FRESHWATER AQUATIC ECOLOGY IN NORTHERN YUKON TERRITORY

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by

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THE INFULENCE OF PIPELINE DEVELOPMENT ON FRESHWATER AQUATIC ECOLOGY IN NORTHERN YUKON TERRITORY. PROGRESS REPORT ON RESEARCH CONDUCTED IN 1971.

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ABSTRACT

The main purpose of this research is to protect the capacity for fish production in aquatic environments influenced by pipelines across permafrost. This report describes some characteristics of the freshwater aquatic ecology of the northern Yukon and includes a preliminary outline of areas which would be particularly sensitive to pipeline development.

Certain chemical and physical characteristics of the rivers and streams are described. Of the coastal rivers and streams, those from the Babbage west were higher in pH and total dissolved solids than those to the east. The same kinds of periphyton and macro-invertebrates were present in most watersheds of the study area.

Arctic grayling was the predominant fish species in many areas, especially in creeks and small rivers. Several more species of fish were present in the Porcupine River than in coastal rivers. Except for the round whitefish, no changes in capture frequency of resident freshwater fish species occurred between July and September in either the Porcupine or Old Crow Rivers. The catch of round whitefish increased with time, suggesting that they had begun a spawning migration. Changes in capture frequency suggested that grayling, inconnu, and burbot moved into the main-stem Porcupine to over-winter.

Salmon passed by Old Crow en route to spawning grounds from late July through mid-December. Chum salmon were much more abundant than the other two species; based on counts of spawners and migration timing, the estimate of the total number of chum salmon was 115,000. Length distributions, age-length relationships, length-weight relationships, sex ratios, and maturity ratios are presented for all species studied. For some of the species, data on fecundity is presented. Although additional data are required for substantiation, the age composition suggested that none of the species studied have large fluctuations in year-class strength. The food of all fish species caught in gill nets near Old Crow is compared and food data for fish from outlying rivers and streams is presented. The concentrations of mercury and pesticides in the fish were much lower than in less remote areas. The concentrations of other heavy metals were similar to those observed in other areas.

Very little recreational fishing and no commercial fishing was observed during the study. Residents of Old Crow captured about 10,000 salmon and 3,000 freshwater fish of all species. Eskimos captured about 300 Arctic char and 1,000 cisco on Herschel Island.

Of the two main routes now being considered for a natural gas pipeline, the coastal route seems preferable from the standpoint of potential damage to fishery resources of the northern Yukon Territory. There would probably be little effect on fishery resources if the pipeline crossed coastal rivers and streams below the 200-ft. contour. Pipelines should not be allowed to cross portions of spawning areas in the Firth River, Fishing Branch River, or Fish Hole Creek, in particular, or any major spawning ground in general.

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INTRODUCTION

Several companies are considering the construction of pipelines to carry natural gas or oil from sources in Alaska across the northern Yukon Territory to the Mackenzie River Valley and south to existing pipelines. The main objective of this study is to protect the productive capacity of the aquatic resources of the area. Effective management of fishery resources during and after construction of pipelines is an ancillary benefit of the research. The first step in achieving the main objective is to describe important characteristics of the aquatic ecology. Good ecological description will enable identification of those areas which would be most severely affected by pipeline development. This report presents preliminary descriptions of the fish stocks and invertebrates as well as some chemical and physical characteristics of the watersheds. The Conclusion section includes a preliminary outline of routes which seem optimal from the standpoint of fishery resources. This report supersedes an earlier manuscript report. (Bryan, Walker, Kendel, and Elson MS 1972).

Some effects of pipelines detrimental to aquatic resources

The most pervasive effects of pipelines will occur in flowing water as changes in the ecology of upstream areas evoke changes in downstream areas. Although pipeline development will affect lakes as well, the effects will be confined to specific lakes along the route. Consequently, most research has concerned rivers and streams.

Many different activities related to the pipelines are detrimental; not all detrimental effects, however, are serious. A few examples may clarify the nature of the effects our research is designed to prevent.

One of the most obvious effects of any pipeline is increased sedimentation of flowing water. Pipelines will usually be laid under the beds of streams. In the process of trenching for the pipe, sediment from the river bed becomes suspended in the water. Sufficient quantities of such sediment can kill fish immediately downstream of the pipeline excavation (Cordone and Kelley 1961). Because sediment gradually settles back to the stream bed, it has no direct influence on fish which are sufficiently far downstream of the excavation. Another danger is that newly settled sediment can kill both fish eggs (Cooper 1956) and the food organisms eaten by fish (Cordone and Kelley 1961).

The effect of construction will be temporary and may not be very serious for many crossings. However, a permanent and much more severe increase in sedimentation may result in some rivers. Increased erosion from the pipeline right of way can permanently destroy spawning grounds and fry-rearing areas. Rather small increases in sedimentation markedly decrease the number of fish in an area and also decrease their food supply and growth rate (Gammon 1970).

Indiscriminate removal of gravel from stream and river beds can also be detrimental. Gravel removal could destroy spawning and fry-rearing areas. Even when gravel is not removed directly from these areas, decreased or delayed recruitment of gravel to such areas and river channel changes resulting from construction can destroy spawning and rearing habitat. Another type of habitat disruption could result when drinking water is pumped from streams to construction camps during the winter. In some northern rivers, the water stops flowing in winter, and the volume available for over-wintering fish is in short supply.

Toxic chemicals and domestic sewage are other hazards of pipeline development. Building, testing, and maintaining pipelines will require the use of many varieties of chemicals which kill aquatic organisms when added to water in sufficient concentration. Most of these chemicals can be shown to have adverse effects even at sublethal concentrations. As in southern areas, toxic chemicals are threats to aquatic environments because of both inadvertent and deliberate disposal into streams and rivers. An obvious example of accidental introduction of toxic chemicals would result from an oil pipeline rupture near a stream or river. In some situations, domestic sewage disposal can be very detrimental, and strict regulations will be required to control all waste disposal.

Another result of pipeline development would be increased sport fishing both by workers building and maintaining the pipeline and by tourists making use of improved access. Improved access would be provided by airstrips, roads, and the pipeline bed itself. As northern fish grow much more slowly and start reporducing when they are older than their southern counterparts, some populations could be over-fished. Regulations must be designed with these considerations in mind, particularly in regions where there would also be competition with subsistence fisheries.

MATERIALS AND METHODS

The study area

The waters studied are located in roughly the northern two hundred miles of Yukon Territory (Figure 1). In the southern portion of the study areas, the rivers and streams flow into the Porcupine River. This river is a major tributary of the Yukon River which flows into the Bering Sea (Pacific Ocean). In the northern part of the study area, most rivers and streams drain directly into the Beaufort Sea (Arctic Ocean), although a few join the Mackenzie River at its delta.

Details of physical and chemical characteristics are presented in another report (Bryan 1973). In the Beaufort drainage, the rivers and creeks flow directly into the sea and many of them have clear water and gravel substrata from their headwaters to their mouths. The Porcupine River is usually turbid during the ice-free season. Rivers and creeks in the Porcupine drainage have clear water with gravel substrata in the headwaters, but some of them become silty near their junction with the Porcupine.

Of the rivers and creeks in the coastal drainage, there are physical and chemical differences between those west and east of the Babbage River (Bryan 1973). The western rivers contained more large gravel and frequently had gravel extending from their headwaters to their mouths. From the Babbage eastward, the rivers contained a greater proportion of small particles. Most of the eastern rivers meandered and had mud substrata near their mouths. Because the spawning potential is related to gravel size, the western rivers had more potentially good spawning area for grayling and char. In most of the coastal rivers, the best potential spawning areas were upstream of the 50 m (200 ft) contour. Exceptions were Fish and Craig creeks where the only portions of the streams remaining unfrozen in winter are at lower elevations. Thus char spawning must occur at lower elevations in these rivers. The western rivers were higher in pH, total alkalinity, and TDS than the eastern rivers.

From July 22 to September 9, a continuous synoptic survey was carried out on both proposed pipeline routes. Old Crow and Herschel Island served as bases for this survey. Within the same period, intensive gill netting was conducted near Old Crow. In September, October, and December, aerial surveys were conducted to locate and count salmon spawning in the headwaters of the Porcupine drainage. The results of this work are presented by Elson (1973). From September 16 to December 18, two residents of Old Crow recorded the species and sizes of fish they caught in the Porcupine River.

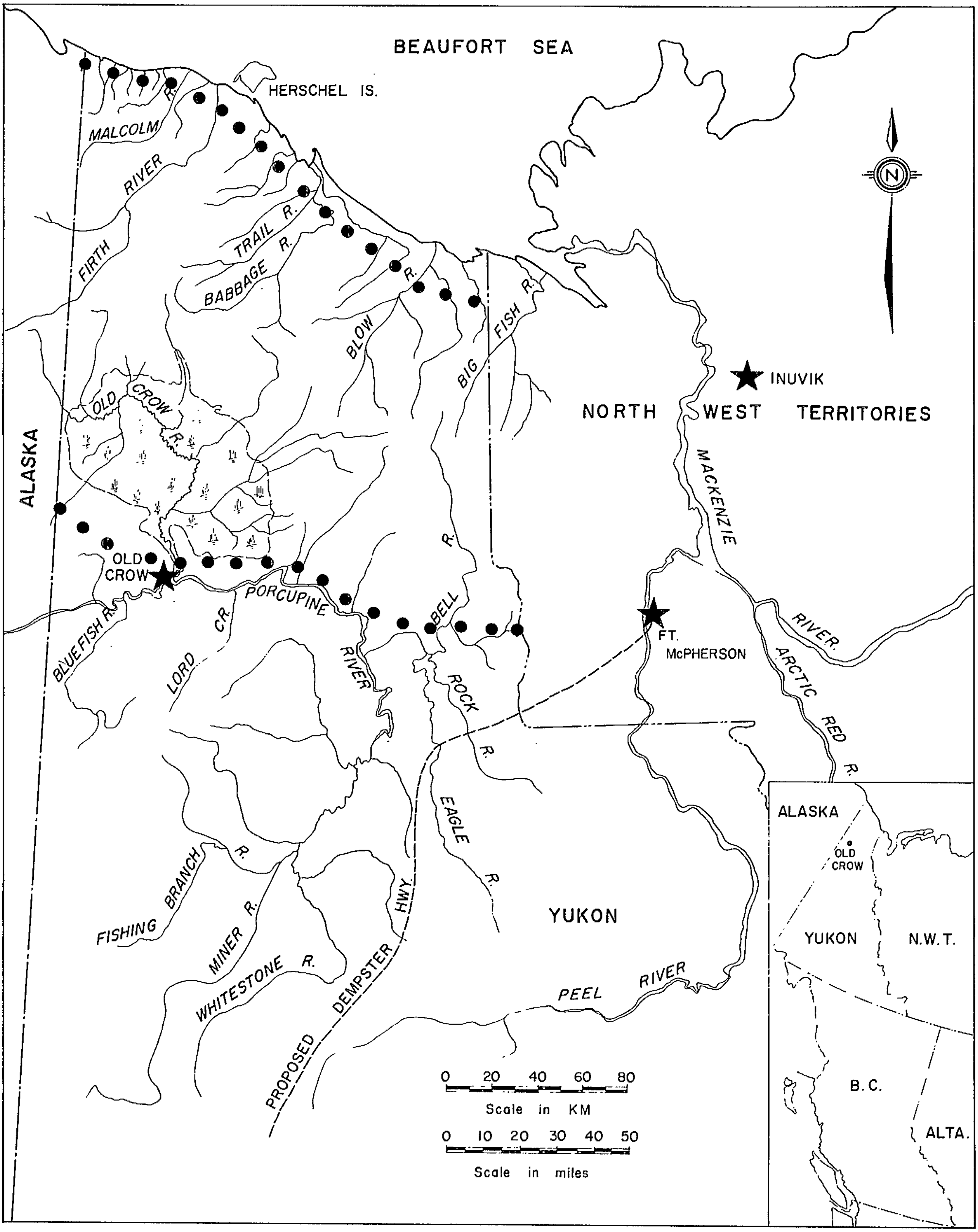

Figure 1. The study area in northern Yukon Territory. Rows of dots indicate alternative routes of the prospective gas pipeline from Prudhoe Bay, Alaska.

As the study area was roadless, travel was by boat near the base camps and by air for longer distances. Near Old Crow, both the Porcupine and Old Crow Rivers were sampled using boat transportation. However, the swiftness of the rivers combined with the slowness of the boats made it infeasible to sample more than 20 km (12 mi) away from town. Helicopters were used to sample other sites in the Porcupine drainage and all sites in the Beaufort drainage. At each sampling site, some physical characteristics of the habitat were observed and usually fish were collected. In most rivers, some chemical characteristics of the water were observed and some plants and animals collected from the stream bottom.

Periphyton and macro-invertebrate samples

Periphyton samples were collected by scraping the surface of rocks with the apparatus described by Stockner and Armstrong (1971). At each sampling station, two samples were collected from different rocks within 5 meters of each other. The samples were collected from areas of slow current (< 15 cm/sec). The samples were preserved in a solution of 5% formalin, 3% glycerine, and 15% ethanol.

The standing crop of macro-invertebrates on the stream bed was measured using a cylindrical sampler (diameter 34 cm; area 0.3633 m^2) similar to the one described by Waters and Knapp (1961). Two such samples were collected at each site from undisturbed areas less than 10 meters apart. Similar types of substratum were sampled in all rivers and streams. The maximum diameter of the particles ranged from 1 to 10 cm. The water depth was 15 to 30 cm, and the current speed 20 to 50 cm/sec. The samples were preserved in 5% formalin.

Fish samples

Most fish samples were collected with gill nets and seines. The larger fish (> 100 mm) collected in the Porcupine and Old Crow Rivers were captured with gill nets. A total of 18 gill net stations were sampled in the Porcupine and Old Crow Rivers (Figure 2). Gill nets were moved to each of the stations during the course of the summer. At any one time, nets were set in the Porcupine River (both upstream and downstream of Old Crow) and in the Old Crow River.

Most stations consisted of 2.5 by 30 meter panel gill nets with six 5-meter sections of different mesh sizes (4, 5, 7.5, 10.5, 12.5 and 14 cm stretch measure). The three small mesh sizes were monofilament whereas the three larger sizes were polyfilament. These nets were set perpendicular to shore with progressively larger mesh sizes in deeper water. Particularly in the Old Crow

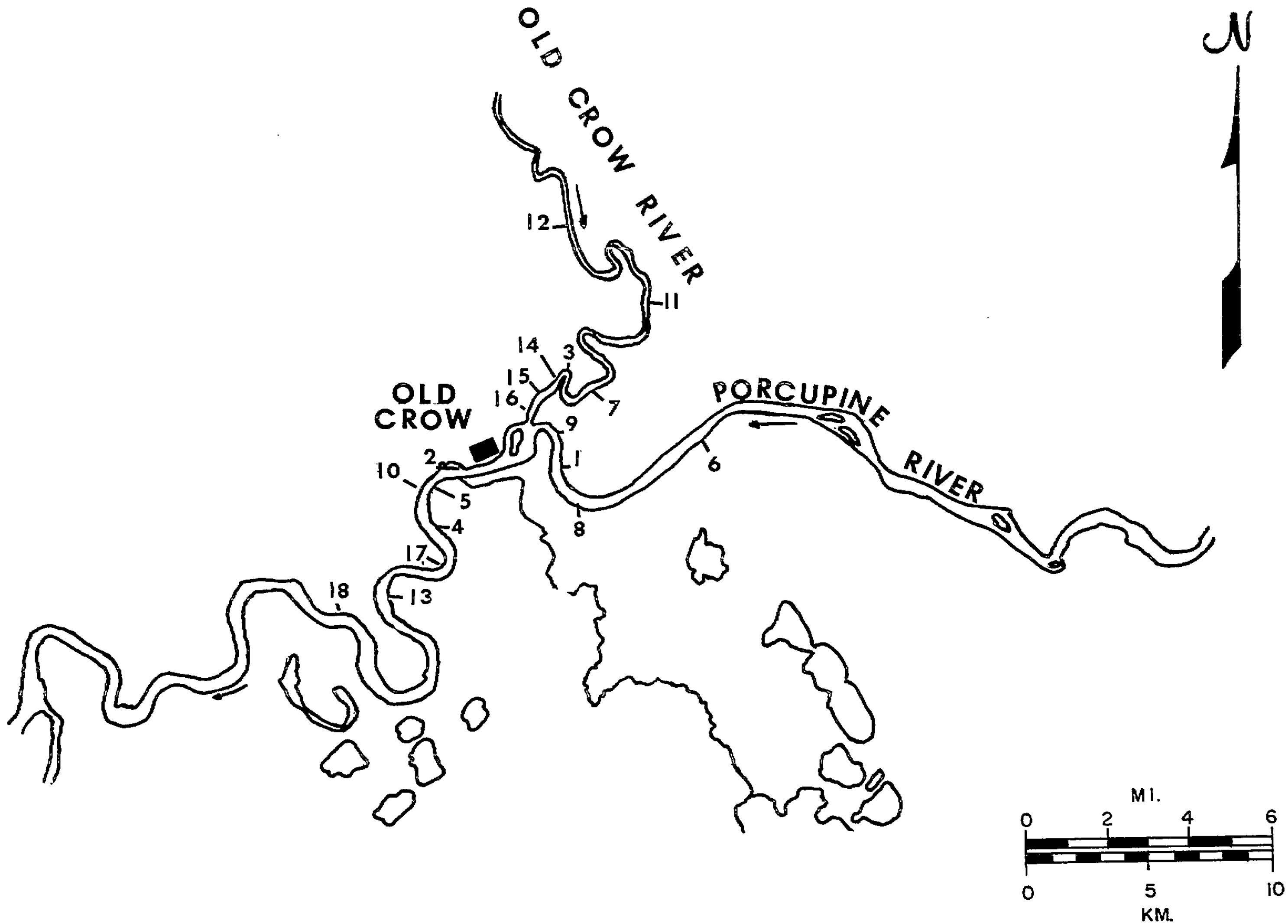

Figure 2. Gill net stations (1 to 18) in the Porcupine and Old Crow Rivers July 22 to September 7, 1971.

River, some stations consisted of 2.5 by 16 meter monofilament gill nets (5 and 7.5 cm mesh) set perpendicular to shore. Between October and December, 2.5 by 10 meter cotton gill nets (10 cm mesh) were used.

In rivers and streams other than the Porcupine and Old Crow Rivers, most fish were captured with a seine which measured approximately 2 by 30 meters. This seine had 12.6 mm mesh except near the center where there was a bunt (approximately 7 meters long) with 4 mm mesh. The seine was usually pulled downstream around pools. Many of the larger Arctic char and a few grayling were captured with sport fishing gear. In addition to the seine, a panel gill net was used to capture fish in lakes connected with Deep Creek and Creek Number 11200.

On larger fish (> 100 mm), several characteristics were measured or sampled. The fork length and total wet weight were measured. The gonads were observed to determine sex, maturity, and spawning condition; gonads of ripe females were preserved for subsequent egg counts. From most fish, otoliths, scales and food samples were collected.

Ages were determined from scale samples for most fish species captured in the Porcupine drainage. The main criteria for recognizing an annulus were crossing-over of circuli in the posterior field of the scale and increased distance between the circuli immediately following an annulus. The otoliths from fish in the Porcupine drainage were opaque so could not be used in age determination. Most otoliths of Arctic char and Arctic grayling from coastal streams were satisfactory for age determinations although a few were discarded because they were damaged or opaque. In some cases, the age assigned to an otolith was checked by a second reader, and there was good agreement between the two ages.

Estimates of egg number were made by measuring the volume displacement of each ovary. Two egg samples of known volume were then removed from each ovary and the number of eggs counted. Total egg number was estimated by direct proportion.

Food samples were obtained by removing stomachs in the field and preserving them in 10% formalin. Stomach contents were sorted in the laboratory within 9 months of collection. The contents were then identified and counted and the volume of each category determined by displacement. The stomach contents of all individuals of a species caught at the same place and time were pooled in the manner of Borgeson (1963).

Intact fish for heavy metal and pesticide analysis were frozen shortly after they were captured. They were stored for a maximum period of 8 months before analysis. Livers were removed from the fish while they were still frozen. Mercury concentrations were measured by the Fish Inspection Laboratory of Fisheries Service using the technique described by Armstrong and Uthe (1971). Analyses of other heavy metals were performed by Department of Geology, University of British Columbia, and the techniques used are outlined by Peterson, Warren, Delavault, and Fletcher (1970). The pesticide analyses were performed by B.C. Department of Agriculture Pesticide Laboratory with the methods of Armour and Burk (1971).

RESULTS AND DISCUSSION

Distribution of periphyton, macro-invertebrates, and fish.

Synedra, *Hannaea*, and *Amphora* were common genera of periphyton (Appendix Table 1). There were no striking differences in the kinds of periphyton observed in the streams of the Beaufort and Porcupine drainages.

The macro-invertebrate composition is similar in rivers of the Beaufort and Porcupine drainages (Table 1). Oligochaeta, Ephemeroptera, Plecoptera, Chironomidae, and Tipulidae were common in both drainages. The data suggest that amphipods are more common in coastal rivers and streams. Tricoptera and Empididae may be more common in the Porcupine drainage. There are differences among the samples in the density of all organisms without regard to kind. This undoubtedly reflects differences among areas of a river as well as any differences among the rivers. More samples would be required to establish which rivers have significantly different standing crops of macro-invertebrates.

Eighteen species of fish were captured in streams of the northern Yukon in 1971 (Table 2). The distribution of species captured in different streams is shown in Tables 3 and 4. Greater fishing effort would undoubtedly increase the number of species observed in many bodies of water. At the mouth of the Firth River, for example, J. G. Hunter (personal communication) found inconnu, broad whitefish, lake whitefish, least cisco, and Arctic cisco (*Coregonus autumnalis* (Pallas)). The authors only observed Arctic cisco in salt water near Herschel Island. It is likely, however, that the samples included all of the species which were common in each river or stream at the time of sampling.

Grayling were ubiquitous (Tables 3 and 4). Grayling was the predominant species in most of the smaller rivers and streams. Arctic char were restricted to coastal streams and were much more abundant in streams from the Babbage and west than to the east. There was a greater diversity of species in the Porcupine drainage than in the Beaufort drainage. Within the Porcupine drainage, a greater number of species were found in the larger rivers where the water was deeper and the habitats more heterogeneous. Further information about the fish species distribution is presented by Bryan (1973).

Characteristics of Fish Populations

Seasonal species composition near Old Crow

Figure 3 shows temporal changes in the catch frequency of fish species. In the Porcupine River, the species composition of fish caught upstream and downstream of Old Crow was similar, so these data were pooled in Figure 3.

Table 1. Density (number/m^2) of macro-invertebrates in some rivers of the Beaufort and Porcupine drainages. The insects are all larvae unless specified as adults (A) or pupae (P).

	Day/month	Location (latitude and longitude in degrees and minutes)	Distance from mouth (km)	Turbellaria	Oligochaeta	Podocopa	Amphipoda	Hydracarina	Ephemeroptera	Plecoptera	Trichoptera	Dytiscidae	Chironomidae	Tipulidae	Simuliidae	Muscidae	Empididae
BEAUFORT DRAINAGE																	
Babbage R.	18/8	69:10; 138:15	13		30	1	1			3			30	1			
Big Fish R.	3/9	68:26; 136:32	23		29			1	14	26			9	1			
Blow R.	6/8	68:44; 137:25	37		1					1			9				
Firth R.	3/8	69:26; 139:31	13		5				5	5			14	3	1P		
Firth R.	4/8	69:02; 140:29	84		3				1	12			5				
Fish Cr.	17/8	69:33; 140:05	8	1	22		868		34				398 14P	8			
Fish Hole Cr.	6/9	68:39; 138:42	19	3	344				20	11			84	15			
Number 11200	3/8	69:21; 139:02	6		47	14	1	3	14	9			79	7			
Running R.	8/8	68:54; 137:20	8		1		3					1	8	3			
PORCUPINE DRAINAGE																	
Bell R.	30/8	67:44; 136:50	138					1	36	8	5		124 14P	7	1P		15
Bluefish R.	26/8	67:03; 140:35	84		249				22	1	1		13				
Cody Cr.	2/9	66:36; 138:55	35		8						1		44	1			1
Driftwood R.	27/8	67:34; 138:29	2		51			1	19	31	1		24	1	1		
Fishing Branch R.	1/9	66:28; 139:02	3		4			5		40			1	1			
Lord Cr.	2/9	67:32; 139:09	24		75				4 1A				16	2		8	
Rock R.	30/8	66:59; 136:44	64		34				37	20	1A		2				

Table 2. List of common and scientific names of fish captured in freshwater of the northern Yukon Territory, 1971.

COMMON NAME	SCIENTIFIC NAME
Arctic char	*Salvelinus alpinus* (Linnaeus)
Arctic grayling	*Thymallus arcticus* (Pallas)
Broad whitefish	*Coregonus nasus* (Pallas)
Burbot	*Lota lota* (Linnaeus)
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)
Chum salmon	*Oncorhynchus keta* (Walbaum)
Coho salmon	*Oncorhynchus kisutch* (Walbaum)
Fourhorn sculpin	*Myoxocephalus quadricornis* (Linnaeus)
Inconnu	*Stenodus leucichthys* (Guldenstadt)
Lake chub	*Couesius plumbeus* (Agassiz)
Lake whitefish	*Coregonus clupeaformis* (Mitchill)
Least cisco	*Coregonus sardinella* Valenciennes
Longnose sucker	*Catostomus catostomus* (Forster)
Ninespine stickleback	*Pungitius pungitius* (Linnaeus)
Northern pike	*Esox lucius* Linnaeus
Round whitefish	*Prosopium cylindraceum* (Pallas)
Slimy sculpin	*Cottus cognatus* Richardson
Trout-Perch	*Percopsis omiscomaycus* (Walbaum)

Table 3. A checklist of fish species captured in streams of the Beaufort Sea drainage, 1971.

RIVER or CREEK	Arctic char	Arctic grayling	Broad whitefish	Fourhorn sculpin	Ninespine stickleback	Northern pike	Round whitefish
Anker Cr.	-	X	-	-	-	-	-
Babbage R.	X	X	-	-	-	-	-
Backhouse R.	-	-	-	X	-	-	-
Big Fish R.	X	X	-	-	-	-	X
Blow R.	X	X	X	-	-	-	X
Craig Cr.	X	-	-	-	-	-	-
Crow R.	X	-	-	-	-	-	-
Deep Cr.	-	X	X	-	-	X	-
Firth R.	X	X	-	-	-	-	-
Fish Cr.	X	-	-	-	-	-	-
Fish Hole Cr.	X	X	-	-	-	-	-
Joe Cr.	X	-	-	-	-	-	-
Malcolm R.	X	X	-	-	-	-	-
No. 11200 Cr.	-	X	X	-	-	-	-
Rapid Cr.	-	X	-	-	-	-	-
Running R.	-	X	-	-	X	-	-
Spring R.	-	X	-	-	-	-	-
Trail R.	-	X	-	-	-	-	-

Table 4. A checklist of fish species captured in streams of the Porcupine River drainage, 1971.

RIVER or Creek	Arctic grayling	Broad whitefish	Burbot	Chinook salmon	Chum salmon	Coho salmon	Inconnu	Lake chub	Lake whitefish	Least cisco	Longnose sucker	Northern pike	Round whitefish	Slimy sculpin	Trout-perch
Bell R.	-	-	-	-	X	-	-	-	-	-	-	X	-	X	-
Berry Cr.	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Black Fox Cr.	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bluefish R.	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Burnthill Cr.	X	-	-	-	-	-	-	-	-	-	X	-	X	X	-
Caribou Bar Cr.	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Cody Cr.	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Driftwood R.	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Eagle R.	X	-	-	-	-	-	X	X	-	X	X	X	X	X	X
Fishing Branch R.	X	-	-	-	X	X	-	-	-	-	-	-	-	X	-
Johnson Cr. (O.C.)	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Johnson Cr. (Por.)	X	-	-	-	-	-	-	X	-	-	X	-	-	X	-
Lord Cr.	X	-	-	-	-	-	-	-	-	-	X	-	X	X	-
Miner R.	X	-	-	X	-	-	-	-	-	-	-	-	X	X	-
No. 21000 Cr.	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Old Crow R.	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X
Pine Cr.	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Porcupine R.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rat R.	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-
Rat Indian Cr.	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Rock R.	X	-	-	-	-	-	-	-	-	-	X	-	X	X	-
Surprise Cr.	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thomas Cr.	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Timber Cr.	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-
Whitestone R.	X	-	-	-	-	-	-	X	-	X	X	-	-	X	-

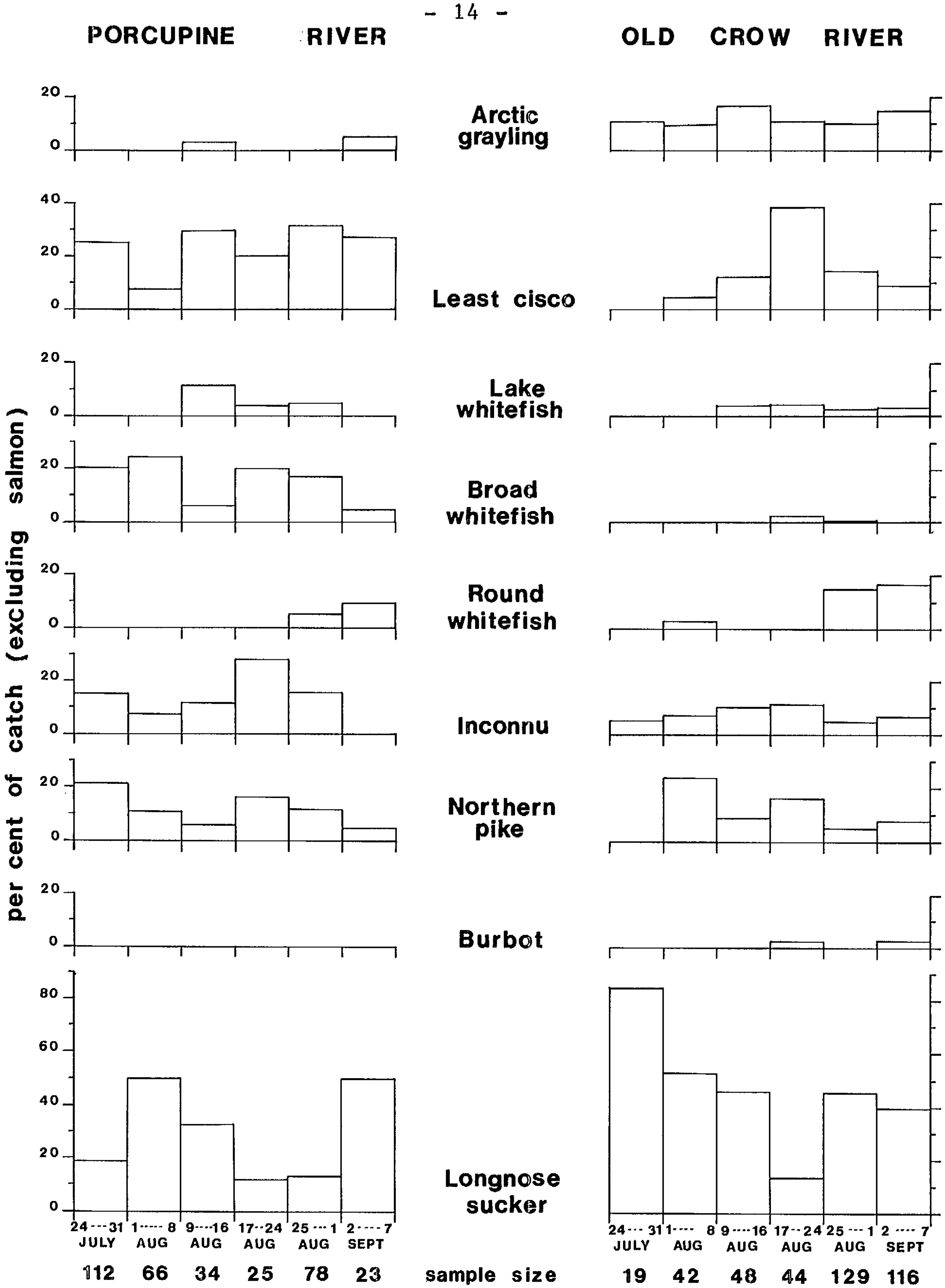

Figure 3. Species composition of fish caught in gill nets set in the Porcupine and Old Crow Rivers at different times in 1971. The total number of all species captured is written below the abscissa.

Figure 3 shows that there were some consistent differences in proportion of species captured in the Porcupine and Old Crow Rivers. Arctic grayling and suckers were caught more frequently in the Old Crow River. Other species, such as lake whitefish, broad whitefish, and inconnu, were captured more frequently in the Porcupine River. For these species, the difference in capture frequency may have resulted partly from an actual difference in abundance. However, it might also have resulted because large mesh sizes were used mainly in the Porcupine River and because most individuals of these species were quite large and therefore more easily captured in the larger mesh. In the case of grayling and suckers, the difference in catch frequency is believed to reflect a genuine difference in abundance as these species were captured in small mesh sizes which were used extensively in both rivers.

For all resident, freshwater species except the round whitefish, the catch frequency showed no particular trend through time (Figure 3). The capture frequency of round whitefish increased during August and September in both the Porcupine and Old Crow Rivers. This suggests that the abundance increased or activity of these fish had increased. It is quite possible that this species was beginning a spawning migration at this time. In the Porcupine River, the catch of all freshwater species decreased in August and September because increasing numbers of salmon were captured, lowering the efficiency of the gill nets.

Figure 4 presents seasonal capture frequency for all species captured in the Porcupine River with particular reference to salmon. The chinook salmon was the first species to appear at Old Crow. Individuals were captured between July 26 and August 27. Chum salmon were first recorded on August 11 and last on November 27. Peaks of abundance probably occurred in October. The coho salmon was latest to appear at Old Crow. Of four fish caught, the first was on November 2 and the last on December 18. As the capture frequency of salmon decreased, the catch of grayling, inconnu, and burbot increased (Figure 4). Although this strongly suggests that these fish moved into the Porcupine to over-winter, the gill nets used were different than those used during the summer and fall.

Spawning salmon were observed in a small section of the Fishing Branch River between September 1 and December 14. The spawning area is fed by groundwater outflows, which allow some portions to remain unfrozen throughout the winter. The number of spawning chum salmon originally estimated was 250,000 (Bryan *et al.* MS 1972). However, this was based on a longevity estimate which has since been found to be erroneous (Elson 1973). The revised estimate of the number of chum salmon which reached the spawning grounds in 1971 is 115,000.

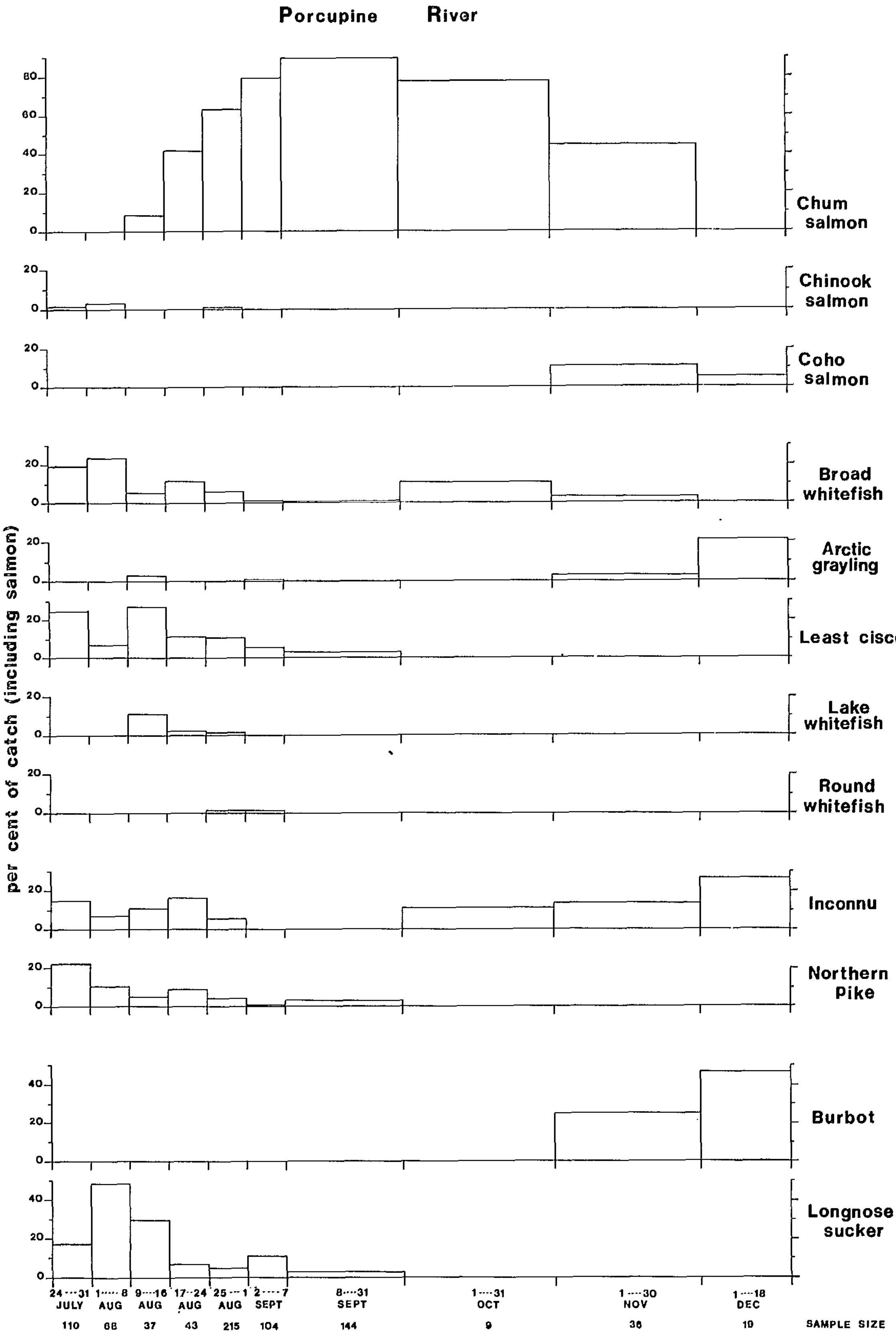

Figure 4. Species composition of all fish captured in the Porcupine River July to December 1971.

Length distributions

Figure 5 presents the size distribution of commonly captured freshwater species. In the Beaufort drainage, fish were captured with seines or sport fishing gear whereas in the Porcupine drainage all species except grayling and round whitefish were captured with gill nets. Most grayling and round whitefish were captured in gill nets but some were captured in seines. Even so, small fish (< 100 mm) were excluded from these samples. Thus small fish are under-represented in all of the histograms shown on Figure 5.

Figure 5 indicates that grayling and round whitefish from the Beaufort drainage were smaller than those captured in the Porcupine drainage. Although some of the fish in the Porcupine drainage had been collected in gill nets, the same difference was apparent when only those fish captured in seines were compared. Thus, the data probably indicate a genuine size difference in two areas, presumably resulting from a difference in growth rate. The size distribution of Arctic char is bimodal. This probably reflects that fishing effort was not uniform. Most large (400-750 mm) char had been caught in the Babbage and Firth Rivers whereas most small (100-350 mm) char had been caught in Fish Creek.

Age composition

Table 5 shows the percentage of fish in different age classes. There was a large proportion of regenerate and unreadable scales, but all of the age data available from 1971 samples was included in the table. The ages assigned to northern pike of different sizes were inconsistent; hence the data were disregarded.

For Arctic char and coastal grayling, the age composition of available samples definitely does not reflect that of the population vulnerable to the sampling gear (Table 5). For both species, fish of age classes 0 (young of the year) and 1 were excluded from the age analyses. All other age classes, however, are represented in proportion to their capture frequency. For both species there is a general decrease in capture frequency with increasing age. This trend would be expected as a result of increased mortality in older age classes. The other species were captured with gill nets; hence the sampling method selected against small individuals. Consequently, these species show an increase followed by gradual decrease in capture frequency with increasing age. For all species, the decrease in capture frequency was fairly uniform. This suggests that there were no great variations in year class strength, although this conclusion requires substantiation with additional data.

Table 5. Per cent age composition in 1971 catches of fish from northern Yukon Territory. Except for Arctic char and coastal Arctic grayling, all fish were captured in gill nets, and their ages were determined from scale samples.

Fish species	Age (years) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Sample size
Arctic char *	3.7	5.6	24.3	12.1	6.5	17.8	12.1	7.5	0.9	6.5	0.9	0.9	0.9		107
Coastal Arctic grayling **	18.7	4.9	8.1	4.1	10.6	21.1	11.4	8.9	5.7	3.2	3.2				123
Interior Arctic grayling			16.1	45.2	22.6	16.1									31
Broad whitefish		3.1		9.4	12.5	34.4	25.0	12.5	3.1						32
Chinook salmon			57.1	14.3	28.6										7
Chum salmon				89.4	10.6										151
Inconnu		17.4	52.2			8.7		17.4	4.3						23
Lake whitefish		14.3				14.3	42.8	28.6							7
Least cisco		5.0	11.7	13.3	41.7	13.3	10.0	5.0							60
Longnose sucker			2.1	13.4	15.5	10.3	3.1	7.2	7.2	13.4	9.3	12.4	5.2	1.0	97
Round whitefish		3.3	53.3	40.0			3.3								30

* All Arctic char were captured with seines or sport fishing gear; ages were determined from otoliths.
** All coastal grayling were caught with seines; ages were determined from otoliths.

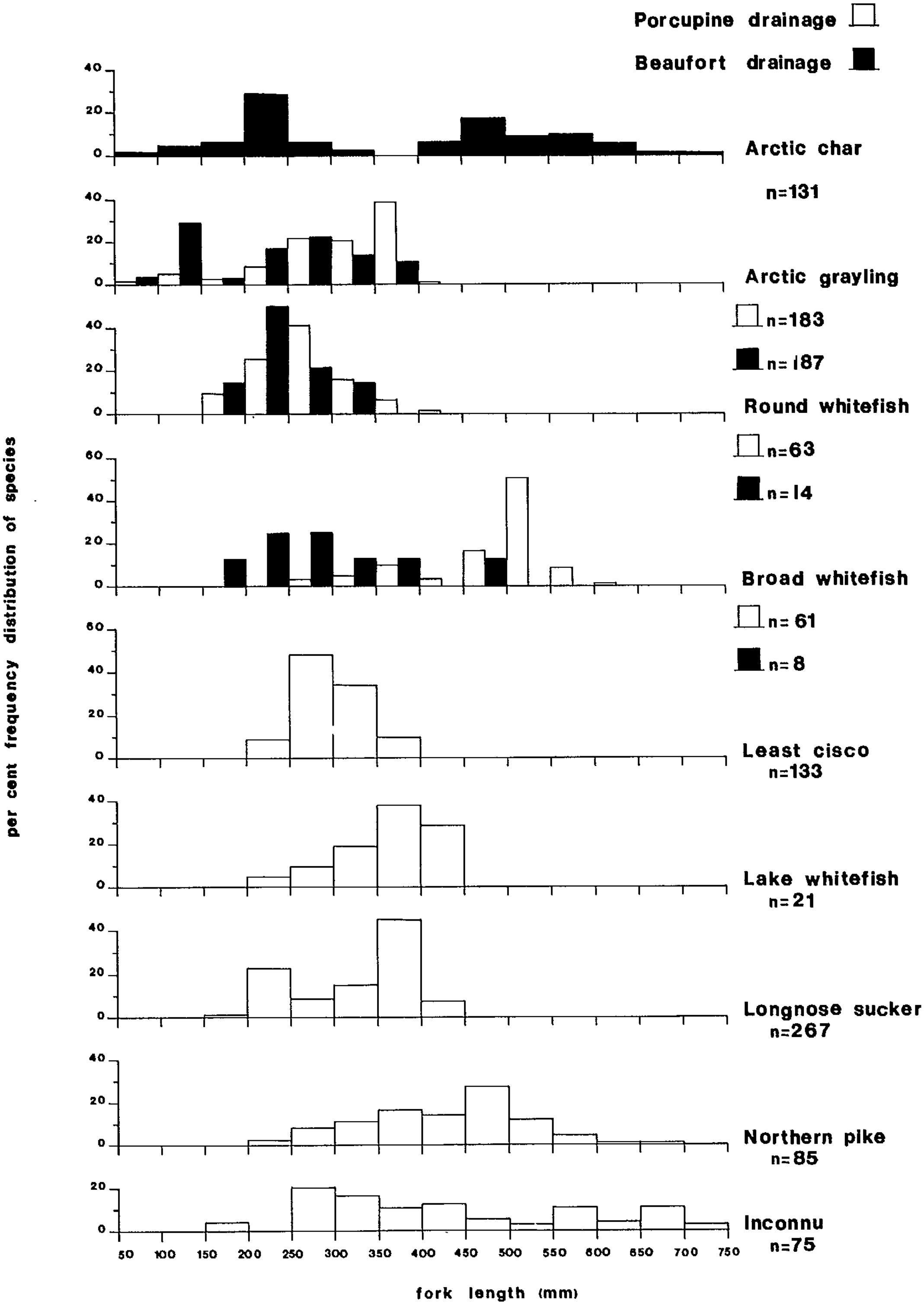

Figure 5. Size distribution for commonly captured species which are resident in freshwater for most of their lives.

Age and size relationships

Age and size relationships are presented in Table 6 and Figures 6 to 16. The sizes were not back-calculated to the last annulus hence include growth during the current year. The data were analyzed to determine whether there were significant differences in growth between the sex categories. For three of the species there were significant differences (Table 6); however, all of these are probably fortuitous. In the case of Arctic char, the difference among the sex categories resulted from fish in the immature category. It is apparent from Figure 6 that the relationship for immature fish was largely determined by fish in age class 3. (There was only one immature fish in age class 4). For longnose suckers, the difference among the sex categories (Table 6) resulted because only a few females had been captured and all were in older age classes (Figure 15). For round whitefish, both the total number of individuals sampled and the number of age classes represented (Figure 16) were small. These conditions are probably the main reasons why there were significant differences among the sex categories.

Table 7 compares growth rates observed by other workers with the age-size relationships observed in the present study. Some of the differences probably resulted because fish lengths in the present study were not back-calculated to the last annulus. This would tend to make growth rates observed by some others appear to be less than those in the present study. Other reasons for differences are outlined below.

As described previously, coastal grayling were aged with otoliths. The ages are thought to be reliable. However, interior grayling were aged with scales because their otoliths, like those of other interior species, were opaque. The ages assigned to interior grayling were probably under-estimates. The main evidence for this view is that when scale ages observed on some coastal grayling were compared with their otolith ages, the scale ages were always less than or equal to the otolith age. The relationship was: Scale age = 0.5366 (otolith age) + 0.6009 (SE slope = 0.0594; n = 36). Thus the interior grayling were probably older than the scale samples indicated resulting in apparent growth rates which exceeded those observed by other workers. It is possible that the scale ages were also underestimates of true age in: broad whitefish, inconnu, lake whitefish, least cisco, and round whitefish.

Ages of Arctic char were determined from otoliths, hence are thought to be reliable. The growth rate of char was generally greater than that for char from both the Sylvia Grinnell River and Herschel Island (Grainger 1953). However there were some exceptions for the Herschel Island char as those age 3 and 4 (4 and 5 winters -- Grainger 1953) were larger than those observed in the present study. Figure 6 shows that the char had a large growth increment between age 4 and 5; this suggests that many of the individuals begin migrating to the sea in their fourth year of life.

Table 6. Regression of age on length for some of the fish species captured in northern Yukon Territory. Separate regressions are presented if there are significant differences among the sex categories. All regressions have the following form: ln age in years = B (ln fish length in mm) + A.

Fish species	Range in length (mm)	Sex(es)	Slope (B)	SE Slope	Intercept (A)	SE Intercept	Sample size	Correlation coefficient
Arctic char	99-710	pooled	0.9149	0.0431	-3.7684	0.2502	107	0.893
	146-686	female	0.9193	0.0620	-3.7559	0.3653	50	-
	170-710	male	0.8384	0.0642	-3.2820	0.3801	43	-
	99-265	immature	1.3994	0.1669	-6.5039	0.8594	14	-
Coastal Arctic grayling	92-374	pooled	1.7153	0.0988	-7.9244	0.5385	123	0.849
Interior Arctic grayling	226-397	pooled	0.9716	0.3051	-4.2462	1.7909	31	0.512
Broad whitefish	299-608	pooled	1.4058	0.2163	-6.9665	1.3468	32	0.714
Chinook salmon	524-812	male	1.3314	0.3570	-7.3378	2.3131	7	0.849
Chum salmon	543-712	pooled	0.2899	0.1149	-0.4596	0.7413	151	0.202
Inconnu	273-694	pooled	1.8575	0.1977	-9.8792	1.1914	23	0.887
Lake whitefish	221-416	pooled	1.3763	0.6544	-6.2974	3.8421	7	0.856
Least cisco	219-392	pooled	1.0202	0.3146	-4.2408	1.7881	60	0.384
Longnose suckers	198-440	pooled	1.6802	0.1354	-7.4976	0.7662	97	0.768
	310-440	female	0.2121	0.6019	1.1476	3.5635	19	-
	212-430	male	1.6190	0.1579	-7.1978	0.9137	35	-
	198-325	immature	2.2378	0.2926	-10.4649	1.5917	43	-
Round whitefish	225-368	pooled	1.3932	0.2445	-6.5320	1.3621	30	0.702
	233-368	female	0.8919	0.3058	-3.7857	1.7148	10	-
	254-348	male	2.6514	0.4783	-13.5885	2.6931	9	-
	225-267	immature	1.3080	0.7747	-6.0299	4.2534	11	-

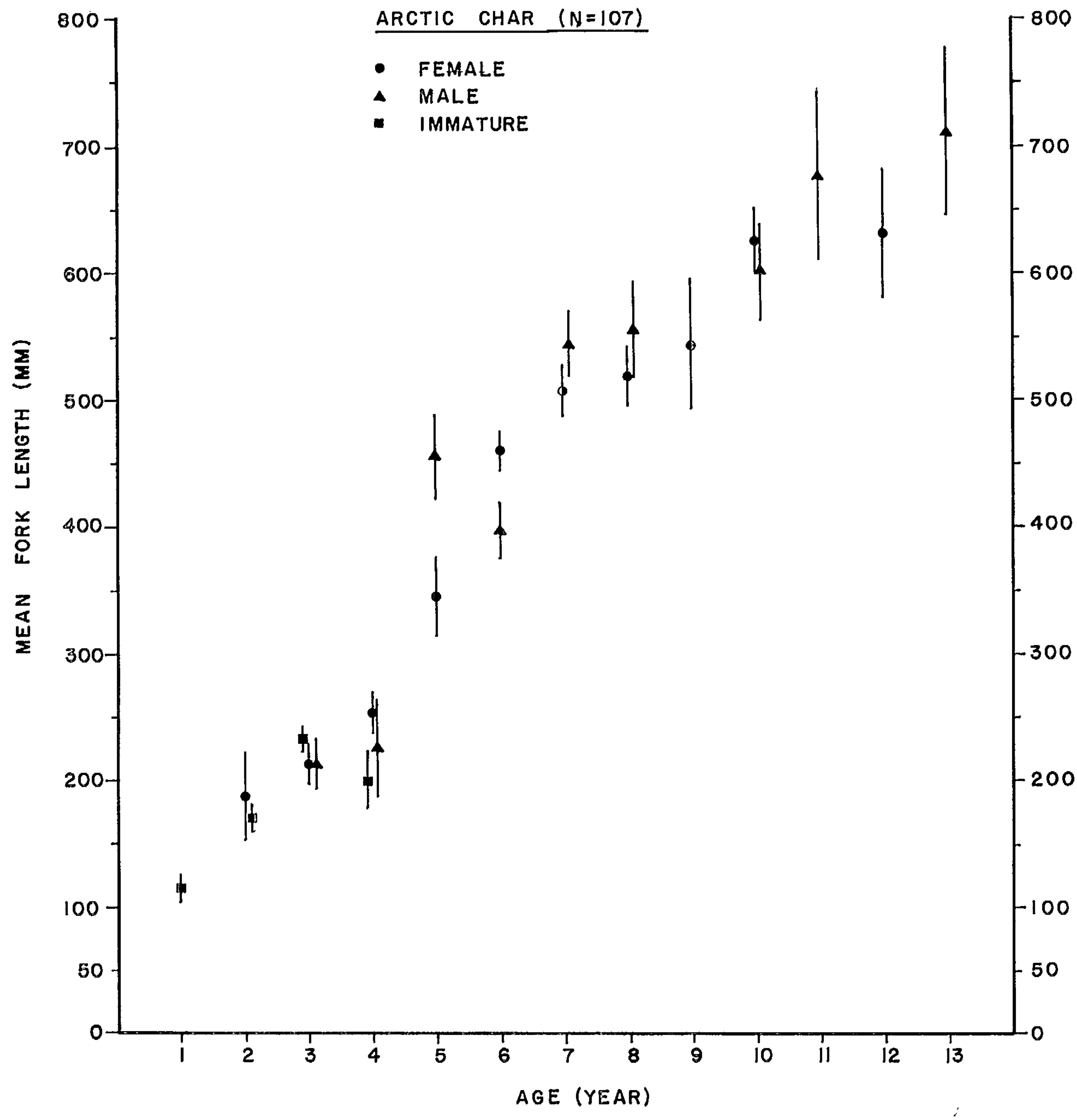

Figure 6. Age and size relationship for Arctic char from the Beaufort drainage.

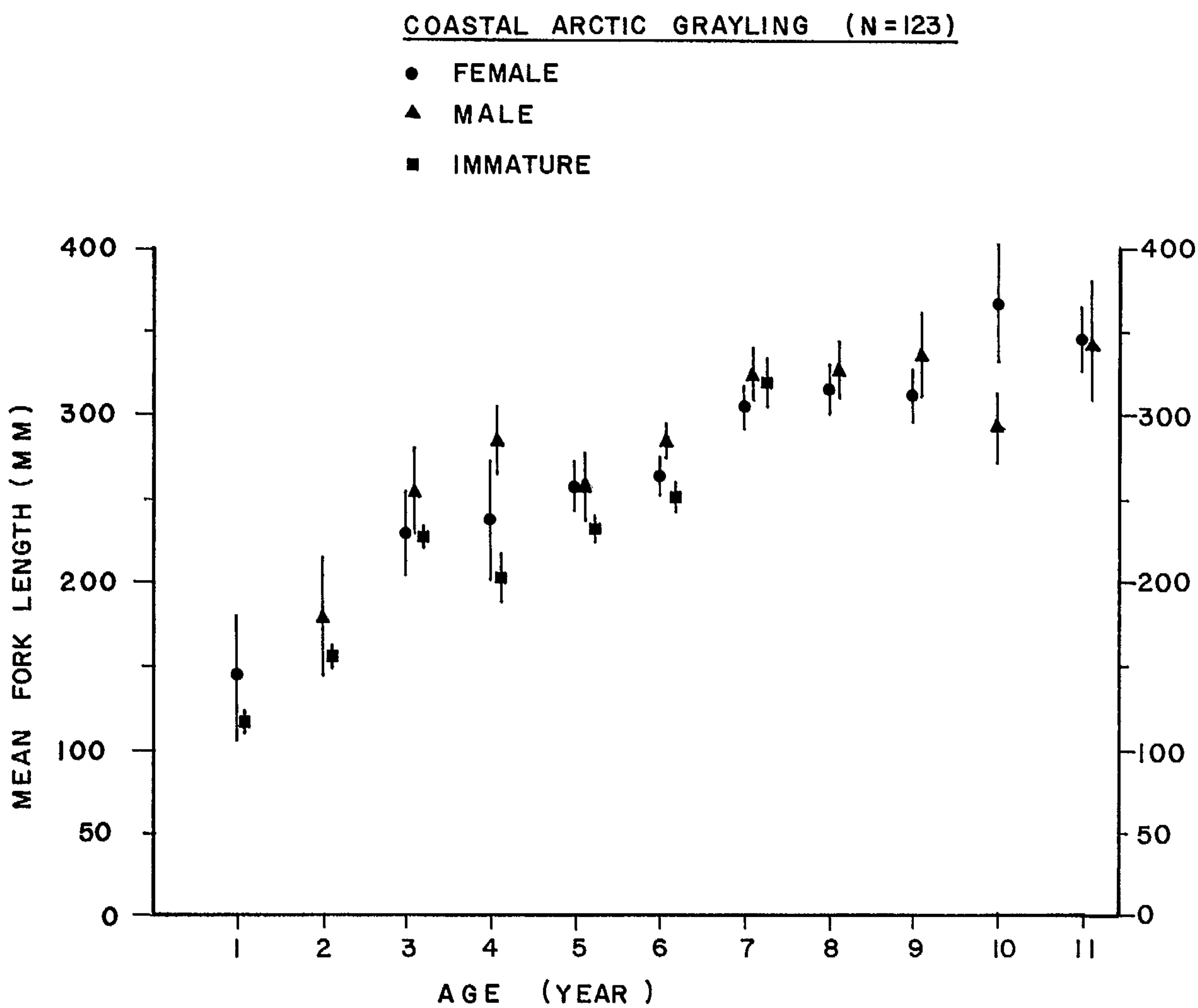

Figure 7. Age and size relationship for Arctic grayling from the Beaufort drainage.

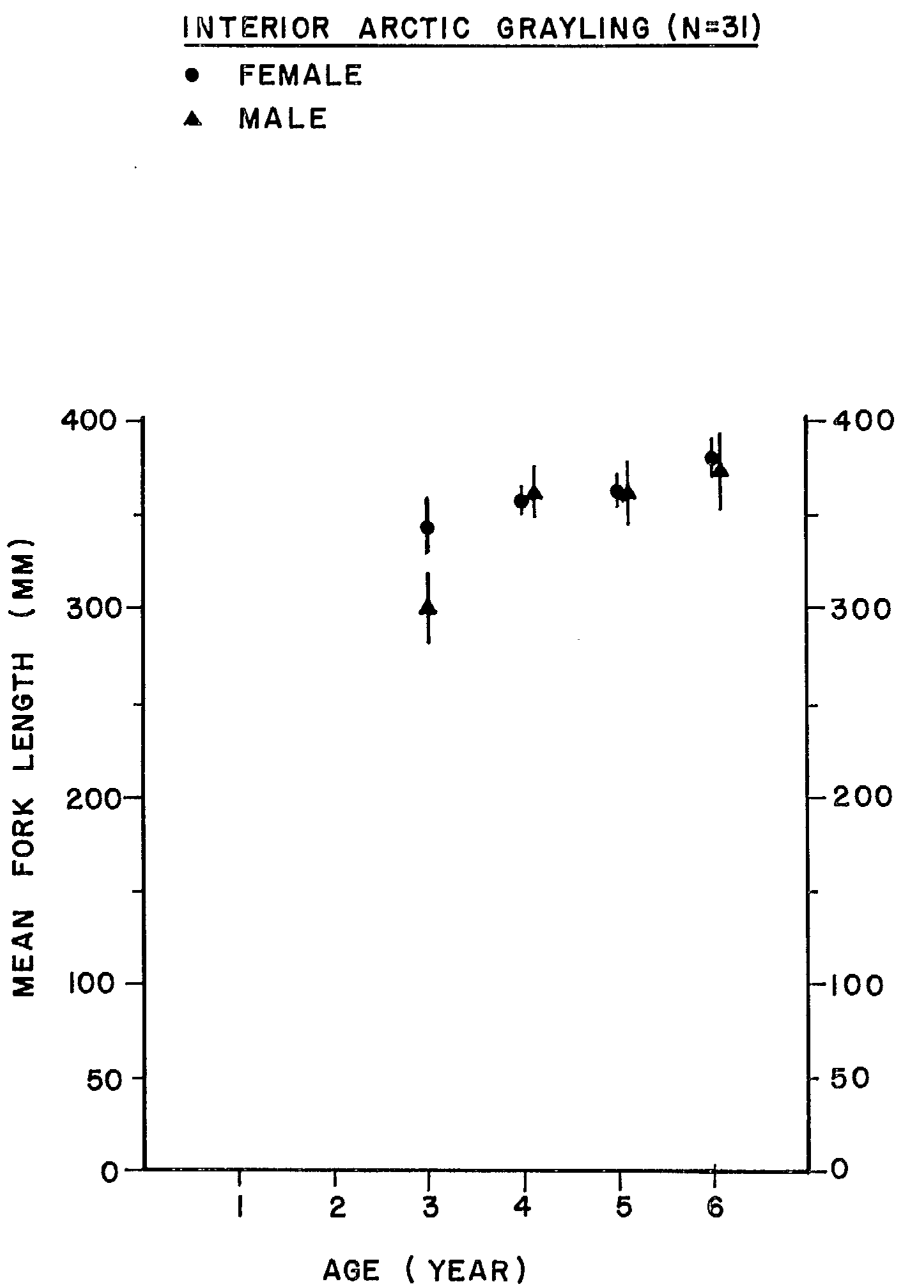

Figure 8. Age and size relationship for Arctic grayling from the Porcupine drainage.

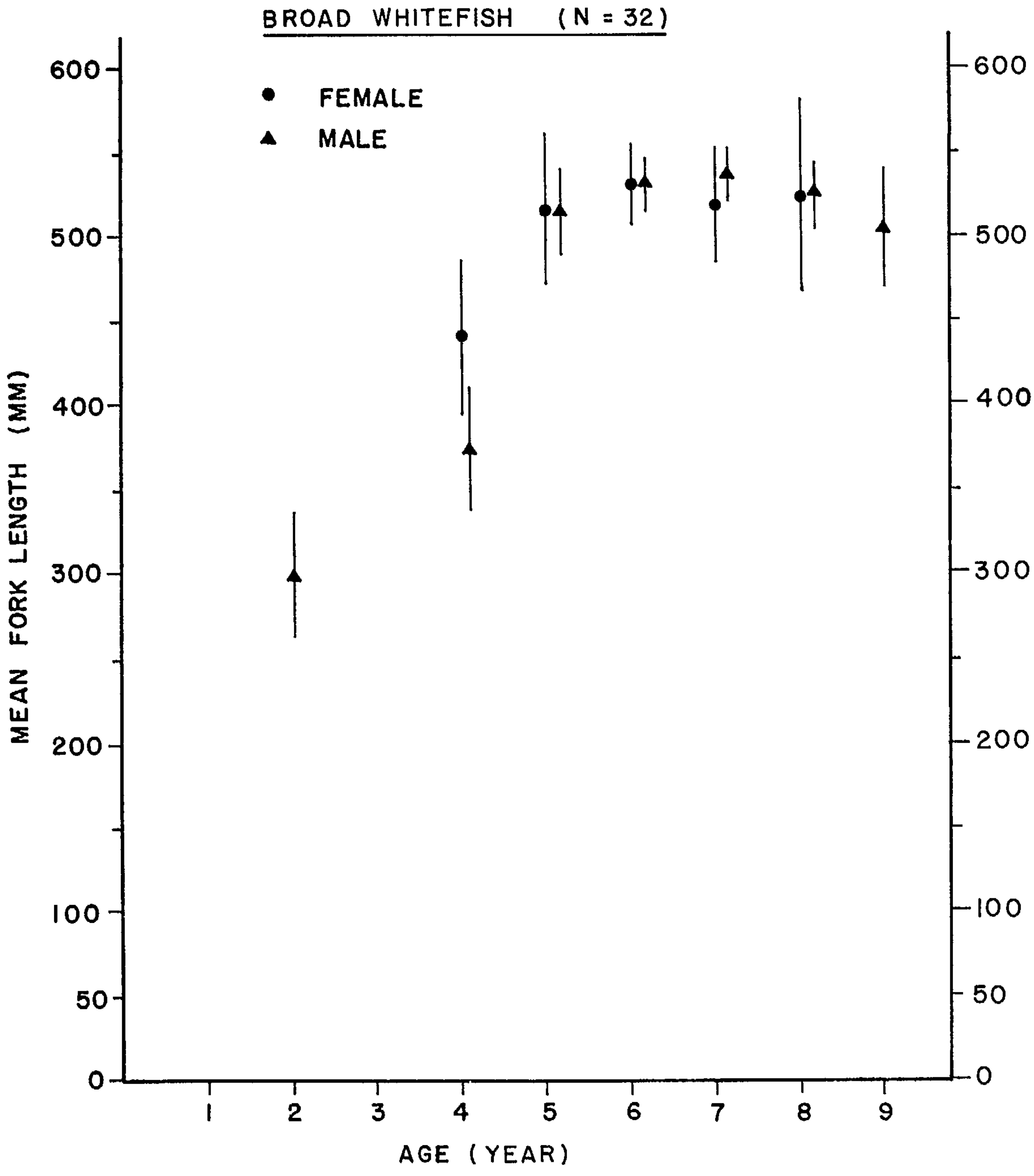

Figure 9. Age and size relationship for broad whitefish from the Porcupine drainage.

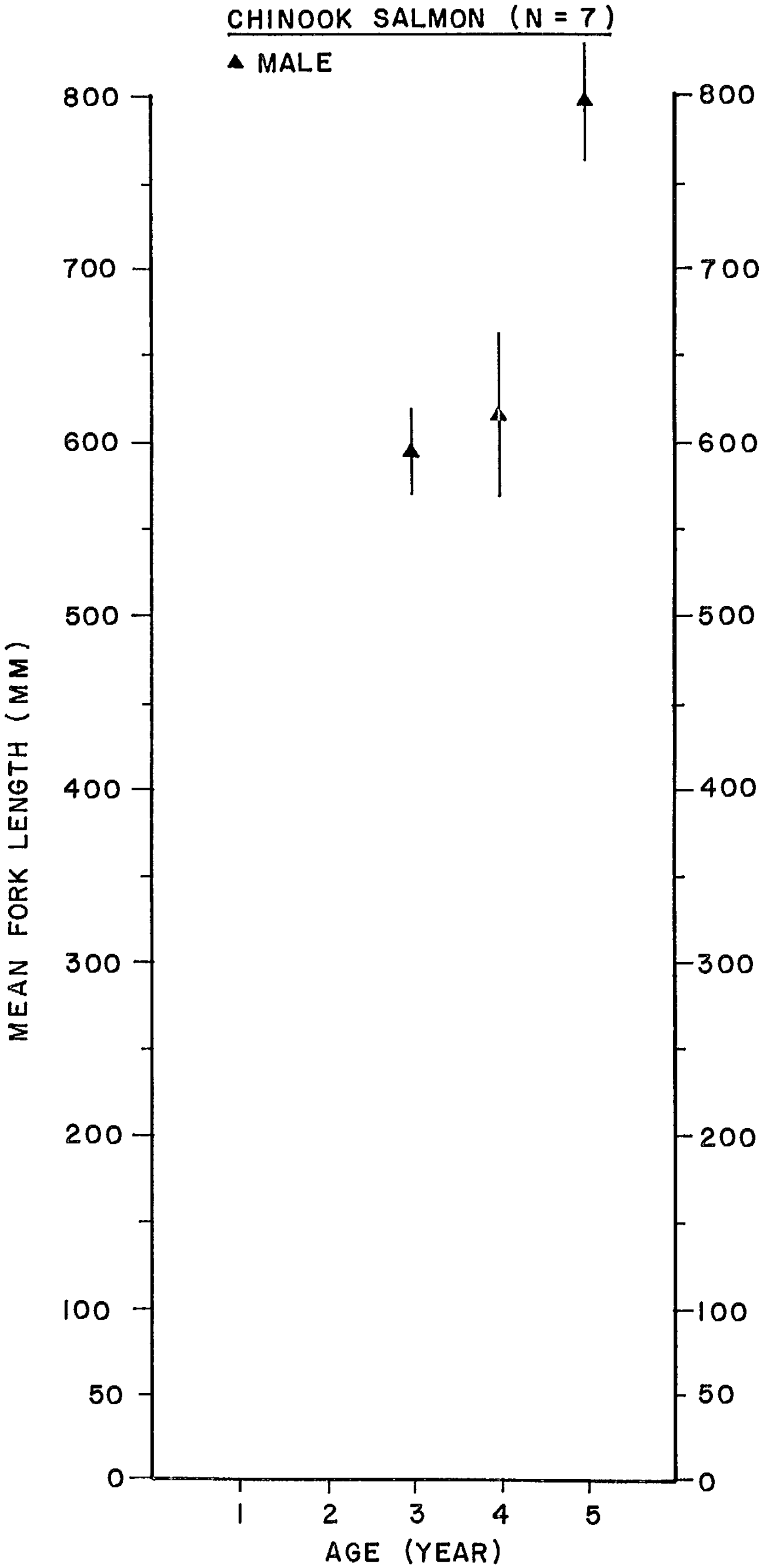

Figure 10. Age and size relationship for chinook salmon from the Porcupine drainage.

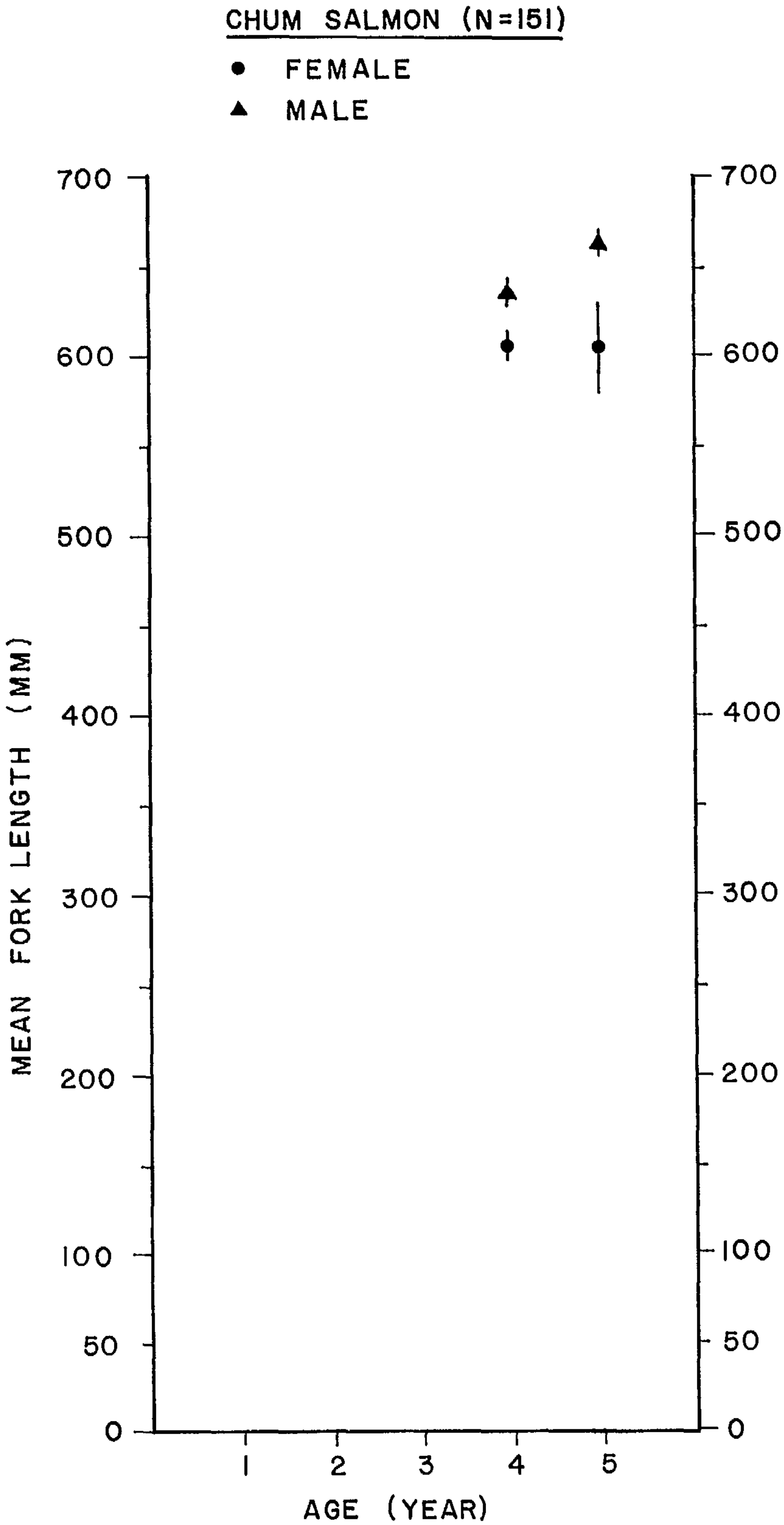

Figure 11. Age and size relationship for chum salmon from the Porcupine drainage.

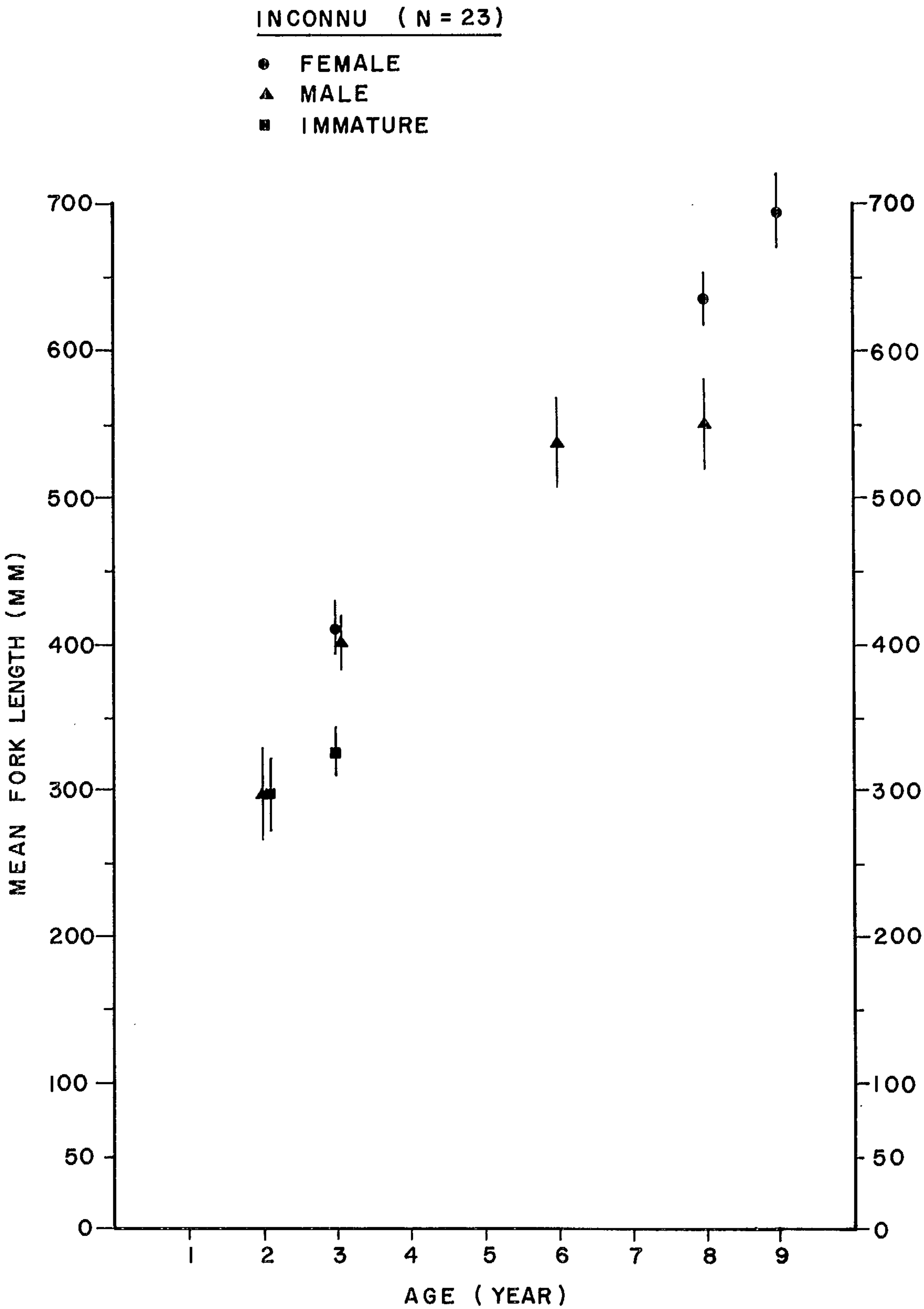

Figure 12. Age and size relationship for inconnu from the Porcupine drainage.

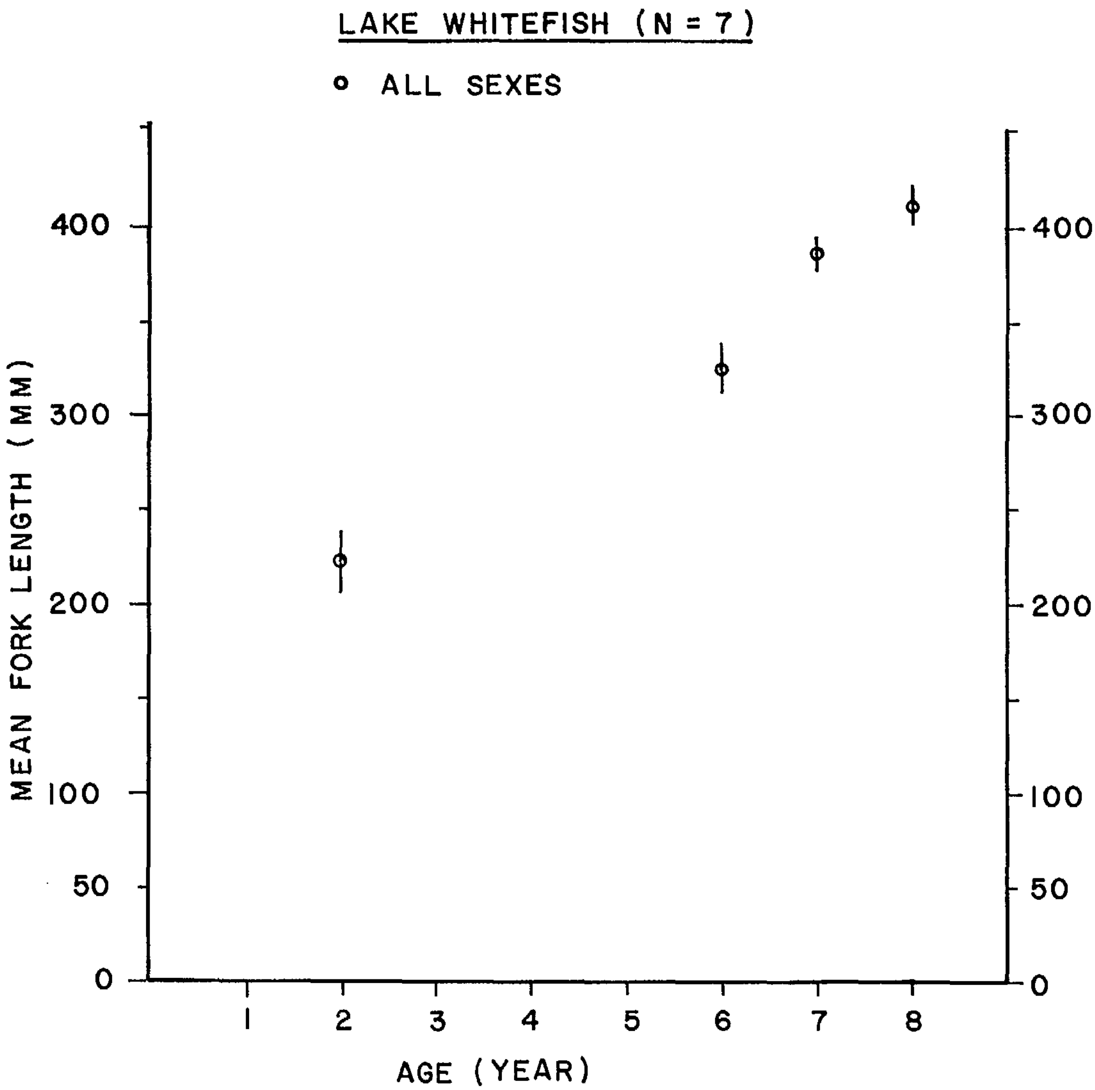

Figure 13. Age and size relationship for lake whitefish from the Porcupine drainage.

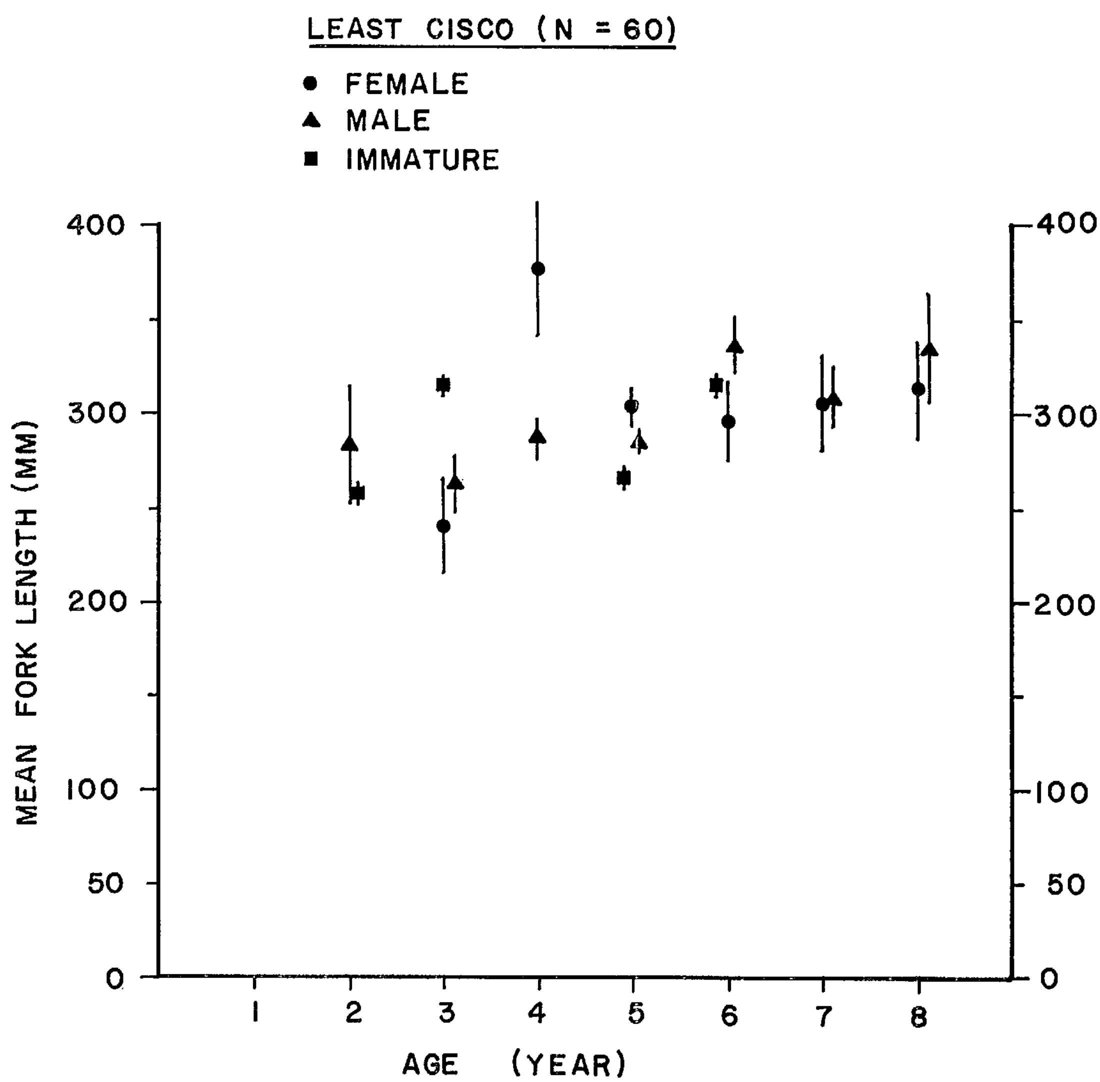

Figure 14. Age and size relationship for least cisco from the Porcupine drainage.

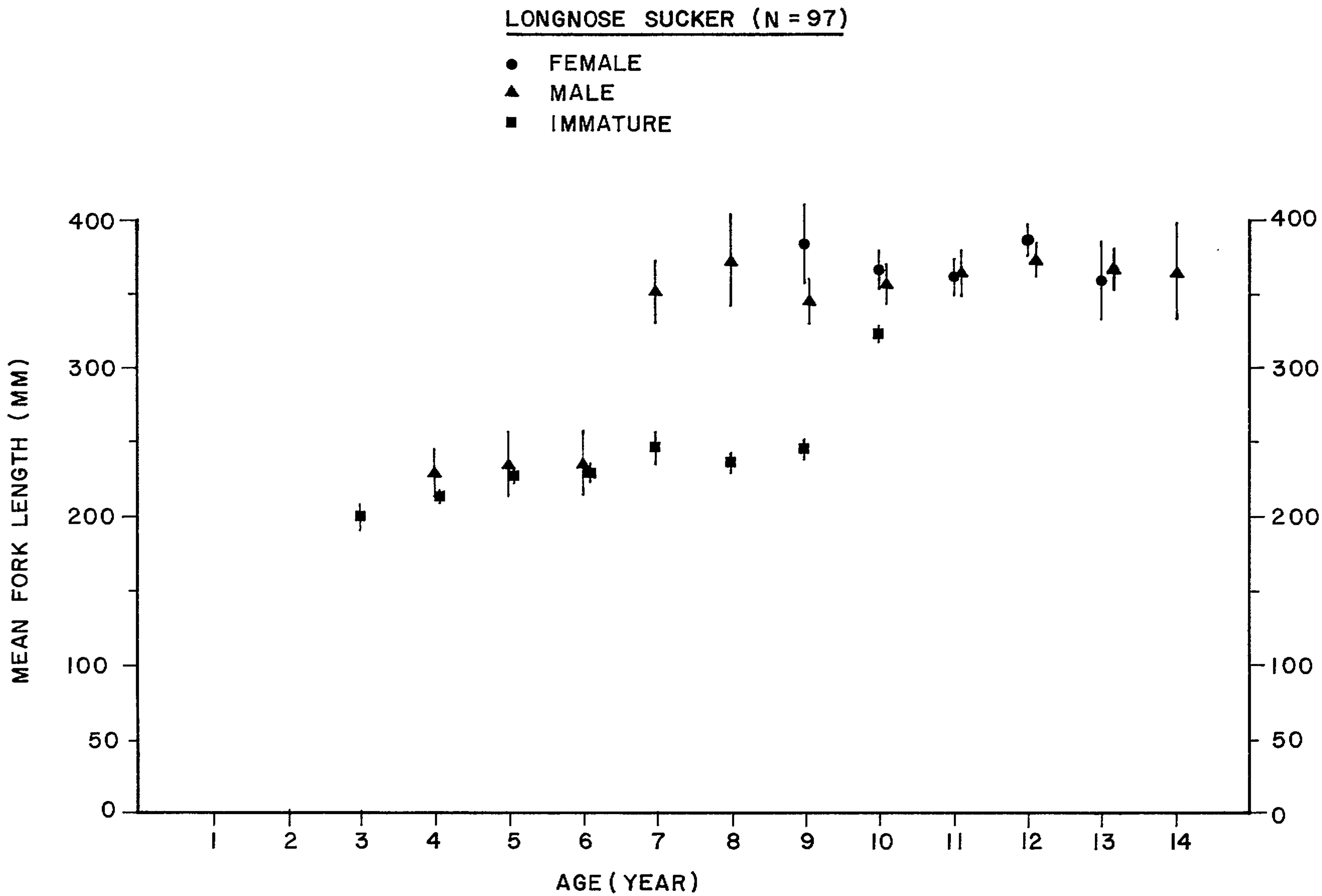

Figure 15. Age and size relationship for longnose sucker in the Porcupine drainage.

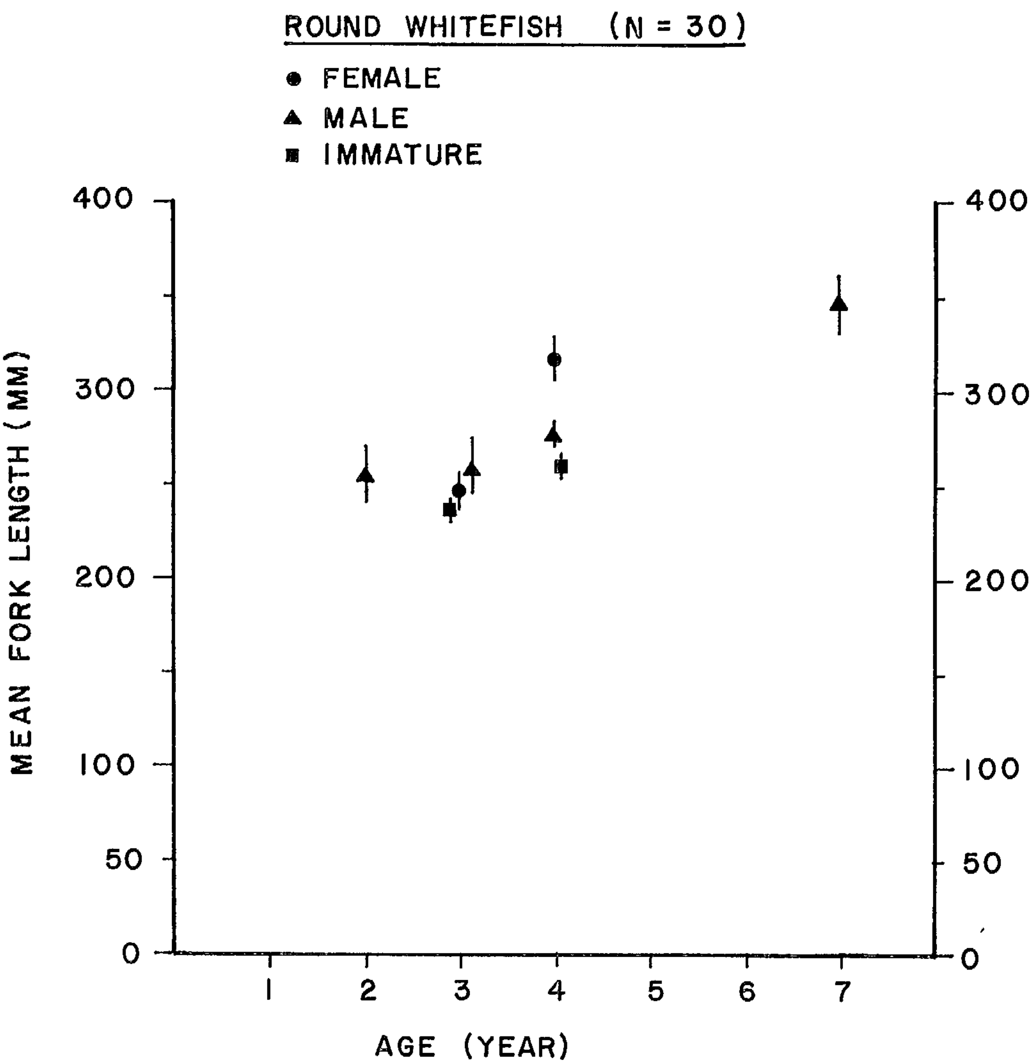

Figure 16. Age and size relationship for round whitefish from the Porcupine drainage.

Table 7. Summary of selected literature comparing growth rates of northern species with those observed in the present study. The symbol S indicates that growth rate was similar to that observed in the present study whereas GT or LT indicate that the rate was generally greater than or less than that observed in the present study.

Fish species	Comparison of growth rates and reference
Arctic char	LT (Granger 1953); S (Berg 1948); S (Andrews and Lear 1956 -- Adlatok)
Coastal Arctic grayling	S (Hatfield, et al. 1972); GT (Miller 1946); GT (Reed 1964)
Interior Arctic grayling	LT (Hatfield, et al. 1972); LT (Miller 1946); LT (Reed 1964)
Broad whitefish	LT (Hatfield, et al. 1972); LT (Muth 1969); LT (Berg 1948)
Chum salmon	S (Berg 1948)
Inconnu	S (Hatfield, et al. 1972); LT (Alt 1969 -- Yukon R.); S (Fuller 1955); LT (Berg 1948)
Lake whitefish	S (Hatfield, et al. 1972)
Least cisco	LT (Hatfield, et al. 1972); LT to Age 5, then GT (Berg 1948)
Longnose sucker	GT (Hatfield, et al. 1972); GT (Harris 1962)
Round whitefish	LT (Mackay and Power 1968)

Length and weight relationships

Table 8 presents length and weight relationships for most species studied. The data used are for the same fish as the age analyses. Separate analyses were done for different sex categories (female, male, and immature), but only chum salmon and northern pike showed any differences. The relationships for grayling, inconnu, longnose sucker and male pike are similar to those observed by Hatfield *et al.* (1972).

Sex and maturity ratios

There appears to be a difference in length at maturity between grayling in the Beaufort and Porcupine drainages (Tables 9 and 10). Coastal grayling mature at shorter lengths than the Porcupine grayling. This is probably a result of differential growth rates in the two areas. The Arctic char appear to mature at 200 mm, but the percentage of males was high. The maturity classifications may not be accurate. Egg size was not measured, and it is possible that some females classified as mature would not have spawned before the following season. An additional source of error is that immature fish may have been wrongly classified as male. Further investigation is required to confirm the maturity classifications. In the case of char, the observed maturity ratios may be misleading because they may be based on non-migratory freshwater populations as well as anadromus populations.

In the Porcupine drainage, individuals of most species had matured by the time they had grown to 300-400 mm (Table 10). The least cisco was an exception which matured at shorter lengths. The sex and maturity ratios of the other species are subject to some of the same sources of error, as the char data. For chum salmon, the sex ratios given definitely do not reflect those of the population as the hooked snout of males made them much more susceptible to capture.

Fecundity

Table 11 shows relationships between weight and egg number for some of the fish species. These relationships gave better correlations than corresponding relationships between length and fecundity. The fecundity of chum salmon was similar to that observed by Berg (1948) for fish caught in August. Although the fecundity of inconnu is lower than that reported by Berg (1948) it is very likely that he observed larger fish. The fecundity of least cisco is consistent with that reported by Berg (1948).

Table 8. Regressions of weight on length for some of the fish species captured in northern Yukon Territory. Separate regressions are presented when there were significant differences among the sexes. All relationships have the following form: ln fish weight in g = B (ln fish length in mm) + A.

Fish species	Range in length (mm)	Sex(es)	Slope (B)	SE Slope	Intercept (A)	SE Intercept	Sample size	Correlation coefficient
Arctic char	99-710	pooled	3.0327	0.0310	-11.7128	0.1802	107	0.995
Coastal Arctic grayling	92-374	pooled	3.0197	0.0480	-11.6166	0.2617	123	0.985
Interior Arctic grayling	226-397	pooled	3.1585	0.1738	-12.3687	1.0200	31	0.960
Broad whitefish	299-608	pooled	1.3725	0.3675	-0.8854	2.2881	32	0.521
Chinook salmon	524-812	male	3.0336	0.2785	-11.7694	1.8043	7	0.983
Chum salmon	543-684	female	2.5658	0.2297	-8.6767	1.4713	36	0.877
	559-712	male	3.1682	0.1602	-12.5086	1.0354	115	0.877
Inconnu	273-694	pooled	3.2446	0.1021	-13.0273	0.6154	23	0.992
Lake whitefish	221-416	pooled	0.7369	1.0458	2.0134	6.1400	7	0.552
Least cisco	219-392	pooled	3.2349	0.1432	-12.6114	0.8139	60	0.945
Longnose sucker	198-440	pooled	2.8880	0.0993	-10.7650	0.5617	97	0.950
Northern pike	384-552	female	1.2656	0.3687	-0.9016	2.2733	5	0.966
	290-527	male	2.9962	0.1286	-11.7290	0.7658	15	0.966
Round whitefish	225-368	pooled	2.6743	0.1231	-9.7320	0.6859	30	0.960

Table 9. Sex and maturity ratios, by size class, for commonly captured species in the Beaufort Sea drainage. Per cent mature includes fish of both sexes which appeared to be capable of spawning in the next season.

	Arctic grayling			Arctic char			Round whitefish		
Fork length (mm)	Per cent males	Per cent mature	Sample size	Per cent males	Per cent mature	Sample size	Per cent males	Per cent mature	Sample size
0-50	--	--	---	--	--	---	--	--	---
51-100	0	0	7	0	0	2	0	0	6
101-150	0	0	55	0	0	6	0	0	5
151-200	100	17	6	80	37	8	--	--	---
201-250	26	26	31	41	29	38	0	0	2
251-300	49	52	42	67	75	8	--	--	---
301-350	54	92	26	33	100	3	--	--	---
351-400	45	80	20	--	--	---	--	--	---
401-450	--	--	---	25	87	8	--	--	---
451-500	--	--	---	23	82	22	0	0	1
501-550	--	--	---	42	100	12	--	--	---
551-600	--	--	---	69	100	13	--	--	---
601-650	--	--	---	15	100	7	--	--	---
651-700	--	--	---	50	100	2	--	--	---
701-750	--	--	---	100	100	2	--	--	---
751-800	--	--	---	--	--	---	--	--	---
801-850	--	--	---	--	--	---	--	--	---
851-900	--	--	---	--	--	---	--	--	---

Table 10. Sex and maturity ratios, by size class, for commonly captured species in the Porcupine River drainage. Per cent mature includes fish of both sexes which appeared to be capable of spawning in the next season.

	Northern Pike			Broad whitefish			Humpback whitefish		
Fork length (mm)	Per cent males	Per cent mature	Sample size	Per cent males	Per cent mature	Sample size	Per cent males	Per cent mature	Sample size
0-50	--	--	---	--	--	---	--	--	---
51-100	--	--	---	0	0	1	--	--	---
101-150	--	--	---	--	--	---	--	--	---
151-200	--	--	---	--	--	---	--	--	---
201-250	0	0	2	--	--	---	0	0	1
251-300	100	0	7	100	0	2	0	0	2
301-350	78	0	9	50	0	3	75	25	4
351-400	77	50	14	33	67	6	43	63	8
401-450	85	85	13	100	100	2	100	100	6
451-500	53	57	23	50	100	10	--	--	---
501-550	22	80	10	52	100	31	--	--	---
551-600	0	100	5	80	100	5	--	--	---
601-650	0	100	1	0	100	1	--	--	---
651-700	0	100	1	--	--	---	--	--	---
701-750	--	--	---	--	--	---	--	--	---
751-800	--	--	---	--	--	---	--	--	---
801-850	--	--	---	--	--	---	--	--	---
851-900	--	--	---	--	--	---	--	--	---

Table 10 continued. Sex and maturity ratios, by size class, for commonly captured species in the Porcupine River drainage. Per cent mature includes fish of both sexes which appeared to be capable of spawning in the next season.

	Arctic grayling			Chum salmon			Longnose sucker		
Fork length (mm)	Per cent males	Per cent mature	Sample size	Per cent males	Per cent mature	Sample size	Per cent males	Per cent mature	Sample size
0-50	--	--	---	--	--	---	--	--	---
51-100	0	0	3	--	--	---	--	--	---
101-150	0	0	9	--	--	---	--	--	---
151-200	100	0	5	--	--	---	100	0	4
201-250	28	7	15	--	--	---	85	0	60
251-300	54	48	40	--	--	---	82	17	23
301-350	57	95	38	--	--	---	73	61	41
351-400	76	97	71	--	--	---	52	93	119
401-450	100	100	2	--	--	---	5	95	20
451-500	--	--	---	--	--	---	--	--	---
501-550	--	--	---	0	100	2	--	--	---
551-600	--	--	---	57	100	40	--	--	---
601-650	--	--	---	88	97	122	--	--	---
651-700	--	--	---	93	100	75	--	--	---
701-750	--	--	---	100	100	4	--	--	---
751-800	--	--	---	--	--	---	--	--	---
801-850	--	--	---	--	--	---	--	--	---
851-900	--	--	---	--	--	---	--	--	---

Table 10 continued. Sex and maturity ratios, by size class, for commonly captured species in the Porcupine River drainage. Per cent mature includes fish of both sexes which appeared to be capable of spawning in the next season.

	Inconnu			Least cisco			Round whitefish		
Fork length (mm)	Per cent males	Per cent mature	Sample size	Per cent males	Per cent mature	Sample size	Per cent males	Per cent matures	Sample size
0-50	--	--	---	--	--	---	--	--	---
51-100	--	--	---	--	--	---	--	--	---
101-150	--	--	---	--	--	---	--	--	---
151-200	100	0	3	--	--	---	0	0	6
201-250	--	--	---	50	55	11	29	6	11
251-300	67	0	15	64	52	63	60	19	26
301-350	75	8	13	60	89	46	40	60	10
351-400	60	0	8	38	100	13	25	100	4
401-450	75	33	9	--	--	---	0	100	1
451-500	75	0	4	--	--	---	--	--	---
501-550	100	0	2	--	--	---	--	--	---
551-600	86	75	8	--	--	---	--	--	---
601-650	33	100	3	--	--	---	--	--	---
651-700	14	87	8	--	--	---	--	--	---
701-750	0	100	2	--	--	---	--	--	---
751-800	--	--	---	--	--	---	--	--	---
801-850	--	--	---	--	--	---	--	--	---
851-900	--	--	---	--	--	---	--	--	---

Table 11. Weight and fecundity relationships for some of the fish species captured in northern Yukon Territory. The relationships have the following form: ln egg number = B (ln wet body weight in g) + A.

Fish species	Range in weight (gm)	Slope B	SE Slope	Intercept A	SE Intercept	Sample size	Correlation coefficient	Range in egg number
Arctic char	124-2950	0.76127	0.05359	2.79478	0.36731	41	0.915	474- 8,560
Broad whitefish	1500-4000	0.79371	0.32767	4.71217	2.54645	11	0.628	28,750-103,120
Chum salmon	1445-3290	0.61583	0.20746	2.98393	1.59876	23	0.544	1,260- 3,200
Inconnu	2750-5390	1.30054	0.46383	0.10319	3.79867	9	0.727	21,280- 88,100
Least cisco	191- 738	0.96231	0.20648	4.56891	1.25567	18	0.759	15,000- 76,320

Stomach content information

Figure 17 shows that burbot, pike, and inconnu ate largely other fish as has been observed previously (Chen 1969; Lawler 1965; Alt 1965). The other fish species were less piscivorous and tended to differ from each other in food categories eaten. Salmon stomachs were examined for food, but none contained any.

Food of fish captured in outlying rivers and streams is presented in Appendix Tables 2 to 4. Most of the large Arctic char returning from the sea contained no food (Appendix Table 2). The smaller, stream-resident fish ate large proportions of diptera larvae and adult insects. One population of round whitefish had eaten largely trichoptera as in Figure 17 whereas another population ate largely diptera larvae (Appendix Table 3). The Arctic grayling (Appendix Table 4) frequently ate larger proportions of diptera larvae and adult insects than indicated in Figure 17.

Heavy metal and pesticide content of fish samples

Fish collected from several areas were analyzed for heavy metal and pesticide concentrations. Table 12 presents results of heavy metal analyses. In British Columbia, there is great variability in heavy metal concentration among various lakes and even among fish from the same lake (Peterson *et al.* 1970). The minimum concentrations (ppm wet weight of liver tissue) that Peterson *et al.* (1970) consider anomalous are: 80 ppm for copper, 40 ppm for zinc, and 1.2 ppm for lead.

The values obtained (Table 12) are well below these anomalous values for copper and lead but approach the anomalous value for zinc. Both of the least cisco from the Old Crow River had livers with unusually high levels (200 and 77 ppm) of zinc. High levels of zinc were also observed by Hatfield, *et al.* (1972) who conclude that they are natural in origin.

The overall average mercury concentration is 0.084 ppm, including one high value of 0.5 ppm in an inconnu (Table 12). The average is much lower than the average value (0.42 ppm) from 85 fish of various species from various British Columbia lakes and rivers (Peterson *et al.* 1970).

Pesticide analyses (H. Epoxide, DDE, Dieldrin, DDD, op DDT, and DDT) were performed on muscle samples of 14 fish from various streams. Only one fish had any detectable chlorinated hydrocarbon residue (Table 12). This fish, a grayling from the Fishing Branch River, contained 0.02 ppm DDE. Grayling in the Fishing Branch River eat large numbers of salmon eggs, so could concentrate any pesticide residue present in the salmon. In the Lower Mainland of British Columbia, the average total DDT concentration in freshwater species is approximately 0.7 ppm; fish from the Okanagan region have

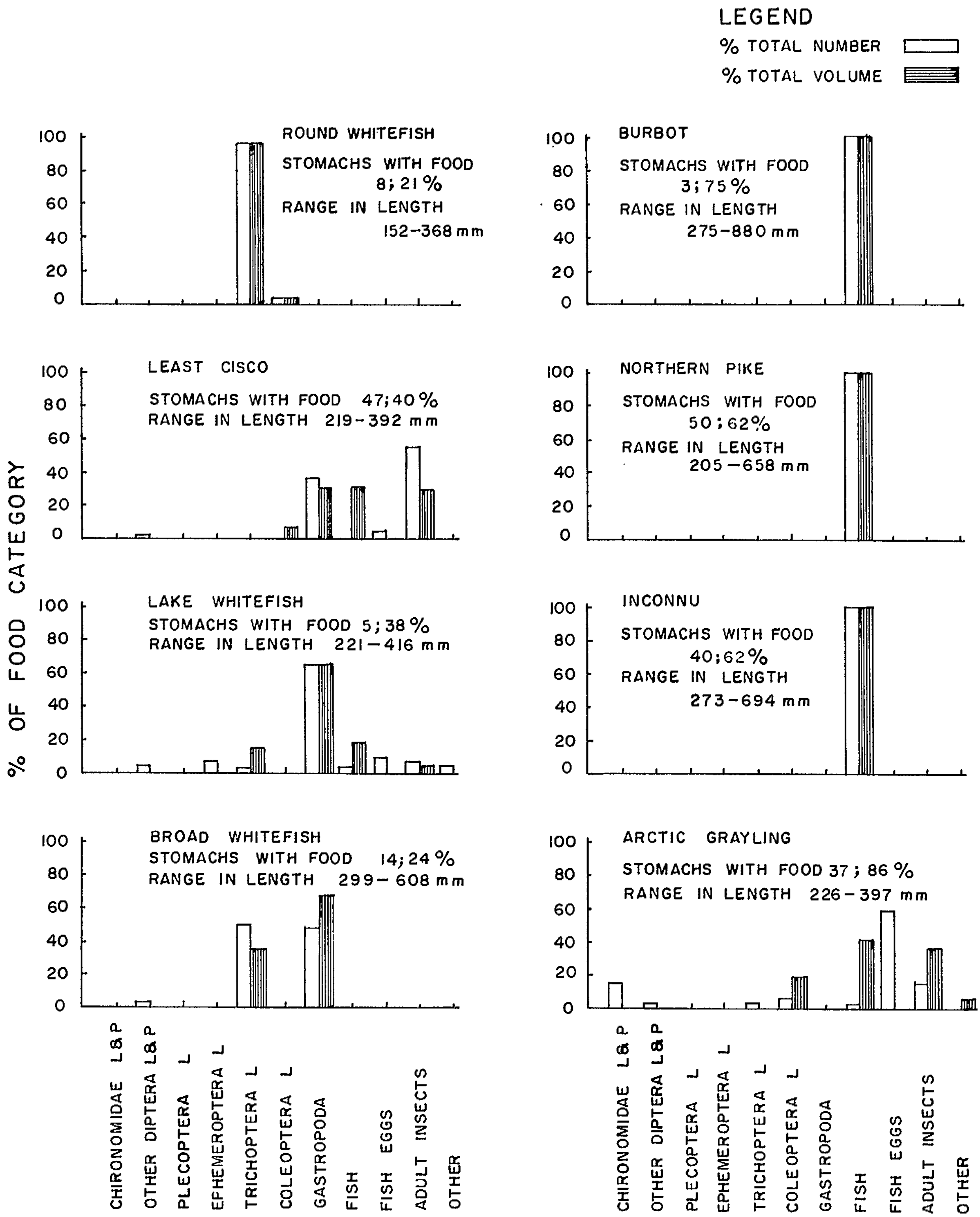

Figure 17. Food eaten by different fish species caught in gill nets set near Old Crow July 24 to September 8, 1971. The number of stomachs containing food is indicated as well as the percentage of the total number of stomachs examined for food. L indicates larva and P indicates pupa.

Table 12. Average concentrations (ppm wet weight of fish) of some heavy metals and/or pesticide residue in tissues of fish captured in the northern Yukon Territory, 1971. The concentrations of lead, molybdenum, cobalt, and nickel were too low for detection (< 0.1 ppm).

River	No. of fish	Species	Range in fork length	Tissue sampled	Cadmium	Copper	Manganese	Zinc	Mercury	Total DDE
No.11200	3	Broad whitefish	298-406 mm	Liver	0.20	5.4	2.6	37.3		
				Muscle	0.12	0.4	0.8	0.8		
Firth R.	5	Arctic char	457-635 mm	Liver	0.18	6.8	2.5	24.3		
				Muscle	0.08	0.5	0.3	5.7		
Fish Creek	2	Arctic char	216-244 mm	Liver						
				Muscle					0.02	0.00
Firth R.	3	Arctic grayling	368-432 mm	Liver	0.17	3.6	2.6	28.6		
				Muscle	0.10	1.0	1.3	29.0		
Old Crow River	2	Arctic grayling	308-317 mm	Liver	0.12	2.2	1.6	20.5		
				Muscle	0.04	0.5	0.4	3.6	0.06	0.00
Fishing Branch R.	2	Arctic grayling	362-419 mm	Liver	0.16	4.6	1.2	19.5		
				Muscle	0.04	0.6	0.2	4.2	0.10	0.01
Fish Hole Cr.	2	Arctic grayling	244-247 mm	Liver						
				Muscle	0.10	0.4	0.6	10.0	0.02	0.00
Old Crow R.	2	Least cisco	286-292 mm	Liver	0.08	7.8	1.8	138.		
				Muscle	0.04	0.6	0.2	3.4	0.04	0.00
Old Crow River	2	Northern pike	317-457 mm	Liver	0.08	3.8	1.4	24.		
				Muscle	0.08	0.6	0.2	4.8	0.07	0.00
Old Crow River	2	Inconnu	457-654 mm	Liver	0.10	7.9	1.3	15.0		
				Muscle	.08	0.8	0.2	3.1	0.28	0.00

up to 50 ppm concentration (W. Sargent, personal communication). Concentrations of total DDT from approximately 35 fish of six species of Atlantic marine fishes averaged 0.26 ppm (Sprague and Duffy, 1971). Thus the pesticide residues in fish of the northern Yukon Territory are much lower than those found in more developed areas.

USE OF FISHERY RESOURCES

At present, most fish caught in both the Porcupine and Beaufort drainages are harvested in subsistence fisheries. Nearly all fishing in the Porcupine River is carried out by the residents of Old Crow. Discussions with them and casual observation of their catches indicate that their harvest of salmon (mainly chum salmon) was about 10,000 fish in 1971. Their harvest of all resident freshwater species combined was approximately 3,000 fish. There are conflicting reports about whether the 1971 harvests of salmon and freshwater species were typical. The only subsistence fishing which was observed in the coastal area was in salt water near Herschel Island. Two Eskimo families spending the summer and fall on Herschel Island captured about 300 Arctic char and 1,000 cisco (*Coregonus autumnalis* and probably some *C. sardinella*). No other subsistence or commercial fishing along the coast of the Yukon was seen or heard of in 1971.

There were very few sport fishermen in the northern Yukon in 1971. Some residents of Old Crow fished for recreation, particularly at the junction of Lord Creek and the Porcupine River. Other recreational fishing was performed by members of various survey crews passing through the Yukon.

There is little information about the fishery potential of the area. However, it is very likely that the recreational and subsistence fisheries could be considerably expanded without decreasing fish production. Many areas have good potential for recreational fisheries on grayling. Coastal rivers and streams from the Babbage system west have good potential for Arctic char fishing. Recreational fishery development could be encouraged in places where it would not conflict with established subsistence fisheries.

The only fishery which seems likely to have good commercial possibilities is an expanded chum salmon fishery in the Porcupine drainage. Salmon flesh might be marketed as a dried or smoked product. Salmon eggs might be treated with brine and sold in specialty markets. To establish the feasibility of this project, information about the size of the run in several successive years is required as well as studies of economic feasibility.

Surveys in 1955 to 1958 indicated that the commercial fishery potential along the Yukon Coast is marginal, J.G. Hunter (personal communication). This conclusion seems to have been substantiated by Menzies Fish Company which terminated operations after two years of fishing in the area. Information is lacking about whether the commercial fishing venture failed only because of insufficient fish stocks. The following table shows the weight (kg) of fish harvested by Menzies.

		Year	
Kind of Fish	Location	1965	1966
Whitefish	Mackenzie delta	9,050	24,500
Arctic char	Mackenzie delta	-	91
Arctic char	Herschel Island	7,300	545

CONCLUSIONS

This report has presented information about fish, macroinvertebrates, and periphyton present in rivers and streams of the northern Yukon in 1971. This information will serve as part of a baseline for detecting environmental change. The information is also valuable for management of the fishery resources. Most important, the information can be used to compare the probable effects of pipeline development in different areas. The following section makes such a comparison and lists rivers where special crossing precautions are necessary.

Pipeline route feasibility

Two principal routes across the northern Yukon have been proposed by companies planning natural gas piplines. Both would begin at Prudhoe Bay, Alaska and transport gas to the Mackenzie River valley. One route parallels the coast, and the other parallels the Porcupine River valley along the north side (Figure 1).

The coastal route seems preferable from the standpoint of potential damage to fishery resources in Yukon Territory. In the coastal rivers and streams, most spawning and overwintering habitat occurs upstream of the 200 ft (60 m) elevation. If a pipeline were to cross streams below this elevation, it appears that there would be little permanent damage to fishery resources. Recreational fishing potential along the coastal route is very good. Moreover, recreational fishing would not seriously conflict with subsistence fishing. Residents of Old Crow sometimes fish for char in the Firth River and the Babbage system during the winter. However, this fishery is not very important to them. As recreational fishing would not affect the catch of cisco, there would be little conflict with the small, coastal subsistence fishery. However, in choosing the route which will minimize damage to fishery resources, the potential damage in Alaska and Northwest Territories should be considered as well as potential damage in Yukon Territory.

Along such a coastal route, most of the river crossings could probably be completed in the winter without damage to fishery resources. If Fish Creek (69:37; 149:07) were crossed, however, summer crossing and other special precautions would be necessary to preserve its char population. A preliminary list of precautions was outlined by Bryan (1973). Depending upon the proposed locations, similar precautions might be required for crossing the Firth and Malcolm Rivers. Fish Hole Creek (Canoe River, 68:47; 138:45) should be avoided as it seems to be the main spawning site for char in the Babbage system.

There is insufficient information to estimate the potential damage to fishery resources along the Porcupine River. The most serious gap in available knowledge is a lack of information about the spawning areas of whitefish (particularly inconnu, broad whitefish, and least cisco). All of the species spawn in the fall, some of them presumably under the ice. It is not known whether they spawn in the main-stem of the Porcupine, in tributary streams, or in both. Neither is it known whether spawning occurs in many different locations or only in one or two places.

The available information about whitefish spawning areas implies that there may be very few of them within a river system. Descriptions presented by Alt (1969) suggest that there are very few inconnu spawning areas in a river. Chum salmon were found spawning only in one short section of the Fishing Branch River (Figure 1). For species with only a few spawning areas, damage to these areas could greatly reduce population size and possibly eliminate species.

The main-stem of the Porcupine River is a major overwintering area for all freshwater species in the system. As a result, sedimentation during winter construction might kill considerable numbers of fish. To prevent mortality, major tributaries of the Porcupine should be crossed carefully, and the sediment concentrations should be continuously monitored. Particularly if whitefish spawning grounds are found downstream of a pipeline route, special precautions must be taken to avoid increased sedimentation from erosion of the pipeline right-of-way; otherwise, spawning area might be permanently destroyed. Additional information about route feasibility has been presented previously (Bryan, 1973).

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APPENDIX

Appendix Table 1. Genera of periphyton collected in rivers and streams of the northern Yukon Territory in 1971. (P=present, C=common, D=dominant, and C-D=co-dominant).

River or Creek	Babbage R.	Bell R.	Bell R.	Bluefish R.	Bluefish R.	Cody Cr.
Dist. from mouth (km)	13	138	193	84	6	35
Location (lat. & long. in deg. & min.)	69:10 138:15	67:44 136:50	68:03 137:00	67:03 140:35	67:28 140:14	66:36 138:55
Day/month	11/8	30/8	24/8	26/8	26/8	2/9
Achnanthes	-	P	-	-	P	P
Amphiprora	-	-	-	-	-	
Amphora	-	-	P	P	-	P
Anomoeneis	-	-	-	-	-	P
Asterionella	C	-	-	-	-	-
Cladophora	-	-	-	-	-	-
Closterium	-	-	P	-	-	-
Cocconeis	-	-	P	-	-	P
Cosmarium	-	P	-	-	-	P
Cyclotella	-	-	-	-	P	-
Cymbella	-	-	P	-	-	P
Diatoma	-	P	P	-	P	P
Fragilaria	-	-	P	-	P	-
Gomphonema	-	P	-	-	P	P
Gyrosigma	-	-	-	-	P	-
Hannaea	C	P	C	-	C-D	-
Heiniochrysis	-	-	D	-	-	-
Lyngbya	-	-	P	-	-	-
Mougeotia	-	P	-	-	P	P
Meridion	-	P	P	-	-	P
Melosira	-	-	-	-	P	-
Nitzschia	C	P	-	-	P	P
Navicula	-	P	-	-	P	P
Oedogonium	-	-	P	-	-	-
Oscillatoria	-	-	-	-	-	-
Pinnularia	-	-	-	-	-	-
Phormidium	-	-	-	-	-	-
Synedra	D	D	P	-	C-D	D
Spirogyra	-	P	-	-	-	-
Surirella	-	-	-	-	P	-
Tabellaria	C	C	-	-	C	C
Ulothrix	-	-	P	-	-	-
Zygnema	-	-	-	-	-	-

Appendix Table 1 continued. Genera of periphyton collected in rivers and streams of the northern Yukon Territory in 1971. (P=present, C=common, D=dominant, and C-D=co-dominant).

River or Creek	Driftwood R.	Firth R.	Fish Cr.	Fish Hole Cr.	Lord Cr.	Malcolm R.
Dist. from mouth (km)	3	83	8	193	56	34
Location (lat. & long. in deg. & min.)	67:34 138:29	69:02 140:29	69:33 140:05	68:39 138:42	67:10 139:36	69:20 140:07
Day/month	27/8	4/8	27/7	6/8	8/25	12/8
Achnanthes	P	-	-	P	P	-
Amphiprora	-	-	-	-	-	-
Amphora	P	-	P	P	-	P
Anomoeneis	-	-	-	-	-	-
Asterionella	-	-	-	-	-	-
Cladophora	-	-	-	-	-	-
Closterium	-	-	-	-	P	-
Cocconeis	-	-	-	-	-	-
Cosmarium	-	-	-	-	P	-
Cyclotella	-	-	-	-	-	-
Cymbella	P	-	-	P	-	P
Diatoma	-	P	-	-	P	-
Fragilaria	-	-	C	D	D	-
Gomphonema	P	-	C-D	C	P	-
Gyrosigma	-	-	-	-	-	-
Hannaea	C-D	P	C-D	P	P	P
Heiniochrysis	-	-	-	-	-	-
Lyngbya	-	-	-	-	-	-
Mougeotia	P	-	-	P	-	-
Meridion	-	-	-	-	C	-
Melosira	-	-	-	-	-	-
Nitzschia	P	-	-	P	-	P
Navicula	P	-	-	P	P	-
Oedogonium	-	-	-	-	-	-
Oscillatoria	-	-	-	-	-	D
Pinnularia	-	-	-	-	-	-
Phormidium	P	-	-	-	-	-
Synedra	C-D	P	P	P	C	P
Spirogyra	-	-	-	-	-	-
Surirella	-	-	-	-	-	-
Tabellaria	P	-	-	-	-	-
Ulothrix	-	-	-	-	-	-
Zygnema	-	-	-	-	-	C

Appendix Table 1 continued. Genera of periphyton collected in rivers and streams of the northern Yukon Territory in 1971. (P=present, C=common, D-dominant, and C-D=co-dominant).

River or Creek	Malcolm R.	Miner R.	No.11200 Cr.	Old Crow R.	Rock R.
Dist. from mouth (km)	27	56	6	6	64
Location (lat. & long. in deg. & min.)	69:23 140:03	66:09 138:52	69:21 139:02	67:37 139:35	66:59 136:44
Day/month	29/7	5/9	3/8	5/8	30/8
Achnanthes	-	-	D	-	-
Amphiprora	-	-	-	P	-
Amphora	P	P	P	P	P
Anomoeneis	-	-	-	-	-
Asterionella	-	-	-	-	-
Cladophora	-	-	D	-	-
Closterium	-	P	-	-	P
Cocconeis	-	P	-	-	-
Cosmarium	-	-	-	-	-
Cyclotella	-	-	-	-	-
Cymbella	C	P	P	-	P
Diatoma	-	C	P	-	P
Fragilaria	-	-	-	-	-
Gomphonema	-	P	P	-	P
Gyrosigma	-	-	-	-	-
Hannaea	C-D	C	-	-	C
Heiniochrysis	-	-	-	-	-
Lyngbya	-	-	-	-	P
Mougeotia	-	P	-	-	-
Meridion	-	C	-	-	-
Melosira	-	-	-	P	-
Nitzschia	P	P	P	P	P
Navicula	P	P	P	P	-
Oedogonium	-	-	-	-	-
Oscillatoria	-	-	-	-	-
Pinnularia	-	-	P	-	-
Phormidium	-	-	-	-	-
Synedra	C-D	D	C	P	D
Spirogyra	-	-	-	-	-
Surirella	-	-	P	P	-
Tabellaria	-	-	P	-	P
Ulothrix	-	-	-	-	-
Zygnema	P	-	-	-	-

Appendix Table 1 continued. Genera of periphyton collected in rivers and streams of the northern Yukon Territory in 1971. (P=present, C=common, D=dominant, and C-D=co-dominant).

River or Creek	Running R.	Whitestone R.
Dist. from mouth (km)	8	32
Location (lat. & long. in deg. & min.)	68:54 137:20	66:23 138:32
Day/month	8/8	5/9
Achnanthes	-	-
Amphiprora	-	-
Amphora	P	-
Anomoeneis	-	-
Asterionella	-	-
Cladophora	-	-
Closterium	-	-
Cocconeis	-	-
Cosmarium	P	-
Cyclotella	-	-
Cymbella	P	-
Diatoma	P	P
Fragilaria	P	-
Gomphonema	-	-
Gyrosigma	-	-
Hannaea	P	-
Heiniochrysis	-	-
Lyngbya	-	-
Mougeotia	-	P
Meridion	-	-
Melosira	C	-
Nitzschia	P	-
Navicula	-	P
Oedogonium	-	-
Oscillatoria	-	-
Pinnularia	-	-
Phormidium	-	-
Synedra	P	P
Spirogyra	P	-
Surirella	-	-
Tabellaria	D	-
Ulothrix	-	-
Zygnema	-	-

Appendix Table 2. Food eaten by all Arctic char captured on a particular day at a particular location in 1971. For each food category, both the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Babbage R.	Big Fish R.	Firth R.	Firth R.	Firth R.
Location (Lat. and long. in deg. and min.)		68:44 139:02	68:26 136:32	69:26 139:31	68:53 140:25	68:53 140:25
Day/month		11/8	3/9	31/7	30/7	4/8
Time		1300	1200	1130	1445	-
Stomachs with food	No.	5	1	1	8	5
	%	50	100	25	35	50
Range in fork length (mm)	Min.	198	121	418	424	441
	Max.	504	121	492	720	632
Chironomidae	N	76.7	2.5		32.8	16.7
	V	1.3	0.0		11.6	11.7
Other Diptera	N	7.9	5.0		51.6	16.7
	V	0.2	36.4		30.8	13.4
Plecoptera	N	2.4	62.5		7.2	19.1
	V	0.0	36.4		8.2	13.0
Ephemeroptera	N		30.0		5.6	21.5
	V		27.3		8.2	21.7
Trichoptera	N					
	V					
Coleoptera	N	0.8				
	V	0.1				
Hydracarina	N					
	V					
Amphipoda	N					
	V					
Gastropoda	N					
	V					
Fish	N	0.4		100		
	V	96.4		100		
Fish eggs	N	2.0				
	V	0.0				
Adult insects	N	9.8			2.8	26.0
	V	1.9			41.1	40.1
Total	N	254	40	1	525	419
	V	25.9	0.2	0.2	1.46	3.0

Appendix Table 2 continued. Food eaten by all Arctic char captured on a particular day at a particular location in 1971. For each food category, both the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Fish Cr.	Fish Hole Cr.	Malcolm R.
Location (Lat. and long. in deg. and min.)		69:33 140:05	68:39 138:42	69:26 139:58
Day/month		27/7	10/8	12/8
Time		1030	1515	1130
Stomachs with food	No.	11	2	5
	%	92	9	100
Range in fork length (mm)	Min.	212	451	99
	Max.	330	593	158
Chironomidae	N	29.5	77.8	43.8
	V	4.0	23.1	21.7
Other Diptera	N	8.6		23.6
	V	31.3		60.9
Plecoptera	N	16.8		21.5
	V	11.5		8.7
Ephemeroptera	N	2.1		6.0
	V	2.4		8.7
Trichoptera	N			
	V			
Coleoptera	N	0.3		
	V	0.9		
Hydracarina	N	0.4		4.7
	V	0.0		0.0
Amphipoda	N	21.1		0.4
	V	3.4		0.0
Gastropoda	N			
	V			
Fish	N		22.2	
	V		76.9	
Fish eggs	N			
	V			
Adult insects	N	21.1		
	V	46.4		
Total	N	1187	9	233
	V	8.8	1.9	0.2

Appendix Table 3. Food eaten by whitefish captured in the synoptic survey at different locations and times in 1971. For each food category, the per cent by number (N) and per cent by volume (V) are indicated.

		Broad whitefish	Round whitefish	
River or creek		Blow R.	Cody Cr.	Driftwood R.
Location (Lat. and long. in deg. and min.)		68:44 137:25	66:36 138:55	67:57 137:48
Day/month		6/8	2/8	24/8
Time		1500	1100	1315
Stomachs with food	No.	3	4	9
	%	100	100	90
Range in fork length (mm)	Min.	163	175	253
	Max.	235	205	374
Chironomidae	N	64.7		75.8
	V	7:2		73.0
Other Diptera	N	30.2		0.7
	V	87.3		0.1
Plecoptera	N	2.6		
	V	0.0		
Ephemeroptera	N			
	V			
Trichoptera	N	0.9	100	24.1
	V	1.8	100	26.9
Coleoptera	N			
	V			
Hydracarina	N			
	V			
Amphipoda	N			
	V			
Gastropoda	N			
	V			
Fish	N			
	V			
Fish eggs	N			
	V			
Adult insects	N	1.7		
	V	3.6		
Total	N	116	54	1451
	V	0.6	1.0	13.0

Appendix Table 4. Food eaten by Arctic grayling captured in the synoptic survey at different locations and times in 1971. For each food category, the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Anker Cr.	Babbage R.	Babbage R.	Berry Cr.	Big Fish R.
Location (Lat. and long. in deg. and min.)		68:38 137:59	68:44 139:02	68:41 139:08	67:33 137:53	68:26 136:32
Day/month		19/8	11/8	11/8	27/8	3/9
Time		1430	1300	1200	1530	1230
Stomachs with food	No.	3	11	2	3	3
	%	100	100	100	100	100
Range in fork length (mm)	Min.	323	224	360	316	124
	Max.	388	366	384	475	129
Chironomidae	N	42.3	67.1	55.8		3.0
	V	4.5	13.7	6.1		0.4
Other Diptera	N	26.1	18.2	35.2	0.9	0.4
	V	82.5	40.8	32.8	0.5	0.4
Plecoptera	N	15.7	6.8	6.7		3.0
	V	2.9	3.2	0.4		0.4
Ephemeroptera	N	2.9	0.3			2.0
	V	0.4	0.4			0.4
Trichoptera	N	0.4			30.9	0.2
	V	7.8			26.4	0.4
Coleoptera	N	0.2	0.7		15.5	0.4
	V	0.2	17.6		68.8	0.8
Hydracarina	N			0.9	41.8	
	V			0.0	1.1	
Amphipoda	N					
	V					
Gastropoda	N				1.7	
	V				2.1	
Fish	N			0.2		
	V			60.7		
Fish eggs	N					
	V					
Adult insects	N	12.1	6.6	1.1	9.1	90.9
	V	1.7	24.3	0.0	1.1	97.3
Total	N	414	760	448	110	495
	V	5.2	2.84	7.2	1.9	2.6

Appendix Table 4 continued. Food eaten by Arctic grayling captured in the synoptic survey at different locations and times in 1971. For each food category, the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Big Fish R.	Blow R.	Blow R.	Blow R.	Blow R.	Bluefish R.
Location (Lat. and long. in deg. and min.)		68:21 136:41	68:44 137:25	68:44 137:25	68:25 137:41	68:26 137:50	67:19 140:29
Day/month		3/9	6/8	19/8	9/8	9/8	26/8
Time		1415	1300	1200	1300	1415	1145
Stomachs with food	No.	23	2	7	3	1	2
	%	100	100	100	100	100	100
Range in fork length (mm)	Min.	139	230	105	222	192	241
	Max.	288	355	302	353	192	370
Chironomidae	N	0.8	42.5	30.5	61.1	33.2	0.9
	V	0.2	1.9	1.9	8.5	1.4	0.0
Other Diptera	N	0.4	36.2	2.5	27.1	12.8	0.5
	V	6.8	65.4	18.8	46.5	16.2	1.4
Plecoptera	N	0.3	10.6	10.2	4.9	3.7	
	V	0.1	0.9	3.8	1.5	1.4	
Ephemeroptera	N		3.2	15.2	1.2	1.4	
	V		0.9	5.7	0.2	0.7	
Trichoptera	N	0.4		1.0	1.8		0.9
	V	14.0		20.1	42.3		1.1
Coleoptera	N	0.0		3.0		3.3	5.5
	V	0.1		6.3		4.2	4.3
Hydracarina	N			2.0			
	V			0.0			
Amphipoda	N						
	V						
Gastropoda	N						0.5
	V						6.8
Fish	N					0.4	
	V					47.2	
Fish eggs	N						
	V						
Adult insects	N	98.0	7.4	35.5	3.1	45.5	91.7
	V	78.8	31.8	43.4	1.1	28.9	86.3
Total	N	3060	94	197	819	219	218
	V	22.8	1.1	1.6	4.73	1.42	2.8

Appendix Table 4 continued. Food eaten by Arctic grayling captured in the synoptic survey at different locations and times in 1971. For each food category, the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Caribou Bar Cr.	Cody Cr.	Crow R.	Driftwood R.	Driftwood R.
Location (Lat. and long. in deg. and min.)		67:30 140:35	66:36 138:55	69:07 138:32	67:34 138:29	67:57 137:48
Day/month		26/8	2/9	18/8	27/8	24/8
Time		1000	1100	1545	1000	1115
Stomachs with food	No.	6	3	9	6	25
	%	100	100	100	100	100
Range in fork length (mm)	Min.	107	111	309	312	243
	Max.	364	136	364	396	318
Chironomidae	N	1.6		51.4		66.1
	V	0.0		6.0		5.3
Other Diptera	N			13.1		2.5
	V			6.3		9.0
Plecoptera	N			2.6	1.0	0.9
	V			0.1	0.0	0.1
Ephemeroptera	N					1.4
	V					0.2
Trichoptera	N	40.3	82.0	2.8	63.1	2.8
	V	13.2	85.7	13.2	49.8	54.4
Coleoptera	N	11.3		1.9	7.8	0.2
	V	29.6		6.2	5.1	0.4
Hydracarina	N					6.3
	V					0.6
Amphipoda	N					0.8
	V					0.1
Gastropoda	N					
	V					
Fish	N		1.6	0.2	1.0	0.0
	V		7.1	61.5	42.2	5.8
Fish eggs	N					3.1
	V					0.7
Adult insects	N	46.8	16.4	28.1	27.1	15.7
	V	57.1	7.1	6.7	2.9	23.4
Total	N	124	61	534	104	3178
	V	1.9	0.7	41.0	15.1	17.1

Appendix Table 4 continued. Food eaten by Arctic grayling captured in the synoptic survey at different locations and times in 1971. For each food category, the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Firth R.	Firth R.	Fish Hole Cr.	Fishing Branch R.	Fishing Branch R.
Location (Lat. and long. in deg. and min.)		69:26 139:31	68:53 140:25	68:35 138:42	66:36 139:33	66:32 139:21
Day/month		31/7	30/7	10/8	1/9	9/9
Time		1130	1445	1300	1415	1730
Stomachs with food	No.	2	2	31	3	15
	%	100	100	100	100	100
Range in fork length (mm)	Min.	346	338	201	152	294
	Max.	390	354	361	315	394
Chironomidae	N	1.4	37.7	74.5	2.9	28.3
	V	0.0	35.1	64.8	3.6	0.2
Other Diptera	N	37.3	45.7	0.9		1.7
	V	68.0	53.9	0.6		0.1
Plecoptera	N	22.7	5.5	0.8		2.5
	V	8.7	0.9	0.3		0.1
Ephemeroptera	N	14.2	7.8	0.8		
	V	11.6	2.2	0.2		
Trichoptera	N				28.6	1.2
	V				17.9	0.2
Coleoptera	N		0.2	0.4	5.7	
	V		1.1	4.0	3.6	
Hydracarina	N			0.6		1.2
	V			0.0		0.2
Amphipoda	N	0.9	0.2	4.1		0.7
	V	0.0	0.0	6.1		0.0
Gastropoda	N					
	V					
Fish	N					0.2
	V					44.5
Fish eggs	N					14.7
	V					45.5
Adult insects	N	24.4	2.8	17.8	62.9	49.5
	V	11.6	6.7	24.1	75.0	9.2
Total	N	352	901	4830	35	407
	V	1.7	4.4	25.3	0.6	22.0

Appendix Table 4 continued. Food eaten by Arctic grayling captured in the synoptic survey at different locations and times in 1971. For each food category, the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Johnson Cr.	Johnson Cr.	Johnson Cr.	Johnson Cr.	Lord Cr.
Location (Lat. and long. in deg. and min.)		67:59 138:54	68:08 138:32	67:17 138:50	67:06 138:15	67:31 139:07
Day/month		29/8	29/8	25/8	25/8	25/8
Time		1100	1230	1130	1315	0815
Stomachs with food	No.	2	5	12	1	4
	%	100	100	100	100	100
Range in fork length (mm)	Min.	350	327	89	298	236
	Max.	403	351	320	298	367
Chironomidae	N	3.3		4.4		29.0
	V	0.0		0.0		0.4
Other Diptera	N	6.6	9.0	1.7	3.1	1.1
	V	4.2	6.9	0.4	0.0	1.1
Plecoptera	N			2.3		
	V			0.0		
Ephemeroptera	N			0.6		
	V			0.0		
Trichoptera	N	84.6	20.7	55.6		7.6
	V	95.5	80.0	72.7		1.2
Coleoptera	N		1.3	1.1	22.2	1.1
	V		0.4	0.0	11.7	0.0
Hydracarina	N		4.3	1.6	9.4	6.5
	V		0.1	0.0	0.0	0.0
Amphipoda	N			0.6		
	V			0.0		
Gastropoda	N	2.0			12.5	
	V	0.2			6.7	
Fish	N			0.6	3.1	1.1
	V			23.4	70.8	84.6
Fish eggs	N					
	V					
Adult insects	N	3.3	64.6	31.6	50.0	53.8
	V	0.2	12.5	3.4	10.8	12.7
Total	N	150	23	180	32	93
	V	6.2	15.3	21.3	1.20	4.7

Appendix Table 4 continued. Food eaten by Arctic grayling captured in the synoptic survey at different locations and times in 1971. For each food category, the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Lord Cr.	Pine Cr.	Rapid Cr.	Rat R.	Running R.
Location (Lat. and long. in deg. and min.)		67:10 139:36	66:57 138:33	68:26 137:13	67:21 136:46	68:54 137:20
Day/month		25/8	25/8	7/8	30/8	8/8
Time		1000	1430	1200	1400	1100
Stomachs with food	No.	1	10	19	8	8
	%	100	100	100	100	100
Range in fork length (mm)	Min.	144	204	129	351	123
	Max.	144	344	371	406	266
Chironomidae	N		5.1	30.3	11.6	9.1
	V		0.2	10.3	6.3	0.2
Other Diptera	N		0.3	33.5	10.1	41.1
	V		0.2	53.7	4.8	79.8
Plecoptera	N		3.4	18.5	29.0	4.6
	V		0.2	4.9	12.6	0.2
Ephemeroptera	N		10.1	12.9	24.2	2.3
	V		0.4	3.3	15.2	0.2
Trichoptera	N	88.5	25.9	0.5	0.6	1.4
	V	100.0	56.4	8.9	32.8	12.6
Coleoptera	N		3.4	0.7	0.4	
	V		14.0	2.1	1.8	
Hydracarina	N	3.8	1.0			
	V	0.0	0.0			
Amphipoda	N	7.7				32.0
	V	0.0				2.4
Gastropoda	N					
	V					
Fish	N		0.3	0.1		
	V		11.9	10.3		
Fish eggs	N					
	V					
Adult insects	N		50.5	3.7	24.2	9.1
	V		16.7	6.5	26.5	4.7
Total	N	26	297	1355	1035	219
	V	0.4	4.79	14.6	3.96	6.4

Appendix Table 4 continued. Food eaten by Arctic grayling captured in the synoptic survey at different locations and times in 1971. For each food category, the per cent by number (N) and per cent by volume (V) are indicated.

River or creek		Thomas Cr.	Trail R.	Trail R.	Whitestone R.
Location (Lat. and long. in deg. and min.)		68:22 140:45	69:01 138:34	68:50 139:13	66:23 138:32
Day/month		26/8	18/8	18/8	5/9
Time		1245	0915	1230	1430
Stomachs with food	No.	5	2	6	1
	%	100	100	100	100
Range in fork length (mm)	Min.	230	322	111	236
	Max.	260	327	276	236
Chironomidae	N	2.6	3.4	11.1	25.0
	V	0.0	0.1	1.8	7.7
Other Diptera	N	0.4	6.5	5.0	
	V	0.3	2.2	13.0	
Plecoptera	N		0.5	20.2	
	V		0.0	7.2	
Ephemeroptera	N			18.4	
	V			4.8	
Trichoptera	N	6.1	9.2	3.7	50.0
	V	68.4	44.7	55.5	15.4
Coleoptera	N	1.3	2.4	0.5	
	V	1.0	0.1	0.4	
Hydracarina	N			0.7	
	V			0.0	
Amphipoda	N	2.2	4.7	3.7	
	V	0.0	0.1	0.2	
Gastropoda	N				
	V				
Fish	N				25.0
	V				76.9
Fish eggs	N				
	V				
Adult insects	N	87.3	73.3	36.7	
	V	30.4	52.7	16.9	
Total	N	229	382	817	4
	V	4.0	6.8	8.3	0.13

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