Fishes of the Yukon Coast

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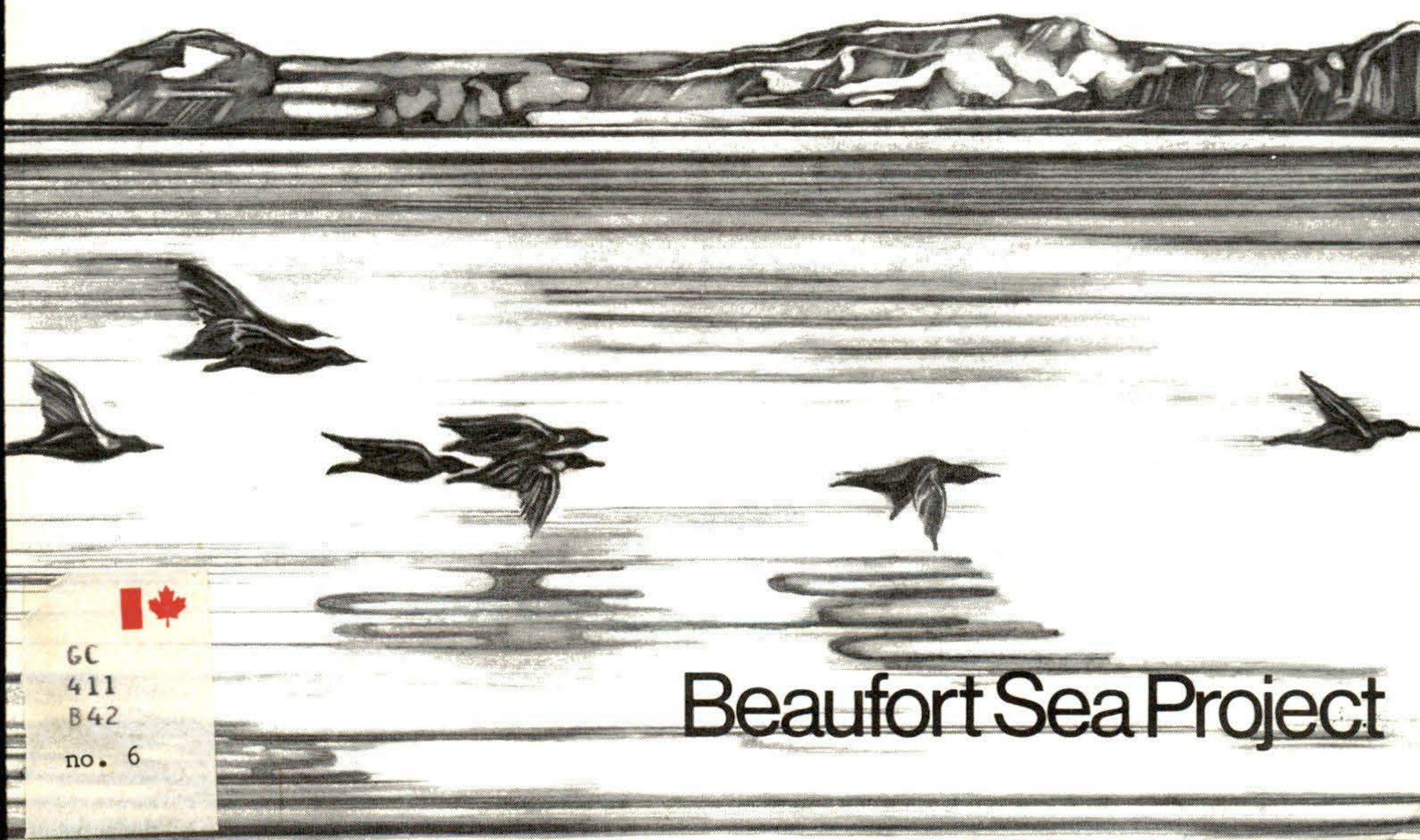

Beaufort Sea Project

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1.0 SUMMARY

The purpose of this study was to collect baseline information regarding the inshore fisheries resource and the aquatic environment of the western coastal Beaufort Sea, and to identify areas that could be critically affected by a major oil spill.

We present data collected from April 1974 to September 1975. The study area included the coastal sea out to 7 km offshore, lagoons, bays and estuaries, bounded by the Blow River delta on the east and by Welles Point, Herschel Island, on the northwest.

Of 21 species of fish recorded within the study area 6 species represented 95% of the total catch in 1974. These were least cisco (*Coregonus sardinella*), Arctic cisco (*Coregonus autumnalis*), Arctic char (*Salvelinus alpinus*), fourhorn sculpin (*Myoxocephalus quadricornis quadricornis*), boreal smelt (*Osmerus eperlanus*), and humpback or lake whitefish (*Coregonus clupeaformis*). Of these only the fourhorn sculpin is considered a marine species, the remainder being anadromous species.

The Mackenzie River is thought to be the major contributor to coastal fish populations. This is indicated by the relatively high abundance of anadromous species in the east, excluding Arctic char. Tag recovery data helps to confirm this for Arctic cisco.

Seasonal movements of the anadromous species can be generalized as an upstream migration of mature individuals into river systems prior to spawning time and a subsequent downstream post-spawning migration to coastal waters. Fry spend variable amounts of time in the river systems before moving down to deltas and coastal waters.

The movements of marine species are not clear, however, there are indications of migrations of some species into sheltered coastal waters at the time of spawning.

The areas of highest density and species diversification were Mackenzie Bay and Phillips Bay. Along the open coast and to a lesser degree inside bays and lagoons fish were noticeably shore-oriented. In most cases nets set nearshore caught fish while those set offshore were either empty or showed reduced catches.

Some of the life history information is presented along with a discussion of the available literature for each species. Age-length relationships, sex ratios and age at maturity are also presented for the most common species.

The feeding habits of coastal fishes vary both with species and area. Crustaceans, insects, other fish, pelecypods and miscellaneous items comprised the diet of most fishes, however, some species such as fourhorn sculpin and inconnu appeared to be more selective. Generally, increased feeding activity, as indicated by lower incidences of empty stomachs occurred in adult fish west of Kay Point. Fry, on the other hand, fed more extensively throughout most of the regions of capture, utilizing the smaller forms and life stages of crustaceans and insects.

Results from chemical and physical measurements show an extremely complex system. Surface and nearshore waters are fresh to brackish with temperatures above 10^{0}C during the summer months.

Some concerns related to offshore drilling and the potential effects of an oil spill on the fisheries resources of the study area are discussed. Of foremost concern is the apparent lack of knowledge pertaining to the behaviour of oil under ice, the direct and indirect effects of crude oil on the aquatic resources and the efficiency of clean-up techniques for spilled oil in the Arctic environment.

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1.1 ACKNOWLEDGEMENTS

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2.0 INTRODUCTION

The Beaufort Sea Project, a joint government and industry study, was initiated in the spring of 1974. The aim was to acquire sufficient physical, chemical and biological information on the Beaufort Sea in order that the Cabinet be able to rule on the future of offshore exploratory drilling for oil and natural gas. Thirty-one different studies were established to collect the necessary information from the various disciplines.

Commencing in early April 1974, fisheries investigations along the western coastal Beaufort Sea were undertaken in order to inventory the resource. Such background information is necessary to predict the probable magnitude of adverse effects of oil spilled in the area. The information will allow an assessment of the sensitivity of the fishery resource in different areas and its potential value in these areas. This will facilitate recommendations where maximum protection should be provided against contamination by oil or other disruptions.

2.1 Objectives

The objectives of our study were:

(a) to obtain baseline information on the fish stocks, species composition, movements and distribution, relative abundance, growth, maturity, size and sex composition and feeding habits;

(b) to identify biologically critical areas and times relative to the fish-life stages such as migrations, spawning, feeding and over-wintering;

(c) to measure some physical and chemical characteristics of the environment relevant to the fishery resource;

(d) to update information on resource utilization;

(e) to identify factors associated with offshore drilling and related activities which may be detrimental to the fishery resources; and

(f) to recommend measures that will prevent degradation of the environment which may arise from offshore drilling or related activities.

2.2 Some general concerns

The most obvious concern related to offshore exploratory drilling is the possibility of a major oil spill from a well blow out, failure of oil holding facilities or failure of an oil transporting device. Knowledge about the behaviour of oil spilled in open or ice-covered Arctic sea water is scarce. Investigations regarding these problems have been intensified in recent years, but many questions are still open or not yet satisfactorily answered. Adequate clean-up procedures, especially for under ice, do not exist. This point must be emphasized since the western Beaufort Sea is ice-covered for up to eight months of the year. Existing oil removal systems function only under optimum conditions and may be of little value in the fast currents and stormy seas common to the Beaufort Sea. It is probable then, that oil would have the opportunity to invade the aquatic ecosystem over indeterminate periods of time.

Oil entering the aquatic environment can affect fish directly, or indirectly through the food web. Listed below are some effects which might be expected as summarized from Holcomb (1969), Brooks et al. (1971), Sprague (1973) and Evans and Rice (1974):

1. direct mortality of fish and fish food organisms through poisoning, coating and asphyxiation. Of particular concern are the more sensitive early life stages of fish such as eggs, larvae and fry;

2. disruption of normal migratory and spawning behaviour and feeding habits of fish due to avoidance reactions to oil;

3. physiological damage to organisms such as reduced fertility and lowered body resistance to infection and/or the eventual mortality of organisms resulting from prolonged exposures to sub-lethal levels of toxic elements;

4. ingestion of emulsified oil droplets by various filter feeders leading to the progressive concentration of toxic fractions in higher trophic levels, such as fish. The destruction of any one trophic level due to contamination by oil may affect many other populations within the food web;

5. absorption of oil particles onto suspended solids and their subsequent sinking resulting in the formation of an impermeable sludge on the bottom thereby eliminating spawning, rearing and feeding habitat of fish. Sedimented oil particles could be chemically re-introduced into the pelagium by benthic-feeders;

6. incorporation of carcinogenic and potentially mutogenic chemicals in aquatic organisms; and

7. changes in water chemistry through the introduction of water-soluable elements and through the disruption of natural physical and chemical exchange, eg. light and oxygen, which occur at the water/air interface. The natural balance of dissolved gases and nutrients could be further upset by increased demands on them brought about by the biodegradation of the oil.

Some factors which influence the effects of oil on aquatic organisms are:

(a) amount of crude spilled;

(b) location of the spill;

(c) time of year;

(d) distribution of ice vs. open water;

(e) turbidity of the water;

(f) abundance and distribution of faunal elements; and

(g) exposure time to organisms.

From this discussion it is clear that oil spilled in the Beaufort Sea would present a very complex problem of which our understanding is limited. Because lagoons, estuaries and shallow seas tend to be highly productive in comparison to surrounding waters(Haig-Brown 1972), it is in these areas which our primary concerns lie. However,this is not meant to imply that offshore deepwater spills pose little threat; there are numerous transport mechanisms such as wind, currents, tides which could carry spill products into critical areas (McDonald and Lewis 1973; Chen 1972; Sprague 1973).

Oil spills are not the only potential hazard to the fishery resource which will arise with the drive to tap offshore oil reserves. Ancillary activities will include the construction of artificial islands, harbours, staging camps, fuel storage depots, airstrips and roads. These activities may affect the fishery resource by:

(i) disrupting migrations either by physical or chemical barriers;

(ii) eliminating spawning and feeding areas through physical disruption or contamination by pollutants;

(iii) causing mortality from pollutants; and

(iv) causing a decline in populations through increased sport fishing pressure.

3.0 STUDY AREA

The study area is approximately 110 x 15 km along the north coast of the Yukon Territory (Figure 1) lying between Welles Point on the southwest corner of Herschel Island (69° 33' N, 139° 19' W) and the mouth of Blow River (68° 57' N, 137° 06' W). The area includes the coastal sea up to 7 km offshore, lagoons, flood-plain lakes, bays and estuaries.

The coastal waters of the western Beaufort Sea can be subdivided into four major areas by differences in geographical, physical and chemical characteristics. Variations in the biological components of these areas can also be expected due to differences in habitat type. Each of these areas is described.

The Mackenzie River estuary as defined for our study includes the shallow waters of Mackenzie Bay and is bounded by Trent Bay in the east, Sabine Point in the west and follows the 10 m depth contour offshore. The major influence in this area is the Mackenzie River, delivering a continuous supply of fresh water and sediments.

Bays and lagoons are common features of the study area. They are generally shallow bodies of water (1-4 m depth) that are open to the sea only by a small outlet channel through a protective gravel spit. The substrate of these enclosures varies from gravel and sand adjacent to the spit, to gravel, sand and mud in mid-lagoon and mud on inner peripheral areas. Most bays and lagoons receive fresh water from small tundra creeks and from surface run-off during the summer months. In addition, brackish water enters from the sea due to a reverse flow pattern caused by tidal action. The introduction of high salinity water occurs periodically by wash over during storm surges.

Phillips Bay is bounded by Kay Point in the east, the Spring River delta to the west and extends seaward to the 5 m depth contour. This shallow water area is influenced by three coastal rivers - Deep Creek, Babbage River and Spring River. Phillips Bay acts as a sediment sink collecting suspended particles carried by opposing longshore currents. Workboat Passage between the mainland and Herschel Island also acts as a sediment sink. This area is influenced by the discharge of the Firth River (McDonald and Lewis 1973). Waters in these areas are shallow (less than 5 m) and the bottom is composed mainly of silt, mud and organic debris.

The coastal waters between Sabine Point and Kay Point, the Spring River delta and Calton Point, and Osborn Point and Collinson Head on Herschel Island are typified by gravel shores, a relatively narrow band of shallow water, and a pronounced drop-off beyond the 5 m depth contour. The major influences in these unprotected waters are ocean currents, wave action and ice scouring.

The coastal zone is usually ice-free each summer for 3 to 4 months. After break-up melting of ice lenses and extensive surf action results in block-slumping and the retreat of the coastline. Generally, the coastline is protected by a narrow beach, 5 to 20 m in width, consisting of sand and gravel. McDonald and Lewis (1973) measured pronounced retreats in exposed areas such as the southeast coast of Herschel Island, Kay Point and King Point. The penetration of storm surges along the coast is usually indicated by a belt of driftwood on the beach. Tidal fluctuations are minimal with an average of

0.25 m. Some examples of coastal forms are illustrated in Figures 2, 3 and 4.

The Mackenzie River and other freshwater inflows are responsible for low surface salinities of the coastal water up to Kay Point. Warm water from the rivers builds a freshwater layer above the heavier and colder saline water. Turbulence caused by high winds brings saline waters of measurable concentration to the surface (Mann 1974).

The climate of the area is severe with mean temperatures above freezing occurring only in June, July, August and September. Precipitation is low throughout the year with the possibility of snowfall occurring in any month including July, the warmest month. Due to high latitude, the area has long periods of darkness for approximately 45 days in winter. The low angle of incidence of the sun's rays and long period of ice and snow cover cause a net radiation loss during most of the year. High winds are common in all seasons.

4.0 METHODS

4.1 The field studies

Studies in the field were carried out during four periods:

(i) April 1 to April 10, 1974;

(ii) July 3 to September 17, 1974;

(iii) May 5 to May 17, 1975;

(iv) July 15 to August 9, 1975.

For the two late winter surveys a crew was stationed at Shingle Point DEW-line station and operated with the support of a Bell 206 helicopter.

Stokes Point served as a base camp for the summer programs. In addition, existing accommodations were used at Shingle Point and Herschel Island, and three tent camps were erected along the coast (Figure 1).

Most transportation along the coast was by inflatable boats, however adverse ice conditions during July 1974 necessitated the occasional use of a helicopter.

4.2 Field sampling techniques

4.2.1. April, 1974

During the April, 1974 study gillnets were set under the ice at six stations between Shingle Point and Herschel Island (Figure 1).

A hole was drilled through the ice with a gasoline powered auger and 20 cm diameter bit. Larger hole dimensions were achieved by additional drilling and by chipping with ice chisels and a needle bar. Nets were set under the ice with the aid of an ice jigger (Figures 6A, 6B and 6C). Sinking monofilament gillnets were used each consisting of four panels with the following dimensions: 30.5 m x 6.0 m of 14.0 cm mesh, 15.0 m x 2.5 m of 7.5 cm mesh, 15.0 m x 2.5 m of 5.0 cm mesh, and 15.0 m x 2.5 m of 2.5 cm mesh. The 30.5 x 7.0 m panel was not used at Station IV due to shallow water. Fishing times at the various stations were; Station I - 72.0 hours, Station II - 121.0 hours, Station III - 122.0 hours, Station IV - 196.5 hours, Station V - 72.5 hours, and Station VI - 36.0 hours. Only one panel net was set at each station and this was checked daily whenever possible. No net was left longer than 53 hours without checking. Nets were set both at the bottom and near the under-surface of the ice.

Those fish which could not be identified in the field were preserved in 10% formalin and processed at a later date in Whitehorse. All specimens were measured for fork length except sculpin, which were measured for total length. In addition, individual fish were weighed, sexed, classified according to their state of sexual maturity and sampled for stomach contents.

Temperature profiles for each station were recorded with a Yellow Springs

Instrument Co. (YSI) Model 43 telethermometer.

Paired surface water samples of one litre each were collected from Stations I to VI. One sample was preserved with 5 ml chloroform for future nutrient analysis. The other sample was frozen for future heavy-metal analysis. Analytical methods used are summarized in Section 4.3.

4.2.2. May, 1975

In May, 1975 a sinking monofilament gillnet consisting of four panels of different mesh sizes (2.5 cm, 5.0 cm, 7.5 cm and 10.0 cm) each measuring 15.0 m long by 2.5 m deep, was set under the ice at Stations B to G (Figure 1). In addition to the equipment used in the 1974 winter survey, a transmitter-equipped ice jigger and a line grabber were used in the net setting procedure. Fishing times at the various stations were: Station B - 45.0 hours, Station C - 48.5 hours, Station D - 38.5 hours, Station E - 72.0 hours, Station F - 68.0 hours, and Station G - 36.0 hours.

Fish samples were treated in a similar manner to that described for the 1974 April survey.

An epibenthic trawl with a 40 cm x 40 cm throat, 1.0 mm mesh bag sitting 7.5 cm off the bottom was used at each station to collect epibenthic invertebrate and fish samples. From a primary hole a line was sent out under the ice to a distance of approximately 60.0 m with an ice jigger and retrieved through a secondary hole. The trawl was fastened to the end of the line at the primary hole and lowered to the bottom with a second rope. The trawl was pulled to the secondary hole at a rate of approximately 1.0 m/sec. until the trawl was felt to be lifting off the bottom. Immediately, the trawl was pulled back to the primary hole and retrieved. Therefore the total distance for each trawl was twice the distance between holes, approximately 120 m. All macro-organisms were picked from the trawl, preserved in 10% formalin and later identified in Whitehorse.

An Ekman dredge of dimensions 15.4 cm x 15.4 cm x 15.2 cm was used to sample the benthos at each of the stations. Each sample consisted of 3 grabs washed through a 0.5 mm sieve. Macro-organisms were picked from the screen, preserved in 10% formalin, and later identified to species by the Arctic Biological Station, Ste. Anne de Bellevue, Quebec.

A temperature and salinity profile was taken at each station with a YSI Model 33 Salinity-Conductivity-Temperature (S-C-T) meter. Two one litre surface water samples were taken. One was preserved with 5 ml chloroform for nutrient analysis and the other frozen for heavy-metal analysis.

4.2.3. Summer, 1974

The 1974 summer fish samples were collected at 39 stations (Figure 1) by means of gillnets and beach seines (Figures 7 and 8). Panelled gillnets of similar lengths, depths and mesh sizes to those described for the 1975 winter survey were used. Seining was done with either a 46.0 x 2.7 m seine of 1.0 cm mesh and center bunt of 0.5 cm, a 9.0 x 1.2 m seine of 0.3 cm mesh, or a 6.0 x 1.0 m pole seine of 0.3 cm mesh.

Gillnets were set at least twice at each station with the exception of those at Phillips Bay and Stokes Point where gillnets were used more frequently. Usually, the gillnets were set perpendicular to shore with the largest mesh in deepest water. Initially, the fishing time was 24 hours but due to extremely large catches over this period of time, the duration was reduced to 4 hours and then to 2 hours. Seining was carried out to depths of 3 metres in the nearshore areas adjacent to the gillnetting station.

A portion of the gillnet-caught fish was sampled in a similar manner to that described in the April, 1974 survey. In order to determine feeding habits, stomach samples were obtained from a number of each species and preserved in 10% formalin for future stomach content analysis.

Small fish in seine catches were preserved in 10% formalin for future identification. Larger fish were sampled in the same manner as those caught in gillnets.

The criteria used for sexual maturity classification were:

1. Juvenile - fish has undeveloped gonads. Males are undistinguishable from females;

2. Immature - distinction can be made between male and female. Eggs are visible to the eye as a granular substance. Testes are almost transparent and appear as a fine line. Fish has never spawned;

3A. Maturing - gonads are developed 2/3 to 3/4 of the way down the body cavity. Eggs are of maximum or near maximum size (Figure 9). Testes are grayish-white and starting to fill the body cavity. Fish will spawn in the next spawning period;

3B. Maturing green - gonads are developing but reach less than 1/2 way along the body cavity. Eggs are small and testes show little development (Figure 10). Ovaries may also contain retained eggs from previous spawning. Fish will spawn but not likely in the coming season. Distinctions were made between 3A and 3B since many of the species do not spawn annually. Classification of these two stages of development is often difficult and some overlap is possible;

4. Ripe - eggs and milt are expelled when pressure is applied to body cavity. Fish have reached full sexual development and are about to spawn; and

5. Spent - testes and ovaries are empty and red. A few eggs may be found in the body cavity. Fish has spawned very recently.

Scales and otoliths were removed for age determination. Scales were taken from whitefish, cisco, inconnu, and smelt from the left side of the fish, mid-way between the lateral line and the anterior margin of the dorsal fin. Otoliths were taken from Arctic char, Arctic grayling, burbot, cod, and fourhorn sculpin and stored in a 9:1 (volumetric ratio) solution of alcohol and glycerine.

Dissolved oxygen and temperature were determined with a YSI Model 34 Oxygen Meter complete with a 15.0 m temperature/oxygen probe (YSI # 5419). Total acidity, total alkalinity (methylorange), carbon dioxide, total hardness, and pH values were obtained using a Hach kit (Model AL-36B). Two one litre surface water samples were taken from each area and preserved with 5 ml chloroform for detailed nutrient analysis.

4.2.4. Summer, 1975

During the 1975 summer survey an effort was made to compare relative abundance, species distribution and catch per unit effort in various areas by standardizing the gillnetting procedures. In order to do this at least two standard gangs of net (as described in Section 4.1.2.) were set in 6 areas: Shingle Point, King Point, Phillips Bay, Stokes Point, Stokes Lagoon and Herschel Island. All areas were sampled once with the exception of Herschel Island (where two areas were tested) and Stokes Lagoon (where three areas were tested).

One gang of nets was set approximately 25 m from shore. The second was set 0.5 to 5 km offshore. The duration of each set was one hour. In order to ascertain the species composition, one gang of nets was set for an extended period, usually 12 to 24 hours. Seining was also conducted along the nearshore areas to complete the species composition information and to more adequately sample fish of smaller sizes unlikely to be caught by gillnet. Samples of small fish were preserved in 10% formalin for future identification.

A 1.0 m diameter circular trawl with 0.5 mm mesh bag was used to sample the surface waters for larval fishes. This device was used primarily in deeper water areas.

A halibut ground line 30 m in length with 20 baited single-barb hooks (1.5 cm from barb to shank) each attached by a 40 cm nylon leader, was set in each sampling area. Various baits were utilized including steak bits, whole fish, fish parts, and isopods.

Epibenthic invertebrate samples were collected at each station with a bottom trawl as described in Section 4.2.2. The trawl was lowered to the bottom and usually towed for 5 minutes (250 m) then retrieved. The macroorganisms were preserved in 10% formalin for future identification.

Benthic invertebrates were collected at each station by pooling 10 grabs of a standard Ekman dredge. Care was taken to ensure that a slightly different area was sampled with each grab. When the dredge malfunctioned, the sample was discarded and another taken.

Temperature and salinity profiles were taken at each sampling station with a YSI Model 33 S-C-T meter.

4.3 Tagging

Throughout the summer surveys, a tagging program was carried out. Fish were collected at various locations by beach seine and tagged with either numbered Petersen disc or Floy tags. The tags were inserted immediately below the posterior margin of the dorsal fin. Tagged species included: Arctic char, least cisco, Arctic cisco, inconnu, broad whitefish and fourhorn sculpin.

4.4 Laboratory Analysis

The University of Alberta Water Laboratory carried out the nutrient analysis of water samples following the methods outlined in Standard Methods for the Examination of Water and Wastewater, 13th edition, 1971, published by the American Public Health Association, Washington, D.C. 20036. Heavy metal analysis was conducted by the Pollution Control Laboratory, Edmonton, Alberta, using the Varian Flameless Carbon Rod and standard procedures for their spectrophotometer (G. Hutchinson, 1976 pers. comm.).

The Ekman dredge samples were sent to the Arctic Biological Station, Ste. Anne de Bellevue, Quebec, where the benthic organisms were counted and identified to species.

Epibenthic invertebrates from trawl samples were counted and identified to order or to family in the Fisheries' laboratory, Whitehorse. Relative abundance was determined by correcting the numbers of organisms to a five minute trawl duration.

In the Fisheries' laboratory, Whitehorse,fry and juvenile fish samples were identified to species using the taxonomic keys available in McPhail and Lindsey (1970) and McAllister (1961). They were also measured for length (fork or total depending upon species), aged by the reading of otoliths and or scales, and examined for stomach contents.

In aging scales, the main criteria for recognizing an annulus was the crossing over of circuli in the posterior field of the scale and increased distance between the circuli immediately following an annulus. The otoliths were read in a manner described in Bain (1974), Mann (1974), and Tesch (1971). In some cases fry one year old and less were aged according to length frequency distribution.

Stomach content analysis of juvenile and adult fish was done by the volumetric displacement method described by Windell (1971). Individual components were identified to order or family and in some cases to species. Fry stomachs were examined and the percent composition of the various food items was estimated.

4.5 Gear limitations

Because of its dimensions, the Ekman dredge samples a very limited area with each grab. In order to obtain a representative sample of 0.25 square metres of substrate ten grabs are required (J.W. Wacasey, 1975 pers. comm.) . Under ice cover it is difficult to avoid sampling the same substrate on successive grabs hence samples may overlap.

Problems were experienced in towing the epibenthic trawl in muddy-bottom areas. Where the substrate was incapable of supporting the weight of the trawl, it filled with mud and debris. In some areas the trawl became snagged on sunken debris giving the entrapped organisms an opportunity to escape. Since there was no closing mechanism,captured nektonic organisms could escape while retrieving the trawl.

The circular hoop-trawl proved to be an ineffective method of sampling fish. It was tested at Shingle Point an area known to abound with fish, yet it failed to produce a single specimen. Its failure was probably due to the inability of the boat to tow the trawl at an adequate speed.

Attempts to collect fish by means of a ground-line were also unsuccessful. The reasons for its failure may be related to hook size, the quality of the bait and the duration of set.

Although gillnets are an effective method of capturing fish,there are several factors which affect both their use and efficiency. Some of these include the mesh size, the overall dimensions of the net, the proportion of the water column being fished, the duration of the set, whether the net is set parallel or perpendicular to shore, whether or not the net is set attached to shore, whether the net is of the floating or sinking variety, and the state of repair and cleanliness of the net. Griffiths et al. (1975) discuss the selectivity of gillnets for Arctic cisco and Arctic char.

Certain characteristics of different fish species may make them more or less susceptible to capture by gillnet such as size, morphology, the presence of large scales or spines, mobility, the size of teeth and mouth parts and sensory acuteness.

Some bias and limitation to offshore gillnetting may be assumed. Nets were set on the bottom. At the deep water Stations 34a, 27 and 100a, nets were below the thermocline in a true marine environment where water temperatures approached -2.0°C..This would eliminate the possibility of capturing the less salinity-tolerant species or those which avoid these extreme temperatures.

The effectiveness of conventional winter sampling equipment is questionable under marine conditions. The movements of fish at temperatures near -2.0°Care known to be sluggish (A. Milne 1974, pers. comm.) and therefore fish may not be susceptible to capture by gillnet. Also the depth of water under the ice in nearshore areas, bays and lagoons is often too shallow to set nets properly thereby eliminating the sampling of the areas where fish concentrations are the greatest during the summer months. Examination of the stomach contents of a ringed seal caught off Stokes Point at Station II (Figure 1) in April 1974 showed it had been feeding exclusively on small fish, whereas our gillnets had failed to produce a single specimen in the area.

Beach seining is limited by the length and depth of the net and is useful only where the bottom is relatively clear of debris. Nevertheless, it is an effective method for sampling the smaller size classes of fish which are less susceptible to capture by gillnets.

5.0 RESULTS AND DISCUSSION

5.1 Physical and chemical data

The results of this phase of our studies showed an extremely complex system. A comprehensive interpretation and description of these coastal systems require further investigations. For this reason, the discussion is limited to a few topics of particular interest.

It is apparent that the limit of freshwater during late winter lies between Sabine Point and King Point. The surface water at King Point in early April 1974 is brackish (Table 1) but the temperature profile (Figure 11) shows this layer to be only 4 metres deep. The stations off Stokes Point and Herschel Island show typical salinity measurements for Arctic sea water. The change in water quality is reflected in a distinctive change in structure of the ice-cover. A line, approximately following the 10 m depth contour, separates the two water bodies with smooth clear ice in the area of freshwater influence and crumbled opaque blocks and pressure ridges toward the northwest.

The analytical results of water samples show the same tendency: high concentrations of sulphate and chloride, high hardness, conductance residue and pH in the marine medium near Stokes Point and Herschel Island with the opposite around Sabine and Shingle Point. The area out from King Point seems to be an intermediate zone (Appendix IV).

The change toward lower surface salinity corresponds to the time of breakup of the major rivers. By May 10, 1975 the surface waters in the west sector of the study area had warmed and become brackish (Table 1).

After breakup, the turbulence caused by currents and winds results in a constant circulation of the shallow waters in lagoons and bays. Temperatures reach $17^{\circ}C$ on warm summer days.

Reliable salinity values are not available for the 1974 summer survey; however, it is suspected that surface salinity concentrations did not exceed $7^{\circ}/oo$ (Appendix V).

In the summer of 1975 surface salinity values ranged from $3.6^{\circ}/oo$ at Sabine Point to $17.6^{\circ}/oo$ at Herschel Island (Table 2). At deep water stations rapid changes in temperature and salinity with depth demonstrate specific stratification. The time of year and weather conditions influence the general pattern that can be described as a warm layer of brackish water over a variable stratum and a stable mass of cold salty water.

One particular phenomenon which does not comply to this general pattern deserves mention. As shown in Figures 12 and 13, in the deep hole between Herschel Island and the mainland, and 3 km offshore of Stokes Point, an increase in temperature and a decrease in salinity was measured at 11 m depth and lower. This condition was either a result of instrument failure beyond this depth, or a water layer rich in suspended matter with absorbed freshwater.

Typical salt-wedge intrusion was observed in the Shingle Point and Trent Bay areas (Figures 14 and 15). The salt-wedge is evident by a very sharp halocline starting at 1 m depth (salinity $6^0/oo$) to 3 m depth (salinity $26^0/oo$).

Effective mixing takes place with the progress of summer due to frequent storms. This process is well illustrated in Figure 16 with two salinity/temperature profiles at comparable stations done 12 days apart. The smaller southeast side of Stokes Lagoon showed well mixed waters of $13.0^0/oo$ salinity and temperature of 9^0C on August 4, 1975 after several storms. On July 18, twelve days previous, a bottom salinity (depth 2.5 m) of $40^0/oo$ had been recorded (Figure 16). This lagoon was the only one observed with mixing rates influenced by tidal movements.

In Trent Bay waters, extremely high sediment loads were observed with secchi disc readings between 0.1 and 0.3 m. This high turbidity could be a limiting factor on primary productivity of the area.

Some additional information on the physical and chemical aspects of the studied waters appear in Appendices IV, V, VI and VII.

5.2 Benthic and epibenthic invertebrate sampling

The results of the benthic and epibenthic invertebrate sampling program are displayed in Tables 3, 4, 5 and 6.

In general the samples reflect an estuarine situation with a mixture of marine and estuarine species in the area around Herschel Island and the deep water stations (J.W. Wacasey 1975, pers. comm.).

A total of 73 species was identified from the Ekman dredge benthic samples (Table 3). Of these, members of the orders Polychaeta and Amphipoda were the most abundant and widely distributed organisms. Pelecypods were well represented to the west of Shingle Point (Table 4). Zoobenthic diversity was greatest in offshore locations particularly near Herschel Island and Station 27. The number of species present increased with distance from Trent Bay (Table 5). Highest densities of organisms were recorded in Phillips Bay and the offshore stations (Table 5). Similar results concerning the relationship between distance offshore and zoobenthic species diversity and density were recorded by Wacasey (1974).

The low number of benthic species in the shallow water area of the Mackenzie River influence can be explained as combination of several variable conditions such as high sediment deposition, instability of the substrate, freezing and ice scouring due to ground fast ice and extreme seasonal changes of temperature and salinity.

Conditions at the substrate level become more stable in deeper water and with distance from the Mackenzie River influence. Hence a more diverse zoobenthic community can be expected at deeper offshore stations.

Species composition also differed between nearshore and offshore stations with only 15 species (12%) common to both regions. The factors listed above also play an important role in the species composition and distribution of zoobenthos in coastal margins.

Mysids and amphipods were the most numerous and widely distributed epibenthic organisms taken in the trawls. Pelecypods were locally abundant in Phillips Bay and 0.5 km offshore of Stokes Point. Greatest density of organisms occurred at King Point (Station 100) followed by Stations 107 (Trent Bay) and 31 (Herschel Island) (Table 6).

5.3 General distribution of fish

Several factors which affect the distribution of fish species within the study area are seasonal and short term fluctuations of the aquatic environment (water temperature, salinity), the availability of food and individual characteristics of the species (spawning areas and times, anadromy and predator avoidance).

The correlation of salinity and/or water temperature with the distribution of anadromous Arctic fish is unclear. Mann (1974) suggest that sub-zero water temperatures and higher salinities during the winter months may provide an unfavourable habitat and therefore present restrictions on faunal distribution.

During the winter months the discharge of the Mackenzie River and other freshwater inflows are at a minimum. At this time the encroachment of sub-zero marine water extends well into Mackenzie Bay (Table 1 and Appendix IV). Sampling during this period has not recorded the presence of anadromous species west of Sabine Point, however marine forms, namely Arctic cod (n=2), (Steigenberger 1975, pers. comm.), Pacific herring (n=1), and fourhorn sculpin (n=1) have been captured.

Although the results from winter surveys are fragmentary, they suggest that some species overwinter in the fresh to brackish waters of the Mackenzie estuary. Jones and Kendel (M.S. 1973) collected inconnu (n=5) and fourhorn sculpin (n=2) approximately 8 km offshore from Shingle Point. In 1974 and 1975 Arctic cisco (n=3) and fourhorn sculpin (n=4) were also captured in Mackenzie Bay. Steigenberger et al.(1975)[2] report the capture of least cisco (n=1) from this area.

Considering the limitations of winter sampling techniques, it must be stressed that these results can be used only as an indication of occurrence and may not reflect abundance.

The potential for overwintering in the lower parts of the rivers and estuaries of our study area is low. Steigenberger et al. (1975)[2] found all rivers and streams between the Firth and Blow Rivers frozen to the bottom except for a few isolated pockets of water in the headwaters and mouth of the Babbage River. They recorded salinities in the lower Babbage River and in Phillips Bay which ranged from 34.5 ^{0}/oo to 67.0 ^{0}/oo. These extremely high salinities (hypersalinities) are rare in marine environments. In the sheltered waters of the north coast the phenomenon is probably the result of salt concentration arising from freezing of brackish waters and the lack of mixing with outside waters due to ice cover. This situation may be a common occurrence in other bays and lagoons, however, other cases have not been documented from our study area.

Migration of anadromous species from stream waters to coastal areas is thought to occur after breakup between late May and early July. At this time coastal surface waters have warmed and become brackish (Table 1). A subsequent migration from coastal waters to overwintering and spawning areas of anadromous species commences in August (Mann 1974; Griffiths et al. 1975). Tag recovery information from our studies also suggests an eastward movement during autumn.

In 1974 fish inhabiting the open coastal margins and to a lesser degree, bays and lagoons, were concentrated nearshore. The results of the catch per unit effort studies (1975) reinforce this observation (Table 11). In all cases the catch was greater in nets set near shore except in Phillips Bay where the catches nearshore were comparable to those offshore. Few fish were captured in any of the offshore stations in open coastal areas suggesting shore orientation for anadromous species.

The reason for shore orientation may be related to water temperature and/or salinity since the shoreline waters are shallow and generally of higher temperature and lower salinity. This, however, does not explain the distribution of fish at Shingle Point where extremely high catches were recorded in variable temperatures and salinities (Figure 14).

The effect of short term exposure to cold saline water on Arctic anadromous species is not known. However, it appears that some tolerance to these conditions exists since large concentrations of anadromous fishes were feeding on benthic and epibenthic organisms in areas where bottom salinities between 8.0 and $40^{o}/oo$ were measured (Table 2).

Evidence of intolerance to high salinities was reported by Hunter (1975). At King Point Lagoon burbot were killed, presumably due to a sudden increase in salinity induced by storm winds.

The distribution of marine species in coastal waters during the summer programs was widespread. Those marine species most frequently caught were demersal forms, whereas nektonic forms such as capelin and Pacific herring were infrequently captured. From Figures 15 and 16 we suggest that high salinity values recorded at the substrate would provide favourable habitat for marine species even though the mid to surface waters are fresh to brackish. This would explain the occurrence of fourhorn sculpin, flounder and saffron cod in coastal waters during the summer months.

The availability of food organisms does not appear to be a limiting factor to fish distribution. Amphipods, mysids, isopods and small fish, which composed the bulk of the food of those species examined, were common at most coastal stations (Tables 4 and 6 and Figure 17). Although feeding activity was more intense to the west of Kay Point and in bays and lagoons, the greatest concentration of anadromous species was in the east at Shingle Point and Trent Bay. Here feeding activity was minimal although an abundant food supply was available.

The lack of life history information on the marine stages of anadromous fish species makes it impossible to identify those factors which govern their distribution. However, individual charcteristics of a species are known to determine, to some extent, its distribution. For example, anadromous behaviour determines the amount of time spent in coastal waters, since these species spawn in fresh water. Also the onset of maturity results in large localized concentrations of fish during migrational activity. Distributional differences between mature and immature members occur. The size and age at first seaward migration and age at maturity must also be considered in the study of distribution. Predatory-prey relationships, species dominance and food requirements are also factors which will affect distribution.

Some benefits of anadromy applicable to fish species of our area are summarized by Craig and McCart (1975). The major advantage is the opportunity to utilize the greater resources of the marine environment. This is reflected in increased growth rate of same age individuals when compared to non-anadromous members of the same species.

5.4 Species composition and classification

A total of 21 species was captured by gillnets and seines in the study area (Table 7). Of these, Arctic cisco (*Coregonus autumnalis*), Arctic char (*Salvelinus alpinus*), Arctic flounder (*Liopsetta glacialis*), boreal smelt (*Osmerus eperlanus*), fourhorn sculpin (*Myoxocephalus quadricornis quadricornis*), humpback or lake whitefish (*Coregonus clupeaformis*), inconnu (*Stenodus leucichthys nelma*), and least cisco (*Coregonus sardinella*) were represented in significant numbers.

Ninespine stickleback (*Pungitius pungitius*) were also abundant but restricted to creeks, rivers and freshwater areas of bays and lagoons. In addition, Arctic cod (*Boreogadus saida*), Arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), capelin (*Mallotus villosus*), longnose sucker (*Catostomus catostomus*), northern pike (*Esox lucius*), Pacific herring (*Clupea harengus pallasi*), round whitefish (*Prosopium cylindraceum*), saffron cod (*Eleginus navaga*), and starry flounder (*Platichthys stellatus*) were also captured but in each case they numbered less than 20 individuals.

Of the 21 species 7 are considered to be marine forms. The fourhorn sculpin was the most common of these, contributing roughly 2.5% to the catch. Arctic cod, Arctic flounder, capelin, Pacific herring, saffron cod, and starry flounder together composed 1% of the catch. Anadromous fish were represented by 5 species namely least cisco, Arctic cisco, Arctic char, inconnu and boreal smelt. The remaining 9 species are freshwater fish.

Species diversification in nearshore waters within the study area is low. McAllister (1962) recorded an additional 15 species in the Beaufort Sea most of which were taken by trawl from the deeper marine waters surrounding Herschel Island (Table 8).

5.5 Relative abundance, summer

In 1974, 6 species represented 95% of the total catch (n=5206), excluding fry. These were least cisco (55.3%), Arctic cisco (28.8%), Arctic char (4.5%), fourhorn sculpin (2.5%), boreal smelt (2.4%), and humpback whitefish (1.6%) (Figure 17).

The abundance of least cisco progressively declined westwards from Trent Bay. This is reflected in Figure 17 which shows the percent composition of gillnet-caught least cisco declining from 89.9% at Shingle Point to 3.3% at Herschel Island.

A similar distribution of least cisco along the Yukon coast was observed by Mann (1974).

Arctic cisco were abundant throughout the study area showing only a minor decline in numbers from Herschel Island to Shingle Point. However their relative abundance if expressed as a percent of the total catch in the eastern section of the study area is diminished by the large concentration of least cisco (Figure 17).

Arctic char showed a marked decline in numbers of fish caught from Herschel Island to Shingle Point and were absent in most cases east of Kay Point.

Fourhorn sculpin were encountered at most sampling stations although they were more common west of Kay Point. They were most abundant in Phillips Bay where they comprised 8.7% of the gillnet catch (Figure 17).

Boreal smelt were found in Phillips Bay where they contributed 2.0% to the total catch. Along the coast east to Trent Bay they were caught more frequently. However, their abundance was overshadowed by the large numbers of least cisco. In one instance, Escape Reef, boreal smelt was the dominant species comprising 51.8% of the catch (n=56).

Humpback whitefish were most numerous in the Phillips Bay and Shingle Point areas. However, at all times they were captured in small numbers and were usually restricted to lagoons and estuaries.

The 1975 summer sampling program was less intense and consequently the gillnet catch was smaller (n=1036). The distribution of major species with the exception of Arctic char was similar to 1974 in most cases (Table 9). However the relative abundance of species at various locations showed several differences between the 1974 and 1975 summer surveys. Table 10 gives a comparison of gillnet catches for 1974 and 1975 by percent composition. In the east the relative abundance of species was similar for both years but from Phillips Bay to Herschel Island several discrepancies occurred. Most notable was the absence of Arctic char in 1975. Char were not present in appreciable numbers until mid August in 1975, after the completion of the field program (J. Jackson 1975, pers. comm). Also noteworthy is the fact that least cisco maintained their dominance as far west as Stokes Point in 1975 and were present in equal numbers to Arctic cisco at Herschel Island.

A slight increase in the number of species in the more westerly sampling areas was recorded in 1975 when compared to the same area in 1974. However, in each case the new species did not appear in significant numbers (Table 10).

The catch per unit effort data presented in Table 11 can be used as a guide to the abundance of fish in various areas at the time sampled. Shingle Point had the highest concentration of fish, yielding a catch per unit effort four times that of any other area. This large concentration of fish is known to occur from Shingle Point east to the Mackenzie River. This is not meant to imply that other areas are of less importance since catches of Arctic char, Arctic cisco and capelin of the same magnitude have also been reported from Herschel Island (B. Mackenzie 1974, pers. comm., McAllister 1962).

From our studies and the information available in the literature it appears that the relative abundance of species within the study area, especially west of Kay Point, undergo some rather large fluctuations from year to year. Craig and Mann (1974) report that Arctic flounder and fourhorn sculpin were the most abundant species caught in Phillips Bay in 1972. This was not the case during our studies. McAllister (1962) recorded the capture of an estimated 1600 pounds of spawning capelin during late July on the beaches of Herschel Island. Our sampling during July in the Herschel area for two consecutive summers failed to produce a single member of this species. A domestic fisherman from Herschel Island reported that the arrival date and abundance of char to the island is variable and that occasionally inconnu, burbot, broad whitefish, and large numbers of smelt are caught.

5.6 Fish species summary

5.6.1 Least cisco

Both anadromous and non-migrant freshwater least cisco have been found in Beaufort Sea drainages (Mann 1974). The former attain greater lengths and ages and exhibit higher growth rates than the latter. These are the primary distinguishing traits between the two (Mann 1974; McPhail and Lindsey 1970; Scott and Crossman 1973). The following information relates to the anadromous least cisco inhabiting coastal waters.

The distribution of least cisco within the study area is shown in Figure 18.

Due to the increasing abundance of least cisco towards the Mackenzie River it has been suggested that they constitute a segment of the Mackenzie spawning stock (Mann 1974; Craig and Mann 1974). As autumn approaches, progressively fewer mature fish are encountered in the brackish coastal areas, indicating the onset of upstream migration, with spawners preceding non-spawners (Mann 1974). A casual observation was made in August 1974 at King and Shingle Points where least cisco consistently entered the gillnets from the west, indicating eastward movement. The locations and frequencies of spawning have not been determined for Mackenzie River least cisco (Mann 1974; Stein et al. 1973). Studies from other regions indicate that alternate year spawning occurs. Spawned out individuals usually move downstream to the overwintering areas in late autumn (Scott and Crossman 1973). Only one incidence of least cisco overwintering in coastal waters has been reported (Steigenberger et al. 1975)[2]. This consisted of a single specimen collected in the vicinity of Shingle Point in March 1974. The timing of movement along the coast is not known but probably occurs after breakup of coastal rivers when water temperatures increase. Hunter (1975) reports that cisco have been caught at the mouth of the Firth River as early as June 30. Herschel Island appears to be the western limit of distribution of this species from the Mackenzie River since few were caught at Nunaluk Lagoon and none were recorded along the coast of the Alaska Wildlife Range (Griffiths et al. 1975).

Fry hatch in the spring (Mann 1974; McPhail and Lindsey 1970), but very little is known of their distribution or movements. Scales are formed by the end of the first summer and rapid growth rates continue for both sexes until age 5. Maturity is reached between the ages of 4 and 9 with males generally maturing before females (Mann 1974). The oldest scale age recorded in 1974 was 11 years. Figure 30 shows the growth and maturity of least cisco captured in the vicinity of Shingle Point during the 1974 summer program. In this sample the youngest mature fish was 4 years and all fish 7 years and older were mature. Least cisco fry (35 to 110 mm length) were common only along the coastal margins at Shingle Point and several were captured in Stokes Lagoon and Phillips Bay. Juveniles and adults (120 to 380 mm length) were taken throughout the study area.

No significant differences in abundance of either sex was observed (Table 20).

The feeding habits of adult least cisco are summarized in Table 12. In all coastal and offshore areas, crustaceans were the primary source of food, constituting 74.3% (by volume) of overall diet. Copepods were the most important food item in fish caught in the lagoons, near Herschel Island, and between Kay Point and Shingle Point. Amphipods were dominant in the diet of fish from Calton Point to Phillips Bay. Selective feeding by fish for crustaceans was evident in all areas of study except in lagoons where the diet also contained a high proportion of insects and in Trent Bay where feeding activity was minimal.

The frequency of occurrence and average volume of insects in fish stomachs were greatest in fish caught in lagoons, where it is probable that high concentrations of allochthonous organisms exist due to their close proximity to freshwater inflows. Chironomids and unidentified dipterans ranked first in frequency of occurrence and contributed the most (24% and 11% by volume, respectively) to the overall diet.

Fish, pelecypods, and miscellaneous items played a minor role in the feeding habits of this species, collectively accounting for less than 10% of the diet.

The greatest diversity in diet occurred in fish inhabiting lagoons and the coastal margins between Calton Point and Stokes Point. As indicated by the decreasing numbers of empty stomachs, feeding activity appeared to increase towards the western coastal regions of our study area. Although the highest concentrations of adult least cisco occurred in Trent Bay, all stomachs from this sample were empty. One explanation for this may lie in the sampling period. In 1974 because of poor ice conditions, sampling in the eastern part of our study area was restricted to August and early September. Hatfield et al. (1972)[1] found that feeding activity ceased prior to spawning. It is suggested that during late July through September feeding activity decreases as least cisco migrate to staging areas east of Shingle Point and ceases prior to their upstream spawning migrations. In late July 1975, cursory field observations revealed that feeding had not yet stopped in this area.

In most areas the peak feeding period occurred from late July to early August. In Phillips Bay, Herschel Island and lagoons, greater proportions of empty stomachs were encountered after August 12, 1974. However, in the coastal region between Calton and Stokes Points the incidence of empty stomachs was low as late as September 2, 1974.

The diet of adult least cisco is given in Figure 36.

The stomach contents of least cisco fry were comparable for all areas.

Crustaceans were of primary importance, constituting 85.4% of the diet by volume. The major food item was copepods (78.1%). Mysids (3.8%) and isopods (3.5%) were of comparatively minor significance. The dominance of zooplankton in the diet of least cisco fry has also been demonstrated by Mann (1974). Combined, insects and miscellaneous items accounted for less than 15% of the average diet. Fry were feeding in all areas of capture and only 3.6% of stomachs examined were empty. The food habits of least cisco fry are presented in Figure 44.

5.6.2 Arctic cisco

The Arctic cisco is an anadromous species which is known to frequent the brackish waters of the study area. This species was, in fact, found throughout the studied waters from Herschel Island to Shingle Point (Figure 19). Arctic cisco along the Yukon coast are thought to be largely of Mackenzie River origin since populations have not been recorded from other rivers in the study area. An Arctic cisco tagged at Herschel Island in the summer of 1974 was recaptured at Shingle Point in the fall of 1975. Another tagged at Stokes Point on July 27, 1974 was recovered November 5, 1974 at the mouth of the Peel River and yet another tagged at King Point on July 30, 1975 was recaptured in the Peel River in September 1975. Thus, an eastward movement during late summer and early fall into the Mackenzie River is suggested. Griffiths et al (1975) observed an eastward movement of Arctic cisco in the vicinity of Nunaluk Lagoon in late August of 1974.

The spawning habits of this species are poorly understood. Sexual development in females approaches completion as early as mid July. Upstream spawning migrations in the Mackenzie River occur from July to September inclusive (Craig and Mann 1974; Stein et al. 1973). In the Colville River to the west Arctic cisco undertake their spawning migrations 2 months later (Griffith et al. 1975). From October through December, post spawning migrations to the mainstream and delta overwintering areas occur (Craig and Mann 1974; Stein et al. 1973). When maturity is reached spawning is thought to occur in alternate years (Griffiths et al. 1975). The exact timing of dispersal to coastal areas is not known. It may correspond with the breakup of the Mackenzie and other coastal rivers. Hunter (1975) reported cisco at the mouth of the Firth River by June 30.

Fry and juvenile Arctic cisco 23 to 107 mm in length were abundant at most coastal sampling stations. The majority of these were captured by seine along shallow shorelines, in bays, lagoons and estuaries. Due to the abundance of fry in coastal waters and their apparent absence from the spawning streams in the Mackenzie River system (Craig and Mann 1974), it is assumed that the young descend the Mackenzie River soon after emergence and distribute themselves along the coast.

A sample of 284 fish caught by seine and gillnet from the vicinity of Stokes Point showed a minimum age maturity of 5 years with all fish older than 8 years being mature. Fish between 5 and 8 years of age were most frequently sampled (Figure 31). The oldest fish examined was 12 years. Griffiths et al. (1975) found females to be larger than males in all age classes.

Of 1170 Arctic cisco examined from all areas 56.5% were males, 42.7% were females and 0.8% were juveniles (Table 20).

Results from the stomach content analysis for adult Arctic cisco are displayed in Table 13 and Figure 37. Crustacea was the most frequently encountered food group occurring in 66.4% of the total number of stomachs containing food, and composing the greatest percent volume overall (62.2%). Mysids were the primary food items and ranked first in percent occurrence and volume in samples from lagoons (29.1% and 26.7% respectively) and Herschel Island (40.0% fN and 30.5% vN): whereas amphipods led in samples from Calton to Stokes Points (48.6% fN and 29.6% vN), and Phillips Bay (53.3% fN and 54.5% vN). Copepods and isopods were also represented in the overall diet. The former composed a substantial portion of the diet of Calton to Stokes Point fish (28.2%) although the overall percent volume was much lower (7.1%). Isopods progressively increased in percent occurrence and volume from Herschel Island to Phillips Bay, but never constituted more than 6% of the diet.

Insects were commonly found in stomach samples of fish from lagoons, the lower Babbage River, and east of Kay Point. No insects were encountered in samples from Herschel Island. Insect fragments appeared most often in the lagoon samples. Chironomids were encountered more frequently especially in lagoon-caught fish where they constituted 14.2% of the diet by volume. Fish, annelida, pelecypoda, and arachnida food groups composed less than 10% of the overall diet.

Of the 999 adult Arctic cisco stomachs examined, 722 or 72.3% were empty. This figure is greater than that reported by Griffiths et al. (1975) for other western Arctic coastal studies. Only fish from the Mackenzie River, where they were undergoing an upstream spawning migration, had a higher proportion (94.4%) of empty stomachs (Hatfield et al. 1972)[2]. Griffiths et al. (1975) suggests that specific feeding times and locations, rapid digestion rates and sampling error may contribute to high frequencies of empty stomachs. Perhaps a similar explanation (decline in feeding activity prior to migration) as given previously for least cisco is applicable to Arctic cisco. As with least cisco, feeding activity was minimal east of Kay Point. Lagoons and the coastal waters lying between Calton Point and Stokes Point seem to be the most important feeding areas for the adult members of Arctic and least cisco.

With the exception of empty stomach frequencies, our results agree with findings of Craig and Mann (1974) and Griffiths et al. (1975) who extensively studied the feeding habits of Arctic cisco in Nunaluk Lagoon to the west of our study area (Figure 1). The representation of the major food groups is almost identical although leading food items occasionally varied, probably reflecting differences in the relative abundance of food organisms from one area to the next.

Figure 45 shows a predominance of crustaceans in the diet of Arctic cisco fry. Copepods appeared to be the preferred food item whereas, chironomids, other diptera, amphipods, mysids, fourhorn sculpin, and plant material appeared to be incidental to the diet.

5.6.3 Arctic char

Three distinct populations of Arctic char have been frequently encountered within the Beaufort Sea drainage. These include an anadromous population which migrates between salt-brackish and freshwater, a non-anadromous population of residual males which inhabits freshwater, and a non-anadromous freshwater self-perpetuating population (Bain 1974; Glova and McCart 1974; Craig and McCart 1975; Stein et al. 1973; Scott and Crossman 1973; McPhail and Lindsey 1970). Generally the non-anadromous differ from anadromous fish in that they are comparatively dwarfed, and in the case of residual males, retain parr marks and typical spawning coloration throughout their life span (McCart et al. 1972; Bain 1974; Craig and McCart 1975). Because our study area is restricted to Yukon coastal waters, the following information relates only the anadromous form of Arctic char.

Upstream migrations from coastal waters occur from mid-summer to early fall. Spawning takes place from August to November with peak spawning activity in September and October on gravel substrates where continuous flows of freshwater exist throughout the winter months (Craig and McCart 1975). There are no reported incidences of char overwintering at sea.

Seaward migrations from the spawning and overwintering areas of smolt and anadromous adults usually occur simultaneously from May to June, about the time of river breakup (Bain 1974; Stein et al. 1973; Glova and McCart 1974). McCart et al. (1972) speculate that immature females have a greater tendency to undertake a seaward migration than do males. This may account for the higher percentage of females in anadromous populations. Table 20 shows female Arctic char outnumbered males in coastal waters by 2:1 in 1974.

The distribution of Arctic char within the study area is mainly restricted to the west of Kay Point (Figure 20). Reports of an annual migration of char moving east along the coast in mid August in the vicinity of Shingle Point (D. Gordon 1973, pers. comm.) were not confirmed by our study.

Population estimates for the various rivers which may contribute Arctic char to the coastal waters of the Beaufort Sea within the study area are summarized by Steigenberger et al. (1975):

Firth River		32,000 - 40,000
Babbage River	less than	5,000
Fish Creek	greater than	1,000
Other rivers	less than	5,000

Since char at sea are known to cover great distances (Griffiths et al. 1975) the populations along the Yukon coast are likely a mixture of stocks from various rivers. However, the degree of mixing of the contributing stocks is not known.

Craig and McCart (1975) suggest the age at first seaward migration is between 3 to 5 years. This is supported by our findings in 1974 when the youngest char captured in coastal waters was age 3 years. Age 5, 6, and 7 year char were the most abundant and the oldest recorded was 11 years (Figure 32). Smolts may migrate between fresh and salt water for several years before reaching maturity. The age at maturity given by Glova and McCart (1974) and Bain (1974) range from 4 to 6 years. All fish 9 years and older were mature in our samples (Figure 32).

The feeding habits of Arctic char are presented in Table 14 and Figure 38. The diet of char comprised chiefly fish (70.9%) by volume) and crustaceans (23.2%). However, habitat appears to affect the feeding of this species. In lagoons feeding was light with 74.1% of the stomachs examined being empty. By volume, fish (31.6%), crustaceans (28.8%), insects (17.1%) and miscellaneous debris (21.6%) were represented in significant quantities. Percent occurrence for these groups are comparable to those reported from Nunaluk Lagoon by Griffiths et al. (1975). In Phillips Bay the general trend was similar with an increase in the use of crustaceans. In coastal areas and at Herschel Island feeding was more extensive with 62.8% and 58.8% of stomachs containing food. Between Stokes Point and Calton Point crustaceans (49.3% vN) and fish (45.6%) were the major food items. Here mysids were the most frequently eaten crustaceans, being found in 10 of 27 stomachs which contained food and contributing 22.1% of the total diet. At Herschel Island char were more selective in feeding, utilizing fish as the major food source. Cod were the most frequently eaten species comprising 51.3% of the total diet. This increased utilization of fish as a food item in coastal areas was also recorded by Griffiths et al. (1975).

5.6.4 Fourhorn sculpin

Fourhorn sculpin have a circumpolar distribution, inhabiting cold brackish coastal waters and lower stretches of rivers. They rarely occur in depths below 15 to 20 m (Griffiths et al. 1975). Adults and juveniles (129 to 304 mm length) were commonly caught by gillnet, whereas seines caught all size groups. Fry measuring 12 to 20 mm with remnant yolk sacs were extremely abundant in the shallow eastern end of Stokes Lagoon in July during both summer programs. From their small size and high density we assume spawning occurs there during late winter or early spring. Fry were also abundant in Phillips Bay, Shingle Point and Trent Bay (Figure 21).

From a sample of 93 fourhorn sculpin, the earliest age of maturity was 4 years, with all fish older than 7 years being mature. The oldest recorded specimen was 12 years (Figure 33). In a sample of 53 fish 67.9% were females and 32.1% were males

Fourhorn sculpin were caught in small numbers 2 km offshore of Shingle Point in late winter during the 1975 winter survey and have been previously recorded from this vicinity (Jones and Kendel MS 1973; Steigenberger et al. 1975)[2]. A single specimen (48 mm length) was captured by bottom trawl about 0.5 km offshore of Stokes Point during May 1975.

The seasonal movements of this species are little known. To the west of our study area, Griffiths et al. (1975) recorded an influx of large fourhorn sculpin into Nunaluk Lagoon with the approach of freeze-up. They speculate that overwintering occurs there in the presence of a ground water spring.

Fourhorn sculpin are an important forage fish for mew gulls, whitefish, burbot, Arctic sculpin, ellpout and Arctic char (Griffiths et al. 1975). In addition fourhorn sculpin were found in the stomachs of inconnu during our studies.

As summarized in Table 15 and Figure 39, adult fourhorn sculpin are bottom feeders which rely heavily upon isopods as their primary source of food. Mysids and fish eggs are of minor significance in their diet. The fourhorn sculpin caught in our study area appear to be more selective in their feeding habits than those encountered by Griffiths et al. (1975). In samples taken from Nunaluk Lagoon, a total of 17 food items, including a variety of insects, crustaceans, small fish and polychaetes was recorded, although isopods (40.4%) and amphipods (27.2%) formed the bulk of the diet.

The overall percent frequency of occurrence of empty stomachs was 39.5%. However this figure was not consistent in all areas. Empty stomachs were common in samples from lagoons (83.3%) and the coastal region from Kay Point to Shingle Point (100%). Extensive feeding activity was apparent in Phillips Bay and in the vicinities of Herschel Island and Shingle Point where concentrations of isopods were greatest (Table 4).

Stomach content analysis of 4 mature specimens captured in April 1974 off Shingle Point showed isopods to be the only food items eaten. Figure 46 shows greater diversity in the feeding habits of fourhorn sculpin fry than in adults. The major food items eaten by fry were amphipods, (55% by volume) and isopods (17.7%). The presence of copepods in the diet suggests that fry are pelagic as well as bottom feeders. Fry (12 to 20 mm length) caught in mid July 1975 had not yet commenced feeding.

5.6.5. Boreal smelt

Both anadromous and landlocked populations of boreal smelt have been recorded (McPhail and Lindsey 1970; Scott and Crossman 1973). For our purposes only the anadromous forms are considered.

The distribution of this species is variable. In the summer of 1974 they were recorded only in the area of Phillips Bay and east to Shingle Point. However during the 1975 summer program boreal smelt were captured as far west as Herschel Island (Figure 22). Fry and juveniles (19 to 118 mm length) were abundant along the gravel beaches of sheltered waters such as Stokes Lagoon, Niakolik Point and Escape Reef.

Spawning migrations into streams occur in late spring and early summer (McPhail and Lindsey 1970; Scott and Crossman 1973). Spent boreal smelt with retained eggs were caught in Phillips Bay in early July during 1974. Newly emerged fry (19 to 28 mm length) were caught in Stokes Lagoon as early as July 18, 1975. Streams used for spawning are little known. However, fry (29 to 44 mm length) were caught in the lower reaches of the Running River, suggesting spawning may occur there. Spawning migrations into the Mackenzie River occur prior to spring breakup (Percy et al. 1974). Only mature fish age 6 years or older appear to participate in the spawning migrations (Stein et al. 1973). Age at maturity in our area is not known, since scales proved unreliable for aging. A small sample($n=14$) aged by otoliths showed all fish 7 years or greater to be mature. Of a sample of 110 individuals caught by gillnet, 56.4% were females, 42.7% were males and 0.9% were juveniles (Table 20).

Fry are thought to move out of the spawning area and drop down to sea soon after hatching. This is substantiated in coastal waters by the abundance of fry that still showed remnant yolk sacs.

Adult boreal smelt tend to be selective feeders both in terms of food organisms and areas (Table 16 and Figure 40). Amphipods, mysids and isopods were the major food items comprising 92.4% of the average diet. Active feeding appeared to be restricted to Phillips Bay where the incidence of empty stomachs was low (27.3%) compared to Trent Bay (98.8%) and the coastal region between Kay Point and Shingle Point (100%).

The feeding habits of boreal smelt fry are summarized in Figure 47. Again the preference for crustaceans is apparent, particularly for mysids, which appeared in all stomachs with food. A large proportion of the empty stomachs originated from fish collected at Station 2 (Figure 1) where no food items were found in the sample of eight fry. Incomplete absorption of yolk sacs was discovered in a sample of 21 individuals ranging in length from 21 to 28 mm indicating that feeding had not yet commenced.

5.6.6 Humpback whitefish

The humpback whitefish is a freshwater, fall-spawning species known to enter brackish waters (McPhail and Lindsey 1970; Griffiths et al. 1975). In 1974 humpback whitefish (197 to 419 mm length) composed 1.6% of the total catch excluding fry (Figure 17). Their distribution extended from Trent Bay west to Roland Bay. The heaviest concentrations of this species were in areas of freshwater influence such as Phillips Bay, Trent Bay, and in lower reaches of most rivers.

In 1974, fry of this species (40 to 80 mm length) were restricted to the Trent Bay and Shingle Point areas. However, in 1975 fry were captured in small numbers as far west as Stokes Lagoon (Figure 23).

Age at maturity is 7 to 9 years. The oldest age, based on scale interpretation, was 13 years (Figure 34). Percy et al. (1974) reported 18 year old fish from the outer delta of the Mackenzie River. Spawning areas within the study area are not known. It is likely that the fish are of Mackenzie River origin and return there to overwinter and spawn. In a sample of 47 fish, males outnumbered females by 1.9:1.0 (Table 20).

The major food group utilized by adult humpback whitefish was insects, with chironomids ranking first in frequency of occurrence (54.5% of all stomachs with food) and constituting the largest volume in the average stomach (50.6%) (Figure 41 and Table 17). Other food items included organic and inorganic debris, amphipods, isopods, plecopterans and ninespine sticklebacks.

When we compare our results with those of Hatfield et al. (1972)[2] coastal humpback whitefish appear to be more selective than those sampled in the Mackenzie River. This is probably due to the reduced availability of surface drift organisms in coastal regions. The low incidence of empty stomachs in fish in lagoons and estuaries such as Phillips Bay indicate that these areas are the important feeding grounds for coastal humpback whitefish.

Due to the difficulty in separating humpback whitefish fry from those of broad whitefish the results and discussions of their feeding habits are combined. These data are presented in Figure 48. Crustaceans accounted for 87.9% of the average diet with copepods (52.6%), mysids (23.1%), and amphipods (9.9%) being the major items consumed. Insects (8.7% by volume) and organic debris (0.9%) appeared to be of much lesser importance. Feeding occurred throughout the study area with the exception of Station 108. Here, no food items were found in a sample of 4 fish.

5.6.7. Broad whitefish

Broad whitefish are distributed throughout the fresh and brackish waters of Arctic drainages in western North America (Scott and Crossman 1973). Upstream migrations in the Mackenzie River peak during September and October, with spawning occurring in the backwaters of streams and rivers (Stein et al. 1973). Ripe and spent fish are most abundant in October after freeze-up and therefore indicate October as being the principal spawning month (Stein et al. 1973). Downstream post-spawning migrations to the overwintering areas (open sections of main streams and deltas) follow in the late fall and early winter (Scott and Crossman 1973; Stein et al. 1973).

In this study broad whitefish contributed 0.2% to the total catch in 1974 and 1.0% in 1975. Their distribution was widespread in waters between Shingle Point to Herschel Island (Figure 23).

A small sample of 11 broad whitefish ranged from 120 to 357 mm in length. No fry positively identified as broad whitefish were captured, although whitefish fry were abundant in Stokes Lagoon, Phillips Bay, and Shingle Point areas. Due to the difficulty in distinguishing between the fry of broad whitefish and humpback whitefish it is possible that their presence has been overlooked.

Broad whitefish are known to occur in some of the tundra lakes adjoining our study area (Steingenberger et al. 1975)[2], however, it is not known if these lakes contribute to the populations in coastal waters.

Data regarding the feeding habits of this species is sparse. In a sample of 3 fish, chironomids were the only food item recorded. Hatfield et al. (1972)[2] found that the diet of Mackenzie River broad whitefish consisted of insects and pelecypods.

5.6.8 Inconnu

Inconnu are often anadromous in coastal regions (McPhail and Lindsey 1970). In the Mackenzie River, prolonged upstream migrations occur from July to September and distinct out-migrations follow spawning in October shortly after freeze-up (Stein et al. 1973).

Little is known about the spawning habits of inconnu along the Yukon coast. The young presumably emerge in the spring and may be carried by high water to the lower reaches of rivers or into brackish water (Stein et al. 1973). However, only 1 juvenile (160 mm in length) and 5 immature inconnu (maturity class 2), ranging in length from 340 to 596 mm were caught throughout the entire study.

Inconnu ranged in length from 160 to 812 mm (n=31) and were 3 to 14 years of age. All fish older than six years were mature (Figure 35). However, only 3 from a sample of 46 examined appeared to be approaching spawning condition. This may indicate that the population in coastal waters is composed largely of non-spawning adults. The presence of older non-ripe fish suggests that individuals do not spawn annually.

Inconnu were most numerous to the east in the vicinity of Shingle Point. West to Stokes Point inconnu were caught in small numbers (Figure 24). This species has been reported as far west as Herschel Island (McAllister 1962) and Nunaluk Lagoon (Griffiths et al. 1975).

Inconnu may overwinter in the area of Mackenzie Bay; five were caught offshore of Shingle Point in March of 1973 (Jones and Kendel MS 1973).

Inconnu are also known to inhabit several of the tundra lakes adjoining our study area, however the role of these fish in relation to coastal populations has not been established.

Results from stomach analysis of inconnu appear in Table 18 and Figure 42. Inconnu were one of the most selective feeders, feeding almost entirely upon fish (99.9%) and to a much lesser degree on isopods (0.1%). Least and Arctic cisco together formed 56.8% of the diet. The size of cisco preyed upon ranged in length from 30 to 375 mm. Ninespine stickleback, boreal smelt and fourhorn sculpin were also eaten by inconnu. During the 1975 summer survey mysids and adult Arctic lamprey were recorded in stomachs. Alt (1965) and Hatfield et al. (1972) have also demonstrated the dominance of fish in the diet of inconnu, although a variety of insects was found to occur in stomachs of inconnu inhabiting freshwater.

In this study, a relatively high percentage (59.5%) of all inconnu stomachs were empty. This figure corresponds with the value given by Hatfield et al. (1972)[2] for Mackenzie River specimens (55%) but is significantly greater than those reported by Alt (1965, 1969) of 23% and 28.6% respectively. It is not clear why the frequency of empty stomachs was high in our study. The catch per unit effort (Table 11) and relative abundance data (Figure 17) show substantial populations of forage species in all areas inhabited by inconnu. It is unlikely that complete digestion could have occurred after capture since all but two of the inconnu sampled were removed from the gillnets within hours of setting.

5.6.9 Arctic flounder

A total of 25 Arctic flounder was captured by seine and gillnet within the study area during 1974. The length range of a sub-sample (n=21) was 105 to 300 mm. During the 1975 summer survey an additional 14 individuals were captured, 2 of which were juveniles. However, no data other than occurrence was recorded.

This species was recorded from most coastal stations including lagoons and estuaries (Figure 25). To the east, Percy et al. (1974) found Arctic flounder of the same size range to be between 5 and 12 years old. Griffiths et al. (1975) reports fish from the Nunaluk area aged 4 to 19 years with the majority in the 6 and 7 year classification (141 to 220 mm lengths). Sexual maturity was reached by age 5.

Spawning areas and times of migrations are not known.

5.6.10 Starry flounder

Five starry flounder ranging in length from 33 to 220 mm were taken by gillnet and seine during 1974, all but one being mature males. In 1975 an additional 9 were captured. One fry and 1 juvenile were encountered at this time. In both years their distribution was limited to Stokes Point Lagoon and Phillips Bay (Figure 25). Off the coast of British Columbia, starry flounder are most commonly found in shallow waters on sandy bottoms and spawning occurs in late winter and early spring over the same substrate (Hart 1973).

The movements of this species are not known.

Because of the small sample size (n=13) of Arctic and starry flounder stomachs, the results and discussions on their feeding habits are combined. This does not necessarily mean that their diets are similar. The data summarized in Table 19 and Figure 43 strongly reflects the demersal habits common to both species. Crustaceans accounted for 68.2% of the average diet with amphipods (29.7% by volume) and isopods (32.1%) being the prominent members of this food group. A substantial portion (18.0%) of the diet consisted of organic debris likely ingested incidentally while the fish were feeding on pelecypoda and other benthic organisms. In Pacific coastal regions starry flounder are known to feed on a variety of shellfish,worms and small fishes (Hart 1973).

5.6.11 Pacific herring

A total of 12 Pacific herring was captured during the summer studies at the following locations: Pauline Cove (n=1), Stokes Lagoon (n=5), Phillips Bay (n=5); and King Point (n=1). During the 1975 May survey one was captured off Sabine Point (Figure 26). All were mature fish of uniform size ranging from 225 to 232 mm in total length.

The occurrence of Pacific herring increases east of the Tuktoyaktuk Peninsula but their distribution is patchy (Hunter 1975). Galbraith and Fraser (1974) found herring to be the only marine species taken in appreciable numbers in the coastal waters of the southeastern Beaufort Sea.

Based on the examination of 34 mature female herring from Tuktoyaktuk, Riske (1960) assumed that spawning occurred in late June to July at which time inshore migrations occurred.

The herring is considered to be primarily a plankton feeder, however, the stomachs of 4 herring caught in this study contained only mysids.

Clemens and Wilby (1967) emphasize the role of herring as a prey species being utilized in various stages of its development by crustaceans, jelly fish, fish, birds and marine mammals.

5.6.12 Capelin

Only 4 capelin were captured within the study area. Three mature males were netted on August 8, 1975 at Stokes Lagoon and a gravid female was caught on August 7, 1975 between Roland Bay and Whale Cove (Figure 26). Length range was 117 to 139 mm. Otolith age of the female was 5 years.

Capelin were recorded spawning on the gravel beaches at Pauline Cove and Simpson Point from July 24 to 30, 1960 at which time they were so abundant that 1,500 to 1,600 pounds were seined with 8 hauls of a 60 foot seine (McAllister 1962).

Of the 4 stomachs examined, 2 contained mysids and 2 were empty.

5.6.13 Arctic lamprey

Only 3 adult lamprey (125 to 177mm length) attached to the bodies of least cisco were taken at King Point and Shingle Point (Figure 27). Another 3 were observed attached to Arctic cisco but fell off the fish before they could be landed. An estimate of 30 to 40% of the least cisco in these areas had external abrasions which appeared to be lamprey scars. Adult lamprey were found in stomachs of Arctic char from Herschel Island and char and inconnu from Stokes Point. At Herschel Island, McAllister (1962) observed what he believed to be an Arctic lamprey attached to the back of a smelt. Lamprey are known to spawn in the Mackenzie River system from late May to early July. The movements of this species within the study area are unknown.

5.6.14 Ninespine stickleback

A total of 129 ninespine stickleback was captured in creeks, bays and lagoons along the Yukon coast (Figure 27). A sample of 43 sticklebacks taken from Whale Cove ranged in length from 32 to 56 mm. Age and growth data are not available.

The movements of ninespine stickleback are not known, however, they are not thought to migrate far from those coastal areas having freshwater inflows.

Ninespine stickleback were utilized as forage by several species including least cisco, Arctic cisco, humpback whitefish, inconnu and burbot.

The only food items found in 10 stomachs were chironomid larvae and diptera fragments.

Authors who have recorded this species from coastal areas include McPhail and Lindsey (1970), Percy et al. (1974) and Steigenberger et al (1975)[2].

5.6.15 Arctic grayling

A total of 9 Arctic grayling was caught, all from estuaries and lagoons (Figure 27). Grayling are not considered to be a significant part of the fish resources of the coastal waters, although they are the most abundant species in many of the coastal rivers (Bryan 1973; Bryan et al. 1973).

Life history information for this species in Beaufort Sea drainages in the Yukon Territory is described by de Bruyn and McCart (1974).

5.6.16 Arctic cod and saffron cod

Only 1 Arctic cod (67 mm in length) and 4 saffron cod (257 to 430 mm in length) were captured during the study. Saffron cod were taken from Shingle Point, King Point, Phillips Bay and Whale Cove. A single juvenile

Arctic cod was caught on the southeast shore of Herschel Island (Figure 28). Arctic cod were gillnetted in Pauline Cove in April 1974 (Steigenberger 1975, pers. comm.).

Information on spawning times, movements and feeding habits are not known for these species along the Yukon coast.

Authors who have recorded information pertinent to cod from the southeastern Beaufort Sea are: McAllister (1962); McPhail and Lindsey (1970); Hunter MS (1975); and Percy et al. (1974).

5.6.17 Burbot

In 1974, catches of burbot were limited to the low salinity waters of Shingle Point where 9 mature specimens (460 to 720 mm in length) were captured. In 1975, a single specimen was captured at Kay Point (Figure 28). However, burbot have been captured as far west as Herschel Island (B. McKenzie 1974, pers. comm.). They are known to spawn in rivers and lake shallows during late fall and early winter.

Arctic and least cisco appear to be the primary food source for burbot inhabiting the coastal waters of the Yukon. Combined, these two species constituted an average 76.9% by volume of the diet in a sample of 8 fish. Fourhorn sculpins (14.3% by volume), ninespine stickleback (0.1%) and isopods (8.7%) were the only other food items recorded. By comparison, burbot inhabiting the Mackenzie River have a more diverse diet including a wide variety of insects, crustaceans and fish common to these waters (Hatfield et al. 1972)[2].

5.6.18 Northern pike, round whitefish and longnose sucker

Only two round whitefish and one each of northern pike and longnose sucker were captured during 2 seasons of sampling. All are freshwater species and are considered to contribute little to the overall fish resources of the coastal waters. Figure 29 shows the distribution of these species.

6.0 RESOURCE USE

6.1 Historic and present fisheries

The historic use of the fisheries resource along the Yukon coast is not well documented. A summary of the available information along with some recent catch figures are summarized by Steigenberger *et al*. (1975)[1], Hunter MS (1975) and Currie (1964).

In 1826 Franklin explored the Yukon coast and found numerous Eskimo camps along the beaches between the Mackenzie River and Demarcation Point. He stated that Herschel Island was often frequented by these people because it abounded with fish and caribou. Between 1889 and 1938 the area was the centre of activity, first as a whaling station and later as a fur trading post. At the turn of the century approximately 3,000 people inhabited Herschel Island. Since that time the population along the Yukon coast has declined to less than 20 permanent residents.

The existence of more recently abandoned Eskimo dwellings at Shingle Point, King Point, Phillips Bay, Stokes Point, Roland Bay, Whale Cove, Ptarmigan Bay and Herschel Island indicates that subsistence fishing for dog food and human consumption was of prime importance to coastal natives. Unfortunately no records are available on the numbers or species of fish caught. The most recent catch figures available are those from the R.C.M.P. post at Herschel Island. In 1955, 489 lake herring (cisco), 441 sculpins, 296 inconnu, 215 flounder and 207 Arctic char were caught; and in 1956, 2,318 lake herring, 777 sculpin, 588 Arctic char, 223 flounder and 10 smelt were taken. Currie (1964) reports that in 1963 the R.C.M.P. catch with 10 nets was 5,000 Arctic char after 10 days of fishing. The number of cisco taken during this time was not reported, but it is suspected to be equal to, or greater than, that of char. Currie also reports that in 1960 at Shingle Point the NA and NR Welfare Project took 18,000 pounds of fish in a few days with sweep nets and that in 1961, 12,000 pounds were taken.

Between 1965 and 1966 a commercial fishery was conducted at Herschel Island and the Mackenzie River Delta by the Menzie Fish Company. The record of catches reported by the company is inconsistent. These figures for both fishing areas combined are : 11,804 pounds (4722 fish) to 16,084 pounds (6434 fish) of char and 19,930 pounds of whitefish in 1965; and 2,222 pounds (889 fish) to 3,200 pounds (1280 fish) of char and 54,000 to 63,998 pounds of whitefish in 1966. Conversions from pounds to pieces of Arctic char is based on an average weight of 2.5 pounds, a similar conversion for whitefish is not possible since species were not defined.

The reason for the failure of this operation is not known, but it was probably related to either the economic feasibility of the fishery or over-exploitation of the char populations.

At present, subsistence fisheries are conducted at Herschel Island, Shingle Point and Shoalwater Bay. One fisherman estimated that 250 fish are required to supply the needs of his family for one year, excluding dog food (Steigenberger *et al*. 1975)[1].

Steingenberger *et al*. (1975)[1] recorded the domestic catch at Herschel

Island between 1971 and 1973. During that time 10 to 12 people and 35 dogs inhabited the island. Annual catches varied from 203 to 1,000 char. The only estimate of the number of cisco caught was made in 1972 when more than 1,500 were taken. An estimate of total numbers of whitefish and char caught in the domestic fishery along the Yukon coast was also presented. These figures ranged from 500 to 1,200 char and from 561 to 1,000 whitefish.

At present, the recreational use of the fisheries resources of the area is low, the major pressure coming from research groups and DEW-line Station personnel.

From this discussion, it is clear that the current fishery along the Yukon coast is minimal compared to past use. Our studies and past records indicate that the small harvest does not reflect abundance but is an expression of the lack of utilization and fishing effort.

It must be emphasized that the cisco are an anadromous species and are part of the Mackenzie River stocks. As such, they are utilized more extensively in other areas, particularly in the communities of Aklavik, Fort McPherson and Arctic Red River, than on the coast.

6.2 Coastal fish as part of the food web

The Arctic marine environment, like the other marine environments, is a complex system of organisms many of which directly or indirectly influence a number of other life forms. Two major differences exist between the aquatic resources of the Arctic and those of the more temperate zone. These are a lower species diversification and a lower level of production. Sprague (1973) predicts that the lack of diversity makes the system more vulnerable to disruption since the loss of a single species may seriously disrupt the food chain, resulting in violent changes at many levels.

Fish are secondary consumers, feeding primarily on other secondary consumers. The fish, in turn, are utilized as forage for other animals including their own kind. Arctic char, Arctic cisco, least cisco, inconnu and fourhorn sculpin are known to be piscivorous to varying degrees.

At least 12 species of birds commonly found in the area utilize fish as a food source. Of these, 5 species are known to feed primarily on fish, (Watson and Divoky 1974; D. Mossop 1976, pers. comm.).

Ring seals are abundant in the western portion of the study area. These marine mammals are known to feed almost exclusively on fish (Arctic cod) during the winter months (T. Smith 1976, pers. comm.). This was substantiated by observation made in April 1974 during the examination of the stomach contents of a ring seal taken offshore of Stokes Point. Information regarding the feeding habits of the bearded seal which also frequents these waters is lacking.

Sergeant and Hoek (1974) report that 75% (n=58) of the beluga whales in the Mackenzie River had empty stomachs. Of those with food, squid, fish and crustacea were the common food items. The fish were anadromous species such as least cisco. Sergeant and Hoek (1974) also report the apparent feeding of beluga on herring close to the southeast shore of Baillie Islands. A similar observation was made by our crew near Shingle Point where least cisco were the apparent prey.

7.0 AREAS OF CONCERN

The possible general effects of an oil spill on the fishery resources have been previously presented. Our studies indicate that during the summer months anadromous species, which comprise the bulk of the fish inhabiting the coastal waters, would be most vulnerable to disruption. Marine species, excluding fourhorn sculpin, on the other hand, are not so abundant in coastal waters hence are less likely to be affected. The lack of information on distribution and relative abundance of fish during the winter months makes a statement on vulnerability difficult for that time period. Of primary concern would be the overwintering areas (for anadromous species) where fish may be highly concentrated.

Some areas that could be critically affected by an oil spill or other activities related to offshore drilling are defined below.

7.1 Mackenzie Estuary

The shallow coastal waters bounded by Trent Bay to the east and Sabine Point to the west have an abundance of fish. During the summer this area is frequented by at least 11 species and catch per unit effort was four times that of other areas sampled. We suspect several species including Arctic cisco, inconnu, least cisco and fourhorn sculpin overwinter in the area and thus reside in the warmer freshwater from the Mackenzie River. It is also known to be on the migration route of anadromous species which spawn in the Mackenzie River or its tributaries and therefore plays an important role in premigrational staging. Since the Mackenzie River is thought to be the major contributor to anadromous fish populations, any large scale mortality could be reflected in a reduction in populations utilizing the coastal waters and Mackenzie River system.

7.2 Sediment sinks

The two sediment sinks are located along the Yukon coast, one at Phillips Bay and the other at Workboat Passage between Herschel Island and the mainland (Figure 1). These areas, particularly Phillips Bay, contain large numbers of fish and are used as feeding and rearing areas. Phillips Bay is also thought to be a pre-migrational staging area for Arctic char which spawn and overwinter in the Babbage River.

7.3 Bays and lagoons

Bays and lagoons are used by several species for feeding and rearing young. Of particular importance are those bays and lagoons with annual sea access. Stokes Lagoon, for example, contains large fish populations and provides summer habitat for at least 10 species of fish and is suspected to be a spawning area for fourhorn sculpin. In addition it is known to be a feeding and rearing area for fry of fourhorn sculpin, boreal smelt and Arctic cisco.

7.4 Coastal margins

The concentrations of fish along the coastal margin of the Beaufort Sea is high. The use of these areas for feeding, particularly west of Kay Point has been confirmed. Migrations of anadromous species along the coast are known to occur between early summer and late fall. In addition, spawning of one marine species is known to occur along the gravel shores of Herschel Island.

7.5 Vulnerability of anadromous species

The risk of change to the environment through disruption is high. However, the life history pattern of anadromous Arctic fish populations is such that they can withstand short term and to a lesser degree long term fluctuations of the marine environment. The reasons for this are:

(i) Spawning occurs in freshwater, hence mass disruption of this critical life stage is not likely to occur;

(ii) Residence at sea of mature populations is limited to 2 to 3 months annually;

(iii) The distribution of species is widespread;

(iv) The great variance of age classes ensures that survival is not dependent on any single year class (Craig and McCart 1975); and

(v) Differences in habitat preference by various life stages ensures that entire populations are not affected by disruptions in a given area.

From this, it is evident that a single isolated disturbance is not likely to eliminate an entire population. However, development may produce chronic pollution problems which can in the long term cause a general weakening and decline in populations.

8.0 RECOMMENDED SAFEGUARDS

If offshore drilling is to proceed in a manner acceptable to both industry and government agencies, safeguards to protect the environment that are agreeable to both parties must be established. With the view of minimizing the deleterious effects arising from activities associated with offshore exploratory drilling on fish populations the following recommendations are put forth for consideration. The list is not complete and must be updated as more specific information becomes available.

These recommendations are:

1. that bays and lagoons be left in their natural state;

2. that spilled oil be prevented from reaching the shore-line or nearshore areas;

3. that drilling muds and fluids not be released into the water unless they are shown to be non-toxic to fish and other aquatic organisms;

4. that waste fuels, lubricants, bilge fluids, detergents and other toxic substances used in drilling or vessel operation be contained and disposed of by non-polluting techniques;

5. that storage facilities for refined or recovered petroleum products and other toxicants be stored on shore in metal containers surrounded by impervious dykes, and that the reservoir inside the dykes be of a volume at least equal to the total volume of the surrounded containers;

6. that the structures described above be no closer than 0.5 km to any water body inhabited by fish or with access to such waters;

7. that no wastes, garbage or unsalvageable equipment be disposed of outside of an area designated for that purpose;

8. that no containers be washed in waters inhabited by fish or with access to such waters;

9. that hoses, nozzles and other dispensing equipment be continually inspected for leaks and spills (electronic surveillance preferred);

10. that all spills of petroleum or other pollutants be reported immediately to the appropriate authorities;

11. that no explosives be used below high water level without the permission of the Fisheries and Marine Service, or other designated authority;

12. that breakwaters or any solid shore-attached structures that

extend more than 0.25 km seaward be made pervious to fish at regular intervals commencing at the beach;

13. that sports fishing be restricted by the Fisheries and Marine Service in areas where such activity may cause a severe reduction in fish stocks;

14. that oil spill counter measures and equipment be continually renewed or upgraded and be on hand as new developments or ideas are made available;

15. that gravel required for support facilities such as roads, airstrips, gravel pads, rip-rap, etc. not be removed from any stream, lake, lagoon, other waterbody, or spit, unless a permit has been issued. All areas of gravel removal must be graded level so that they will not trap fish when the water level recedes;

16. that water may be removed for general use under the following conditions:

    (a) the water supply at the proposed site must be sufficient that the amount of fish habitat will not be greatly reduced;

    (b) the water intakes must be equipped with screens made of material approved by Fisheries and Marine Service and built to specifications outlined by the Service:

    (c) siltation is to be minimized during water discharge;

17. that a team of environmental representatives including one fisheries specialist be appointed to oversee activities in order that decisions pertaining to environmental safeguards can be made on site.

9.0 CONCLUSIONS

1. The overall fish species diversification in the Yukon coastal waters is low. Twenty-one species were recorded during the 1974 and 1975 field programs. Of these, only seven are considered to be marine fishes.

2. Anadromous cisco were the most frequently captured and widely distributed species in 1974 and 1975.

3. The relative abundance and distribution of species varies from year to year, particularly west of Kay Point.

4. Fish are concentrated mainly nearshore, in bays, lagoons and estuaries. The greatest concentrations occur in the Shingle Point and Trent Bay areas where catch per unit effort was four times greater than that found in other areas.

5. Due to the increasing abundance of anadromous fish (excluding Arctic char) from Herschel Island to the Mackenzie River, we conclude that the majority of anadromous fish species are of Mackenzie River origin. Tag recovery information supports this for Arctic cisco.

6. The summer distribution of marine and anadromous fish populations is influenced by water salinity and/or temperature.

7. The winter range of marine and anadromous species is limited by the freshwater influence of the Mackenzie River. We suspect that as winter progresses and the Mackenzie River flow diminishes, the range of anadromous species becomes increasingly more restricted. By late winter it does not extend beyond Sabine Point. Arctic cod and Pacific herring inhabit marine waters in winter while fourhorn sculpin are found in marine and fresh water.

8. The feeding habits of the coastal fish varies with species and area. Crustaceans, insects, fish and pelecypods comprise the diet of most species although some species such as fourhorn sculpin and inconnu are more selective.

9. The most important feeding areas for fish occur west of Kay Point in bays, lagoons and in coastal waters of the mainland and Herschel Island.

10. Due to high concentrations of anadromous fish in Trent Bay. most of which had empty stomachs, we conclude that this region is utilized as a staging area rather than a feeding ground.

11. The availability of food organisms is not a primary limiting factor on fish distribution.

12. Movements of mature, fall spawning species can be generalized as an up-stream migration to spawning areas commencing in mid summer, followed by a post spawning downstream migration. Spring spawning species move into spawning streams prior to breakup of coastal waters and return to the sea soon after spawning. Juveniles and non-spawning adults are thought to move to overwintering areas in rivers and delta regions during late summer and early

fall. Newly emerged fry spend variable amounts of time in freshwater before moving down to coastal waters.

13. The movement of various anadromous populations to coastal waters occurs after breakup of the coastal rivers when nearshore waters have warmed and become brackish.

14. The life history pattern of anadromous species is such that a severe isolated disturbance may not result in the total elimination of the populations. However, continual exposure of several age classes to a factor having adverse effects on the aquatic system, may result in a decline in fish populations.

15. The domestic use of the fishery resource in the study area is currently low. Historic information shows that the potential to support a much heavier use exists.

16. If safeguards and restraints are followed by the developer, adverse effects on the fish populations can be minimized.

17. Fish play an important role in the food web of the Arctic environment and a decline in any species may have far reaching effects.

10.0 NEED FOR FURTHER STUDY

Because there is such variability of species abundance and distribution, efforts should be made to continue studies over several years with greater concentration on specific areas and species. With the number of fish inventories now available, synoptic surveys over large areas have outlived their usefulness. What is required are continuing programs on specific topics and areas of importance. Times of migrations must be pinpointed and spawning areas defined for most species. Study into the effects of oil on the behaviour and well-being of Arctic fish is essential. How shore-oriented species react when confronted with physical or chemical barriers to migrational pathways is still unknown. Very little is known about overwintering fish populations or the importance of the fresh waters of the Mackenzie Bay and Delta as a winter refuge for anadromous species.

11.0 REFERENCES

Alt, K.T. 1969. Taxonomy and ecology of the inconnu, *Stenodus leucichthys nelma*, in Alaska. University of Alaska, Biological Papers, Fairbanks No. 12: 63 p.

Alt, K.T. 1965. Food habits of inconnu in Alaska; Trans. Amer. Fish. Soc. 94: 272-274.

Bain, L.H. 1974. Life histories and systematics of Arctic char *Salvelinus alpinus*, (Linn.) in the Babbage River system, Yukon Territory. IN: P.J. McCart (ed.). Life histories of three species of freshwater fishes in Beaufort Sea drainages, Yukon Territory. Canadian Arctic Gas Study Ltd., Calgary. Biological Report Series, Vol.18(4): 100 p.

Brooks, J.W., C. Bartonek, D.R. Klein and D.L. Spencer. IN: A.S. Thayer (ed.), 1971. Environmental influences of oil and gas development in the Arctic Slope and Beaufort Sea. United States Dept. of the Interior, Fish and Wildlife Service. Resource Publication No. 96.

Bryan, J.E. 1973. The influence of pipeline development on freshwater fishery resources of northern Yukon Territory. Aspects of research conducted in 1971 and 1972. Environmental-Social Committee Northern Pipelines, Task Force on Northern Oil Development, Vancouver. Report No. 73-6: 63 p.

Bryan, J.E., C.E. Walker, R.E. Kendel and M.S. Elson. 1973. Freshwater aquatic ecology in northern Yukon Territory. Environmental-Social Committee Northern Pipelines, Task Force on Northern Oil Developments, Vancouver. Report No. 73-21: 46 p.

Campbell, W.J. and S. Martin. 1973. Oil and ice in the Arctic Ocean. Possible large scale interaction. Science 181. No. 4094: 56 p.

Chen, E.C. 1972. Arctic winter oil spill test. Department Environment, Inland Water Directorate, Technical Bull. No. 68.

Clemens, W.A. and G.V. Wilby. 1967. Fishes of the Pacific Coast of Canada. Fish. Res. Bd. Canada, Bull. 68,Ottawa.

Craig, P.C. and G.J. Mann. 1974. The life history and distribution of the Arctic cisco *Coregonus autumnalis* along the Beaufort Sea coastline in Alaska and Yukon Territory. IN: P.J. McCart (ed.), Life histories of anadromous and freshwater fishes in the Western Arctic. Canadian Arctic Gas Study Ltd., Calgary. Biological Report Series, Vol. 20 (4).

Craig, P.C. and P. McCart. 1975. Fish utilization of nearshore coastal waters between Colville and Mackenzie Rivers with an emphasis on anadromous species. Canadian Arctic Gas Study Ltd., Calgary. Biological Report Series (in press).

Craig, P.C. and P. McCart. 1974. Classification of stream types in Beaufort Sea drainage between Prudhoe Bay, Alaska and the Mackenzie Delta. IN: P.J. McCart (ed.). Classification of streams in Beaufort Sea drainages and distribution of fish in Arctic and sub-Arctic drainages. Canadian Arctic Gas Study Ltd., Calgary, Alberta. Biological Report Series, Vol. 17(1): 47 p.

Craig, P.C. and P. McCart 1974. Fall spawning and overwintering areas of fish populations along routes of proposed pipeline between Prudhoe Bay, Alaska and Mackenzie Delta 1972-73. IN: P.J. McCart (ed.), Fish research associated with proposed gas pipeline routes in Alaska, Yukon and Northwest Territories. Canadian Arctic Gas Study Ltd., Calgary, Alberta. Biological Report Series 15(3):36 p.

Currie, R.D., MS. 1964. The Yukon Territory Littoral. An Economic Development Program Industrial Divison, Department of Northern Affairs and National Resources, Ottawa.

de Bruyn, M and P. McCart.1974. Life history of the grayling, *Thymallus arcticus*, in Beaufort Sea drainages in the Yukon Territory. IN: P.J. McCart (ed.), Fisheries research associated with proposed gas pipeline routes in Alaska, Yukon and Northwest Territories. Canadian Arctic Gas Study., Calgary. Biological Report Series, Vol. 15(2) 39 p.

Dunbar, M. 1973. The Arctic and sub-Arctic marine environment. IN: D.H. Pimlott, K.M. Vincent and C.E. McKnight (eds.) Arctic Alternatives, Mail-O-Matic Printing, Ottawa. 284-288.

Evans, D.R. and S.P. Rice. 1974. Effect of oil on marine ecosystems: A review for administrators and policy makers. Fishery Bulletin. Vol. 72, No. 4: 625-637.

Galbraith, D.F. and D.C. Fraser, 1976. Fishes of Offshore Waters and Tuktoyaktuk Peninsula. Beaufort Sea Project technical report #7. Department of the Environment, Victoria, B.C.

Glova, G. and P. McCart. 1974. Life history of Arctic char, *Salvelinus alpinus* in the Firth River, Yukon Territory. IN: P.J. McCart (ed.), Life histories of anadromous and freshwater fishes in the Western Arctic. Canadian Arctic Gas Study Ltd., Calgary. Biological Report Series. Vol. 20(3) : 37 p.

Griffiths, W., P. Craig, G. Walder and G. Mann. 1975. Fisheries investigation in a coastal region of the Beaufort Sea - Nunaluk Lagoon, Yukon Territory. Aquatic Environments Ltd., Calgary. (in press).

Griffiths, W., A. Sekerak and M. Jones. 1974. Distribution of fish species along alternative gas pipeline corridors in Alaska, and the Yukon Territory IN: P.J. McCart (ed.), Classification of streams in Beaufort Sea drainages. Canadian Arctic Gas Study Ltd., Calgary. Biological Report Series Vol. 17(2):176 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Bd. Canada Bull. 180. Ottawa.

Haig-Brown, R. 1972. Views of a prominent conservationist in pollution and the fisheries. EPSG - WP - 72 - 2.

Hatfield, C.T., J.N. Stein, M.R. Falk and C.S. Jessop. 1972[1]. Fish resources of the Mackenzie River Valley. Environment Canada, Interim Report Vol. 1. Winnipeg, Manitoba. 247 p.

Hatfield, C.R., J.N. Stein, M.R. Falk, C.S. Jessop and D.N. Shepherd. 1972[2]. Fish resources of the Mackenzie River Valley. Environment Canada, Interim Report Vol. 11. Winnipeg, Manitoba. 289 p.

Hill, R.M. 1971. The Arctic environment and petroleum pipelines. Muskox 9: 35-41.

Holcomb, R.W. 1969. Oil in the ecosystem. Science Vol. 166: 204-206.

Hunter, J.G., M.S. Fishery resource of the Western Arctic. (ed.) A.W. Mansfield (1975). FRBC Manuscript Report Series (Biological) No. 1335 Arctic Biological Station. Ste. Anne de Bellvue, P.Q. 24 p.

Jones, M., and R. Kendel. 1973. The Beaufort Sea gillnetting program in the vicinity of King Point, Yukon. Memorandum Report. Department of Environment, Fisheries and Marine Service, Whitehorse, Y.T.

Mann, G.J. 1974. Life history types of the least cisco, *Coregonus sardinella*, (Valenciennes) in the Yukon Territory, North Slope and eastern Mackenzie River Delta drainages. IN: P.J. McCart (ed.), Life histories of three species of freshwater fishes in Beaufort Sea drainages, Yukon Territory. Canadian Arctic Gas Study Ltd., Calgary. Biological Report Series. Vol. 18(3): 160 p.

McAllister, D.E. 1961. Revised keys to the marine fishes of Arctic Canada. National Museum of Canada, Ottawa. Natural History Paper No. 5: 17 p.

McAllister, D.E. 1962. Fishes of the 1960 "Salvelinus" Program from western Arctic Canada. National Museum of Canada, Ottawa. Bull. 185.

McCart, P., P. Craig and H. Bain. 1972. Report of fisheries investigations in the Sagavanirktok River and neighbouring drainages. Report to Alyeska Pipeline Service Co., Bellevue, Washington. 186 p.

McDonald, B.C. and C.P. Lewis. 1973. Geomorphic and sedimentologic processes of rivers and coast, Yukon coastal plain. Environmental-Social Committee, Northern Pipelines, Task Force on Northern Oil Development. Report No. 73-39.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Fisheries Res. Bd. of Canada. Bulletin No. 173: 381 p.

Mutch, R.A. and P. McCart. 1974. Springs within the northern Yukon drainage system (Beaufort Sea drainage) IN: P.J. McCart (ed.) Fisheries research associated with proposed gas pipeline route in Alaska, Yukon and Northwest Territories. Canadian Arctic Gas Study Ltd., Calgary, Biological Report Series Vol. 15(9):30 p.

Percy, R., 1976. Fishes of the Outer Mackenzie Delta. Beaufort Sea Project technical report #8. Department of the Environment, Victoria, B.C.

Quast, J.C. 1974. Density distribution of juvenile Arctic cod, *Boreogadus saida*, in the eastern Chukchi Sea in the fall of 1970. Fishery Bull. 72-4, 1094-1105.

Ramseier, R.O. 1974. Oil on Ice Environment. Vol. 16, No. 4: 14 - 6.

Riske, M.E. 1960. A comparative study of north Pacific and Canadian Arctic herring, *Clupea*. A dissertation for M. Sc. degree. Department of Zoology, University of Alberta.

Sergeant, D.E. and W. Hoek. 1974. Seasonal distribution of bowhead and white whales in the eastern Beaufort Sea. Arctic Biological Station, Dept. of Environment Fisheries and Marine Service. IN: J.C. Reed and J.E. Sater (eds.). The coast and shelf of the Beaufort Sea. Proceedings of a symposium on Beaufort Sea coast and shelf research. Arctic Institute of North America, Arlington, Virginia. 705-719.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fish. Res. Bd. Canada. Bull. No. 184:966 p.

Sprague, J.B. 1973. Aquatic resources in the Canadian North: Knowledge, dangers and research needs. IN: D.H. Pimlott, K.M. Vincent and C.E. McKnight (eds.) Arctic Alternatives, Mail-O-Matic Printing, Ottawa. 169-189.

Steigenberger, L.W., M.S. Elson and R.T. Delury. 1975[1]. Northern Yukon Fisheries Studies 1971 - 1974 Vol. 1. Department of the Environment, Fish Mar. Serv., Northern Operations Branch, Vancouver. PAC/T 75-19.

Steigenberger, L.W., R.A. Robertson, K. Johansen, M.S. Elson. 1975[2]. Biological Engineering evaluation of the proposed pipeline crossing sites in Northern Yukon Territory. Fish Mar. Serv. Pacific Region, Vancouver. PAC/T-75-11.

Stein, J.N., C.S. Jessop, T.R. Porter and K.T.J. Chang-Kue . 1973. Fish resources of the Mackenzie River Valley.D.O.E., Fish. Mar. Serv. Winnipeg, Interim Report II:260 p.

Tesch, F.W. 1971. Age and growth. IN: W.E. Ricker (ed.) Methods for assessment of fish production in fresh water. Int. Biol. Programme. Oxford. Handbook No. 3: 93-123.

Wacasey, J.W. 1974. Zoobenthos of the southern Beaufort Sea. IN: J.C. Reed and J.E. Sater (eds.). The coast and shelf of the Beaufort Sea. Proceedings of a symposium on Beaufort Sea Coast and Shelf Research. Arctic Institute of North America. Arlington, Virginia. 697-704.

Watson, G.E. and G.J. Divoky. 1974. Marine birds of the western Beaufort Sea IN: J.D. Reed and J.E. Sater (eds.). The coast and shelf of the Beaufort Sea. Proceedings of a symposium on Beaufort Sea Coast and Shelf

Research. Arctic Institute of North America. Arlington, Virginia. 681-695.

Windell, J.T. 1971. Food analysis and rate of digestion. IN: W.E. Ricker (ed.). Methods for assessment of fish production in freshwater. Int. Biol. Programme. Oxford. Handbook No. 3: 215-226.

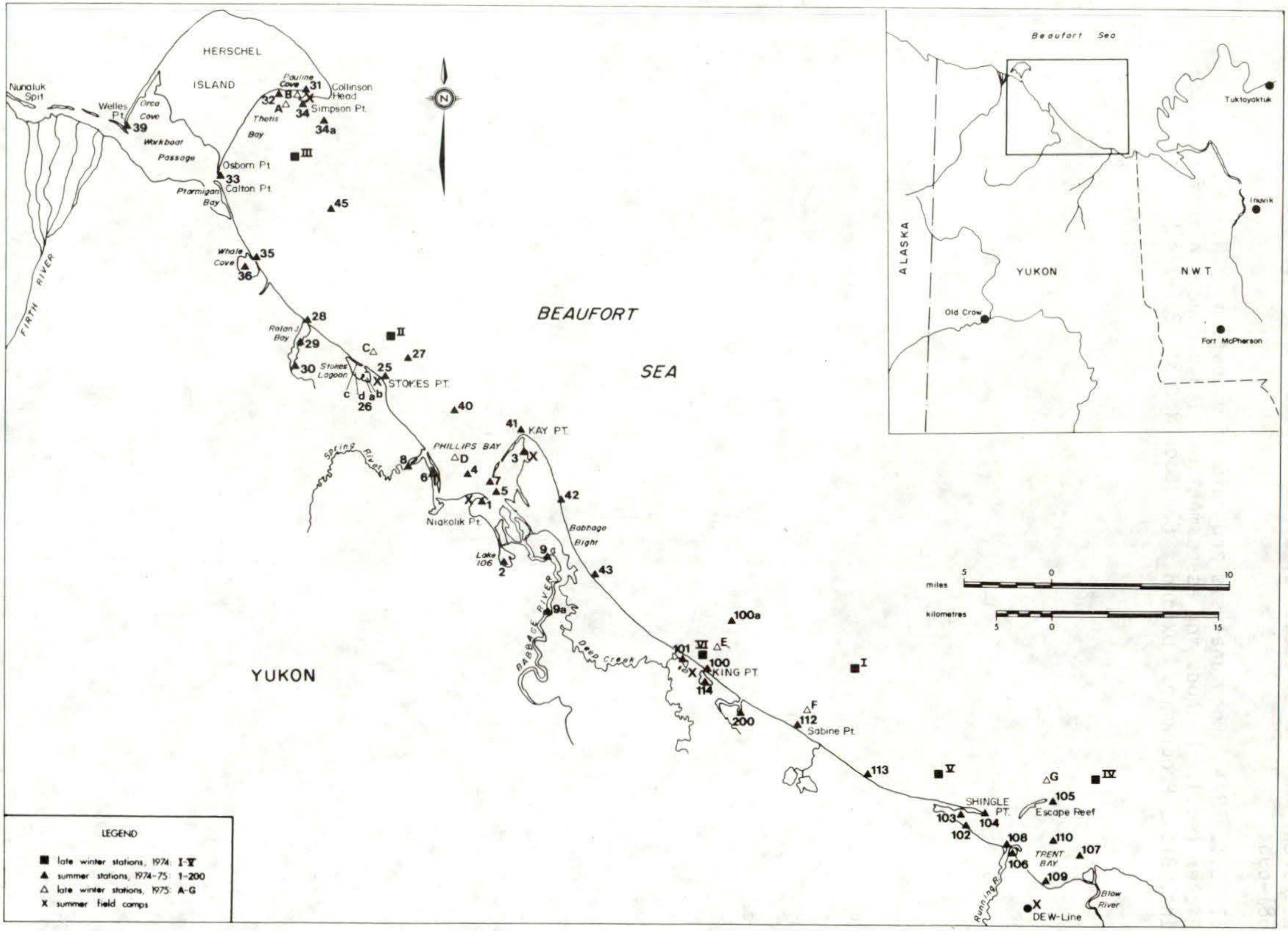


Figure 1 Map of study area showing locations of sampling stations and field camps.

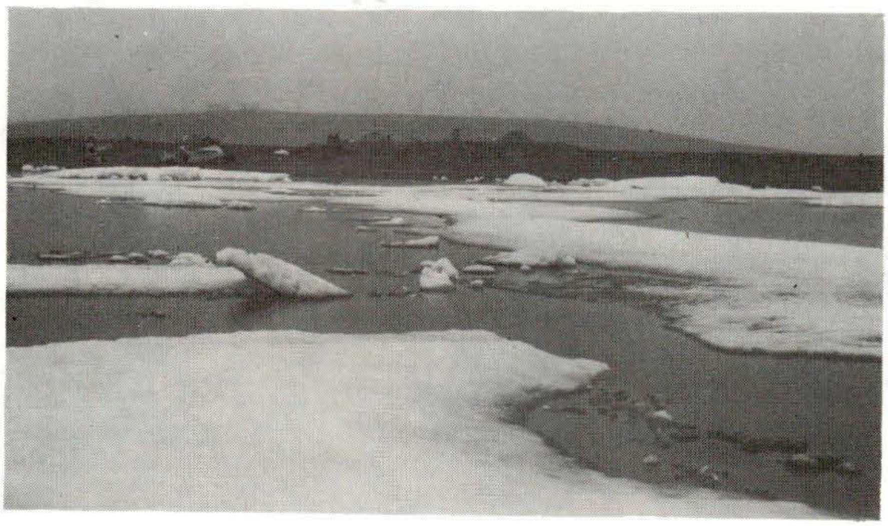
Figure 2. Coastline between Kay Point and Babbage Bight, looking southeast. The line of driftwood shows the level of storm surges.

Figure 3. Washover-slope on the lagoon-side of Roland Bay.

Figure 4. Beach consisting of mud and organic matter along the east side of Roland Bay.

A.

B.



C.

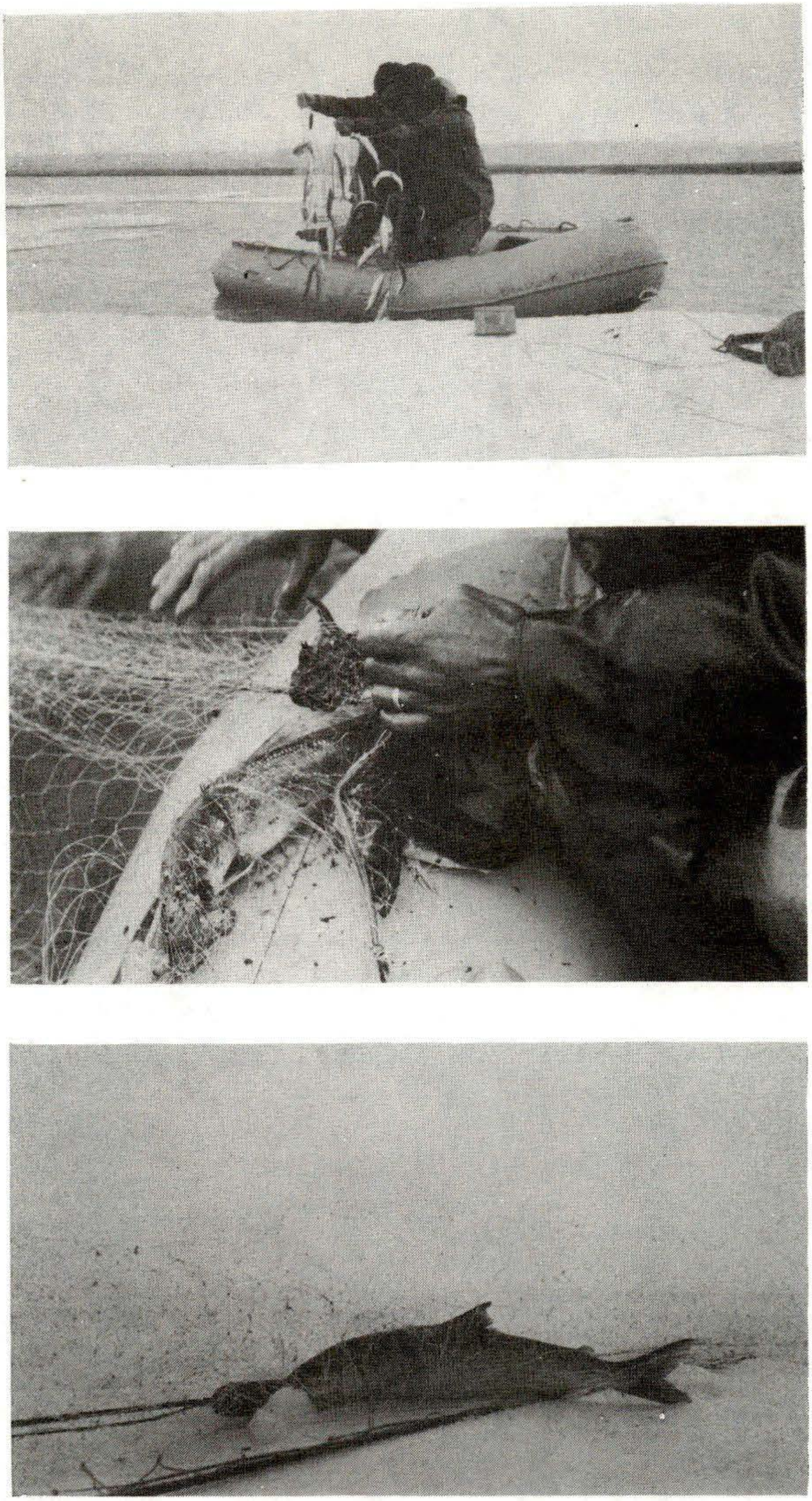
Figure 5. A, B and C; Ice conditions at Stokes Point in July 1974.

A.

B.

C.

Figure 6. Winter gillnetting operations: A. using an ice auger to pre-drill hole; B. sending out the jigger; and C. retrieving the gillnet.

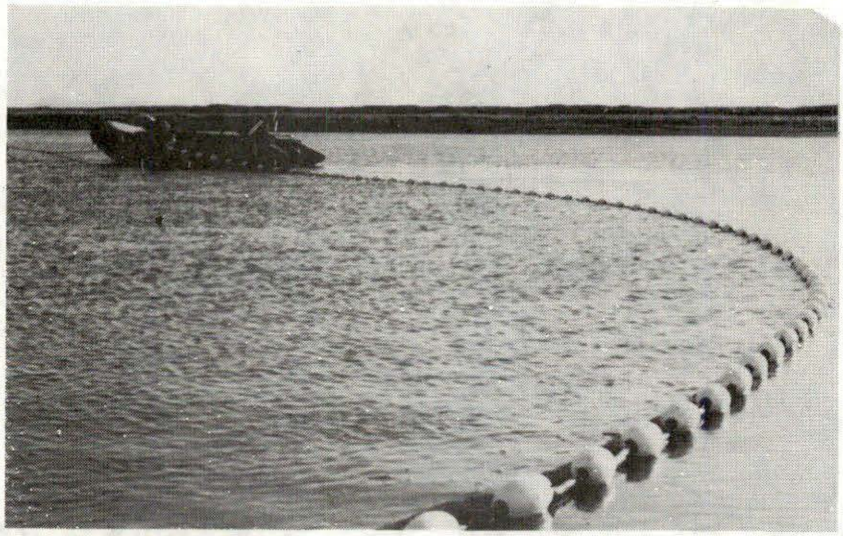


A.

B.

C.

Figure 7. Gillnet entangled with: A. least cisco; B. Arctic cisco and fourhorn sculpin; and C. Arctic cisco, May 1975.



A.

B.

C.

Figure 8. Seining operations with: A. a large beach seine; B. a hand seine; and C. a pole seine.

Figure 9. Ovaries of least cisco; development stage 3A.

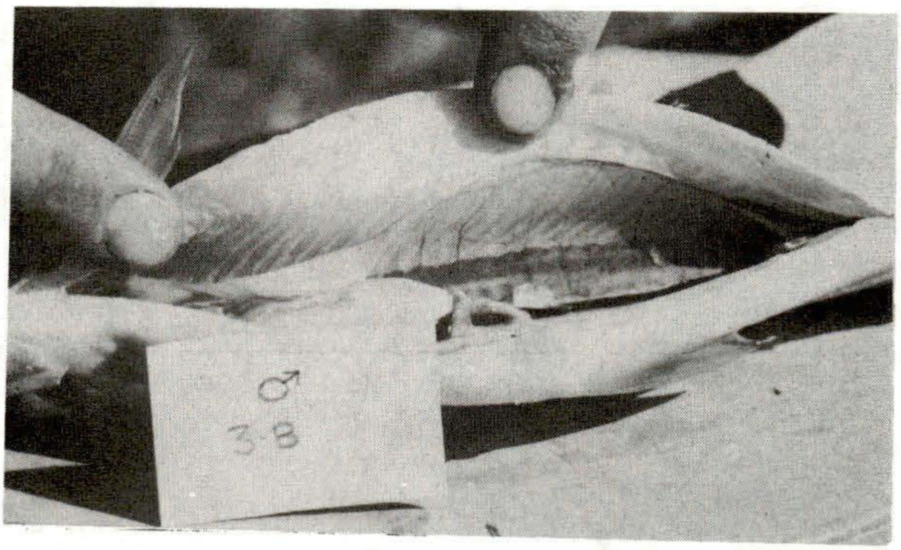


Figure 10. Testes of Arctic cisco; development stage 3B.

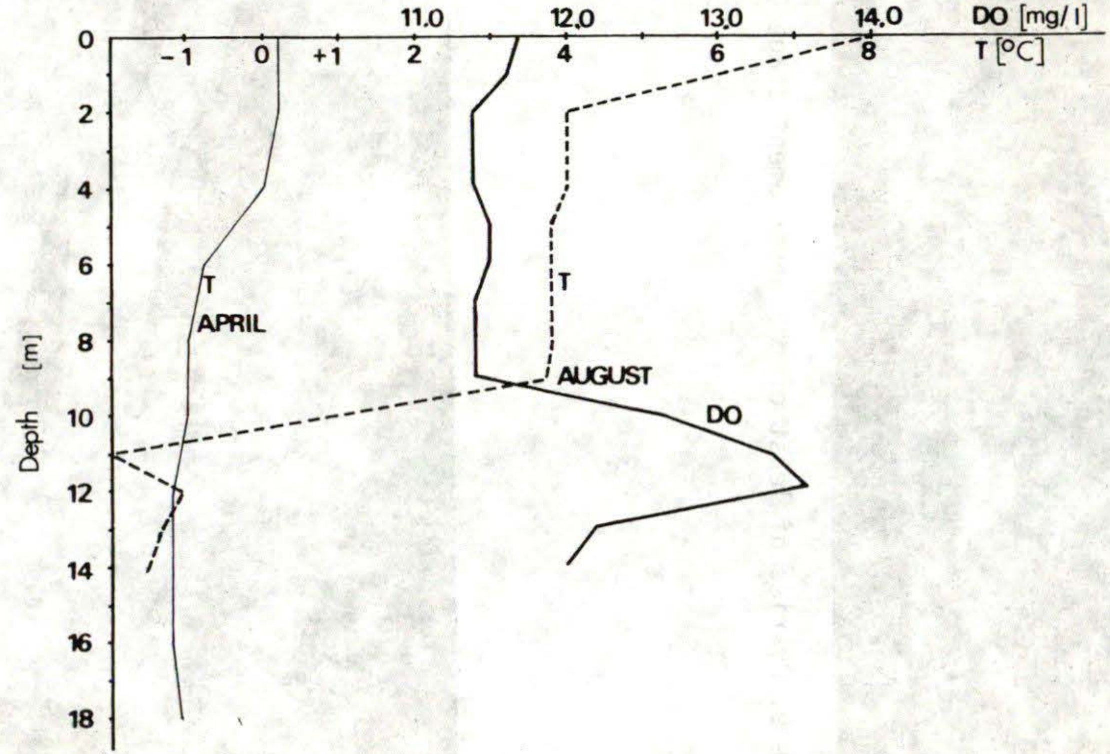


Figure 11. Temperature profile taken April 8, 1974 at Station VI near King Pt.; temperature/oxygen profile taken August 15, 1974 at Station 112 near Sabine Pt.

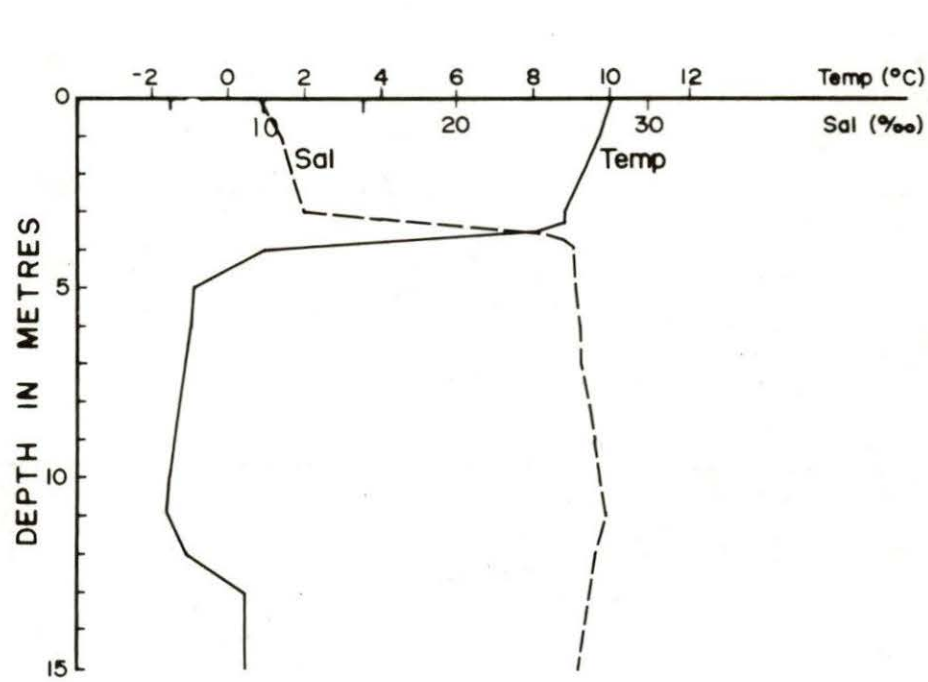


Figure 12. Salinity/temperature profile taken near deep hole between Stokes Point and Herschel Island, summer 1975.

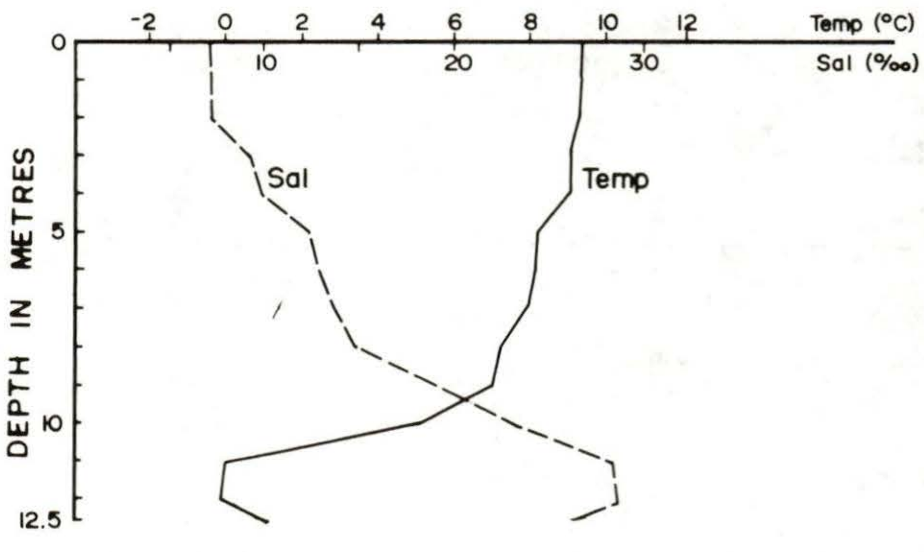


Figure 13. Salinity/temperature profile taken 3 km off Stokes Point, summer 1975.

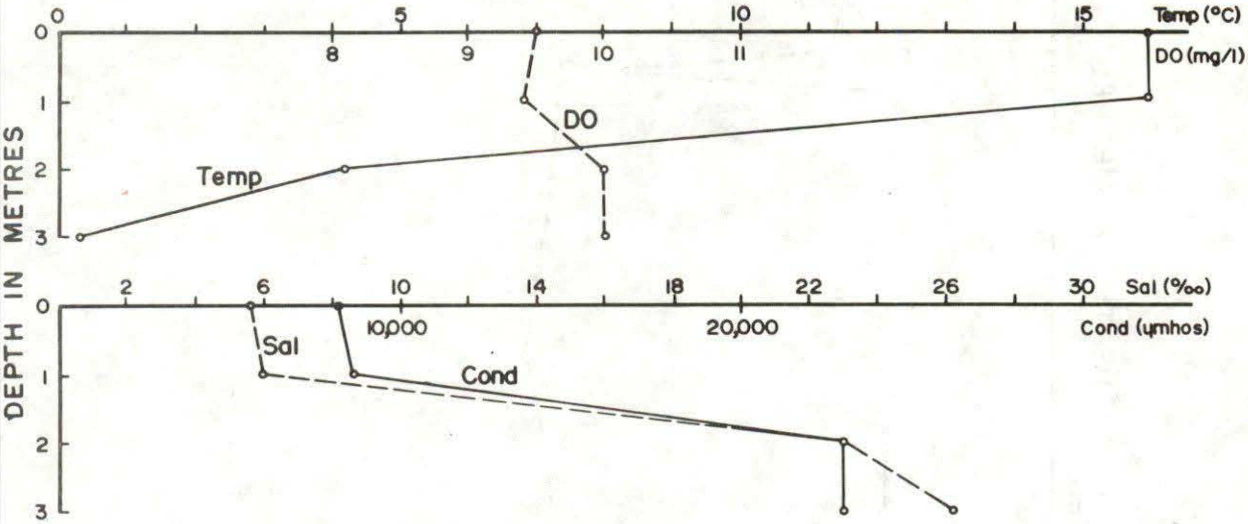


Figure 14. Temperature/dissolved oxygen and salinity/conductivity profiles at Station 104 showing salt wedge intrusion, summer 1975.

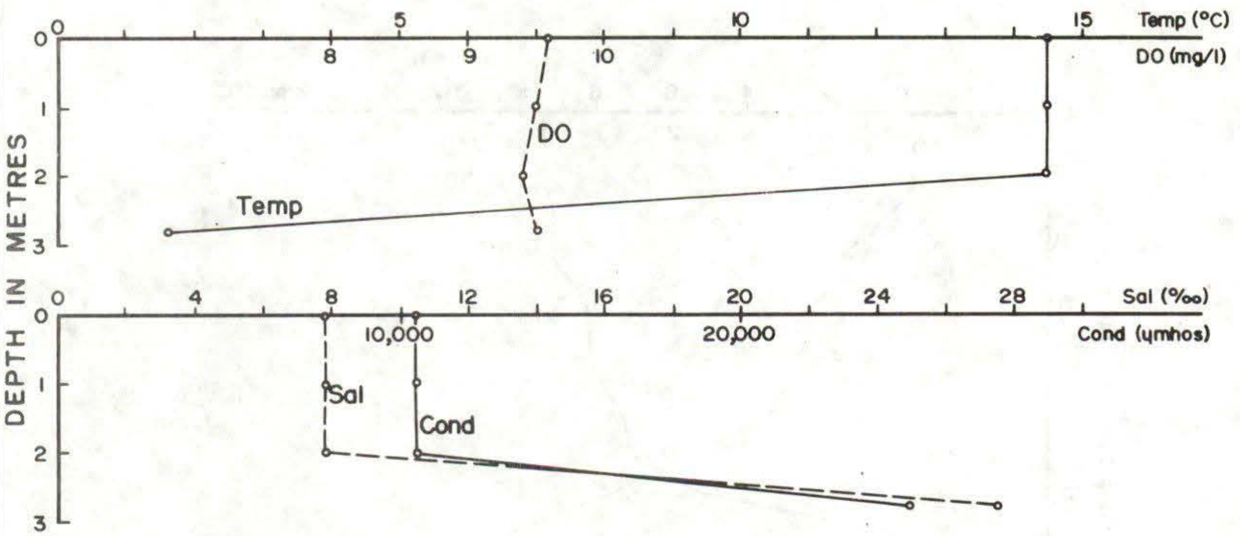


Figure 15. Temperature/dissolved oxygen and salinity/conductivity profiles at Station 107 showing salt wedge intrusion, summer 1975.

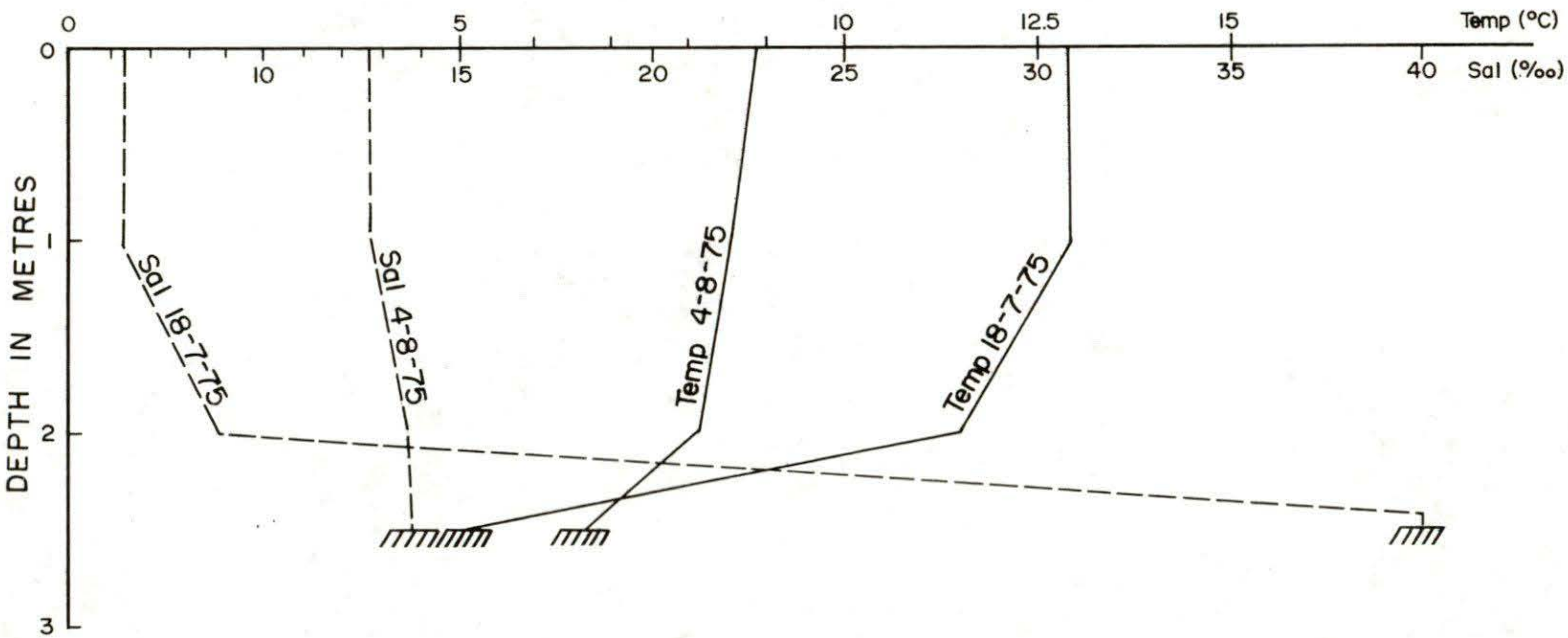


Figure 16. Salinity/temperature profiles taken 12 days apart at Stokes Lagoon in July,1975.

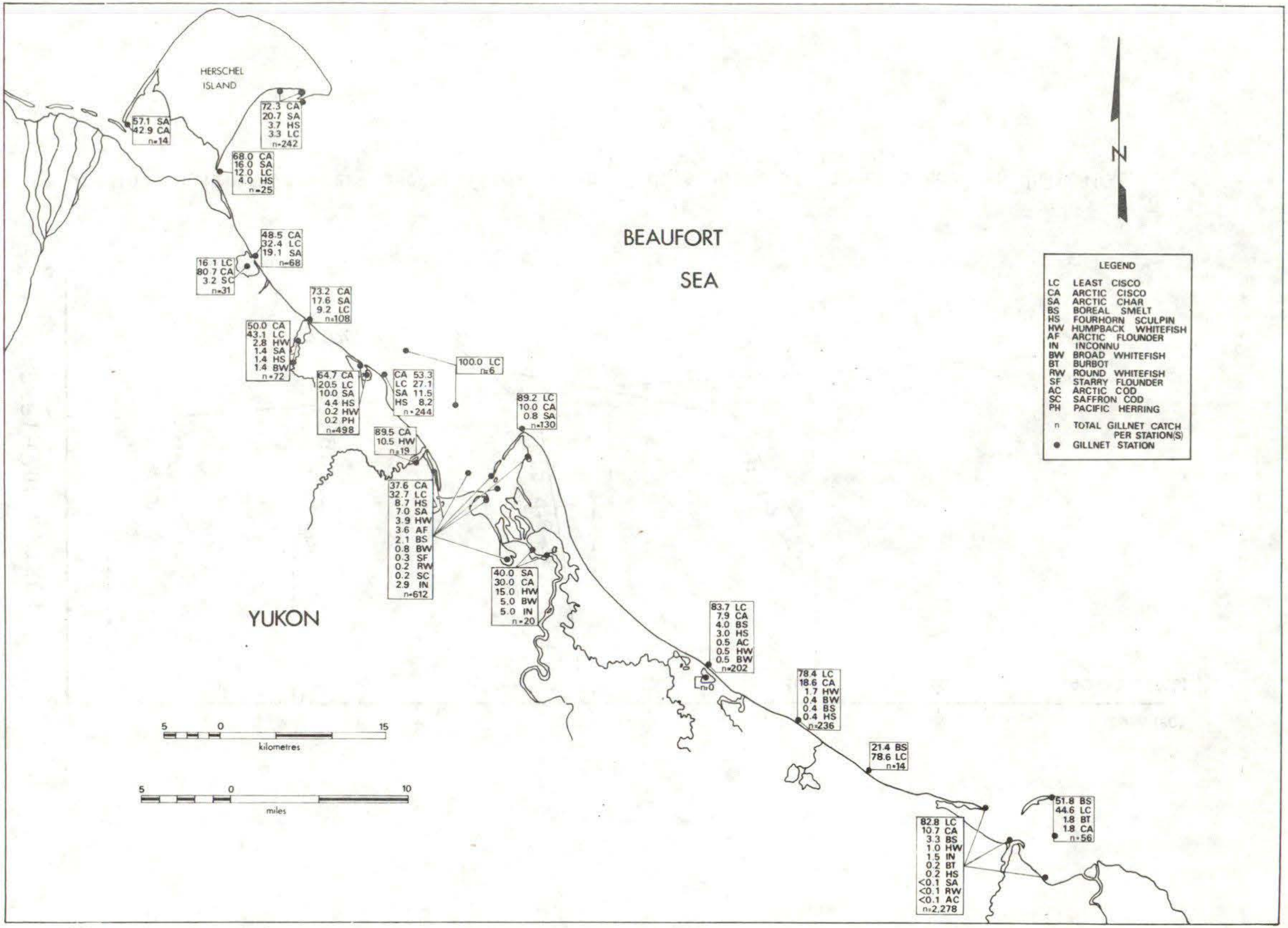


Figure 17. Distribution and relative abundance of gillnet-caught species by percent composition (summer 1974).

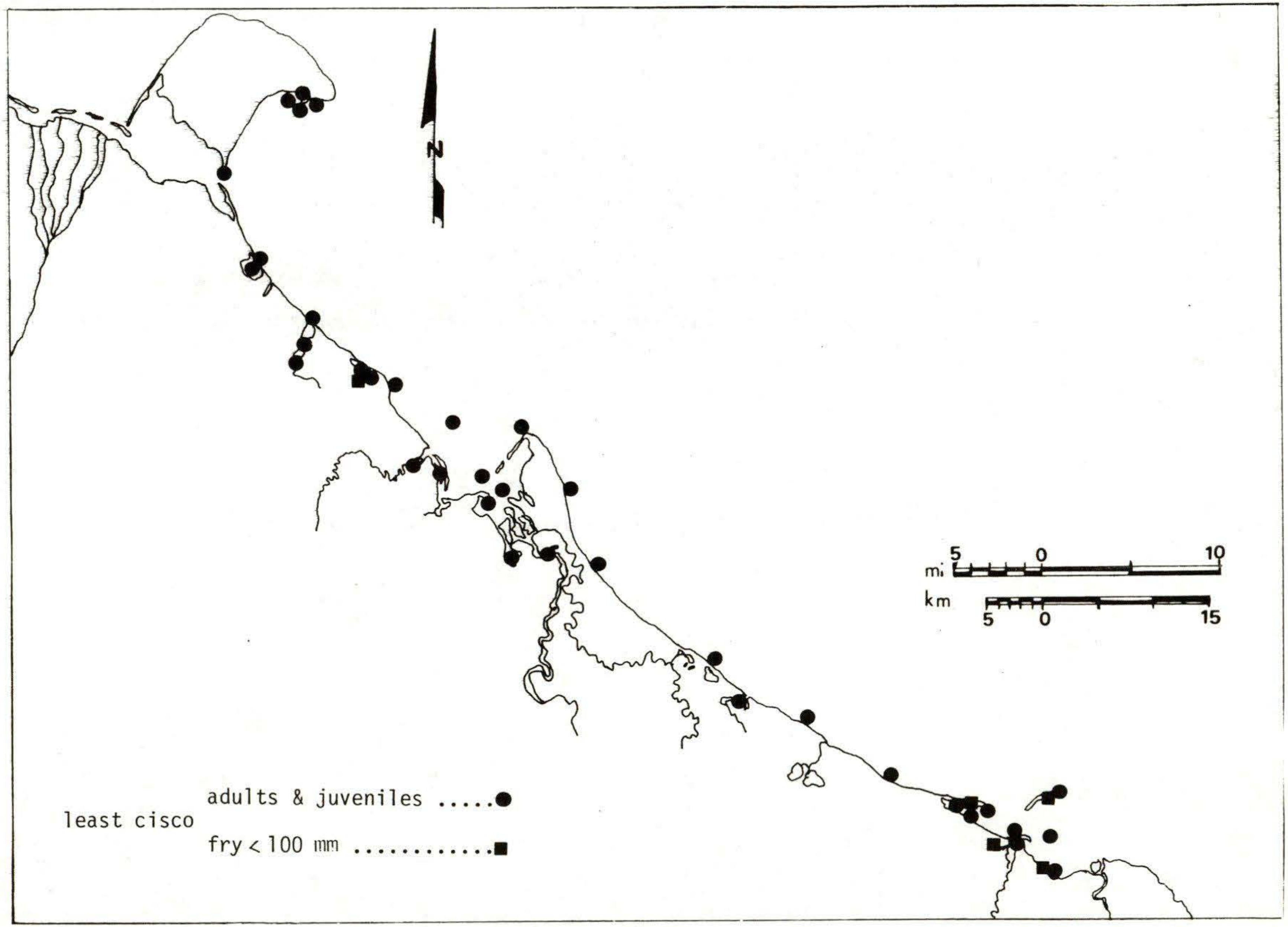


Figure 18. The distribution of least cisco within the study area.

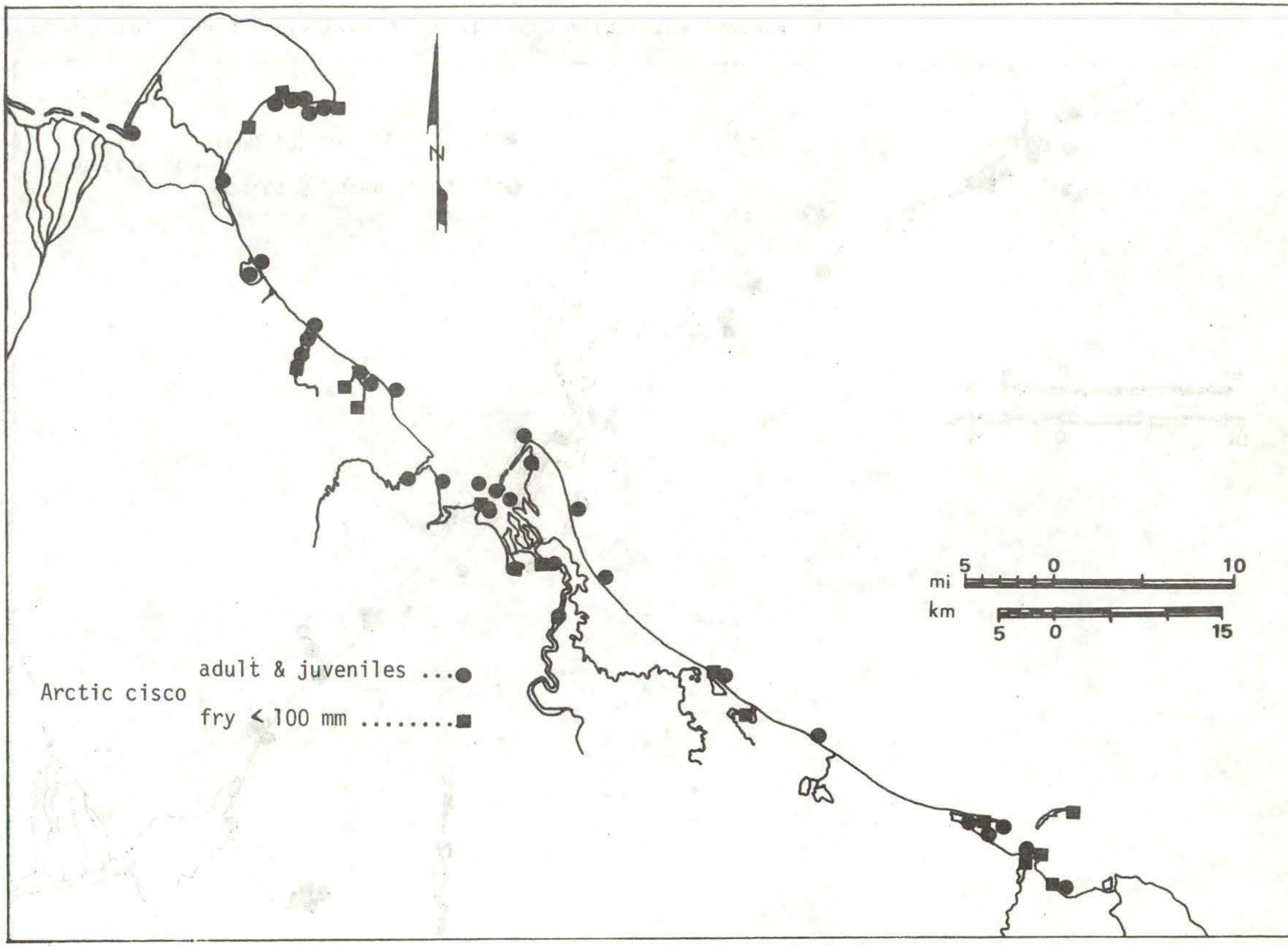


Figure 19. The distribution of Arctic cisco within the study area.

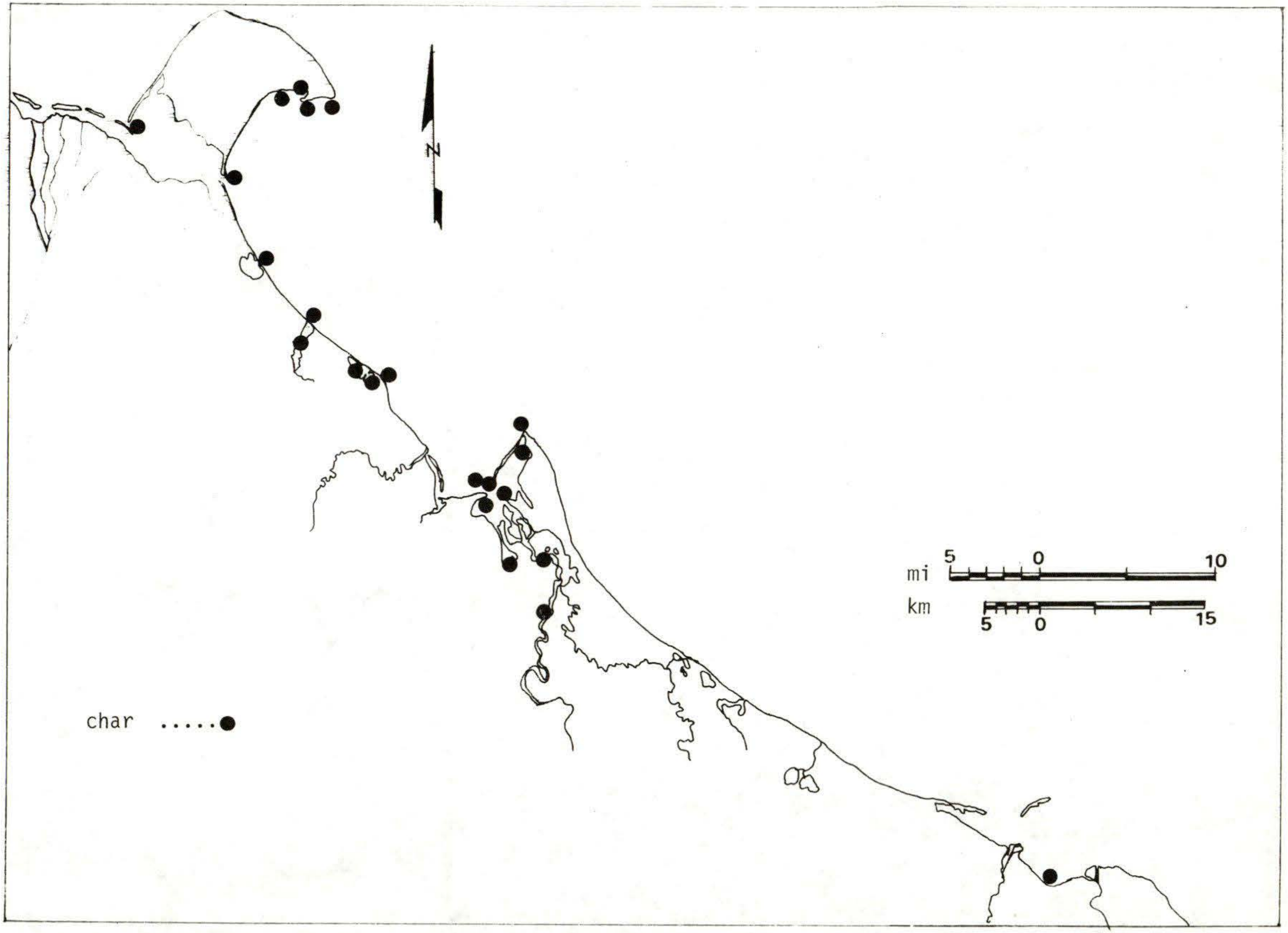


Figure 20. The distribution of Arctic char within the study area.

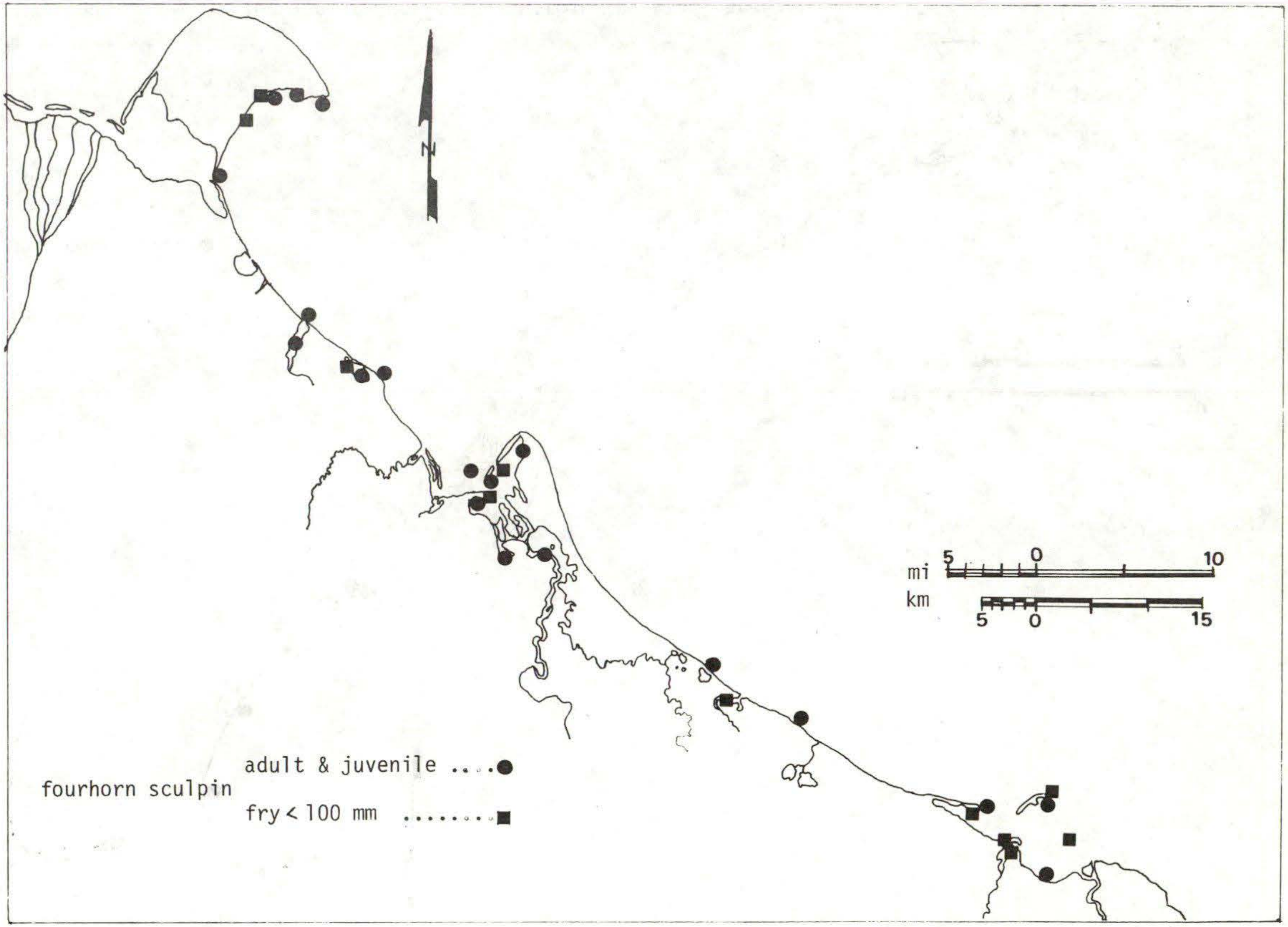


Figure 21. The distribution of fourhorn sculpin within the study area.

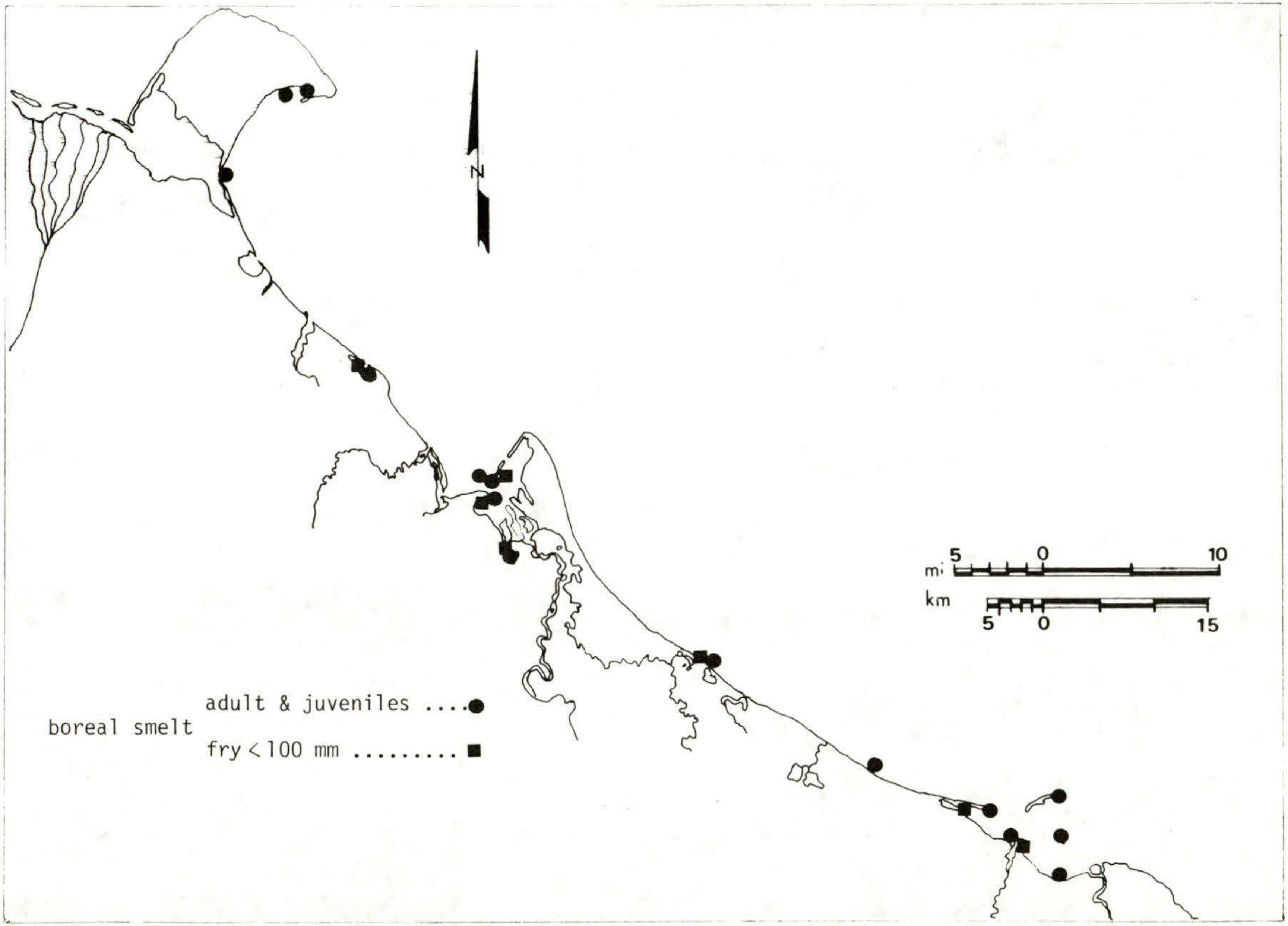


Figure 22. The distribution of boreal smelt within the study area.

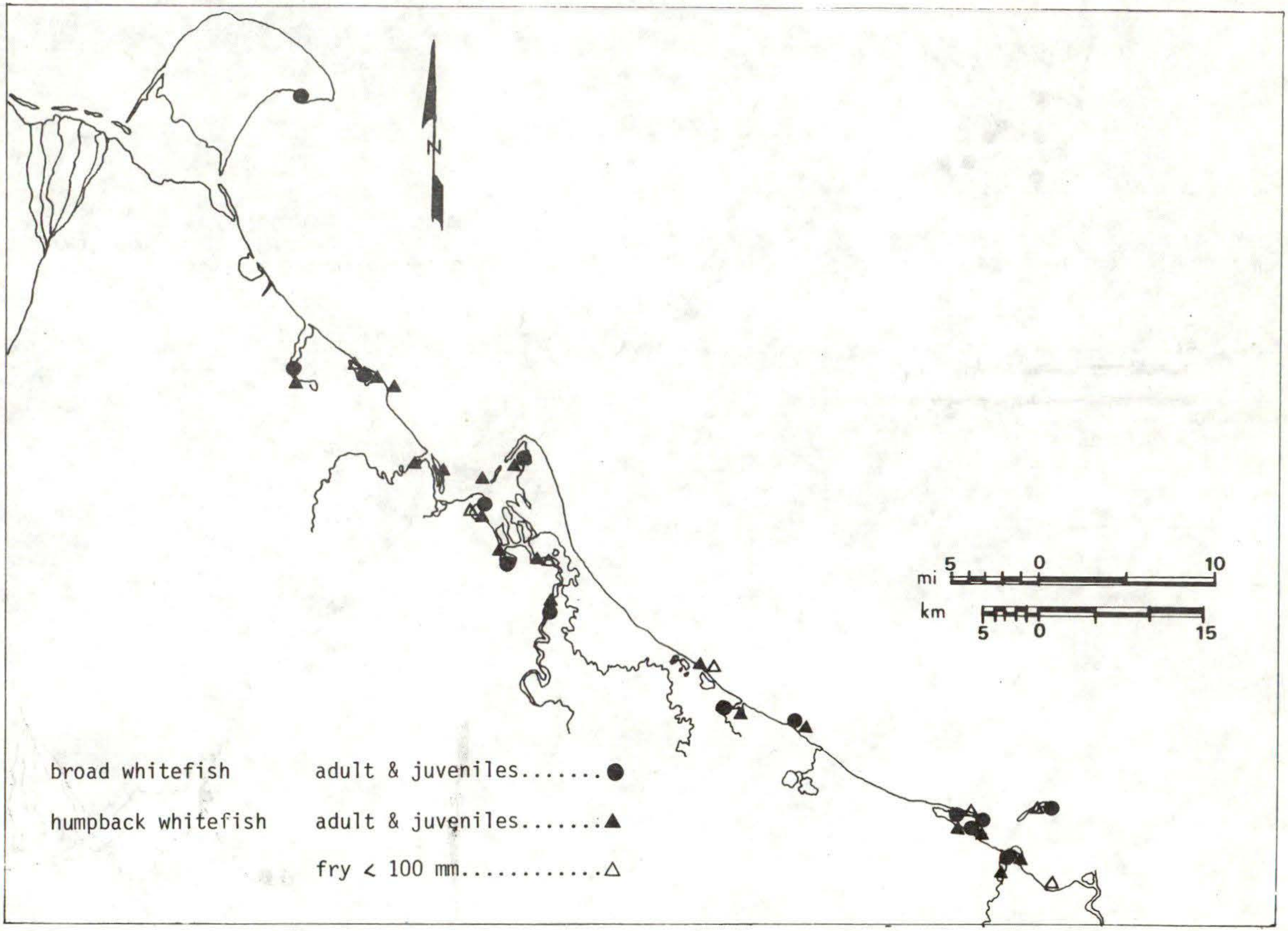


Figure 23. The distribution of broad and humpback whitefish within the study area.

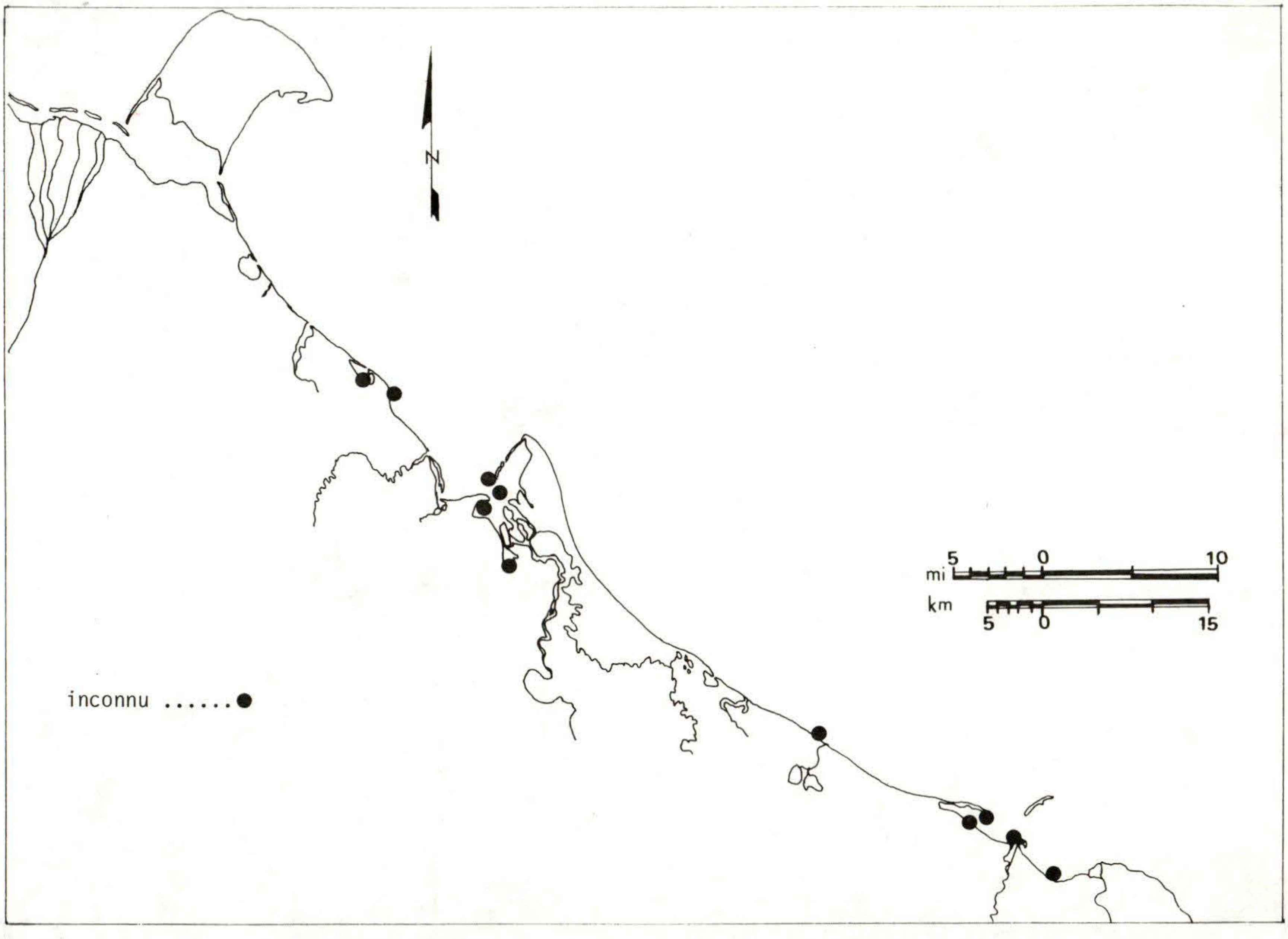


Figure 24. The distribution of inconnu within the study area.

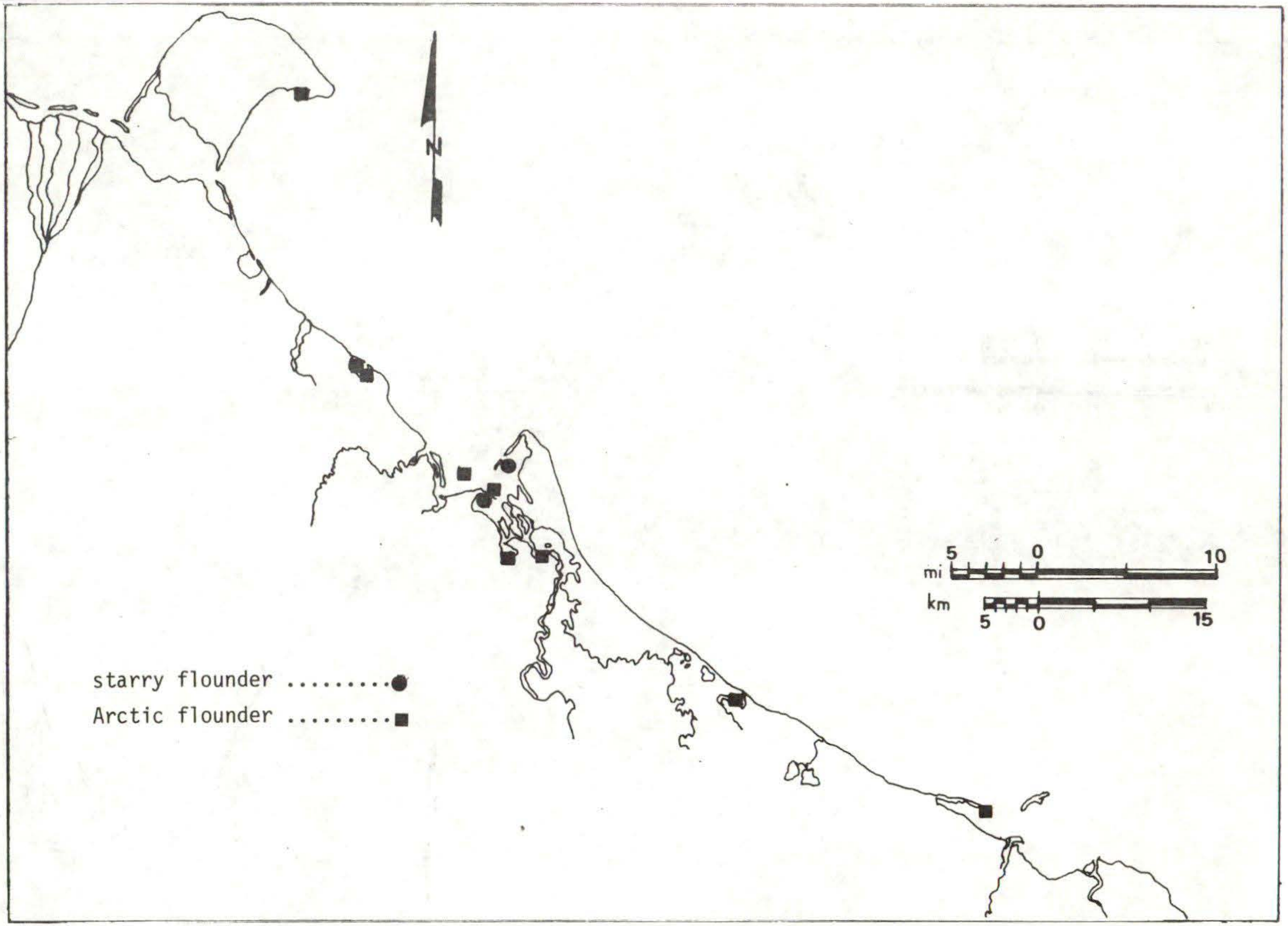


Figure 25. The distribution of starry flounder and Arctic flounder within the study area.

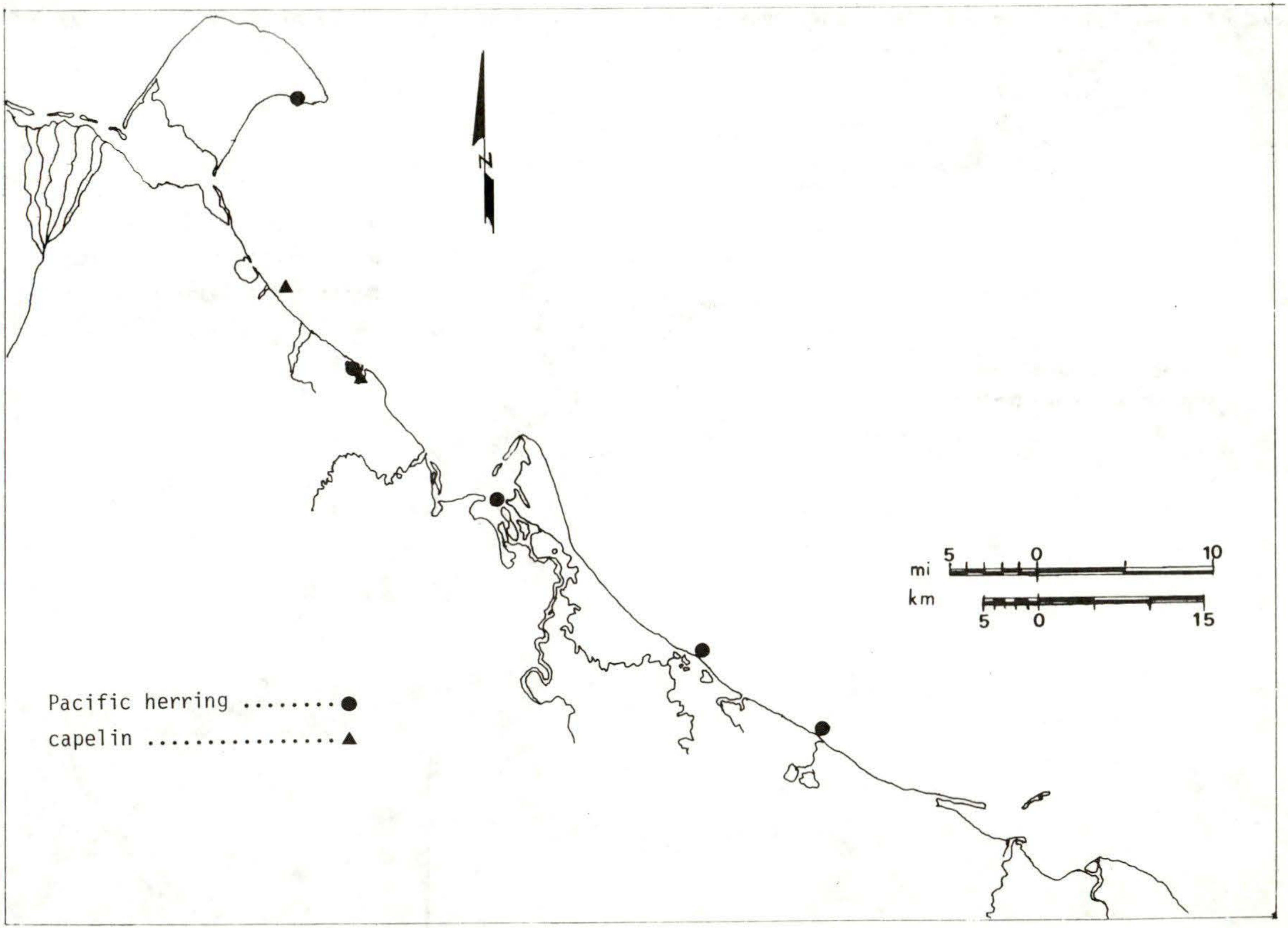


Figure 26. The distribution of capelin and Pacific herring within the study area.

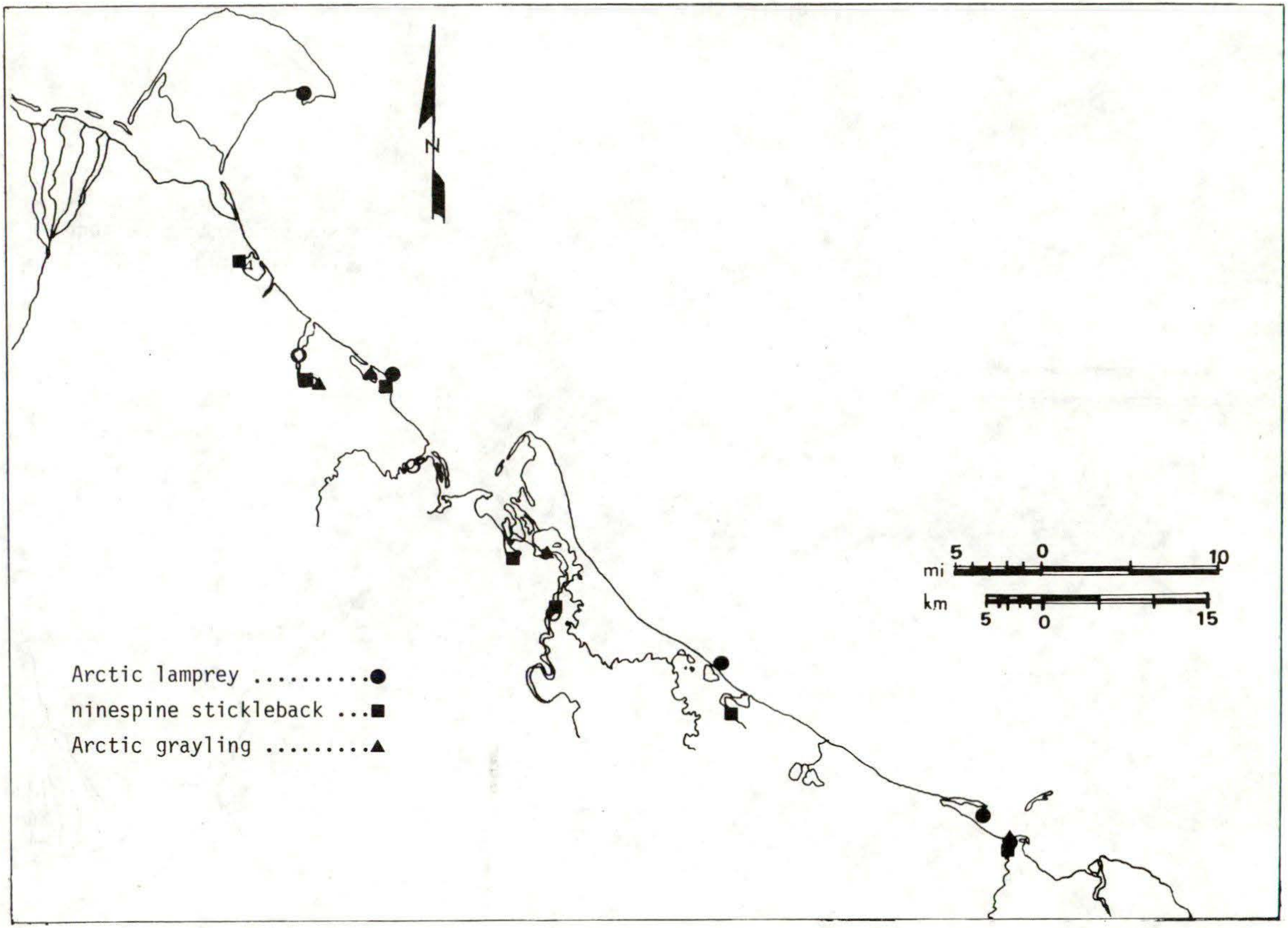


Figure 27. The distribution of Arctic lamprey, ninespine stickleback and Arctic grayling within the study area.

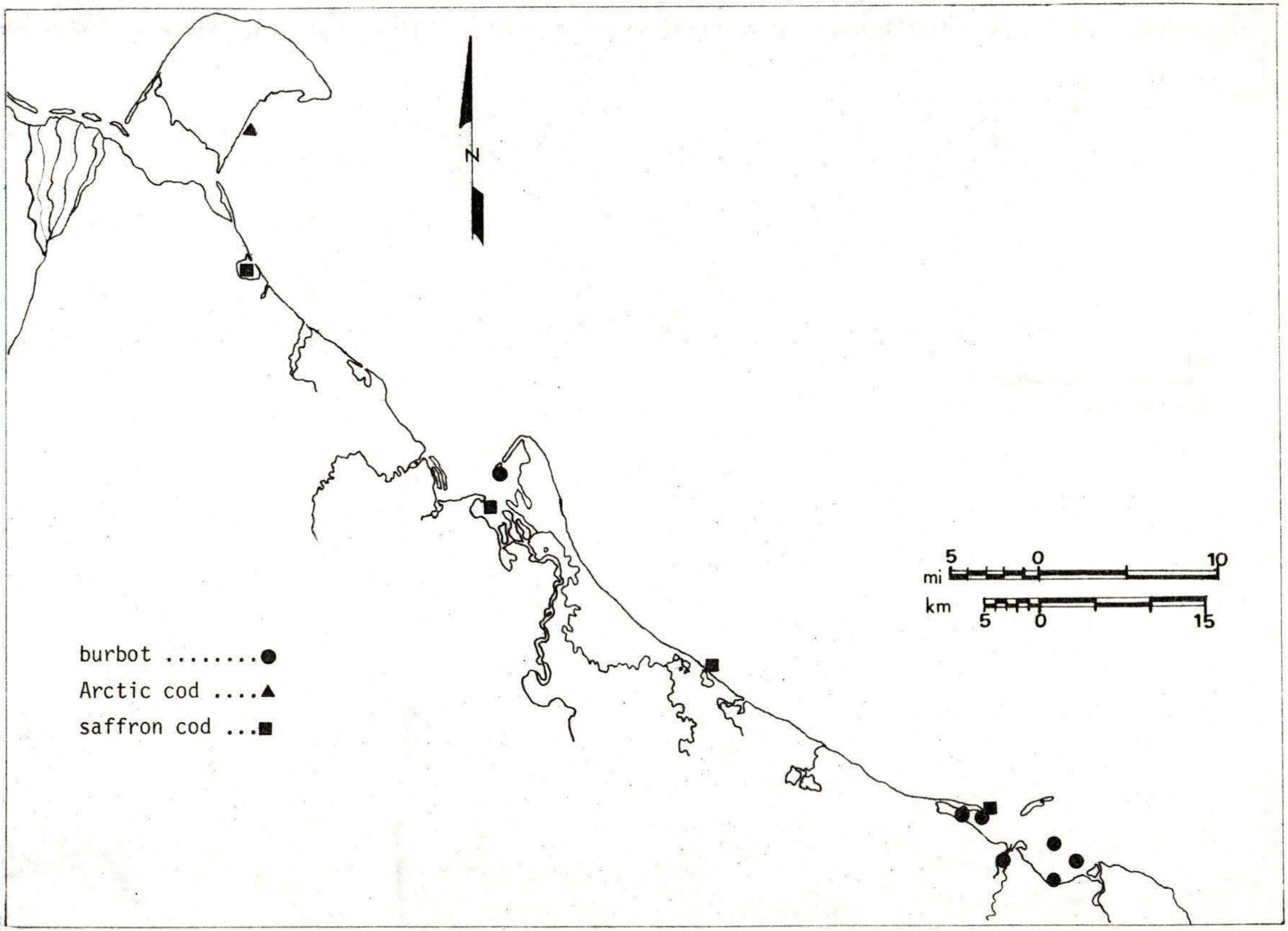


Figure 28. The distribution of burbot, Arctic cod and saffron cod within the study area.

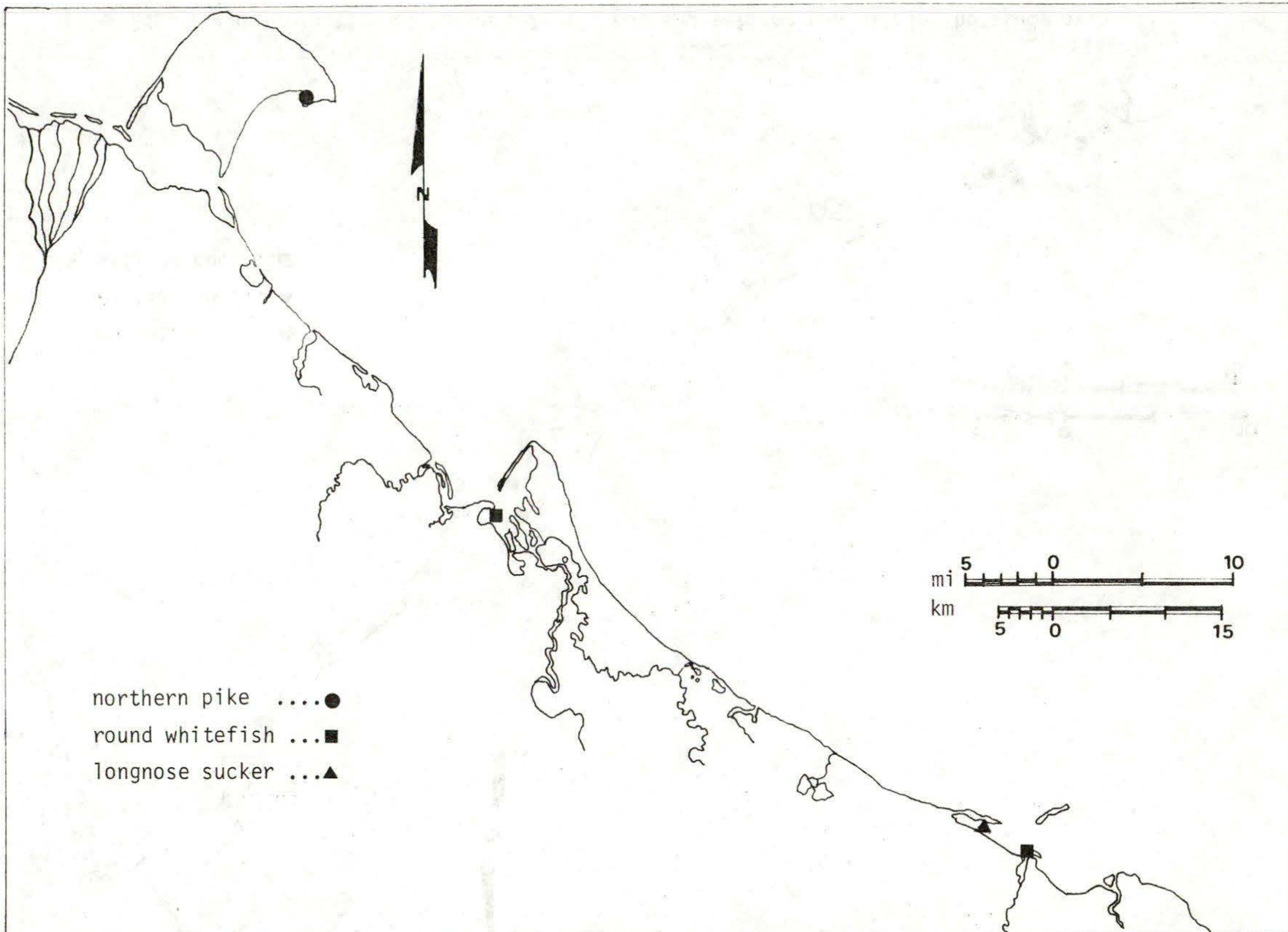


Figure 29. The distribution of northern pike, round whitefish and longnose sucker within the study area.

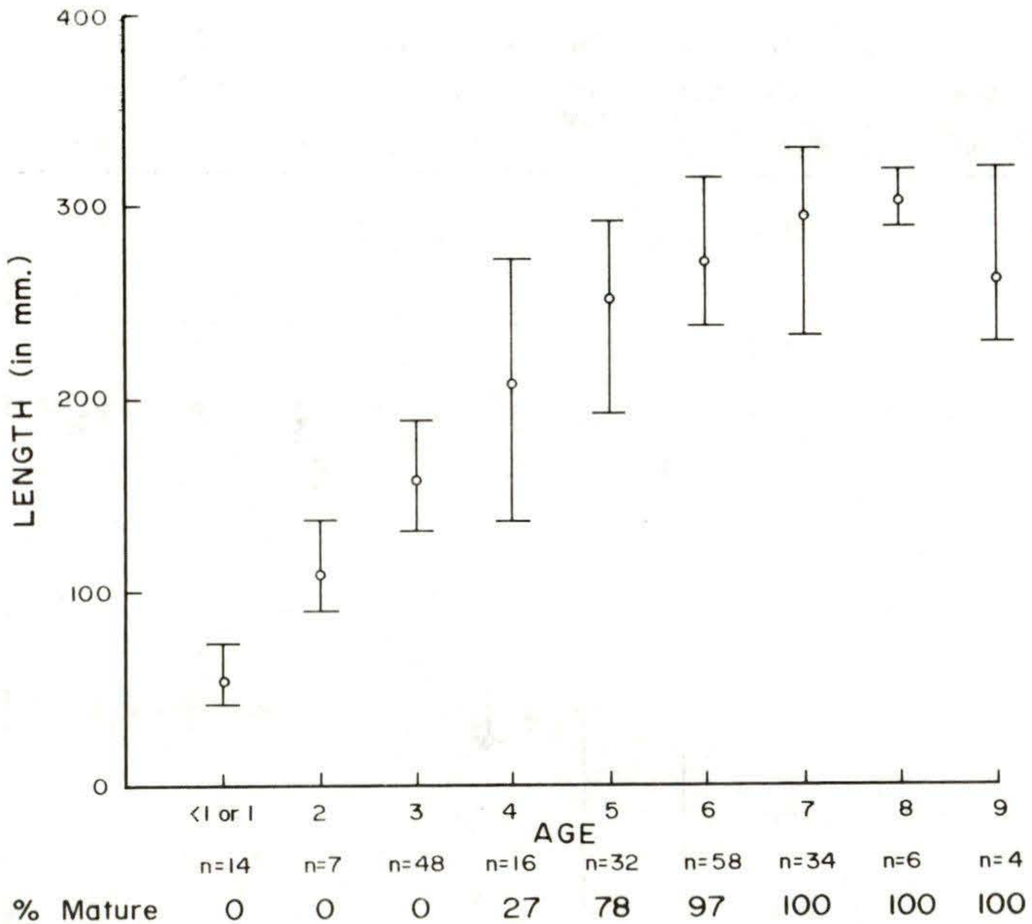


Figure 30. Age to length relationship and maturity of a sample of least cisco from the Shingle Point area.

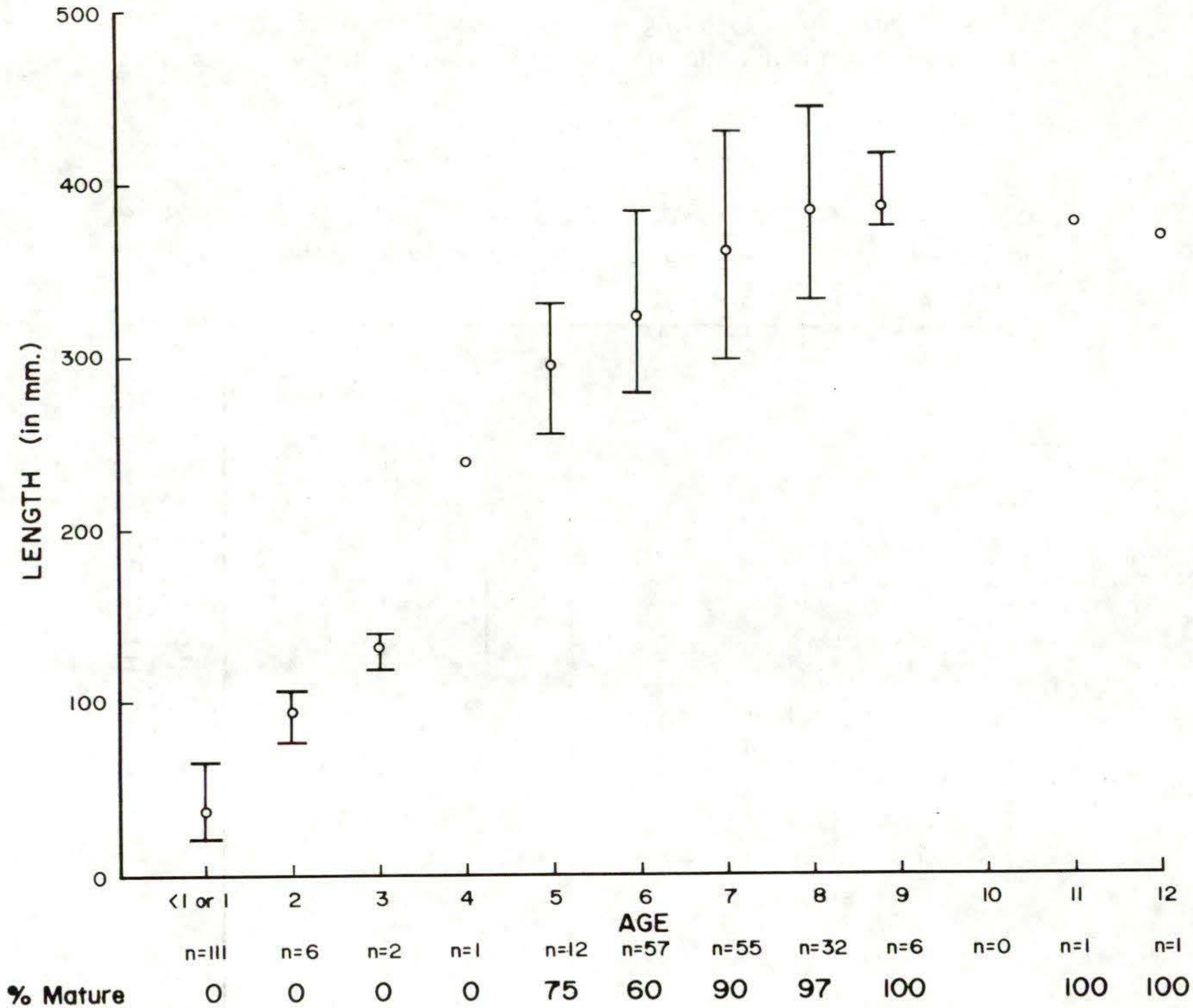


Figure 31. Age to length relationship and maturity of Arctic cisco from Stokes Point and Stokes Lagoon.

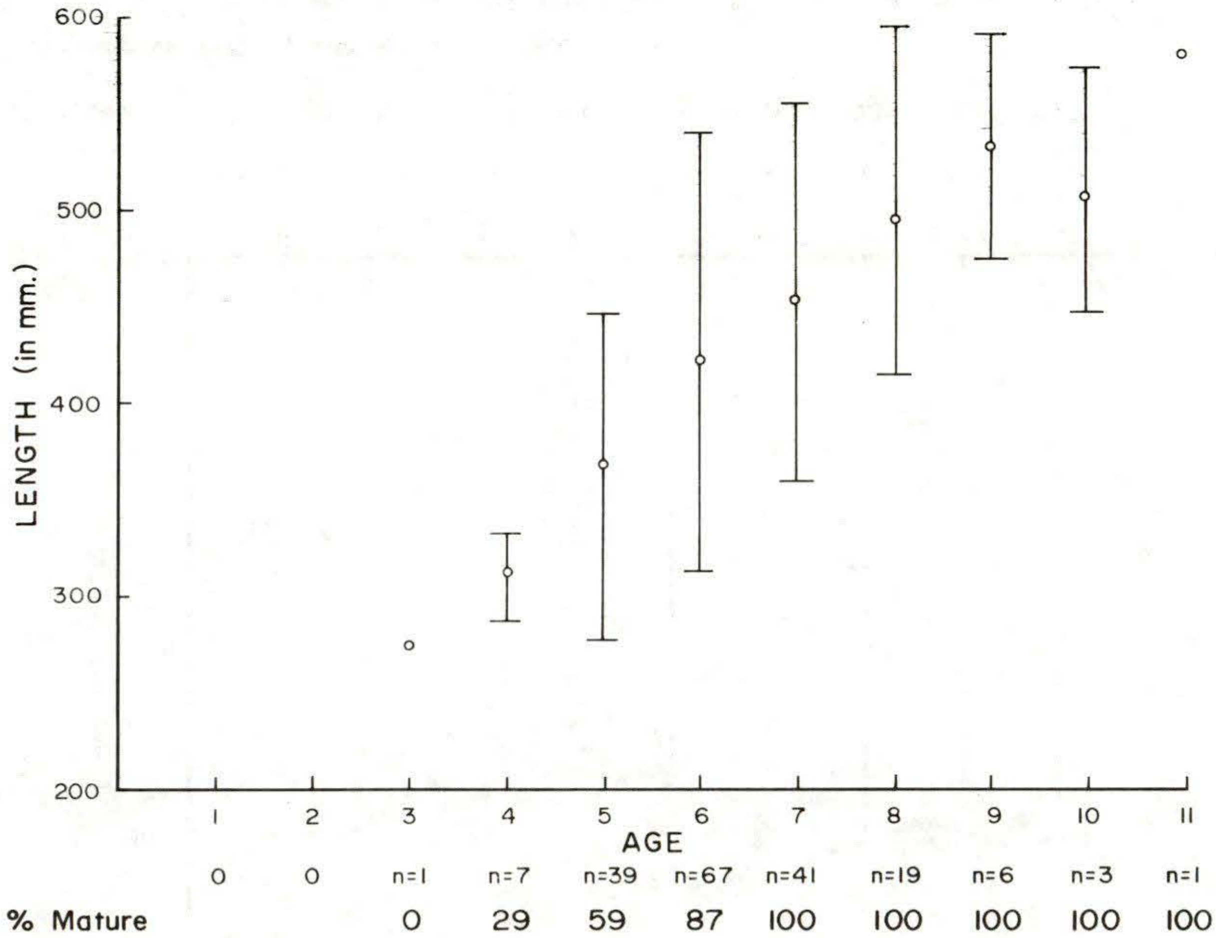
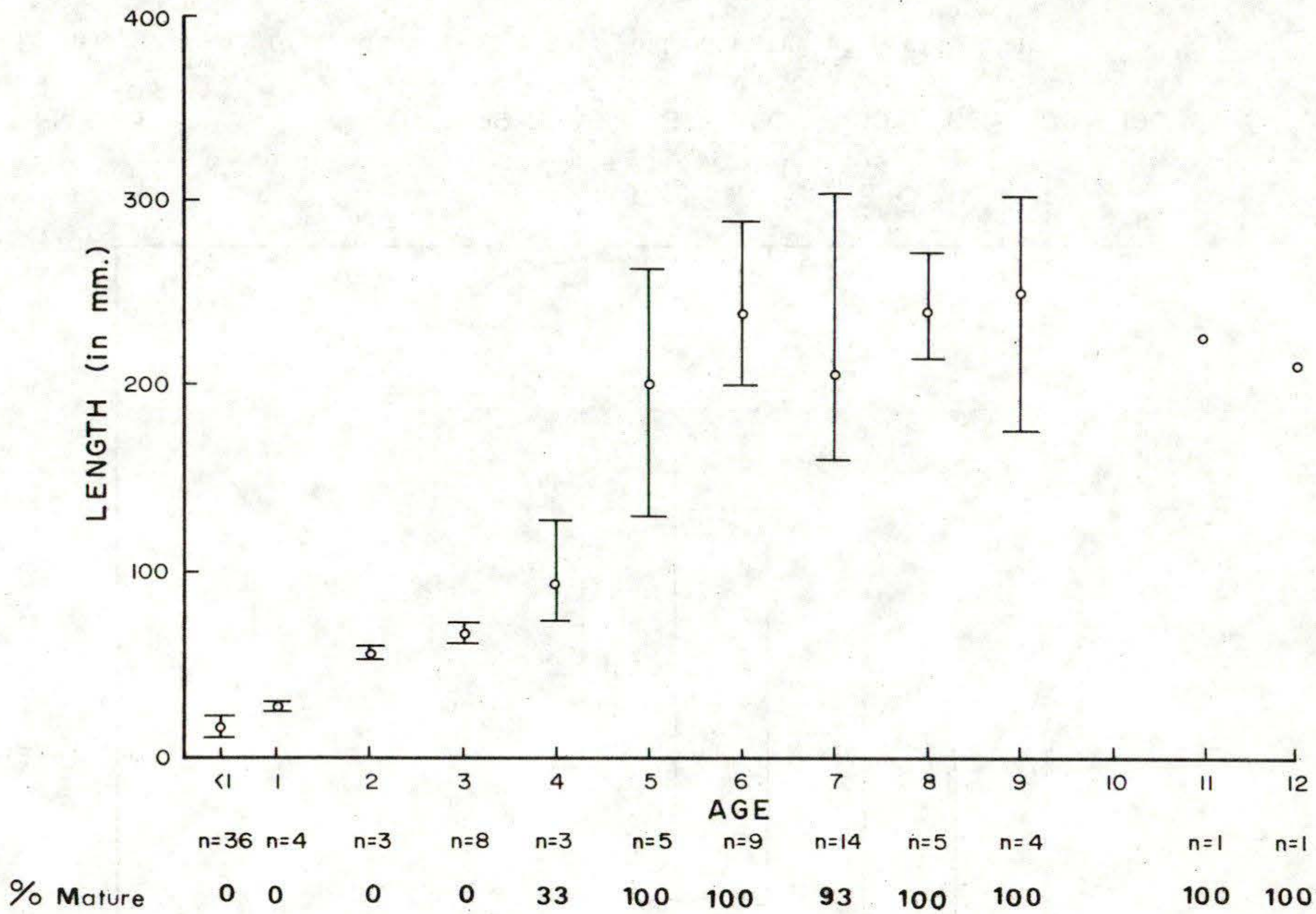


Figure 32. Age to length relationship and maturity of Arctic char.



*subsample of 100Q fry with remnant yolk sac

Figure 33. Age to length relationship and maturity of fourhorn sculpin.

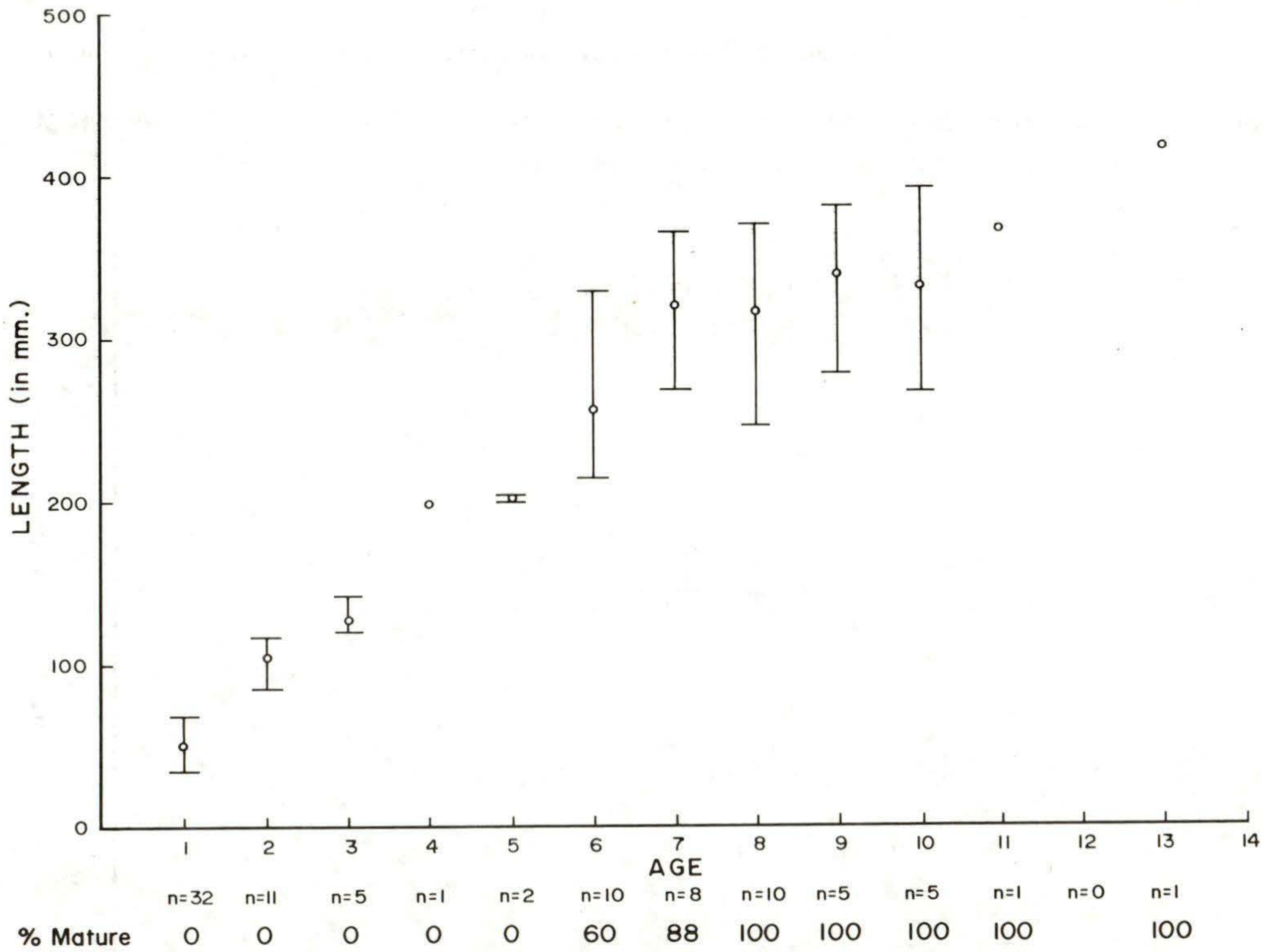


Figure 34. Age to length relationship and maturity of humpback whitefish.

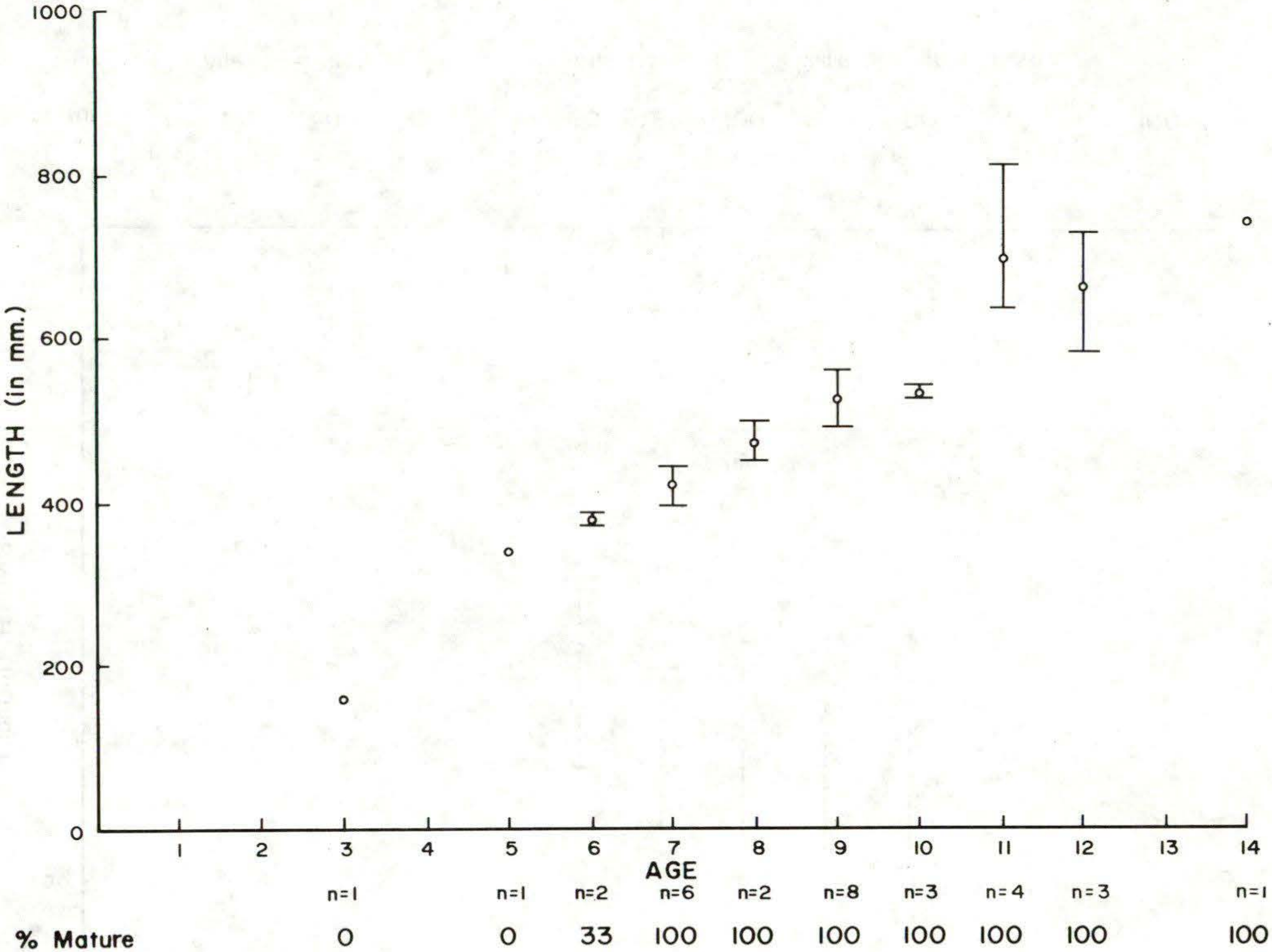


Figure 35. Age to length relationship and maturity of inconnu.

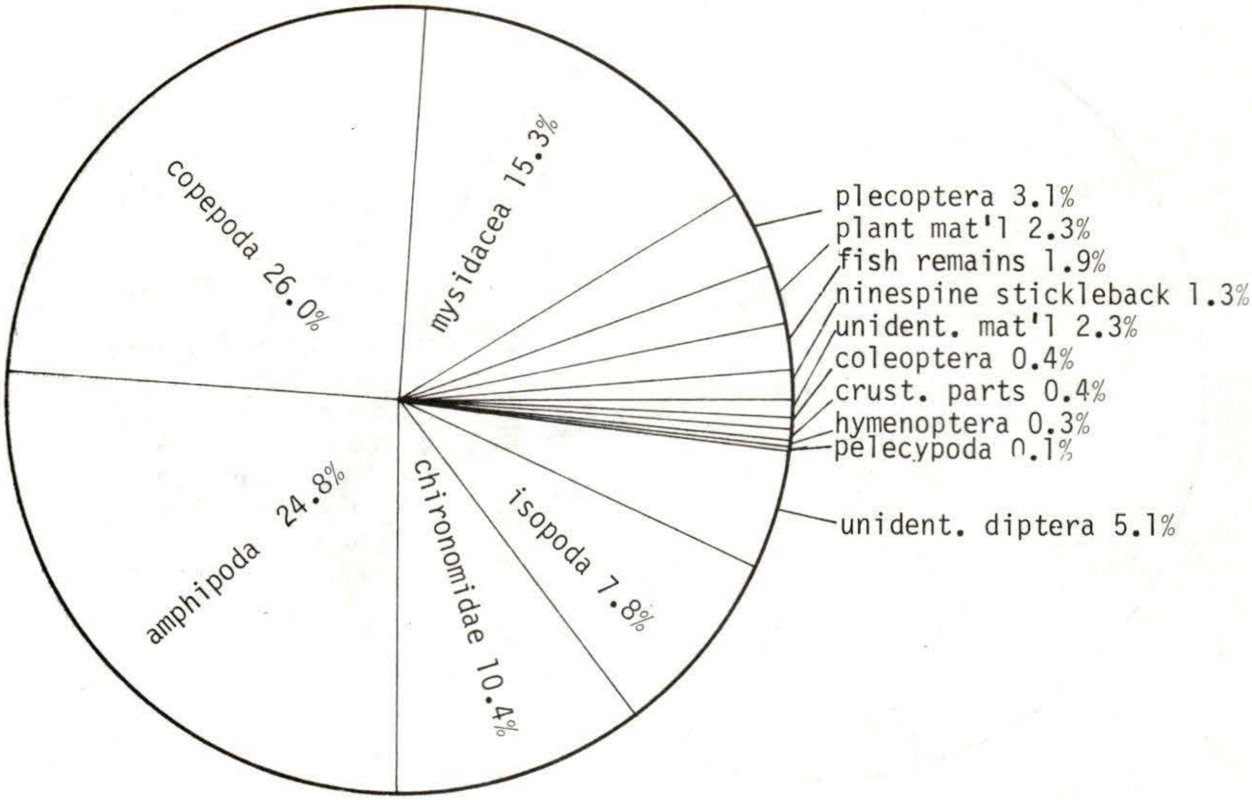


Figure 36. Average diet of adult least cisco.

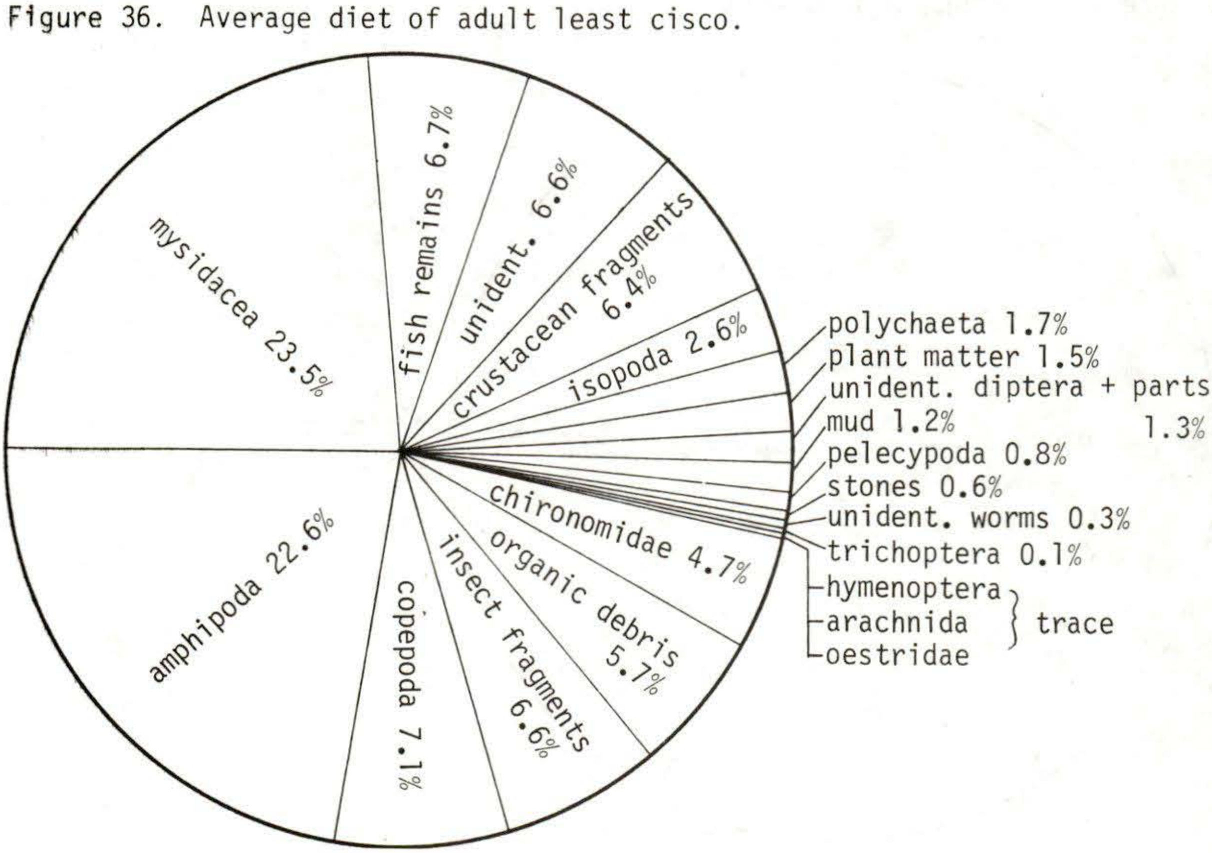


Figure 37. Average diet of adult Arctic cisco.

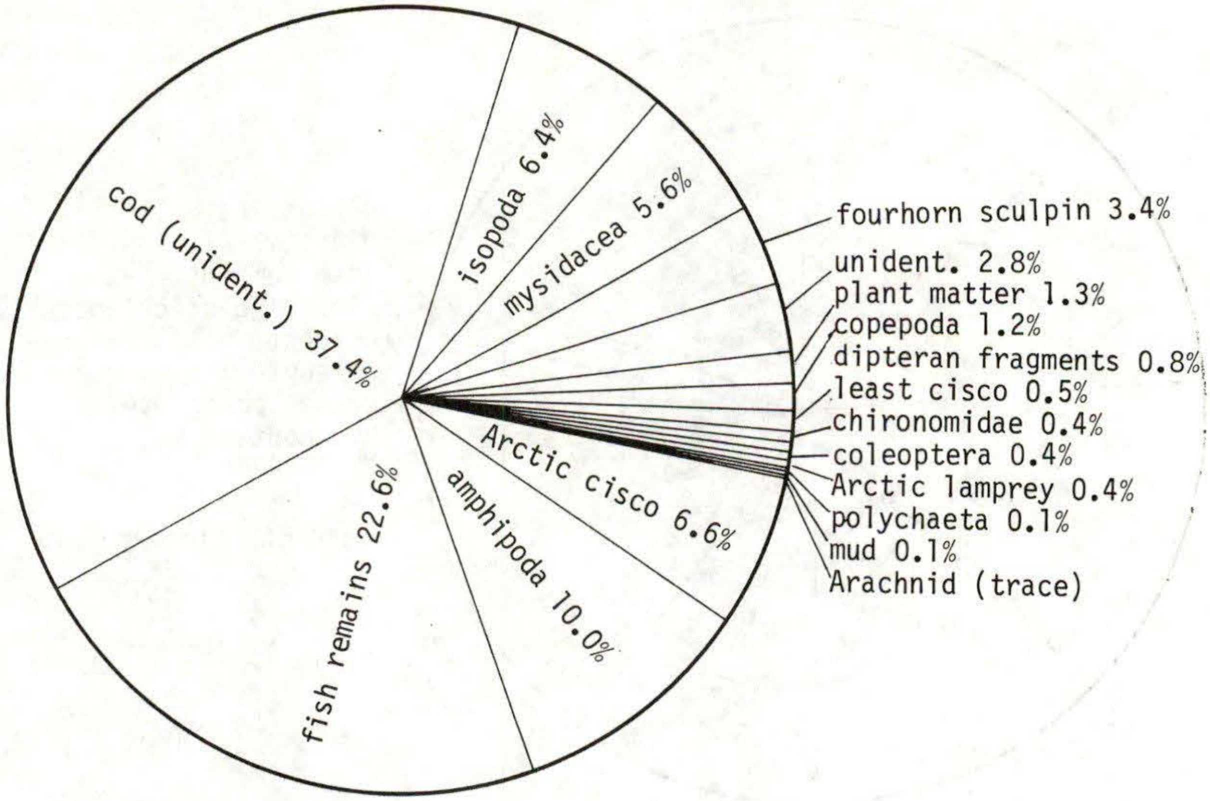


Figure 38. Average diet of Arctic char.

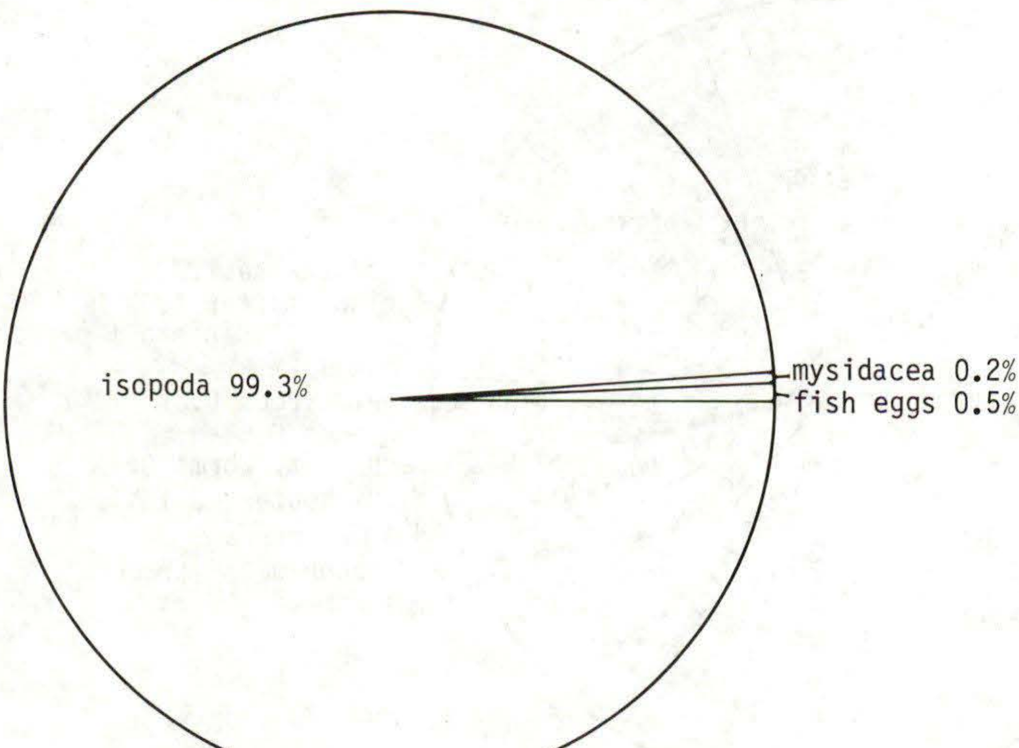


Figure 39. Average diet of adult fourhorn sculpin.

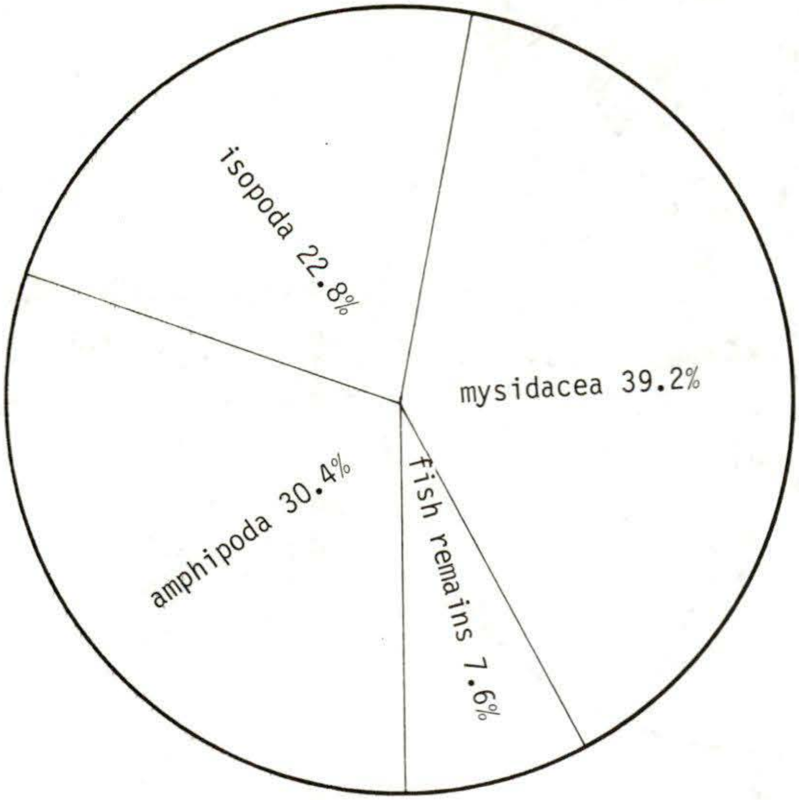


Figure 40. Average diet of adult boreal smelt.

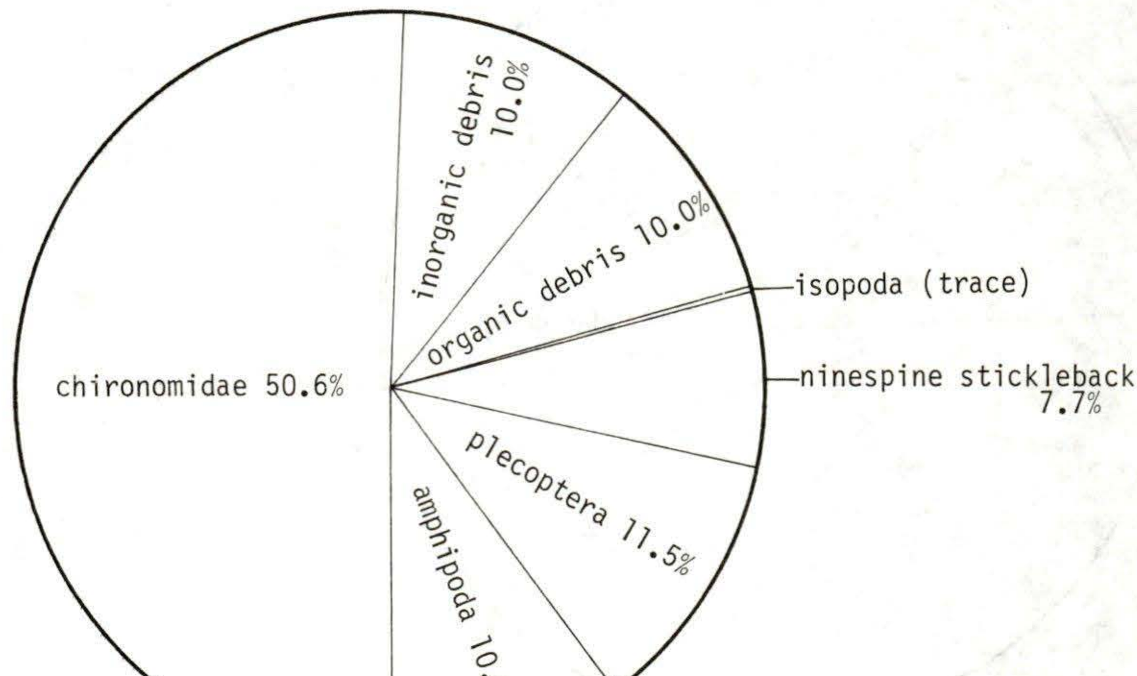


Figure 41. Average diet of adult humpback whitefish.

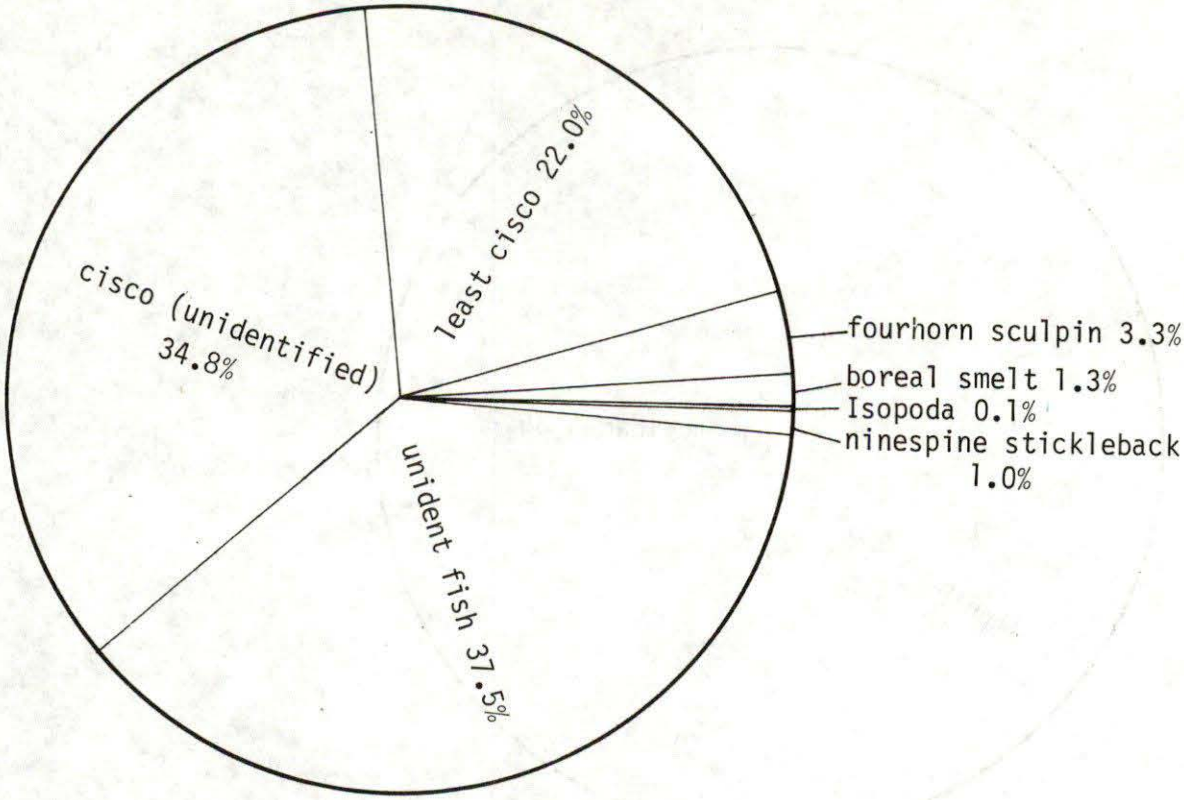


Figure 42. Average diet of inconnu.

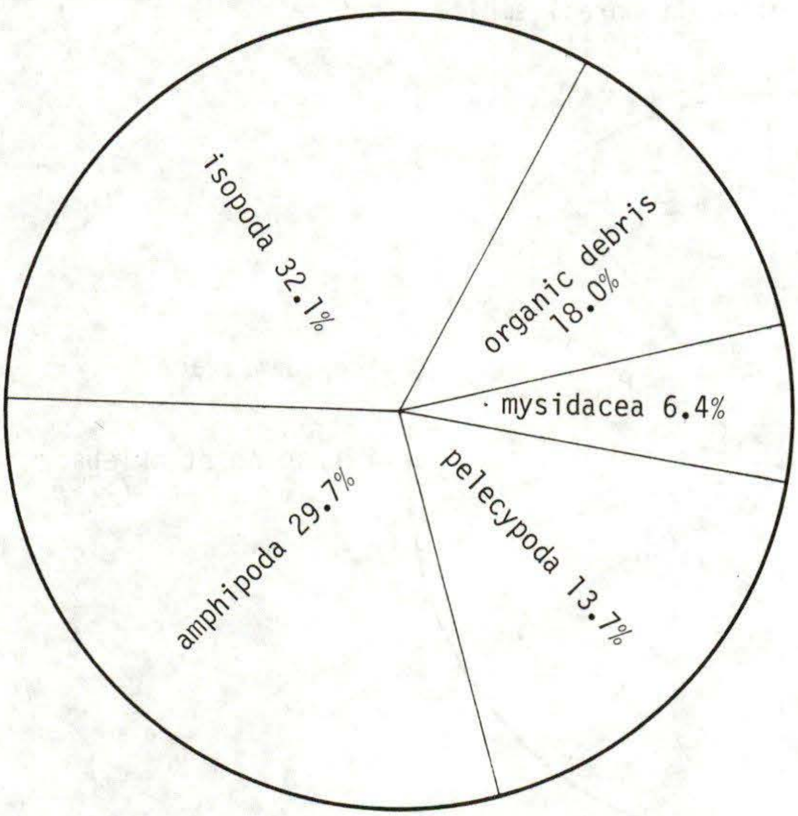


Figure 43. Average diet of flounder.

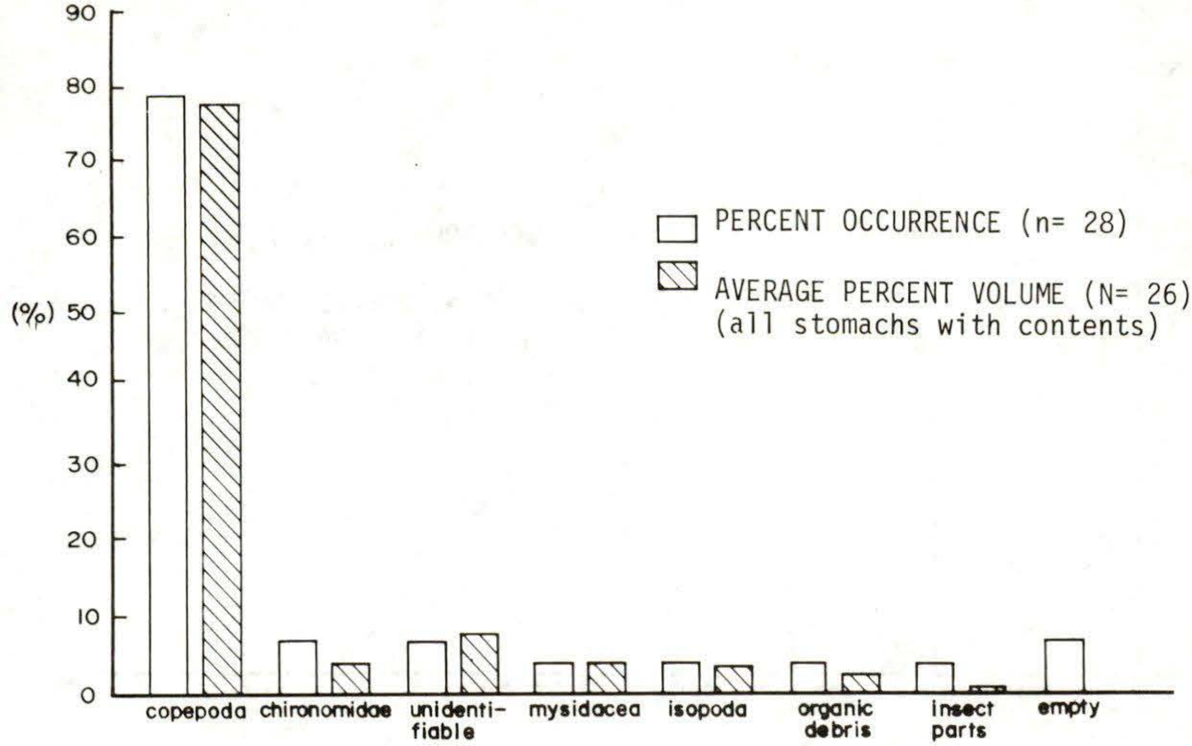


Figure 44. Food habits of least cisco fry by percent occurrence and average percent volume.

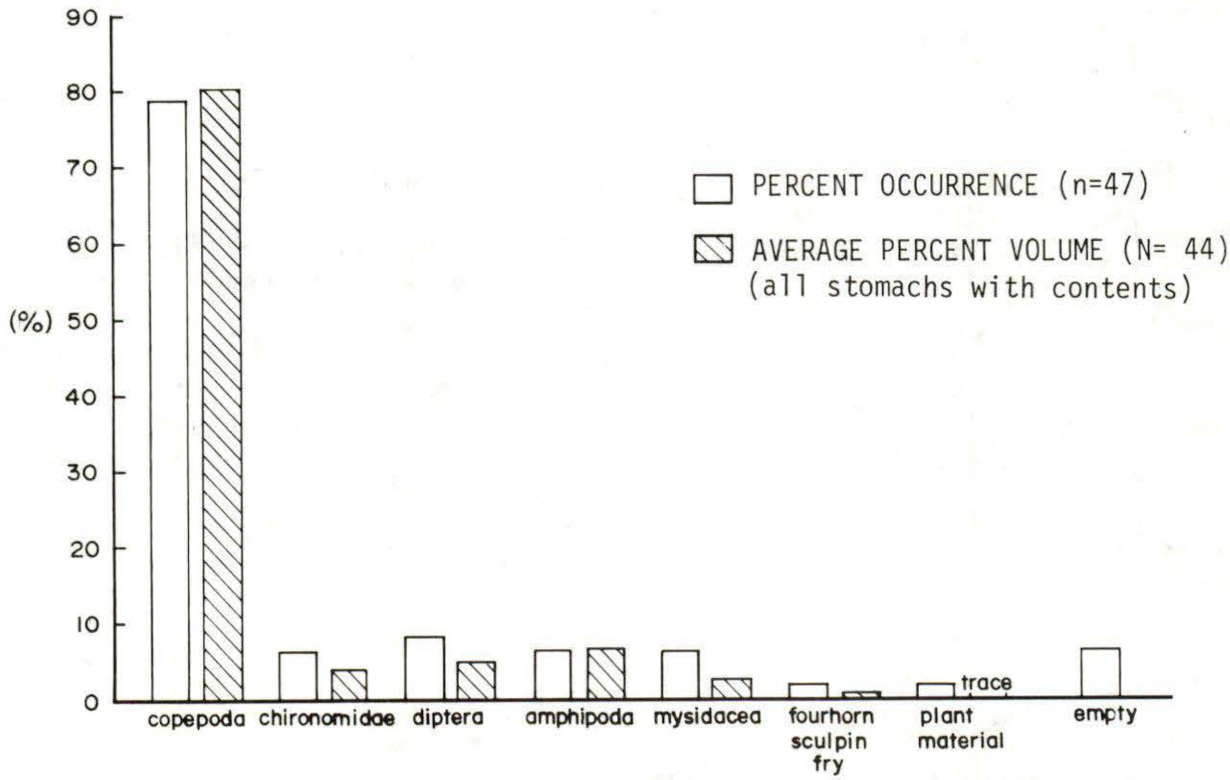


Figure 45. Food habits of Arctic cisco fry by percent occurrence and average percent volume.

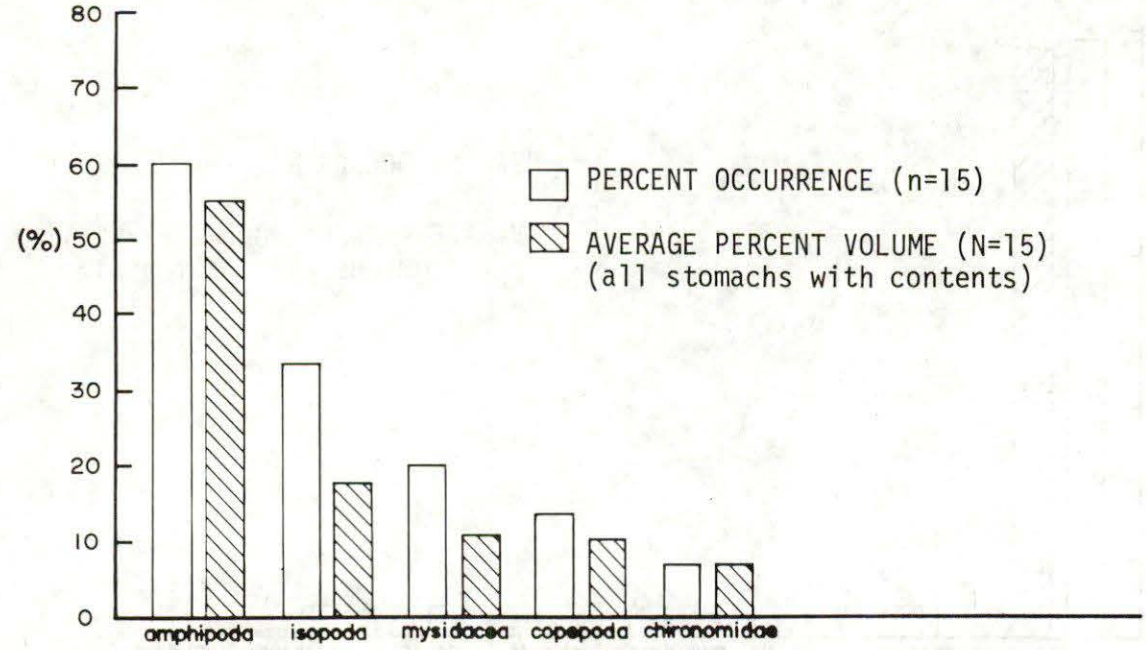


Figure 46. Food habits of fourhorn sculpin fry by percent occurrence and average percent volume.

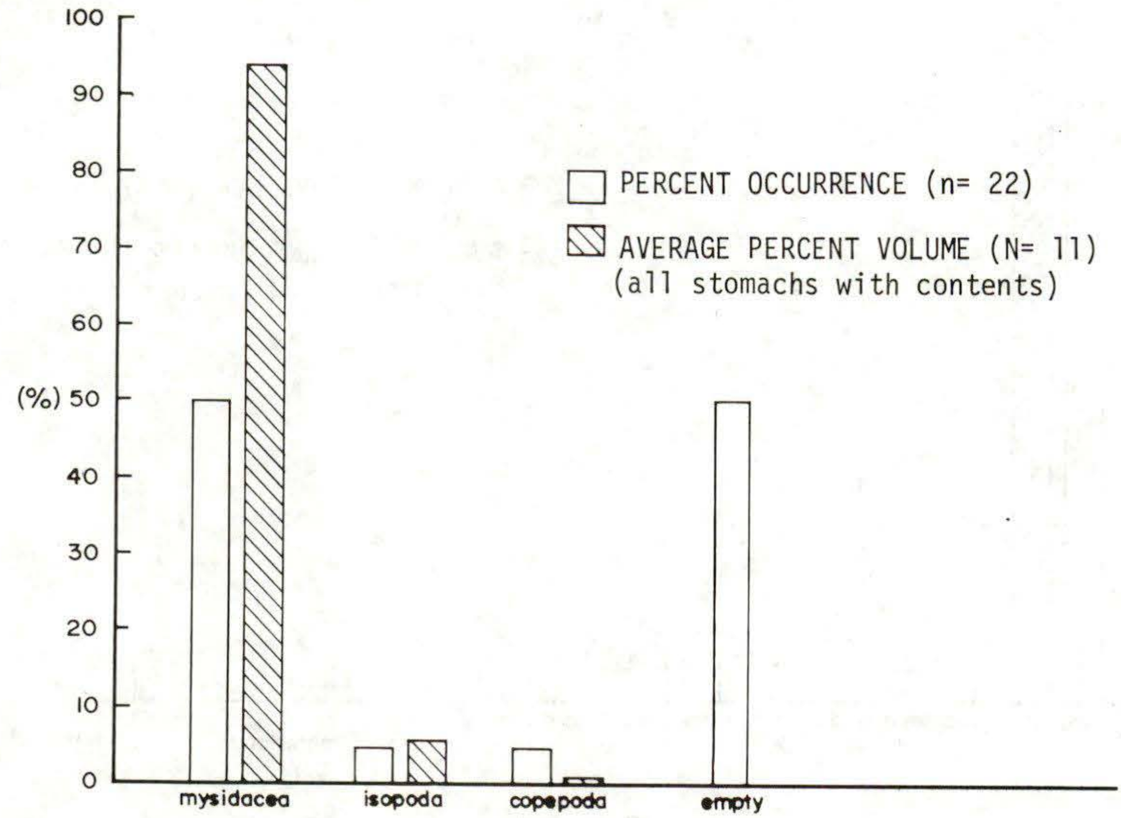


Figure 47. Food habits of boreal smelt fry by percent occurrence and average percent volume.

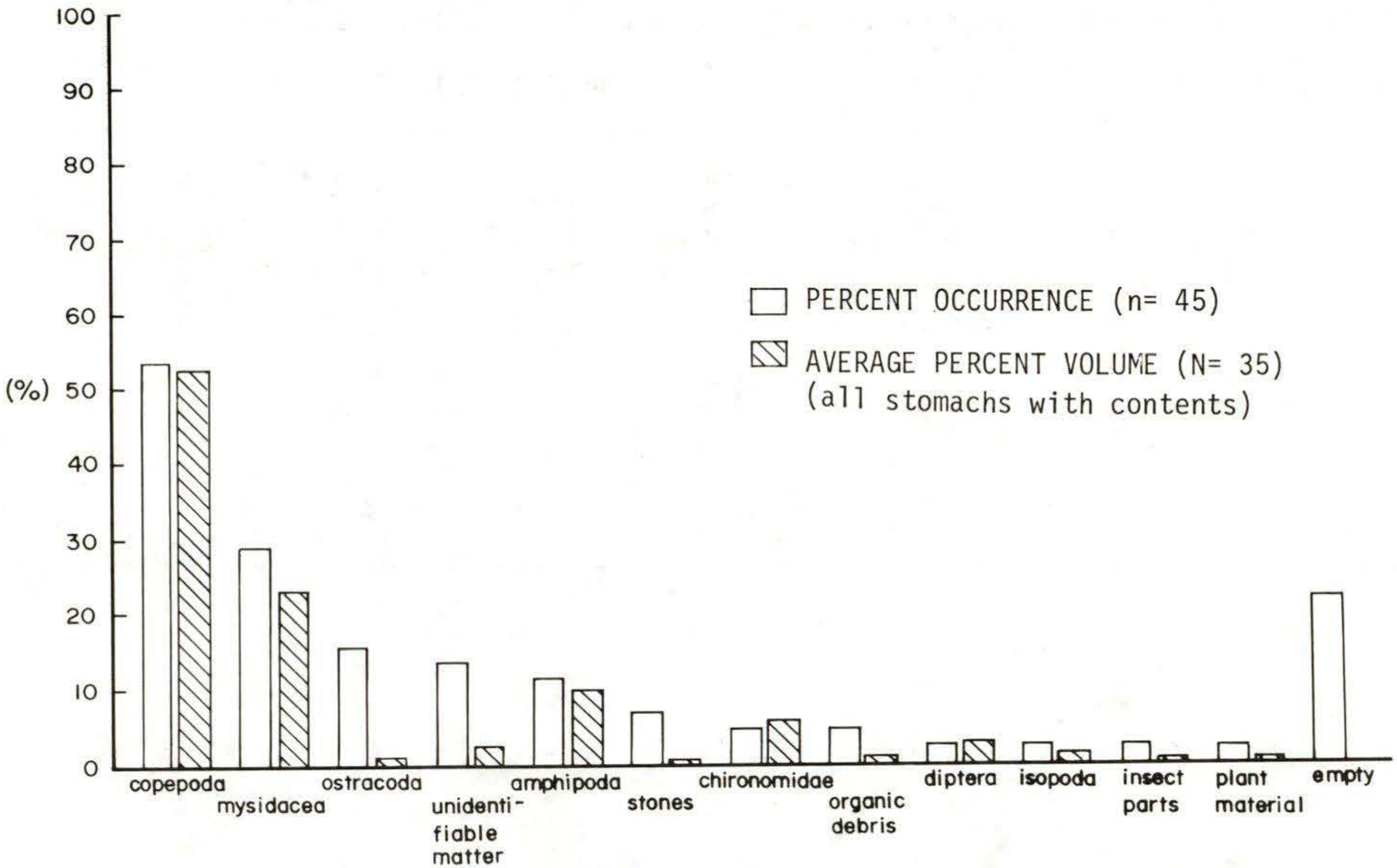


Figure 48. Food habits of whitefish fry by percent occurrence and average percent volume.

Table 1. Salinity and temperature data collected at different locations along the Yukon coast in April, 1974 and May, 1975.

Location	Station	Surface salinity (ppt)	Bottom salinity (ppt)	Depth of halocline (m)	Surface temperature (°C)	Bottom temperature (°C)	Depth of thermocline (m)	Depth (m)
April 1974								
Shingle Point	V	0	-	-	0.3	0.3		3.7
Sabine Point	I	0	-	-	0.7	-1.0	3	6.0
King Point	VI	5	-	-	0.2	-1.1*	4	18.0
Stokes Point	II	26	-	-	-1.0	-1.2		11.0
Herschel Island	III	28	-	-	-1.3	-1.1*		50.0
May 1975								
Escape Reef	G	0.5	0.5		0.0	-0.2		4.5
Sabine Point	F	1.5	18.0	6.5	0.7			12.0
King Point	E	1.1	30.1	6.5	-0.5	-2.0*	6.5	16.0
Phillips Bay	D	2.0	2.2		-0.6	-1.1		7.0
Stokes Point	C	2.7	13.1	6.5	-0.3	-1.0	5.5	7.0
Herschel Island	B	4.7	9.8	6.5	-0.2	-0.6		5.0

- information not collected

* indicates those values measured @ 15 m - the maximum depth of our instrumentation

Table 2. Salinity, temperature and secchi data collected in summer, 1975.

Stations		Date	Air Temp. (°C)	Surface Temp. (°C)	Bottom Temp. (°C)	Thermo-cline (m)	Surface Salinity (°/oo)	Bottom Salinity (°/oo)	Halocline Depth (m)	Halocline Salinity (°/oo)	Depth (m)	Secchi (m)
	104	16.7	11.0	16.0	0.3	1-3	5.7	26.2	1-2	23.0	3.0	
	107	16.7		14.5	1.6	2-3	7.8	27.5	2-3	27.5	2.8	0.5
2.5 km off	100	17.7	11.5	13.9	-0.1*	2-4	8.7	28.0	1-4	26.9	20.0	0.9
	100	17.7	10.5	13.5	-0.2	2-4	9.9	29.0	1-3	26.7	13.0	0.6
	100	17.7	13.0	13.5			10.6					
	100a	29.7	11.7	8.5	-1.3*	8-9	15.2	35.9*	0-8	32.3	26.0	
	114	17.7	13.0	15.6			3.6					
	114	29.7	4.2	8.2	9.7		12.6	36.6	2.3-2.5	37.1	2.6	22.0
	1	24.7	7.5	9.1	9.1		7.5	7.5			1.4	0.7
	40	24.7	8.5	9.0	9.0		8.1	8.1			1.8	
	26b	18.7	10.4	12.9	5.1	2-3	6.3	40.0	2-2.5	40.0	2.5	2.2
	25	23.7	5.4	9.3	1.0	4-11	7.2	26.2	8-11	28.3	12.5	1.3
	25	23.7	5.2	9.0	9.1		8.0	8.0			2.5	
	26b	4.8	7.1	8.3	6.5		14.0	18.6			3.1	
	26c	4.8	6.4	8.9	12.6		12.7	13.8			2.5	
	26c	4.8	6.4	8.9	2.6		13.7	17.8			3.0	
	25	7.8	0.8	6.0	4.2		17.5	22.6			6.0	
	45	20.7	10.5	10.0		3-5	9.6		3-3.5	23.5	3.0	1.5
	31	20.7	10.0	8.8	6.3		13.7	16.4			3.5	0.8
	34	21.7	6.0	7.0	0.5		17.6	18.8			3.0	6.7
	31b	5.8	5.2	8.6	0.8	4-6	16.4	34.0	4-5	9.8	5.0	

(* indicates those values measured @ 15 m - the maximum depth of our instrumentation)

Table 3. Species list of benthic organisms taken in Ekman dredge samples during May, July and August, 1975.

OLIGOCHAETA

- Peloscolex sp.

POLYCHAETA

- Ampharete acutifrons
- Ampharete vega
- Amphicteis sundevalli
- Antinoellsa sarsi
- Artacama proboscidea
- Capitella capitata
- Chaetozone sp.
- Cirratulid
- Ephesiella biserialis
- Ephesiella minuta
- Eteone longa
- Leichone polaris
- Lumbrineris tenuis
- Malacoceros fuliginosus
- Micronephthys minuta
- Phyllodoce groenlandica
- Prionospio cirrifera
- Scoloplos armiger
- Scoloplos sp.
- Terebellides stroemi
- Tharyx acutus
- Trochochaeta carica

AMPHIPODA

- Acanthostepheia behringiensis
- Atylus carinatus
- Boeckosimus affinis
- Gammaracanthus loricatus
- Gammarus oceanicus
- Haploops laevis
- Monoculodes sp.
- Monoculopsis longicornis
- Onisimus glacialis
- Pontoporeia affinis
- Pontoporeia femorata
- Priscillina armata
- Tryphosella sp.

CUMACEA

- Brachydiastylis resima
- Diastylis sulcata

NEMERTINA

- Nemertean

ISOPODA

- Mesidotea entomon
- Mesidotea sabini
- Mesidotea sibirica
- Mesidotea sp.

MYSIDACEA

- Mysis litoralis
- Mysis relicta

OSTRACODA

- Cyprideis sorbyana
- Cythereis sp.

HOLOTHUROIDEA

- Holothuroid

GASTROPODA

- Cingula eastanea
- Cylichna alba
- Cylichna occulta
- Oenopota arctica
- Oenopota elegans
- Oenopota novajasemliensis
- Oenopota reticulata

PELECYPODA

- Astarte borealis
- Astarte montagui
- Cyrtodaria kurriana
- Liocyma fluctuosa
- Lyonsia arenosa
- Macoma balthica
- Macoma calcarea
- Macoma moesta
- Montacuta maltzani
- Musculus corrugatus
- Pecten groenlandicus
- Portlandia arctica
- Thracia myopsis
- Thyasira gouldi
- Yoldiella fraterna
- Yoldiella intermedia

PRIAPULIDA

- Halicryptus spinulosus
- Priapulus caudatus

Table 4. Orders, number of species and number of individuals represented in Ekman dredge samples collected from various stations during May, July and August, 1975.

Order		Number of species and individuals by station																			
		A*	B	31	34	C	25	26	27	1	4	D	40	E	100	114	200	104	107	G	Totals
Oligochaeta	S				1													1	1		1
	I				8													36	2		46
Polychaeta	S	5	3	6	2	2	1	1	11	2	1	2		2	5	1		1	1	1	22
	I	36	4	63	3	2	1	1	24	201	218	2		4	34	7		24	2	1	627
Amphipoda	S	2	2	4	5		1	1	1	3	1		1	2	2	3	1	1	3	1	13
	I	4	12	52	88		3	1	1	526	3		1	4	2	4	1	40	13		755
Cumacea	S	1	2	1					1												2
	I	11	2	108					2												123
Isopoda	S		1	1	1		1		2	1	1	1		1	1			1		1	4
	I		1	2	1		2		3	15	3	1		1	2			16		1	48
Mysidacea	S				1		1			2	2							2	1		2
	I				2		1			6	4							12	2		27
Ostracoda	S	1	1									1									2
	I	2	3									29									34
Holothuroidea	S								1												1
	I								1												1
Gastropoda	S	2	1						2			3		2							7
	I	2	6						5			6		3							22
Pelecypoda	S	2	7	3	2	2			7			4		2	1	3	2				16
	I	12	58	46	34	4			66			26		7	1	24	31				309
Nemertina	S				1																1
	I				2																2
Priapulida	S	1	1					1								1	1				2
	I	1	2					1								4	1				9

S = species
I = individuals

*lettered stations represent those of the May, 1975 study.

Table 5. Species diversification and abundance of benthic organisms collected by Ekman dredge at various stations along the Yukon coast in May, July and August, 1975.

	Station	Depth (m)	Bottom temp. (°C)	Bottom salinity (°/oo)	Area sampled (sq. m)	# of species	Total individuals per sq. m	# Species per area	
	A	9.0	-1.2	22.0	0.07	14	971		
West	B	5.0	0.6	9.8	0.07	18	1257	39	Herschel Is.
	31	3.5	6.3	16.4	0.23	15	1165		
	34	3.0	6.5	18.8	0.23	13	593		
	C	7.0	-1.0	13.1	0.23	4	86		
	25	2.5	9.1	8.0	0.23	4	30	32	Stokes Point
	26	2.5	5.1	>40.0	0.23	3	13		
	27	12.5	-1.0	26.2	0.23	25	439		
	1	1.4	9.1	7.5	0.23	8	3216		
	4	1.3	9.1	8.1	0.23	5	980	19	Phillips Bay
	D	7.0	-1.1	2.2	0.07	11	914		
	40	1.8	9.0	8.1	0.23	1	4		
	E	16.0	-2.0	30.1	0.07	9	271	16	King Point
	100	13.0	1.0	28.3	0.23	9	168		
	114	2.6	9.7	37.6	0.23	8	168	8	Eastern lagoons
	200	2.9	9.8	3.5	0.12	4	274		
	104	3.0	0.3	26.2	0.23	8	550	8	Shingle Point
East	107	2.8	1.6	27.5	0.23	4	82	6	Trent Bay
	G	4.5	-0.2	0.5	0.07	2	29		

Table 6. Bottom invertebrates caught by epibenthic trawl along the Yukon coast in May, July and August, 1975.

Order	Number of organisms per 5 min. trawl by station															
	HERSCHEL IS.			STOKES PT.			PHILLIPS BAY			KING PT.		SABINE - SHINGLE PT.				
	31	31b	32	27	C	25	D	4	1	114	100	F	104	107	G	Totals
Amphipoda	18	8	8	1		5	6		14		15		2	30	1	108
Mysidacea	386	22	76	27	6		46	3	12	20	2100	10	20	500		3228
Cumacea		2					15						1			18
Nemertea											2			5		7
Scyphozoa			1	2												3
Isopoda		1			1		1		13						3	19
Polychaeta		2					1									3
Pelecypoda					25		79									104
Fourhorn sculpin					1											1
TOTALS	404	35	85	30	33	5	148	3	39	20	2117	10	23	535	4	3491

Table 7. List of common and scientific names with code of fish species captured during the study.

Common Name	Scientific Name	Code
Arctic cisco	*Coregonus autumnalis* (Pallas)	CA
Arctic char	*Salvelinus alpinus* (Linnaeus)	SA
Arctic cod	*Boreogadus saida* (Lepechin)	AC
Arctic flounder	*Liopsetta glacialis* (Pallas)	AF
Arctic grayling	*Thymallus arcticus* (Pallas)	AG
Arctic lamprey	*Lampetra japonica* (Martens)	AL
Boreal smelt	*Osmerus eperlanus* Linnaeus)	BS
Broad whitefish	*Coregonus nasus* (Pallas)	BW
Burbot	*Lota lota* (Linnaeus)	BT
Capelin	*Mallotus villosus* (Muller)	CP
Fourhorn sculpin	*Myoxocephalus quadricornis quadricornis* (Linnaeus)	HS
Humpback whitefish	*Coregonus clupeaformis* (Mitchill)	HW
Inconnu	*Stenodus leucichthys nelma* (Pallas)	IN
Least cisco	*Coregonus sardinella* Valenciennes	LC
Longnose sucker	*Catostomus catostomus* (Forster)	LN
Ninespine stickleback	*Pungitius pungitius* (Linnaeus)	NS
Northern pike	*Esox lucius* (Linnaeus)	NP
Pacific herring	*Clupea harengus pallasi* Valenciennes	PH
Round whitefish	*Prosopium cylindraceum* (Pallas)	RW
Saffron cod	*Eleginus navaga* (Pallas)	SC
Starry flounder	*Platichthys stellatus* (Pallas)	SF

Table 8. Additional fish species in the western Arctic recorded by D.E. McAllister, 1962.

Common Name	Scientific Name
Arctic alligaterfish	*Aspidophoriodes olrikii* Lütken
Arctic sculpin	*Myoxocephalus scorpioides* (Fabricius)
Arctic staghorn sculpin	*Gymnoscanthus tricuspis* (Reinhardt)
Bartail snailfish	*Liparis herschelinus* Scofield
Canadian eelpout	*Lycodes polaris* (Sabine)
Gelatinous seasnail	*Liparis koefoedi* Parr
Hamecon	*Artediellus scaber* Knipowitch
Lycodes rossi	*Lycodes rossi* (Malmgren)
Pale eelpout	*Lycodes pallidus* Collett
Ribbed sculpin	*Triglops pingelii* Reinhardt
Sand lance	*Ammodytes hexapterus* Pallas
Slender eelblenny	*Lunpenus fabricii* (Valenciennes)
Schulupaoluk	*Lycodes jugoricus* Knipowitch
Spatulate sculpin	*Icelus spatula* Gilbert and Burke
Twohorn sculpin	*Icelus bicornis* (Reinhardt)

Table 9. Species composition, numerical abundance and percent composition of gillnet-caught fish, 1975.

AREA		FISH SPECIES															
		LC	CA	HS	BS	IN	SA	BW	HW	PH	AF	SF	CP	SC	NP	AL	Total
Shingle	n	181	14	2	1	2											200
Point	%	90.5	7.0	1.0	0.5	1.0											
Kay Pt. to	n	92	20	5												3	120
King Pt.	%	76.7	16.6	4.2												2.5	
Phillips	n	91	8	13	22	3		2		4	1	4		2			150
Bay	%	60.6	5.3	8.7	14.7	2.0		1.3		2.7	0.7	2.7		1.3			
Stokes	n	31	13	1		2			1								48
Pt.	%	64.6	27.1	2.1		4.1			2.1								
Herschel	n	82	82	11	4					1					1		181
Is.	%	45.3	45.3	6.1	2.2					0.6					0.6		
Stokes	n	190	111			3	1	3	2	5	3		3				321
Lagoon	%	59.2	34.6			0.9	0.3	0.9	0.6	1.6	0.9		0.9				
Station	n	2	4	4				5			1						16
200	%	12.5	25.0	25.0				31.3			6.3						
Total	n	669	252	36	27	10	1	10	3	10	5	4	3	2	1	3	1020
	%	64.6	24.3	3.5	2.6	1.0	0.1	1.0	0.3	1.0	0.5	0.4	0.3	0.2	0.1	0.3	

n = number of each species.

% = percent composition.

Table 10. Comparison of the percent composition of the total gillnet catch of the summer programs of 1974 and 1975 by area.

Shingle Point

Species	Percent composition 1974 (n=2,278)	1975 (n=200)
LC	82.8	90.5
CA	10.7	7.0
BS	3.3	0.5
HW	1.0	
IN	1.5	1.0
BT	0.2	
HS	0.2	1.0
SA	0.1	
RW	0.1	
AC	0.1	

King Point

Species	Percent composition 1974 (n=202)	1975 (n=120)
LC	83.7	76.7
CA	7.9	16.7
BS	4.0	
HS	3.0	4.2
AC	0.5	
HW	0.5	
BW	0.5	
LA		2.5

Kay Point

Species	Percent composition 1974 (n=130)	1975 (n=74)
LC	89.2	83.8
CA	10.0	10.8
SA	0.8	
HS		5.4

Phillips Bay

Species	Percent composition 1974 (n=612)	1975 (n=150)
CA	37.6	5.3
LC	32.7	60.7
HS	8.7	8.7
SA	7.0	
HW	3.9	
AF	3.6	0.7
IN	2.9	2.0
BS	2.1	14.7
BW	0.8	1.3
SF	0.3	2.7
RW	0.2	
SC	0.2	
PH		2.7
AC		1.3

Stokes Point

Species	Percent composition 1974 (n=244)	1975 (n=48)
CA	53.3	27.1
LC	27.1	64.6
SA	11.5	
HS	8.2	2.1
IN		4.2
HW		2.1

Stokes Lagoon

Species	Percent composition 1974 (n=498)	1975 (n=321)
CA	64.7	34.6
LC	20.5	59.2
SA	10.0	0.3
HS	4.4	
HW	0.2	0.6
PH	0.2	1.6
IN		0.9
AF		0.9
CP		0.9
BW		0.9

Herschel Island

Species	Percent composition 1974 (n=242)	1975 (n=181)
CA	72.3	45.3
SA	20.7	
HS	3.7	6.1
LC	3.3	45.3
BS		2.1
PH		0.6
NP		0.6

Table 11. Comparison of catch per unit effort for nearshore and offshore stations in six different areas.

Area		Depth (m)	Station number	Date	Time * ± 5 min.	LC	CA	HS	BS	IN	HW	PH	AF	SC	Total
						Number of each species									
Shingle Point	NS	3.0	104	30.7.75	1230-1330	181	14	2	1	2					200
	OS	3.0	105	31.7.75	1340-1440			1							1
King Point	NS		100	29.7.75	2340-0040	8	12	1							21
	NS		100	29.7.75	2230-2330	22									22
	OS	26.0	100a	29.7.75	1930-2130										0
Phillips Bay	NS	1.4	1	24.7.75	1600-1700	34	3	1	8			1	1		48
	OS	1.3	4	24.7.75	1655-1855	32	3	2	8	1				1	47
Stokes Point	NS	2.5	25	23.7.75	0225-0325	31	13	1		2	1				48
	OS	6.0	27	23.7.75	0205-0305										0
Stokes Lagoon	NS	3.3	26c	17.7.75	1230-1330	30	1			1					32
	OS	2.5	26d	17.7.75	1245-1350	2									2
	NS	3.3	26c	18.7.75	0105-0205	20	4								24
	OS	2.5	26d	18.7.75	0140-0250	2									2
	NS	3.3	26c	4.8.75	0025-0125	39	10								49
	OS	2.5	26d	4.8.75	0145-0245	3	6								9
Herschel Island	NS	3.0	31	20.7.75	2000-2100	11	9								20
	OS	5.0	31	20.7.75	2015-2115										0
	NS	3.0	34	21.7.75	2310-0010	8	3								11
	OS	7.0	34a	21.7.75	2315-0015										0

NS = nearshore, nets set within 25 m from shore
OS = offshore, nets set more than 500 m from shore

*Pacific Standard Time

Table 12. Stomach contents of least cisco caught at different locations along the Yukon coast in July, August and early September, 1974.

FOOD ITEM	LAGOONS (N=44)			HERSCHEL IS. (N=4)			CALTON-STOKES (N=39)		
	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN
CRUSTACEA									
Copepoda	22	50.0	36.5	3	75.0	60.0	14	35.9	16.8
Amphipoda	7	15.9	5.7	3	75.0	40.0	22	56.4	40.8
Mysidacea	8	18.7	6.5				12	30.8	26.4
Isopoda	3	6.8	3.6				7	17.9	3.1
Crust. parts	2	4.5	0.9				1	2.6	0.2
TOTAL	33	75.0	53.2	4	100.0	100.0	34	87.2	87.3
INSECTA									
Chironomidae (L)	10	22.7	10.3				3	7.7	1.7
(P)	8	18.2	11.2				2	5.1	0.9
(A)	2	4.5	2.3						
Total	11	25.0	23.8				3	7.7	2.6
Unident. diptera	9	20.5	11.0				4	10.3	1.3
Hymenoptera							3	7.7	0.7
Plecoptera	2	4.5	8.1						
Coleoptera	1	2.3	0.9						
TOTAL	20	45.5	43.8				9	23.1	4.6
FISH									
Unident. remains							3	7.7	2.2
Stickleback	1	2.3	2.3				1	2.6	0.8
TOTAL	1	2.3	2.3				4	10.3	3.0
PELECYPODA	1	2.3	0.2						
MISCELLANEOUS									
Unident. mat'l.	3	6.8	0.5				1	2.6	0.7
Plant mat'l.							1	5.1	4.4
TOTAL	3	6.8	0.5				3	7.7	5.1

FOOD ITEM	PHILLIPS BAY (N=14)			KAY-SHINGLE (N=11)			TRENT BAY (N=0)		
	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN
CRUSTACEA									
Copepoda	5	35.7	6.0	5	45.5	48.0			
Amphipoda	8	57.1	32.0	2	18.2	8.8			
Mysidacea	1	7.1	6.9	1	9.1	26.3			
Isopoda	7	50.0	42.5						
Crust. parts									
TOTAL	13	92.9	87.4	8	72.7	83.1			
INSECTA									
Chironomidae (L)	1	7.1	0.2						
(P)	1	7.1	0.1						
(A)									
Total	1	7.1	0.3						
Unident. diptera	1	7.1	0.3	2	18.2	8.1			
Hymenoptera									
Plecoptera									
Coleoptera									
TOTAL	1	7.1	0.6	2	18.2	8.1			
FISH									
Unident. remains	1	7.1	8.6						
Stickleback									
TOTAL	1	7.1	8.6						
PELECYPODA									
MISCELLANEOUS									
Unident. mat'l.				2	18.2	8.8			
Plant mat'l.	1	7.1	3.4						
TOTAL	1	7.1	3.4	2	18.2	8.8			

FOOD ITEM	OFFSHORE (N=1)			RIVERS (N=1)			TOTAL ALL AREAS (N=114)		
	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN
CRUSTACEA									
Copepoda	1	100	100				50	43.9	26.0
Amphipoda							42	36.8	24.8
Mysidacea							22	19.3	15.3
Isopoda							17	14.9	7.8
Crust. parts							3	2.6	0.4
TOTAL	1	100	100				93	81.6	74.3
INSECTA									
Chironomidae (L)				1	100	70.0	15	13.2	4.8
(P)				1	100	30.0	12	10.5	4.7
(A)							2	1.8	0.9
Total				1	100	100.0	16	14.0	10.4
Unident. diptera							16	14.0	5.1
Hymenoptera							3	2.6	0.3
Plecoptera							2	1.8	3.1
Coleoptera							1	0.9	0.4
TOTAL				1	100	100.0	33	28.9	19.3
FISH									
Unident. remains							4	3.5	1.9
Stickleback							2	1.8	1.3
TOTAL							6	5.3	3.1
PELECYPODA							1	0.9	0.1
MISCELLANEOUS									
Unident. mat'l.							6	5.3	0.8
Plant mat'l.							3	2.6	2.3
TOTAL							9	7.9	3.1

	LAGOONS	HERSCHEL IS.	CALTON-STOKES	PHILLIPS BAY	KAY-SHINGLE	TRENT BAY	OFFSHORE	RIVERS	TOTAL ALL AREAS
n	85	8	62	69	98	221	3	1	547
% empty	48.2	50.8	37.1	79.7	88.8	100	66.7	0	79.2
Average vol. (ml)	1.3	1.3	1.5	1.3	0.5	0	0.2	0.3	1.3
Mean length (mm)	284.8	285.8	289.6	263.6	252.7	221.1	157.0	287.0	250.5
Length range (mm)	220-373.0	232-311.0	218-371.0	148-335.0	133-326.0	131-353.0	130-190.0		130-373.0
Stations included	2, 3, 6, 8, 26a, 26b, 26c, 29, 30, 36, 106	31, 32, 33, 34, 39	25, 28, 35	1, 4, 5, 7	41, 42, 43, 100, 112, 113	102, 103, 104, 105, 107, 109, 110	27	9	

N = total number of stomachs with food.

n = total number of stomachs examined.

f = frequency of occurrence; the number of stomachs in which a particular item occurred.

fN = the frequency of occurrence expressed as percentage of 'N'.

%vN = the average volume expressed as a percentage of the total volume of a particular item in 'N' stomachs.

(L) = larvae

(P) = pupae

(A) = adult

Table 13. Stomach contents of Arctic cisco caught at different locations along the Yukon coast in July, August and early September, 1974.

FOOD ITEM	LOCATION																				TOTAL		
	LAGOONS (N=127)			HERSCHEL IS. (N=55)			CALTON-STOKES (N=72)			PHILLIPS BAY (N=15)			KAY-SHINGLE (N=4)			TRENT BAY (N=2)			RIVERS (N=2)			ALL AREAS (N=277)	
	f	fN	vN	f	fN	vN	f	fN	vN	f	fN	vN	f	fN	vN	f	fN	vN	f	fN	vN	f	fN	vN
CRUSTACEA																								
Mysidacea	37	29.1	26.7	22	40.0	30.5	23	31.9	16.8	5	33.3	17.6										87	31.4	23.5
Amphipoda	12	9.4	7.4	16	29.1	25.7	35	48.6	29.6	8	53.3	54.5										71	25.6	22.6
Isopoda	11	8.7	3.0	1	1.8	0.5	9	12.5	4.3	4	26.7	5.9										25	9.0	2.6
Copepoda	14	11.0	5.7				10	13.9	28.2													24	8.7	7.1
Crustacean parts	18	14.2	7.4	8	14.5	12.3	1	1.4	0.2	1	6.7	0.2				1	50.0	1.2				29	10.5	6.4
TOTAL	72	56.7	50.2	40	72.7	69.0	61	84.7	79.1	10	66.7	78.2				1	50.0	1.2				184	66.4	62.2
INSECTA																								
Chironomidae (L+P)	27	21.3	14.2				3	4.2	trace	1	6.7	0.2										32	11.6	4.7
Trichoptera	1	0.8	trace				1	1.4	0.3													2	0.7	0.1
Hymenoptera	1	0.8	trace																1	50.0	40.0	2	0.7	trace
Oestridae							1	1.4	0.1													1	0.4	trace
Diptera (A) + parts	1	0.8	0.7							3	20.0	2.5	3	75.0	89.7							7	2.5	1.3
Insect fragments	16	12.6	6.1				6	8.3	1.2							1	50.0	98.8				23	8.3	6.6
TOTAL	37	29.1	21.0				10	13.9	1.6	4	26.7	2.7	3	75.0	89.7	1	50.0	98.8	1	50.0	40.0	56	20.2	12.7
FISH																								
Unident. remains	3	2.4	3.7	9	16.4	15.9				1	6.7	4.1										13	4.7	6.7
ANNELIDA																								
Polychaeta				1	1.8	0.1	1	1.4	1.8	2	13.3	11.3										4	1.4	1.7
Unident. worms	3	2.4	0.8																			3	1.1	0.3
TOTAL	3	2.4	0.8	1	1.8	0.1	1	1.4	1.8	2	13.3	11.3										7	2.5	2.0
PELECYPODA	3	2.4	1.8	2	3.6	0.5	1	1.4	0.3													6	2.2	0.8
ARACHNIDA																								
Hydrachna	1	0.8	trace																			1	0.4	trace
MISCELLANEOUS																								
Unident. mat'l.	16	12.6	7.7	16	29.1	9.5	14	19.4	4.8	2	13.3	1.9							1	50.0	60.0	[illegible]	[illegible]	6.6
Organic debris	36	28.3	12.5	4	7.3	4.4				1	6.7	1.8										41	[illegible]	5.7
Plant matter							8	11.1	8.2				1	25.0	10.3							[illegible]	[illegible]	1.5
Stones	5	3.9	0.8	2	3.6	0.6	1	1.4	0.5													[illegible]	[illegible]	0.6
Mud	2	1.6	1.5				1	1.4	3.7													[illegible]	[illegible]	1.2
TOTAL	54	42.5	22.5	22	40.0	14.5	25	34.7	17.2	3	20.0	3.7	1	25.0	10.3				1	50.0	60.0	[illegible]	38.3	15.6
n		279			197			176			134			67			138			8			999	
empty		54.4			72.1			59.1			88.8			94.0			98.6			75			72.3	
Average vol. (ml)		0.9			2.1			1.0			3.1			0.8			8.1			0.1			1.3	
Mean length (mm)		333.6			347.1			333.1			336.4			306.5			350.9			351.8			337.3	
Length range (mm)		126-430			245-440			209-442			110-455			221-400			141-435			288-421			110-455	
Stations included		2, 3, 6, 8, 26a, 26b, 26c, 29, 30, 36, 106			31, 32, 33 34, 39			25, 28, 35			1, 4, 5, 7			40, 41, 42, 100, 112, 113			102, 103, 104, 105, 107, 108 109, 110			9, 9a				

N = total number of stomachs with food.

n = total number of stomachs examined.

f = frequency of occurrence; the number of stomachs in which a particular item occurred.

fN = the frequency of occurrence expressed as percentage of 'N'.

vN = the average volume expressed as a percentage of the total volume of a particular item in 'N' stomachs.

(L) = larvae

(P) = pupae

Table 14. Stomach contents of Arctic char caught at different locations along the Yukon coast in July, August and early September, 1974.

FOOD ITEM	LOCATION																		TOTAL		
	LAGOONS (N=7)			HERSCHEL IS. (N=40)			CALTON-STOKES (N=27)			PHILLIPS BAY (N=8)			TRENT BAY (N=1)			RIVERS (N=2)			ALL AREAS (N=85)		
	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN
CRUSTACEA																					
Amphipoda	2	28.6	9.0	16	40.0	10.7	9	33.3	8.6	1	12.5	10.1				1	50.0	5.4	29	34.1	10.0
Mysidacea				8	20.0	1.8	10	37.0	22.1										18	21.2	5.6
Isopoda	3	42.9	19.8	4	10.0	1.0	2	7.4	14.9	2	25.0	42.0							11	12.9	6.4
Copepoda							2	7.4	3.7										2	2.4	1.2
TOTAL	5	71.4	28.8	20	50.0	13.5	16	59.3	49.3	3	37.5	52.1				1	50.0	5.4	45	52.9	23.2
INSECTA																					
Diptera (A) + parts				1	2.5	0.4				1	12.5	12.7							2	2.4	0.8
Chironomidae (L)	2	28.6	16.2																2	2.4	0.4
Coleoptera	1	14.3	0.9	1	2.5	0.5													2	2.4	0.4
TOTAL	2	28.6	17.1	2	5.0	0.9				1	12.5	12.7							5	5.9	1.6
FISH																					
Unident. fish remains	3	42.9	31.6	21	52.5	24.7	8	29.6	13.7	4	50.0	26.5				1	50.0	73.3	37	43.5	22.6
Cod (unident.)				9	22.5	51.3							1	100	100				10	11.8	37.4
Fourhorn sculpin				1	2.5	1.2	4	14.8	13.0										5	5.9	3.4
Arctic cisco				1	2.5	5.1	1	3.7	14.2										2	2.4	6.6
Arctic lamprey							1	3.7	2.0										1	1.2	0.4
Least cisco							1	3.7	2.7										1	1.2	0.5
TOTAL	3	42.9	31.6	32	80.0	82.3	13	48.1	45.6	4	50.0	26.5	1	100	100	1	50.0	73.3	54	63.5	70.9
ARACHNIDA	1	14.3	0.9																1	1.2	trace
POLYCHAETA										1	12.5	2.5							1	1.2	0.1
MISCELLANEOUS																					
Unident. material				4	10.0	3.2	2	7.4	2.4							1	50.0	21.3	7	8.2	2.8
Plant matter	1	14.3	18.0				1	3.7	2.7	1	12.5	6.2							3	3.5	1.3
Mud	1	14.3	3.6																1	1.2	0.1
TOTAL	2	28.6	21.6	4	10.0	3.2	3	11.1	5.1	1	12.5	6.2				1	50.0	21.3	10	11.8	4.2
n		27			68			43			25			1			2			166	
% empty		74.1			41.2			37.2			68.0			0			0			48.8	
Average volume (ml)		1.7			8.1			3.4			4.6			9.0			1.5			4.7	
Mean length (mm)		423.7			427.3			414.9			428.5									423.7	
Length range (mm)		289-595			301-590			142-579			314-581									142-595	
Stations included		2, 26a, 26b, 26c			31, 32, 33, 34, 39			25, 28, 35			1, 4, 5, 7			109			9a				

N = total number of stomachs with food.

n = total number of stomachs examined.

f = frequency of occurrence; the number of stomachs in which a particular item occurred.

%fN = the frequency of occurrence expressed as percentage of 'N'.

%vN = the average volume expressed as a percentage of the total volume of a particular item in 'N' stomachs.

(L) = larvae

(A) = adult

Table 15. Stomach contents of fourhorn sculpin caught at different locations along the Yukon coast in July, August and early September, 1974.

FOOD ITEM	LOCATION																			TOTAL	
	LAGOONS (N=2)			HERSCHEL (N=8)			CALTON-STOKES (N=1)			PHILLIPS BAY (N=12)			KAY-SHINGLE (N=0)			TRENT BAY (N=3)			ALL AREAS (N=26)		
	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN
CRUSTACEA																					
Isopoda	2	100	100	8	100	99.6	1	100	100	12	100	99.0				3	100	100	26	100	99.3
Mysidacea				1	12.5	0.4													1	3.8	0.2
TOTAL	2	100	100	8	100	100	1	100	100	12	100	99.0				3	100	100	26	100	99.5
FISH																					
Eggs										1	8.3	1.0							1	3.8	0.5
TOTAL										1	8.3	1.0							1	3.8	0.5
n		12			9			1			13			4			4			43	
% empty		83.3			11.1			0			7.7			100.0			25.0			39.5	
Average vol. (ml)		3.8			7.5			1.0			18.2			0			7.3			7.6	
Mean length (mm)		233.5			206.3			164			238.9			172.3			268.3			222.1	
Length range (mm)		129-281			181-240						171-304			130-215			229-303			129-304	
Stations included		2, 26a, 26b, 29			31, 32			25			1, 4, 5, 7			100			107				

N = total number of stomachs with food.

n = total number of stomachs examined.

f = frequency of occurrence; the number of stomachs in which a particular item occurred.

%fN = the frequency of occurrence expressed as percentage of 'N'.

%vN = the average volume expressed as a percentage of the total volume of a particular item in 'N' stomachs.

Table 16. Stomach contents of boreal smelt caught at different locations along the Yukon coast in July, August and early September, 1974.

FOOD ITEM	LOCATION									TOTAL		
	PHILLIPS BAY (N=8)			KAY-SHINGLE (N=0)			TRENT BAY (N=1)			ALL AREAS (N=9)		
	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN
CRUSTACEA												
Amphipoda	5	62.5	40.7							5	55.6	30.4
Mysidacea	4	50.0	18.6				1	100	100	5	55.6	39.2
Isopoda	3	37.5	30.5							3	33.3	22.8
TOTAL	8	100	89.8				1	100	100	9	100	92.4
FISH												
Unident. remains	1	12.5	10.2							1	11.1	7.6
TOTAL	1	12.5	10.2							1	11.1	7.6
n	11			10			81			102		
% empty	27.3			100			98.8			91.2		
Average vol. (ml)	0.7			0			2.0			0.8		
Mean length (mm)	261.4			213.9			229.5			231.4		
Length range (mm)	171-321			170-281			118-305			118-321		
Stations included	1, 4			100, 113			104, 105, 108, 109, 110					

N = total number of stomachs with food.

n = total number of stomachs examined.

f = frequency of occurrence; the number of stomachs in which a particular item occurred.

%fN = the frequency of occurrence expressed as percentage of 'N'.

%vN = the average volume expressed as a percentage of the total volume of a particular item in 'N' stomachs.

Table 17. Stomach contents of humpback whitefish caught at different locations along the Yukon coast in July, August and early September, 1974.

FOOD ITEM	LOCATION													TOTAL	
	LAGOONS (N=6)			PHILLIPS BAY (N=4)			KAY-SHINGLE (N=0)			TRENT BAY (N=1)			ALL AREAS (N=11)		
	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN
CRUSTACEA															
Amphipoda				2	50.0	33.2							2	18.2	10.2
Isopoda	1	16.7	0.2										1	9.1	trace
TOTAL	1	16.7	0.2	2	50.0	33.2							3	27.3	10.2
INSECTA															
Chironomidae (L)	5	83.3	41.7	1	25.0	3.4							6	54.5	30.2
(P)	4	66.7	27.6	1	25.0	3.4							5	45.5	20.4
Total	5	83.3	69.3	1	25.0	6.8							6	54.5	50.6
Plecoptera	1	16.7	16.6										1	9.1	11.5
TOTAL	6	100	85.9	1	25.0	6.8							7	63.6	62.1
FISH															
Stickleback	1	16.7	11.1										1	9.1	7.7
TOTAL	1	16.7	11.1										1	9.1	7.7
MISCELLANEOUS															
Organic debris	1	16.7	2.8	2	50.0	26.9				1	100	100	4	36.4	10.0
Inorganic debris				1	25.0	33.1							1	9.1	10.0
TOTAL	1	16.7	2.8	2	50.0	60.0				1	100	100	4	36.4	20.0
n		9			6			4			17			36	
% empty		33.3			33.3			100			94.1			69.4	
Average vol. (ml)		5.4			3.6			0			0.5			4.3	
Mean length (mm)		333.3			335.5			364.8			305.2			323.9	
Length range (mm)		311-383			269-371			340-377			214-430			214-430	
Stations included		2, 3, 26c, 30			1, 7			111			102, 104, 108 109				

N = total number of stomachs with food.

n = total number of stomachs examined.

f = frequency of occurrence; the number of stomachs in which a particular item occurred.

%fN = the frequency of occurrence expressed as percentage of 'N'.

%vN = the average volume expressed as a percentage of the total volume of a particular item in 'N' stomachs.

(L) = larvae

(P) = pupae

Table 18. Stomach contents of inconnu caught at different locations along the Yukon coast in July, August and early September, 1974.

FOOD ITEM	LOCATION												TOTAL		
	LAGOONS (N=4)			PHILLIPS BAY (N=2)			TRENT BAY (N=10)			RIVERS (N=1)			ALL AREAS (N=17)		
	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN	f	%fN	%vN
CRUSTACEA															
Isopoda				1	50.0	1.6							1	5.9	.1
TOTAL				1	50.0	1.6							1	5.9	.1
FISH															
Unident. fish	2	50.0	48.7	2	100.0	98.4	3	30.0	20.0	1	100	100	8	47.1	37.5
CA	2	50.0	41.5				6	60.0	36.0				8	47.1	34.8
LC							2	20.0	40.5				2	11.8	22.0
HS *	1	25.0	8.9										1	5.9	3.3
NS	1	25.0	0.9				2.	20.0	1.1				3	17.6	1.0
BS							1	10.0	2.4				1	5.9	1.3
TOTAL	4	100	100	2	100.0	98.4	10	100	100	1	100	100	17	100.0	99.9

	LAGOONS	PHILLIPS BAY	TRENT BAY	RIVERS	ALL AREAS
n	6	4	31	1	42
% empty	33.3	50.0	67.7	0	59.5
Average vol. (ml)	42.6	15.5	25.3	10	27.3
Mean length (mm)	528.5	561.5	502.8		541.3
Length range (mm)	425-630	495-638	340-812		340-812
Stations included	2	1, 4	104, 108, 109	9a	

N = total number of stomachs with food.

n= total number of stomachs examined.

f = frequency of occurrence; the number of stomachs in which a particular item occurred.

%fN = the frequency of occurrence ex expressed as percentage of 'N'.

%vN = the average volume expressed as a percentage of the total volume of a particular item in 'N' stomachs.

* = code names for fish species (see Table 1).

Table 19. Stomach contents of Arctic and starry flounders (results combined) caught along the Yukon coast in July, August and early September, 1974.

FOOD ITEM	ALL AREAS (N=13)		
	f	%fN	%vN
CRUSTACEA			
Amphipoda	7	53.8	29.7
Isopoda	6	46.2	32.1
Mysidacea	1	7.2	6.4
TOTAL	12	92.3	68.4
PELECYPODA	2	15.4	13.8
MISCELLANEOUS			
Organic debris	4	30.8	18.0
n		16	
% empty		18.8	
Average vol. (ml)		1.9	
Mean length (mm)		211.0	
Length range (mm)		105-300	
Stations included		1,2,4,5,7,26a	

N = total number of stomachs with food.

n = total number of stomachs examined.

f = frequency of occurrence; the number of stomachs in which a particular item occurred.

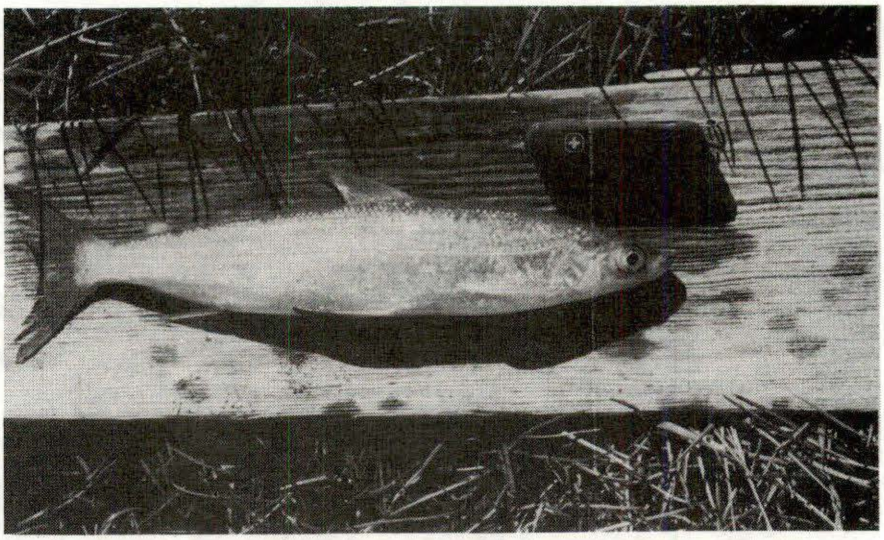
% fN = the frequency of occurrence expressed as percentage of 'N'.

%vN = the average volume expressed as a percentage of the total volume of a particular item in 'N' stomachs.

Table 20. Percent composition by sex of 9 fish species caught in gillnets along the Yukon coast in July, August and early September, 1974.

Species	No. sexed	% female	% male	% sex unidentified
Arctic cisco	1170	42.7	56.5	0.8
Arctic char	191	63.4	33.5	3.1
Arctic flounder	19	36.8	5.3	57.9
Boreal smelt	110	56.4	42.7	0.9
Broad whitefish	8	12.5	62.5	25.0
Fourhorn sculpin	53	67.9	32.1	0
Humpback whitefish	47	34.0	66.0	0
Inconnu	45	53.3	46.7	0
Least cisco	2296	51.7	47.9	0.5

Appendix I. The three most frequently caught fish species in 1974:
A. least cisco; B. Arctic cisco; and C. Arctic char.



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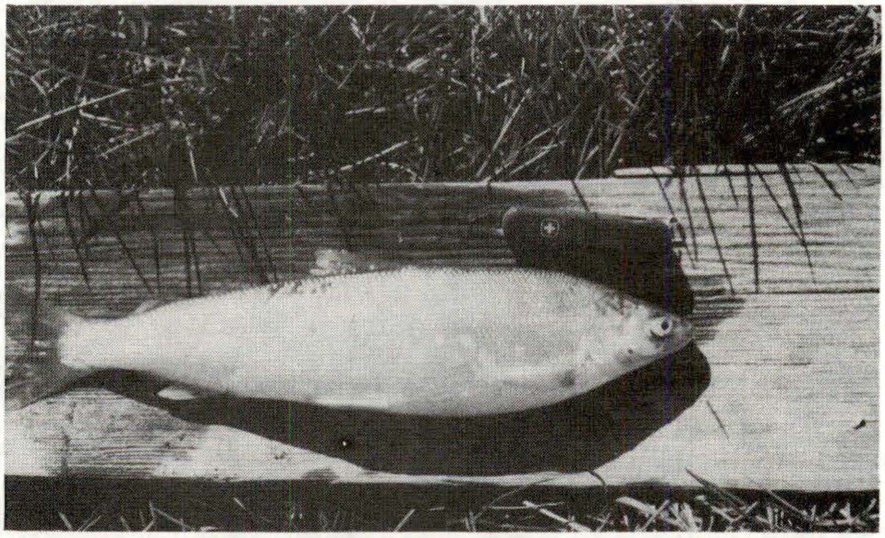

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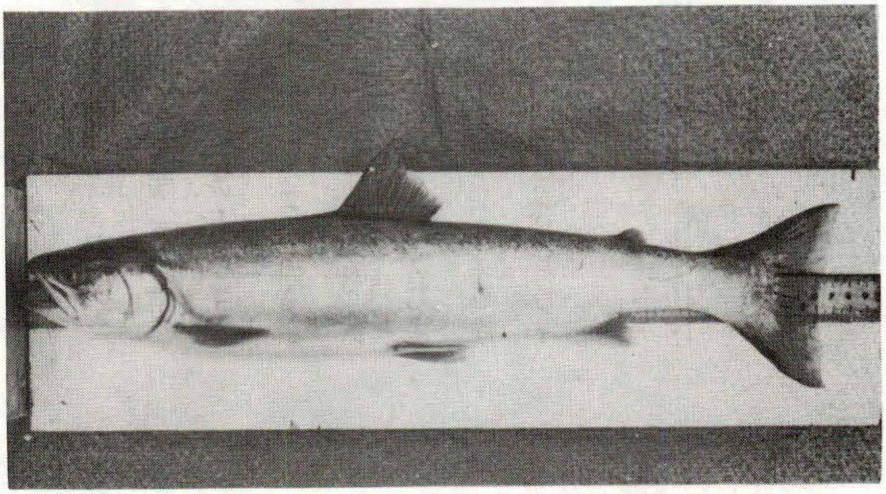
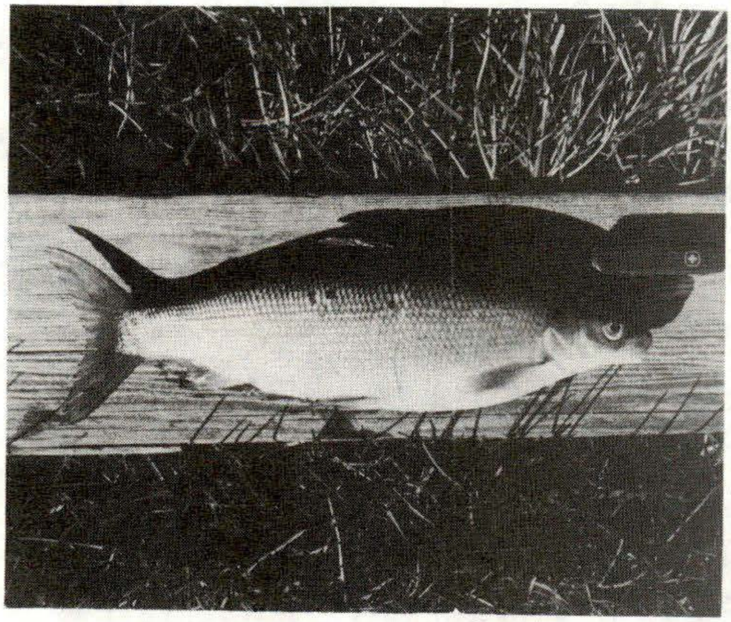


C.

Appendix II. Other frequently caught fish: A. humpback whitefish; B. inconnu; and C. fourhorn sculpin.

A.



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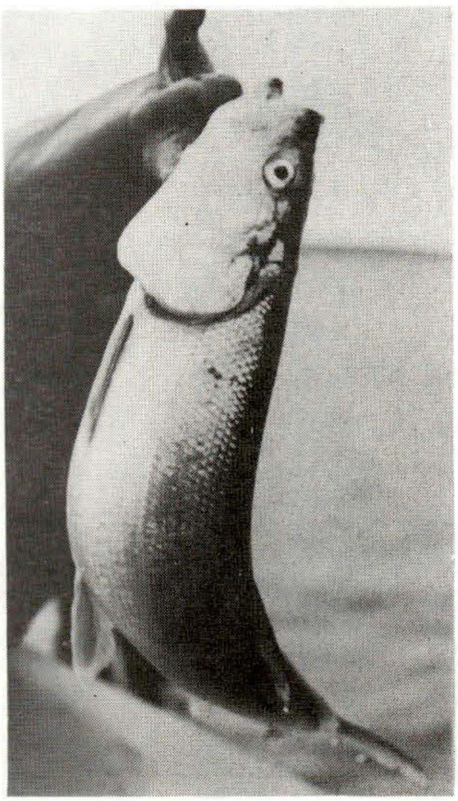

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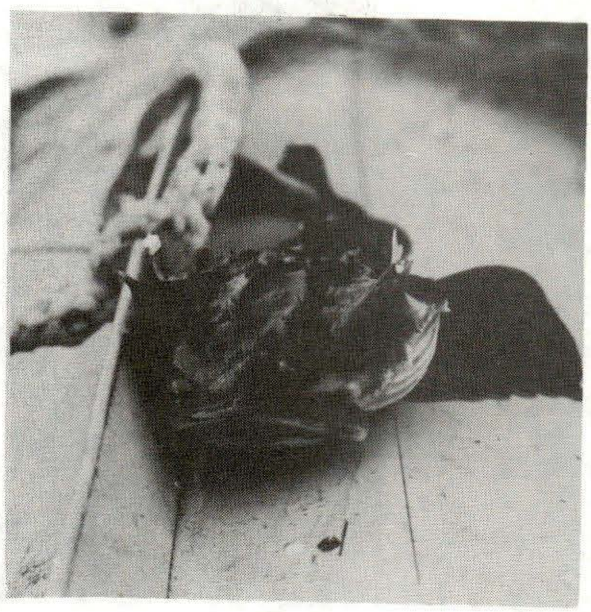
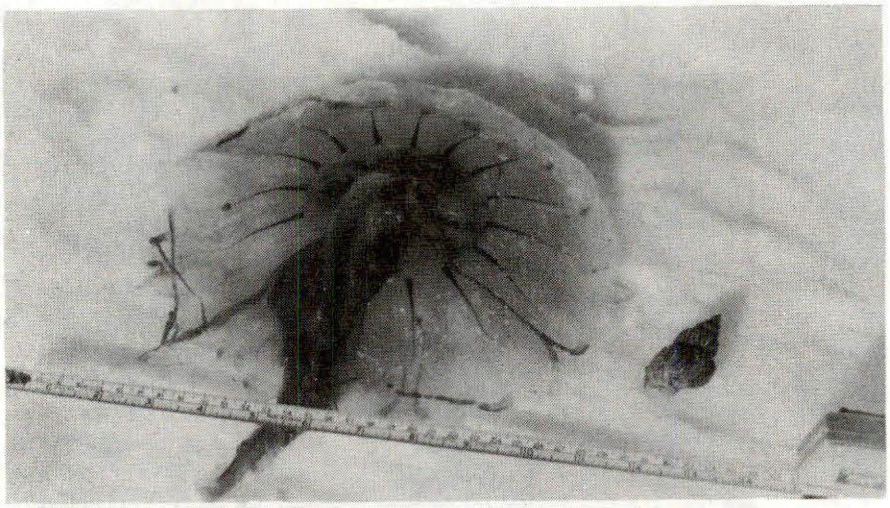
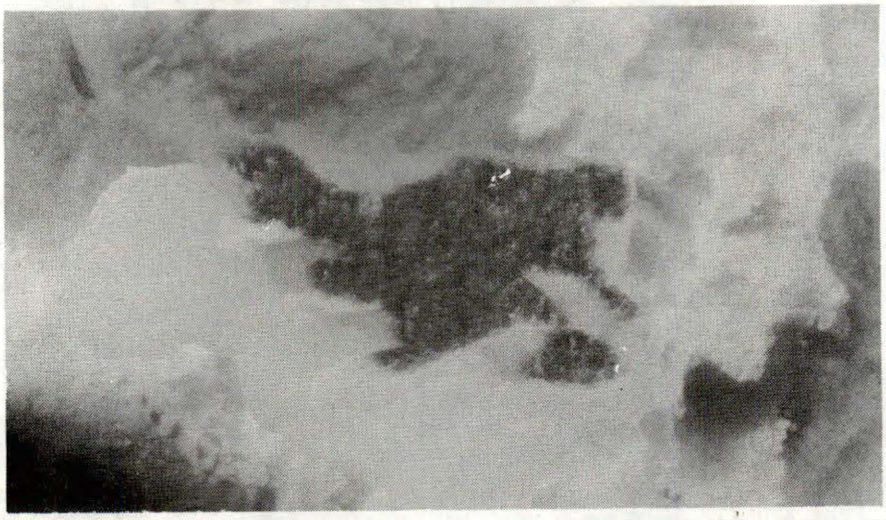


Appendix III. A. large jellyfish and gastropod caught at Station IV, April 1974; B. dense mat of phyto-plankton on the under-surface of ice at Station III, April 1974; C. sample of emergent fourhorn sculpin fry seined July 26, 1974 at Station 26a.



A.



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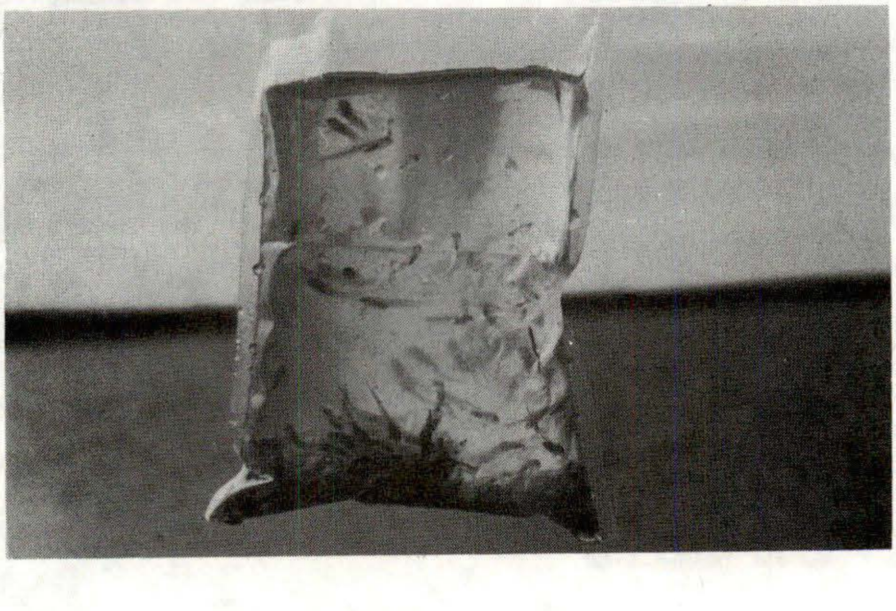


C.

Appendix IV. Chemical analyses of surface water samples collected in April, 1974.

Location	Station #	pH	Alkalinity as $CaCO_3$: Phen1	Alkalinity as $CaCO_3$: Total	Phosphate (ortho)	Nitrate-N	Silica	Hardness as $CaCO_3$: Calcium	Hardness as $CaCO_3$: Total
Shingle	V	7.29	0	105.1	0.03	0.15	3.30	124	180
Sabine	I	7.45	0	98.6	0.07	0.17	3.30	116	180
King	VI	7.69	0	101.6	0.03	0.20	3.00	300	1004
Stokes	II	7.94	0	123.0	0.06	0.07	1.10	1533	5700
Herschel	III	7.89	0	116.5	0.04	0.07	0.78	1110	5300

Location	Station #	Chloride	Sulfate	Iron	Total residue	Filterable residue	Conductance (μmhos/cm)	Salinity (ppt)
Shingle	V	46.2	68	0.06	465.8	219.4	430	0
Sabine	I	93.1	52	0.06	397.7	324.4	540	0
King	VI	2640	620	0.14	5987.2	4962	8000	5
Stokes	II	20265	3000	0.02	30326	28127	> 8000	26
Herschel	III	17096	-	0.11	33319	32465	> 8000	28

Location	Station #	Hg	Cu	Ni	Cr	Zn	Mo	Co	Mn	Cd	Pb	Ag
Shingle	V	0.0002	0.018	0.110	0.001	0.10	-	0.022	0.044	0.001	0.001	-
Sabine	I	0.0014	0.004	0.160	0.001	0.10	-	0.030	0.002	0.001	0.007	-
King	VI	0.0009	0.022	0.720	0.010	0.20	-	0.007	0.025	0.012	0.100	-
Stokes	II	0.1633	0.033	0.916	0.892	0.02	-	0.025	0.576	0.001	0.050	-
Herschel	III	0.0009	0.012	0.021	0.050	0.01	-	0.016	0.018	0.001	0.050	-

Appendix V. Chemical analyses of surface water samples collected in the summer of 1974.

Station	pH	Alkalinity as $CaCO_3$ Phenl mg/l	Alkalinity as $CaCO_3$ Total mg/l	Phosphate (Ortho) mg/l	Silica mg/l	Nitrate-N mg/l	Conductance Micromhos	Total Residue mg/l	Iron mg/l	Organic N mg/l	Salinity mg/l	Color	Turbidity (Hach Kit)	Hardness as $CaCO_3$ Calcium mg/l	Hardness as $CaCO_3$ Total mg/l	Chloride mg/l	Sulfate mg/l	Phosphate (Total) mg/l	Phosphate (Acid Hydril) mg/l	Phosphate (Organic) mg/l
Babbage R station 9	8.21	-	64.0	< 0.05	1.95	0.04	175	241.3	0.12	0.08	-	33	9	72	84	0.46	16	0.08	0.04	0.04
Niakolik Pt. station 1	8.24	-	63.0	0.05	1.75	0.04	750	556.0	0.38	0.16	0.3	40	11	76	132	172.0	40	0.07	-	0.01
Stokes Lagoon station 26c	8.21	-	46.0	< 0.05	1.01	0.04	4700	2930.0	0.24	0.07	2.7	33	9	120	504	1378.0	275	0.07	0.04	0.03
Herschel Is. station 31	8.08	-	50.0	< 0.05	1.20	0.02	9800	7399.0	0.08	0.03	6.3	16	5	212	1160	3580.0	650	0.04	0.04	-
Herschel Is. station 32	8.34	1.0	70.0	0.05	1.60	0.02	9600	8104.0	0.25	0.12	6.0	21	17	294	1364	4225.0	633	0.08	0.03	-
Babbage Lk. station 2	8.50	2.2	61.2	0.12	1.85	0.06	1150	585.8	0.62	-	0.2	45	17	30	188	308	66	0.27	-	0.15
King Pt. Lagoon station 114	7.95	-	44.4	0.09	0.34	0.03	8900	5955.0	0.05	-	4.0	6	8	138	1020	3043	500	0.16	-	0.07
Roland Bay station 30	8.76	4.6	44.4	0.03	1.21	0.05	4250	2216.0	0.64	0.08	2.0	33	18	104	432	1189	220	0.14	0.02	0.04
Shingle Pt. Lagoon station 104	8.27	-	69.8	0.37	1.75	0.04	490	462.9	3.00	0.28	0.1	87	84	30	146	75.2	66	0.62	0.14	0.11
Kay Pt. station 41	8.67	4.6	64.8	0.23	1.60	0.03	4700	2388.0	1.55	0.22	2.2	63	70	134	484	1264	260	0.35	0.05	0.07
King Pt. station 100	8.49	3.1	71.8	0.55	2.80	0.07	925	562.2	3.34	0.32	0.5	131	142	86	176	204	52	0.76	0.04	0.16

Appendix VI. Field measurements and Hach kit analysis of surface water samples collected along the Yukon coast, summer 1974.

Location	Sta. #	H_2O sample	Date	T °C	DO mg/l	DO/T profile	secchi m	pH	TAlk mg/l	TAc mg/l	TH mg/l	CO_2 mg/l
Babbage River	9	x	15.7	13.0	11.4	-	-	8.3	105	0	120	2
Herschel Island												
- Pauline Cove	31	x	24.8	2.5	11.6	x	1.6	8.3	-	-	-	-
- Collinson Head	-	-	1.9	4.5	10.1	x	1.7	8.3	85	6	7850	5
- mid SE side	-	x	1.9	4.7	10.0	x	-	-	-	-	-	-
Deep Hole	45	-	4.9	5.0	9.8	x	2.0	-	-	-	-	-
Kay Point	41	x	16.8	10.0	-	-	-	-	-	-	-	-
King Point Lagoon	114	x	30.7	12.4	11.3	x	-	8.8	68	8	7850	10
- 2 km offshore	-	x	1.8	8.1	11.7	x	-	-	-	-	-	-
Lake 106	2	x	7.7	5.8	10.0	-	-	8.5	85	0	260	-
Niakolik Pt. SE side	1	x	17.7	17.0	9.5	-	0.6	8.3	85	10	220	10
NW side	-	-	17.7	14.5	10.0	-	0.9	8.2	85	10	240	5
Roland Bay	30	x	31.7	11.0	10.4	x	0.7	-	-	-	-	-
Sabine Point	112	-	15.8	10.5	11.2	x	0.1	-	-	-	-	-
- 800 m offshore	-	-	15.8	10.5	11.5	x	-	-	-	-	-	-
Shingle Point	104	x	8.8	16.5	10.5	x	0.15	-	-	-	-	-
Spring River Delta	6	-	16.7	14.2	10.3	-	-	8.3	35	11	120	10
Spring River	8	-	18.7	18.0	-	-	-	8.5	68	6	120	5
Whale Cove	36	-	2.9	8.0	11.5	x	0.7	8.5	-	-	-	-

TAlk = Total alkalinity as $CaCO_3$ (methylorange)

TAc = Total acidity as $CaCO_3$ (phenolphthalein)

TH = Total hardness in mg $CaCO_3$

x = samples taken

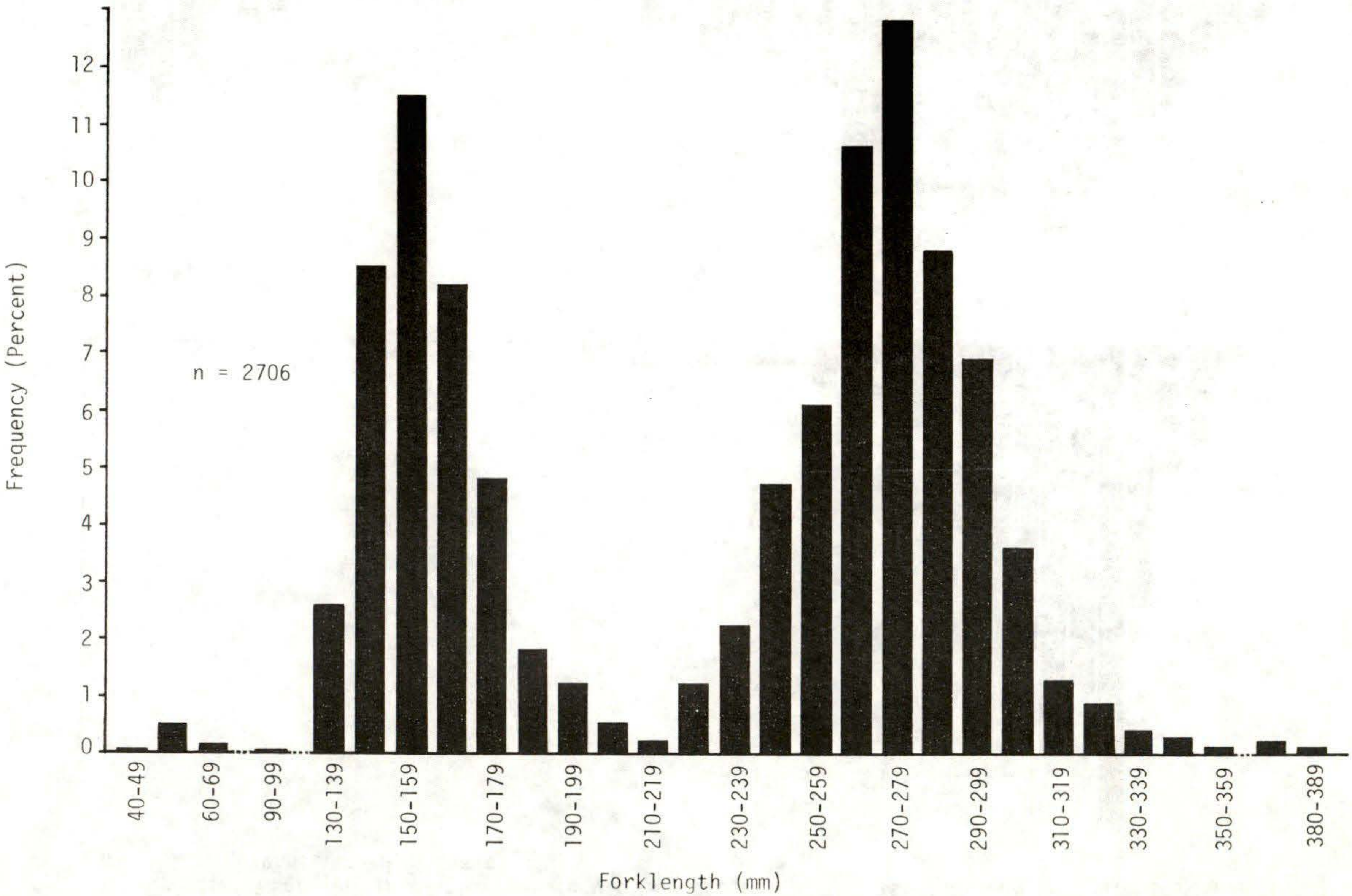
Appendix VII. Chemical analyses of surface water samples collected along the Yukon coast in May, 1975.

Location	Station	pH	Alkalinity as $CaCO_3$ Phenl Mg/1	Alkalinity as $CaCO_3$ Total mg/1	Conduction micromhos	Total Residue mg/1	Total PO_4 mg/1	Ortho PO_4 mg/1	Acid Hy PO_4 mg/1	Organic PO_4 mg/1	Hardness as $CaCO_3$ Calcium mg/1	Hardness as $CaCO_3$ Total mg/1
Herschel Is.	B	8.23	-	129.2	2900	1790.0	0.29	0.10	0.15	0.04	272	1157
Stokes Pt.	C	8.06	-	115.1	1830	1067.0	0.17	0.08	0.04	0.05	163	671
Phillips Bay	D	8.12	-	109.5	2100	1336.0	0.19	0.11	0.04	0.04	161	530
King Pt.	E	7.94	-	92.4	645	402.7	0.32	0.10	0.03	0.19	300	255
Sabine Pt.	F	7.95	-	92.0	695	345.1	0.16	0.05	0.09	0.02	109	249
Shingle Pt.	G	7.83	-	89.8	260	188.0	0.26	0.04	0.05	0.17	93	146

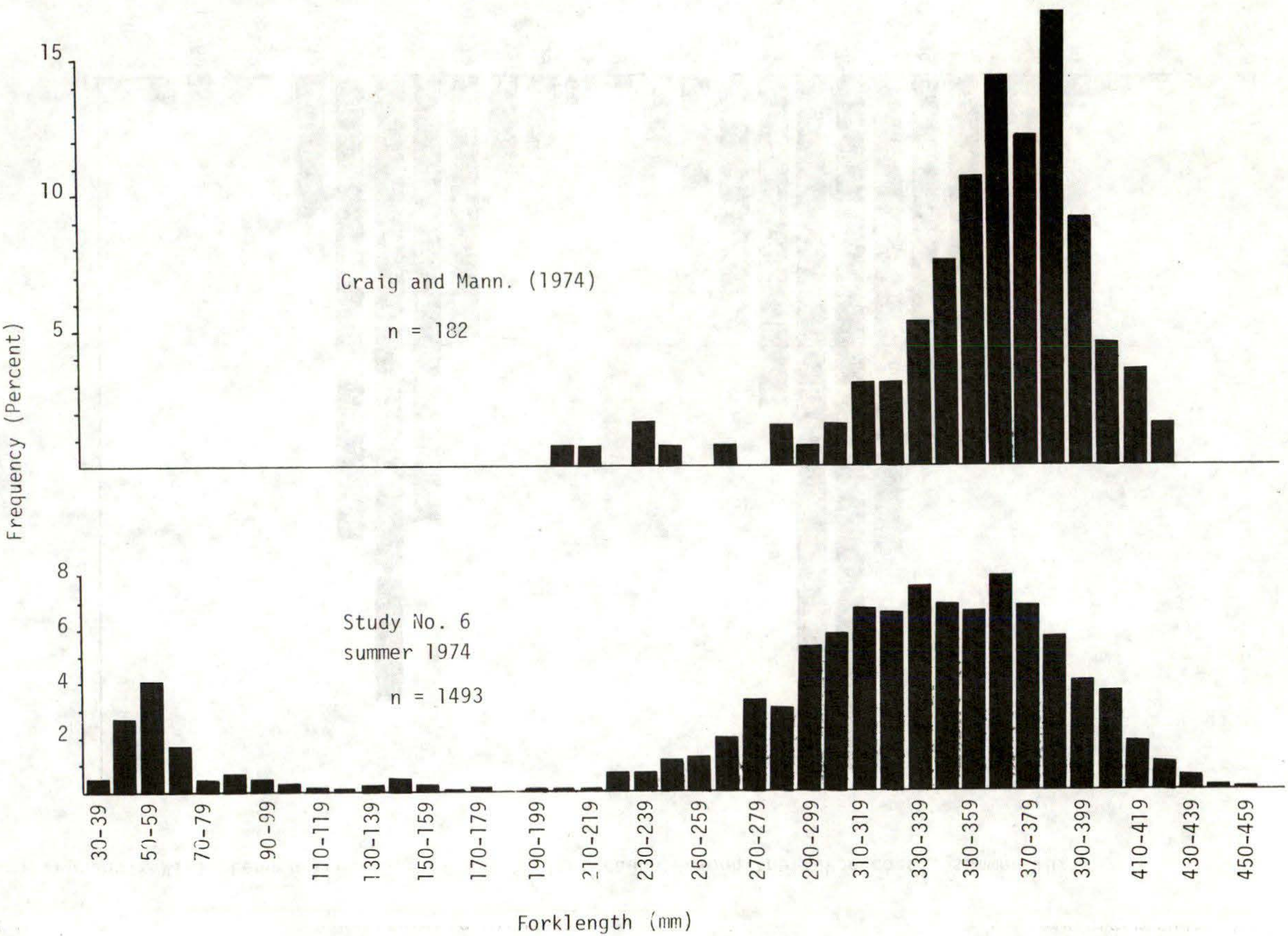
Location	Station	Iron mg/1	Chloride mg/1	Color	Turbidity JTU	Sulfate mg/1	Silica mg/1	Ttl Kjld Nitrogen mg/1	NH_3-N mg/1	Organic Nitrogen mg/1	NO_3-N mg/1	NO_2-N mg/1
Herschel Is.	B	0.30	3616	21	7	633	4.10	-	-	-	0.07	not tested
Stokes Pt.	C	0.35	1205	3	14	325	4.10	-	-	-	0.09	
Phillips Bay	D	0.26	1120	16	13	240	4.50	0.99	0.04	0.95	0.10	
King Pt.	E	0.44	365	16	14	180	4.15	0.01	-	0.01	0.10	
Sabine Pt.	F	0.37	408	21	11	136	3.90	-	-	-	0.10	
Shingle Pt.	G	0.40	18.6	6	18	520	3.80	0.10	0.02	0.08	0.12	

Location	Station	Hg	Cu	Ni	Cr	Co	Mn	Cd	Pb
Herschel Is.	B	0.0001	0.002	0.020	0.010	0.008	0.002	0.002	0.006
Stokes Pt.	C	0.0001	0.002	0.012	0.003	0.001	0.003	0.001	0.003
Phillips Bay	D	0.0001	0.028	0.024	0.004	0.009	0.003	0.002	0.012
King Pt.	E	0.0001	0.002	0.002	0.002	0.002	0.002	0.001	0.002
Sabine Pt.	F	0.0004	0.002	0.001	0.002	0.001	0.006	0.001	0.008
Shingle Pt.	G	0.0001	0.001	0.002	0.003	0.001	0.003	0.001	0.002

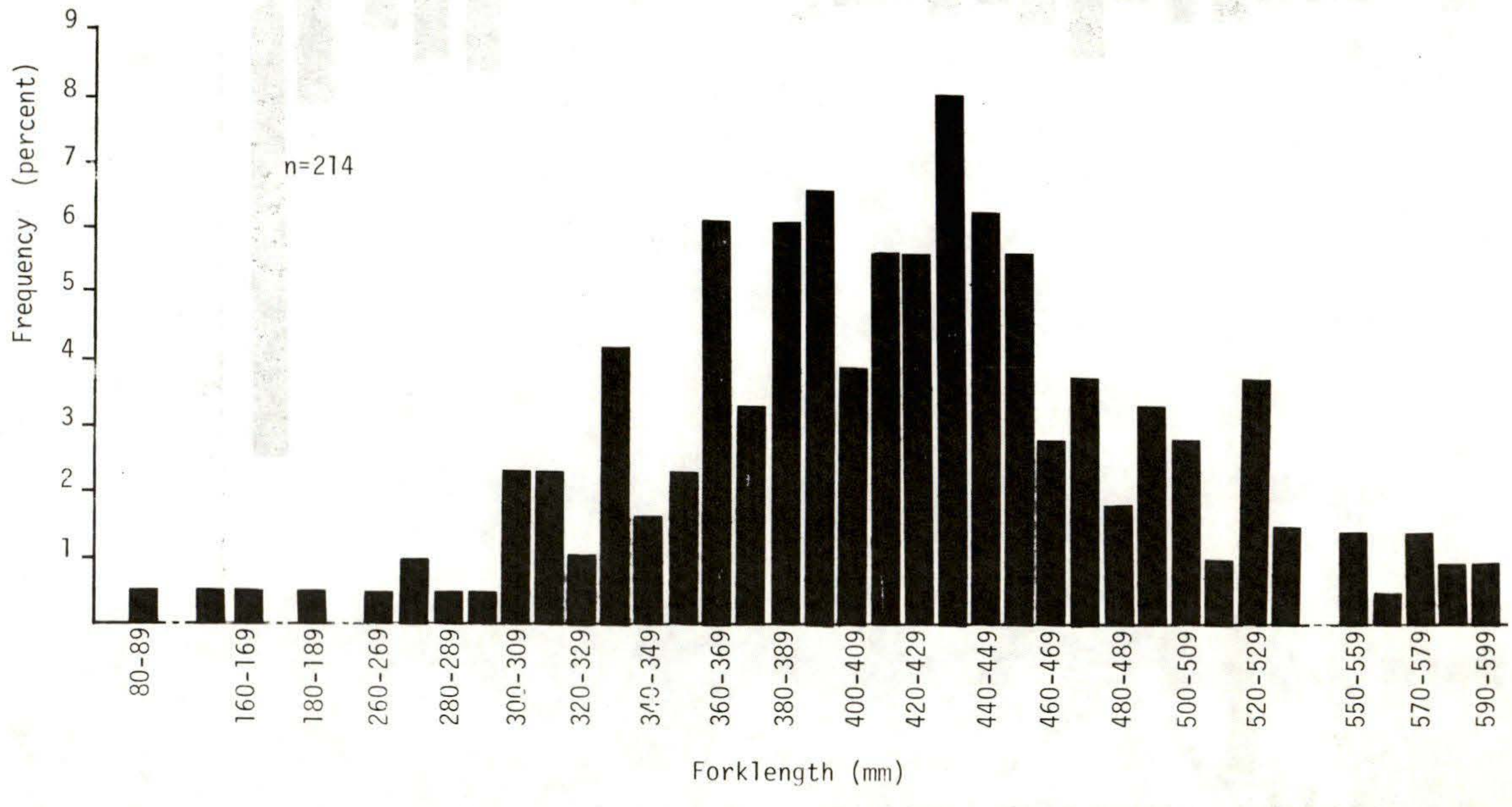
Appendix VIII. Length frequency of least cisco caught along the Yukon coast, summer 1974.



Appendix IX. Comparison of length frequency of Arctic cisco in this study and by Craig and Mann (1974) along the Yukon coast.



Appendix X. Length frequency of Arctic char caught along the Yukon coast, summer 1974.



Appendix XI. Length frequency of fourhorn sculpin caught along the Yukon coast, summer 1974.