scouring and siltation of spawning substrate

during incubation periods may displace or smother eggs and alevins and fish may be affected indirectly by reduction of spawning and rearing habitat. Good grayling habitat is characterized by clear, unpolluted waters and their preference for clean, gravel or rubble substrate for spawning purposes makes them particularly vulnerable to increased sediment loads. According to studies by Brunskill (1973) small streams having a clear rubble or gravel substrate, and which normally run clear, as is typical of the streams in the Little Nahanni drainage, will be most sensitive to increased siltation. He also found, however, that streams with relatively high velocities (greater than 1 mps) could transport large amounts of sediment, yet maintain a clean gravel substrate, whereas silt deposition occurred over gravel and boulders in slower moving streams. Thus local, temporary, increases in sediment-loading should have a relatively minor impact, particularly during periods of high discharge. For clear streams and lakes studied in the MacKenzie and Porcupine drainages, Brunskill (1973) suggested that turbidity levels should not exceed 10-15 mg/liter during pipeline or road construction.

In addition to the effects of increased siltation on fish populations, fish food resources may be adversely affected by substrate alterations. Brunskill (1973) for example found that increased siltation of rivers or lakes was associated with a decrease in the abundance and diversity of aquatic invertebrates, which were shown in Section 4.3.3 to be the principle food of arctic grayling and lake trout in the study area.

Since the proposed route D will run parallel to Flat Lake and the Little Nahanni River, potential siltation problems due to sidehill construction and stream crossings is a major consideration. However, the magnitude of the impact is largely controlled and can be alleviated by the proper design, construction and maintenance of the access road. It is anticipated that the potential for increased siltation of the watercourses of the Little Nahanni River drainage, can be minimized if consideration is given to the following recommendations for mitigation.

1. Maintain a vegetated buffer strip between the road right-of-way and the high water levels of lakes and streams to minimize disturbances to active stream channels. A minimum distance of 100 meters has been recommended in the guidelines for the protection of fish resources in the Northwest Territories (Dryden and Stein, 1975). Preliminary engineering studies have indicated that this distance can easily be maintained at Flat Lake and along most of the route paralleling the Little Nahanni River. At specific sites between miles 24.5 and 26, however, this is not considered feasible and it is recommended that construction in this area should not coincide with the spawning season of arctic grayling as a precautionary measure. Special care would also be required in this area to avoid short and long-term erosion of the road and river banks.

2. Select stream crossing locations based on terrain stability to minimize potential erosion problems. Disturbances to ground vegetation should be minimized and stream banks stabilized in the vicinity of the crossings to prevent long-term erosion. These considerations should apply for temporary as well as permanent stream crossings.
3. Design stream crossings to minimize alteration of the natural river regime. Since bridge crossings are proposed for all third-order streams, this can easily be avoided for the larger streams. As a result, potential long-term problems of bank erosion, scouring, and siltation should be minimal provided stream banks are stabilized and the accumulation of debris in the vicinity of the crossing site is prevented. Although culvert installation will involve streams not frequented by fish, consideration should be given to downstream effects of construction at these sites, since tributary creeks contribute to the overall water quality and productivity of the major streams.
4. Stream crossings should be inspected and maintained routinely after completion to prevent washouts and to ensure that scouring, siltation, and the accumulation of debris is minimized.

#### Gravel Removal

The major concern associated with gravel borrow for construction and/or maintenance purposes is the removal of spawning

substrate utilized by arctic grayling. Removal of gravel from active stream channels should therefore be avoided, particularly in the Little Nahanni River, Mac and Guthrie Creeks, where potential spawning habitat is available. Gravel removal in these streams should be restricted to exposed gravel bars above high water levels. Preferably, gravel could be taken from non-aquatic sites. Since increased siltation can result from borrow operations, gravel removal should also be restricted to times which will not interfere with fish spawning, incubation and juvenile rearing. Borrow sites should also be regraded after gravel removal to eliminate areas that can trap fish during receding water levels.

Depending on the magnitude and the exact locations of gravel borrow operations, which were not determined during this study, it may be necessary to estimate the use of proposed borrow sites by spawning grayling to avoid any conflicts. Preliminary observations indicated, however, that suitable spawning gravels were extensive in the above-mentioned streams and that small localized disturbances should have a relatively minor impact. Gravel removal from small first-order streams would not be expected to have a significant impact on fish populations.

#### Water Quality

In addition to the potential changes in water quality due to increased turbidity of streams discussed in previous sections, the accidental introduction of construction wastes, in

particular pollutants such as fuels, lubricants and other petroleum products, are also hazardous to both fish and invertebrate populations. Water quality problems can be prevented by the proper handling and disposal of all wastes according to the objectives and guidelines of the appropriate government agencies.

#### Resource Use

The effects and management requirements of increased access in the project area might also be considered in view of the potential future development of the mining road to provide a link with the North Canal Road. Arctic grayling and lake trout are both popular gamefish and increased access will undoubtedly increase fishing pressure, particularly at Flat Lake. The slow growth and late maturity of fish populations in northern climates makes them vulnerable to over-exploitation. Arctic grayling are particularly sensitive due to their relative ease of capture. Flat Lake presently supports an important recreational fishery for the people of Tungsten.

5.0 SUMMARY AND DISCUSSION OF ENVIRONMENTAL  
CONSIDERATIONS ASSOCIATED WITH THE  
DEVELOPMENT OF THE CANEX PLACER ACCESS ROAD.

This report has identified the nature and location of environmental impacts that may occur, resultant from the development of the access road to Howard's Pass. Field studies emphasized the gathering of data to determine the presence or absence of specific terrestrial and aquatic species and to develop a general classification of habitat types. Additionally, brief consideration was given to the economic and recreational use of the wildlife resources found in the project area.

The possible impact of the road, opportunities for mitigation, and recommendations for alleviating specific problems are dealt with separately for each wildlife resource discussed. There are, however, a number of points that should be emphasized with respect to the completed study and these are discussed as follows:

1. The wildlife component of the report has identified 3 points of concern that are separate from those of the aquatic resources:
  - a) Construction of a roadway through important habitat -- It is not intended to suggest that all habitat is not important. However, it is felt that beaver habitat is particularly limited in this area and therefore should be avoided to the practical extent possible. The alignment

presently marked out on the ground by-passes known areas where beaver have been observed. Changes to this alignment should respect the need to preserve this particular habitat.

- b) Wintering of large ungulates in the project area -- From evidence gathered during the study, it appears extremely unlikely that caribou winter in the Little Nahanni Valley on a regular basis. It may be possible that they could do so during very mild winters. On the other hand, moose have been observed to overwinter in the most southern perimeter of the general area and therefore specific use of the project area by this species, during critical periods of the winter, has not been determined.
- c) The effects of the physical presence of the road -- It has generally been stated that animals are not influenced a great deal by the road per se and in many cases, use its surface as a corridor for daily or seasonal movements. From this point of view, it is important that animals have ready access to cross the road or if using it as a travel corridor, to easily move off the road. In this regard, thoughtful construction and maintenance practices are essential, especially with respect to bush clearing along the roadside and winter snow removal.

2. Fisheries studies have indicated that population of arctic grayling and lake trout are present in the Little Nahanni drainage. The points of concern involve the problems associated with removal of gravel, bank erosion, siltation and construction debris disposal. With care taken to follow the recommendations in this report, no significant impact on the fishery is to be expected.

One aspect of this development that has not received sufficient discussions within the text of the report is the expanded access to the wilderness areas through which the proposed route passes. The increased availability of wildlife populations to the pressures of hunting and fishing could be very detrimental if proper management principles are not followed. On the other hand, recreational opportunities, other than hunting and fishing, will also be considerably enhanced. Access to the Little Nahanni Valley would provide aesthetic and recreational advantages that do not presently exist in the Tungsten area. The development of this access road would bring the northern portion of Nahanni National Park more accessible to those who enjoy wilderness areas. If the road remains terminated at Howard's Pass, general local use by Canex Placer personnel and Tungsten residents is expected. However, it has been indicated that this route may be upgraded to the level of a resource road, and at this time the question of increased access should be re-examined. As long as the road remains terminated at Howard's Pass, only local use of the road by Canex Placer personnel and Tungsten residents is expected.

However, it has been indicated that this road may be upgraded to the level of a resource road, and at this time the question of increased access should be re-examined.

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APPENDIX I



One further criteria suggested by Canex as a result of their several years of experience in the area was that as much of the route as possible be located below the 4500 foot contour, as snow removal becomes a more serious problem above this elevation.

## 2. ROUTES EXAMINED

In all, four routes or variations of routes were examined in the field, which are identified as Routes A, B, C and D on the attached map, with Routes A, B and C being indicated by broken lines. Local names as indicated on the map are used for some of the creeks and rivers in the area to make it easier to identify the routes.

Route A: Routes A, B, and C have common origins at approximately mile 112 on the Cantung Road on the west end of Harrison Pass - another generally accepted local name. The first five miles of all three of these routes follow the valley of Little Hyland River, a broad U-shaped valley with evidence of sand and gravel deposits along the toe of the side slopes. Routes A and B follow the Little Hyland for another five miles, in similar terrain, and then cross a poorly drained pass into Mac Creek. Route A continues westerly to the headwaters of Mac Creek, in a narrow V-shaped valley in which rock outcrops predominate with pockets of shallow till.

From Mac Creek the route descends into Lidia Creek at approximately Mile 25, through a Pass over 5,000 feet in elevation, the highest point reached on any of the proposed routes. This too is a narrow V-shaped valley, with many rock outcrops. There are some deposits of sand and gravel along the river bottom, but surficial material is generally talus or thin till. There are several small canyons in this valley, which the road would have to avoid. A winter road to the property used during the winter of 1972-73 followed this route, but because of the confining nature of the terrain, it was only possible to do so by making numerous crossings of Lidia Creek. This would not be feasible in the case of an all-weather road.

From Mile 40 Route A follows Canex Creek to Howard's Pass, through another V-shaped valley with rock outcrops and surficial deposits of thin till and talus, and scattered occurrences of sand and gravel and deltaic deposits of mixed sand, silt and clay. The overall scaled distance of Route A is approximately 50 miles, about the same as Route D. There would, therefore, be no saving in distance, and the confining terrain and the numerous rock outcrops would tend to result in higher construction costs than those on the other projected routes.

Route B: This route is a 12-mile variation of Routes A and D that links Mile 11 of Route A to approximately Mile 22 of Route D, by turning downstream in Mac Creek, and following the west side of a

distinctive elongated hill that is a prominent topographic feature at the intersection of Mac Creek and Little Nahanni River. The lower part of Mac Creek Valley is also V-shaped and narrow with poor soil conditions and canyons to contend with. There is no overall saving in distance resulting from the use of this route, and the construction costs of the variation would be comparable to those of Route A.

Route C: This 13 mile variation links Mile 5 of Route A with Mile 20 of Route D, in the Little Nahanni River Valley. Between Mile 5 and Mile 10 it continues to follow the same broad U-shaped pass that is traversed by the first five miles of Route A, B and C. The same favourable indications of sand and gravel occurrences that are found in the first five miles persist through this section of the pass. In the ten miles beyond the pass the route would descend gradually to the Little Nahanni River, following generally sand ridges, or exposures of sand and gravel in side slopes. Some side hill cutting would be required in making this descent, but stream crossings would be minimized. In addition, there would be a saving of approximately two miles in the overall distance if this route was used.

In spite of the obvious advantages, however, Route C in combination with the last 30 miles of Route D is not recommended. A considerable portion of Route C is above 4500 feet in elevation and above tree line. The green plate on the Nahanni Map Sheet is not too accurate in this regard, as there is certainly little timber between Mile 5 and 10 in spite of what the map indicates. Snow removal, particularly on a skim grade, would therefore be a costly operation in this pass, which would be exposed to both heavy snowfall and to the full force of the winter winds and the resultant drifting. In addition at this stage of the Howard's Pass development, it seems extravagant to duplicate snow removal and construction costs of a road crossing of the Yukon-N.W.T. height of land. Using the present route through Harrison Pass would add only approximately two miles of new construction over the route followed by Route C, and about five percent to the overall distance to Howard's Pass, and only one pass would have to be kept cleared in winter instead of two. In addition, the road through Harrison Pass traverses more hilly but more protected terrain, with a considerable proportion of sidehill construction, on which snow removal, or the clearing of slides if necessary, would be easier and cheaper than in the more exposed and open pass on Route C.

Route D: This route originates at the switch-back curve on the Cantung Road at the east end of Harrison Pass, approximately Mile 116. The route would follow the Little Nahanni River for approximately 35 miles, and would then climb to Howard's Pass by way of Lidia Creek and Placer Creek. The overall scaled distance is approximately 50 miles, with most of the first 45 miles of the new construction being

below 4500 feet in elevation, and about 60% of the new construction being below 3500 feet.

Because this is the route recommended by this report, and because it is the route preferred by the government planners, it is discussed in detail in the next section of the report.

### 3. DETAILS OF SELECTED ROUTE

In reviewing Route D in detail, it must be emphasized that though the constructed route would generally be close to this projected alignment, local variations might occur as a result of differences between the actual soil conditions and the interpretation that might be revealed during road construction. Without an instrumental location survey and exploratory drilling at regular intervals, some route flexibility must be allowed for. In the case of this projection, however, no major departures from the proposed alignment are anticipated.

From Mile 0 + 00 to approximately Mile 6 the projected route follows a bench that parallels the narrow lakes and sections of swamp along the low divide between the Flat River and the Little Nahanni. The bench is a hundred feet or more above the lakes, and several hundred feet away from the edges of them. Access to them would not be practicable from the new road. Along the bench are a succession of sand or sand and gravel exposures which the road would follow, with the skim grade hugging the ascents and descents of the gently rolling terrain. There would appear to be no requirement for borrow except possibly in the crossing of four creeks just before they break over the edge of the bench. Sufficient gravel for these crossings is available adjacent to the crossing sites and close to the streams. Twenty-four inch corrugated iron pipe (C.I.P.) will handle the flow, as the drainage area in each case is small.

Beyond Mile 6 the benches begin to pinch out and the route gradually moves closer to the river, following at first a low ridge between some small pothole lakes and the main river, and crossing drainage courses from these lakes for which 24-inch C.I.P. will still be sufficient. By about Mile 9 the road is comparatively close to the river and sidehill construction becomes necessary for most of the route as far as Mile 20. The soil in this section is predominantly shallow till, though pockets of sand or sand and gravel are periodically encountered. The rock underlying the till is shale, and if previous construction experience in this vicinity is any guide, it should be readily rippable by a suitably equipped D8 tractor or equivalent. Borrow should not be required in this section, and it should be no problem to remain more than 300 feet from the banks of the main stream.

Stream crossings in the vicinity of Mile 12, Mile 13.5, Mile 14.6, Mile 17.5 and Mile 18 require 36-inch C.I.P., with random

avoided by the road if at all possible. The most prominent feature of this stretch of creek is a 3000 foot long canyon about Mile 36, which has cut through exposed bed rock which outcrops in the valley sides to an elevation considerably above the canyon. This rock appears to be harder than the shales previously encountered, and at this stage of construction should if possible be avoided. This is accomplished by locating the road high up the valley wall above the right limit of the creek, crossing a knob with a swampy draw behind it. This route will involve between 500 and 1,000 feet of rock work instead of 3,000 but will require a climb at maximum grade when entering the valley and a similar descent before leaving it and turning up Placer Creek. Because of a bad slide on the north side of the valley close to the canyon the road cannot be located on this side: Lidia Creek must therefore be crossed by the road as close to the mouth of Placer Creek as possible, preferably upstream from it to save a crossing of this creek as well.

The crossing of Lidia Creek will require a bridge approximately 100 feet in length. Double single chord reinforced Bailey Bridging, if available, would be desirable, as piers in the river would then not be required. A trestle of this length would require the driving of three timber bents in the stream bed.

As the east slope of Placer Creek valley is visibly slide-prone for the first three miles above the creek mouth, the road must enter the valley along the west side, on the right limit from the stream. A canyon a mile or so from the mouth has bedrock exposures above it similar to those above the canyon on Lidia Creek, though this one is smaller and the rock exposures less extensive. This rock should be avoided by climbing the valley wall, passing above a rock knob that overlooks the canyon. This would require that the road enter the valley at a maximum grade, and then descend to the valley floor beyond the canyon. This descent could be made at less than maximum grade.

Placer Creek would be crossed at approximately Mile 43, above the slide area: it is necessary because of the terrain that the road be on the east side of the valley for the final climb to Howard's Pass. A 36 inch culvert will handle this crossing, and another 36 inch pipe would take the flow of a tributary stream which crosses the road at Mile 44. As this is a narrow, V-shaped valley sidehill construction would be necessary while following it. There are sand and gravel deposits along the stream bed, with thin till or talus on the sidewalls. About Mile 46 the route would break out of the valley at an elevation of approximately 4800 feet. The last section of the road to Howard's Pass would also be sidehill and construction, in till with some clay and sand and fragments of shale and limestone.

APPENDIX II



Table 1.

Some stream measurements of the Little Nahanni and Little Hyland drainages, June 1976.

	Stn. No. 1	Date	Temp. °C		Conduct. uhmos /cm.	Est. width (m. )	Est. depth (cm.)	Est. veloc. 2 (mps)	Bottom composition
Little Nahanni River	11	Jun 17	21	8.5	65	36	-	1.9	rubble, gravel
	15	Jun 16	19	7		18	60-90	1.7	rubble, gravel
	16	Jun 16				22	-	1.7	rubble, gravel
	19	Jun 25		10		22	90-120	1.5	coarse gravel
Lidia Creek	2	Jun 21			70	18	60-90	2.1	rubble, boulders
	4	Jun 19	12	6		23	-	1.9	rubble, gravel
	7	Jun 15				21	-	1.2	rubble, gravel
	10	Jun 20		7		38	-	2.0	rubble, gravel
Mac Creek	18	Jun 17	18	7	30	12	30-60	2.0	rubble, boulders
	17	Jun 22	17	4		20	60-90	1.7	coarse gravel
Guthrie Creek	14	Jun 16	21	10		6	30	1.2	rubble
	near	mouth				6	30	1.7	rubble, boulders
Canex Creek	1	Jun 21				12	30-60	2.5	rubble, boulders
Placer Creek	9	Jun 19	9.5	4		5	30-60	2.0	rubble
	8	Jun 15				4	30-60	1.8	rubble, gravel
Little Hyland River	21	Jun 24	14	5	35	21	60	1.6	coarse gravel
	23	Jun 24				18	-	1.2	gravel, silt

1 Stream survey stations are shown in Fig. 4-3 .

2 Velocities were estimated by timing a floating object over a distance of 100 feet. As most streams meander to some extent, velocities vary with the cross sectional profiles. Water velocities recorded in this table represent the maximum flows.

Table 2.

## Summary of fish catches from the Little Nahanni and Little Hyland River systems, 1976

Date	Stn. No.	Time	Capture Method	Species <sup>1</sup>	Sex	Matu- rity <sup>2</sup>	Age	Length (cm.)	Weight (grams)
June 16	15	15:00 16:00	Angling	G	F	M	6	33.0	400
				G	M	M	7	33.5	420
				G	M	M	8	37.3	500
				G	M	M	5	37.0	450
				G	F	M	6	35.0	440
June 17	11	16:00 16:30	Angling			0	catch		
June 19	4	14:30 15:30	Angling			0	catch		
June 19 June 20	5	21:00 12:00	gill net 2" mesh			0	catch		
	3	21:30 11:45	gillnet 2" mesh			0	catch		
June 20 June 21	10	14:00 09:15	gillnet 2" mesh	G	F	M	8	37.8	510
				G	F	M	3-4	30.7	300
				G	F	M	4	28.0	200
				G	F	M	4	26.8	180
				G	F	M	3	23.1	120
				G	F	M	3	23.2	120
				G	F	M	3	23.1	110
June 21 June 22	6	14:30 08:45	gillnet 2" mesh			0	catch		
	12	21:00 21:15	gillnet 2" mesh	G	F	M	3	26.0	160
	15	22:00 09:45	gillnet	G	F	M	6	32.2	370
				G	F	M	4	36.5	500
				G	M	M	6	36.2	500
				G	M	M	5	35.2	420
				G	M	M	4	30.5	320
				G	M	M	8	38.5	620
				G	F	M	5	34.0	425
				G	M	M	5	34.0	450
				LT	-	I	3	33.0	380

<sup>1</sup>  
 G = Arctic grayling  
 W = Mountain whitefish  
 LT = Lake trout

<sup>2</sup>  
 M = Mature  
 I = Immature

Date	Stn. No.	Time	Capture Method	Species	Sex	Maturity	Age	Length (cm.)	Weight (grams)
June 24	19	16:00	gillnet	G	M	M	6	38.0	550
June 25		16:00	3" mesh	G	M	M	5	35.1	460
				G	F	M	6	37.0	460
				G	M	M	7	34.7	425
				G	M	M	5	35.0	460
				G	M	M	5	35.0	420
				G	M	M	7	38.0	600
				G	M	M	6	37.1	550
				G	F	M	6	38.4	575
				G	M	M	7	37.9	620
				G	F	M	4	34.2	400
				G	M	M	7	35.4	500
				G	F	M	5	32.5	360
				G	F	M	6	36.6	510
				G	F	M	4	32.8	350
				G	F	M	5	36.6	510
				G	M	M	4	33.1	400
				G	M	M	5	33.9	420
				G	M	M	7	36.3	500
				G	F	M	5	36.1	480
				G	F	M	5	34.0	440
				G	M	M	5	37.3	510
				G	F	M	5	37.3	575
				G	M	M	4	32.1	350
				G	M	M	5	33.1	400
				G	M	M	7	38.0	560
				G	F	M	5	34.0	390
				G	M	M	6	36.2	510
				G	F	M	6	34.5	425
				G	M	M	6	37.3	475
				G	F	M	7	35.2	440
				G	F	M	6	36.0	500
				G	M	M	6	36.0	490
June 25	20	21:00	gillnet	LT	F	M	8	37.6	500
June 26		13:30	1", 2", 3", 4" mesh	LT	F	M	9	41.0	850
				LT	F	M	8	40.9	750
				LT	F	M	7	39.0	700
				LT	F	M	7	36.5	560
				LT	F	M	7	38.0	675
				LT	-	I	3	26.5	180
				LT	F	I	3	23.0	110
				LT	F	I	4	26.1	170
				LT	F	I	4	25.1	160
				LT	-	I	5	28.9	220
				LT	-	I	4	24.0	140

Date	Stn. No.	Time	Capture Method	Species	Sex	Maturity	Age	Length (cm.)	Weight (grams)
June 22	17	09:30 10:30	Angling				0	catch	
June 24	22	12:10	gillnet	G	-	I	2	21.6	105
June 25		11:30	2" mesh	G	F	M	4	28.0	220
				G	F	M	6	34.0	390
				G	F	M	7	37.8	500
	23	13:30 09:45	gillnet 2½" mesh	G	F	M	8	38.5	555
				G	M	M	7	39.5	620
				G	F	M	7	38.0	580
				G	F	M	8	38.5	600
				G	F	M	6	34.9	460
				G	M	M	7	38.2	575
				G	F	M	6	37.2	550
				G	F	M	7	35.0	480
				G	F	M	7	37.0	550
				G	M	M	8	38.1	575
				G	M	M	6	37.2	575
				G	M	M	5	36.8	550
				G	M	M	7	39.2	650
				G	M	M	4	30.1	300
				G	M	M	4	31.2	315
				G	M	I	2	20.2	80
				G	M	M	6	37.0	525
				G	M	M	7	41.0	700
				G	F	M	6	35.0	470
				G	M	M	6	34.9	490
				G	M	M	2	28.0	210
				G	M	M	5	32.8	330
				W	M	M	9	36.6	550
				W	M	M	7	39.0	575
				W	F	M	7	35.8	475
				W	M	M	-	42.9	750
				W	M	M	6	32.1	320
June 25	13	15:00 15:30	Angling	G	M	M	5	34.8	400
				G	M	M	3	29.0	240

Table 3.

Stomach contents of 27 Arctic grayling  
from the Little Nahanni River, 1976

Food Organism	Abundance		Frequency of Occurrence	
	Nos.	Percent	Nos.	Percent
<u>Aquatic Insects</u>				
Diptera	7641	87.0	22	81.5
Tendipedidae larvae	5098			
Tendipedidae pupae	2471			
Simuliidae	59			
Tipulidae				
Tipula sp.	11			
Tabanidae	2			
Ephemeroptera	376	4.3	22	81.5
Ephemerella sp.	9			
Siphonurus sp.	157			
Pseudocleon sp.	149			
Cinygmula sp.	7			
Baetodes sp.	42			
Centroptilum sp.	11			
Unidentified pupa	1			
Plecoptera	126	1.4	21	77.8
Hastaperla sp.	111			
Isogenus sp.	4			
Nemoura sp.	1			
Alloperla sp.	5			
Unidentified	5			
Trichoptera	95	1.1	23	85.2
Brachycentrus sp.	31			
Platycentropus sp.	3			
Rhyacophila sp.	20			
Glossosoma sp.	4			
Limnephilidae	8			
Unidentified	29			
Coleoptera	5	<.1	4	14.8
Dytiscidae	2			
Unidentified larvae	3			
<u>Terrestrial (Adult) Insects</u>	533	6.1	26	96.3
<u>Other Invertebrates</u>				
Mollusca	4	<.1	2	7.4
Gastropoda				
Valvata sp.	4			
Nematoda	1	<.1	1	3.7

Table 4.

Stomach contents of 14 Arctic grayling  
from the Little Hyland River, 1976

Food Organism	Abundance		Frequency of Occurrence	
	Nos.	Percent	Nos.	Percent
<u>Aquatic Insects</u>				
Diptera	1322	65.8	13	92.9
Tendipedidae larvae	1029			
Tendipedidae pupae	156			
Tipulidae				
<u>Tipula</u> sp.	7			
Tabanidae	2			
Helinae				
<u>Palpomyia</u> sp.	106			
Empedidae	16			
<u>Hemirodromia</u> sp.	1			
Unidentified	5			
Ephemeroptera	163	8.1	10	71.4
<u>Ephemerella</u> sp.	1			
<u>Siphonurus</u> sp.	7			
<u>Pseudocleon</u> sp.	134			
<u>Cinygmula</u> sp.	19			
Unidentified	2			
Plecoptera	96	4.8	10	71.4
<u>Hastaperla</u> sp.	38			
<u>Isogenus</u> sp.	58			
Trichoptera	45	2.2	10	71.4
Psychomyidae				
<u>Platycentropus</u> sp.	21			
Limnephilidae	4			
Unidentified	20			
Coleoptera				
Unidentified larvae	3	.1	1	7.1
<u>Terrestrial (Adult) Insects</u>	356	17.8	13	92.9
<u>Other Invertebrates</u>				
Mollusca	11	.5	2	14.3
Gastropoda				
<u>Lymnaea</u> sp.	11			
Acarina	14	.7	4	28.6

Table 5.

Species and abundance of benthic invertebrates collected in the Little Nahanni and Little Hyland River systems, 1976 \*

Station No.	L. Nahanni R.					Lidia Creek		Mac Creek			Little Hyland
	15	15	11	11	11	4	4	18	18	17	21
Ephemeroptera											
Baetidae											
<u>Centroptilum</u> so.					2	1	2	6	2	1	
<u>Pseudocleon</u> sp.		1				2	1	3			
<u>Baetodes</u> sp.	1										
Ephemerellidae											
<u>Ephemerella</u> sp.											
Heptageniidae											
<u>Cinygmula</u> sp.	3	3				4	4		1		4
<u>Rithrogena</u> sp.						1				1	
Plecoptera											
Perlidae											
Chloroperlidae											
<u>Hastaperla</u> sp.	1	3						1			
Perlodidae											
<u>Isogenus</u> sp.											2
<u>Arcynopteryx</u> sp.				1							
Diptera											
Tendipedidae											
<u>Pentaneura</u> sp.	1					1	1		1		
Tipulidae											
<u>Prioncera</u> sp.	1										
<u>Tipula</u> sp.			1						1		
Tabanidae	1										

\* Area sampled was approximately .46 square meters (5 square feet)

Table 6.

Stomach contents of 12 lake trout  
from Flat Lake, 1976

Food Organism	Abundance		Frequency of Occurrence	
	Nos.	Percent	Nos.	Percent
<u>Aquatic Insects</u>				
Diptera	> 3271	84.2	12	100
Tendipedidae larvae	> 470			
Tendipedidae pupae	> 2800			
Simulidae	1			
Ephemeroptera	9	.2	2	16.7
Pseudocleon sp.	6			
Cinygmula sp.	1			
Baetis sp.	2			
Trichoptera	361	9.3	2	16.7
Limnephilidae				
Clostoecca sp.	6			
Unidentified	355			
<u>Terrestrial (Adult) Insects</u>	3	<.1	2	16.7
<u>Other Invertebrates</u>				
Mollusca	191	4.9	4	33.3
Gastropoda				
Lymnaea sp.	3			
Valvata sp.	23			
Pelecypoda sp.				
Pisidium sp.	165			
Oligochaeta	3	<.1	3	25.0
Lumbriculidae	2			
Unidentified	1			
Acarina	45	1.2	8	66.7

Table 7.

Stomach contents of 5 mountain whitefish  
from the Little Hyland River, 1976.

Food Organism	Abundance		Frequency of Occurrence	
	Nos.	Percent	Nos.	Percent
<u>Aquatic Insects</u>				
Diptera				
Tendipedidae larvae	57	54.3	5	100
Ephemeroptera	34	32.4	4	80
Ephemerella sp.	1			
Siphonurus sp.	1			
Pseudocleon sp.	31			
Cinygmula sp.	1			
Plecoptera	8	7.6	4	80
Hastaperla sp.	1			
Isogenus sp.	6			
Isoperla sp.	1			
Trichoptera	4	3.8	3	60
<u>Other Invertebrates</u>				
Mollusca	2	1.9	1	20
Gastropoda				
Lymnaea sp.	2		1	20