Isserk Artificial Island

Environmental Baseline & Monitoring Study 1977

Imperial Oil Limited

envirocon ltd

207

Isserk Artificial Island Environmental Baseline and Monitoring Study 1977

for

Imperial Oil Limited

prepared by

envirocon Ltd.
Calgary, Alberta
December, 1977

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF APPENDICES

1.0 SUMMARY

1.1 Conclusions

The biological communities sampled around Isserk F-27 contained offshore (pennate diatoms, *Aglantha* sp. and *Calanus glacialis*) and nearshore species (*Tabellaria* sp. and *Limnocalanus macrurus*). Therefore, it is concluded that the artificial island is located in a transition zone between marine and estuarine habitats. The nature of the biological populations may change seasonally and annually depending on prevailing climatic conditions which affect the physical and chemical character of the aquatic environment.

Increases in the nitrogen concentrations of the water column from mid-to late-summer stimulate the abundance of phytoplankton. Zooplankton populations also increase due to the availability of additional phytoplankton on which to graze.

The benthic populations decline from mid-to late-summer. The reason for this is unclear although storm incidents in August caused considerable turbulence on the seafloor which may have adverse effects on the benthos.

The construction activities associated with Isserk F-27 caused substantial turbidity both around and downstream of the island. However, a dyke built around the island perimeter substantially reduced the dredged material spilling into the adjacent waters.

The phytoplankton population was either stimulated or entrained by the turbidity plume due probably to nutrient enrichment from the disturbance of underlying sediments. Neither the zooplankton nor benthos within the plume were significantly affected by the construction activities. However, an estimated 6000 kg. of benthos were either destroyed or displaced from habitat at the borrow site or under the island base. Still, the underwater surfaces of Isserk F-27 provide potential habitat for benthos colonization. In addition, the presence of new shoreline may attract other biological communities including fish. Any deleterious environmental effects that may have gone undetected were likely to have only a short-term impact since the construction schedule lasted only about three months. Furthermore, such impacts would be restricted to the immediate Isserk F-27 area.

1.2 Introduction

Envirocon Ltd. was engaged by Imperial Oil Limited to conduct an environmental baseline and monitoring study during construction of the artificial island, Isserk F-27 in the Beaufort Sea. This island, located approximately 16.5 km north of Pullen Island in 12.8 m of water, provides a base from which exploratory drilling will be conducted.

Isserk F-27 was built using a combination of hydraulic dredging from a borrow area adjacent to the island site, and by barging sand fill from Tuft Point. These activities, started in mid-July 1977, produced a turbidity plume both around and downstream of the island. Since one of the objectives of the Envirocon study was to monitor environmental effects associated with Isserk's construction, a number of stations were selected near the proposed site and within the turbidity plume. Still others were situated beyond the potential influence of the island, as far away as 8 km, so that reliable baseline data could be collected.

Field studies were undertaken during two periods in 1977, July 26 to 31 and August 22 to 29. Island construction was proceeding ahead of schedule until a storm erupted during the latter period and caused major damage to Isserk. This same storm thoroughly mixed the water column and disturbed bottom sediments, giving the entire study area a very turbid appearance.

1.3 Physical Data

1.3.1 *Water Temperature and Salinity*

In July the water column at all stations was thermally stratified with mean surface and bottom temperatures of 11.2 and -0.3°C respectively. Although this stratification persisted in August, it was less apparent and became negligible as a result of thorough vertical mixing during the storm.

The salinity profiles in July were highly stratified with a surface mean of 15.2 ppt. and a bottom average of 29.9 ppt. August values were much more homogeneous.

The hydraulic dredging operation had no detectable effect on the temperature and salinity regime near Isserk F-27. Instead, the variability in these parameters is largely a function of Mackenzie River discharge and the prevailing air temperatures. As both of these decrease, the homogeneity of the water column increases.

1.3.2 *Water Currents*

The direction and velocity of currents varied substantially between stations and with depth. However, in general velocities decreased from the surface to the seafloor and surface currents flowed in a westerly direction. Mean velocities at 0.6 of the depth (depth ranges = 10.1 to 15.6 m) were 0.23 and 0.20 m/sec for July and August respectively. Since surface currents on the continental shelf are primarily wind driven, then the prevailing climatology will affect both current directions and velocity. Although currents were westerly during the field studies, it is quite possible that they flowed in other directions when not being monitored.

1.3.3 *Turbidity Plume*

The plume generated by the hydraulic dredging activities moved in the direction of the surface currents and could be seen in July for approximately 1 km from the island centre. Low secchi disc readings and high suspended solids concentrations characterized the visible plume. High subsurface levels of suspended solids indicated that the plume was settling and spreading for at least 2 km from Isserk F-27.

The plume was less prominent during the August field study period due to increased background turbidity and to a perimeter dyke that had been built at Isserk to prevent much of the dredged material spilling into the surrounding waters.

1.3.4 *Sediment Size Distribution*

Stations located adjacent to the island occasionally provided sediment samples that were over 70% sand. These probably reflect spreading of dredged or barged material around the island base since most stations further from the construction activities had sediments composed mainly of clay.

1.4 Chemical Data

1.4.1 *Dissolved Oxygen*

Similar dissolved oxygen profiles characterized the waters in the study area regardless of construction activities. Surface concentrations were usually in excess of 100% saturation while near bottom values were about 90% saturated. Oxygen was always sufficient to support normal biological processes.

1.4.2 *Nutrients*

Both nitrate and phosphate concentrations in the water increased with depth and from July to August. Concentrations of nitrite and ammonia also increased with depth, but declined from July to August. Silica was unique in having lowest concentrations at mid-water and during August. With the exception of nitrite, none of the other nutrients appeared to be influenced by island construction. Nitrite however did have above average levels at stations adjacent to Isserk F-27. This indicated possible nutrient enrichment caused by the suspension of bottom materials due to the dredging.

1.4.3 *Sediment Carbon*

With the exception of sediment samples containing high sand fractions, all samples had total carbon values in excess of 2%. Organic carbon composed approximately half of the total concentration.

1.5 Biological Data

1.5.1 *Phytoplankton* (passively floating plant organisms)

A total of 55 phytoplankton types (taxa) were identified in the Isserk area with pennate diatoms being the most abundant overall. The stations nearest the island or within the visible turbidity plume supported the largest phytoplankton populations, with *Achnanthes* sp., *Navicula* sp., *Licmophora* sp. and *Fragilaria* sp. usually dominant at these stations. Such findings suggest that phytoplankton undergo a seasonal change in population size (standing crop) associated with rising nitrogen levels in August. Furthermore, the construction activities at Isserk appear to have either stimulated or entrained phytoplankton within the areas of greatest turbidity, possibly due to nutrient enrichment from the underlying sediments disturbed by the hydraulic dredging.

1.5.2 *Zooplankton* (passively floating animal organisms)

Copepods were the most numerous of the zooplankton types (taxa), but polychaete trochophores were also abundant in July. There was no indication that the numbers or mass of zooplankton were affected by the construction of Isserk F-27. Only a seasonal increase in standing crop between July and August was significant. This trend may have reflected the concomitant increase in phytoplankton on which the zooplankton feed.

1.5.3 *Benthic Invertebrates* (bottom dwelling animals without backbones)

A total of 70 different types of benthos were identified from bottom grab samples. Marine worms (polychaetes), protozoans with calcareous shells (foraminiferans), bivalve molluscs (pelecypods) and unishelled molluscs (gastropods) accounted for 70% of these types. The foraminiferan *Elphidiella arctica* was numerically dominant accounting for over 50% of the total catches.

Population densities of benthos decreased from July to August. Similarly, biomass (wet weight) dropped from July to August, although this change did not prove to be statistically significant. The biomass differences were associated with the abundance of the bivalve *Portlandia yoldiella*.

The abundance data tended to increase at greater distances from the Isserk site. However, the biomass information did not support this pattern. In fact no statistically significant associations were present between biomass and either the transect bearing or distance from the island. Therefore, there is no reason to suspect that island construction had any important adverse effects on the bottom fauna surrounding Isserk F-27.

1.5.4 *Fish*

Six fish species were collected in very small numbers by gillnet in the Isserk area. Arctic cisco was numerically dominant among these with only single specimens representing the other 5 species. In addition, larvae of the giant wrymouth, pleuronectiforms and cottids were sampled with a surface trawl. The results of the fishing program indicate that abundance is very low compared to populations moving adjacent to the coastline. Still, gear selectivity may have contributed to the poor catches. Therefore, the data presented may not be representative either of the true offshore abundance or the diversity of fish species.

2.0 INTRODUCTION

In July, 1977, Imperial Oil Limited commenced construction of an artificial island in the Isserk block, approximately 20 km north of Richards Island, as part of their exploratory drilling in the Beaufort Sea (Figure 2.1). In keeping with their support of environmental programs associated with these exploration activities, Imperial Oil Limited engaged Envirocon Ltd. to conduct an environmental baseline and monitoring study near the Isserk F-27 construction site.

2.1 Terms of Reference

There exists little data on the physical-chemical oceanography and marine life in the Isserk block, an area influenced to a lesser degree by the Mackenzie River than previous Imperial Oil artificial island sites. The following study objectives were developed in response to these information deficiencies:

1. to improve the data base on physical-chemical oceanography, benthos, plankton, and fish for the Isserk exploration block.

2. to monitor any changes in oceanographic and marine life parameters associated with the construction of Isserk F-27 artificial island in summer, 1977.

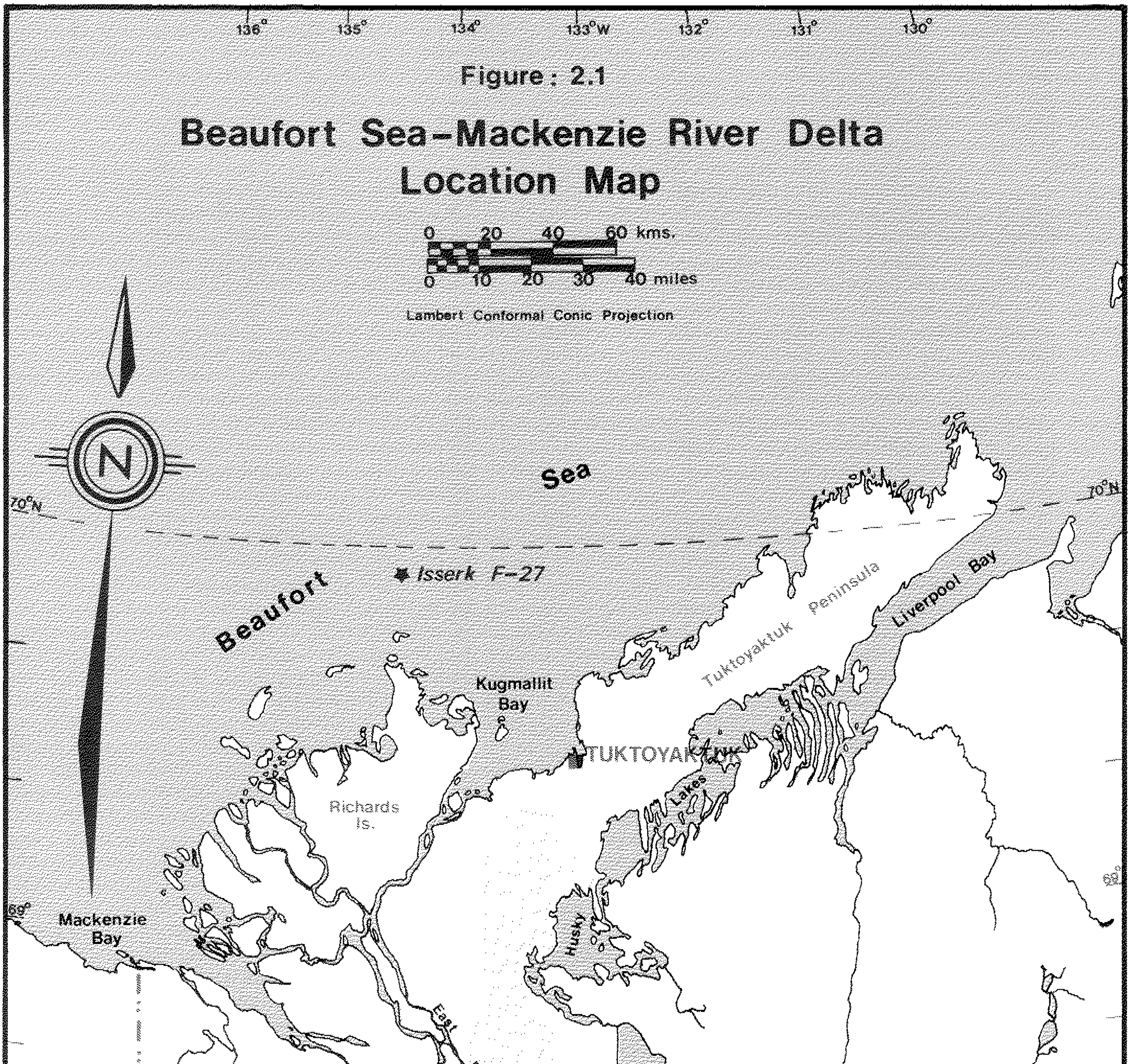


Figure: 2.1

Beaufort Sea-Mackenzie River Delta Location Map

The components and scope of the studies conducted by Envirocon Ltd. during July and August, 1977 are outlined below:

1. to analyse the physical-chemical oceanographic, planktonic and benthic data collected from Imperial off-shore areas in 1976 (including Isserk) to aid in designing the 1977 sampling program.

2. to conduct baseline sampling in the Isserk block removed from the area affected by island construction.

3. to monitor changes related to offshore dredging and island construction by sampling near the Isserk F-27 site.

4. to determine species composition, abundance, and habitat utilization for existing benthos, plankton, and fish communities.

5. to determine physical-chemical oceanographic parameters by field sampling and analysis, and by laboratory analysis where necessary.

6. to identify temporal variations in physical, chemical and biological parameters by conducting field sampling during two periods in July-August, 1977.

The report includes a summary, the methods, data analysis, results, and conclusions resulting from this study. In addition, detailed appendices with the physical, chemical and biological field data are provided.

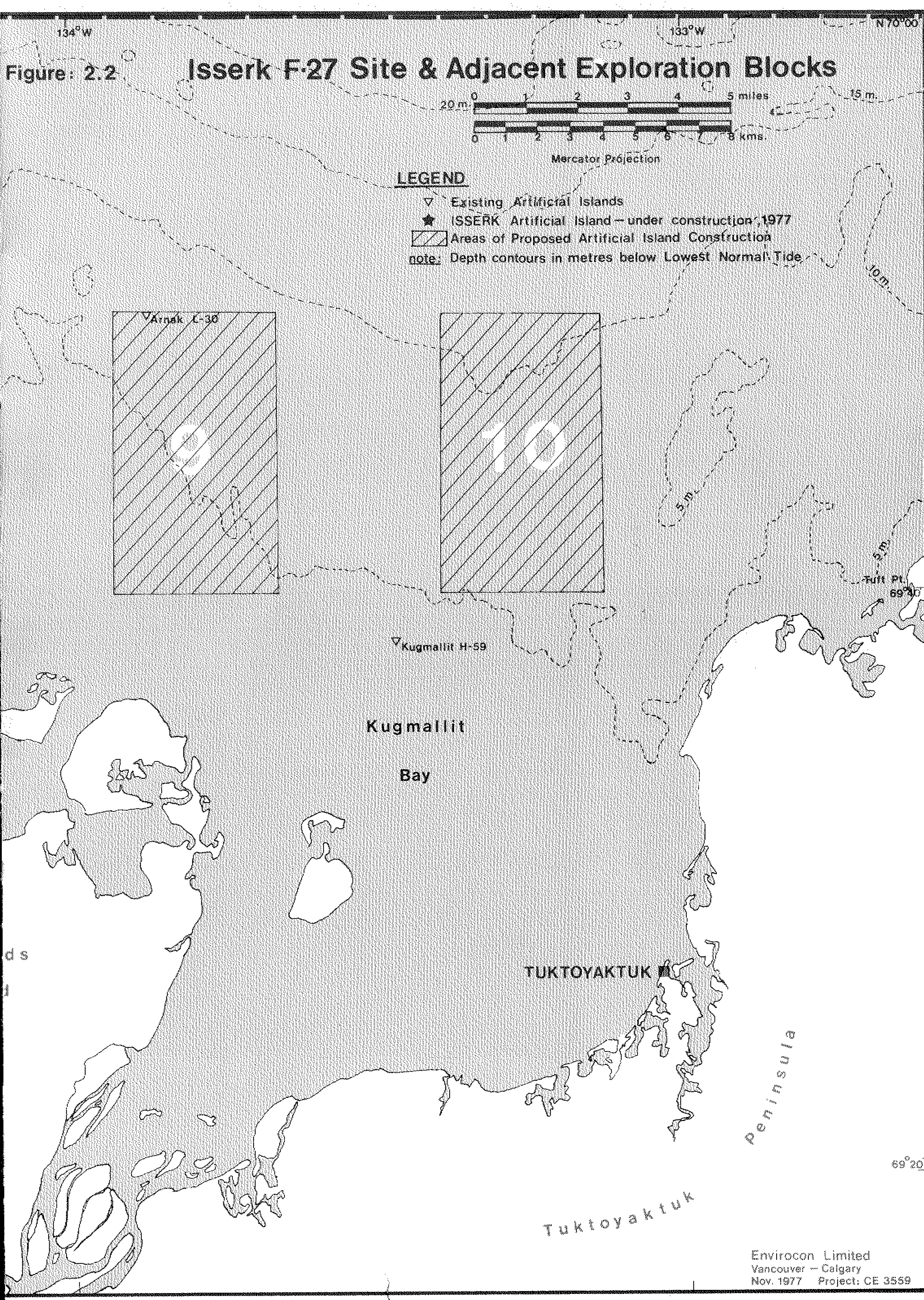
2.2 Isserk F-27 Artificial Island

The Isserk site is located at coordinates 69° 56' 21.2" N, 134° 21' 21.1" W (Figures 2.2). This is approximately 16.5 km north of Pullen Island where the water depth is 12.8 m. Island construction commenced the third week of July, 1977 shortly after the ice was clear of the area. The construction schedule originally estimated island completion by mid-October. Unfortunately, severe storm conditions during August 26 and 27 resulted in substantial erosion to both the exposed portions and base of the island structure. This set-back extended the completion date well into November. Still, exploratory drilling commenced on December 4.

The completed island is conical in shape with a surface diameter of 100 m at an elevation of 5 m, and a seafloor base averaging about 500 m in diameter (Figure 2.3). The slope of the island beach and underwater profiles was designed to protect against wave action from the prominent wind direction. Additional slope protection was achieved by covering approximately half of the beach area with Terrafix filter cloth held in place by groins at 15 m intervals.

An estimated 1.5 x 10^6 m^3 of material was required to form the island. Approximately 67% of this was derived by the suction dredge, Beaver Mackenzie, pumping onto the island site from an adjacent borrow area. The remaining material was hauled in 1,500 m^3 dump barges from Tuft Point. This was deposited next to the island site for later pumping by the Beaver Mackenzie onto the island surface.

Figure: 2.2 Isserk F·27 Site & Adjacent Exploration Blocks



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Vancouver – Calgary
Nov. 1977 Project: CE 3559

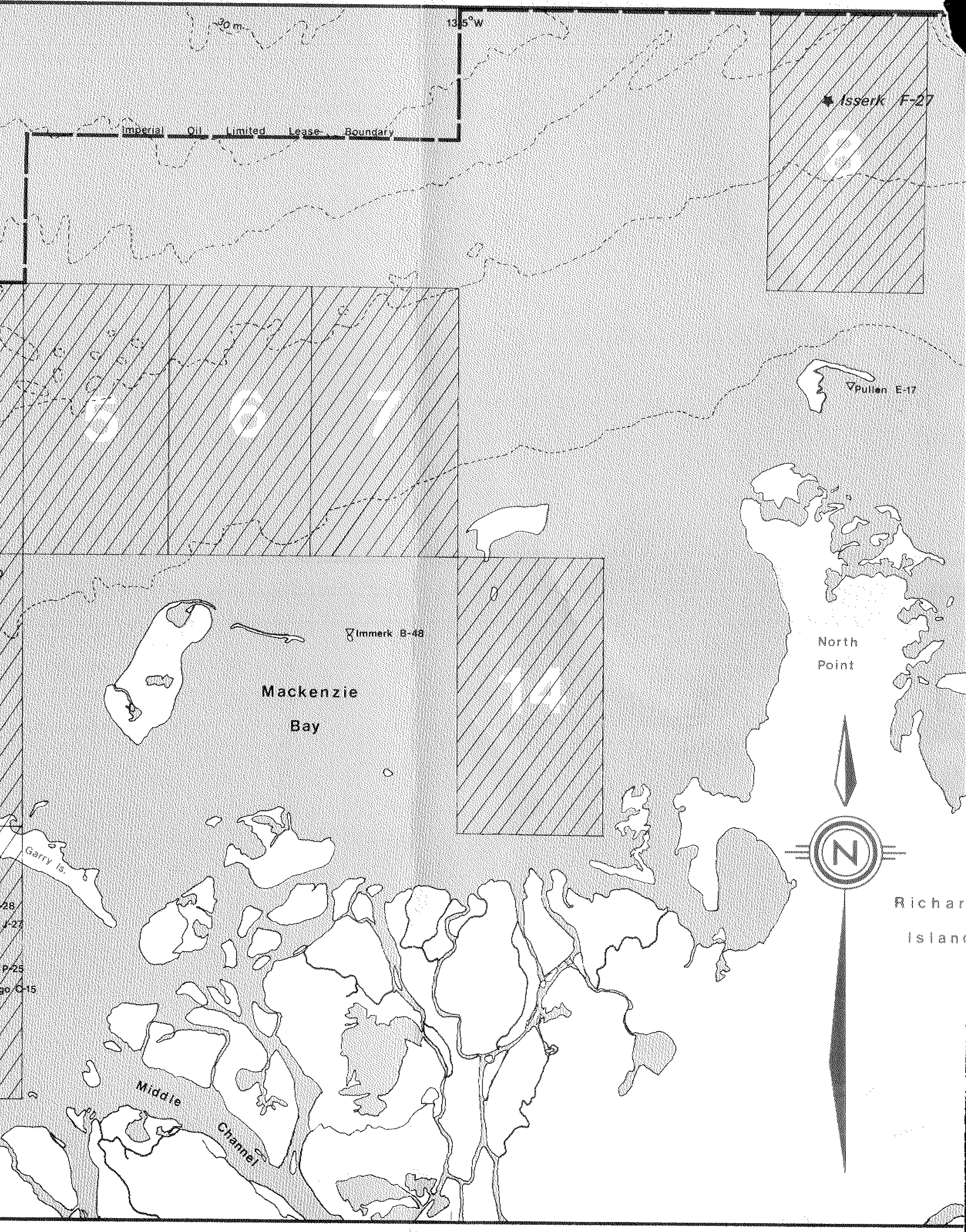
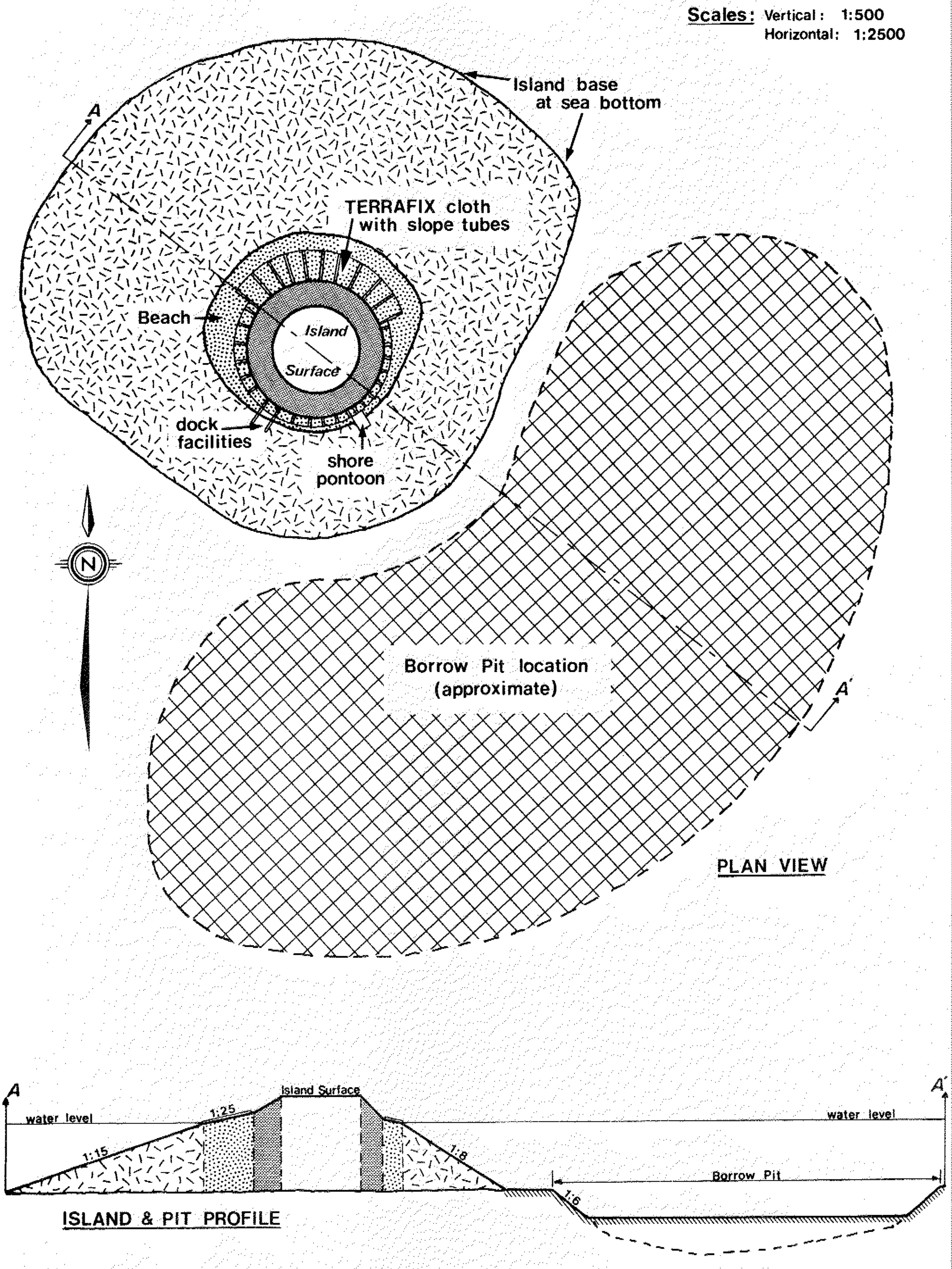

30 m
135°W
Imperial Oil Limited Lease Boundary
Isserk F-27
8
5
6
7
Pullen E-17
Immerk B-48
Mackenzie
Bay
14
North
Point
N
Garry Is.
Richar
Islanc
Middle
Channel
P-25
-28
J-27
go C-15

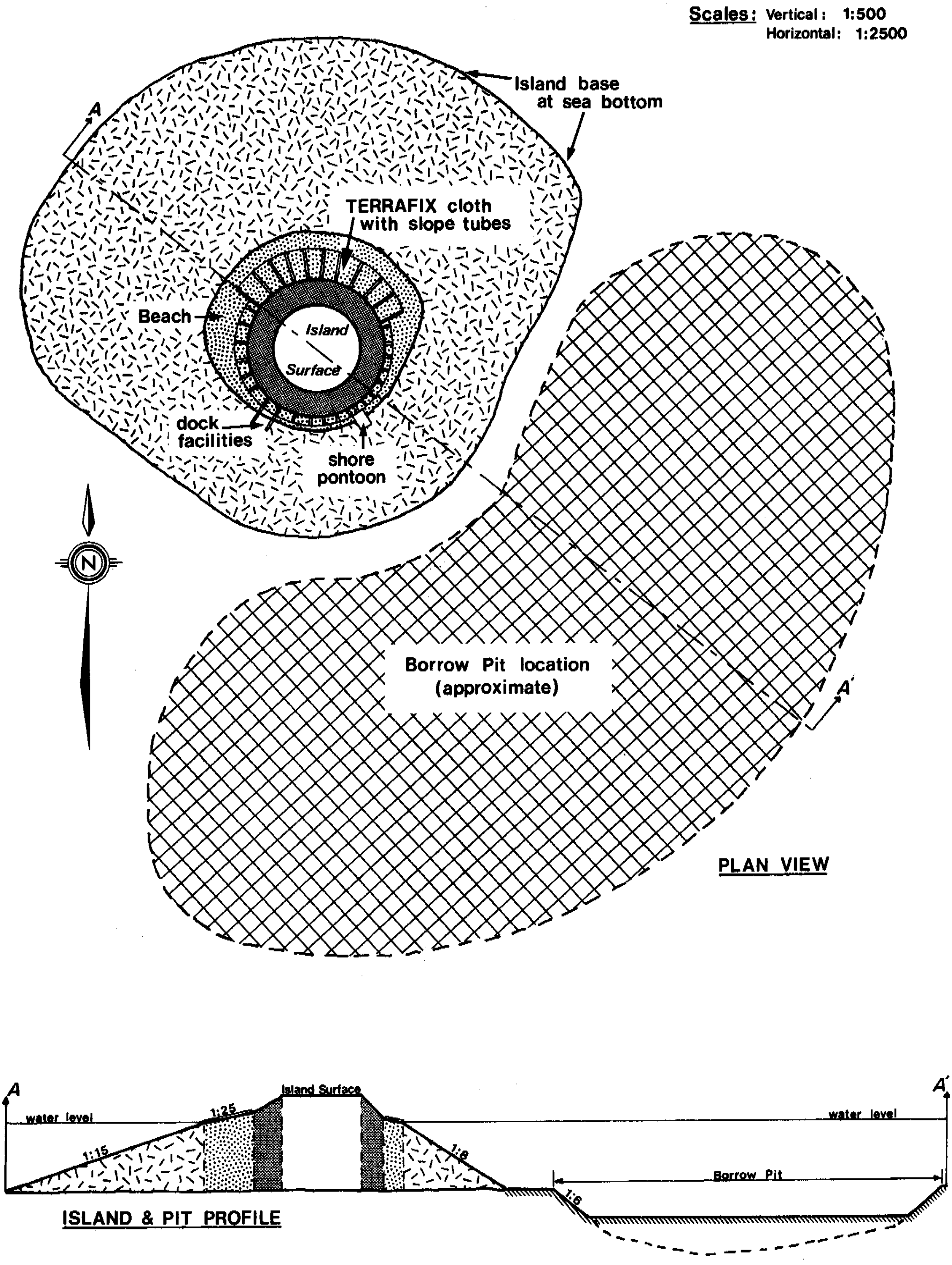
Figure 2.3 : ISSERK F-27 Construction Design



The on-site borrow pit was chosen after analyzing core samples from the Isserk area. The dredged material was composed largely of sand-gravel and silt-clay. Since the latter is not suitable for island construction, it was estimated that the Beaver Mackenzie would have to pump about 1.43×10^6 m^3 from the pit. This would yield a hole 8 to 10 m deep and 1.59×10^5 m^2. However, due to the heavy erosion during the late August storm, the estimated amount of dredged material and borrow pit area was probably conservative. A total of $1.56 \times 10^6 m^3$ was actually required.

The island surface is formed primarily from the good quality sand barged from Tuft Point. The sand was pumped by the suction dredge from the barge dump site into the island centre. Loss of this material during the pumping was minimized by a retaining berm which encompasses the above-water perimeter.

Figure 2.3 : ISSERK F-27 Construction Design



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3.0 METHODS

3.1 Field Techniques

The field studies were undertaken during two time intervals in the summer of 1977. These were July 26 to 31 and August 22 to 29. Island construction had commenced prior to conducting the environmental investigations. However, only a small area was exposed above water immediately adjacent to the dredge pipeline discharge during the first interval (Plate I). Construction progress by August 26 provided an island surface approximately 100 m in diameter (Plate II). Following a storm on August 26 and 27, the island was reduced to a shoal (Plate III).

The environmental team operated from the 13.5 m work tug, Imperial Immerk, and from a 4.2 m Zodiac inflatable boat. During the first study period accommodations were provided at Imperial Oil's floating Camp 17 anchored adjacent to Pelly Island. Quarters during the second interval were aboard the A.T.L. tug, Arctic Pelly, which performed survey and tender duties in the Isserk F-27 area.

A total of 16 sampling stations were occupied around the island site during each of the study periods (Figure 3.1). These stations were equally distributed among 4 transects which radiated at 90^{o} intervals around the island centre. It was desirable to have some stations located downstream of Isserk F-27 because the effects of the sediment plume (Plate IV) generated by hydraulic dredging were to be monitored. Therefore, one transect was located on a bearing

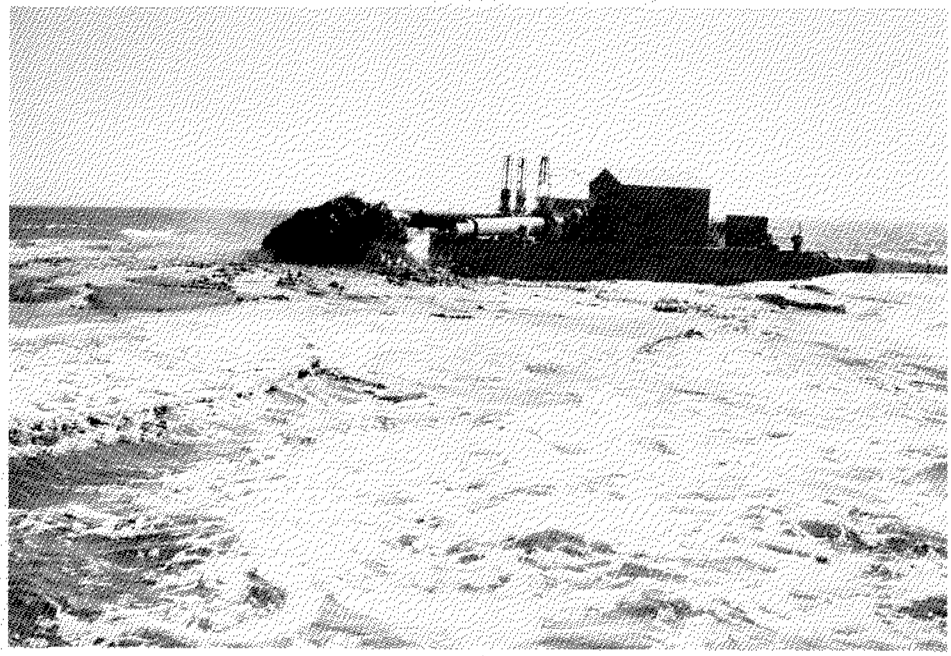


Plate I Shore pontoon with suction dredge discharging onto the surface of Isserk F-27, July 28, 1977

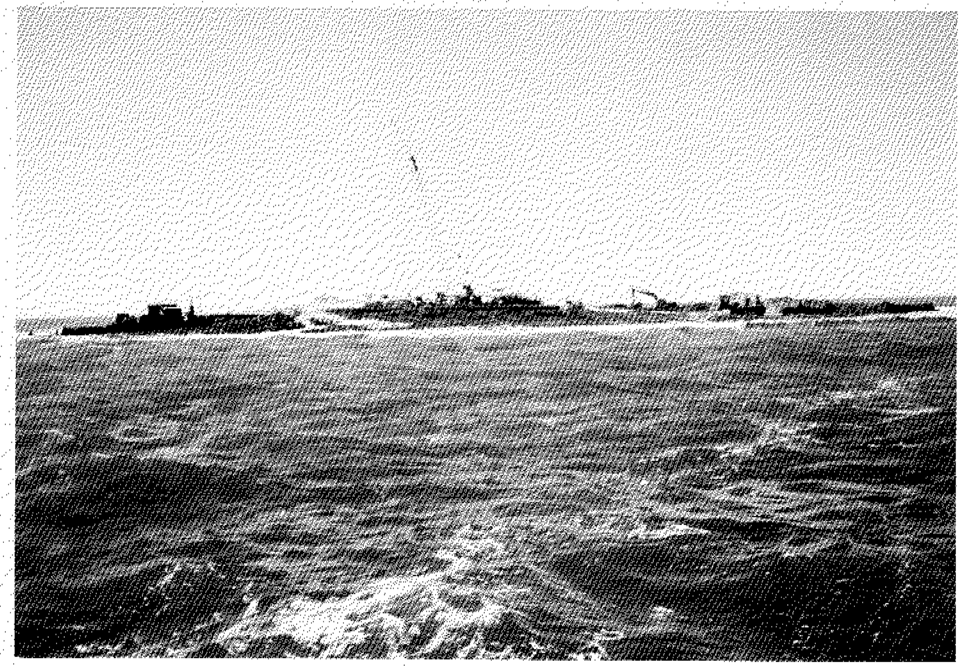


Plate II Isserk F-27 on August 26, 1977

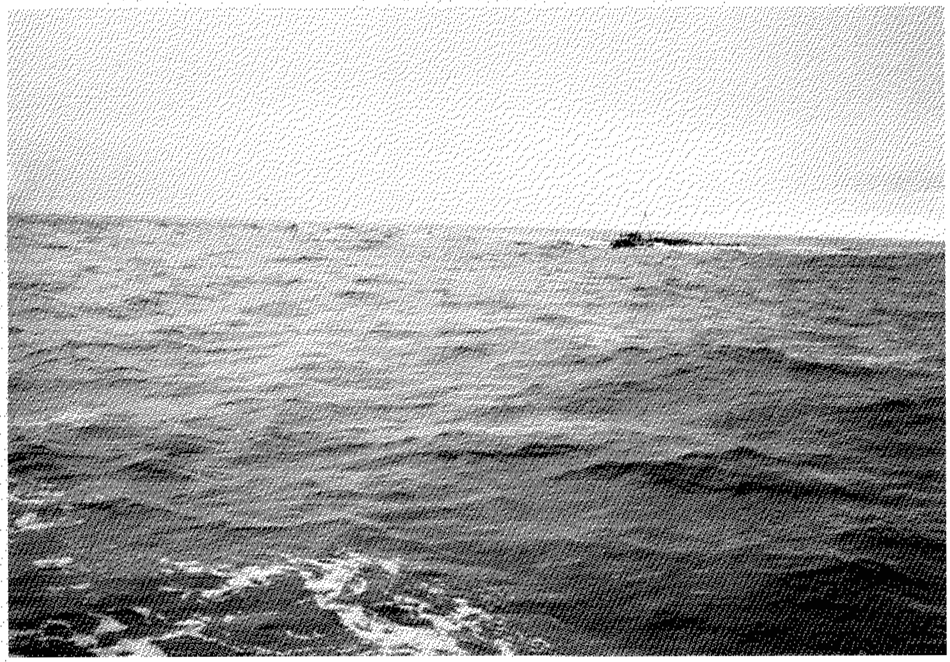


Plate III Isserk F-27 on August 29, 1977 after two days of erosion from a severe storm.

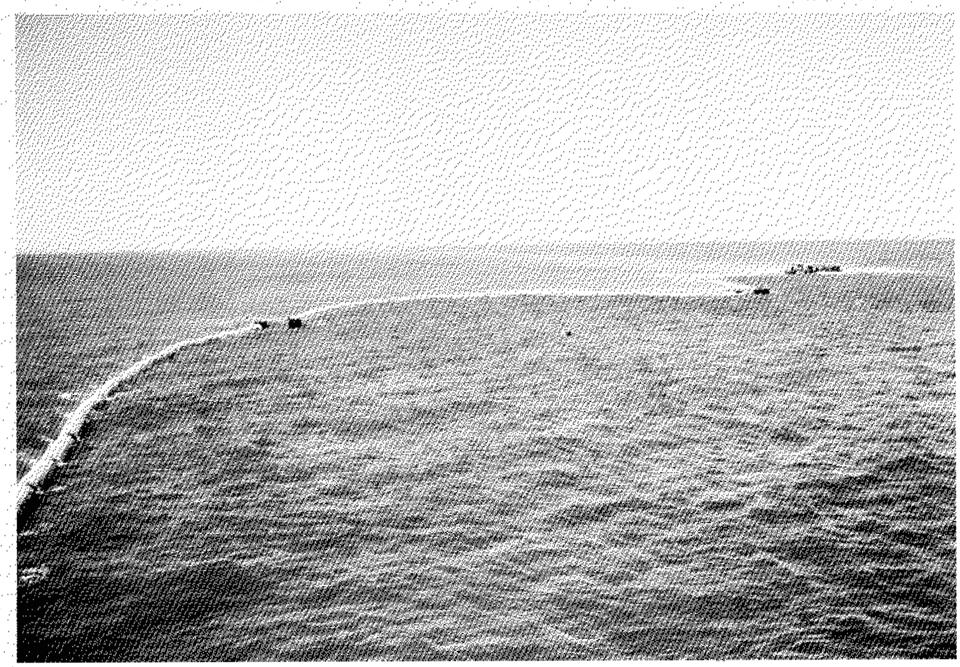


Plate IV Turbidity plume from construction of Isserk F-27. This view is from the suction dredge Beaver Mackenzie, July 26, 1977.

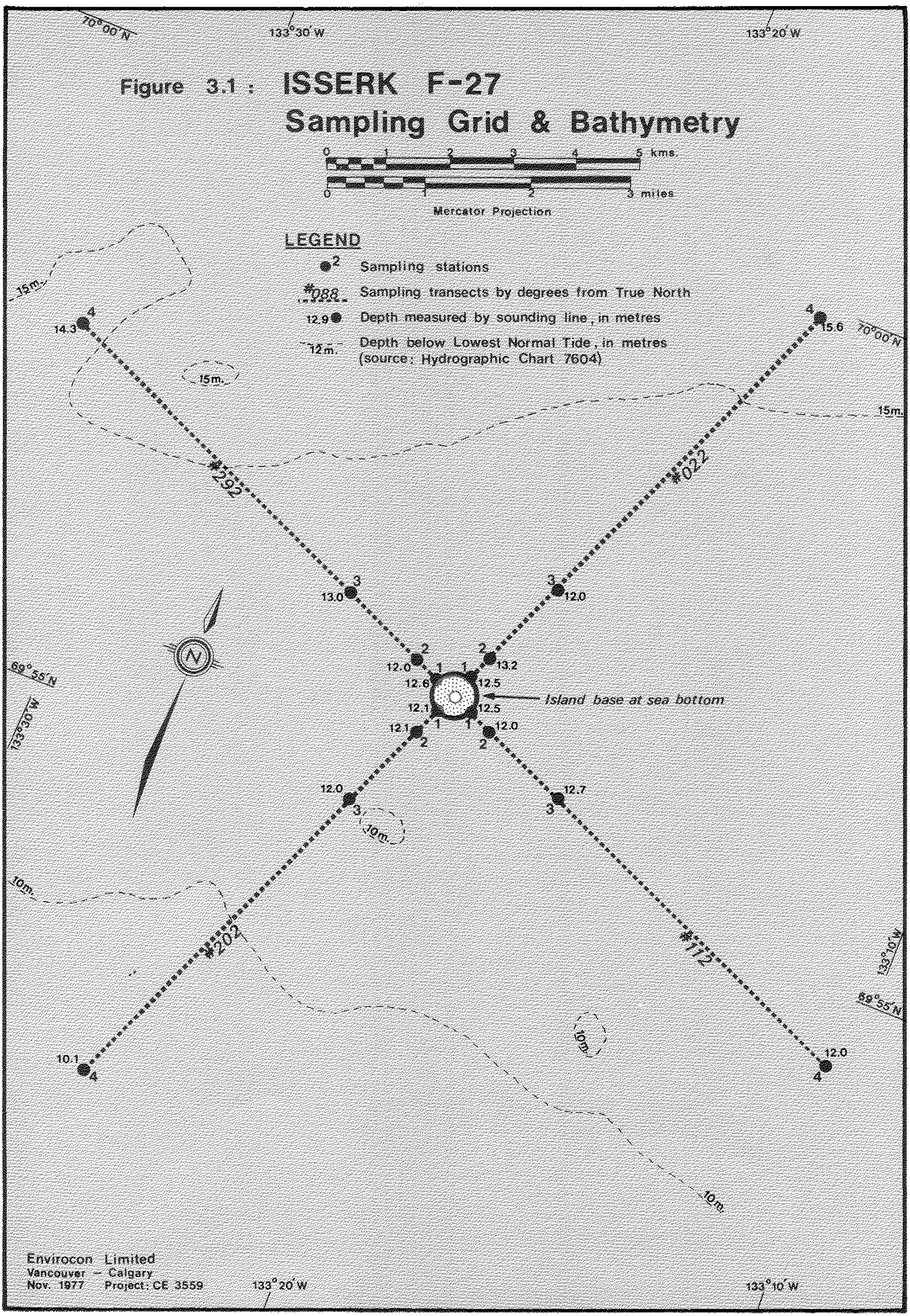


Figure 3.1 : ISSERK F-27 Sampling Grid & Bathymetry

of 202° T, the predominant plume direction prior to commencing the field program. However, by the time field work started the plume had shifted to a more westerly direction. Therefore, three transects were located at 022°, 112° and 202° T, and the plume transect was set at 292°T. Since the plume did not continue in a uniform direction throughout the study, the 292° transect was shifted slightly when necessary.

Stations were located along each transect starting next to the proposed island base (i.e. 300 m from the island centre), then at distances of 500, 2,000 and 8,000 from this toe. Each station was identified by its bearing and position from the island along the transect. For example, the station on transect bearing 112° out 2,000 m was named 112-3. The sampling procedures at each station are described in the following subsections.

Station locations were determined using the compass and radar aboard the Imperial Immerk. The stationary shore pontoon for the dredge pipeline was used as the radar target. Once the tug occupied a station, position was maintained by deploying a 23 kg anchor. Drift was generally minimal unless sea conditions exceeded approximately 1.5 m waves.

3.1.1 *Physical Parameters*

The physical parameters investigated and the techniques used are summarized in Table 3.1. All such measurements were taken on a single date at the respective stations

TABLE 3.1 FIELD TECHNIQUES FOR PHYSICAL PARAMETERS

Parameter	Method
Air Temperature (wet/dry bulb)	Taylor sling psychrometer
Solar Conditions	Visual estimate
Wind Velocity and Direction	Weathermeasure W1 hand wind meter
Wave Action	Visual estimate
Station Depth	Hand sounding line
Water Transparency	Secchi disc (30 cm dia. white)
Water Current Profile *	Hydro Products model 960 S savonius rotor current meter (speed accuracy ± 3%; direction accuracy ± 3%).
Water Temperature Profile *	YSI model 33 S-C-T meter (± 0.1°C at -2.0°C).
Salinity/Conductivity Profile *	YSI model 33 S-C-T meter (± 0.7ppt at 20 ppt and 4°C
Suspended Solids **	1 *l* water samples were passed through tared glass fibre filters for re-weighing in the lab.
Sediment Size Distribution	Approx. 50 ml were subsampled from a Ponar grab sample, frozen and returned to the lab for further analysis

* profile measurements taken from the surface to 12 m depth at 1 m intervals.

** suspended solid samples were collected at 1, 5 and 12 m depths.

during each of the two sampling periods. The water profile data were collected at one metre intervals from the surface to a depth of 12 m. Samples for suspended solid determinations were taken at 1, 5 and 12 m depths using a 3 l Van Dorn water bottle. These samples were passed under vaccum through preweighed Whatmann GF/C glass fibre filters. The filters were carefully placed in labelled petri dishes for return to Calgary where the suspended solid determinations were made. A 50 ml sub-sample from a Ponar grab was taken using a small hand corer, 2.5 cm in diameter. This material was frozen in water-proof kraft paper envelopes and returned to Calgary for estimation of bottom sediment particle sizes.

3.1.2 *Chemical Parameters*

Table 3.2 summarizes the chemical parameters considered and the field sampling methods used during the study. With the exception of dissolved oxygen and alkalinity, the analyses were completed by Chemex Labs (Alberta) Ltd. in Calgary. All chemical sampling was done concurrently with the physical sampling. Water was collected at depths of 1, 5 and 12 m in the 3 l Van Dorn bottle, and the frozen sediment sample taken for grain size analysis was used for carbon determinations.

Dissolved oxygen profiles were made at 1m intervals using a YSI oxygen meter with a depth compensating probe. This data was checked by taking water samples from 1 and 12 m and measuring dissolved oxygen following the azide modification of the Winkler method (Standard Methods, 1975).

TABLE 3.2 FIELD TECHNIQUES FOR CHEMICAL PARAMETERS

Parameter	Sample Handling	Sample Analyses
Dissolved oxygen profile *	field analysis	YSI model 54 oxygen meter ($\pm$ 1% of full scale)
Alkalinity **	field analysis	titrimetric method (Hach, 1976)
Silica ** Nitrate ** Nitrite **	250 ml samples frozen at $-20^{o}C$ in plastic bottles	forwarded to Chemex for analysis
Ammonia ** Total Phosphate **	250 ml samples preserved with conc. H_2SO_4 1 ml/l	forwarded to Chemex for analysis
Sediment Carbon	50 ml sediment sample frozen	forwarded to Chemex for analysis

* profile measurement taken from the surface to 12 m depth at 1 m intervals.

** samples collected at 1, 5 and 12 m depths.

Alkalinity was measured on site following the titrimetric methods as outlined in Standard Methods (1975) but modified for field use with prepackaged chemicals (Hach, 1976). Alkalinity was determined for 1, 5 and 12 m depths.

Since the other parameters were forwarded to Chemex for analyses, it was necessary to carefully collect and preserve samples in the field. Water samples destined for total nitrate, nitrite and silica determinations were kept in a cooler until they could be deposited in a deep freeze (-20°C). either at Camp 17 or aboard the Arctic Pelly. The time between sampling and freezing did not usually exceed 4 hr.

Total phosphate and ammonia were measured from water preserved with 1.0 ml of concentrated H_2SO_4 for each litre of sample.

3.1.3 *Biological Parameters*

All biological material collected during the study was appropriately preserved, then forwarded to either Envirocon's Calgary or Nanaimo office for complete examination. The field collection and preservation techniques are summarized in Table 3.3

One litre water samples were taken at 1, 5 and 12 m depths and preserved with Lugol's solution (1:100) for future enumeration and identification of phytoplankton. In addition, a second litre was taken at similar depths

TABLE 3.3 FIELD TECHNIQUES FOR BIOLOGICAL PARAMETERS

Parameter	Gear	Preservative
Phytoplankton	- 3 ℓ Van Dorn bottle - sample taken at 1, 5 and 12 m depths	- 1 ℓ sample preseved with 10 ml of Lugol's soln. - 1 ℓ passed through Whatmann GF/C filter, wrapped in foil and frozen for Chl-a analysis
Zooplankton	- 50 cm dia. conical plankton net (156 u mesh) - 3 vertical hauls per station from a depth of 12 m.	- 5% buffered formalin
Nekton a) micronekton	- 1 m dia. conical trawl net (571 u mesh) - towed immediately below surface at 0.4 m/s for 2 min.	- 5% buffered formalin
b) fish	- 2.5 to 12.5 cm mesh monofilament gill nets (15 x 2.5 m panels providing 75 m long gangs) - 1 floating and 1 bottom set at each station for 24 hr.	- scales unpreserved in envelopes - otoliths preserved in ethanol/glycerine soln. (9:1) - stomachs preserved in 10% buffered formalin - other tissues frozen
Benthos	- 22.5 x 22.5 cm Ponar grab - 5 samples per station washed through 0.47 mm. mesh seive.	- 10% buffered formalin

for chlorophyll a analysis. These samples were filtered under vaccum through Whatmann GF/C glass fibre filters. The filters were then wrapped in foil and frozen before forwarding them to Chemex for final analysis.

Three vertical hauls were made at each station to collect zooplankton. A conical-shaped plankton net, with mouth diameter of 50 cm and mesh size of 156 u, was hauled from the seafloor to the surface. The collection from each haul was preserved in 5% buffered formalin then sent to Nanaimo for identification and enumeration.

The nekton, those animals capable of mobility independent of wave and current action, was sampled with two types of gear. A conical-shaped trawl, with a 1m diameter mouth and 5 m long, was made up of 571 u mesh. It was towed horizontally just below the surface behind the Zodiac for 2 min at a speed of 0.4 m/s. This procedure collected both the smaller nekton and the larger zooplankton. The catch was preserved in 5% buffered formalin.

Fish, also part of the nekton, were sampled using gill nets. Due to ship traffic around the island site it was not possible to deploy such gear at all stations. Instead, only the two outer stations along each transect were sampled in both study intervals. During the July field program successful sets were also made at station 112-2. Two gangs, each 76 m long by 2.5 m deep, were used at each sampled station. The gangs were composed of 15 m long monofilament panels containing stretched mesh of 2.5, 5.0, 7.5, 10.0 and 12.5 cm. One of the two nets was set directly on the seafloor to sample demersal species while the other was draped just below the surface to collect pelagic varieties. The soak time always exceeded 21 hr. Fish collected in this manner were examined so that fork length, wet weight, sex and maturity could be determined. In addition, stomachs were removed and preserved in 10% buffered formalin and scale samples or otoliths were collected for age determinations. The otoliths were fixed in an ethanol/glycerine solution (9:1). Since Beak Consultants Ltd. was conducting a trace metal study for Imperial Oil in the Beaufort Sea, the captured fish were filleted and the muscle frozen until delivery was made to a Beak representative.

3.2 Laboratory Analysis and Data Processing

Although it was possible to complete the analysis of some parameters in the field, many others required a laboratory setting for proper determination. Therefore, water and sediment samples were forwarded to Chemex Labs (Alberta) Ltd., and biological material went to Envirocon Ltd. (Nanaimo).

3.2.1 *Physical Parameters*

Only suspended solids and sediment particle sizing required analysis in the laboratory. Therefore, complete determinations were made on samples sent to Calgary.

The glass fibre filters through which the suspended solids samples were passed were removed from their individual sealed petri dishes and placed overnight in a drying oven at 103 - 105^{o}C. Following this treatment they were cooled to room temperature in a dessicator and weighed, along with several unused (blank) filters, to 0.01 mg. The final value was then estimated as follows:

$$\text{Suspended Solids (mg/l)} = \frac{(R-F+B) \times 1000}{\text{vol. of sample (ml)}}$$

where R = filter + residue wt. (mg)
F = filter wt. (mg)
B = blank correction wt (+/- mg).

Particle size distribution of sediments was determined using a buoyocous hydrometer method (Means and Parcher, 1963). Portions of the frozen samples were oven dried before 50 g were added to 500 ml of distilled water along with 5 ml of a $(NaPO_3)_6$ solution (5% V/V). This mixture was thoroughly agitated before being added to a special graduated cylinder. A hydrometer, precalibrated in grams, was used to record changes after 20 and 40 sec. with the difference in readings providing the weight of sand. The sample was reagitated and hydrometer readings taken after 2 hr to give the weight of clay. Silt was estimated by subtracting the sum of clay and sand from the total. This method determines particle sizes as 0.05 - 2.00 m for sand, 0.002 - 0.05 mm for silt and less than 0.002 for clay. The weight measurements were converted to percentages of the total sample. The detection limit for this procedure is 0.2%.

3.2.2 *Chemical Parameters*

Nitrate and nitrite determinations were performed using an automated cadmium reduction method which incorporates a Technicon Auto Analyzer (Stainton et al.,1974). This procedure reduces NO_3 to NO_2 using a Cd-Cu catalyst. The NO_2 is reacted with sulfanilamide and N-1 naphthylethylene diamine dihydrochloride to form an azo dye. The absorbance of the resulting colour is measured at 543 nm to yield the NO_2 concentration. Separate values for NO_3 and NO_2 are obtained by repeating the procedure with and without the Cd-Cu reduction step. The detection limit is 0.001 mg/l.

Ammonia was also determined using the Technicon Auto Analyzer unit following an indophenol method (Stainton et al, 1974). The intensity of the blue colour formed by the reaction of NH_4 with alkaline phenol hypochlorite is measured at 650 nm. Sodium nitroprusside is used to catalize colour development. The detection limit is 0.01 mg/l.

Phosphate samples were pretreated under acidic conditions with ammonium persulfate to oxidize and hydrolize all soluble forms to orthophosphate (Standard Methods, 1975). Total PO_4 was then determined by an automated method incorporating the Technicon Auto Analyzer (Stainton et al, 1974). The principle of this technique involves the reaction of pretreated samples with ammonium molybdate to form molybdophosphoric acid. This is reduced with ascorbic acid to produce an intense molybdenum blue which is measured at 650 nm. The detection limit is 0.003 mg/l.

Silica concentrations were measured following a method similar in principle to that for PO_4 (Stainton, 1974). Silica reacts with ammonium molybdate to produce coloured heteropoly acids. Oxalic acid is used to destroy molybdophosphoric acid so that PO_4 interference is prevented. The remaining molybdosilicic acid is reduced with ascorbic acid to produce heteropoly blue which is read at 650 nm. This method is conducted on the Technicon Auto Analyzer. The detection limit is 0.05 mg/l.

The carbon content of the sediment samples was estimated using a LECO induction furnace. Combustion in this equipment coverts all carbon to CO_2 which is then measured on a 577-100 carbon analyzer. The resulting readings give the total carbon present. For organic carbon, the samples were acidized with HCl to remove inorganic calcium and magnesium carbonates. Analysis was then as for total carbon. The detection limit for this procedure is 0.01%.

3.2.3 *Biological Parameters*

Phytoplankton samples were vigorously shaken prior to removing a 12.5 ml aliquot which was added to a counting cell. The cell was carefully closed to exclude bubbles and the suspended material allowed to settle for at least 3 hr. Identification and enumeration was done utilizing a Leitz inverted compound microscope equippped with phase contrast at 320X magnification. When required, powers up to 1600X were used to confirm identifications.

Chlorophyll a was analyzed from the material filtered for this purpose in the field following a trichromatic method (Standard Methods, 1975). After extraction of the chlorophyll in 90% acetone solution (24 hr in the dark at 4^oC) a 10 to 15 ml aliquot was centrifuged for 10 min at 500 G. The supernatant was placed in cuvettes and the optical density measured at 750, 665, 645 and 630 nm in a 1 cm light path. The concentration was then calculated using the optical densities in the following formula:

$$\text{Chl a (mg/l)} = 11.6D_{665} - 0.14D_{630} - 1.31\ D_{645}$$

where D is the optical density corrected for turbidity and blank values.

The detection limit for this method is 0.001 mg/l (1 mg/m^3) which is close to the range of values occurring in the Beaufort Sea (Grainger, 1974). Unfortunately, due to an oversight, a range expander was not used with the spectrophotometer and the sensitivity of this method was not increased.

Zooplankton samples were washed into 1 l beakers, placed on a white background and the large organisms counted. The sample was then split, using a folsom plankton splitter, to a fraction containing 500 to 2,000 individuals. This quantity was sufficient to include rare species and maintain the relative proportions of the various taxa present in the total sample. The subsamples were placed in petri dishes and the large organisms identified using 6.4X magnification. The smaller specimens were enumerated and identified at 16X. Wet weights for the total samples were determined by straining the catch through pieces of tared 100 u mesh. The seived material was blotted dry and weighed on a Sartorius 2255 balance.

Benthos was analyzed in a similar manner to zooplankton except that no subsampling was done. Biomass was determined by straining samples through 0.5 mm mesh, blotting dry and weighing. The shells of molluscs were removed prior to estimating the sample biomass.

The identification of some taxa was confirmed by other authorities not associated with Envirocon Ltd. Mr. F. Bernard and J. Fulton of the Pacific Biological Station kindly checked the identification of some molluscs, copepods and cnidarians. Dr. M. Arai of the University of Calgary also assisted with cnidarians.

3.2.4 *Data Analysis* :

Due to a lack of replication for the physical and chemical data collected at the various sampling stations, the analysis of such information was restricted to a qualitative nature. However, both multiple samples and large representative collections charactertized much of the biological data Therefore, this information was subjected to various statistical methods.

The abundance and taxa data for phytoplankton, zooplankton and benthos were evaluated using the Shannon-Wiener diversity index. This function is defined as:

$$H = \sum_{i=1}^{s} (Pi)\ (\log_2 Pi)$$

where s is the number of species and Pi is the proportion of the total sample belonging to the ith species. This index ranges from less than 1 for low diversity communities to well over 2. Low diversities can result with communities subjected either to severe natural conditions or to pollution.

An extension of the diversity index is the calculation of equitability (i.e. the degree to which the abundance in a community is evenly distributed between the various taxa). Equitability is the ratio between the observed diversity index and the maximum index that is possible for a community with that given number of taxa. It can range in value from 0 to 1, but often approaches the lower end of the scale when a biological community is deleteriously affected.

Some of the abundance and biomass data was evaluated using analysis of variance (ANOVA) and student t-tests (Sokal and Rohlf, 1969). To expedite these statistical tests, they were performed with SPSS computer packages (Nie *et al*, 1975) at the computer science centre of Simon Fraser University.

Cluster analyses (Sokal and Sneath, 1973) is a technique used to group variables according to the degree of similarity between them. Each variable is assigned a point in multidimensional space with co-ordinates based on the data input. The analysis then proceeds by grouping those positions with the smallest geometric distances between them. Clustering occurs in successive steps gradually uniting variables to form larger and larger groups (agglomerative clustering). Not more than two entities are associated per subgroup per clustering step and these are united only if the distance between them is smaller than between any other paired combination (sequential, hierarchic clustering). Since some of the various subgroups will include more than one of the original variables, distances are determined between the various centres of these subgroups. The "centroid" is an abstraction for this centre that is located at the centre of gravity of each cluster. Representation of the association hierarchy is normally made in the form of a dendogram.

In this study the cluster analysis was applied to the abundance data for major taxa (i.e. those taxa composing greater than 1% of the total abundance) at each station. The resulting output grouped stations together having the most similar community compositions. All such analyses were completed using the MTS computer program, CLUSTER, incorporating the unweighted paired-group centroid option with Minkowski distances.

4.0 RESULTS

4.1 Physical Data

The information dealing with the physical environment gathered during this study is contained in Appendix I. The following summarizes these findings.

4.1.1 *Climatology*

From July 26 to July 31, air temperatures ranged from 11.1°C to 15.6°C with clear, sunny skies. Winds were always light (Range = 0 - 18 km/hr) and generally out of the east.

The weather between August 24 and August 30 was inclement compared to July. Cloud cover usually exceeded 90% with periodic intervals of freezing rain. Air temperatures varied between 5.4°C and 7.8°C. Winds typically came from the northwest quadrat with higher velocities than during July. Except on August 26 and 27, velocities ranged from 0 to 20 km/hr. During August 26 and 27, a severe storm erupted with gale-force winds reaching 80 km/hr. at Isserk F-27.

4.1.2 *Bathymetry and Wave Action*:

The depths in the study area ranged from 10.1 m at 202-4 in the south to 15.6 m at 022-4 towards the north. The stations adjacent to the island site had depths of 12.1 to 12.6 m.

Due to the extensive shallow waters in the south Beaufort Sea wave action can change substantially in short time intervals. In July, when weather conditions were uniform, waves in the Isserk area were generally about 0.3 m high, but did reach 1.2 m. The more variable August weather produced swells usually of 0.7 to 1.0 m, but these reached heights of about 3.0 m during the storm on August 26 and 27.

4.1.3 *Water Temperature and Salinity*

Water temperature was highly stratified in July with averages of 11.2 ± 0.54°C, and -0.3 ± 0.08°C at the surface and bottom respectively. The thermocline usually started at a depth of 4 m and continued down to 6 or 7 m (Figure 4.1 - 4.5). The proximity to the island and its related construction activities had no apparent effect on this thermal stratification (Figure 4.1).

During late August, the temperature stratification persisted prior to August 26 (Figure 4.1 and 4.4) but following the storm activities of the 26 and 27, the surface-to-bottom temperatures were much more homogeneous (Figure 4.2, 4.3 and 4.5). For example, station 292-3, which was occupied both before and after the storm, had surface and bottom temperatures of 8.0°C and 1.5°C respectively on August 26. By August 28, the surface temperature was 9.0°C and the bottom value had increased to 5.5°C.

Like temperature, salinity was stratified in July with mean surface and bottom values of 15.2 ± 0.53 ppt and 29.9 ± 0.22 ppt. The halocline occupied similar depths to the

Figure 4.1 : **Temperature and Salinity profiles at Station 292-1 in the Isserk area on July 30 and August 25, 1977 (Plume station)**

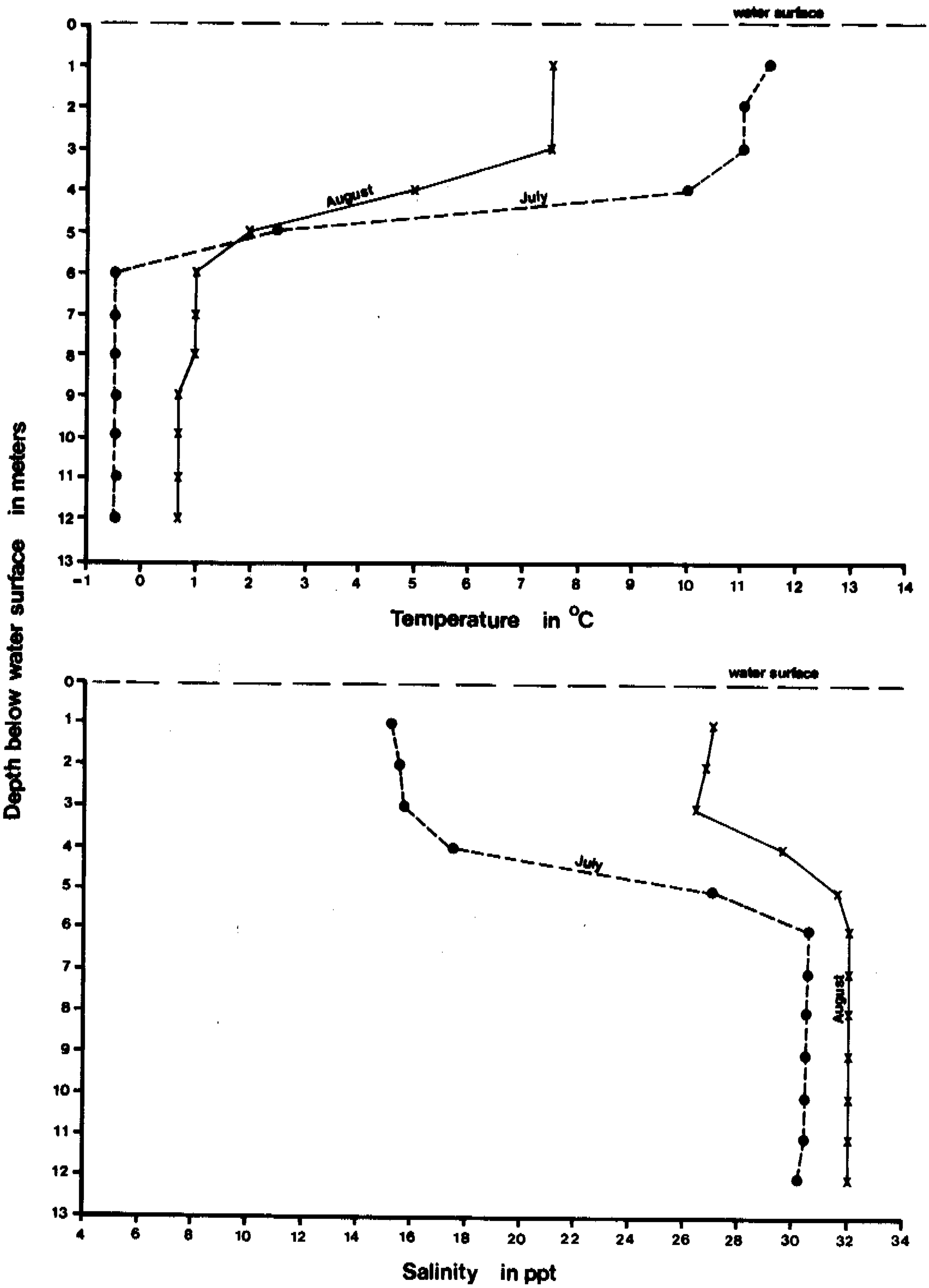


Figure 4.2 : **Temperature and Salinity profiles at Station 022-4 in the Isserk area on July 31 and August 29, 1977**

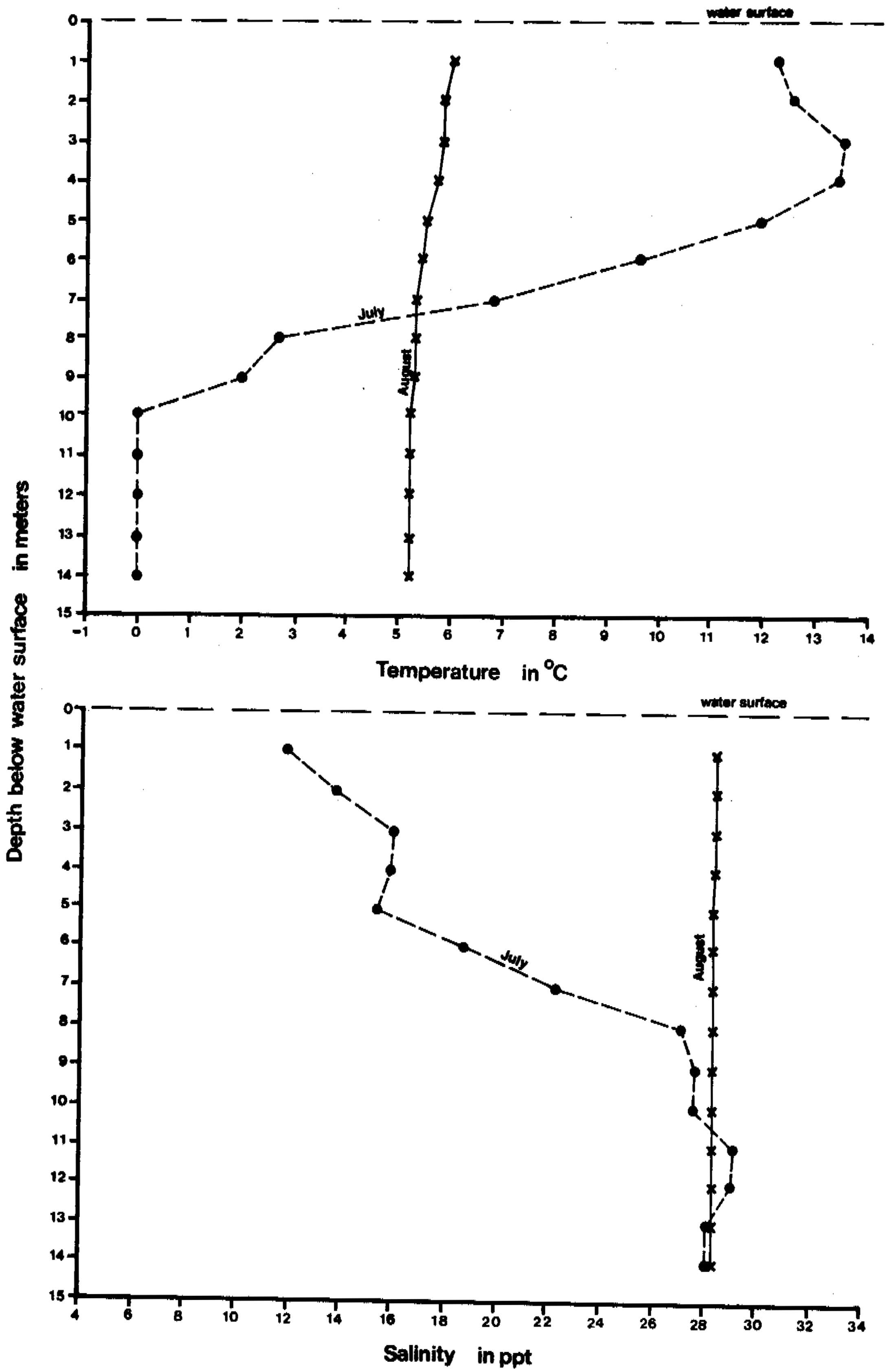


Figure 4.3 : **Temperature and Salinity profiles at Station 112-4 in the Isserk area on July 27 and August 29, 1977**

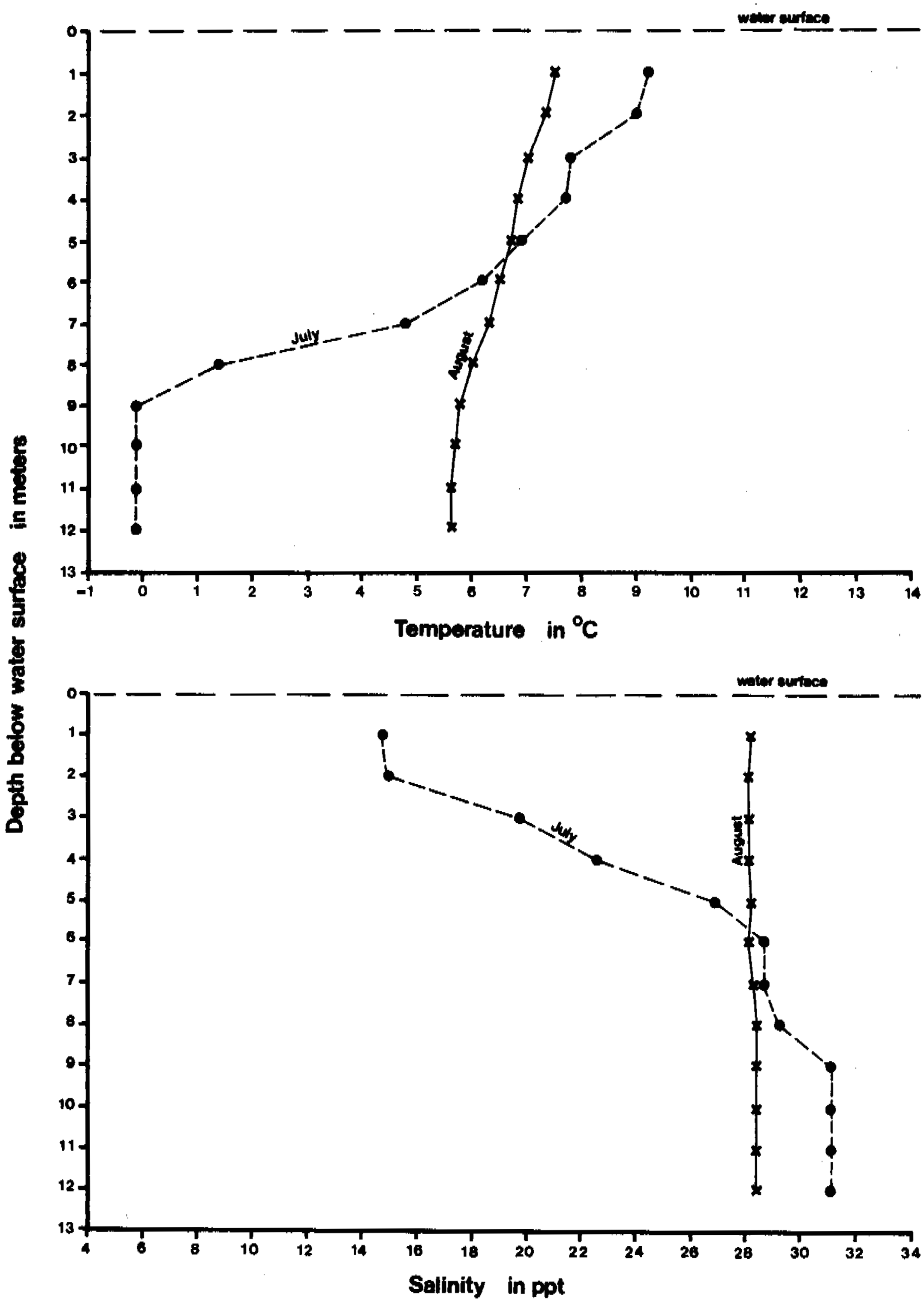


Figure 4.4 : **Temperature and Salinity profiles at Station 202-4 in the Isserk area on July 30 and August 26, 1977**

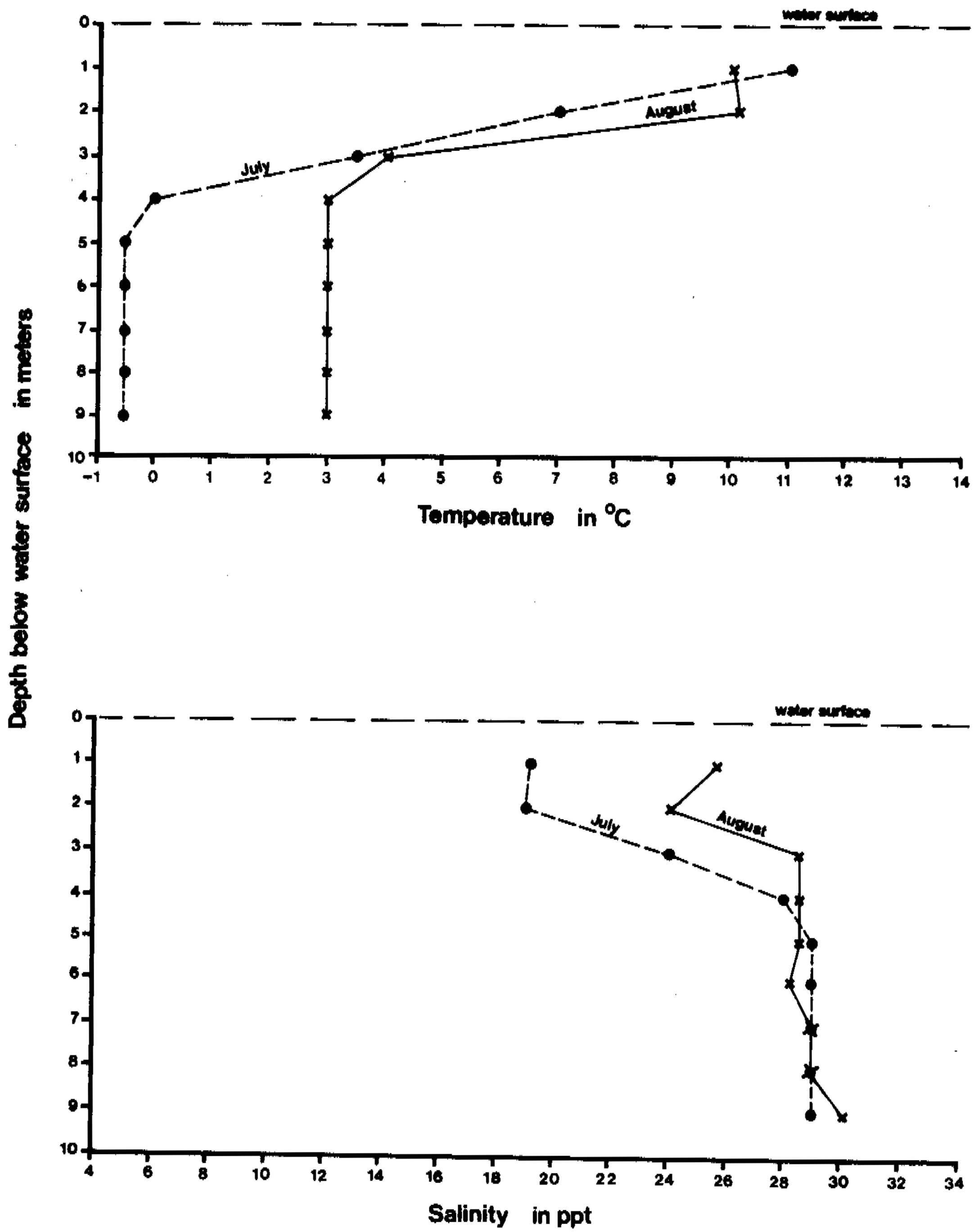
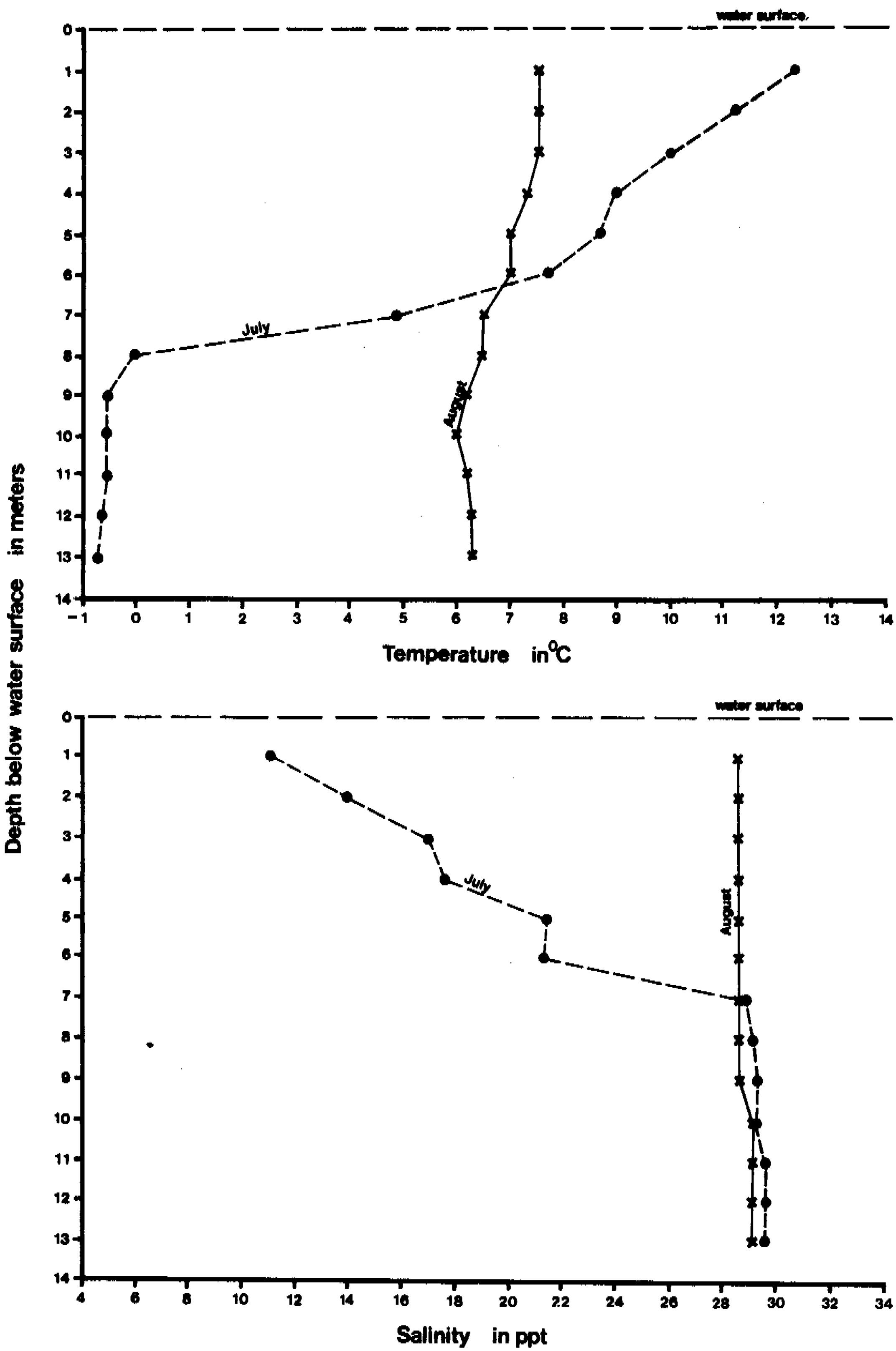


Figure 4.5 : Temperature and Salinity profiles at Station 292-4 in the Isserk area on July 30 and August 28, 1977



thermocline at most stations. Again, proximity to island construction did not affect the profile (Figure 4.1) compared to distal stations (Figures 4.2 - 4.5).

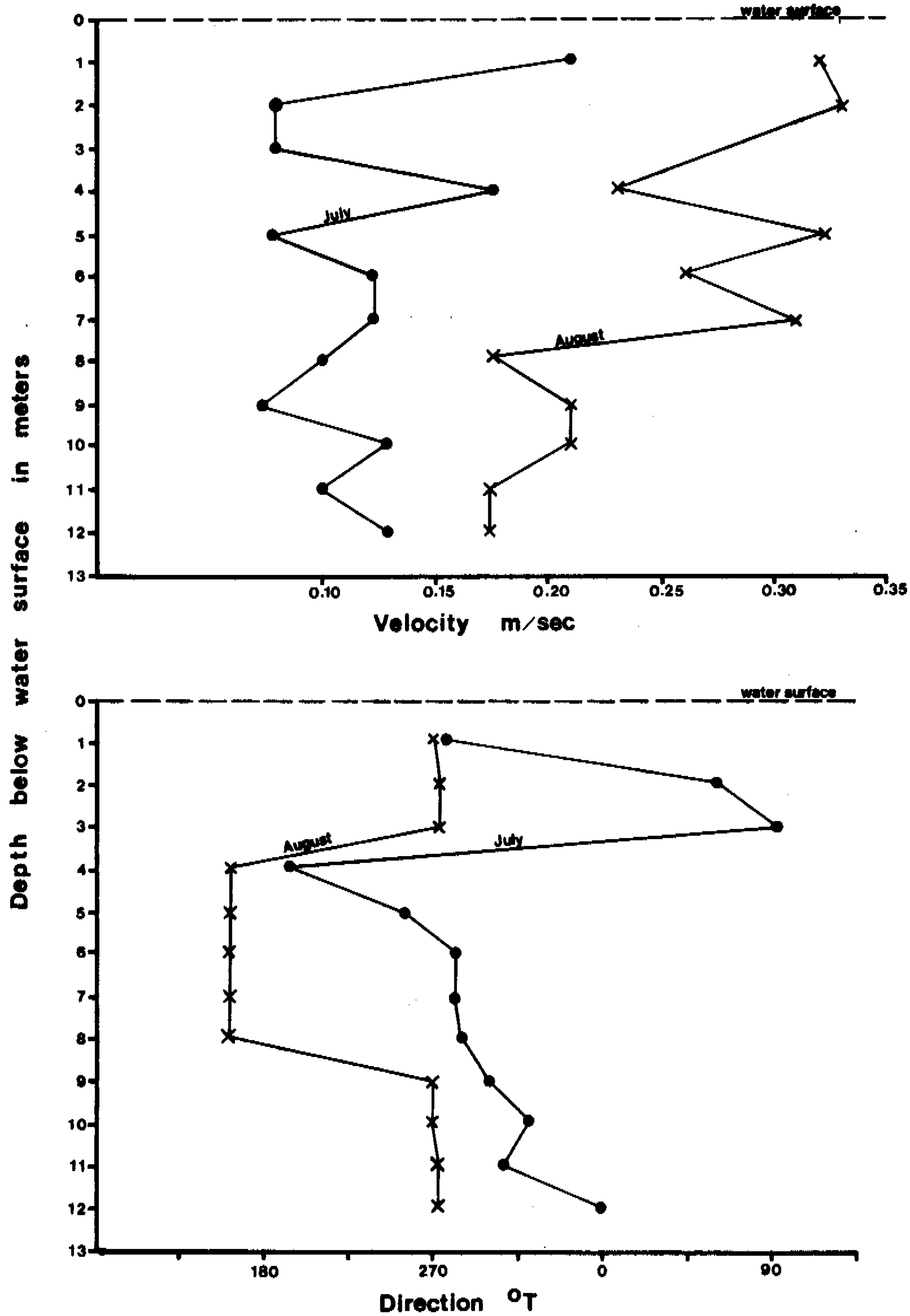
August salinities were much more homogeneous in vertical profiles than in July. The difference between surface and bottom values was about 4 ppt prior to the August 26 storm (Figure 4.1 and 4.4) and 0 ppt following it (Figure 4.3 and 4.5). Therefore, what little salinity stratification existed at the onset of the August field work, none remained by the end of the study.

4.1.4 *Water Currents*

The direction and velocity of the water currents in the study area varied widely both among the stations and at different depths. Figure 4.6 illustrates typical water current profiles.

The surface currents in July flowed in a west to southwest direction, but bottom currents wandered widely. Generally, however, the latter flowed towards the southeast, or northeast. August surface currents tended to flow more to the northwest rather than the southwest and bottom currents had westerly, southwesterly or south-southeasterly bearings. The current velocity usually decreased from surface (mean at 1 m = 0.26 and 0.24 m/sec for July and August respectively) towards the seafloor (mean at 12 m = 0.19 and 0.18 m/sec for July and August respectively). The average velocities measured at 0.6 of the depth were 0.23 m/sec in July and 0.20 m/sec in August.

Figure 4.6 : Water Current profiles at Station 202-3 in the Isserk area during July and August, 1977



4.1.5 *Discharge Plume, Suspended Solids and Water Transparency*

The sediment plume generated by the hydraulic dredging at the Isserk F-27 site was very apparent in July (Plate IV). The area surrounding the island was inundated by visible turbidity for a distance of approximately 50 m in all directions. In addition, the plume could be seen flowing downstream of the island for at least 1 km. However, the direction and width of this discharge was variable. The week prior to commencing the July field studies, the plume was reported to flow south-southwest of the island centre. Once field work commenced the direction had shifted to the west. Still, some turbidity was apparent in a southerly direction as well, but this veered to the west within a few 100 m of the island.

By the start of the August field work the water in the entire study area was much more turbid than in July. This made it difficult to visually locate the plume except very close to the island. The direction of this near-island discharge was into the northwest quadrant. Following the storm of August 26 and 27, any turbidity resulting from the presence of the island could not be detected against the high background turbidity.

In July, the amount of suspended solids in the study area tended to be greater south of the island than it was to the north. The most southerly stations (202-3, 202-4, and 112-4) had a surface mean of 15.4 mg/l compared to an average of only 9.1 mg/l at northern stations (022-3), 022-4, and 292-4). Secchi disc depths generally supported this trend with a high value of 6.0 m at 022-4 compared to only 2.9 m at 202-4.

The four stations adjacent to the island all had secchi depths in July less than 0.5 m. This lack of transparency was accompanied by values for surface suspended solids in excess of 20 mg/l. Low secchi depths (i.e. less than 1.0 m) and high suspended solids (i.e. greater than 50 mg/l) also characterized stations influenced by the visible plume. These included stations 202-2 and 292-2.

In July suspended solids at a depth of 5 m were much higher at some stations near the island or along the plume than the corresponding surface values. This phenomenon indicated that subsurface sinking and spreading of the turbidity plume was occurring at stations with little visible surface plume. For example, station 292-3 had a value of 133.4 mg/l at 5 m compared to only 24.3 at the surface. Station 202-1 had the highest 5 m value at 388.8 mg/l. The 5 m concentrations at the stations most distant from the island were low (range = 3.2 - 11.8 mg/l). It appears that the turbidity plume flowed into the southwest quadrant along transect 292. As it proceeded it began sinking below the surface at 292-2 where both the 1 and 5 m suspended solids concentrations were about 100 mg/l. At a distance of 2 km from the island (i.e. station 292-3) the plume was not detectable at the surface, where the suspended solids level was 24.3 mg/l, but was still moving at subsurface depths as indicated by a 5 m concentration of 133.4 mg/l. Station 292-4, 8 km from the island, had 1 and 5 m concentrations less than

10 mg/l suggesting that the plume had dispersed before reaching this location.

Suspended solid levels near the seafloor ranged from 5.7 to 124.7 mg/l in July. However, most values were in the 30 to 40 mg/l range. In general, the concentrations near the bottom were higher than at the surface. Exceptions were at stations with particularly high values resulting from the turbidity plume.

The transparency of water in the study area was much lower in August than in July. Almost all stations had secchi depths less than 1.5 m. The only exceptions were stations 112-3 (2.2 m), 292-2 (2.5 m) and 292-3 (2.2 m). In all three cases the secchi depth was determined prior to the storm of August 26 and 27. The increased vertical mixing caused by the storm resulted in low transparency at most other stations. For example, station 022-4, which had the greatest secchi depth in July, had a 1.0 m extinction depth following the storm.

Suspended solids were generally higher in August than July. The four stations adjacent to the island had a near surface value of 112.6 mg/l. None of the other stations had surface concentrations above the range 14.5 to 53.4 mg/l. In addition, values in this range were randomly distributed among the remaining stations. Suspended solids at a depth of 5 m were at similar concentrations to the corresponding surface values at all stations. Near-bottom concentrations ranging from 31.4 to 215.4 mg/l, were randomly distributed among the stations not adjacent to the island. Station 112-1 was noteworthy for having the highest bottom value at 455.5 mg/l.

4.1.6 *Sediment Size Distribution*

With the exception of samples collected at stations 022-3 in July, 112-1 in August, 202-1 in July, 292-1 in July and August, and 292-3 in August, the remaining 25 samples were very similar in their particle size distribution. Mean values for sand, silt and clay fractions at these stations were 1.5 ± 0.47%, 7.6 ± 1.31% and 90.9 ± 1.66%. The other 6 samples were noteworthy for their high sand content (mean = 91.1 ± 3.09%) and low clay fraction (Mean = 4.2 ± 2.80%). Since 112-1, 202-1 and 292-1 were at the toe of the island base, the sandy material collected from them was probably due to the shifting of dredged or barged fill onto these stations. Stations 022-3 and 292-3 were well away from the island centre so a similar explanation is unlikely for them. Perhaps their high percentage sand simply reflected a random variation in the bottom sediments. The high sand content, out of keeping with surrounding sediments, may have resulted from ice rafting at these two stations.

4.2 Chemical Data

The following subsections contain summaries of the chemical information collected in the Isserk F-27 area. The raw data can be found in Appendix II.

4.2.1 *Dissolved Oxygen Profiles*

Only small variations occurred in dissolved oxygen from the surface to the bottom of the water column (Table 4.1). Figure 4.7 illustrates representative profiles taken at stations outside and inside the plume. During both July and August the oxygen concentration tended to drop slightly immediately above the seafloor. Similar dissolved oxygen values and profile patterns characterized all stations whether or not they were in the sediment plume or immediately adjacent to the island site.

During July the oxygen concentrations at 1 and 12 m depths averaged 10.6 ± 0.10 and 10.5 ± 0.11 mg/l (n=16) respectively. When the ambient salinity and temperature were taken into consideration, these values were equivalent to saturation levels of 105 ± 1.4% at the surface and 89 ± 0.9% near the bottom.

The dissolved oxygen values in August were generally lower than in July. Mean values for 1 and 12 m depths were 10.2 ± 0.05 and 9.8 ± 0.11 mg/l respectively. Again, the degree of saturation was higher at the surface (mean = 101 ± 0.7%) than at the bottom (mean = 90 ± 1.3%).

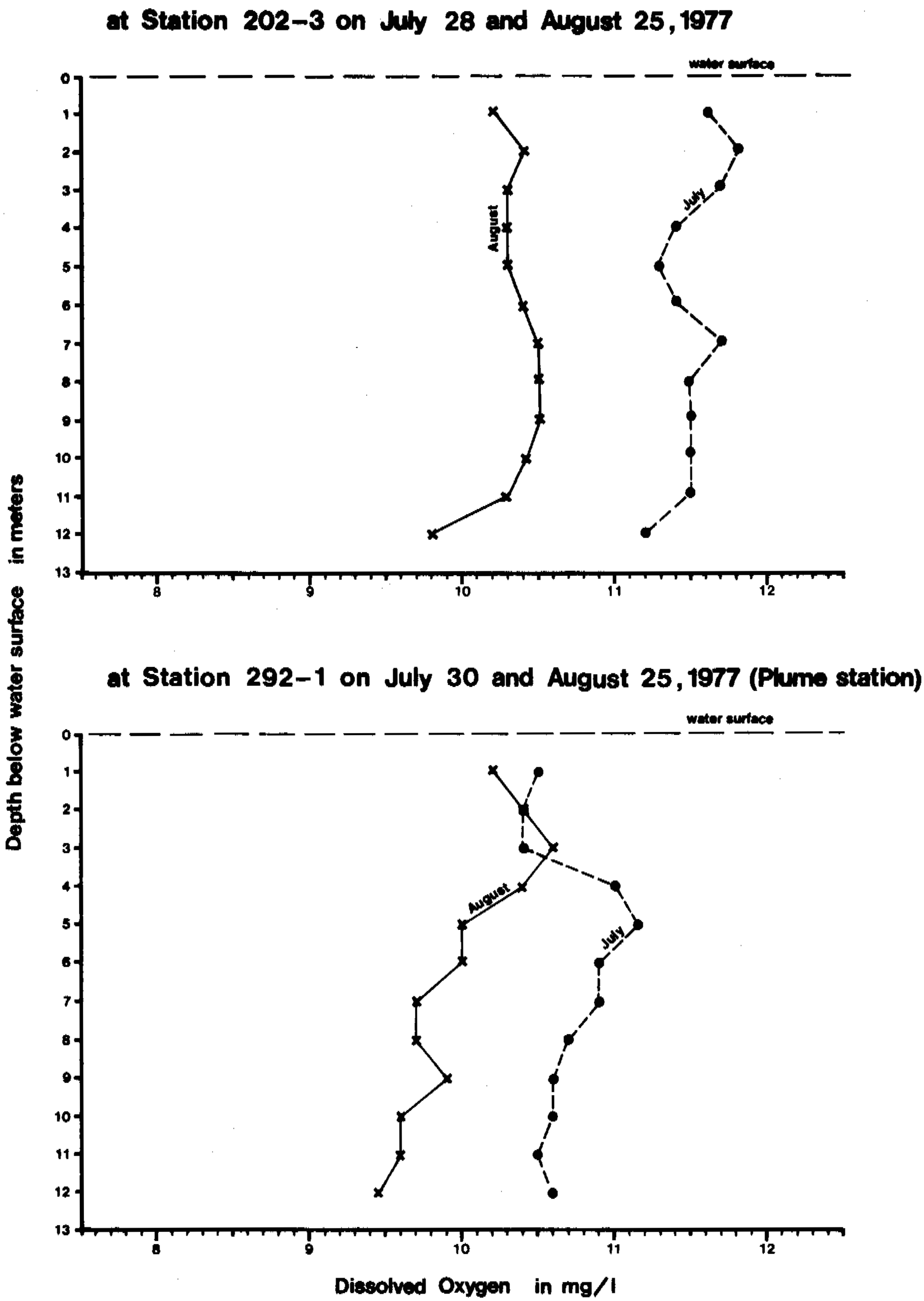
TABLE 4.1 MEAN (± STANDARD ERROR) CHEMICAL VALUES FROM THE ISSERK F-27 AREA, 1977

Parameter	1m below surface July	1m below surface August	5 m July	5 m August	1m above bottom July	1m above bottom August
Dissolved Oxygen (mg/l)	10.6 ± 0.10	10.2 ± 0.05	10.9 ± .16	10.2 ± 0.09	10.5 ± 0.11	9.8 ± 0.11
Total Alkalinity (mg/l)	92 ± 2.9	106 ± 1.7	97 ± 1.9	110 ± 1.7	113 ± 2.5	110 ± 1.9
NO_3 - N (mg/l)	0.007 ± 0.008	0.009 ± 0.0013	0.005 ± 0.008	0.015 0.0029	0.010 ± 0.0013	0.034 0.0045
NO_2 - N * (mg/l)	0.002 ± 0.0003	<0.001 to 0.003	0.003 ± 0.0002	<0.001 to 0.002	0.005 ± 0.0003	<0.001 to 0.002
NH_3 - N * (mg.l)	0.03 ± .003	<0.02 to .04	0.04 ± .003	<0.02 to .09	0.05 ± .003	<0.02 to 0.14
PO_4 - P (mg.l)	0.034 ± 0.0087	0.045 ± 0.0059	0.055 ± 0.0178	0.058 ± 0.0126	0.060 ± 0.0069	0.073 ± 0.0071
Silica (mg/l)	1.2 ± 0.07	0.4 ± 0.06	1.0 ± 0.05	0.3 ± 0.03	1.3 ± 0.04	0.3 ± 0.03

	Total Carbon July	Total Carbon August	Total Organic Carbon July	Total Organic Carbon August
Sediment Carbon (%)	2.18 ± 0.165	2.27 ± 0.180	1.06 ± 0.109	1.10 ± 0.127

* when some of the August values were below the sensitivity of the analytical techniques, only the range is provided.

Figure 4.7 : Dissolved Oxygen profiles in the Isserk F-27 area



4.2.2 *Total Alkalinity*

Alkalinity measurements showed no particular relationship either to plume location or proximity to the Isserk site. Instead, alkalinity varied in a manner similar to salinity. During July the surface measurements averaged 91 $\pm$ 2.9 mg/l (n=16) and increased to 113 $\pm$ 2.5 mg/l at the bottom (Table 4.1). The August measurements were more uniform throughout the water column with surface and bottom means of 106 $\pm$ 1.5 and 110 $\pm$ 1.9 mg/l respectively.

4.2.3 *Nutrients*

The concentrations of NO_3 - N tended to increase from the surface towards the bottom, particularly in August (Table 4.1). August was also noteworthy for having average levels consistently higher at all depths than in July. However, a relationship between the measured concentrations and proximity to the island site was not apparent during either sampling interval.

A pattern was visible in August along a north-south axis. The three most northerly stations (022-3, 022-4 and 292-4) averaged only 0.003 $\pm$ .0002 mg/l (n=16) in the top 5m. This contrasted with their southern counterparts (202-3, 202-4 and 112-4) which had a mean of 0.016 $\pm$ 0.0058 mg/l. A similar trend was not observed in July.

The NO_2 - N concentrations usually increased from the surface to the bottom, but with the July values much higher than the corresponding August ones (Table 4.1). Unlike the

NO_3 - N measurements, the NO_2 - N values did not follow a pattern associated with the north-south axis. Instead, three of the stations immediately adjacent to the island site (022-1, 112-1 and 292-1) had higher than average values during both sampling intervals.

As with the NO_2 - N measurements, NH_3 - N was present at greater concentrations in July than in August (Table 4.1). Furthermore, the level in the water column generally increased with depth. However, no other patterns were apparent in the distribution of NH_3 - N.

The mean total phosphate concentrations increased both from July to August and with depth (Table 4.1). The distribution throughout the study area was random with July and August PO_4 - P values ranging from 0.009 to 0.270 mg/l and 0.003 to 0.220 mg/l respectively.

Unlike the other nutrients, silica concentrations which averaged about three times higher in July than in August (Table 4.1), had a minima at a depth of 5 m rather than near either the surface or bottom. Similar to PO_4 - P, the silica concentrations were randomly distributed with ranges of 0.5 to 1.6 mg/l in July and 0.1 to 1.0 mg/l in August.

4.2.4 *Sediment Carbon*

The total and organic carbon content of the sediments surrounding the Isserk site averaged 2.23 $\pm$ 0.176 and 1.08 $\pm$ 0.120% respectively. As would be expected, most samples collected at the same station in both July and August provided similar concentrations (Table 4.1). Nevertheless a few notable exceptions to an otherwise uniform distribution of carbon did occur. For example, an August sample from station 112-1 had a total carbon value of only 0.98%. This particular sample, collected from adjacent to the island site, also contained 92.4% sand, far exceeding the quantities at most stations. The other stations adjacent to the island base also provided samples with low carbon content along with high proportions of sand. This phenomenon may have occurred as a result of sand fill barged from Tuft Point for island construction drifting onto these stations. However, low total carbon values were measured in July at 022-3 and in August at 292-3, again correlated with very high sand contents. Since these samples were both 2.0 km from the island site it is unlikely that they were associated with any aspect of island construction. Instead they probably reflect random events in the sediment composition for this part of the Beaufort Sea.

4.3 Biological Data

Appendices III, IV, V and VI contain the complete taxa lists and enumerations from the biological sampling program. The following subsections provide a synopsis of this data.

4.3.1 *Phytoplankton*

Table 4.2 lists the taxa collected in the phytoplankton samples during both July and August. Fifty-five different groups were identified with 49 and 40 occurring in July and August respectively. However, of this diverse assemblage,

TABLE 4.2 PHYTOPLANKTON TAXA COLLECTED IN THE ISSERK F-27 AREA, 1977

PHYLUM	CLASS	ORDER	GENUS - SPECIES	TEMPORAL OCCURRENCE July	August
Cyanophyta	(blue-green algae)		Unidentified	x	x
Chlorophyta	Chlorophyceae (green algae)	Ulotrichales	*Protoderma* (?) sp.	x	-
Chrysophyta	Chrysophyceae (yellow-green algae)	Chrysomondales	*Dinobyron* sp.	x	xx
			Chrysomonas sp.	x	-
	Bacillariophyceae (diatoms)	Pennales	*Achnanthes* sp.	xx	xx
			Actinella sp.	x	-
			Amphipleura sp.	x	-
			Asterionella sp.	x	x
			Centronella sp.	x	-
			Cocconeis sp.	x	-
			Cymbella sp.	x	xx
			Diatoma sp.	x	x
			Epithemia sp.	x	xx
			Eunotia sp.	x	x
			Fragilaria (*Ceratoneis*) *arcus*	-	x
			Fragilaria sp.	x	xx
			Gomphonema sp.	x	x
			Gyrosigma sp.	x	x
			Licmophora sp.	xx	xx
			Navicula gregaria	x	-
			Navicula sp.	xx	xx
			Nitzschia seriata	xx	x
			Nitzschia longissima	-	xx
			Nitzschia sp.	xx	x
			Peronia sp.	x	-
			Rhabdomena sp.	x	x
			Rhaphoneis sp.	x	xx
			Sceletonema sp.	x	-
			Stenoneis sp.	x	x
			Surirella sp.	x	x

PHYLUM	CLASS	ORDER	GENUS-SPECIES	TEMPORAL OCCURRENCE July	August
			Synedra sp.	xx	xx
			Tabellaria fenestrata	x	x
			Tabellaria sp.	xx	x
			Tetracyclus lacustris	-	x
		Centrales	Arachnodiscus	-	x
			Chaetoceros borealis	x	x
			Chaetoceros sp.	xx	x
			Coscinodiscus	xx	x
			Cyclotella	x	-
			Melosira islandica	x	x
			Melosira arctica	x	-
			Melosira sp.	x	x
			Rhizosolenia sp.	-	x
			Stephanodiscus sp.	x	x
Pyrrhophyta	Dinophyceae (dinoflagellates)	Dinokontae	Dinophysis sp.	x	x
			Ceratium sp.	x	-
			Chrysococcus sp.	-	x
Protozoa	Mastigophora (flagellata)		Unidentified	x	x
	Sarcodina	Amoebina	Unidentified	xx	-
		Radiolaria	Unidentified	x	x
	Ciliata		Unidentified	xx	x
		Tintinnida	Unidentified	x	xx
			Unidentified protozoan	x	xx

PHYLUM	CLASS	ORDER	GENUS-SPECIES	TEMPORAL OCCURRENCE July	August
Rotatoria			*Keratella cochlearis*	x	-
			Kellicottia longispina	x	-

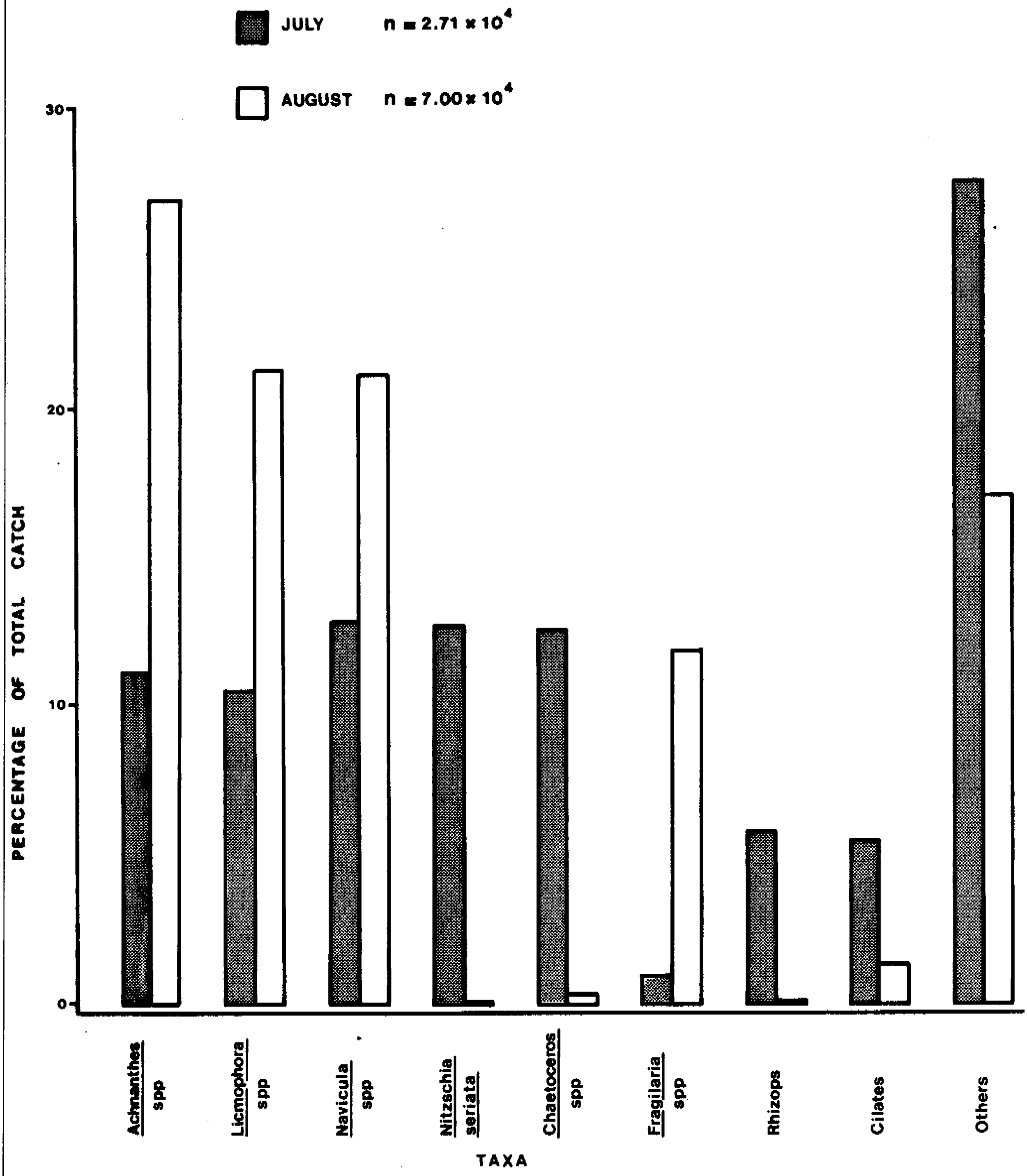
- organism absent

x organism present

xx Organism present at greater than 1% of the total abundance diatoms comprised 70% of the mean abundance in July and increased to 90% in August. When the pennate species *Achnanthes* sp., *Fragilaria* sp., *Licmophora* sp., and *Navicula* sp. were present in samples they dominated the catches (Figure 4.8) but their occurrence was sporadic. On the other hand, the pennate diatoms *Nitzschia seriata* and *Nitzschia* sp., and the centric forms *Chaetoceros* sp. and *Coscinodiscus* sp. were common to all stations in July. August samples contained few centric types and characteristic pennate specimens were *Nitzschia longissima* and *Synedra* sps. Ciliated protozoans were found in all July and August collections, while rhizopods were abundant in July and the yellow-green alga *Dinobryon* sp. frequented many August samples.

The abundance of phytoplankton was highly variable among stations and between sampling periods. After integrating the densities for the three sampling depths at each station, the July mean for all stations was $4.49 \pm 1.048 \times 10^4$ cells/l. (n = 16). Although the number of taxa declined in August, the average abundance increased significantly to $1.23 \pm 0.404 \times 10^5$ cells/l (n=15). The abundance data at each station, as illustrated in Figure 4.9, suggests that in July the largest numbers of individuals usually occurred both at locations immediately adjacent to the island site and along plume transect 292 for up to 2 km. The August results generally supported the trend of densest populations at stations closest to the Isserk site although no similar pattern remained along transect 292. Another characteristic common to both sampling periods was that the southerly and westerly sides of the island site, the predominant direction of the water current in the study area, had

Figure 4.8 : Percentage occurrence of Phytoplankton Taxa in the total catches for July and for August, 1977



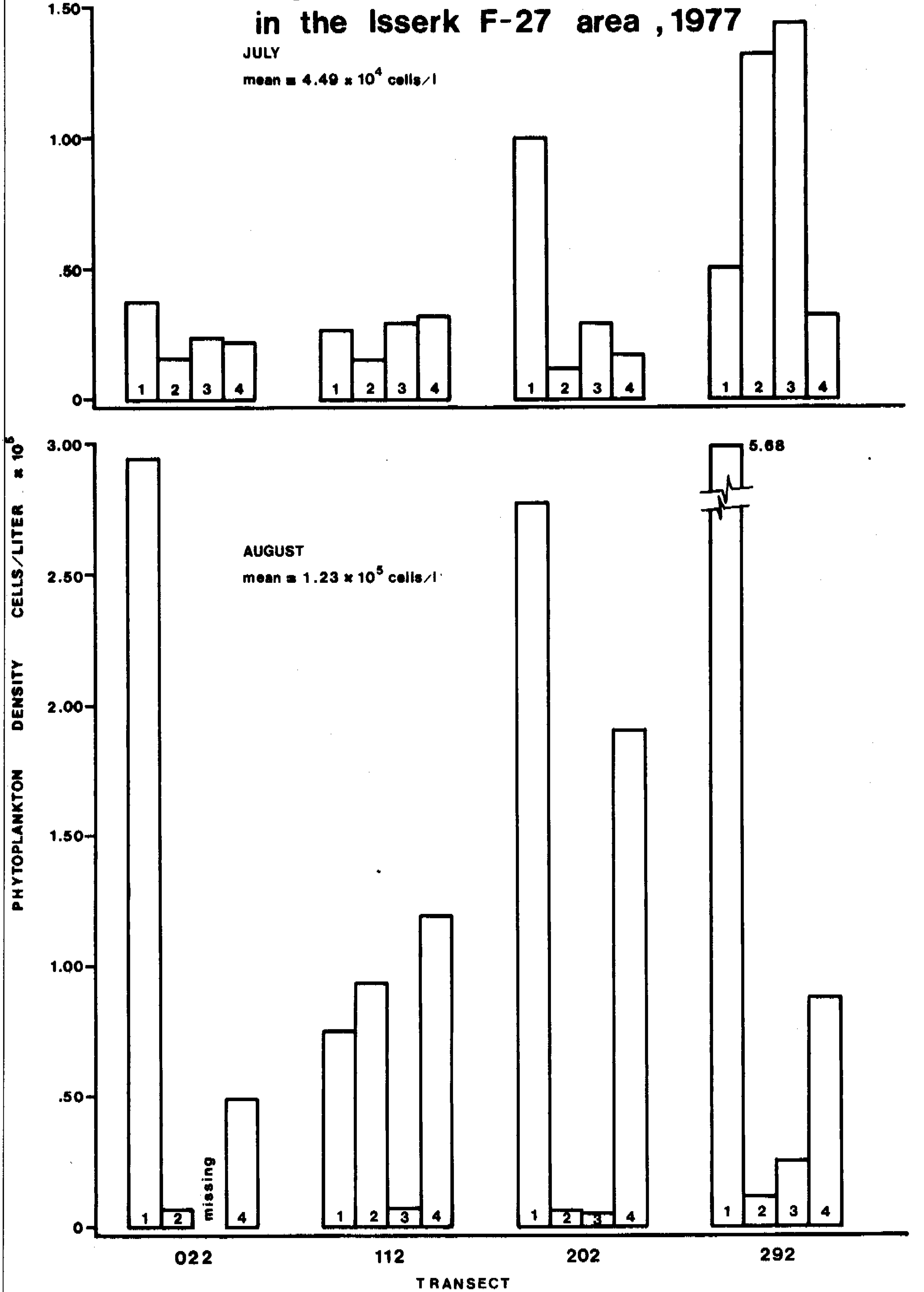


Figure 4.9 : Phytoplankton abundance (cells/liter) in the Isserk F-27 area, 1977

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greater phytoplankton densities adjacent to the island site than on the northerly and easterly sides. While the trends in abundance were visually apparent, statistically they rarely proved significant. Two-way ANOVA's with the abundance data (Appendix III b), having the transects ($F_s = 2.60$; $F_{0.05(3,9)} = 3.86$; $P > 0.05$) and distance ($F_s = 0.532$; $F_{0.05(3,9)} = 3.86$; $P > 0.05$) from the island site as factors, indicated that within factor variance far exceeded the between factor variance in July. In August only the distance factor provided marginal significance ($F_s = 4.55$; $F_{0.05(3,9)} = 3.86$; $P < 0.05$). This occurred because the intermediate distances along all transects tended to have low plankton densities. Since the most distant stations did not sustain this trend it may have simply been a random event rather than indicative of any particular biological phenomenon associated with island construction.

Chlorophyll a values ranged from less than 1 to 9 mg/m^3 for all depths during both sampling periods. Unfortunately, as already mentioned, the analytical technique followed had a sensitivity of only 1 mg/m^3. Therefore, evaluation of standing crop in terms of this parameter is marginal since more than 75% of all samples were below this sensitivity. Still, the few samples containing chlorophyll a above the critical concentration did not follow any consistent relationship with plankton abundance.

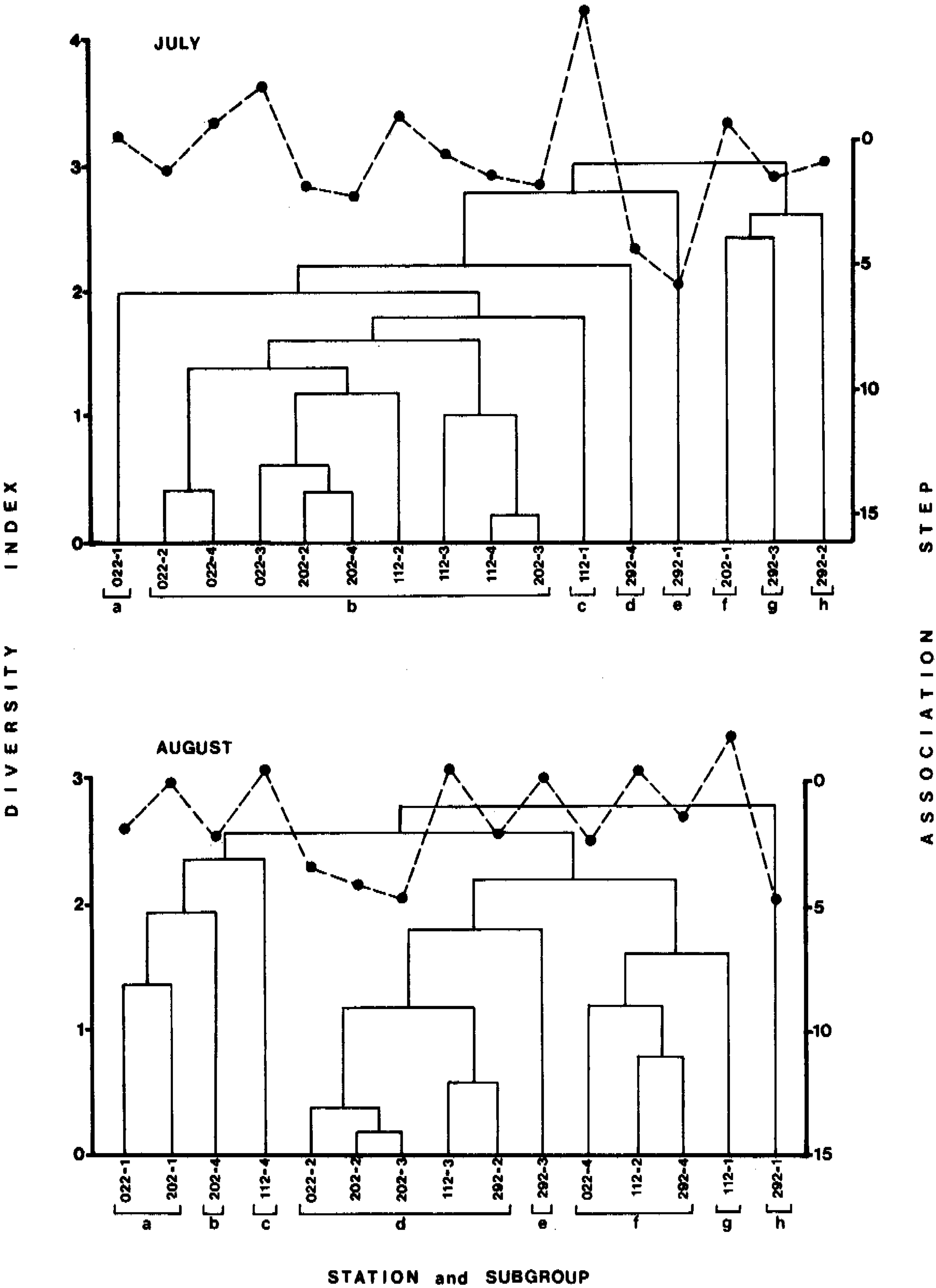
The inverse relation between phytoplankton abundance and number of taxa present between sampling periods was reflected in the Shannon-Wiener diversity indices (Figure

4.10) where the overall mean index was 3.06 and 2.68 in July and August respectively. Index values always exceeded 2.00 and reached a maximum of 4.25 at station 112-1 in July. Furthermore, the equitability index ranged from 0.43 at 292-1 to 0.84 at 112-1 in July with an overall mean value of 0.63 for both sampling periods. Such consistently high index values suggest both a richness in phytoplankton community structure and a reasonable distribution of individuals among the varied taxa, regardless of station location or sampling period.

Characterization of phytoplankton distribution was increased through the use of cluster analysis for the communities at each station (Figure 4.10; Appendix IIIc). Using the middle association step to provide the final groupings, the 16 stations in July formed 8 clusters. The largest of these sub-groups contained all the stations that were not immediately adjacent to the island site and not along the plume transect. These stations had plankton abundance averaging approximately 2 x 10^4 cells/l (Figure 4.9) and they provided samples containing fewer than 30 specimens of *Achnanthes* sp., *Licmophora* sp.and *Navicula* sp.

The remaining 7 groups were composed of the individual stations immediately surrounding Isserk and along the plume transect. With the exception of 122-1, these stations had much greater plankton abundance (i.e. greater than 3.5 x 10^4 cells/l) than did the large group, but sustained individuality through the distribution of this abundance among their taxa. Station 112-1 shared with stations 202-1, 292-2 and 292-3 large numbers of *Achnanthes* sp.

Figure 4.10 : Cluster analysis and diversity indicies for Phytoplankton community composition in the vicinity of Isserk F-27, 1977



Licmophora sp. and *Navicula* sp. Station 292-4 was similar to the large group except for the presence of numerous *Nitzchia seriata*. Stations 022-1 and 292-1 owed their identity to abundant *Tabellaria* sp. and *Chaetoceros* sp. respectively.

Clustering of the August data also formed 8 main subgroups, although in different associations than in July (Figure 4.10) Those stations adjacent to the island site still clustered independently of the others, and had in common to one another an abundance of *Achnanthes* sp., *Fragilaria* sp. and *Navicula* sp. Stations 112-4 and 202-4 similarly had an abundance of all of these except *Licmophora* sp. The largest August subgroup contained a random assortment of stations characterized by densities less than 1.3 x 10^5 cells/l.

The vertical distribution of phytoplankton abundance was highly variable in July. However, abundance was usually greater at a depth of 5 m than at either 1 m below the surface or above the bottom (Table 4.3). This pattern persisted, but was less well defined in August when the mean percentages of the total catch at each station were more alike at all depths. Furthermore, in many cases the greatest abundance was not at 5 m. When *Achnanthes* sp., *Fragilaria* sp., *Licmophora* sp. and *Navicula* sp. were present in samples, particularly in August, the depth at which they occurred provided the largest percentage of the total vertical abundance. These pennate varieties are usually associated with a periphytic nature rather than a planktonic one, yet they occurred at various depths. This depth often corresponded to that which also had the highest concentration of suspended solids.

TABLE 4.3 AVERAGE PERCENTAGE OF THE TOTAL PHYTOPLANKTON CATCHES AT VARIOUS DEPTHS IN THE ISSERK F-27 AREA, 1977

Depth	Percentage ± S.E. July (n=16)	Percentage ± S.E. August (n=15)
1m below surface	35.7± 6.02	30.2± 8.07
5m below surface	42.9± 6.81	37.5± 7.64
1m above bottom	21.3± 5.23	32.4± 8.34

4.3.2 *Zooplankton*

Table 4.4 includes the 54 salt-water taxa collected in both vertical plankton hauls and in the surface trawls. Although the vertical hauls contained most of these taxa, 7 of them composed about 99% of the total catches (Figure 4.11). Of these, polychaete trochophores, and the copepods *Calanus glacialis*, *Pseudocalanus minutus*, *Oithona* sp., copepodids and copepod nauplii were common in both July and August. The July samples also contained large numbers of the copepod *Metridia longa* while August samples abounded with *Oncaea* sp. Furthermore, the relative abundance of copepodids increased almost three-fold from July to August while nauplii dropped to less than half (Figure 4.11).

The collections made with the surface trawls contained only a fraction of the marine taxa found in vertical hauls (Table 4.4). This is not surprising considering the four times coarser mesh in this trawl compared to the vertical gear. However, the trawl catches also included 11 insect taxa of which aphids were common in July samples (Appendix IVb). July collections consisted primarily of *Metridia longa* (95% of total catch) and most August samples contained an abundance of the medusa *Aglantha* sp. (93% of the total catch).

Copepods were by far the most numerous animals in vertical hauls making up 76% and 96% of the total collections from July and August respectively. The remainder of the July catches were mainly polychaete trochophores which comprised larger percentages of the communities at northern stations than those towards the south. For example, station 022-4 had 35.0% trochophores while 202-4 samples included only 1.4% of the larvae. On the other hand,

TABLE 4.4 ZOOPLANKTON TAXA COLLECTED IN THE ISSERK F-27 AREA, 1977

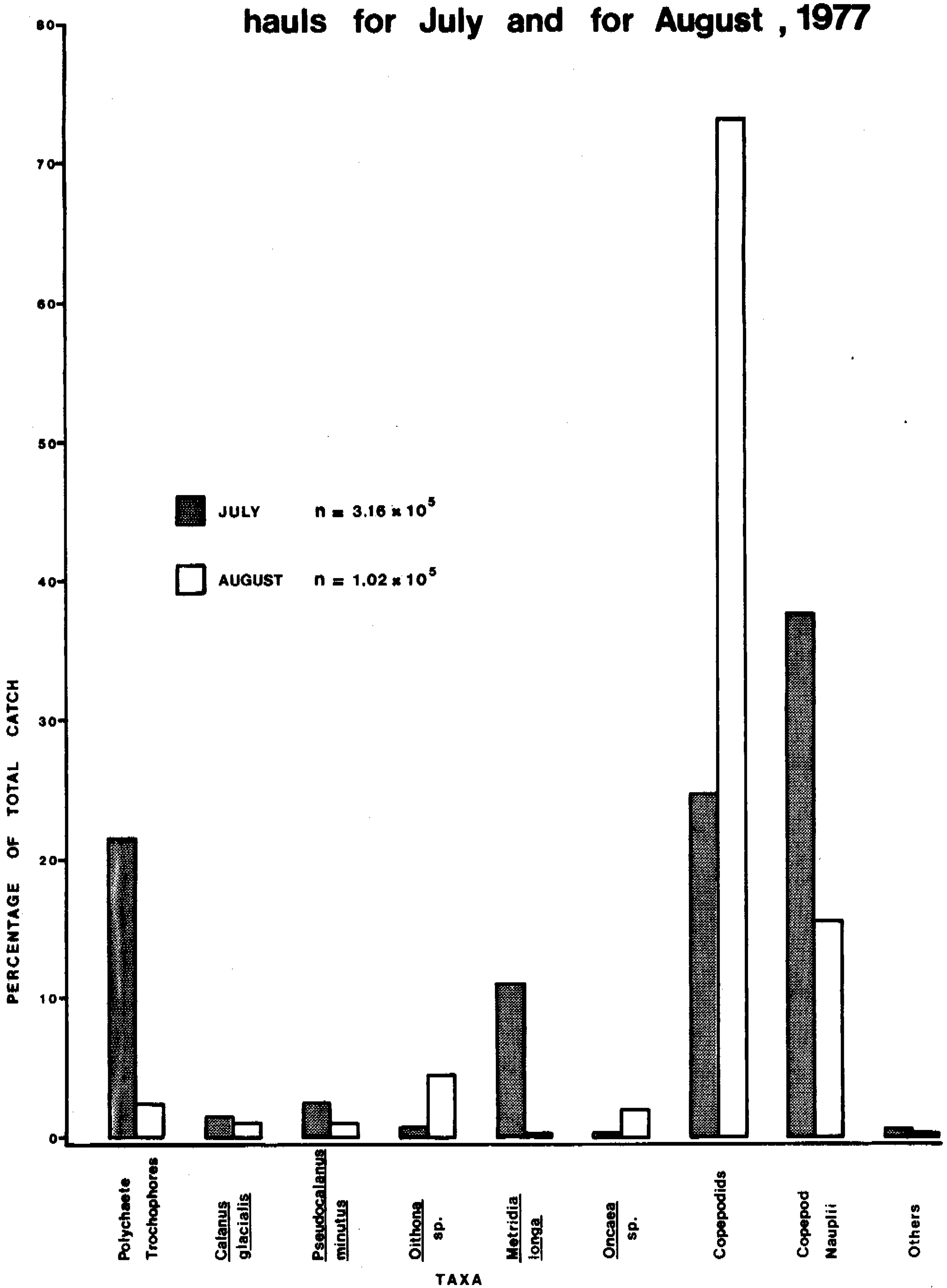
PHYLUM	CLASS OR SUBCLASS	ORDER, SUBORDER OR FAMILY	GENUS - SPECIES	TEMPORAL OCCURRENCE July Vert. hauls	July Surf. tows	August Vert. hauls	August Surf. tows
Protozoa	Rhizopoda	Foraminifera	Elphidiella arctica	x	-	-	-
Coelenterata or Cnidaria	Hydrozoa	Trachylina	Aegina citrea	x	-	x	-
			Aglantha sp.	x	x	x	xx
		Hydroida	Gonionemus vertens	-	-	x	x
			Obelia sp.	x	-	x	x
			Polyorchis karafutoensis	-	-	x	x
			Leuckatiara sp.	x	x	x	x
			Coryne princeps	-	-	x	x
			Laomedia longissima	x	-	-	x
			Corymorpha flammea	-	-	-	x
			Mitrocomella sp.	x	-	-	-
Ctenophora			Dryadora sp.	x	x	x	x
Annelida	Polychaeta	Fam. Spionidae	Unidentified	x	-	-	-
		Unidentified families	Trochophores (polychaeta larvae)	xx	x	xx	-
Mollusca	Pelecypoda		Unidentified	-	-	x	-
	Gastropoda	Thecosomata	Limacina helicina	x	x	x	x
			Limacina sp.	x	x	-	-
		Gymnosomata	Clione sp.	x	x	x	x
		Unidentified orders	veliger larvae (gastropoda)	x	-	-	-

PHYLUM	CLASS OR SUBCLASS	ORDER, SUBORDER OR FAMILY	GENUS - SPECIES	TEMPORAL OCCURRENCE July Vert. hauls	July Surf. tows	August Vert. hauls	August Surf. tows
Arthropoda	Crustacea, sub class Copepoda	Calanoida	Calanus hyperboreus	x	x	x	-
			Calanus glacialis	xx	x	xx	x
			Calanus finmarchicus	-	-	x	-
			Calanus sp.	-	-	x	-
			Metridia longa	xx	xx	x	x
			Metridia lucens	-	-	x	-
			Metridia sp.	x	-	x	x
			Pseudocalanus minutus	xx	x	xx	x
			Eurytemora sp.	x	x	x	-
		Cyclopoida	Oithona sp.	xx	x	xx	-
			Oncaea sp.	x	x	xx	-
		Harpacticoida	Unidentified	x	-	x	-
			Unidentified copepodids	xx	x	xx	-
			Nauplii	xx	x	xx	-
	Crustacea, sub class Branchiopoda	Suborder Cladocera	Podon sp.	x	x	x	-
	Crustacea, sub class Malacostraca	Decapoda, Fam. Pandalidae	Unidentified	x	-	-	-
		Amphipoda Suborder Hyperiidae	Unidentified (Hyperia ? sp)	x	-	x	x

PHYLUM	CLASS OR SUBCLASS	ORDER, SUBORDER OR FAMILY	GENUS - SPECIES	TEMPORAL OCCURRENCE July Vert. hauls	July Surf. tows	August Vert. hauls	August Surf. tows
		Suborder Gammaridea					
		Fam. Lysianassidae	Orchomene sp.	x	x	-	x
			Unidentified	x	-	-	-
		Fam. Calliopiidae	Unidentified	x	-	-	-
		Fam. Oedocerotidae	Oedocerus sp.	x	-	-	-
		Euphausiacea	Euphausia sp.	-	x	-	-
			Unidentified furcilia (larva)	x	-	x	-
	Subclass Cirripedia		Unidentified (barnacle nauplii)	x	x	x	-
	Insecta			-	x	-	-
Sipuncula			Prionglossa sp.	x	-	-	-
Bryozoa			Cyphonaut larvae	x	-	-	-
Echinodermata	Ophiuroidea		Unidentified	-	-	x	-
	Asteroidea		Unidentified	-	-	x	-
Chordata	Larvacea		Oikopleura sp.	x	x	x	-
Chaetognatha			Sagitta sp.	x	-	x	x
	Osteichthyes	Fam. Cottidae (sculpins)	Myxocephalus quadricornis	-	x	-	-
		Fam. Cryptocantodidae (wrymouths)	Delolepis gigantea	-	x	x	x
		Fam. Cyclopteridae (lumpfishes & snailfishes)	Liparis rutteri	x	x	x	-
		Fam. Pleuronectidae (flounders)	Unidentified larval fish	x	x	x	x

\- organism absent
* organism present
** organism present at greater than 1% of the total abundance

Figure 4.11 : **Percentage occurrence of Zooplankton Taxa in the total catches of vertical hauls for July and for August, 1977**



copepodids followed an opposite pattern in July with only 14.5% at 022-4 and 39.3% at 202-4. The percentage occurrence of other taxa among the different stations varied randomly about the mean for July and no trends were apparent among August samples.

The density of zooplankton collected in vertical hauls increased over three-fold from July (overall mean = 3.35×10^4 individuals/m^2) to August (overall mean = 1.09×10^5 individuals/m^2). In addition, inter-station variability was apparent, particularly in August (Figure 4.12). The relatively homogeneous July densities had high values at 022-2 and 292-4, and low ones at 022-1 and 122-2. August densities were especially high at 022-3 and 202-4, with lows occurring randomly among the remaining stations.

Biomass data from vertical hauls, a better estimate of standing crop than abundance, generally reflected the patterns present in the density values (Figure 4.13). The August biomass (overall mean = 21.8 g/m^2) was over twice that in July (overall mean = 9.7 g/m^2), and this difference was statistically significant (t_s = 5.89; df = 91; $P < 0.001$). Furthermore, much of the between-station variability fluctuated similarly for biomass and density data. However, there were some noticeable exceptions. The August density at 202-3 was about average, but the biomass was well below the mean. This was due to a preponderance of small specimens such as copepodids and relatively minor presence of larger taxa such as *Calanus glacialis* and *Pseudocalanus minutus*. On the other hand, the August density at 292-2 was only slightly above average, but the

Figure 4.12 : Abundance (numbers/m²) of Zooplankton collected by vertical hauls in the Isserk F-27 area, 1977

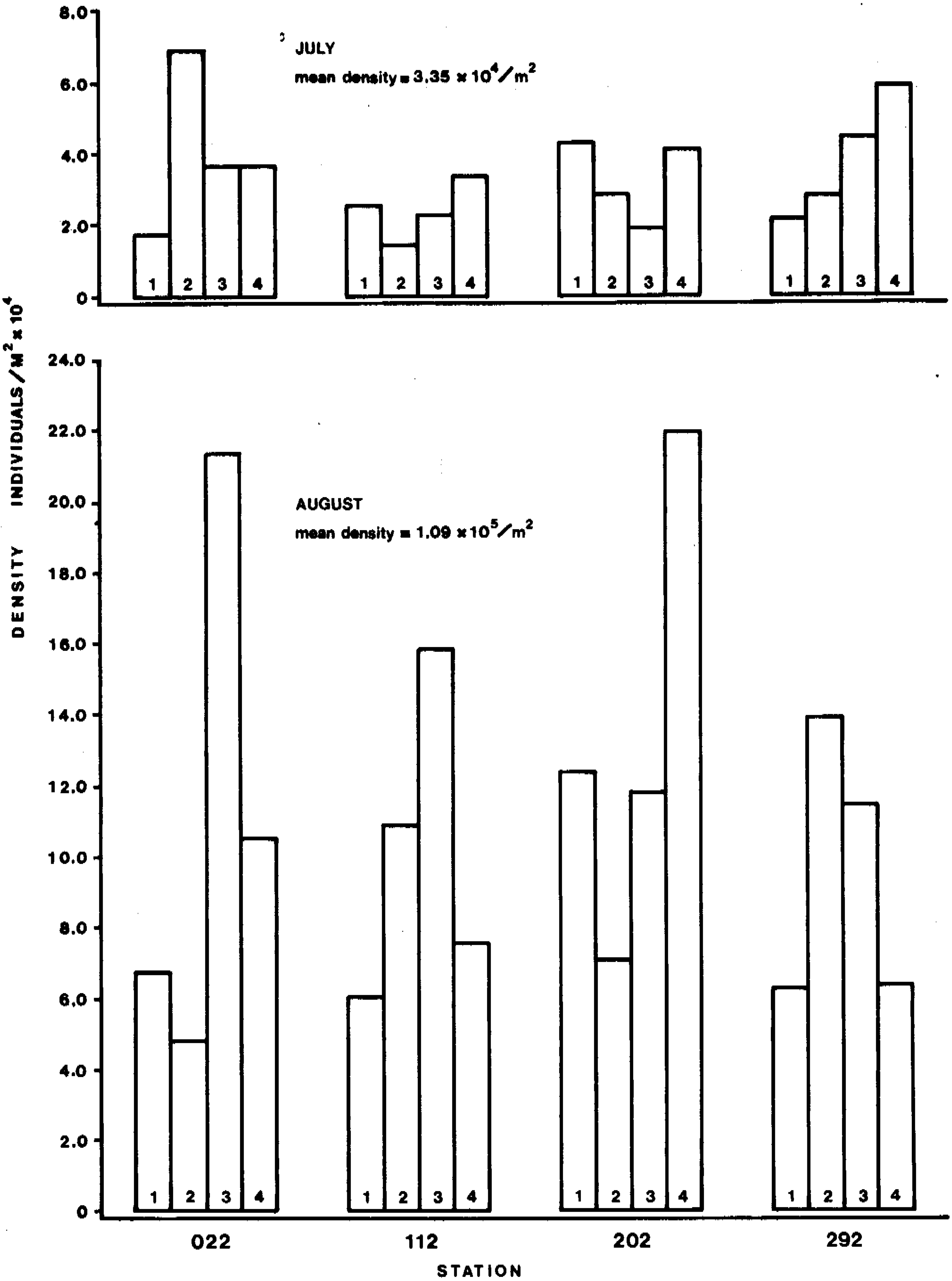
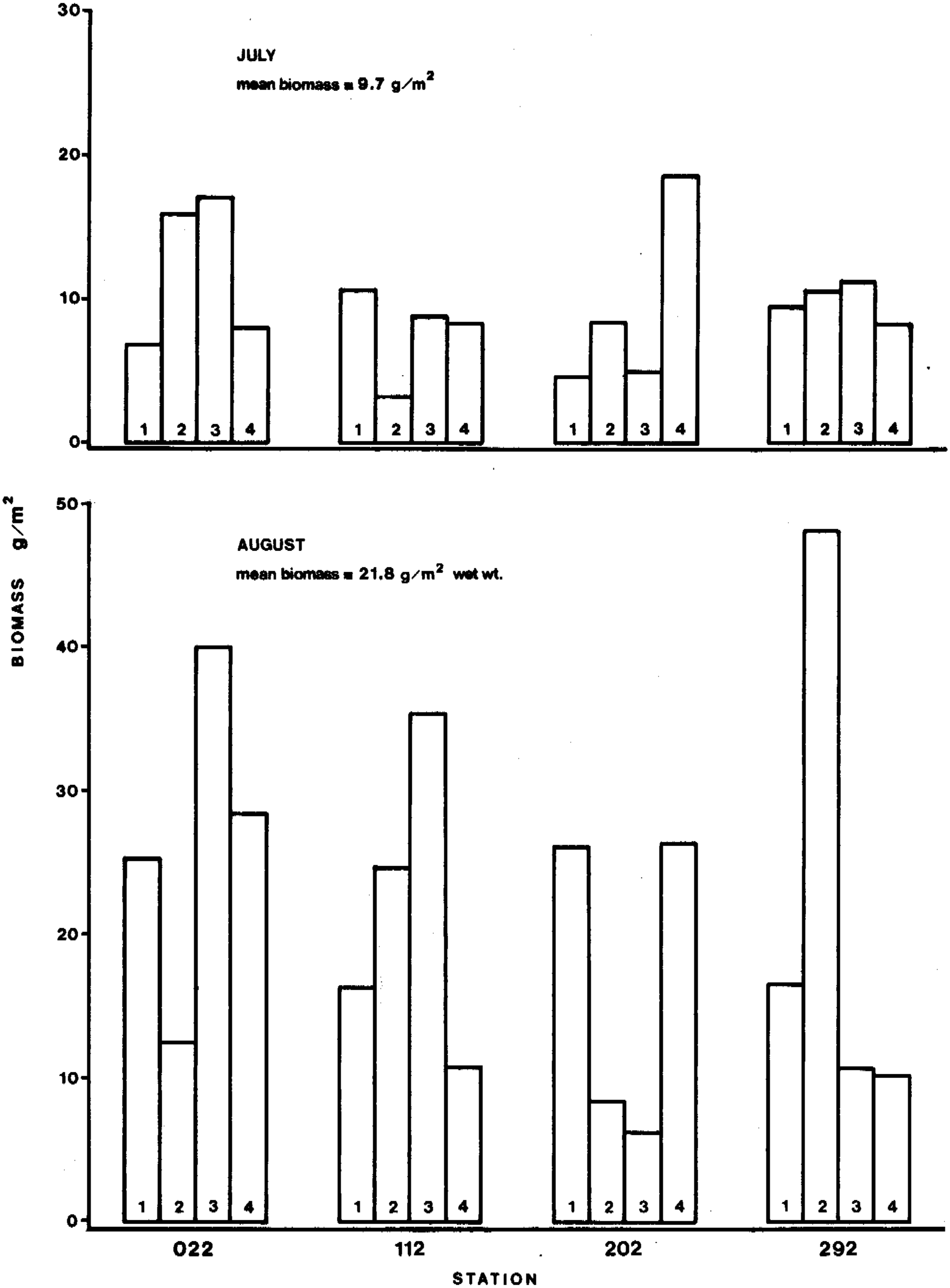


Figure 4.13 : Biomass (wet wt./m²) of Zooplankton collected by vertical hauls in the Isserk F-27 area, 1977



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biomass was over twice the mean. This resulted from the presence of numerous small specimens, as at most other stations, but along with an above average complement of large animals (e.g. *Aglantha* sp.) which contributed substantially to the weight of the total sample.

Figure 4.13 illustrates that substantial differences in mean biomass occurred between stations for both July and August. However, when these differences were examined using a two-way ANOVA (Appendix IVc), with transect location (July F_s = 1.901, August $F_s = 0.821$; $F_{0.05(3,30)} = 2.92$; $P > 0.05$) and distance (July $F_s = 0.868$, August $F_s = 0.141$; $F_{0.05(3,30)} = 2.92$; $P > 0.05$) from the island site as main factors, the differences between stations were not statistically significant for either sampling period. Although there was a significant interaction in August, the total explained variation was not significant. ($F_s = 1.884$; $F_{0.05(15,31)} = 2.01$; $P > 0.05$). This indicates that the variability in biomass for samples at any one station was comparable to that between stations. However, the analysis on the July biomass data indicated that all factors pooled accounted for a significant portion of the variation. ($F_s = 3.012$; $F_{0.01\ (15,30)} = 2.70$; $P < 0.01$). A Student-Newman-Keuls test for comparisons among means (Appendix IVd) was applied to the July data and it indicated that the high values at 202-4 and 022-3 were significantly different from the low at 112-2 ($P < 0.05$). No other differences exceeded the critical Least Significant Range values. Due to the spurious location of the high and low biomass stations there is no reason to suspect any association with island construction activities.

Although the collections made with the surface trawl included some nekton, the majority of the animals were planktonic. However, the relationship between density

(Figure 4.14) and biomass (Figure 4.15) was quite different from vertical haul catches. The July density, averaging 347 ± 139.5 specimens/m^3, was over 30 times that in August (mean = 10.4 ± 2.20). However, the July biomass was substantially smaller (mean = 0.17 ± 0.060 g/m^3) than the August average of 0.94 ± 0.180 g/m^3. This pattern resulted from the great abundance of small *Metridia longa* in July, compared to their general absence in August catches, and the presence of numerous *Aglantha* sp. in August.

The overall mean diversity index for the vertical haul catches dropped from 1.96 ± 0.045 in July to 1.28 ± 0.053 in August (Figure 4.16). Since the equitability index dropped from an average of 0.49 ± 0.012 to 0.32 ± 0.014 for July and August respectively, the decline in the diversity index is at least partially due to a less even distribution of the abundance among the various taxa. Station 202-1 was noteworthy for having the lowest diversity indices during both sampling intervals (July, diversity = 1.49, equitability = 0.40; August, diversity = 0.738, equitability = 0.18).

The clustering of vertical haul data from the various stations (Figure 4.16) provided associations having no particular pattern relative to the Isserk site. Instead the stations which grouped closest together were generally from random locations. July clusters were largely determined by the abundance of trochophores, copepodids and nauplii present at any one station. For example, the grouping from 022-1 to 292-1 encompassed 5 stations where the total catch included fewer than 1,000 trochophores, 5,000 copepodids and 7,000 nauplii. On the other hand, station 292-3, the station that was the most dissimilar to the

Figure 4.14: **Abundance (numbers/m³) of Zooplankton collected by surface trawl in the Isserk F-27 area, 1977**

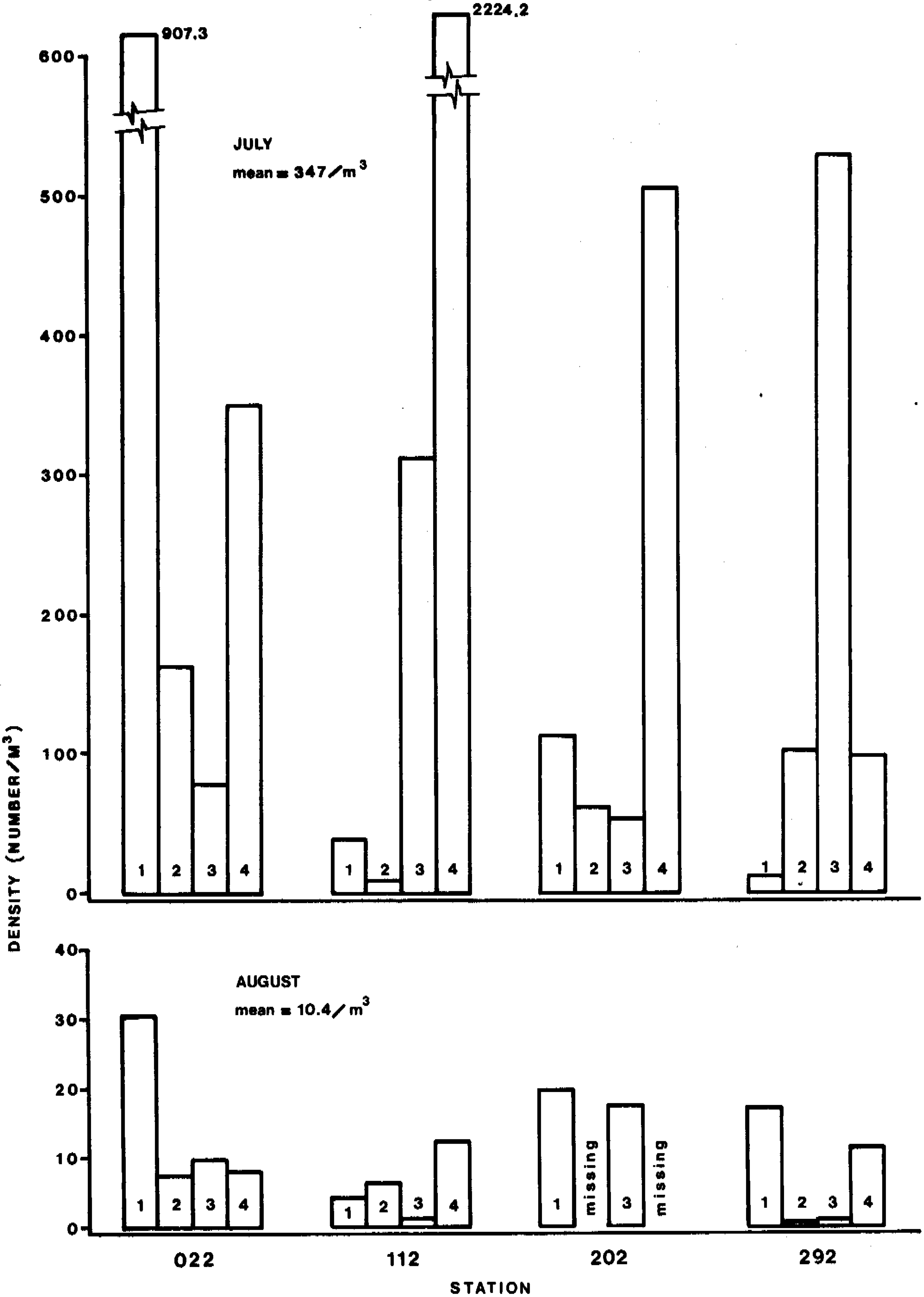


Figure 4.15 : Biomass (wet wt./m³) of Zooplankton collected by surface trawl in the Isserk F-27 area, 1977

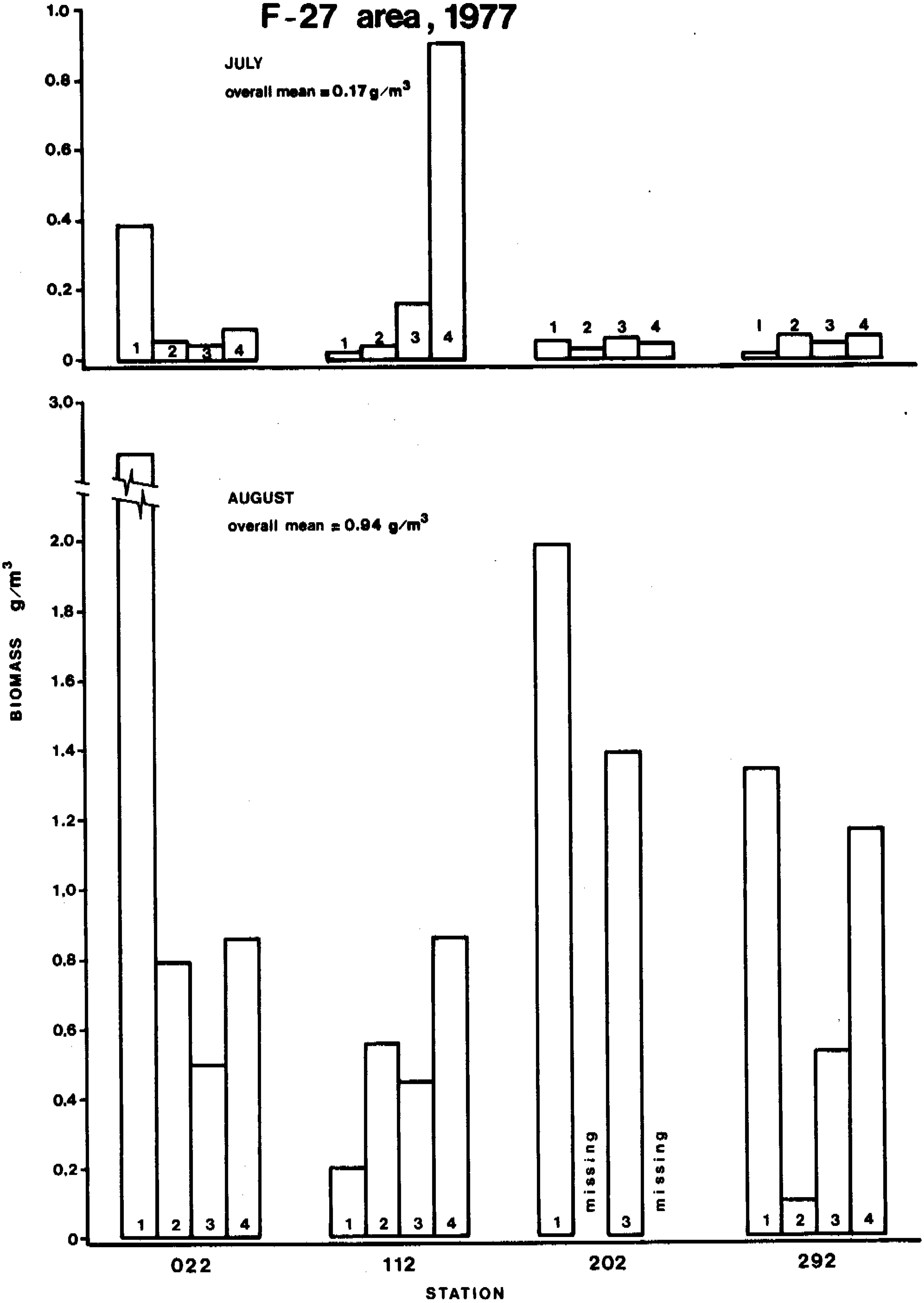
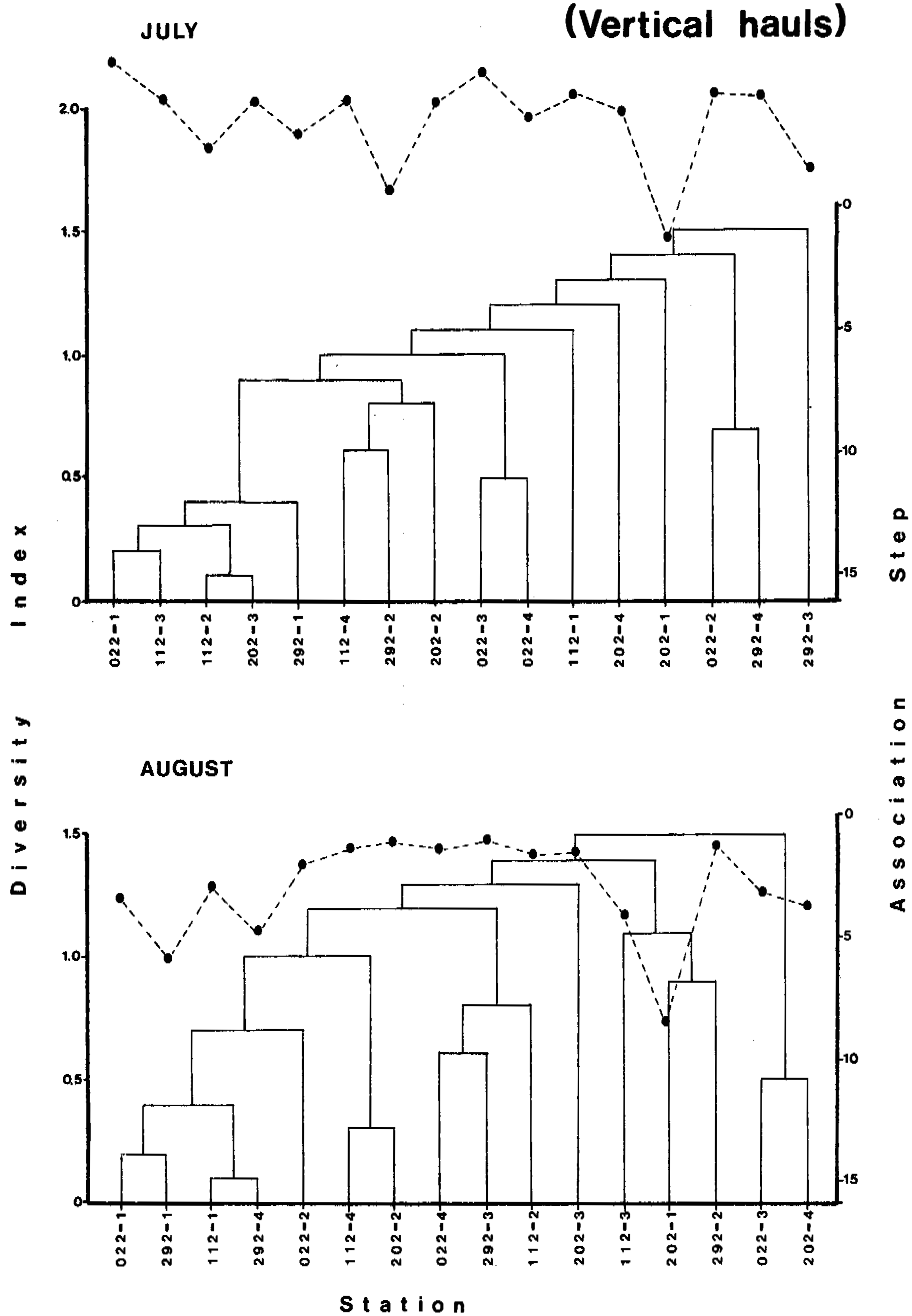


Figure 4.16: **Cluster analysis and diversity indices for Zooplankton community composition in the vicinity of Isserk F-27, 1977 (Vertical hauls)**



above grouping, was unique because of the presence of 15762 trochophores. August groupings were determined primarily by the numbers of copepodids and nauplii present. The grouping to the left of the dendogram (Figure 4.16), 022-1 to 022-2, included stations having less than 6,000 nauplii but 20,000 to 30,000 copepodids. Stations 022-3 and 202-4, to the right of the dendogram, were characterized by large numbers of both copepodids and nauplii (i.e. over 90,000 and 12,000 respectively).

4.3.3 *Benthic Invertebrates*

The benthic invertebrates of the Isserk F-27 area include representatives of 10 phyla consisting of 7 classes and an estimated 79 species (Table 4.5). Combined results from the 16 stations sampled in July and August, 1977, indicate that the polychaetes (segmented worms) with 29 species (37%); the foraminiferans ($CaCO_3$/silica shelled protozoans) with 11 species (14%); the pelecypods (bivalves) with 8 species (10%); the gastropods (snails) with 7 species (9%); the copepods (small crustaceans) with 6 species (8%); and the gammarid amphipods (compressed shrimp-like crustaceans) with 4 species (5%) accounted for about 83% of the total number of species collected. The number of species collected per station declined slightly from a July mean of 28.8$\pm$ 0.85 (n = 16) to an average of 23.0$\pm$ 1.47 (n=15) in August (Figure 4.17).

The foraminiferan *Elphidiella arctica* dominated the benthic fauna, accounting for over 50% of the total catches in July and August (Figure 4.18). Substantially less abundant,but

TABLE 4.5 BENTHIC TAXA COLLECTED IN THE ISSERK F-27 AREA, 1977

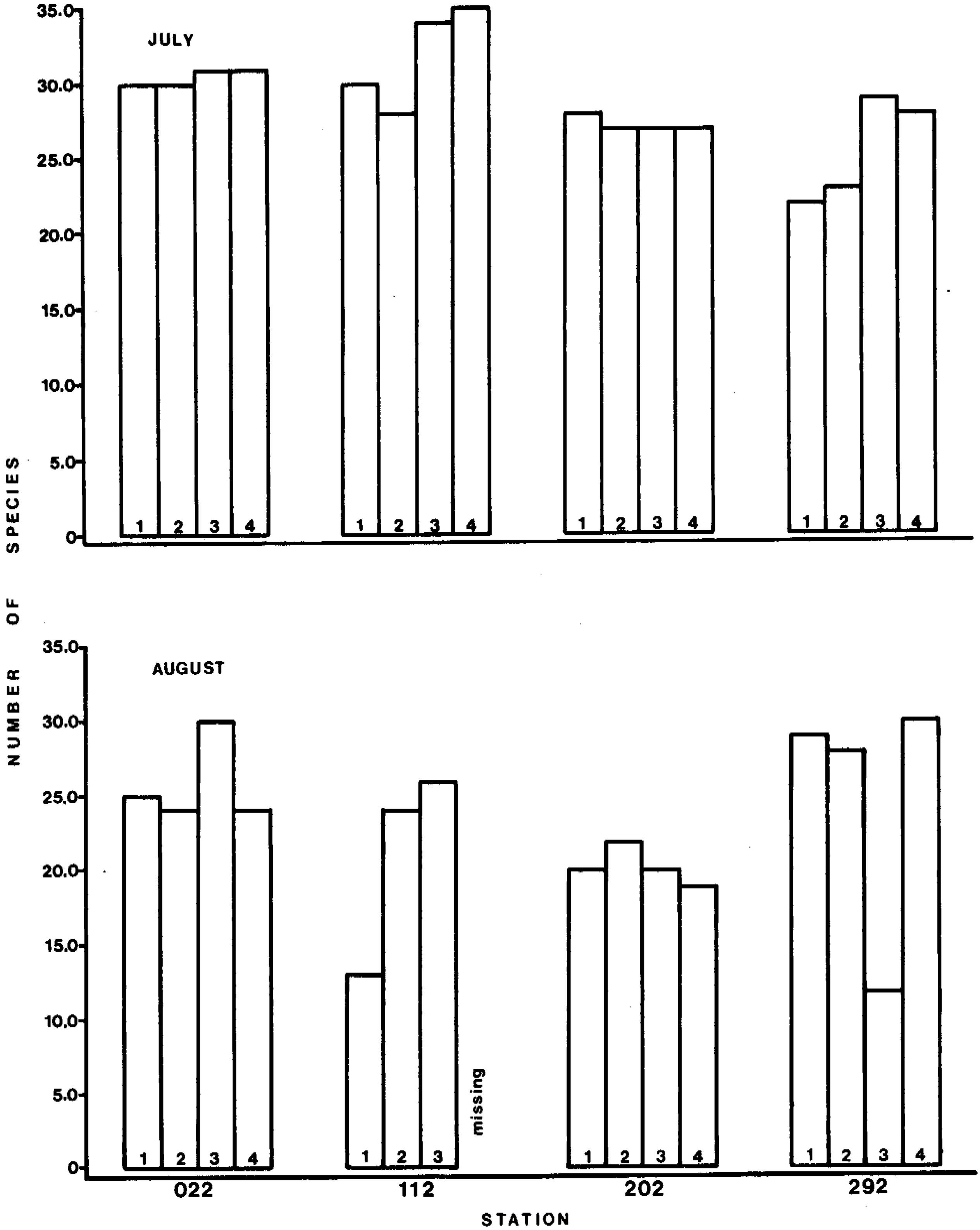
PHYLUM	CLASS OR SUBCLASS	ORDER, SUBORDER OR FAMILY	GENUS - SPECIES	TEMPORAL OCCURRENCE July	August
Protozoa	Rhizopoda	Foraminifera	Elphidiella arctica	xx	xx
			Hippocrepina sp.	x	x
			Cornuspira involvens	xx	xx
			Triloculina sp.	x	x
			Pseudopolymorphina sp.	x	x
			Bulimina auriculata	x	-
			Bulimina sp.	x	-
			Miliammina lata	-	x
			Miliammina sp.	x	x
			Globulimina pacifica	x	-
			Unidentified foramine-feran	x	-
Platyhel-minthes	Turbellaria		Unidentified	x	x
Nemertea			Unidentified	x	-
Nematoda			Unidentified	x	x
Annelida	Polychaeta	Fam. Nepthyidae	Micronepthys sp.	xx	xx
		Lumbrineridae	Lumbrinereis fragilis	x	-
			Lumbrinereis sp.	x	x
		Maldanidae	Praxillella praeter-missa	x	x
			Praxillella sp.	x	-
		Cirratulidae	Cirratulus sp.	xx	xx
			Cossura longicirrata	x	x
		Terebellidae	Thelepus sp.	xx	xx
			Unidentified	x	-

PHYLUM	CLASS OR SUBCLASS	ORDER, SUBORDER OR FAMILY	GENUS - SPECIES	TEMPORAL OCCURRENCE July	August
Arthropoda	Crustacea, Subclass Ostracoda		*Cythereis* sp.	xx	xx
			Loxoconcha sp.	xx	xx
	Subclass Copepoda	Calanoida	*Metridia longa*	xx	x
			Metridia glacialis	x	-
			Calanus hyperboreus	-	x
			Calanus glacialis	x	xx
			Pseudocalanus minutus	-	x
			Unidentified calanoida	x	-
	Subclass Malacostraca	Amphipoda, suborder Hyperiidea			
		Fam Hyperiidae	Unidentified (Hyperia? sp.)	x	-
		Suborder Gammaridea			
		Fam Calliopiidae	Unidentified gammarid	x	-
		Lysianassidae	*Orchomene* sp.	x	x
		Leucothoidae	*Leucothoe* sp.	-	x
		Isaeidae	*Podoceropsis* sp.	x	-
		Cumacea	*Diastylopsis* sp.	x	x
			Unidentified cumacean	x	-
		Euphausiacea	Unidentified (*Euphausia*? sp.)	x	-
		Isopoda	*Saduria entomon*	x	x
		Tanaidacea	*Leptognathia* sp.	x	x
Sipuncula			Unidentified	x	x
Priapulida			*Priapulus* sp.	x	x
Bryozoa	Gymnolaemata	Ctenostomata	*Buskia* sp.	x	x

- organism absent
x organism present
xx organism present at greater than 1% of the total abundance

PHYLUM	CLASS OR SUBCLASS	ORDER, SUBORDER OR FAMILY	GENUS - SPECIES	TEMPORAL OCCURRENCE July	August
		Spionidae	*Prionospio malmgrenis*	x	-
			Prionospio sp.	xx	xx
			Spio filicornis	x	-
			Spio sp.	x	-
			Nerinides sp.	x	-
		Capitellidae	*Capitella capitata*	x	x
		Orbiniidae	*Scoloplos armiger*	xx	xx
			Scoloplos sp.	x	-
		Flabelligeridae	*Flabelligera affinis*	x	x
		Dorvilleidae	*Protodorvillea gracilis*	x	-
			Protodorvillea sp.	x	x
		Ampharetidae	*Ampharete acutifrons*	x	-
			Asabellides sp.	x	-
		Polynoidae	*Antinoe sarsi*	x	x
		Phyllodocidae	*Eteone barbata*	x	-
		Pectinariidae	*Pectinaria hyperborea*	-	x
			Pectinaria sp.	x	-
		Opheliidae	Unidentified	x	x
		Ariciidae	Unidentified	x	-
		Paraonidae	Unidentified	x	-
Mollusca	Gastropoda		*Diaphane* sp.	xx	x
			Admete sp.	x	x
			Neptunea sp.	x	-
		Gymnosomata	*Retusa obtusa*	xx	xx
			Clione sp.	x	x
		Thecosomata	*Limacina helicina*	x	-
			Unidentified gastropod	x	-
	Pelecypoda		*Portlandia yoldiella*	xx	xx
			Pandora glacialis	x	x
			Axinopsida sp.	x	x
			Cardita crebicostata	x	-
			Cardita ventricosa	-	x
			Macoma moesta	x	x
			Lucinoma sp.	x	x
			Unidentified pelecypod	x	-

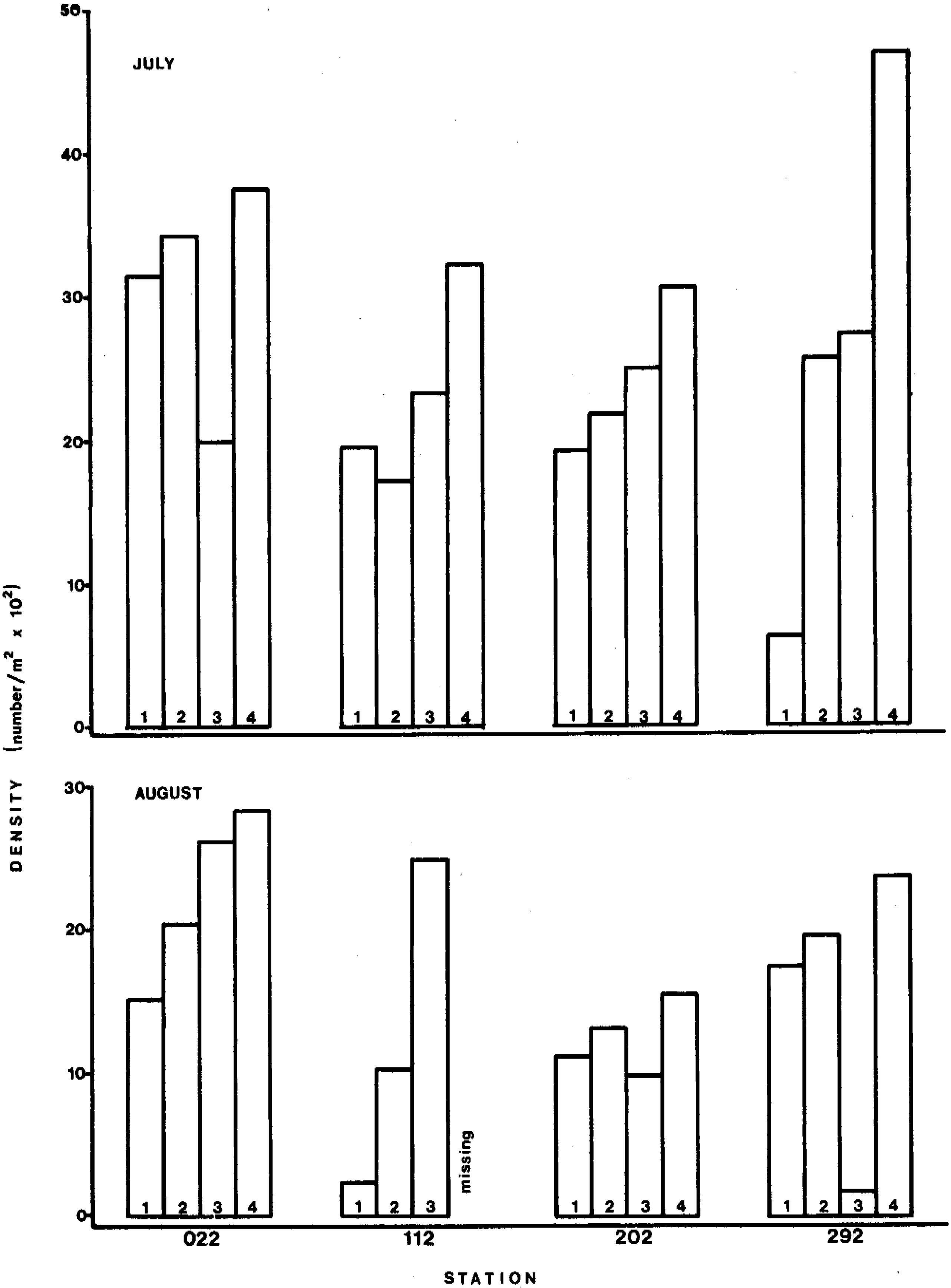
Figure 4.17 : **Spatial variation in total number of Benthic species in the Isserk F-27 area during July and August, 1977**



still very common in both months were the polychaete *Micronepthys* sp., the gastropod *Retusa obtusa*, and the two ostracods *Cythereis* sp. and *Loxoconcha* sp. The copepods *Metridia longa* and *Calanus glacialis* were abundant only during one of the two sampling intervals when each accounted for over 6% of the catches for July and August respectively. The average density of benthic invertebrates for the combined stations was greater in July, with a mean of 2618± 236.2 (n=16) individuals/m^2, than in August which averaged only 1606± 209.4 (n=15) individuals/m^2. Spatial variations in density for each month are shown in Figure 4.19. Relatively low densities (624-2000/m^2) in July at stations 022-3, 112-1, 112-2, 202-1 and 292-1 were associated with very low numbers of the foraminiferan *E. arctica*. In addition, there was a decreased abundance of the ostracods *Cythereis sp.* and *Loxoconcha sp.* at station 022-3 and of all benthic species at station 292-1. The low densities at stations 022-3, 202-1 and 292-1 may be related to the unusually high proportions (87% to 98%) of sand at these stations and the corresponding low values for total carbon and total organic carbon (see Appendix II; Table 4.1).

The high densities (3000/m^2) shown in Figure 4.19 were almost invariably associated with the numerical abundance of *E. arctica*, although high numbers of the polychaete *Micronepthys sp.*, the pelecypod *P. yoldiella*, and the copepod *M. longa* at station 022-4; of *P. yoldiella* at station 112-4; and of the ostracods *Cythereis sp.* and *Loxoconcha sp.* at station 202-4 also contributed to high densities. A trend of increasing density from the near island stations to the distal stations occurred at all four

Figure 4.19 : **Abundance (number/m²) of Benthos collected in the Isserk F-27 area, 1977**



transects. The only aberrant data point was the low density at station 022-3, where a high proportion of sand was found; an unusual event for a station so distant from the island site. Although it is possible that observed low densities at proximal stations are associated with dredging/filling activities near the island, it would be premature to make such a conclusion with the existing data.

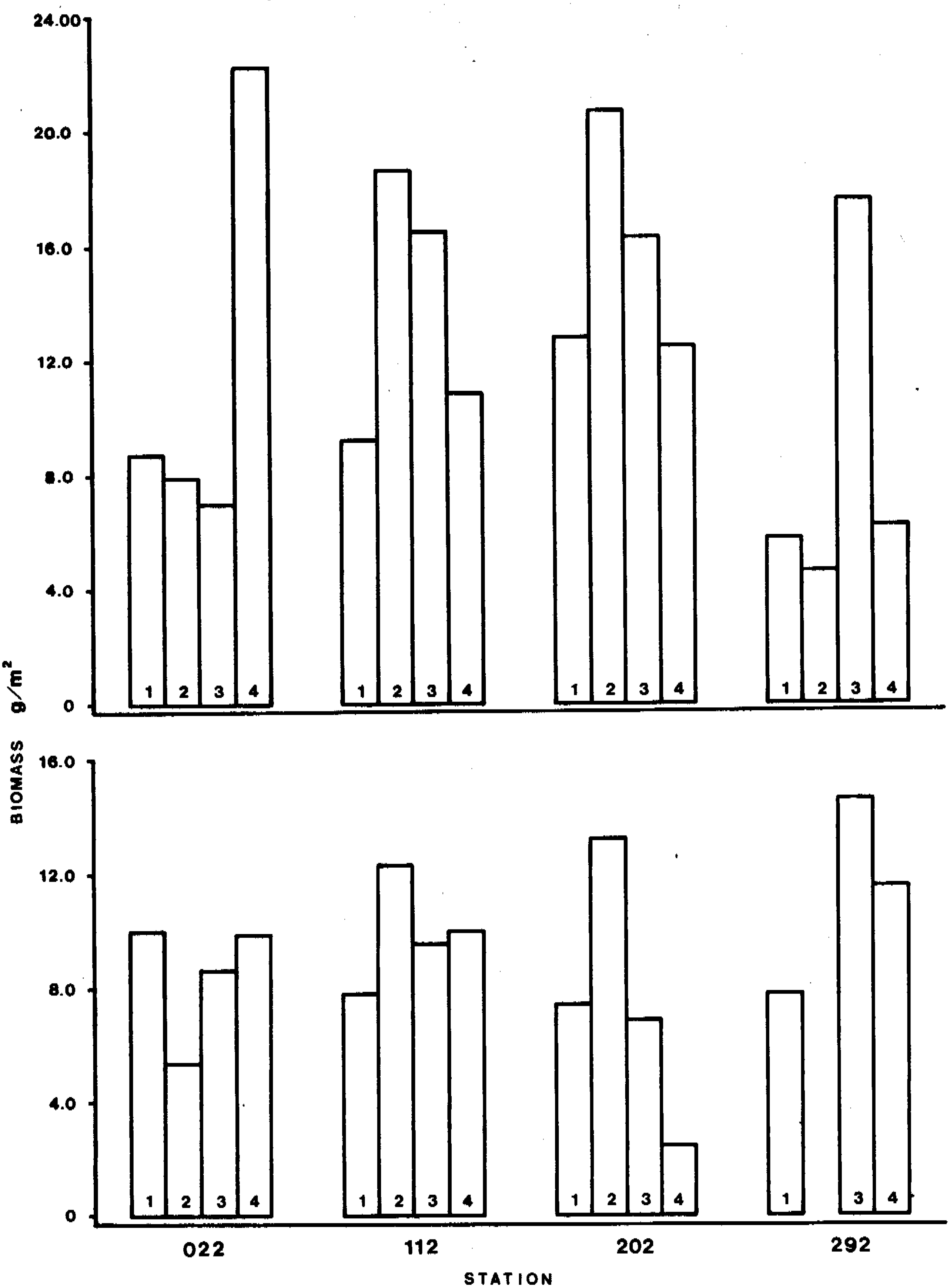
Relatively low benthos densities (196-992/m^2) in August at stations 112-1, 202-3, and 292-3 (Figure 4.19), as with the July samples, were associated with less abundant *E. arctica*, although there was also a significant reduction in all species at station 292-3. Furthermore, similar to July, the extremely low values at stations 112-1 and 292-3 in August were associated with high proportions (92% - 98%) of sand and the low total carbon and total organic carbon. High densities (>2000/m^2) shown in Figure 4.19 were also related to the abundance of *E. arctica* , but high numbers of pelecypods also contribute to high densities. The trend of increasing density with increasing distance from the island that was observed in the July data (Figure 4.19), is also present in August for all four transects. However, despite the occurrence of this "trend" in both sets of data, it is not possible to confirm this pattern since some of these data points digress from the trend.

Mean wet biomass for all July stations was 12.4 $\pm$ 1.42 g/m^2 (n=16) which was about 30% greater than the average of 9.1 $\pm$ 0.80 g/m^2 (n=15) in August. This pattern is consistent with the higher benthos densities observed in July. Analysis of the faunal composition among stations clearly indicated that greater abundance of the bivalve *P. yoldiella* in July than in August was the cause of this biomass pattern. However, comparison of wet biomass means for July and August by student's t-test showed no statistically significant difference between the months (t_s = 0.872, df = 153; $P > 0.05$).

Figure 4.20 illustrates that there was considerable variation in benthic biomass among stations for both July and August. However, when these variations were examined using a two-way ANOVA (Appendix Vb), with transect location (July $F_s = 1.258$; August $F_s = 0.443$; $F_{0.05\ (3,60)} = 2.76$; $P > 0.05$) and distance from the island site (July $F_s = 1.256$; August $F_s = 0.886$; $F_{0.05\ (3,60)} = 2.76$; $P > 0.05$) as the main factors, these differences were not significant for either sampling period. Similarly, all factors pooled did not account for a significant portion of the variation (July $F_s = 1.558$; August $F_s = 0.756$; $F_{0.05\ (14,60)} = 1.86$; $P > 0.05$). High biomass values generally reflect the relative abundance of large individuals of such taxons as bivalve molluscs (*P. yoldiella*), copepods (*M. longa*) and polychaeta worms (*Micronepthys sp.* and *Thelepus sp.*).

Shannon-Weiner diversity indices, which take into account the abundance of individuals as well as the number of taxa, had overall means of 2.7± 0.14 (n=16) and 2.7 ± 0.10 (n=15) for July and August respectively.

Figure 4.20: Biomass (wet wt./m^2) of Benthos collected in the Isserk F-27 area, 1977



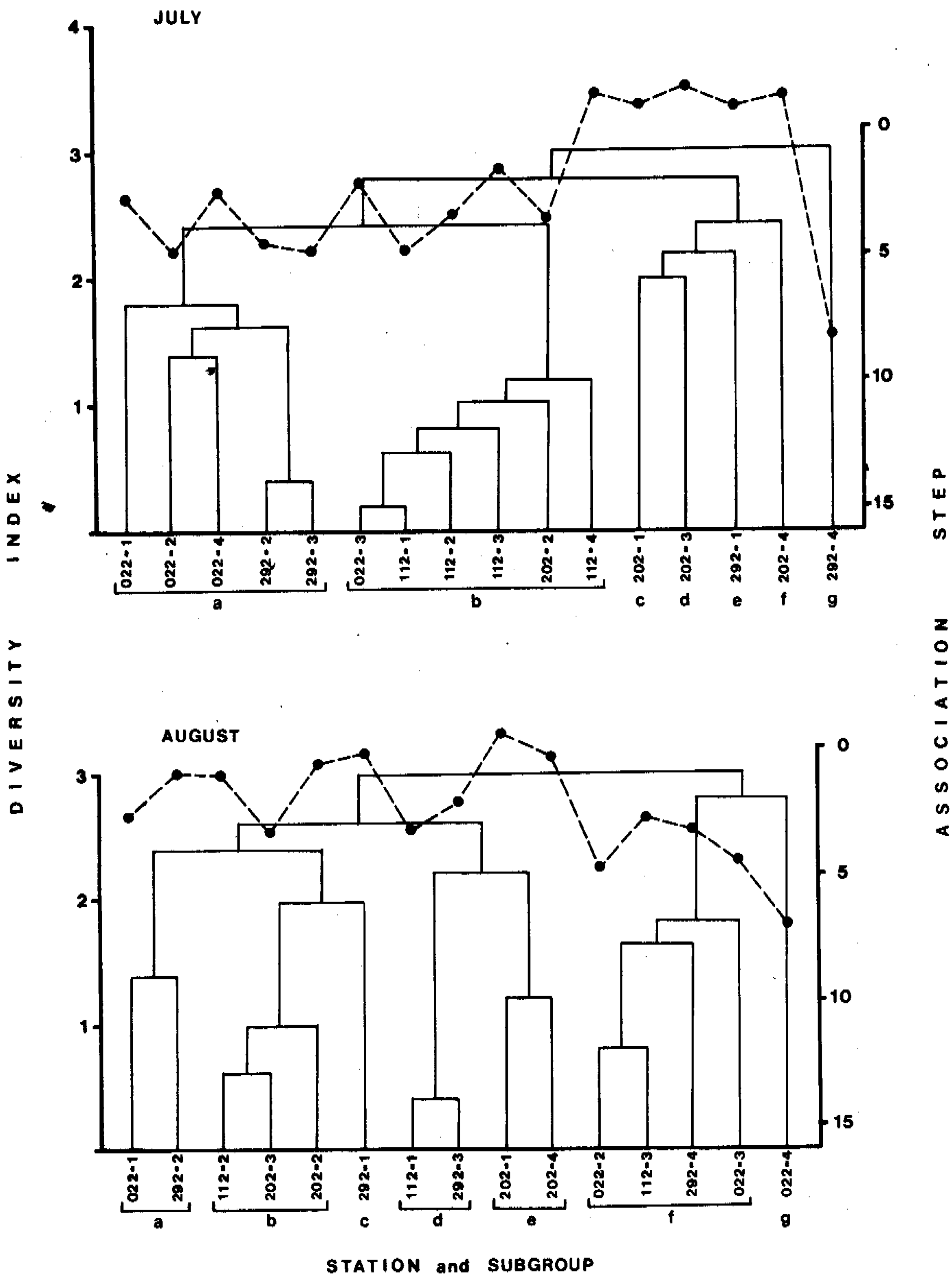
envirocon

Furthermore, overall mean equitability indices for July and August were 0.56 ± 0.029 and 0.57 ± 0.029 respectively. Such comparable values suggest no significant change in community structure between sampling periods and the consistently high indices indicate both a richness in benthic invertebrate community structure and a reasonable distribution of individuals among the varied taxa. However, there was considerable variability in the diversity indices among stations during each sampling month (Figure 4.21). Index values generally exceeded 2.00 and reached a maximum of 3.5 at station 202-3 in August. Transect 202 stations generally had the highest diversity values during July and August with mean index values of 3.1± 0.23 and 2.99± 0.16 (S.D. = 0.32) respectively.

The apparent pattern of increasing density at increased distances from the island site that was observed for all transects in July and August was also reflected by the Shannon-Weiner diversity values for transect 112 for July. This pattern is related to a larger number of taxa, and to large increases in numerical abundance of such species as *E. arctica, P. yoldiella, Micronepthys sp.* and *Loxoconcha sp.* However, the inverse relationship was apparent for transect 292 during July and August, with higher diversity occurring near the island site.

Benthic invertebrate associations were characterized using a cluster analysis of the distribution of number of taxa and number of individuals among stations for each month (Figure 4.21; Appendix V_c). This analysis showed no pattern in relation to distance from the island. For

Figure 4.21: Cluster analysis and diversity indicies for Benthos community composition in the vicinity of Isserk F-27, 1977



example, using the sixth association step to obtain the sub-groupings, the 16 stations in July formed 7 individual clusters. The largest of these clusters (b) contains all stations from transect 112 plus stations 022-3 and 202-2. These stations were characterized by samples with a similar number of species and similar numbers of the foraminiferan *E. arctica* (290 - 310 individuals). Diversity index values were also alike, ranging from 2.2 to 2.9. The next largest cluster (a) contained 3 stations from transect 022 (1, 2 and 4) plus 2 stations from transect 292 (2 and 3). These stations all had intermediate numbers of *E. arctica* (400 - 550). The remaining 5 clusters each contained one station. Although clusters c, d, e and f all had high diversity values, they still grouped independently; cluster c had extremely low numbers of *E. arctica* (28) and a relatively high abundance of the copepod *M. longa* (123); cluster d had relatively low numbers of *E. arctica* but very high abundance of the mollusc *P. yoldiella;* cluster e is characterized by a very low abundance of all species; and cluster f had low numbers of *E. arctica*. Cluster g (Station 292-4) has abundant *E. arctica* (900) and an extremely low diversity.

As with the July clusters, the August associations show no pattern in relation to distance from the island site, but different stations clustered in August. Again using the sixth association step to obtain the sub-groupings, a total of 7 clusters resulted. These clusters were largely determined by the numerical abundance of *E. arctica*. For example, cluster g is comprised of station 022-4 which was dominated by this foraminiferan species (519) and also had the lowest diversity of all stations. Cluster d (stations

112-1 and 292-3) on the other hand had the lowest abundance of *E. arctica* (6 - 9), although it is characterized by very low numbers of all species. Stations 202-1 and 202-4 of cluster e are characterized by very high diversities, low numbers of *E. arctica*, and a substantially greater abundance of the polychaeta *Micronepthys sp.* The largest cluster, f, is characterized by generally lower diversities and high numbers of *E. arctica* as well. Very high numbers of the copepod *C. glacialis* and the polychaete *Micronepthys sp.* account for the individual grouping of station 292-1 in cluster c.

4.3.4 *Fish*

A total of 6 species were captured by gillnets in the Isserk F-27 study area during July and August, 1977 (Table 4.6). Common and generic names of these are presented in Appendix VI along with the catch data. The anadromous Arctic cisco numerically dominated the catch with 19 individuals sampled in July (90.5%) and 2 netted in August (40%). Only 1 example of each of the remaining 5 species was sampled during the study. A total of 21 fish were sampled in July, compared to a catch of only 5 fish in August. The majority of these specimens were mature adults greater than 4 years. However, the one Arctic cod that was collected was immature (1 year) and the single Arctic char was only 2 years.

A total of 13 fish stomachs were examined and the relative importance of various invertebrate organisms is presented in Table 4.7. The marine gastropod *Limacina helicina* occurred in the most stomachs, but copepods, amphipods and euphausiids were also common food items. From these data, it appears that benthic invertebrates were the most common food items.

TABLE 4.6: NUMERICAL ABUNDANCE AND PERCENT TOTAL COMPOSITION OF THE TOTAL GILLNET CATCH FROM ISSERK F-27 AREA, 1977

Sample Station	Arctic Cisco	Arctic Char	Arctic Cod	Fourhorn Sculpin	Least Cisco	Bartail Snailfish
July						
022-3	-	-	-	-	-	-
022-4	-	-	-	1	-	-
112-3	8	-	-	-	1	-
112-4	-	-	-	-	-	-
202-3	5	-	-	-	-	-
202-4	5	-	-	-	-	-
292-3	-	-	-	-	-	-
292-4	1	-	-	-	-	-
TOTAL	19	-	-	1	1	-
PERCENT	90.5	-	-	4.8	4.8	-
August						
022-3	-	-	-	-	-	-
022-4	-	-	-	-	-	-
112-3	1	1	-	-	-	-
112-4	-	-	-	-	-	-
202-3	-	-	1	-	-	-
202-4	-	-	-	-	-	-
292-3	-	-	-	-	-	-
292-4	1	-	-	-	-	1
TOTAL	2	1	1	-	-	1
PERCENT	40	20	20	-	-	20
TOTAL CATCH	21	1	1	1	1	1
PERCENT	80.8	3.8	3.8	3.8	3.8	3.8

TABLE 4.7 FREQUENCY OF OCCURRENCE OF VARIOUS FISH FOOD ORGANISMS, 1977

Fish Food Organism	Number of Fish Stomachs
Polychaeta	2
Gastropoda	11
Pelecypoda	1
Copepoda	4
Gammaridea	4
Euphausiacea	4
Tunicata	1
Homoptera (Terrestrial insect)	1
Empty	1

Although rare in occurrence, larval fishes were also captured in the surface trawl. Seven larvae of the giant wrymouth (*Delolepis gigantea*) were collected in August, and 2 pleuronectiformes (flatfish) larvae were sampled in July. In addition, 1 Cottidae (sculpin) larva and about 6 unidentified larval specimens were collected.

5.0 DISCUSSION

5.1 Physical Data

5.1.1 *Climatology*

Berry et al. (1975) analyzed 10 to 15 years of climatic data collected at various shore-based weather stations around the south Beaufort Sea. They found that wind velocities were usually light from June through August. However, wind speeds in excess of 50 km/hr did comprise 4% of the August velocities. Certainly, the velocities during the Isserk study were low most of the time. The exception was during the late August storm when galeforce winds were encountered. Speeds up to 70 km/hr from the northwest were recorded at Tuktoyaktuk on August 27 (Bristow, 1977). This compares with the 80 km/hr winds noted at Isserk.

5.1.2 *Temperature and Salinity Profiles*

Vertical stratification during the summer is a common feature of the water temperature and salinity on the shelf of the Beaufort Sea (Herlinveaux and de Lange Boom, 1975). Profiles measured near the Isserk block in early September, 1976 (Owens, 1976) were highly stratified, as observed in July, 1977. However, surface to bottom data were homogeneous in August, 1977. Profiles near Arnak L-30 taken in 1976 had similar temporal changes to the 1977 Isserk findings, with little apparent stratification by late August. The variability both seasonally and geographically is largely a function of Mackenzie River discharge, winds and air temperature.

Monitoring at the Arnak site indicated that hydraulic dredging caused sufficient surface and bottom water mixing to disrupt the normal July stratification within the discharge plume (MacDonald and Cambers, 1977). A similar effect was not detected at Isserk F-27.

5.1.3 *Water Currents*

North of the continental shelf the ocean currents flow westward at 0.01 to 0.05 m/sec. in accordance with the clockwise Beaufort Gyre (Herlinveaux and de Lange Boom, 1975). However, on the continental shelf the currents are varied and less predictable. This is apparent when one compares results from the present study with those collected during 1976 in the Arnak L-30 area (MacDonald and Cambers, 1977). Both investigations observed similar velocities throughout the water column, but surface currents were usually in near opposite directions.

A study during the summer of 1974 (MacNeil and Garrett, 1975) indicated that distinct circulation patterns exist on the shelf under different wind conditions. When the wind is easterly then the surface current north of Pullen Island flows to the west at 0.03 to 0.5 m/sec. Following northwest winds the current still maintains a west to northwest direction. Such wind and surface current directions match those observed in the Isserk area during 1977 when the velocity averaged 0.26 m/sec. However, MacNeil and Garrett (1975) also noted that during northwest winds the surface current shifts to an easterly direction, as was observed at Arnak L-30 in 1976. Therefore, the surface currents, which are chiefly wind driven, will be highly variable anywhere on the shelf. As a result, non-continuous current monitoring will not necessarily reflect the predominant current patterns. Still, a review of 1977 climatological data collected at Tuktoyaktuk Airport (Bristow, 1977) indicated that July winds were almost always from an easterly direction. Therefore, the westerly surface current observed around Isserk at the end of July was probably typical of the entire month. On the other hand, August wind directions at Tuktoyaktuk were from northerly directions about a third of the time. Thus, August surface currents in the Isserk area may have followed directions other than those observed at the end of that month.

Huggett et al. (1975) examined bottom currents in the south Beaufort Sea and found that they usually flowed in an easterly direction,as was noted in the present study. For example, one 1975 station located just north of the Isserk block had bottom currents with an average velocity of 0.5 cm/sec towards 159°T. Such velocities were more than twice those recorded in 1977 for the Isserk area. Since bottom currents are sensitive to wind speeds but not wind direction (Huggett et al.,1975), the lower 1977 speeds may simply reflect the prevailing climatic conditions during this study.

5.1.4 *Discharge Plume, Suspended Solids and Water Transparency*

The direction of the turbidity plume at Isserk F-27 correlated with that of the surface current directions. Monitoring at Arnak L-30 also detected a similar response (MacDonald and Cambers, 1977). Although the plume direction was westerly at Isserk during the two study intervals, that at Arnak underwent substantial direction changes ranging from northwest to southeast. If similar changes characterized the Isserk area during the absence of the study team, then the Isserk plume would have swept a larger area than observed directly. Since this plume was reported in a southwesterly direction prior to the field studies, it is quite likely that it moved at various times from a southerly to a northwesterly direction.

The August plume was not as evident at Isserk as it was during July, due largely to high background turbidity. In addition a retaining dyke constructed around the island perimeter reduced the loss of dredged material into the surrounding waters.

Grainger(1974) observed in the Isserk block a secchi depth of only 0.3 m for late July. During the same month but on different years, control stations at Arnak L-30 (MacDonald and Cambers, 1977) and a non-plume stations at Isserk F-27 had extinct depths about 10 times greater than this. However, values in the influence of the plume were less than 0.5 m. Since the reduction in secchi depth correlates with decreased depth of surface light penetration, one might expect an effect on primary productivity. However, neither this study nor the Arnak L-30 study found phytoplankton to be adversely influenced by the plume.

Bornhold (1975) reported surface water suspended solids in the south Beaufort Sea ranged from less than 0.1 to 17 mg/l during summer months. The values observed at Isserk F-27 usually approached or exceeded the high end of this range. Results from 1976 in the Isserk block (Slaney, 1977) for mid-August were similar to the 1977 observations.

The closer one is to the coast the higher the suspended solids concentration usually becomes. Certainly, the surface concentrations at extreme northerly and southerly Isserk stations tended to support such a trend. This pattern is due to the 15 x 10^6 tonnes of sedimentary material contributed annually to the Beaufort Sea by the Mackenzie River (Bornhold, 1975). Therefore, the further one is from the river delta, the lower will be the sediment load.

Near bottom turbidity and elevated suspended solid levels were a common feature of the Isserk area and the Beaufort Sea in general. Bornhold (1975) speculated that this bottom effect was the result of undirectional bottom currents, surface waves associated with storms, tidal currents or breaking internal waves.

5.1.5 *Sediment Size Distribution*

The particle size distribution of sediments has been surveyed by Pelletier (1975). He indicated that the area north of Pullen Island had 1 to 10% sand, 20 to 40% silt and 60 to 80% clay. Two stations sampled in the Isserk block in 1976 (Slaney, 1977) tended to the high side of these ranges for sand and silt, and to the low side for clay. Most of the 1977 analyses indicated that clay was by far the most abundant fraction, composing about 90% of the sample. This exceeds the range suggested by Pelletier (1975) but does support the preponderance of small sized particles in the sediments. This is the result of low hydrodynamic vigour which cannot transport the heavier fractions far from their source in the Mackenzie delta.

5.2 Chemical Data

5.2.1 *Dissolved Oxygen*

The dissolved oxygen around the Isserk F-27 site was within the range of values observed by others for this area (Grainger, 1974; MacDonald and Cambers, 1977; Slaney, 1977). In all cases, the surface concentrations during open water periods were over 100% saturation and decreased towards the seafloor. Furthermore, the lack of difference in the concentrations at stations within and beyond the influence of island construction was noted both during this study and during construction of Arnak L-30 (MacDonald and Cambers, 1977). Certainly, oxygen was always sufficient to prevent any deleterious biological response.

5.2.2 *Alkalinity*

Alkalinity measurements can be useful for the detection of some types of contamination or for the identification of water from different sources. The low salinity surface waters of July, probably originating from the Mackenzie River, provided lower alkalinity values than did the more saline bottom water. However, the vertical uniformity in August alkalinities reflects the absence of continued stratification. Both this study and one conducted at Arnak L-30 (MacDonald and Cambers, 1977) provided similar alkalinity measurements and both showed increases from July to August. In addition, these studies compliment each other by indicating that dredging activity did not seem to be related to the variations in the alkalinity measurements.

5.2.3 *Nutrients*

Previous measurements in the Isserk block determined only that open water NO_3 - N concentrations were below a detection limit of 0.1 mg/l (Slaney, 1977). However, Grainger (1974, 1975) found that surface concentrations, which decline with increasing distance from the coast, averaged about 0.035 mg/l in the top 5 m for stations near the Isserk block, three to six times higher than the 1977 findings. Although not apparent in the July measurements of the present study, the August values did decrease with increasing distance from the coast. This may have occurred because the study area was well within the influence of the Mackenzie River discharge during July, but was only on the fringe in August. Therefore, the NO_3 - N levels at southerly stations in August were replenished by river-born materials while northerly stations reflected more marine-like conditions. Furthermore, this study indicated a seasonal increase in NO_3 - N. Still, even in August the concentrations were substantially less than those reported by Grainger (1974).

The concentrations of NO_2 - N, varying from less than 0.001 to 0.005 mg/l in the surface waters, conformed to previous observations for the south Beaufort Sea which found amounts to be generally below the level of detection (Grainger, 1974, 1975). It was also noted in this study that NO_2 - N, like NO_3 - N, increased with depth. However, a seasonal decrease was observed for NO_2 - N opposite to NO_3 - N between July and August. In addition, NO_2 - N concentrations were slightly elevated at stations near the island site, suggesting possible nutrient enrichment as a result of dredging activities. Except for the variation associated with the proximity to the island site, NH_3 - N followed similar trends to NO_2 - N, but at an order of magnitude higher concentrations.

The increase in total N in the Isserk area from July to August was due entirely to NO_3, the most oxidized state of N. Under aerobic conditions intermediate forms in the N-cycle such as NO_2 and NH_3 are converted by microbial action to NO_3. The sea conditions of August were probably responsible for resuspending sediment-bound nitrogenous materials into the water column. At the same time, bacterial populations, perhaps associated to sediment particles, may have been distributed in the water column. These bacteria could oxidize much of the N-forms to stable NO_3. Such an explanation probably accounted for the increased NO_3, and decreased NO_2 and NH_3 observed in late August, 1977 in the Isserk F-27 area.

Phosphate increased both with depth, as observed in a previous arctic survey (Grainger, 1975), and seasonally from July to August. Still, neither this study nor one at Arnak L-30 (MacDonald and Camber, 1977) detected any relationship between island construction and PO_4 - P concentrations. The average level of 0.048 mg/l observed around Isserk F-27 in 1977 for the surface 5 m of the water column was generally two to three times that previously recorded by Grainger (1974) for coastal waters surrounding the Isserk block. The only other data from the Isserk area merely noted that PO_4 - P was below a detection limit of 0.12 mg/l (Slaney, 1977).

Silica concentrations in this study declined three-fold from July to August. A similar reduction was noted during the monitoring study at Arnak L-30 in 1976 (MacDonald and Cambers, 1977). Possibly the increased standing crop of siliceous diatoms observed during late August scavenged the free silica from the water column thus causing the lower measurements. Furthermore, Grainger (1974) remarked on the high concentrations of silica in the Mackenzie delta compared to the adjacent sea. Therefore, due to reduced river discharge in late August, replenishment of ocean levels from terrestrial sources may have dropped.

Although the temporal reduction in silica was similar in both this Isserk F-27 and the Arnak L-30 studies, the concentrations in the former were substantially lower than in the latter. A surface range of 3.7 to 4.5 mg/l in late July 1976 at Arnak (MacDonald and Cambers, 1977) exceeded the Isserk values by three to four times. The same differential also characterized late August measurements in both study areas. In addition, 1976 concentrations in the Isserk block were comparable to those at Arnak. Still, the lower 1977 Isserk values were within the range of 0.7 to 1.9 mg/l measured in 1973 (Grainger, 1974) at stations in this part of the south Beaufort Sea. Neither the Isserk nor the Arnak study found any correlation between island construction activities and the silica concentrations.

5.2.4 *Sediment Carbon*

A survey of the Beaufort Sea sediment samples indicated that the organic carbon content ranges from 1.4 to 1.6%

north of Pullen Island (Pelletier, 1975). Such values are slightly higher than the 1.1% average determined during this study for the Isserk block. However, a single sample from this block in 1976 (Slaney, 1977) was identical to the 1977 mean. Furthermore, the organic carbon comprised 48.5% of the total carbon content in 1977 which was similar to the previous year's estimate.

5.3 Biological Data

5.3.1 *Phytoplankton*:

Hsiao's (1976) survey in the south Beaufort Sea noted the high percentage of diatoms in phytoplankton collections made at inshore stations compared to an abundance of flagellates well offshore. Since the species observed during the present study were mainly diatoms, then the Isserk area has inshore characteristics. Other investigations, where the bathymetry was similar also found a preponderance of diatoms (Duval, 1977b; Slaney 1977). Such organisms are favoured by waters of high nutrient concentrations, low light intensities, and warm waters (Sverdrup *et al.*, 1942; Ryther, 1956; Raymond, 1963; Hubbert, 1970) and these conditions typified the Isserk site during this study.

According to Wacasey (1975), the estuarine habitat extends from the coast to waters where the depth does not exceed 15 m. This definition places Isserk F-27 on the transition between estuarine (inshore) and marine (offshore) areas. Hsiao (1976) found the centric diatom, *Chaetoceros sp.*, to be very abundant at nearshore stations while pennate forms became more common further offshore. Data collected by Slaney (1977) during the summer of 1976 at two stations in the Isserk block had a preponderance of *Chaetoceros sp.*, although these decreased in abundance by late August. The current study contradicts this estuarine trait since mainly pennate types were collected in late July with *Chaetoceros sp.* composing only about 12.6 % of the abundance. Furthermore, by late August very few centric forms were observed. Still, the occurrence of freshwater algae such as *Tabellaria sp.* (Olmstead, 1975) around Isserk F-27 in 1977 indicate that the study area also had near-shore characteristics. These conflicting properties support the possibility that the Isserk area is on a transitional zone and that its nature may lean either more to estuarine or marine on different occasions.

Nearshore stations in the south Beaufort Sea generally have phytoplankton abundance in the order of 10^5 cells/l (Hsiao, 1976; Duval, 1977) with decreasing numbers occurring offshore. Samples collected inside the Isserk block during 1976 (Slaney, 1977) had abundance that was an order of magnitude lower than the 1977 values. By late August, 1977, the number of cells per litre matched the 10^5 level. The increasing abundance noted between July and August samples reflects a seasonal trend which may have a mid-August maximum (Duval, 1977a). However this particular temporal change is not always the same. For example, a decreasing abundance was observed in 1976 at Arnak L-30 as the summer progressed (Duval, 1977b).

Phytoplankton are not often uniformly distributed in the water column. The largest standing crop was usually found at the 5 m depth in the Isserk area. This is in keeping with similar findings throughout the Beaufort Sea where the maximum numbers are normally at a depth of 3 to 5 m (Hsiao, 1976). Such depths coincide with the thermo- and halocline, and thus delineate the less dense surface waters from the colder more saline bottom waters. This physical stratification may inhibit sinking of the phytoplankton into the deeper water and therefore account for the abundant standing crop at the subsurface depth.

The distribution of phytoplankton abundance was not homogeneous between the various stations in the Isserk area. Instead, stations adjacent to the island site had greater standing crop than at stations towards the distal ends of the transects. Also, in July the abundance was well above average at stations in the plume within 2 km of Isserk F-27. A study during construction of Arnak L-30 similarly found that stations within the plume had elevated numbers of phytoplankton (Duval, 1977b). These increased numbers may have resulted from the suction dredging which suspended nutrients into the water column from the bottom sediments, thus stimulating phytoplankton in the vicinity of this activity (i.e., around the island site) and along the discharge plume. The failure to detect increased numbers in August at plume stations some distance from the island construction may have resulted because the amount of material carried from the island site was reduced due to the erection of a dyke around the island perimeter. This dyke effectively isolated the dredged material to the island centre instead of allowing much of it to spill into the surrounding waters, as occurred in July.

Nitrogen is usually considered to be the nutrient that limits primary productivity in Arctic seas (Grainger, 1975). Nitrate is the principal N-source in nutrient-rich waters, but others such as amino-N and ammonia can be important species in nutrient-poor areas (Thomas, 1966; 1970; MacIssac and Dugdale, 1972). Certainly, the phytoplankton standing crop was greatest at stations where N-levels were high, but abundance was also high at some locations where N-concentrations were average. This is particularly true of the stations suspected of being within the influence of island construction. Although NO_2 - N concentrations did appear elevated adjacent to the island, the small portion of the total available N that NO_2 provides makes it unlikely that NO_2 alone was responsible for the high phytoplankton numbers. Possibly NO_3 - N enrichment had occurred at these stations as well, but rapid uptake by phytoplankton quickly depleted the concentrations to within average values.

Although standing crops expressed as number of cells per unit volume is generally considered a less desirable index than concentrations of chlorophyll-a, most of the latter values in this study were below 1 mg/m^3, the sensitivity of the analytical technique used. Concentrations measured in surface samples from the Isserk block in 1976 rarely exceeded 1 mg/m^3 (Slaney, 1977). However, other studies indicate that chlorophyll-a levels are highest below the surface and near shore (Alexander, 1974; Grainger and Lovrity, 1975) as with abundance.

The diversity of taxa collected during the present study far exceeded the 16 taxa observed in the Isserk block in 1976 (Slaney, 1977). This was reflected in August diversity indices averaging only 1.7 in 1976 compared to 2.9 in 1977. In addition, the 1976 data indicated, contrary to the 1977 work, that the diversity index increased from July to August. High diversity indices are often equated with community stability and a capability for tolerating environmental perturbations. Neither the results of this study nor the one conducted during construction of Arnak L-30 (Duval, 1977b) indicated that the activities associated with the artificial islands had any adverse effects on diversity.

Although the species composition and diversity were not significantly influenced by the construction of Isserk F-27, cluster analysis did isolate those stations which were adjacent to the island or in the plume. This occurred not because diversity was altered, but because the abundance of several taxa, particularly *Achnanthes sp*, *Licmophora sp*. and *Navicula sp*., was greatly enhanced. These organisms apparently were very opportunistic and demonstrated an ability to thrive in habitat altered by the dredging activities.

5.3.2 *Zooplankton*

The dominance of copepods in the zooplankton collections of this study is consistent with findings from the other reports on the Beaufort Sea (Grainger, 1975; Grainger and Grohe, 1975). The copepod species collected in 1977 included ones considered common to these Arctic waters (Johnson, 1956). In addition, the abundance of polychaete trochophores and the medusa *Aglantha* sp. is not uncharacteristic of the south Beaufort Sea. However, previous investigations near the Isserk block do differ in some respects to the results of this study. For example, collections in 1973 produced only a few species (Grainger, 1975), compared to the 54 taxa from this program. Similarly, 1976 samples from the Isserk block included a mere 11 taxa (Slaney, 1977). These wide differences indicate that the study area can support a heterogeneous fauna at various times.

Although previous surveys found *Limnocalanus macrurus* to be abundant in the Isserk block (Grainger, 1975; Slaney, 1977), such was not the case in 1977. Since this species typifies nearshore waters where the salinity does not exceed 20 ppt, it suggests that during the present study the physical conditions reflected a more marine nature. The presence in 1977 of numerous *Aglantha* sp. and *Calanus glacialis*, characteristic of high salinity offshore waters (Grainger, 1975), supports this hypothesis. Since the area previously has had elements of nearshore communities, then its nature is in flux. The salinity stratification characteristic of early summer in the Isserk area probably provides niches simultaneously for typical nearshore species above the halocline and offshore species in the deeper high salinity waters. However, the decreasing stratification in late summer yields a more uniform habitat which would be attractive to marine species alone. The area may then be considered to exist along the transition zone between near and offshore, as was proposed for phytoplankton.

The standing crop of zooplankton in the Isserk block measured at two sites in 1976 ranged from 433.5 to 23,635 specimens/m^2 (Slaney, 1977). These values, as with the numbers of taxa, are much lower than the 1.3 to 21.9 x 10^4 specimens/m^2 measured in 1977. The difference may simply reflect elevated phytoplankton numbers in 1977 which were available to zooplankton grazing. This idea is supported by the concomitant increase in both phytoplankton and zooplankton from late July to late August, indicative of a significant seasonal change in standing crop.

Contrary to the increased zooplankton abundance from July to August, the diversity indices declined, due largely to a less equitable distribution of numbers among the various taxa. Still, the only previous value determined from a 1976 vertical haul made in the Isserk block (Slaney, 1977) approached the low end of the range for 1977. However, this may simply reflect the low sampling effort in 1976.

Neither community diversity nor biomass demonstrated any significant relationship to the dredging activity at the Isserk F-27 site. The cluster analysis confirmed that variations in community structure were randomly distributed among the sampling sites. Similarly, the monitoring study during construction of Arnak L-30 concluded that the hydraulic fill operation did not adversely affect the surface zooplankton community (Duval, 1977b). However, phytoplankton were affected by the construction, and one might have expected zooplankton to respond to changes in phytoplankton standing crop. The lack of apparent effect may be related to the greater mobility of zooplankton which permitted them to move freely in and out of conditions which were influencing the abundance of phytoplankton.

5.3.3 *Benthic Invertebrates*

The major taxa collected during this study in the Isserk F-27 area are similar to ones observed during previous surveys (Wacasey, 1975; Olmstead, 1977a) in the Beaufort Sea (Table 5.1). Four or five taxa contained a very high proportion of species (70% to 75%) for studies encompassing depths up to 900 m. Polychaetes dominated (31% to 45%) and gastropods and pelecypods contributed about 9% to 11% of the species in the Envirocon and Wacasey (1975) studies. Foraminiferans composed 14% of the species sampled at Isserk F-37, but were uncommon to the species lists of the benthic communities observed by Wacasey (1975) and Olmstead (1977a). The numerous species

TABLE 5.1: RELATIVE PERCENT COMPOSITION OF BENTHIC TAXA COLLECTED BY BOTTOM GRAB IN THE BEAUFORT SEA

	NUMBER OF SPECIES AND PERCENT COMPOSITION		
Taxon	Wacasey (1975)*	Olmstead (1977a)**	Envirocon (1977)***
Formanifera	-	-	11 (14%)
Polychaeta	101 (31%)	9 (45%)	29 (37%)
Gastropoda	33 (10%)	1 (5%)	7 (9%)
Pelecypoda	36 (11%)	1 (5%)	8 (10%)
Amphipoda	67 (20%)	3 (15%)	4 (5%)
TOTAL	237 (72%)	14 (70%)	59 (75%)

*0-900 m station depths

** >10 m station depths

*** 10-15 m station depths

(337) reported for the Beaufort Sea (Wacasey, 1975) reflect the expansive area surveyed and the wide range of habitat types from adjacent to the coastline to the continental slope.

The relatively small area examined by Envirocon Ltd. around Isserk F-27 produced a total of 79 species, exceeding the 33 reported by Olmstead (1977a) for near- and offshore stations. The fewer species observed in the latter study may be partially due to the use of a small Ekman grab (225 cm^2) compared to the less selective Ponar gear (506 cm^2) utilized in the present study.

In general, the densities of benthic organisms in the Isserk F-27 area were significantly higher than densities documented by Olmstead (1977a). Mean densities of 2,618 organisms/m^2 (Range = 624 - 4584) for July and 1,606 organisms/m^2 (Range = 196 - 3164) for August were observed at Isserk F-27; whereas averages of only 656 organisms/m^2 (Range = 44 - 3067) at offshore stations (>10m) and 722 organisms/m^2 (range = 0 - 3956) at inshore stations (<10m) were reported by Olmstead (1977a). On the other hand, Wacasey (1975) reported a density in 1973 about twice that of the mean observed in this study for a station near the Isserk block (Table 5.2). Still this single value was within the range observed at Isserk in 1977. The generally low density previously recorded by Olmstead (1977a) probably reflect an absence of foraminiferans from his samples. This taxon was the most abundant in the present study.

TABLE 5.2: COMPARISON OF BENTHIC INVERTEBRATE SAMPLING DATA IN THE VICINITY OF ISSERK F-27

Station	Depth (m)	No. of Species*	Density ($\#/m^2$) Mean	Density ($\#/m^2$) Range	Wet Biomass (gm/m^2) Mean	Wet Biomass (gm/m^2) Range	No. of Samples	Source
536	9	29	4320	-	23.98**	-	5	Wacasey (1975)
Isserk H-47	11.5	8	208	124-292	7.61	7.00-8.22	10	Slaney (1977)
Isserk NN	8.5-9.5	10	194	178-211	0.84	0.09-1.58	10	Slaney (1977)
Arnak L30	8.5-9.5	20	485	160-960	3.45	2.27-7.21	25	Olmstead (1977b)
Arnak L30 Control	10	13	501	382-658	12.90	8.22-15.99	15	Olmstead (1977b)
Arnak L30 Plume	8	21	1174	232-2116	10.62	6.79-14.44	10	Olmstead (1977b)
Isserk F-27 (July)	10-15	73	2618	624-4684	12.36	4.68-22.28	80	Envirocon (1977)
Isserk F-27 (August)	10-15	47	1606	196-3164	9.14	2.44-14.60	75	Envirocon (1977)

*All grab samples washed through a 0.5 mm screen

**Dry weight converted to equivalent wet weight by multiplying dry weight by 4.44 (Olmstead, 1977a)

Benthic biomass near the Isserk site for 1977 exceeded values obtained by Slaney (1977) in the same area during 1976 (Table 5.2). However, the range of values for 1977 was similar to that observed near Arnak L-30 (Olmstead, 1977b). Only a station of Wacasey's (1975) near the Isserk block had unusually high biomass, about double the mean value from this study. Still, even this large value was close to the upper end of the range observed during the present study. The extremely variable biomass may be due to the effects of ice scouring (Wacasey, 1975). Unscoured areas probably have high biomass while those recently scoured may be relatively devoid of benthos.

The depth range (10.1 to 15.6m) and bottom salinities (25 to 30 ppt) of the Isserk F-27 area are in keeping with Wacasey's (1975) Transition Zone for Beaufort Sea benthos. Both the biomass and species diversity are in agreement with the characteristics of this zone. Since such habitat is between estuarine and marine conditions, it may oscillate in nature between nearshore and offshore attributes, as was proposed for the planktonic communities.

The abundance of benthos around Isserk F-27 tended to increase with increasing distance from the island. This pattern suggests that construction activities may have interacted with the benthic fauna. Since the turbidity plume varied in bearing, the benthic habitat influenced may have been substantially larger than the area covered by visible turbidity during the two sampling periods. However, biomass data indicated that those stations within the influence of the plume were not significantly different from other stations. A study during the construction of Arnak L-30 supports this finding (Olmstead, 1977b). Furthermore, cluster analysis provided only random associations of stations without regard to the island site. Therefore, it is unlikely that the construction of the island had any significant deleterious effect on the benthos inhabiting the seafloor surrounding Isserk F-27.

5.3.4 *Fish*

The fish catch results from the Isserk F-27 area tend to verify Poulin's (1977) conclusion that fish abundance is very low in the Beaufort Sea in waters not immediately adjacent to the coast. However, gear selectivity probably reduced the success of the sampling program. Therefore, it is unlikely that the scant data of this study truly relect the fish community composition. Still, a greater diversity of fish species was collected at Isserk F-27 than during 1976 at Arnak L-30 (Olmstead, 1977c). Specimens of Arctic char, Arctic cod, Bartail snailfish and giant wrymouth were found only at Isserk. However, Pacific herring were collected at Arnak and not at Isserk. All species were either anadromous or marine, and each has been reported previously in arctic waters (McAllister, 1962; Kendel et al., 1975; Percy, 1975). Unfortunately, information on the abundance and distribution of fish in waters not adjacent to the coast is scarce. Therefore, any conclusions on the effects of island construction are speculative. However, the suspected low abundance in offshore areas such as the Arnak and Isserk blocks suggests that any impact would be minor. Direct mortality is most unlikely due to the mobility of fish which enables them to vacate conditions that are acutely noxious.

6.0 CONCLUSIONS

6.1 Baseline Information

6.1.1 *Physical/Chemical Data*

(i) Weather conditions in 1977 deteriorated substantially between the end of July and late August. Strong winds, primarily from the northwest, and decreasing air temperatures are not uncommon to the Isserk block at the close of summer. These conditions can create severe sea conditions which not only interact with other elements of the natural environment, but also handicap the construction of artificial islands located as far from the coastline as Isserk F-27.

(ii) The highly stratified temperature and salinity profiles characteristic of mid-summer largely disappeared by late August. This decrease is associated with both declining air temperatures and reduced freshwater discharge from the Mackenzie River. In addition, the increased turbulence accompanying inclement weather enhanced the homogeneity of the water column.

(iii) Surface water currents were westerly in the Isserk area during the sampling periods. However, since these currents are primarily wind driven it is quite likely that their bearings can change substantially depending on the prevailing climatology.

(iv) The transparency of water in the Isserk area decreases as the summer advances. This probably results from increased vertical mixing which resuspends particulate matter from the bottom sediments.

(v) The bottom sediments in the Isserk area are composed primarily of clay with sand making up less than 2% of the total.

(vi) Nitrate and phosphate concentrations in the waters of the study area showed a seasonal increase from July to August. However, all other nutrients measured declined over the same period.

6.1.2 *Biological Data*

(i) The phytoplankton community contains a rich diversity of species dominated by pennate diatoms. Abundance increased three-fold from July to August due possibly to elevated levels of NO_3 - N. A subsurface maximum characterized the vertical distribution of the standing crop in July. This may have been due to the density stratification of the water column, associated with the thermo- and halocline, which inhibited sinking into the bottom water.

(ii) Copepods dominated the zooplankton community, but polychaete trochophores and the medusa *Aglantha* sp. were also abundant. Typical of zooplankton, the Isserk samples contained large numbers of both holoplankton (permanent plankton) and meroplankton (temporary plankton, larval stages of either benthos or nekton). The reduction from July to August in the percent abundance of polychaete trochophores and copepod nauplii simply reflected normal seasonal changes in the life cycles of these organisms as they mature towards adult forms. The increase in abundance and biomass of zooplankton in late August was probably due to the availability of additional phytoplankton on which to graze.

(iii) Some 10 phyla and 70 species composed the benthic community in the Isserk area. Polychaetes, foraminiferans, pelecypods and gastropods accounted for 70% of the total number of species. Unlike the other biological communities, the benthos decreased both in numbers and biomass from July to August. The reason for this is unclear although the storm incidents and accompanying bottom turbulence that characterize late-summer on the south Beaufort Sea may have an adverse effect.

(iv) Six fish species were collected in the Isserk area dominated by arctic cisco, but all were caught in very small numbers. Although low abundance probably typifies arctic waters not immediately adjacent to the coast, the ineffectiveness of the sampling gear may also have contributed to the small sample sizes. To confirm both the abundance and diversity of fish in the area, it would be necessary to utilize active gear such as commercial size otter trawls.

(v) The biological communities contain elements of an estuarine and marine nature. Pennate diatoms, *Aglantha* sp. and *Calanus glacialis* reflect offshore characteristics. Species such as *Tabellaria* sp. and *Limnocalanus macrurus* indicate the study area also has nearshore traits.

In addition, the salinity and depth characteristics, and a benthos diversity in excess of 20 species coincides with Wacasey's (1975) Transition Zone. Therefore, it is concluded that the flora and fauna of the Isserk area exist in a region of biological flux.

6.2 Monitoring of Island Construction

6.2.1 *Physical/Chemical Data*

(i) Monitoring during the construction of Arnak L-30 indicated that hydraulic dredging caused vertical mixing of the otherwise stratified temperature and salinity profiles downstream of the island site. A similar phenomenon was not detected at Isserk F-27. This may have occurred because the dredging operation was intermittent during the July field study. The natural deterioration of stratification would negate any effect dredging had on the water column in August.

(ii) The hydraulic dredging operation accompanying island construction substantially increased downstream turbidity in July. Since this discharged material was carried in the direction of the current, the location of its deposition would have been dependent on wind direction. Although the plume dispersed to the west during the field studies, it is quite likely that it also moved in other directions when not being monitored. In view of wind conditions reported at shore-based weather stations, the plume may have wandered from southerly through northwesterly bearings during the summer.

(iii) The turbidity plume was less apparent in August than in July. This was a function of increased background levels of suspended solids and a perimeter dyke around the island which reduced the amount of dredged material spilled into the surrounding waters. The severe erosion of the island during a late August storm undoubtedly increased the load of suspended solids near the island site. However, the entire area was very turbid because of the same storm and this made the island-related turbidity visually indistinct.

(iv) Although the bottom sediments were composed primarily of clay, the stations adjacent to the Isserk site produced samples which were mainly sand. These probably resulted from the spreading of dredged or barged material around the island base.

(v) With the exception of NO_2 - N, none of the other nutrients measured in the surrounding waters showed concentration changes associated with the island. Nitrite did have higher concentrations adjacent to the island suggesting that resuspension of bottom materials by the dredging operation may have caused some nutrient enrichment.

6.2.2 *Biological Data*

(i) Phytoplankton abundance was greater near the Isserk site and at stations in the turbidity plume. The enhancement of the standing crop may have been caused by the suspension of nutrients from the bottom sediments during hydraulic dredging.

(ii) Unlike phytoplankton, the zooplankton community was not affected by the island construction.

(iii) The species abundance and biomass data for benthos did not provide significant trends related to island construction when subjected to various statistical tests. Therefore, it is concluded that the activities at the Isserk site did not have an important adverse effect on the bottom fauna surrounding the island.

(iv) The island base covers approximately 2×10^5 m^2 of benthic habitat. Furthermore, the adjacent borrow area disrupted an additional 3×10^5 m^2. Using a mean biomass of 12 g (wet wt.)/m^2, then it is estimated that approximately 6000 kg. of bottom fauna was either destroyed or displaced. However, the underwater surface area of the island provides new potential habitat that may be colonized through both invasion from the surrounding undisturbed seafloor and "parachuting" of larval forms from the zooplankton. In addition, the presence of new shoreline may attract other biological communities including fish. The long-term effect will depend on the structural soundness of the island to sustain itself against the physical environment following abandonment.

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APPENDIX I

Physical Data

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 022-1 DATE: 28/7/77 TIME: 14:30

AIR TEMPERATURE (°C) Wet Bulb: 13.9 % Humidity: 82
Dry Bulb: 15.6

WIND DIRECTION (°true): 110 WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.): 8

SOLAR CONDITIONS: Clear and sunny

SECCHI DEPTH (m): 0.5

MAX. STATION DEPTH (m): 12.5

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 2.0 (0.05-2.00 mm)

% SILT: 5.0 (0.05-0.002 mm)

% CLAY: 93.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.21	260	11.0	15.5	182	25.0
2	.26	260	11.0	15.2	182	
3	.31	275	9.0	18.1	192	
4	.31	275	8.0	20.0	220	
5	.15	230	7.2	21.2	225	3.8
6	.31	310	3.8	23.2	224	
7	.21	360	0.3	28.2	245	
8	.20	360	0.2	29.0	246	
9	.20	230	0.2	29.0	246	
10	.10	50	0.2	29.0	247	
11	.10	320	0.2	29.0	246	
12	.10	310	0.2	29.0	246	40.4

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 022-2 DATE: 31/7/77 TIME: 8:30

AIR TEMPERATURE (°C) Wet Bulb: 13.9 % Humidity: 83
Dry Bulb: 15.6

WIND DIRECTION (°true): 120 WAVE ACTION: 0.3m waves
VELOCITY (km/hr.): 8

SOLAR CONDITIONS: Clear and sunny

SECCHI DEPTH (m): 4.5

MAX. STATION DEPTH (m): 13.2

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 2.0 (0.05-2.00 mm)

% SILT: 4.4 (0.05-0.002 mm)

% CLAY: 93.6 (<0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.21	260	12.1	15.0	181	15.5
2	.26	260	12.3	15.5	183	
3	.31	275	11.0	15.8	177	
4	.31	275	10.6	17.5	200	
5	.15	230	3.5	28.0	250	12.3
6	.31	310	-0.5	30.5	253	
7	.21	5	-0.5	30.5	253	
8	.21	5	-0.5	30.5	153	
9	.21	230	-0.5	30.5	253	
10	.10	45	-0.5	30.5	252	
11	.10	320	-0.5	30.2	252	
12	.10	310	-0.5	30.2	252	72.5

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 022-3 DATE: 27/7/77 TIME: 21:00

AIR TEMPERATURE (°C) Wet Bulb: 12.8 % Humidity: 83
Dry Bulb: 14.4

WIND DIRECTION (°true): 50 WAVE ACTION: 1 m waves
VELOCITY (km/hr.): 12

SOLAR CONDITIONS: Clear and sunny

SECCHI DEPTH (m): 1.0

MAX. STATION DEPTH (m): 12.0

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 97.6 (0.05-2.00 mm)

% SILT: 1.0 (0.05-0.002 mm)

% CLAY: 1.4 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.21	230	5.0	18.5	200	13.5
2	.22	230	5.5	19.2	210	
3	.20	210	6.0	20.5	210	
4	.21	220	6.0	19.0	220	
5	.15	220	5.0	22.0	230	7.2
6	.10	320	1.5	26.5	232	
7	.10	320	-1.0	27.0	232	
8	.10	5	-0.5	30.2	250	
9	.10	10	-0.5	31.0	250	
10	.13	20	-0.5	31.0	252	
11	.08	140	-0.5	31.0	252	
12	.08	140	-0.5	31.0	252	17.4

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 022-4 DATE: 31/7/77 TIME: 12:00

AIR TEMPERATURE (°C) Wet Bulb: 12.2 % Humidity: 82
Dry Bulb: 13.9

WIND DIRECTION (°true): 20 WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.): 15

SOLAR CONDITIONS: Clear and sunny

SECCHI DEPTH (m): 6.0

MAX. STATION DEPTH (m): 15.6

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 6.0 (0.05-2.00 mm)

% SILT: 15.0 (0.05-0.002 mm)

% CLAY: 79.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.21	220	12.2	11.8	149	6.5
2	.19	175	12.5	13.7	170	
3	.13	160	13.5	16.0	196	
4	.18	160	13.4	15.8	200	
5	.39	150	11.9	15.3	198	9.0
6	.46	160	9.6	18.6	208	
7	.46	175	6.8	22.2	232	
8	.45	180	2.7	27.0	245	
9	.39	180	2.0	27.5	247	
10	.41	175	0.0	27.5	247	
11	.40	185	0.0	29.1	248	
12	.44	185	0.0	29.0	248	
13	.44	185	0.0	28.0	247	
14	.37	185	0.0	28.0	247	31.6

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 112-1 DATE: 28/7/77 TIME: 12:00

AIR TEMPERATURE (°C) Wet Bulb: 12.8 % Humidity: 84
Dry Bulb: 13.9

WIND DIRECTION (°true): 125 WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.): 8.5

SOLAR CONDITIONS: Clear and sunny

SECCHI DEPTH (m): 0.6

MAX. STATION DEPTH (m): 12.5

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 2.0 (0.05-2.00 mm)

% SILT: 14.0 (0.05-0.002 mm)

% CLAY: 84.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.36	260	12.5	15.6	192	25.1
2	.31	275	10.0	15.5	190	
3	.36	275	8.0	20.0	213	
4	.31	275	7.5	21.0	222	
5	.31	310	6.8	23.0	238	25.7
6	.20	320	5.5	23.0	238	
7	.20	320	2.2	25.5	238	
8	.36	320	-0.2	29.6	250	
9	.20	320	-0.2	30.0	250	
10	.15	290	-0.2	30.0	251	
11	.18	340	-0.2	30.0	251	
12	.21	320	-0.2	30.0	251	124.0

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 112-2 DATE: 27/7/77 TIME: 19:00

AIR TEMPERATURE (°C) Wet Bulb: 12.2 % Humidity: 82
Dry Bulb: 13.9

WIND DIRECTION (°true): 20 WAVE ACTION: 0.6 m waves
VELOCITY (km/hr.): 15.0

SOLAR CONDITIONS: Clear and sunny

SECCHI DEPTH (m): 1.0

MAX. STATION DEPTH (m): 12.0

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.4 (0.05-2.00 mm)

% SILT: 3.2 (0.05-0.002 mm)

% CLAY: 96.4 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.28	260	10.0	17.8	205	24.2
2	.23	230	10.0	18.0	208	
3	.13	185	7.0	19.0	204	
4	.10	230	6.0	21.3	220	
5	.13	310	5.5	22.3	225	2.9
6	.18	320	3.5	23.0	223	
7	.18	320	0.0	28.3	240	
8	.08	320	-0.5	29.0	241	
9	.05	140	-0.5	29.0	242	
10	.05	95	-0.5	29.0	242	
11	.13	95	-0.5	29.0	242	
12	.13	95	-0.5	29.0	242	52.0

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 112-3 DATE: 26/7/77 TIME: 17:30

AIR TEMPERATURE (°C) Wet Bulb:
Dry Bulb: 12.1
% Humidity:

WIND DIRECTION (°true): 100
VELOCITY (km/hr.): 9
WAVE ACTION:

SOLAR CONDITIONS: -
SECCHI DEPTH (m):
MAX. STATION DEPTH (m): 12.7

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm)
% SILT: 2.8 (0.05-0.002 mm)
% CLAY: 97.2 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.14	250	9.2	15.5	192	1.9
2	.18	220	9.1	15.5	190	
3	.22	200	8.9	18.0	208	
4	.31	190	7.2	18.3	214	
5	.30	200	4.9	18.6	216	8.1
6	.26	195	3.8	23.0	223	
7	.26	185	-0.4	27.8	239	
8	.21	185	-0.4	29.0	242	
9	.21	180	-0.6	29.6	251	
10	.21	180	-0.7	30.0	251	
11	.21	170	-0.6	30.0	251	
12	.21	170	-0.7	31.0	252	5.7

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 112-4 DATE: 27/7/77 TIME: 15:30

AIR TEMPERATURE (°C) Wet Bulb: 10.6 % Humidity: 95
Dry Bulb: 11.1

WIND DIRECTION (°true): 30 WAVE ACTION: 0.7 m waves
VELOCITY (km/hr.): 15

SOLAR CONDITIONS: Sunny and clear

SECCHI DEPTH (m): 1.0

MAX. STATION DEPTH (m): 12.0

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 1.0 (0.05-2.00 mm)

% SILT: 4.2 (0.05-0.002 mm)

% CLAY: 94.8 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.41	230	9.2	14.7	195	3.1
2	.39	190	9.0	14.9	206	
3	.39	190	7.8	19.7	218	
4	.67	175	7.7	22.5	221	
5	.67	175	6.9	26.8	234	3.2
6	.51	185	6.2	28.6	240	
7	.41	185	4.8	28.6	240	
8	.31	150	1.4	29.2	246	
9	.24	145	-0.1	31.0	252	
10	.21	135	-0.1	31.0	252	
11	.18	125	-0.1	31.0	252	
12	.18	125	-0.1	31.0	252	15.6

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 202-1 DATE: 31/7/77 TIME: 13:20

AIR TEMPERATURE (°C) Wet Bulb: 12.2 % Humidity: 82
Dry Bulb: 13.9

WIND DIRECTION (°true): 100 WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.): 9

SOLAR CONDITIONS:
50% cloud and Sunny

SECCHI DEPTH (m): 0.5

MAX. STATION DEPTH (m): 12.1

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 93.7 (0.05-2.00 mm) % SILT: 4.3 (0.05-0.002 mm) % CLAY: 2.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.06	240	13.0	16.2	205	30.4
2	.09	240	12.5	16.8	205	
3	.14	220	12.0	17.5	212	
4	.15	210	8.5	20.7	228	
5	.13	195	4.2	25.0	236	388.8
6	.08	180	0	29.5	250	
7	.08	195	0	29.6	250	
8	.09	195	0	29.5	250	
9	.08	185	0	29.5	250	
10	.06	185	0	29.5	250	
11	.05	180	0	29.5	250	
12	.05	180	0.5	29.7	250	31.6

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 202-2   DATE: 30/7/77   TIME: 13:15

AIR TEMPERATURE (°C) Wet Bulb: 12.2 % Humidity: 93
Dry Bulb: 12.8

WIND DIRECTION (°true): 120   WAVE ACTION: 0.6m swells
VELOCITY (km/hr.): 7

SOLAR CONDITIONS: Foggy   SECCHI DEPTH (m): 1.0   MAX. STATION DEPTH (m): 12.1

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm)   % SILT: 1.6 (0.05-0.002 mm)   % CLAY: 98.4 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/1)
1	.21	140	13.0	15.0	180	54.3
2	.31	110	12.0	17.5	207	
3	.33	95	12.0	17.7	225	
4	.40	80	6.0	24.5	250	
5	.40	70	3.0	27.5	255	39.8
6	.42	70	0.5	30.5	262	
7	.39	60	0	31.0	262	
8	.41	60	0	31.0	260	
9	.36	60	0	31.0	260	
10	.40	60	0	31.0	260	
11	.39	60	0	31.0	260	
12	.33	60	0	30.5	260	27.3

APPENDIX 1

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 202-3 DATE: 28/7/77 TIME: 18:30

AIR TEMPERATURE (^{o}C) Wet Bulb: 12.8 % Humidity: 94
Dry Bulb: 13.3

WIND DIRECTION (^{o}true): 80 WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.): 9

SOLAR CONDITIONS: Sunny and clear

SECCHI DEPTH (m): 1.0

MAX. STATION DEPTH (m): 12.0

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 1.0 (0.05-2.00 mm)

% SILT: 2.6 (0.05-0.002 mm)

% CLAY: 96.4 (<0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (^{o}true)	WATER TEMP. (^{o}C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/1)
1	.21	275	12.8	14.5	178	28.4
2	.08	60	11.0	14.9	181	
3	.08	95	7.5	17.6	208	
4	.15	195	6.9	20.8	218	
5	.08	255	3.0	25.5	238	20.6
6	.12	280	0.0	30.6	259	
7	.12	280	-0.5	31.0	259	
8	.10	285	-0.5	31.0	259	
9	.08	300	-0.5	31.0	259	
10	.13	320	-0.5	31.0	259	
11	.10	210	-0.5	31.0	259	
12	.13	360	-0.5	31.0	259	27.5

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 202-4 DATE: 30/7/77 TIME: 10:30

AIR TEMPERATURE (°C) Wet Bulb: % Humidity:
Dry Bulb: 13.2

WIND DIRECTION (°true): 50 WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.): 7

SOLAR CONDITIONS: Clear and sunny

SECCHI DEPTH (m): 2.9

MAX. STATION DEPTH (m): 10.1

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm)

% SILT: 2.8 (0.05-0.002 mm)

% CLAY: 97.2 (<0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.24	305	11.0	19.2	195	14.7
2	.16	310	7.0	19.0	210	
3	.16	310	3.5	24.0	230	
4	.22	310	0.0	28.0	240	
5	.18	310	-0.5	29.0	240	11.8
6	.16	310	-0.5	29.0	240	
7	.15	310	-0.5	29.0	240	
8	.15	310	-0.5	29.0	240	
9	.13	310	-0.5	29.0	240	34.1
10	.10	310				

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-1 DATE: 30/7/77 TIME: 23:00

AIR TEMPERATURE (^{o}C) Wet Bulb: - % Humidity:
Dry Bulb: 11.4

WIND DIRECTION (^{o}true): 90 WAVE ACTION: 1.2 m waves
VELOCITY (km/hr.): 18

SOLAR CONDITIONS:
Clear and sunny

SECCHI DEPTH (m):
0.1 (July 30)
1.3 (July 31)

MAX. STATION DEPTH (m): 12.6

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 86.8 (0.05-2.00 mm)

% SILT: 10.0 (0.05-0.002 mm)

% CLAY: 3.2 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (^{o}true)	WATER TEMP. (^{o}C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.21	230	11.5	15.2	183	21.1
2	.15	230	11.0	15.5	183	
3	.21	275	11.0	15.7	177	
4	.21	185	10.0	17.5	200	
5	.21	160	2.5	27.0	250	33.4
6	.21	230	-0.5	30.5	253	
7	.18	320	-0.5	30.5	253	
8	.36	320	-0.5	30.5	253	
9	.36	140	-0.5	30.5	252	
10	.36	160	-0.5	30.5	252	
11	.36	150	-0.5	30.5	252	
12	.36	185	-0.5	30.2	252	34.1

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-2 DATE: 30/7/77 TIME: 21:30

AIR TEMPERATURE (°C) Wet Bulb: % Humidity:
Dry Bulb: 11.7

WIND DIRECTION (°true): 90 WAVE ACTION: 1.0 m waves
VELOCITY (km/hr.): 17

SOLAR CONDITIONS: Clear and sunny

SECCHI DEPTH (m): 0.3

MAX. STATION DEPTH (m): 12

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm)

% SILT: 9.4 (0.05-0.002 mm)

% CLAY: 90.6 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.31	275	12.4	13.8	170	99.8
2	.31	230	12.2	15.8	186	
3	.41	275	9.5	18.7	215	
4	.62	275	4.0	24.8	237	
5	.77	275	0.3	29.5	255	99.3
6	.77	260	-0.4	29.8	255	
7	.77	275	-0.4	30.4	255	
8	.62	275	-0.4	30.5	255	
9	.62	260	-0.4	30.5	255	
10	.62	290	-0.4	30.5	254	
11	.51	290	-0.4	30.5	255	
12	.51	230	-0.4	30.5	255	67.7

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-3 DATE: 29/7/77 TIME: 14:00

AIR TEMPERATURE (°C) Wet Bulb: 11.7 % Humidity: 94
Dry Bulb: 12.2

WIND DIRECTION (°true): W WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.): 11.5

SOLAR CONDITIONS: Sunny, 25% overcast

SECCHI DEPTH (m): 1.5

MAX. STATION DEPTH (m): 13.0

COMMENTS:

Note changes on 28/8/77

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm)

% SILT: 3.8 (0.05-0.002 mm)

% CLAY: 96.2 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1.	.31	235	12.5	14.0	175	24.3
2	.42	245	11.7	14.5	175	
3	.49	240	10.0	18.0	208	
4	.39	215	8.7	19.5	225	
5	.26	195	7.5	21.5	230	133.4
6	.24	195	6.0	22.5	235	
7	.26	250	1.0	28.0	242	
8	.003	230	-0.5	29.5	250	
9	.003	190	-0.5	29.5	250	
10	.05	235	-0.5	29.5	250	
11	.08	190	-0.5	29.5	250	
12	.003	240	-0.5	29.5	250	37.2

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-3 DATE: 28/7/77 TIME:

AIR TEMPERATURE (°C) Wet Bulb: % Humidity:
Dry Bulb:

WIND DIRECTION (°true): 90 WAVE ACTION:
VELOCITY (km/hr.): 11.5

SOLAR CONDITIONS: SECCHI DEPTH (m): 0.1 MAX. STATION DEPTH (m):

COMMENTS:

Note these changes follow the storm activity of the 27th - 28th

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SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm) % SILT: 3.8 (0.05-0.002 mm) % CLAY: 96.2 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1			9.0	28.0	285	
2			8.5	28.0		
3			8.5	27.8		
4			8.5	27.4		
5			8.5	26.5	285	
6			8.5	27.0		
7			8.2	28.0		
8			8.0	28.0		
9			7.8	28.0		
10			7.8	28.0		
11			7.2	28.0		
12			5.5	28.0	285	

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-4 DATE: 30/7/77 TIME: 15:00

AIR TEMPERATURE (°C) Wet Bulb: 12.2 % Humidity: 87
Dry Bulb: 13.3

WIND DIRECTION (°true): - WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.): 0

SOLAR CONDITIONS: Overhast and haze

SECCHI DEPTH (m): 5.5

MAX. STATION DEPTH (m): 14.3

COMMENTS:
Aug. results follow storm activity - water very turbid

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 1.0 (0.05-2.00 mm)

% SILT: 1.2 (0.05-0.002 mm)

% CLAY: 97.8 (<0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.32	210	12.3	11.0	138	7.3
2	.44	235	11.2	13.8	170	
3	.42	185	10.0	16.9	195	
4	.42	160	9.0	17.5	200	
5	.32	160	8.7	21.3	235	9.9
6	.27	160	7.7	21.2	235	
7	.13	50	4.9	28.8	239	
8	.12	50	0.0	29.0	245	
9	.09	40	-0.5	29.2	245	
10	.09	40	-0.5	29.2	248	
11	.09	40	-0.5	29.5	248	
12	.10	40	-0.5	29.5	248	
13	.13	55	-0.7	29.5	248	10.4

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 022-1 DATE: 25/8/77 TIME: 17:00

AIR TEMPERATURE (°C) Wet Bulb: 6.7 % Humidity: 86
Dry Bulb: 7.8

WIND DIRECTION (°true): 310 WAVE ACTION: 1.2 m swells
VELOCITY (km/hr.): 20

SOLAR CONDITIONS: Clear and Sunny

SECCHI DEPTH (m): 0.5

MAX. STATION DEPTH (m): 12.5

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 2.0 (0.05-2.00 mm)

% SILT: 18.6 (0.05-0.002 mm)

% CLAY: 79.4 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/1)
1	.21	275	7.5	26.5	275	117.4
2	.36	275	7.5	27.0	275	
3	.21	230	6.5	28.2	285	
4	.16	230	5.0	29.8	295	
5	.13	230	3.0	30.5	282	56.3
6	.15	230	1.5	31.5	282	
7	.18	230	1.0	32.0	275	
8	.10	275	0-5	32.0	275	
9	.15	260	0.5	32.0	275	
10	.13	275	0.5	32.0	275	
11	.21	275	0.5	32.0	275	
12	.15	230	0.5	32.0	275	24.4

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 022.2 DATE: 29/8/77 TIME: 8:30

AIR TEMPERATURE (°C) Wet Bulb: 6.4 % Humidity: 89
Dry Bulb: 6.9

WIND DIRECTION (°true): 80 WAVE ACTION: 1 m swells
VELOCITY (km/hr.): 10

SOLAR CONDITIONS: 95% cloud cover

SECCHI DEPTH (m): 0.5 (Aug. 24)

MAX. STATION DEPTH (m): 13.2

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.4 (0.05-2.00 mm)   % SILT: 11.2 (0.05-0.002 mm)   % CLAY: 88.4 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/1)
1	.28	275	6.0	29.0	289	27.3
2	.28	275	6.0	28.8	288	
3	.28	275	6.0	29.0	287	
4	.28	270	6.0	29.0	287	
5	.31	275	6.0	29.0	287	29.1
6	.33	160	6.0	28.8	286	
7	.31	185	6.0	28.8	286	
8	.32	185	5.8	28.6	286	
9	.21	185	5.7	28.5	285	
10	.26	180	5.5	28.2	283	
11	.21	160	5.1	28.5	280	
12	.18	160	5.0	28.5	280	37.4

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 022-3 DATE: 29/8/77 TIME: 15:30

AIR TEMPERATURE (°C) Wet Bulb: 7.8 % Humidity: 85
Dry Bulb: 8.9

WIND DIRECTION (°true): - WAVE ACTION: 0.7 m swells
VELOCITY (km/hr.): 0

SOLAR CONDITIONS: 90% Cloud

SECCHI DEPTH (m): -

MAX. STATION DEPTH (m): 12.0

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 2.0 (0.05-2.00 mm)

% SILT: 17.2 (0.05-0.002 mm)

% CLAY: 80.8 (<0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.18	230	6.7	27.3	282	25.1
2	.18	185	6.6	27.3	282	
3	.13	95	6.4	27.5	282	
4	.15	95	6.2	27.5	282	
5	.08	95	6.1	27.7	282	26.0
6	.15	95	6.0	27.7	280	
7	.15	290	5.9	27.7	280	
8	.13	140	5.8	27.7	281	
9	.15	95	5.6	27.8	280	
10	.15	230	5.5	28.2	280	
11	.10	275	5.4	28.3	280	
12	.15	275	5.3	28.3	280	31.4

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 022-4 DATE: 29/8/77 TIME: 16:15

AIR TEMPERATURE (°C) Wet Bulb: 7.2 % Humidity: 90
Dry Bulb: 7.8

WIND DIRECTION (°true): N.I.T WAVE ACTION: 0.7 m swells
VELOCITY (km/hr.): N.I.

SOLAR CONDITIONS: 90% cloud and calm

SECCHI DEPTH (m): 1.0

MAX. STATION DEPTH (m): 15.6

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 2.2 (0.05-2.00 mm)

% SILT: 20.6 (0.05-0.002 mm)

% CLAY: 77.2 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (pp^t)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.13	275	6.0	28.3	280	46.2
2	.13	275	5.8	28.3	280	
3	.13	275	5.8	28.3	280	
4	.15	140	5.7	28.3	280	
5	.13	230	5.5	28.2	278	34.1
6	.10	140	5.4	28.2	278	
7	.10	230	5.3	28.2	278	
8	.13	275	5.3	28.2	278	
9	.13	275	5.3	28.2	278	
10	.15	275	5.2	28.2	278	
11	.15	290	5.2	28.2	278	
12	.15	275	5.2	28.2	278	
13	.15	275	5.2	28.2	278	
14	.15	275	5.2	28.2	278	40.9

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 112-1 DATE: 29/8/77 TIME: 16:00

AIR TEMPERATURE (°C) Wet Bulb: 5.8 % Humidity: 93
Dry Bulb: 6.1

WIND DIRECTION (°true): 280 WAVE ACTION: 1.0 m swells
VELOCITY (km/hr.): 7.0

SOLAR CONDITIONS: SECCHI DEPTH : 1.2 (Aug.25) MAX. STATION DEPTH (m): 12.5

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 92.4 (0.05-2.00 mm) % SILT: 7.0 (0.05-0.002 mm) % CLAY: 0.6 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.21	230	6.5	29.0	288	21.3
2	.28	230	6.5	28.5	287	
3	.23	230	6.5	28.5	286	
4	.28	230	6.5	28.5	286	
5	.26	230	6.5	28.5	286	24.7
6	.26	230	6.5	28.5	286	
7	.26	230	6.3	28.2	284	
8	.28	260	6.0	28.2	284	
9	.15	270	6.0	28.5	287	
10	.18	275	5.5	28.4	287	
11	.10	230	5.5	28.5	284	
12	.18	275	5.5	28.5	283	455.5

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 112-2 DATE: 29/8/77 TIME: 7:30

AIR TEMPERATURE (°C) Wet Bulb: 5.8 % Humidity: 93
Dry Bulb: 6.1

WIND DIRECTION (°true): 300 WAVE ACTION: 1.0 m swells
VELOCITY (km/hr.): 7.0

SOLAR CONDITIONS: SECCHI DEPTH (m): 1.2 (Aug. 25) MAX. STATION DEPTH (m): 12.0

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 1.0 (0.05-2.00 mm) % SILT: 3.0 (0.05-0.002 mm) % CLAY: 96.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.26	275	7.0	28.4	290	31.5
2	.21	260	7.0	28.3	290	
3	.23	260	6.7	28.2	288	
4	.21	275	6.5	28.5	290	
5	.23	275	6.5	28.6	289	36.3
6	.26	275	6.3	28.5	289	
7	.23	260	6.0	28.4	287	
8	.15	185	5.8	28.3	284	
9	.18	185	5.6	28.4	284	
10	.15	275	5.3	28.3	283	
11	.26	275	5.0	28.2	281	
12	.13	275	5.0	28.1	280	49.0

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 112-3 DATE: 26/8/77 TIME: 10:00

AIR TEMPERATURE (°C) Wet Bulb: 43 % Humidity: 100
Dry Bulb: 43

WIND DIRECTION (°true): 350 WAVE ACTION: 1.3 m swells
VELOCITY (km/hr.): 18

SOLAR CONDITIONS: 100% cloud and rain

SECCHI DEPTH (m): 2.2

MAX. STATION DEPTH (m): 12.7

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm) % SILT: 6.6 (0.05-0.002 mm) % CLAY: 93.4 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.26		8.0	27.5	290	24.2
2	.19		8.5	27.5	290	
3	.21		6.5	30.0	300	
4	.10		3.5	30.0	275	
5	.17		1.5	30.0	267	28.5
6	.06		1.5	30.0	267	
7	.10		1.5	30.0	267	
8	.13		1.5	30.0	267	
9	.12		1.5	30.0	265	
10	.10		1.5	30.0	265	
11	.12		1.5	30.0	265	
12	.12		1.5	30.0	265	34.2

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 112-4 DATE: 29/8/77 TIME: 14:00

AIR TEMPERATURE (°C) Wet Bulb: 6.4 % Humidity: 98
Dry Bulb: 6.7

WIND DIRECTION (°true): 290 WAVE ACTION: 0.7 m waves
VELOCITY (km/hr.): 5

SOLAR CONDITIONS: 90% overcast and clearing
SECCHI DEPTH (m): 1.2
MAX. STATION DEPTH (m): 12.0

COMMENTS: Aug. data follows storm - high turbidity

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: (0.05-2.00 mm)	% SILT: (0.05-0.002 mm)	% CLAY: (<0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.33	230	7.5	28.1	290	44.5
2	.26	230	7.3	28.0	290	
3	.21	275	7.0	28.0	290	
4	.21	275	6.8	28.0	289	
5	.21	275	6.7	28.1	289	-
6	.21	95	6.5	28.0	289	
7	.21	95	6.3	28.2	285	
8	.18	110	6.0	28.3	284	
9	.18	275	5.8	28.3	283	
10	.36	230	5.7	28.3	283	
11	.26	230	5.6	28.3	283	
12	.24	230	5.6	28.3	283	215.4

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 202-1 DATE: 25/8/77 TIME: 14:30

AIR TEMPERATURE (°C) Wet Bulb: 6.1 % Humidity: 87
Dry Bulb: 6.7

WIND DIRECTION (°true): 40 WAVE ACTION: 0.6 m swells
VELOCITY (km/hr.): 12

SOLAR CONDITIONS: 50% cloud cover

SECCHI DEPTH (m): 1.2

MAX. STATION DEPTH (m): 12.1

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 2.0 (0.05-2.00 mm)

% SILT: 8.4 (0.05-0.002 mm)

% CLAY: 89.6 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.31	275	6.5	27.2	270	229.6
2	.41	260	6.2	27.2	275	
3	.36	260	6.2	27.2	275	
4	.23	275	6.2	27.5	285	
5	.21	260	4.8	30.8	290	106.6
6	.18	275	4.5	30.5	280	
7	.18	275	0.5	32.0	265	
8	.21	285	0.5	31.8	268	
9	.13	275	0.5	31.5	268	
10	.10	290	0.5	31.5	268	
11	.08	260	0.5	31.5	268	
12	.08	275	0.5	31.5	268	123.0

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 202-2   DATE: 29/8/77   TIME: 21:30

AIR TEMPERATURE (°C) Wet Bulb: -   % Humidity: -
Dry Bulb: 5.4

WIND DIRECTION (°true): 260   WAVE ACTION: 1.0 m swells
VELOCITY (km/hr.): 9

SOLAR CONDITIONS: SECCHI DEPTH (m):   MAX. STATION DEPTH (m): 12.1
100% cloud and foggy

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 1.0 (0.05-2.00 mm)   % SILT: 4.2 (0.05-0.002 mm)   % CLAY: 94.8 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.26	230	6.5	28.8	285	29.3
2	.26	260	6.5	28.2	285	
3	.33	275	6.5	28.2	285	
4	.31	275	6.4	28.5	285	
5	.13	185	6.4	28.5	284	32.1
6	.15	275	6.2	28.4	284	
7	.18	275	6.2	28.3	285	
8	.26	270	6.0	28.4	285	
9	.26	185	5.8	28.3	283	
10	.13	185	5.6	28.3	281	
11	.10	180	5.4	28.1	280	
12	.18	160	5.2	28.1	280	32.6

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 202-3 DATE: 29/8/77 TIME: 19:00

AIR TEMPERATURE (°C) Wet Bulb: 5.0 % Humidity: 86
Dry Bulb: 5.6

WIND DIRECTION (°true): 340 WAVE ACTION: 1.0 m swells
VELOCITY (km/hr.): 13

SOLAR CONDITIONS: Overcast

SECCHI DEPTH (m): 1.3 (Aug. 25)

MAX. STATION DEPTH (m): 12.0

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 1.0 (0.05-2.00 mm)

% SILT: 3.0 (0.05-0.002 mm)

% CLAY: 96.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.31	270	6.7	28.7	286	31.5
2	.33	275	6.7	27.8	285	
3	.28	275	6.6	27.8	285	
4	.23	160	6.5	27.8	285	
5	.31	160	6.4	27.8	285	13.4
6	.26	160	6.2	27.8	284	
7	.31	160	6.0	27.8	283	
8	.18	160	5.9	27.8	283	
9	.21	270	5.8	27.8	283	
10	.21	270	5.8	27.6	282	
11	.18	275	5.5	27.5	281	
12	.18	275	5.5	28.2	282	33.1

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 202-4 DATE: 26/8/77 TIME: 16:30

AIR TEMPERATURE (°C) Wet Bulb: % Humidity:
Dry Bulb: 6.0

WIND DIRECTION (°true): WAVE ACTION: 3.0 m swells
VELOCITY (km/hr.):

SOLAR CONDITIONS: SECCHI DEPTH (m): MAX. STATION DEPTH (m): 10.1
80% overcast and very windy

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm) % SILT: 2.6 (0.05-0.002 mm) % CLAY: 97.4 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.44	290	10.0	25.6	270	31.9
2	.77	280	10.1	24.0	270	
3	.37	290	4.0	28.5	280	
4	.31	275	3.0	28.5	280	
5	.31	225	3.0	28.5	280	47.9
6	.26	275	3.0	28.2	280	
7	.23	260	3.0	29.0	280	
8	.21	260	3.0	29.0	280	
9	.23	260	3.0	30.0	280	34.1
10	.31	220				186.2

APPENDIX I

ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-1 DATE: 25/8/77 TIME: 15:30

AIR TEMPERATURE (°C) Wet Bulb: 6.9 % Humidity: 82
Dry Bulb: 7.8

WIND DIRECTION (°true): 25 WAVE ACTION: 0.7 m swells
VELOCITY (km/hr.): 16

SOLAR CONDITIONS: 80% cloud

SECCHI DEPTH (m): 0.1

MAX. STATION DEPTH (m): 12.6

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 11.0 (0.05-2.00 mm)

% SILT: 22.0 (0.05-0.002 mm)

% CLAY: 67.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.08	275	7.5	27.0	280	82.0
2	.15	275	7.5	26.7	280	
3	.21	220	7.5	26.3	278	
4	.21	275	5.0	29.5	285	
5	.15	275	2.0	31.5	282	279.6
6	.15	275	1.0	32.0	275	
7	.10	265	1.0	32.0	275	
8	.08	230	1.0	32.0	275	
9	.10	275	0.7	32.0	275	
10	.08	275	0.7	32.0	275	
11	.15	275	0.7	32.0	275	
12	.13	275	0.7	32.0	275	66.8

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-2 DATE: 26/8/66 TIME: 15:00

AIR TEMPERATURE (°C) Wet Bulb: 6.1 % Humidity: 100
Dry Bulb: 6.1

WIND DIRECTION (°true): 220 WAVE ACTION: 0.7 m swells
VELOCITY (km/hr.): 14

SOLAR CONDITIONS: 80% cloud, freezing rain

SECCHI DEPTH (m): 2.5

MAX. STATION DEPTH (m): 12

COMMENTS:

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 11.0 (0.05-2.00 mm)

% SILT: 22.0 (0.05-0.002 mm)

% CLAY: 67.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.18	275	8.5	27.5	288	14.5
2	.21	230	8.2	27.5	290	
3	.10	275	7.8	27.5	282	
4	.10	275	6.2	26.8	278	
5	.13	275	4.0	29.0	275	17.6
6	.08	260	2.0	29.5	265	
7	.13	275	2.2	29.5	265	
8	.18	275	2.0	29.5	264	
9	.16	260	2.0	29.5	264	
10	.08	290	2.0	29.5	264	
11	.08	290	2.0	30.0	264	
12	.16	230	1.5	30.0	265	66.4

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-3 DATE: 26/8/77 TIME: 11:00

AIR TEMPERATURE (°C) Wet Bulb: 6.1 % Humidity: 100
Dry Bulb: 6.1

WIND DIRECTION (°true): 320 WAVE ACTION: 0.3 m waves
VELOCITY (km/hr.):

SOLAR CONDITIONS: 100% cloud, rain

SECCHI DEPTH (m): 2.2

MAX. STATION DEPTH (m): 13.0

COMMENTS:

Note changes on 28/8/77

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 97.8 (0.05-2.00 mm)

% SILT: 2.2 (0.05-0.002 mm)

% CLAY: 0.0 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.15	230	8.0	26.0	277	53.4
2	.13	275	8.0	26.2	280	
3	.15	275	8.0	26.6	285	
4	.15	260	8.0	27.5	292	
5	.15	275	2.0	30.0	267	28.4
6	.13	275	1.5	30.0	267	
7	.15	260	1.5	30.0	265	
8	.15	275	1.5	30.0	265	
9	.13	275	2.0	30.0	265	
10	.13	275	2.0	30.0	265	
11	.18	260	1.5	29.8	265	
12	.10	260	1.5	29.8	265	47.0

APPENDIX I ISSERK F-27 ENVIRONMENTAL STUDY

1977 PHYSICAL DATA

STATION: 292-4 DATE: 28/8/77 TIME: 21:00

AIR TEMPERATURE (°C) Wet Bulb: 5.8 % Humidity: 85
Dry Bulb: 6.7

WIND DIRECTION (°true): 330 WAVE ACTION: 1.3 m swells
VELOCITY (km/hr.): 16

SOLAR CONDITIONS: 70% cloud

SECCHI DEPTH (m):

MAX. STATION DEPTH (m): 14.3

COMMENTS:

Aug. results follow storm activity, water very turbid.

SEDIMENT PARTICLE SIZE ANALYSIS

% SAND: 0.0 (0.05-2.00 mm)

% SILT: 1.8 (0.05-0.002 mm)

% CLAY: 98.2 (< 0.002 mm)

STATION PROFILES

DEPTH (m)	WATER VELOCITY (m/sec)	CURRENT DIRECTION (°true)	WATER TEMP. (°C)	SALINITY (ppt)	CONDUCTIVITY (uhmos/cm) x 100	SUSPENDED SOLIDS (mg/l)
1	.26	230	7.5	28.5	287	33.7
2	.26	260	7.5	28.5	287	
3	.26	275	7.5	28.5	287	
4	.31	275	7.3	28.5	287	
5	.31	275	7.0	28.5	287	32.9
6	.26	230	7.0	28.5	282	
7	.31	275	6.5	28.5	282	
8	.28	160	6.5	28.5	282	
9	.21	230	6.2	28.5	282	
10	.26	275	6.0	29.0	282	
11	.26	275	6.2	29.0	282	
12	.26	275	6.3	29.0	282	
13	.26	275	6.3	29.0	282	81.8

APPENDIX II

Chemical Data

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
022-1	28/7	14:30	1.73	0.90	1	10.55	110	0.001	0.004	0.05	0.046	1.1
					2	10.00						
					3	10.20						
					4	11.25						
					5	11.15	103	0.001	0.004	0.03	0.016	1.2
					6	11.50						
					7	10.40						
					8	9.35						
					9	9.35						
					10	9.35						
					11	9.35						
					12	9.35	123	0.014	0.003	0.06	0.061	1.2
022-2	31/7	8:30	2.27	1.07	1	10.80	82	0.007	0.001	0.02	0.027	0.6
					2	10.10						
					3	9.80						
					4	9.70						
					5	10.80	103	0.002	0.003	0.03	0.040	0.8
					6	11.20						
					7	11:10						
					8	11:00						
					9	10.35						
					10	10.50						
					11	10.90						
					12	11.10	123	0.014	0.005	0.07	0.79	1.4

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
022-3	27/7	21:00	0.67	0.22	1	10.62	103	0.004	0.003	0.03	0.046	1.0
					2	12.20						
					3	11.60						
					4	11.10						
					5	11.10	96	0.003	0.003	0.03	0.013	0.5
					6							
					7							
					8							
					9							
					10							
					11							
					12	10.65	123	0.015	0.006	0.04	0.047	1.3
022-4	31/7	12:00	1.80	0.98	1	11.6	82	0.005	0.003	0.02	0.012	1.4
					2	11.4						
					3	11.0						
					4	11.0						
					5	11.2	103	0.004	0.003	0.02	0.011	0.9
					6	10.8						
					7	10.9						
					8	10.6						
					9	10.3						
					10	11.0						
					11	10.9						
					12	10.9						
					13	10.9						
					14	10.9	123	0.013	0.007	0.04	0.050	1.3

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
112-1	28/7	12:00	2.00	0.90	1	10.45	116	0.009	0.003	0.02	0.040	1.4
					2	10.45						
					3	10.80						
					4	11.40						
					5	11.70	89	0.002	0.003	0.04	0.038	0.7
					6	11.80						
					7	11.40						
					8	10.3						
					9	9.8						
					10	9.8						
					11	10.0						
					12	10.4	103	0.006	0.007	0.04	0.12	1.5
112-2	27/7	19:00	2.51	1.27	1	10.48	96	0.001	0.003	0.03	0.025	1.6
					2	10.60						
					3	10.70						
					4	10.8						
					5	11.05	82	0.003	0.005	0.05	0.020	0.7
					6	11.90						
					7	10.70						
					8	10.0						
					9	10.10						
					10	10.10						
					11	10.20						
					12	10.2	116	0.015	0.008	0.05	0.12	1.5

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
112-3	26/7	17:30	2.73	1.47	1	10.5	96	0.009	0.002	0.02	0.019	1.4
					2	10.5						
					3	10.7						
					4	10.7						
					5	10.8	96	0.008	0.004	0.04	0.028	1.0
					6	9.6						
					7	10.8						
					8	10.7						
					9	10.3						
					10	9.8						
					11	10.0						
					12	10.4	110	0.019	0.004	0.03	0.027	0.7
112-4	27/7	15:30	2.68	1.51	1	10.4	96	0.003	0.005	0.03	0.012	1.4
					2	10.5						
					3	10.0						
					4	9.5						
					5	9.3	89	0.005	0.003	0.03	0.016	1.0
					6	9.9						
					7	10.1						
					8	10.1						
					9	9.9						
					10	10.3						
					11	10.3						
					12	10.3	103	0.003	0.005	0.06	0.058	1.4

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
202-1	31/7	13:20	1.86	0.44	1	10.40	96	0.006	0.001	0.03	0.041	1.0
					2	10.3						
					3	10.4						
					4	10.5						
					5	10.55	103	0.004	0.003	0.04	0.27	1.1
					6	10.7						
					7	10.8						
					8	11.1						
					9	10.9						
					10	10.9						
					11	10.8						
					12	10.80	116	0.012	0.005	0.05	0.061	1.2
202-2	30/7	13:15	2.90	1.46	1	10.5	82	0.006	0.001	0.05	0.061	1.2
					2	11.5						
					3	11.0						
					4	11.6						
					5	11.6	89	0.007	0.002	0.06	0.044	1.2
					6	11.4						
					7	11.3						
					8	11.2						
					9	11.0						
					10	10.9						
					11	10.7						
					12	10.6	96	0.004	0.005	0.05	0.049	1.3

envirocon

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
202-3	28/7	18:30	2.86	1.28	1	11.6	82	0.009	0.002	0.04	0.009	1.0
					2	11.8						
					3	11.7						
					4	11.4						
					5	11.3	103	0.004	0.003	0.05	0.017	1.0
					6	11.4						
					7	11.7						
					8	11.5						
					9	11.5						
					10	11.5						
					11	11.5						
					12	11.2	123	0.013	0.005	0.06	0.022	1.2
202-4	30/7	10:30	2.91	1.58	1	10.4	82	0.006	0.001	0.03	0.011	0.9
					2	11.3						
					3	10.8						
					4	10.1						
					5	9.8	110	0.004	0.004	0.02	0.046	1.2
					6	9.8						
					7	10.1						
					8	10.2						
					9	10.2	116	0.005	0.005	0.04	0.053	1.3

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
292-1	30/7	23:00	0.98	0.22	1	10.5	96	0.004	0.003	0.03	0.028	1.5
					2	10.4						
					3	10.4						
					4	11.0						
					5	11.15	103	0.015	0.003	0.04	0.046	0.9
					6	10.4						
					7	10.9						
					8	10.7						
					9	10.6						
					10	10.6						
					11	10.5						
					12	10.6	116	0.007	0.007	0.05	0.059	1.3
292-2	30/7	21.30	2.09	1.08	1	10.4	82	0.008	0.001	0.04	0.15	1.3
					2	10.2						
					3	10.3						
					4	10.8						
					5	10.8	96	0.004	0.003	0.04	0.17	1.2
					6	10.6						
					7	10.7						
					8	10.6						
					9	10.4						
					10	10.4						
					11	10.4						
					12	10.2	103	0.013	0.005	0.06	0.076	1.3

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
292-3	29/7	14:00	2.50	1.34	1	10.6	89	0.006	0.001	0.04	0.010	0.8
					2	10.8						
					3	10.8						
					4	11.5						
					5	11.8	103	0.003	0.004	0.03	0.086	1.0
					6	11.4						
					7	10.9						
					8	10.7						
					9	10.6						
					10	10.7						
					11	10.7						
					12	10.7	123	0.007	0.004	0.05	0.046	1.1
292-4	30/7	15:00	2.41	1.24	1	10.4	75	0.006	0.001	0.06	0.013	1.4
					2	10.1						
					3	9.8						
					4	10.0						
					5	10.4	89	0.006	0.001	0.04	0.011	0.8
					6	11.2						
					7	11.3						
					8	10.9						
					9	10.9						
					10	10.9						
					11	10.9						
					12	10.9						
					13	11.0	96	0.006	0.005	0.04	0.039	1.2

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
022-1	25/8	17:00	1.81	0.82	1	9.78	116	0.015	0.003	<0.02	0.095	1.0
					2	9.20						
					3	8.40						
					4	9.20						
					5	10.60	110	0.013	<0.001	0.03	0.065	0.5
					6	10.40						
					7	10.60						
					8	9.60						
					9	10.00						
					10	9.80						
					11	10.60						
					12	11.20	103	0.031	<0.001	0.02	0.055	0.4
022-2	29/8	8:30	2.47	1.33	1	10.80	103	0.015	<0.001	<0.02	0.043	0.8
					2	10.80						
					3	10.30						
					4	10.20						
					5	10.10	103	0.011	<0.001	<0.02	0.035	0.3
					6	10.10						
					7	10.10						
					8	10.20						
					9	10.30						
					10	10.20						
					11	10.20						
					12	10.20	110	0.026	<0.001	0.03	0.056	0.5

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
022-3	29/8	15.30	2.79	1.36	1	10.10	103	0.003	<0.001	<0.02	0.028	0.3
					2	10.10						
					3	10.10						
					4	9.70						
					5	10.10	103	0.003	<0.001	<0.02	0.025	0.2
					6	10.10						
					7	10.00						
					8	9.90						
					9	9.80						
					10	9.90						
					11	9.80						
					12	9.80	103	0.042	<0.001	<0.02	0.045	0.5
022-4	29/8	16:15	2.12	1.14	1	10.20	110	0.004	<0.001	<0.02	0.070	0.2
					2	10.20						
					3	10.20						
					4	10.20						
					5	10.10	110	0.003	<0.001	<0.02	0.030	0.1
					6	10.10						
					7	10.10						
					8	10.10						
					9	10.10						
					10	9.80						
					11	9.80						
					12	9.80						
					13	9.60						
					14	9.45	110	0.004	<0.001	<0.02	0.035	0.2

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
112-1	29/8	16:00	0.98	0.19	1	10.2	103	0.019	<0.001	<0.02	0.065	0.6
					2	10.3						
					3	10.0						
					4	10.2						
					5	10.25	110	0.012	<0.001	<0.02	0.050	0.3
					6	10.6						
					7	10.5						
					8	10.1						
					9	10.1						
					10	10.0						
					11	9.45						
					12	9.45	116	0.026	<0.001	0.03	0.080	0.3
112-2	29/8	7:30	3.10	1.90	1	10.2	110	0.013	<0.001	0.03	0.055	0.4
					2	10.3						
					3	10.5						
					4	10.3						
					5	10.3	116	0.015	<0.001	<0.02	0.088	0.2
					6	10.3						
					7	10.4						
					8	10.3						
					9	10.0						
					10	9.8						
					11	9.6						
					12	9.45	116	0.025	<0.001	<0.02	0.060	0.2

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
112-3	26/8	10:00	1.75	0.83	1	10.4	110	0.013	<0.001	0.03	0.050	0.3
					2	10.8						
					3	10.4						
					4	10.4						
					5	10.4	110	0.012	<0.001	<0.02	0.028	0.3
					6	10.3						
					7	10.0						
					8	9.8						
					9	10.0						
					10	10.1						
					11	9.9						
					12	9.6	110	0.028	<0.001	<0.02	0.058	0.3
112-4	29/8	14:00			1	10.2	110	0.010	0.001	0.04	0.042	0.5
					2	10.3						
					3	10.0						
					4	10.2						
					5	10.3	110	0.004	<0.001	<0.02	0.037	0.2
					6	10.2						
					7	10.0						
					8	9.7						
					9	9.6						
					10	9.6						
					11	9.7						
					12	9.45	110	0.014	0.001	<0.02	0.11	0.3

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
202-1	25/8	14:30	2.69	1.51	1	10.15	116	0.010	<0.001	0.04	0.040	0.2
					2	10.55						
					3	11.2						
					4	10.5						
					5	10.5	123	0.010	<0.001	0.03	0.11	0.4
					6	9.7						
					7	9.0						
					8	9.7						
					9	10.0						
					10	10.8						
					11	10.3						
					12	9.45	116	0.072	<0.001	0.04	0.080	0.4
202-2	29/8	21:30	2.83	1.60	1	10.1	103	0.010	<0.001	0.03	0.020	0.4
					2	10.3						
					3	10.5						
					4	10.1						
					5	10.1	96	0.028	<0.001	0.02	0.045	0.4
					6	10.1						
					7	10.2						
					8	10.1						
					9	10.1						
					10	10.0						
					11	9.9						
					12	9.85	110	0.042	<0.001	0.14	0.12	0.5

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
202-3	29/8	19:00	2.73	1.31	1	10.2	96	0.004	<0.001	<0.02	0.040	0.3
					2	10.4						
					3	10.3						
					4	10.3						
					5	10.3	103	0.028	<0.001	0.04	0.070	0.3
					6	10.4						
					7	10.5						
					8	10.5						
					9	10.5						
					10	10.4						
					11	10.3						
					12	9.75	96	0.042	<0.001	<0.02	0.050	0.3
202-4	26/8	16:30	2.98	1.57	1	10.2	110	0.009	<0.001	0.02	0.003	0.4
					2	10.6						
					3	10.2						
					4	10.5						
					5	10.5	110	0.038	0.002	0.02	0.060	0.5
					6	10.9						
					7	10.7						
					8	10.6						
					9	10.0	96	0.053	0.002	0.02	0.11	0.3

APPENDIX II

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
292-1	25/8	15:30	1.98	0.61	1	10.2	110	0.017	0.002	0.03	0.080	0.5
					2	10.4						
					3	10.6						
					4	10.4						
					5	10.0	123	0.017	0.002	0.03	0.22	0.3
					6	10.0						
					7	9.7						
					8	9.7						
					9	9.9						
					10	9.6						
					11	9.6						
					12	9.45	123	0.057	0.001	0.06	0.12	0.3
292-2	26/8	15:00	2.52	1.11	1	10.3	96	<0.003	<0.001	<0.02	0.025	0.4
					2	10.1						
					3	9.8						
					4	9.8						
					5	10.0	110	0.039	0.001	<0.02	0.028	0.3
					6	10.4						
					7	10.2						
					8	10.0						
					9	9.9						
					10	9.7						
					11	9.7						
					12	9.45	116	0.041	0.001	<0.02	0.055	0.5

ISSERK F-27 ENVIRONMENTAL STUDY

1977 CHEMICAL DATA

STATION	DATE	TIME	SEDIMENT C (%) Total	SEDIMENT C (%) Organic	DEPTH (m)	D.O. (mg/l)	TOT.ALK. (mg/l)	NO_3-N (mg/l)	NO_2-N (mg/l)	NH_3-N (mg/l)	PO_4-P (mg/l)	SILICA (mg/l)
292-3	26/8	11:00	0.65	0.14	1	10.0	103	<0.003	<0.001	<0.02	0.030	0.4
					2	10.4						
					3	10.4						
					4	9.0						
					5	9.0	110	0.011	<0.001	0.09	0.015	0.2
					6	9.6						
					7	9.7						
					8	9.5						
					9	9.4						
					10	9.8						
					11	9.8						
					12	9.45	116	0.027	0.002	0.05	0.085	0.3
292-4	28/8	21:00	2.66	1.03	1	10.4	103	<0.003	<0.001	<0.02	0.040	0.1
					2	10.4						
					3	10.6						
					4	10.3						
					5	10.3	110	<0.003	0.001	0.02	0.025	0.1
					6	10.2						
					7	10.2						
					8	10.4						
					9	10.2						
					10	9.7						
					11	10.0						
					12	9.9		0.009	0.002	0.02	0.050	0.2
					13	10.2	110					

APPENDIX III

a) Phytoplankton catch

b) Analysis of variance of phytoplankton abundance

c) Cluster analysis of phytoplankton by stations

APPENDIX IIIa

PHYTOPLANKTON CATCH (12.5 ml SUBSAMPLE COUNTED)

GEAR: 3 LITRE VAN DORN BOTTLE

STATION JULY, 1977	022-1			022-2			022-3			022-4		
Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
CYANOPHYTA												
Unidentified	7	6			1			1				
CHLOROPHYTA												
Protoderma ? sp.	1											
CHRYSOPHYCEAE												
Dinobryon	6										4	
Chrysomonas sp.	1											
BACILLARIOPHYCEAE												
Achnanthes sp.							1	9	1			
Actinella sp.					1			5	1	1		1
Amphipleura sp.												
Asterionella sp.	109				4		15		3			7
Centronella sp.	26						13	3	1			
Cocconeis sp.												
Cymbella sp.							2					
Diatoma sp.										1		
Epithemia sp.				1			1	1				
Eunotia Sp.	1					1		1			1	
Fragilaria (Ceraton-eis) arcus												
Fragilaria sp.	35	2		3	3	1		1	1	4	1	
Gomphonema sp.												
Gyrosigma sp.							1					1
Licmophora sp.	1						3	2	1		2	1
Navicula gregaria												
Navicula sp.	1	3	2	2	5	1	2	14	4		2	2
Nitzschia seriata	78	370	5	93	20		52		48		98	30
Nitzschia longissima												
Nitzschia sp.	19	3		3	3	18	12	14	6	35	2	4
Peronia sp.												
Rhabdomena sp.									1			
Rhaphoneis sp.	2	1			1	1	1	3		2	4	
Sceletonema sp.									3		1	
Stenoneis sp.	3		1					1				1
Surirella sp.												2

STATION JULY, 1977	022-1			022-2			022-3			022-4		
Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
BACILLARIOPHYCEAE (cont'd)												
Synedra sp.		9		1	2	1	11			2	8	2
Tabellaria fenestrata		3			2						3	1
Tabellaria sp.	261	1		2	5	2	31		2	1		3
Tetracyclus lacustris												
Arachnodiscus												
Chaetoceros borealis								1				
Chaetoceros sp.	99	18	3		5	4	52		194	36	36	60
Coscinodiscus	10	1		14	3		12	5		8	9	3
Cyclotella	9						2	2		1		1
Melosira islandica	75			2	3		7		6	1		5
Melosira sp.	10		2				10	3	2	5		5
Rhizosolenia sp.												
Stephanodiscus sp.	9						1	10	1			
DINOPHYCEAE		1		12	1	3	2			18	14	
Dinophysis sp.	4	2		25		2			1	14	9	2
Ceratium sp.					2			5				
Chrysococcus sp.												
MASTIGOPHORA												
Unidentified	2							1	2			
SARCODINA												
Unidentified Amoebina												
Unidentified Radiolaria												
Unidentified Rhizopoda		11		227	2	3	79	3		74	136	1
CILIATA		22	1	55	12	8	62	2		40	108	8
Unidentified Tintinnida	9	2		5	5			18	2	1	7	1
Unidentified Protozoa	159	2		3	19		140		1	7	9	
ROTATORIA												
Keratella cochlearis												
Kellicottia longispina	1											
Density cells/ml		37.6			15.8			24.0			22.6	
Chlorophyll A (ppm)	<.001	<.001	.001	<.001	<.001	.003	<.001	<.001	<.001	<.001	<.001	.001

APPENDIX IIIa

PHYTOPLANKTON CATCH (12.5 ml SUBSAMPLE COUNTED)
GEAR: 3 LITRE VAN DORN BOTTLE

STATION JULY, 1977	112-1			112-2			112-3			112-4		
Depth (m)	1	5	12	1	5	11	1	5	12	1	5	11
CYANOPHYTA												
Unidentified				9	4		4		3			
CHLOROPHYTA												
Protoderma ? sp.												
CHRYSOPHYCEAE												
Dinobryon		1					5		2			
Chrysomonas sp.												
BACILLARIOPHYCEAE												
Achnanthes sp.	1	2	78	1	1		1		2	2		
Actinella sp.			13							2		
Amphipleura sp.												
Asterionella sp.	1			1	6		2			9		
Centronella sp.				6								
Cocconeis sp.		1										
Cymbella sp.		1	10	2				1	1			
Diatoma sp.			95							5		
Epithemia sp.			33					1	2			
Eunotia Sp .		6	33	3			1	1				
Fragilaria (Ceraton-eis) arcus												
Fragilaria sp.	1		8	2	2		23	7	7	10	1	2
Gomphonema sp.			23									
Gyrosigma sp.						1						
Licmophora sp.		2	35	1				1				
Navicula gregaria												
Navicula sp.			190	6	1		1	4	3	6	3	
Nitzschia seriata	21	47	8	46	80	1	206	75	20	232	171	8
Nitzschia longissima												
Nitzschia sp.	11	2	33	10	4		8	6	8	3		
Peronia sp.						2						
Rhabdomena sp.												
Rhaphoneis sp.				2	1		4	1	1	2	1	
Sceletonema sp.	1				3		1	2	3	3		
Stenoneis sp.			15			1		1		1		
Surirella sp.			18									

STATION JULY, 1977	112-1			112-2			112-3			112-4		
Depth (m)	1	5	12	1	5	11	1	5	12	1	5	11
BACILLARIOPHYCEAE (cont'd)												
Synedra sp.	5	5	30		8	2	4	1	2		3	1
Tabellaria fenestrata	2	3	13									
Tabellaria sp.	11	1		42	4			2	3	7	1	2
Tetracyclus lacustris												
Arachnodiscus												
Chaetoceros borealis				1								
Chaetoceros sp.	38	2		29	8		87	48	25	63	58	123
Coscinodiscus	15	4	5	11	4	1	13	11	2	25	58	3
Cyclotella	1	2					4			1		
Melosira islandica	11	1	15	7	1			1		1		1
Melosira sp.	4	1	10	1	6		1	2		5	18	3
Rhizosolenia sp.												
Stephanodiscus sp.	3		3				1					
Melosira arctica											3	
DINOPHYCEAE (Dinokontae)	4			1		1	40	2	2	17	7	1
Dinophysis sp.			8				15	2	2	1	4	
Ceratium sp.			3								4	
Chrysococcus sp.												
MASTIGOPHORA												
Unidentified												
SARCODINA												
Unidentified Amoebina												
Unidentified Radiolaria										4	3	
Unidentified Rhizopoda	3	2	4	20	41	1	157	29	14	134	43	2
CILIATA	19	10	10	14	9	9	136	41	21	16	51	19
Unidentified Tintinnida	1				7		1	4	4	6	22	5
Unidentified Protozoa	41	2		152	7		9			6		1
ROTATORIA												
Keratella cochlearis												
Kellicottia longispina												
Density Cells/ml.	26.2			15.6			29.2			31.6		
Chlorophyll A (ppm)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001

APPENDIX IIIa

PHYTOPLANKTON CATCH (12.5 ml SUBSAMPLE COUNTED)
GEAR: 3 LITRE VAN DORN BOTTLE

STATION JULY, 1977	202-1			202-2			202-3			202-4		
Depth (m)	1	5	11	1	5	11	1	5	11	1	5	9
CYANOPHYTA												
Unidentified									1	1		
CHLOROPHYTA												
Protoderma ? sp.												
CHRYSOPHYCEAE												
Dinobryon							1					
Chrysomonas sp.												
BACILLARIOPHYCEAE												
Achnanthes sp.		319										
Actinella sp.												
Amphipleura sp.												
Asterionella sp.	2							3				
Centronella sp.	2							2				
Cocconeis sp.												
Cymbella sp.		6			1					1		
Diatoma sp.	1	50								1		4
Epithemia sp.		88					1			1		
Eunotia Sp.		119							1			
Fragilaria (Ceratoneis) arcus												
Fragilaria sp.		69	1	1			2	4	1			1
Gomphonema sp.												
Gyrosigma sp.												
Licmophora sp.		1044	1		1							
Navicula gregaria												
Navicula sp.	3	725	3	1	1	1	3	3	2	1		2
Nitzschia seriata	54	6	115	19	17		145	119	70	47	52	12
Nitzschia longissima												
Nitzschia sp.	4	56	4			100		2	13	1	1	
Peronia sp.				1								
Rhabdomena sp.												
Rhaphoneis sp.		13				1	1	5	2			2
Sceletonema sp.								2				
Stenoneis sp.									1			
Surirella sp.												

STATION JULY, 1977	202-1			202-2			202-3			202-4		
Depth (m)	1	5	11	1	5	11	1	5	11	1	5	9
BACILLARIOPHYCEAE (cont'd)												
Synedra sp.	2	188	1	2			1	4				
Tabellaria fenestrata											1	
Tabellaria sp.	11	25					5	1	4	2	1	2
Tetracyclus lacustris												
Arachnodiscus												
Chaetoceros borealis								1	1			
Chaetoceros sp.	34	6	328	4	4	147	2	51	166	2	189	40
Coscinodiscus	19		2	5	7	8	8	9	4	6	6	1
Cyclotella											1	
Melosira islandica	2	13	3	2		2		3	2	1	1	1
Melosira sp.	3	13	1		2	4	1	13	18		1	2
Rhizosolenia sp.												
Stephanodiscus sp.		6										
DINOPHYCEAE (Dinokontae)											1	
Dinophysis sp.				2		1	8	3	2	6	1	
Ceratium sp.						1		1		3		
Chrysococcus sp.												
MASTIGOPHORA												
Unidentified												
SARCODINA												
Unidentified Amoebina									1			
Unidentified Radiolaria							1			1		
Unidentified Rhizopoda	2			12	32	3	140	86	7	24	23	
CILIATA	34	119	13	5	24	7	6	9	21	51	63	3
Unidentified Tintinnida	4	6	4	1	4	3	2	5		5	1	1
Unidentified Protozoa	236		3	8	16	1	21	72		16	35	3
ROTATORIA												
Keratella cochlearis												
Kellicottia longispina												
Density Cells/ml	100.4			12.0			28.4			16.6		
Chlorophyll A (ppm)	<.001	<.001	.006	<.001	<.001	<.001	<.001	<.001	.002	<.001	.009	.003

APPENDIX IIIa

PHYTOPLANKTON CATCH (12.5 ml SUBSAMPLE COUNTED)

GEAR: 3 LITRE VAN DORN BOTTLE

STATION JULY, 1977	292-1			292-2			292-3			292-4		
Depth (m)	1	5	12	1	5	11	1	5	10	1	5	13
CYANOPHYTA												
Unidentified												9
CHLOROPHYTA												
Protoderma ? sp.												
CHRYSOPHYCEAE												
Dinobryon					31							1
Chrysomonas sp.												
BACILLARIOPHYCEAE												
Achnanthes sp.		1			938			1663				
Actinella sp.			1									
Amphipleura sp.												
Asterionella sp.		1	1						2			
Centronella sp.		2										
Cocconeis sp.												
Cymbella sp.				2	50			94				
Diatoma sp.	2				1150			113				
Epithemia sp.				1	56	1		81		1		2
Eunotia sp.					169		1	88		1		1
Fragilaria (Ceratoneis) arcus												
Fragilaria sp.	1		2		13			94	3			1
Gomphonema sp.												
Gyrosigma sp.											1	
Licmophora sp.	1				731			1044				1
Navicula gregaria	1											
Navicula sp.	1	2	2		1100	1	1	1400			1	4
Nitzschia seriata	21	21	115	4	38	101	45	6	48	85	540	71
Nitzschia longissima												
Nitzschia sp.	2	2	10		63	10		63	2	3	1	4
Peronia sp.	1							13				
Rhabdomena sp.												
Rhaphoneis sp.		3	1					19		1	1	3
Sceletonema sp.										1		
Stenoneis sp.		1	1			1		19				3
Surirella sp.												
Eunotia polydentula			1									

STATION JULY, 1977	292-1			292-2			292-3			292-4		
Depth (m)	1	5	12	1	5	11	1	5	10	1	5	13
BACILLARIOPHYCEAE (cont'd)												
Synedra sp.	3	1	1		138	1		250		6	7	12
Tabellaria fenestrata		1			44					4		
Tabellaria sp.	20	6	2		88	3	4	56	1		3	
Tetracyclus lacustris												
Arachnodiscus												
Chaetoceros borealis												
Chaetoceros sp.	284	261	619		19	151			34	7	7	70
Coscinodiscus	42	7	8			12	19	19	2		15	7
Cyclotella												2
Melosira islandica	2	8	4		6	1		13	1			
Melosira sp.	13	6	1	1	6	3	1			1		5
Rhizosolenia sp.												
Stephanodiscus sp.									2			
DINOPHYCEAE (Dinokontae)	1						5		1	14	2	
Dinophysis sp.			1			1	4		1	12	3	3
Ceratium sp.												
Chrysococcus sp.												
MASTIGOPHORA												
Unidentified												
SARCODINA												
Unidentified Amoebina												
Unidentified Radiolaria	2						1					
Unidentified Rhizopoda	7	15		1		10	72			99	71	3
CILIATA	84	63	17	2		6	27	6	7	52	22	7
Unidentified Tintinnida	8	1				5	2		3	2	16	8
Unidentified Protozoa	121	53	2		6		4	69		7	3	
ROTATORIA												
Keratella cochlearis										1		
Kellicottia longispina												
Density Cells/ml.	49.6			132.4			144.1			32.2		
Chlorophyll A (ppm)	<.001	<.001	<.001	<.001	<.001	.002	<.001	<.001	<.001	<.001	<.001	<.001

envirocon

APPENDIX IIIa

PHYTOPLANKTON CATCH (12.5 ml SUBSAMPLE COUNTED)
GEAR: 3 LITRE VAN DORN BOTTLE

STATION AUGUST, 1977	022-1			022-2			022-3			022-4		
Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
CYANOPHYTA								NO SAMPLES				
Unidentified		13										
CHLOROPHYTA												
Protoderma ? sp.												
CHRYSOPHYCEAE					1							
Dinobryon	156	213	1	1	1	1						
Chrysomonas sp.												
BACILLARIOPHYCEAE												
Achnanthes sp.	1094	2644										295
Actinella sp.												
Amphipleura sp.												
Asterionella sp.		6		1								
Centronella sp.												
Cocconeis sp.												
Cymbella sp.		38										55
Diatoma sp.			1									
Epithemia sp.	119	81										3
Eunotia sp.		6										3
Fragilaria (Ceratoneis) arcus		19										3
Fragilaria sp.	781	1426									1	208
Gomphonema sp.												
Gyrosigma sp.				1						1		
Licmophora sp.	213	1294		1								650
Navicula gregaria												
Navicula sp.	1031	1256	1	2		9				1	2	488
Nitzschia seriata												
Nitzschia longissima		106	6	31	120	25					7	5
Nitzschia sp.	88	13	1	3	3	1						5
Peronia sp.												
Rhabdomena sp.	6											
Rhaphoneis sp.	19											3
Sceletonema sp.												
Stenoneis sp.	6	6			1							
Surirella sp.												

STATION	022-1			022-2			022-3			022-4		
AUGUST, 1977												
Depth (m)	1	5	12	1	5	11	1	5	12	1	5	11
BACILLARIOPHYCEAE (cont'd)												
Synedra sp.	100	81	6	1	3	14					1	10
Tabellaria fenestrata	6											
Tabellaria sp.	6	6		2	1	1				2		8
Tetracyclus lacustris												
Arachnodiscus						1						
Chaetoceros borealis												
Chaetoceros sp.	13		2	1	1	1						
Coscinodiscus	50	6	2	3	2					1	9	
Cyclotella												
Melosira islandica		13	1	1						2		8
Melosira sp.	13			1							2	3
Rhizosolenia sp.												
Stephanodiscus sp.				4		1				7		20
DINOPHYCEAE												
Dinophysis sp.												
Ceratium sp.												
Chrysococcus sp.								NO SAMPLES				
MASTIGOPHORA												
Unidentified	6			2							1	5
SARCODINA												
Unidentified Amoebina												
Unidentified Radiolaria	6	6										
CILIATA			2	6						4	2	3
Unidentified Tintinnida	6	6	2	4	6	2				2	4	5
Unidentified Protozoa	13	31		14	7	2				2	1	
ROTATORIA												
Keratella cochlearis												
Kellicottia longispina												
Density cells/ml.		294.1			7.6			121.0			48.9	
Chlorophyll A (ppm)	<.001	<.001	<.001	.001	.002	<.001	<.001	<.001	<.001	<.001	.003	<.001

APPENDIX IIIa

PHYTOPLANKTON CATCH (12.5 ml SUBSAMPLE COUNTED)

GEAR: 3 LITRE VAN DORN BOTTLE

STATION	112-1			112-2			112-3			112-4		
AUGUST, 1977 Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
CYANOPHYTA												
Unidentified												
CHLOROPHYTA												
Protoderma ? sp.												
CHRYSOPHYCEAE												
Dinobryon		10	75							69	63	163
Chrysomonas sp.												
BACILLARIOPHYCEAE												
Achnanthes sp.		328		1	1180					1269		
Actinella sp.												
Amphipleura sp.												
Asterionella sp.			19		5							
Centronella sp.												
Cocconeis sp.												
Cymbella sp.		55	263		220					125	13	275
Diatoma sp.							1					
Epithemia sp.		13	25		320		1					
Eunotia sp.			13		5							
Fragilaria (Ceratoneis) arcus		8			25					19		
Fragilaria sp.		231	69		515		1			781		238
Gomphonema sp.					5							
Gyrosigma sp.												13
Licmophora sp.		160	138		268					413		125
Navicula gregaria												
Navicula sp.	11	423	425	4	503	4	3	2	14	1188		275
Nitzschia intermedia?					108							
Nitzschia longissima	29	10	13	54	10	16	21	33	18	13	25	13
Nitzschia sp.		10	56	4	25	5		1		19		100
Peronia sp.												
Rhabdomena sp.												
Rhaphoneis sp.		3	150	2	3	1			1	31		150
Sceletonema sp.												
Stenoneis sp.												
Surirella sp.												

STATION AUGUST, 1977	112-1			112-2			112-3			112-4		
Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
BACILLARIOPHYCEAE (cont'd)												
Synedra sp.	2	25	38		35	5	7	7	14	131		38
Tabellaria fenestrata		3										
Tabellaria sp.		3	31			5		1	1	38		
Tetracyclus lacustris					3							
Arachnodiscus	1		6		10							
Chaetoceros borealis												
Chaetoceros sp.		3	6	2	8	5		13	12	6		13
Coscinodiscus	11			3		3	2	10	2	13		38
Cyclotella												
Melosira islandica		3			20	1		2	3	6	6	38
Melosira sp.					10	2		2	1			38
Rhizosolenia sp.								3				
Stephanodiscus sp.			6	1	3			2		13		
DINOPHYCEAE												
Dinophysis sp.								1				
Ceratium sp.												
Chrysococcus sp.								1				
MASTIGOPHORA (flagellata)	1				3							
Unidentified												
SARCODINA												
Unidentified Amoebina												
Unidentified Radiolaria												
CILIATA	24		6	31	5		12	12		6		13
Unidentified Tintinnida	65	15		4	38	1	31	52	1	6	6	
Unidentified Protozoa	12	5	19	7	3	1	9	4		13		13
ROTATORIA												
Keratella cochlearis												
Kellicottia longispina												
Density cells/ml.		75.3			93.1			7.9			117.7	
Chlorophyll A (ppm)	.001	<.001	<.001	<.001	.001	.003	<.001	.002	<.001	<.001	<.001	<.001

APPENDIX IIIa

PHYTOPLANKTON CATCH (12.5 ml SUBSAMPLE COUNTED)

GEAR: 3 LITRE VAN DORN BOTTLE

STATION AUGUST, 1977	202-1			202-2			202-3			202-4		
Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
CYANOPHYTA												
Unidentified												
CHLOROPHYTA												
Protoderma ? sp.												
CHRYSOPHYCEAE												
Dinobryon	313	238	44						1	1		113
Chrysomonas sp.												
BACILLARIOPHYCEAE												
Achnanthes sp.			2294									2200
Actinella sp.												
Amphipleura sp.												
Asterionella sp.			6									
Centronella sp.												
Cocconeis sp.												
Cymbella sp.		750	144	1			1				30	175
Diatoma sp.												
Epithemia sp.			6									50
Eunotia sp.	13											
Fragilaria (Ceratoneis) arcus			19									25
Fragilaria sp.		400	725						1		5	1288
Gomphonema sp.		13										
Gyrosigma sp.												
Licmophora sp.		125	1981								8	838
Navicula gregaria												
Navicula sp.		650	1663	4	4	2	2	4	2	2	30	1975
Nitzschia intermedia?											3	
Nitzschia longissima			13	78	51	1	56	40	29	3	15	13
Nitzschia sp.		100	6	1	3		3				20	63
Peronia sp.												
Rhabdomena sp.												
Rhaphoneis sp.	13	363	13								18	
Rhopalodia gibba				1								
Stenoneis sp.		13										
Surirella sp.												

STATION AUGUST, 1977	202-1			202-2			202-3			202-4		
Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
BACILLARIOPHYCEAE (cont'd)												
Synedra sp.	25	88	38	1	5	4	6	1	14	4	5	100
Tabellaria fenestrata	13											25
Tabellaria sp.	13	50	6	2			1		4	1	20	25
Tetracyclus lacustris												
Arachnodiscus		50						1				
Chaetoceros borealis										1		13
Chaetoceros sp.		13	6	4	2		1	2			3	
Coscinodiscus	25			6	1		1	2	2	1		
Cyclotella												
Melosira islandica			6									25
Melosira sp.		38	13	2			1		1			
Rhizosolenia sp.												
Stephanodiscus sp.				9			2					
DINOPHYCEAE												
Dinophysis sp.												
Ceratium sp.												
Chrysococcus sp.												
MASTIGOPHORA												
Unidentified												
SARCODINA												
Unidentified Amoebina												
Unidentified Radiolaria												
CILIATA				5				1		1	3	
Unidentified Tintinnida	50	13		2	1	1		4		6		
Unidentified Protozoa		38	19	14			7	1		8	5	
ROTATORIA												
Keratella cochlearis												
Kellicottia longispina												
Density cells/ml.		277.6			5.5			5.1			189.9	
Chlorophyll A (ppm)	<.001	<.001	<.001	<.001	<.001	.002	<.001	<.001	<.001	<.001	<.001	<.001

APPENDIX IIIa

PHYTOPLANKTON CATCH (12.5 ml SUBSAMPLE COUNTED)

GEAR: 3 LITRE VAN DORN BOTTLE

STATION AUGUST, 1977	292-1			292-2			292-3			292-4		
Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
CYANOPHYTA												
Unidentified												
CHLOROPHYTA												
Protoderma ? sp.												
CHRYSOPHYCEAE												
Dinobryon	3	63	88	2								50
Chrysomonas sp.												
BACILLARIOPHYCEAE												
Achnanthes sp.	325	3875	2225								1028	150
Actinella sp.												
Amphipleura sp.												
Asterionella sp.												
Centronella sp.												
Cocconeis sp.												
Cymbella sp.	15	200	106								30	31
Diatoma sp.												
Epithemia sp.	3		13								3	
Eunotia sp.	3										5	13
Fragilaria (Ceratoneis) arcus	5		13								10	
Fragilaria sp.	298	775	294	1		3					220	44
Gomphonema sp.												
Gyrosigma sp.												
Licmophora sp.	25	4438	3825				10				703	
Navicula gregaria												
Navicula sp.	8	2475	1856	5		5	30	2	3	10	508	125
Nitzschia seriata					3		10					
Nitzschia longissima	5		6	14	20	13	140	77	2		13	19
Nitzschia sp.	5		44			3				3	8	6
Peronia sp.												
Rhabdomena sp.							10					
Rhaphoneis sp.			38								5	6
Sceletonema sp.												
Stenoneis sp.								1				
Surirella sp.			6									

STATION AUGUST, 1977	292-1			292-2			292-3			292-4		
Depth (m)	1	5	12	1	5	12	1	5	11	1	5	15
BACILLARIOPHYCEAE (cont'd)												
Synedra sp.	13	25	50	31	5	3	20	3	2		38	50
Tabellaria fenestrata												
Tabellaria sp.		63	6				10			3	68	13
Tetracyclus lacustris												
Arachnodiscus												
Chaetoceros borealis	3			9			50	10				
Chaetoceros sp.		13	19	14				19				6
Coscinodiscus	5	13		17	5	13	50	10	4	13	25	25
Cyclotella												
Melosira islandica						5				8	5	6
Melosira sp.			6	6		3			1		3	
Rhizosolenia sp.												
Stephanodiscus sp.												
DINOPHYCEAE												
Dinophysis sp.												
Ceratium sp.												
Chrysococcus sp.												
MASTIGOPHORA												
Unidentified	3						70			3		
SARCODINA												
Unidentified Amoebina												
Unidentified Radiolaria												
CILIATA	3			22			40			3		
Unidentified Tintinnida	3	25		212		8	290	1	3	10		6
Unidentified Protozoa	3			10			70			3		19
ROTATORIA												
Keratella cochlearis												
Kellicottia longispina												
Density cells/ml.	567.7			11.5			25.0			87.9		
Chlorophyll A (ppm)	<.001	<.001	<.001	<.001	<.001	<.001	.003	.002	<.001	<.001	.001	.008

APPENDIX IIIb

ANALYSIS OF VARIANCE OF PHYTOPLANKTON ABUNDANCE

JULY, 1977

Source of Variation	Sum of squares (ss)	Degrees of Freedom (df)	Mean square (ms)	F
Distance	2294.2	3	764.7	0.532 ns
Transect	11172.9	3	3724.3	2.60 ns
Residual	12914.7	9	1435.0	
Total	26381.8	15		

AUGUST, 1977

Source of Variation	Sum of squares (ss)	Degrees of Freedom (df)	Mean square (ms)	F
Distance	193822.8	3	64607.6	4.55 *
Transect	19898.6	3	6632.9	0.47
Residual	127856.2	9	14206.2	
Total	341577.6	15		

* Significant $P < 0.05$
ns Not significant at the 0.05 level

APPENDIX IIIc CLUSTER ANALYSIS OF PHYTOPLANKTON BY STATIONS

JULY, 1977

Step	Low	High	Distance Value
1	022-1	202-1	1332.1
2	022-1	292-1	998.01
3	202-1	292-2	991.20
4	202-1	292-3	766.48
5	022-1	292-4	482.23
6	022-1	022-2	401.59
7	022-2	112-1	300.02
8	022-2	112-3	286.46
9	022-2	022-3	252.08
10	022-3	112-2	221.65
11	112-3	112-4	208.95
12	022-3	202-2	191.73
13	202-2	202-4	176.34
14	022-2	022-4	165.73
15	112-3	202-3	132.02

AUGUST, 1977

Step	Low	High	Distance Value
1	022-1	292-1	3264.1
2	022-1	022-2	1659.7
3	022-1	112-4	947.38
4	022-2	022-4	630.51
5	022-1	202-4	358.93
6	022-2	292-3	353.70
7	022-4	112-1	349.38
8	022-1	202-1	267.75
9	022-4	112-2	249.56
10	022-2	112-3	222.92
11	112-2	292-4	178.04
12	112-3	292-2	153.36
13	022-2	202-2	54.881
14	202-2	202-3	23.452

APPENDIX IV

a) Total zooplankton catch from vertical hauls

b) Total zooplankton catch from surface trawls

c) Analysis of variance of zooplankton biomass

d) Student-Newman-Keuls test for July zooplankton biomass

e) Cluster analysis of zooplankton by stations

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977

STATION:	022-1			022-2			022-3			022-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
RHIZOPODA												
Elphidiella arctica									8			
HYDROZOA												
Aegina citrea				8	8					4		
Aglantha sp.		12			1							
Gonionemus vertens												
Obelia sp.										8	12	
Polyorchis karafutoensis												
Leuckatiara sp.				1	1			1				2
Coryne princeps												
Laomedia longissima				64	40	4	32	40				
Corymorpha flammea												
Mitrocomella sp.												
CTENOPHORA												
Dryadora sp.												
POLYCHAETA												
Unidentified Spionidae	1											
Trochophores (polychaeta larvae)		468	360	5,776	3,288	2,512	3,696	1,432	736	2,104	2,396	1,564
PELECYPODA												
Unidentified												
GASTROPODA												
Limacina helicina	15	36	17				17	16	208	16	20	40
Limacina sp.				20	29	22						
Clione sp.	1	4		5	1	4	2		8			1
Veliger larvae												

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977

STATION:	022-1			022-2			022-3			022-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
COPEPODA												
Calanus hyperboreus	1						8					
Calanus glacialis	38	20	12	216	128	92	32	112	104	20	164	80
Calanus finmarchicus												
Calanus sp.												
Metridia longa	924	1,444	644	1,232	912	892	376	224	616	1,052	560	644
Metridia lucens												
Metridia sp.												
Pseudocalanus minutus	12	188	96	384	296	244	96	152	80	24	76	72
Eurytemora sp.				8	24	16				4	4	4
Oithona sp.		40	32	80	64	108	48	104	40		12	20
Oncaea sp.		8									16	4
Unidentified harpacticoids											8	
Unidentified copepodids	544	1,040	684	2,368	2,528	1,456	1,720	2,056	976	456	880	1,144
Nauplii	464	1,992	1,072	6,592	5,664	4,832	2,688	3,648	1,960	1,016	5,232	3,744
BRANCHIOPODA												
Podon sp.								4				
MALACOSTRACA												
Unidentified (Pandalidae)	1											
Unidentified (Hyperia ? sp)												
Orchomene sp.												
Unidentified (Lysianassidae)									8			
Unidentified (Calliopiidae)												
Oedocerus sp.		4										
Euphausia ? sp						4						
Unidentified furcilia (Euphausiacea)												
CIRRIPEDIA												
Unidentified (barnacle nauplii)		4	4		16	4	8	8		4		
INSECTA												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977

STATION:	022-1			022-2			022-3			022-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
SIPUNCULA												
Prionglossa sp.		4										
BRYOZOA												
Cyphonaut larvae												
ECHINODERMATA												
Unidentified												
(Ophiuroidea)												
(Asteroidea)												
CHORDATA												
Oikopleura sp.	7	4	4	16	8	40	8	16		12	32	32
CHAETOGNATHA												
Sagitta sp.	2					4		8				
OSTEICHTHYES												
Myxocephalus quadricornis												
Delolepis gigantea												
Liparis rutteri												
Unidentified larval fish (Pleuronectidae)												
Density organisms/m^2 ($\times 10^3$)		17.4			68.0			36.2			36.5	
Biomass (wet) g/m^2		2.253			5.254			5.680			2.641	

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS
GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977

STATION:	112-1			112-2			112-3			112-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
RHIZOPODA												
Elphidiella arctica				2		2				8		
HYDROZOA												
Aegina citrea												
Aglantha sp.	4	20							4		8	4
Gonionemus vertens												
Obelia sp.												
Polyorchis karafutoensis												
Leuckatiara sp.			1				4		1			
Coryne princeps												
Laomedia longissima												
Corymorpha flammea												
Mitrocomella sp.												
CTENOPHORA												
Dryadora sp.					4				4			
POLYCHAETA												
Unidentified Trochophores (polychaeta larvae)	668	3,016	3,576	2		114	132		104	96	580	296
Spionidae	14	4		6	6		8					
PELECYPODA												
Unidentified												
GASTROPODA												
Limacina helicina	9	16	1									
Limacina sp.												
Clione sp.	1		1									
Veliger larvae												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977

STATION:	112-1			112-2			112-3			112-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
COPEPODA												
Calanus hyperboreus		4			2			4				
Calanus glacialis	62	36	48	30	84	4	72	50	68	216	28	120
Calanus finmarchicus												
Calanus sp.												
Metridia longa	354	412	784	466	410	40	1,144	660	1,292	1,040	1,304	584
Metridia lucens												
Metridia sp.												
Pseudocalanus minutus	194	84	72	76	122	10	180	56	132	400	84	452
Eurytemora sp.												
Oithona sp.	4	16	72	82	4	4	172		76	16	8	32
Oncaea sp.		8	32	6	2		8		28		4	
Unidentified harpacticoids		8										
Unidentified copepodids	370	944	1,184	1,396	456	952	2,416	460	1,508	3,648	1,320	1,188
Nauplii	186	860	1,808	1,908	660	952	2,140	380	1,720	5,640	996	1,724
BRANCHIOPODA												
Podon sp.												
MALACOSTRACA												
Unidentified (Pandalidae)												
Unidentified (Hyperia ? sp)												
Orchomene sp.												
Unidentified (Lysianassidae)												
Unidentified (Calliopiidae)												
Oedocerus sp.												
Euphausia ? sp		4										
Unidentified furcilia (Euphausiacea)	2											
CIRRIPEDIA												
Unidentified (barnacle nauplii)		8										
INSECTA												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977

STATION:	112-1			112-2			112-3			112-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
SIPUNCULA												
Prionglossa sp.												
BRYOZOA												
Cyphonaut larvae						2						
ECHINODERMATA												
Unidentified												
(Ophiuroidea)												
(Asteroidea)												
CHORDATA												
Oikopleura sp.					2							
CHAETOGNATHA												
Sagitta sp.	1										4	
OSTEICHTHYES												
Myxocephalus quadricornis												
Delolepis gigantea												
Liparis rutteri												
Unidentified larval fish (Pleuronectidae)												
Density organisms/m^2 ($x10^3$)	25.3			13.3			21.8			35.4		
Biomass (wet) g/m^2	3.546			1.122			2.988			2.692		

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977

STATION:	202-1			202-2			202-3			202-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
RHIZOPODA												
Elphidiella arctica												
HYDROZOA												
Aegina citrea												
Aglantha sp.			4	2			4			9	4	
Gonionemus vertens												
Obelia sp.		4										
Polyorchis karafutoensis												
Leuckatiara sp.						4						1
Coryne princeps												
Laomedia longissima												
Corymorpha flammea												
Mitrocomella sp.											4	
CTENOPHORA												
Dryadora sp.	no sample											
POLYCHAETA												
Unidentified Trochophores (polychaeta larvae)		24	44	264	1,952	1,432	480		96	148	80	112
Spionidae								3	8	4		
PELECYPODA												
Unidentified												
GASTROPODA												
Limacina helicina		14	12	14	28	25	32	15	18	8	4	5
Limacina sp.												
Clione sp.					2				4		8	1
Veliger larvae									18			

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977 STATION:	202-1			202-2			202-3			202-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
COPEPODA												
Calanus hyperboreus					8							
Calanus glacialis		152	196	84	232	48	164	183	188	240	184	160
Calanus finmarchicus												
Calanus sp.												
Metridia longa		172	248	64	440	120	184	210	334	2,540	1,784	2,975
Metridia lucens												
Metridia sp.								3				
Pseudocalanus minutus		172	240	20	72	92	176		90	220	268	144
Eurytemora sp.						4						
Oithona sp.		64	104	4	64	48	36		2	100	72	144
Oncaea sp.					32		8					8
Unidentified harpacticoids										8		
Unidentified copepodids		2,628	2,584	448	2,864	1,628	1,792	2,025	1,014	3,160	3,460	2,664
Nauplii	no sample	4,360	5,480	680	2,416	3,040	1660	1,188	880	2,300	1,604	1,192
BRANCHIOPODA												
Podon sp.												
MALACOSTRACA												
Unidentified (Pandalidae)												
Unidentified (Hyperia ? sp)					1	1						1
Orchomene sp.		1										
Unidentified (Lysian assidae)			4									
Unidentified (Calliop-iidae)							8					
Oedocerus sp.												
Euphausia ? sp										2		
Unidentified furcilia (Euphausiacea)												
CIRRIPEDIA												
Unidentified (barnacle nauplii)												
INSECTA												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977												
STATION:	202-1			202-2			202-3			202-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA	no sample											
SIPUNCULA												
Prionglossa sp.												
BRYOZOA												
Cyphonaut larvae												
ECHINODERMATA												
Unidentified												
(Ophiuroidea)												
(Asteroidea)												
CHORDATA												
Oikopleura sp.			8	4			4	5	2		8	8
CHAETOGNATHA												
Sagitta sp.								1		1		
OSTEICHTHYES												
Myxocephalus quadricornis												
Delolepis gigantea												
Liparis rutteri												
Unidentified larval fish (Pleuronectidae)												
Density organisms/m^2 ($x10^3$)		63.2			27.4			18.4			40.2	
Biomass (wet) g/m^2		2.418			2.759			1.716			6.219	

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977

STATION:	292-1			292-2			292-3			292-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA					no sample							
RHIZOPODA												
Elphidiella arctica				4								
HYDROZOA												
Aegina citrea												
Aglantha sp.	1	2	4	12		3	2	8				8
Gonionemus vertens												
Obelia sp.							20	8				
Polyorchis karafutoensis												
Leuckatiara sp.				1		1	2	8		1	8	1
Coryne princeps												
Laomedia longissima												
Corymorpha flammea												
Mitrocomella sp.												
CTENOPHORA												
Dryadora sp.						4						
POLYCHAETA												
Unidentified Trochophores (polychaeta larvae)		48	60	184		436	3,048	10,272	2,432	2,320	2,144	4,792
PELECYPODA												
Unidentified												
GASTROPODA												
Limacina helicina	6	9	32	3		2	11	136	128	30	18	21
Limacina sp.												
Clione sp.		1					2	24	16			2
Veliger larvae												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977												
STATION:	292-1			292-2			292-3			292-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
COPEPODA												
Calanus hyperboreus												
Calanus glacialis	72	160	196	40		48	68	40	16	8	88	152
Calanus finmarchicus												
Calanus sp.												
Metridia longa	472	788	564	104		232	416	1,712	584	872	856	1,080
Metridia lucens												
Metridia sp.												
Pseudocalanus minutus	124	132	248	36		60	68	104	16	192	240	136
Eurytemora sp.						24	4	32		8	8	
Oithona sp.	20	16	80	96		16	32	24	32	88	40	184
Oncaea sp.	12		8	4			4			8		
Unidentified harpacticoids												
Unidentified copepodids	912	880	1,080	1,456		3,440	800	1,328	472	1,872	2,640	2,408
Nauplii	2,024	1,792	2,752	2,408		1,988	1,640	1,920	496	4,368	5,728	4,256
BRANCHIOPODA					no sample							
Podon sp.												
MALACOSTRACA												
Unidentified (Pandalidae)												
Unidentified (Hyperia ? sp)	1											2
Orchomene sp.												
Unidentified (Lysianassidae)												
Unidentified (Calliopiidae)												
Oedocerus sp.												
Euphausia ? sp									8			
Unidentified furcilia (Euphausiacea)												
CIRRIPEDIA												
Unidentified (barnacle nauplii)		4										
INSECTA												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: JULY, 1977												
STATION:	292-1			292-2			292-3			292-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
SIPUNCULA												
Prionglossa sp.												
BRYOZOA												
Cyphonaut larvae												
ECHINODERMATA												
Unidentified												
(Ophiuroidea)												
(Asteroidea)												
CHORDATA												
Oikopleura sp.	4						8	8	8	16	16	2
CHAETOGNATHA												
Sagitta sp.	1	1								2	16	16
OSTEICHTHYES												
Myxocephalus quadricornis												
Delolepis gigantea												
Liparis rutteri	1			1								
Unidentified larval fish (Pleuronectidae)			1									
Density organisms/m^2 ($x10^3$)		21.3			40.6			44.1			58.9	
Biomass (wet) g/m^2		3.206			5.198			2.713			2.755	

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977

STATION:	022-1			022-2			022-3			022-3		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
RHIZOPODA												
Elphidiella arctica												
HYDROZOA												
Aegina citrea	7	7						16	16	16	1	
Aglantha sp.	224	2	12	1	9	1	9	16	128	3	11	10
Gonionemus vertens	2											
Obelia sp.												
Polyorchis karafutoensis											1	
Leuckatiara sp.	1				1	3	1					
Coryne princeps												
Laomedia longissima												
Corymorpha flammea												
Mitrocomella sp.												
CTENOPHORA												
Dryadora sp.	16	1		1			4		48	32	1	
POLYCHAETA												
Unidentified Trochophores (polychaeta larvae)	384	1,048	72	96	4	32	2,240	1,504	960	1,984	1,264	1,456
PELECYPODA												
Unidentified		12			10							
GASTROPODA												
Limacina helicina							96	48		16		8
Limacina sp.												
Clione sp.		1		1					16			
Veliger larvae												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977

STATION:	022-1			022-2			022-3			022-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
COPEPODA												
Calanus hyperboreus												
Calanus glacialis	448	20	76	56	25	496	672	976	368	352		48
Calanus finmarchicus												
Calanus sp.			4									
Metridia longa							64			32		8
Metridia lucens												
Metridia sp.				12				32				
Pseudocalanus minutus	128	64	16	16	40	1,088	768	800	288	80		16
Eurytemora sp.												
Oithona sp.	192	456	200	1,112	228	128	1,600	960	672	832	352	768
Oncaea sp.	32	824	88	72	20	160	1,280	896	352	448	24	144
Unidentified harpacticoids												
Unidentified copepodids	20,352	5,164	5,160	6,200	3,256	10,624	42,240	36,320	19,904	18,912	8,112	15,120
Nauplii	192	3,904	144	2,832	1,204	64	4,864	4,704	2,528	2,080	3,440	6,496
BRANCHIOPODA												
Podon sp.										16		
MALACOSTRACA												
Unidentified												
Unidentified (Hyperia? sp)		1									8	
Orchomene sp.												
Unidentified (Lysianassidae)												
Unidentified (Calliopiidae)												
Oedocerus sp.												
Euphausia ? sp			1		1	1						1
Unidentified furcilia (Euphausiacea)										16		
CIRRIPEDIA												
Unidentified (barnacle nauplii)					2							
INSECTA												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977												
STATION:	022-1			022-2			022-3			022-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
SIPUNCULA												
Prionglossa sp.												
BRYOZOA												
Cyphonaut larvae												
ECHINODERMATA												
Unidentified												
(Ophiuroidea)								16				
(Asteroidea)												
CHORDATA												
Oikopleura sp.		4					32					
CHAETOGNATHA												
Sagitta sp.	5				3	3						1
OSTEICHTHYES												
Myxocephalus quadricornis												
Delolepis gigantea					1							
Liparis rutteri												
Unidentified larval fish (Pleuronectidae)												
Density organisms/m^2 ($\times 10^3$)		66.8			47.3			213.3			105.6	
Biomass (wet) g/m^2		8.379			4.136			13.364			9.488	

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977 STATION:	112-1			112-2			112-3			112-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
RHIZOPODA												
Elphidiella arctica												
HYDROZOA												
Aegina citrea			16	80	2		1	2	2			
Aglantha sp.		7	4	7	80	5	10	5	1	6	7	
Gonionemus vertens												
Obelia sp.												
Polyorchis karafutoensis												
Leuckatiara sp.		16		1			1	2	1			
Coryne princeps				1								
Laomedia longissima												
Corymorpha flammea												
Mitrocomella sp.												
CTENOPHORA												
Dryadora sp.	3	5	32		4	2	1	2	3			
POLYCHAETA												
Unidentified Trochophores (polychaeta larvae)	12	192	896	416	640	560	768	384	1,216	32	16	no sample
PELECYPODA												
Unidentified					16						20	
GASTROPODA												
Limacina helicina				16	32		32	32	32			
Limacina sp.					1		1			1		
Clione sp.												
Veliger larvae												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977

STATION:	112-1			112-2			112-3			112-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
COPEPODA												
Calanus hyperboreus		32							32	1		
Calanus glacialis	14	336		128	224	176	272	336	800	80	32	
Calanus finmarchicus												
Calanus sp.												
Metridia longa		48					16			32	8	
Metridia lucens												
Metridia sp.												
Pseudocalanus minutus		128	320	96	96	96	112	96	192	160	8	
Eurytemora sp.												
Oithona sp.	52	80	1,440	3,456	928	656	1,024	1,088	2,176	1,440	712	
Oncaea sp.	24	64	224	1,408	928	720	608	608	1,088	128	96	
Unidentified harpacticoids	2		16									
Unidentified copepodids	1,076	12,128	13,792	16,000	18,240	12,176	20,608	12,704	40,704	10,848	6,080	no sample
Nauplii	1,272	768	2,656	1,728	1,984	2,256	1,664	992	4,672	9,120	712	
BRANCHIOPODA												
Podon sp.												
MALACOSTRACA												
Unidentified (Pandalidae)												
Unidentified (Hyperia ? sp)												
Orchomene sp.												
Unidentified (Lysianassidae)												
Unidentified (Calliopiidae)												
Oedocerus sp.												
Euphausia ? sp		16		2	1		2	1		2	5	
Unidentified furcilia (Euphausiacea)												
CIRRIPEDIA												
Unidentified (barnacle nauplii)												
INSECTA												

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TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977

STATION:	112-1			112-2			112-3			112-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
SIPUNCULA												
Prionglossa sp.												
BRYOZOA												
Cyphonaut larvae												
ECHINODERMATA												
Unidentified												
(Ophiuroidea)												
(Asteroidea)												
CHORDATA												
Oikopleura sp.												
CHAETOGNATHA												
Sagitta sp.				1				16				
OSTEICHTHYES												
Myxocephalus quadricornis												
Delolepis gigantea												
Liparis rutteri										1		
Unidentified larval fish (Pleuronectidae)												
Density organisms/m^2 ($x10^3$)		60.7			107.4			157.0			113.1	
Biomass (wet) g/m^2		5.481			8.224			11.832			5.429	

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS
GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977 STATION:	202-1			202-2			202-3			202-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
RHIZOPODA												
Elphidiella arctica												
HYDROZOA												
Aegina citrea			2								1	
Aglantha sp.	3		3	7	4		7	8	2	4	8	8
Gonionemus vertens												
Obelia sp.												
Polyorchis karafutoensis										1		
Leuckatiara sp.	1		1	1						8	1	
Coryne princeps												
Laomedia longissima												
Corymorpha flammea												
Mitrocomella sp.												
CTENOPHORA												
Dryadora sp.		1	5							3	3	1
POLYCHAETA												
Unidentified Trochophores (polychaeta larvae)	16	256	288	96	48	96	64	48	48	1,024	576	80
PELECYPODA												
Unidentified				104	12		60	24	8		32	24
GASTROPODA												
Limacina helicina		16					1		1			
Limacina sp.												
Clione sp.						1					32	
Veliger larvae												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977

STATION:	202-1			202-2			202-3			202-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
COPEPODA												
Calanus hyperboreus		16	48	80	4							
Calanus glacialis	272	272	160	24	24	64	20	16	24	800	480	16
Calanus finmarchicus					12		4			192		8
Calanus sp.												
Metridia longa	32		16	8	12	8	32		16	32	32	24
Metridia lucens		16										
Metridia sp.												
Pseudocalanus minutus	160	224	448	32	72	40	80	48	112	576	1,664	64
Eurytemora sp.				8								8
Oithona sp.	256	1,152	672	1,472	760	1,792	1,344	1,664	1,808	960	800	1,680
Oncaea sp.	256	352	672	160	56		136	80	272	2,176	1,216	416
Unidentified harpacticoids		16										
Unidentified copepodids	15,264	25,792	23,936	8,928	5,376	10,592	7,568	6,032	14,160	48,704	44,928	7,824
Nauplii	192	704	800	4,432	3,144	3,824	11,552	8,432	15,248	512	512	13,488
BRANCHIOPODA												
Podon sp.						8						
MALACOSTRACA												
Unidentified (Pandalidae)												
Unidentified (Hyperia ? sp)										1		
Orchomene sp.												
Unidentified (Lysianassidae)												
Unidentified (Calliopiidae)												
Oedocerus sp.		1	2		3		1		2	1		
Euphausia ? sp												4
Unidentifed furcilia (Euphausiacea)												
CIRRIPEDIA												
Unidentified (barnacle nauplii)								8		32		
INSECTA												

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TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977												
STATION:	202-1			202-2			202-3			202-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
SIPUNCULA												
Prionglossa sp.												
BRYOZOA												
Cyphonaut larvae												
ECHINODERMATA												
Unidentified												
(Ophiuroidea)												
(Asteroidea)											32	
CHORDATA												
Oikopleura sp.												
CHAETOGNATHA												
Sagitta sp.	2		3	2		8				2		3
OSTEICHTHYES												
Myxocephalus quadricornis												
Delolepis gigantea												
Liparis rutteri	1											
Unidentified larval fish (Pleuronectidae)												
Density organisms /m^2 ($x10^3$)		123.0			70.3			117.2			219.4	
Biomass (wet) g/m^2		8.685			2.753			2.062			8.831	

APPENDIX IVa

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977

STATION:	292-1			292-2			292-3			292-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
RHIZOPODA												
Elphidiella arctica												
HYDROZOA												
Aegina citrea	16	1			16		1	2				
Aglantha sp.		24		16	16	16	3	1	8	8	8	2
Gonionemus vertens												
Obelia sp.												8
Polyorchis karafutoensis												
Leuckatiara sp.	1	1		16	1	1				1		
Coryne princeps												
Laomedia longissima												
Corymorpha flammea												
Mitrocomella sp.												
CTENOPHORA												
Dryadora sp.												
POLYCHAETA												
Unidentified Trochophores (polychaeta larvae)	128	240	32	1,344	1,120	992	448		544	48	224	40
PELECYPODA												
Unidentified											120	
GASTROPODA												
Limacina helicina				32	112	16	48	24	24		8	
Limacina sp.												
Clione sp.												
Veliger larvae												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977												
STATION:	292-1			292-2			292-3			292-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
TAXA												
COPEPODA												
Calanus hyperboreus												
Calanus glacialis	256	120	26	384	304	624	27	240	248	48	72	8
Calanus finmarchicus												
Calanus sp.												
Metridia longa					16			8	40			2
Metridia lucens												
Metridia sp.						16						
Pseudocalanus minutus	16	24	4	96	144	448	96	512	336	80	96	4
Eurytemora sp.												
Oithona sp.	1,280	304	24	2,144	1,392	1,184	880	1,008	1,136	384	816	416
Oncaea sp.		160	32	1,280	704	768	720	992	560	64		120
Unidentified harpacticoids								24	8		16	
Unidentified copepodids	18,400	9,520	3,016	14,624	20,976	24,512	9,600	13,264	22,144	10,016	14,016	4,640
Nauplii	1,184	1,104	224	2,784	3,440	1,952	6,048	3,696	4,656	1,264	2,800	1,264
BRANCHIOPODA												
Podon sp.												
MALACOSTRACA												
Unidentified (Pandalidae)												
Unidentified (Hyperia ? sp)				48								
Orchomene sp.												
Unidentified (Lysianassidae)												
Unidentified (Calliopiidae)												
Oedocerus sp.												
Euphausia ? sp	1			32	1					4	1	
Unidentified furcilia (Euphausiacea)												
CIRRIPEDIA												
Unidentified (barnacle nauplii)					56				8			
INSECTA												

TOTAL ZOOPLANKTON CATCH FROM VERTICAL HAULS

GEAR: 50 cm. diameter net 150 u mesh

DATE: AUGUST, 1977

STATION:	292-1			292-2			292-3			292-4		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3
<u>TAXA</u>												
SIPUNCULA												
Prionglossa sp.												
BRYOZOA												
Cyphonaut larvae												
ECHINODERMATA												
Unidentified												
(Ophiuroidea)												
(Asteroidea)												
CHORDATA												
Oikopleura sp.	384										128	4
CHAETOGNATHA												
Sagitta sp.				16		16						
OSTEICHTHYES												
Myxocephalus quadricornis												
Delolepis gigantea	1											
Liparis rutteri	1											
Unidentified larval fish (Pleuronectidae)												
Density organisms/m^2 ($x10^3$)		62.1			138.9			114.5			62.5	
Biomass (wet) g/m^2		5.544			16.065			3.522			3.360	

APPENDIX IVb

TOTAL ZOOPLANKTON CATCH FROM SURFACE TRAWLS

GEAR: 1 m. diameter net 571 u mesh

DATE: JULY, 1977

STATION:	022				112				202				292			
	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4
TAXA																
HYDROZOA																
Aegina citrea																
Aglantha sp.												48		8	96	
Gonionemus vertens																
Obelia sp.																
Polyorchis karafutoensis																
Leuckatiara sp.									1			1				
Coryne princeps																
Laomedia longissima																
Corymorpha flammea																
CTENOPHORA																
Dryadora sp.																
POLYCHAETA																
Trochophores (polychaeta larvae)		24														
GASTROPODA																
Limacina helicina									4			3				
Limacina sp.		13														
Clione sp.												1			1	
Veliger larvae																

DATE: JULY, 1977

STATION:	022				112				202				292			
	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4
COPEPODA																
Calanus hyperboreus			8													
Calanus glacialis	96	168	72		10				96	4	4	480	8			
Metridia longa	32800	144	2616	12576	1322	299	11344	80704	4008	2152	1904	16896	132	3592	18784	3520
Metridia sp.																
Pseudocalanus minutus	32	236	24	80		1	24	64	16	12	8	608			128	4
Eurytemora sp.										8					32	
Oithona sp.		144		16												
Oncaea sp.		8														
Nauplii		3032														
Unidentified copepods	64	2176		32		1	24	192	96	4		464		24		8
BRANCHIOPODA																
Podon sp.			8													
Nymphon pixellae					1											
MALACOSTRACA																
Unidentified Hyperiidae																
Orchomene sp.									1							
Euphausia ? sp.							8									
CIRRIPEDIA	32															
Unidentified (barnacle nauplii)																
INSECTA			104	16	34				16		1		266	48	128	
CHORDATA																
Oikopleura sp.										1				8		
CHAETOGNATHA																
Sagitta sp.																

DATE: JULY, 1977

STATION:	022				112				202				292			
	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4
OSTEICHTHYES																
Myxocephalus quadricornis															1	
Delolepis gigantea																
Liparis rutteri									1							
Pleuronectidae														2		
Cryptacanthodidae									1							
Unidentified fish larvae					3					1						
Density organisms/m^3	907.3	163.3	77.8	349.5	37.6	8.3	313.2	2224.2	113.8	59.9	52.7	508.3	11.2	101.2	526.6	97.0

APPENDIX IVb

TOTAL ZOOPLANKTON CATCH FROM SURFACE TRAWLS

GEAR: 1 m. diameter net 571 u mesh

DATE: AUGUST, 1977

STATION:	022				112				202				292			
	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4
TAXA																
HYDROZOA										NO SAMPLE		NO SAMPLE				
Aegina citrea							5									
Aglantha sp.	1074	257	341	208	146	226	8	428	679		596		563	30	6	359
Gonionemus vertens	1		1	1							2					
Obelia sp.													1			
Polyorchis karafutoensis							4		1		1					
Leuckatiara sp.	3			3		1			2		3		4		7	5
Coryne princeps		1	1						1							
Laomedia longissima		1	1	1												
Corymorpha flammea													1			
CTENOPHORA																
Dryadora sp.							28							2	24	
POLYCHAETA																
Trochophores (polychaeta larvae)																
GASTROPODA																
Limacina helicina	10		3	29					20		1		8			16
Limacina sp.																
Clione sp.		12		32		5	1	6	12		7		7			24
Veliger larvae																

DATE: AUGUST, 1977

STATION:	022				112				202				292			
	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4	-1	-2	-3	-4
COPEPODA																
Calanus hyperboreus																
Calanus glacialis	5		2	1		5							5			
Metridia longa				6	1	2		2			6		3			
Metridia sp.	3	1	2													
Pseudocalanus minutus								2					1			
Eurytemora sp.																
Oithona sp.																
Oncaea sp.																
Nauplii										NO SAMPLES		NO SAMPLES				
BRANCHIOPODA																
Podon sp.																
MALACOSTRACA																
Unidentified Hyperiidae		1		1			4						2			
Orchomene sp.							9									
Euphausia ? sp.																
CIRRIPEDIA																
Unidentified (barnacle nauplii)																
INSECTA														3	4	
CHORDATA																
Oikopleura sp.		1	1													
CHAETOGNATHA																
Sagitta sp.		1					1									

DATE: AUGUST, 1977

STATION:	022-1	022-2	022-3	022-4	112-1	112-2	112-3	112-4	202-1	202-2	202-3	202-4	292-1	292-2	292-3	292-4
OSTEICHTHYES										NO SAMPLES		NO SAMPLES				
Myxocephalus quadricornis																
Delolepis gigantea	1				1	1					4					
Liparis rutteri																
Pleuronectidae																
Cryptacanthodidae																
Unidentified fish larvae									1							
Density organisms/m^3	30.1	7.5	9.6	7.7	4.0	6.5	1.6	12.0	19.6		17.0		16.3	0.9	1.1	11.1

APPENDIX IVc

ANALYSIS OF VARIANCE OF ZOOPLANKTON BIOMASS

JULY, 1977

Source of Variation		Sum of squares (ss)	Degrees of freedom (df)	Mean square (ms)	F
A	Transect	3.923	3	1.308	1.901 ns
B	Distance	1.791	3	0.597	0.868 ns
A-B	Interaction	25.389	9	2.821	4.101 **
	Explained	31.082	15	2.072	3.012 **
	Residual	20.637	30	0.688	
	Total	51.719	45	1.149	

AUGUST, 1977

A	Transect	22.472	3	7.491	0.821 ns
B	Distance	3.855	3	1.285	0.141 ns
A-B	Interaction	231.309	9	25.701	2.817 *
	Explained	257.786	15	17.186	1.884 ns
	Residual	282.833	31	9.124	
	Total	540.619	46	11.753	

ns Not significant at the 0.05 level
** Significant $P < 0.01$
* Significant $P < 0.05$

APPENDIX IVd STUDENT - NEWMAN - KEULS TEST FOR JULY ZOOPLANKTON BIOMASS

$$\text{Pooled Variance} = MS_{\text{within}} = 0.688$$

$$LSR = Q_{\alpha}(k,v)\sqrt{MS_{\text{within}}}\sqrt{\frac{n_1 + n_2}{2n_1 n_2}}$$

α = significance level = 0.05

k = no. of means in comparison = 2 to 16

v = df within = 30

Q = values from students' t-distribution

$n_1 + n_2$ = sample sizes of the means in any single comparison.

If $\overline{Y}_1 - Y_2 > LSR$ then means are considered significantly different from each other ($\alpha = 0.05$). Of all the possible paired comparisons for the 16 means of the July zooplankton data, only the differences between the means 112-2 and 202-4, and 112-2 and 022-3 exceeded the LSR values. Therefore, it was concluded that the biomass at 112-2 was significantly smaller than at 202-4 and 022-3, but all other stations were similar to one another.

Station	112-1	202-1	202-3	022-1	022-4	112-4	292-4	202-2	112-3	292-1	292-2	112-1	292-3	022-2	022-3	202-4
Mean Biomass	0.66	0.95	1.01	1.33	1.55	1.58	1.62	1.62	1.76	1.89	2.04	2.09	2.18	3.09	3.34	3.66

APPENDIX IVe CLUSTER ANALYSIS OF ZOOPLANKTON BY STATIONS

JULY, 1977

Step	Low	High	Distance Value
1	022-1	292-3	12808.
2	022-1	022-2	12343.
3	022-1	202-1	9563.3
4	022-1	202-4	7510.4
5	022-1	112-1	6040.5
6	022-1	022-3	6088.7
7	022-1	112-4	4430.4
8	112-4	202-2	4040.1
9	022-2	292-4	3665.5
10	112-4	292-2	3332.4
11	022-3	022-4	3040.0
12	022-1	292-1	2652.2
13	022-1	112-2	2782.3
14	022-1	112-3	2323.2
15	112-2	202-3	2188.0

AUGUST, 1977

Step	Low	High	Distance Value
1	022-1	022-3	53658.
2	022-1	112-3	31858.
3	022-1	202-3	24364.
4	022-1	022-4	17574.
5	112-3	202-1	12542.
6	022-1	112-4	9585.5
7	202-1	292-2	9153.4
8	022-4	112-2	8902.1
9	022-1	022-2	8475.7
10	022-4	292-3	5682.8
11	022-3	202-4	5131.9
12	022-1	112-1	3722.4
13	112-4	202-2	3488.8
14	022-1	292-1	2340.1
15	112-1	292-4	1981.2

APPENDIX V

a) Total benthic invertebrate catch from Ekman grabs

b) Analysis of variance of benthos biomass

c) Cluster analysis of benthos by stations

APPENDIX Va TOTAL BENTHIC INVERTEBRATE CATCH FROM EKMAN GRABS

STATION JULY, 1977	022-1					022-2					022-3					022-4				
REPLICATE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RHIZOPODA																				
Elphidiella arctica	95	58	28	194	72	98	78	125	116	133	99	69	19	97	7	86	73	35	28	274
Hippocrepina sp.		2										1					1			1
Cornuspira involvens	1	4		3	5		2	3	8	5		4	5	8		2	1	2	4	8
Triloculina sp.										1						1	1			
Pseudopolymorphina sp.											1									
Bulimina auriculata						1	1	1		1								1		
Bulimina sp.																				
Miliammina lata																				
Miliammina sp.				1																
Globulimina pacifica																				
Unidentified foraminiferan																				
PLATYHELMINTHES																				
Unidentified turbellaria																	1			
NEMERTEA																				
Unidentified					1													3		
NEMATODA																				
Unidentified																				
POLYCHAETA																				
Micronepthys sp.				47					1	2	5	6	5	9	6		14	12	39	
Lumbrinereis fragilis			4								1				1					
Lumbrinereis sp.	2			1		1	2	2	3	2		1	4				1	2		
Praxillella praetermissa	1					1	1	3		2										
Praxillella sp.																				
Cirratulus sp.				6				3	3	1		1	4	4				1	5	
Cossura longicirrata							1													
Thelepus sp.						1	2	1	1	1	1		5	2	1		6	5	9	

JULY 1977	022-1					022-2					022-3					022-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
POLYCHAETA (cont'd)																				
Unidentified Terebellidae				1																
Prionospio malmgrenis																				
Prionospio sp.?				11				4						7				5	4	
Spio filicornis												1								
Spio sp.																				
Nerinides sp.																				
Capitella capitata					1										2			1	1	
Scoloplos armiger	3			1		2	1			2	2	3	3	7	2			4	5	
Scoloplos sp.						1								1					1	
Flabelligera affinis		1								1										
Protodorvillea gracilis													1							
Protodorvillea sp.										1		2		1				1		
Ampharete acutifrons																				
Asabellides sp.																				
Antinoe sarsi																			1	
Eteone barbata								1												
Pectinaria hyperborea																				
Pectinaria sp.																				
Unidentified Opheliidae						2			1											
Unidentified Aricidae	2			2									1							
Unidentified Paraonidae																				
GASTROPODA																				
Diaphane sp.	1	2		3		1	3		2								3	4	5	2
Admete sp.																		1	1	2
Neptunea sp.										1										
Retusa obtusa	2	3	1	13	2	4	6	1	6	2	4	3	6	1	1		10	5	19	12
Clione sp.																		1		
Limacina helicina				3							1			1	1					
Unidentified gastropod																				

JULY, 1977	022-1					022-2					022-3					022-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PELECYPODA																				
Portlandia yoldiella	2	12		10	6	10	10	9	3	2	3	5	21	6	3	1	13	16	19	17
Pandora glacialis		1				1						1	1			3			1	1
Axinopsida sp.																				
Cardita crebicostata																				
Cardita ventricosa																				
Macoma moesta													1	1			1	2		1
Lucinoma sp.									1							1		1		2
Unidentified pelecypod																				
OSTRACODA																				
Cythereis sp.	2	1		4		2	5	6	17	9	1			4		1	4	2	1	6
Loxoconcha sp.	4	4	4	8	5	2	3	11	16	14	5	2	2	6		2	4	1		22
COPEPODA																				
Metridia longa	8		12						19	28			10	15			13	56	43	
Metridia glacialis																				
Calanus hyperboreus																				
Calanus glacialis								6	1	7			3							
Pseudocalanus minutus																				
Unidentified calanoida				50																
MALACOSTRACA																				
Unidentified Hyperiidae																				
Unidentified Calliopiidae				1										1			2			
Orchomene sp.	1	6			9	1														
Leucothoe sp.																				
Podoceropsis sp.																				
Diastylopsis sp.	1	4	1			1	2				1	1		1	1					
Unidentified cumacean		54																		
Undentified (Euphausia? sp.)											1							1		
Saduria entomon																				
Leptognathia sp.		1						2			1			1	1		1	1		
SIPUNCULA																				
Unidentified																				

JULY, 1977	022-1					022-2					022-3					022-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PRIAPULIDA																				
Priapulus sp.													1							
BRYOZOA																				
Buskia sp.																				
Density organisms/m^2			3152					3412					2068					3772		
Biomas (wet) gm/m^2			2.183					1.988					1.763					5.568		

APPENDIX Va TOTAL BENTHIC INVERTEBRATE CATCH FROM EKMAN GRABS

STATION JULY, 1977	112-1					112-2					112-3					112-4				
REPLICATE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RHIZOPODA																				
Elphidiella arctica	5	34	31	179	75	44	82	30	54	46	70	45	72	62	39	37	54	55	119	22
Hippocrepina sp.				1									1							
Cornuspira involvens				7	1		4	3	2	5	4		3	10	5	2	3	4	10	1
Triloculina sp.																				
Pseudopolymorphina sp.							1				2								5	
Bulimina auriculata				1																
Bulimina sp.																			3	
Miliammina lata																				
Miliammina sp.																				
Globulimina pacifica																1	1		2	
Unidentified foraminiferan						1														
PLATYHELMINTHES																				
Unidentified turbellaria																1				
NEMERTEA																				
Unidentified																				
NEMATODA																				
Unidentified																				
POLYCHAETA																				
Micronepthys sp.	1	6	2	1	4	13			29		8	1	8	6	2	2	5	16	11	2
Lumbrinereis fragilis					2				6											
Lumbrinereis sp.		1				1				2	1		4			2	6		1	6
Praxillella praetermissa		1			1				1	2				1		1	1	1	2	2
Praxillella sp.																				
Cirratulus sp.							2			1			2				3		1	4
Cossura longicirrata																				
Thelepus sp.			2	2		2	1		3	1	2		3	2	1		9	5		3

JULY, 1977	112-1					112-2					112-3					112-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
POLYCHAETA (cont'd)																				
Unidentified Terebellidae																				
Prionospio malmgrenis																				
Prionospio sp.?		3	1			2				2			2	3	1	1	2	9	6	1
Spio filicornis																				
Spio sp.																				
Nerinides sp.																				
Capitella capitata	1					1									1				1	
Scoloplos armiger			1		12		3		5	1	2	2	2	1		2	11		3	1
Scoloplos sp.		1																		
Flabelligera affinis											1								1	
Protodorvillea gracilis		1																		
Protodorvillea sp.												1								
Ampharete acutifrons							1						2						2	2
Asabellides sp.																		1		
Antinoe sarsi																				
Eteone barbata																				
Pectinaria hyperborea																				
Pectinaria sp.																				
Unidentified Opheliidae																				
Unidentified Ariciidae			1			1	1				1				2					
Unidentified Paraonidae																		5		
GASTROPODA																				
Diaphane sp.													3	4			4	3	2	4
Admete sp.						1	1													
Neptunea sp.																				
Retusa obtusa	1		4	4		5	2		6	1	4		5	4	4	3	12	2	10	7
Clione sp.																				
Limacina helicina		2																		
Unidentified gastropod														2					1	

JULY, 1977	112-1					112-2					112-3					112-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PELECYPODA																				
Portlandia yoldiella	3	2	7	11	5	7	1	3	7	2	18		11	5	13	16	30	23	24	7
Pandora glacialis	1										1								1	
Axinopsida sp.				1																
Cardita crebicostata															1					
Cardita ventricosa																				
Macoma moesta				1					1											1
Lucinoma sp.										1	1	2				1	2	3	1	10
Unidentified pelecypod									1											
OSTRACODA																				
Cythereis sp.		1	1	6			2	1		2	1	1	2	1	1	3	6	6	30	4
Loxoconcha sp.		6	1	18	2	3	5		1	5	7	8	8	6	3	5	11	14	28	1
COPEPODA																				
Metridia longa		7		6	9		5		6	2	11		25	31	10		2	12	4	6
Metridia glacialis																				
Calanus hyperboreus																				
Calanus glacialis																				
Pseudocalanus minutus																				
Unidentified calanoida																				
MALACOSTRACA																				
Unidentified Hyperiidae																	1			
Unidentified Calliopiidae							2									4	1	1	1	2
Orchomene sp.					1							1								
Leucothoe sp.																				
Podoceropsis sp.																				
Diastylopsis sp.		1		2	2						2	4	1				1			
Unidentified cumacean																				
Undentified (Euphausia? sp.)					1						1									
Saduria entomon									1				1							1
Leptognathia sp.					1				1					1				1		
SIPUNCULA																				
Unidentified					1									2			1			

JULY, 1977	112-1					112-2					112-3					112-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PRIAPULIDA																				
Priapulus sp.							1						1						1	1
BRYOZOA																				
Buskia sp.	1	1									1									
Density organisms/m^2	1952					1712					2332					3204				
Biomas(wet) gm/m^2	2.295					4.672					4.124					2.706				

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APPENDIX Va TOTAL BENTHIC INVERTEBRATE CATCH FROM EKMAN GRABS

STATION JULY, 1977	202-1					202-2					202-3					202-4				
REPLICATE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RHIZOPODA																				
Elphidiella arctica	6	5	9	5	3	83	30	91	42	63	11	10	44	35	13	24	52	7		
Hippocrepina sp.																				
Cornuspira involvens						1	1	1		3	1		2	1		1				
Triloculina sp.																				
Pseudopolymorphina sp.																				
Bulimina auriculata								1												
Bulimina sp.																				
Miliammina lata																				
Miliammina sp.																				
Globulimina pacifica																				
Unidentified foramine-feran																				
PLATYHELMINTHES																				
Unidentified tur-bellaria										1				1						
NEMERTEA																				
Unidentified												1								
NEMATODA																				
Unidentified	2			7				1												
POLYCHAETA																				
Micronepthys sp.	16	30	12	39	40	1					3	7	3	16	45	6	8	7	35	1
Lumbrinereis fragilis																				
Lumbrinereis sp.	1	3	2	3						1		2	1	1	3	3	1		5	2
Praxillella praeter-missa											1			2	1			1		1
Praxillella sp.																				
Cirratulus sp.	4	3		11		2		4	3	1	1	6	1	4	2		1	3	6	
Cossura longicirrata		1						1											1	
Thelepus sp.	1	1		2	3						6	5	2	6		2				6

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JULY,1977	202-1					202-2					202-3					202-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
POLYCHAETA (cont'd)																				
Unidentified Terebellidae																				
Prionospio malmgrenis																			67	
Prionospio sp. ?	7	9		15	8	2		1			1	6		7	59	11	10			2
Spio filicornis																				
Spio sp.															2				1	
Nerinides sp.																			1	
Capitella capitata																				
Scoloplos armiger	4	1		2		1	2	3	5	1	1	2	2	3	1			1	3	1
Scoloplos sp.																				
Flabelligera affinis				1										1			1			
Protodorvillea gracilis																				
Protodorvillea sp.	3											1								
Ampharete acutifrons																				
Asabellides sp.																				
Antinoe sarsi				1								1								
Eteone barbata																				
Pectinaria hyperborea																				
Pectinaria sp.																				
Unidentified Ophelliidae				2	1	2			1											
Unidentified Ariciidae																				
Unidentified Paraonidae																				
GASTROPODA																				
Diaphane sp.		4		2	1		2	6			6	5		3	1			2		
Admete sp.						1					2				1					
Neptunea sp.															1		1	1		
Retusa obtusa	2	3	4	4	3	6	5	11	3	6	5	8	3	5	4	4	4	2	2	
Clione sp.																				
Limacina helicina		1		1	1															
Unidentified gastropod	1				1															

JULY, 1977	202-1					202-2					202-3					202-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PELECYPODA																				
Portlandia yoldiella	4	9	8	3	4	3	2	9	2	3	17	19	26	10	28	9	9	13	12	
Pandora glacialis						1		1		1										
Axinopsida sp.										1										
Cardita crebicostata																				
Cardita ventricosa																				
Macoma moesta																				
Lucinoma sp.																				
Unidentified pelecypod																				
OSTRACODA																				
Cythereis sp.				1	1	16	5	13	11	6	1			3	37	63	92	24	35	
Loxoconcha sp.		1	2	2	1	19	3	14	10	3		2		3	24	16	39	7	100	
COPEPODA																				
Metridia longa	42	28	6	25	23	7		10	1	5		16	19	26	21	6	11		15	20
Metridia glacialis											1									
Calanus hyperboreus																				1
Calanus glacialis	12			1																
Pseudocalanus minutus																				
Unidentified calanoida																				
MALACOSTRACA																				
Unidentified Hyperiidae																				
Unidentified Calliopiidae	1																1	1		
Orchomene sp.		1			7				1		2									
Leucothoe sp.																				
Podoceropsis sp.																				2
Diastylopsis sp.		1		1	3				1											
Unidentified cumacean																				
Undentified (Euphausia? sp.)																				
Saduria entomon		1					1		1					1		1				
Leptognathia sp.		1						1												
SIPUNCULA																				
Unidentified												1							1	

JULY, 1977	202-1					202-2					202-3					202-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PRIAPULIDA																				
Priapulus sp.						1	1	2		1						1	1		1	
BRYOZOA																				
Buskia sp.										1										
Density organisms/m^2	1920					2184					2500					3072				
Biomas (wet) gm/m^2	2.561					5.184					4.083					3.124				

APPENDIX Va

TOTAL BENTHIC INVERTEBRATE CATCH FROM EKMAN GRABS

STATION JULY, 1977	292-1					292-2					292-3					292-4				
REPLICATE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RHIZOPODA																				
Elphidiella arctica		15			8	112	83	98	87	29	153	143	38	50	61	379	50	281	85	105
Hippocrepina sp.					1		1	1	1		1					9		6	2	3
Cornuspira involvens			1		2	7	2		7		2	1			1	7		10	3	
Triloculina sp.																1				
Pseudopolymorphina sp.																				
Bulimina auriculata												2	1							
Bulimina sp.																				
Miliammina lata																				
Miliammina sp.															1					
Globulimina pacifica																				
Unidentified foramineferan																				
PLATYHELMINTHES																				
Unidentified turbellaria															1	1				
NEMERTEA																				
Unidentified									1							1				
NEMATODA																				
Unidentified																			1	
POLYCHAETA																				
Micronepthys sp.	1	1					1		24				4	3	2	1	1			8
Lumbrinereis fragilis																				
Lumbrinereis sp.		2				1	2		3					1						1
Praxillella praetermissa													1							1
Praxillella sp.																1				
Cirratulus sp.		3							2				3	5						4
Cossura longicirrata															1					
Thelepus sp.		1	1		2	1	2		4			1	1	2						2

JULY, 1977	292-1					292-2					292-3					292-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
POLYCHAETA (cont'd)																				
Unidentified Terebellidae																				
Prionospio malmgrenis																				
Prionospio sp.?		5	2						11			1		1						
Spio filicornis																				
Spio sp.																				
Nerinides sp.																				
Capitella capitata														1						
Scoloplos armiger		5	2	2		1	3	1	5		1	2	6	10						
Scoloplos sp.																				
Flabelligera affinis																				
Protodorvillea gracilis																				
Protodorvillea sp.																				
Ampharete acutifrons		2																		
Asabellides sp.																				
Antinoe sarsi																				
Eteone barbata																				
Pectinaria hyperborea																				
Pectinaria sp.																				
Unidentified Ophelliidae																	2			
Unidentified Ariciidae																				
Unidentified Paraonidae																				
GASTROPODA						3	5	1	2		3	2			4	3	1	3		4
Diaphane sp.										2			1	1	1				1	
Admete sp.																				
Neptunea sp.		1	1		1	5	5	4	13	2	6	5	4	3	5	19	5	9	3	5
Retusa obtusa															1					
Clione sp.																				1
Limacina helicina		7																		
Unidentified gastropod		1					1													

JULY, 1977	292-1					292-2					292-3					292-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PELECYPODA																				
Portlandia yoldiella		3	1	1	6	13	7	9	12	7	7	6	10	11	8	5	16	8	15	28
Pandora glacialis							1				4				1	1			1	1
Axinopsida sp.											1					4				
Cardita crebicostata							1													
Cardita ventricosa																				
Macoma moesta						1														
Lucinoma sp.																				
Unidentified pelecypod																1				
OSTRACODA																				
Cythereis sp.		1			1	1	2	5	4	1		5	7	12	13	5	1	8		2
Loxoconcha sp.		3				1	1	5	13	2		5	2	8	5	16	2	23	2	1
COPEPODA																				
Metridia longa	12	32	14			3			18		2	4	6	17	5			4		5
Metridia glacialis																				
Calanus hyperboreus																				
Calanus glacialis																				
Pseudocalanus minutus																				
Unidentified calanoida																				
MALACOSTRACA																				
Unidentified Hyperiidae																				
Unidentified Calliopiidae		1															1			
Orchomene sp.									1		1									
Leucothoe sp.																				
Podoceropsis sp.																		1		
Diastylopsis sp.	1	2																		
Unidentified cumacean																				
Undentified (Euphausia? sp.)																				
Saduria entomon													1							
Leptognathia sp.		6												2			1			
SIPUNCULA																				
Unidentified									1											

JULY, 1977	292-1					292-2					292-3					292-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PRIAPULIDA																				
Priapulus sp.					1										1					
BRYOZOA																				
Buskia sp.	1	1	1		1							1								
Density organisms/m²			624					2568					2728					4684		
Biomass (wet) gm/m²			1.453					1.168					4.410					1.564		

APPENDIX Va TOTAL BENTHIC INVERTEBRATE CATCH FROM EKMAN GRABS

STATION AUGUST, 1977	022-1					022-2					022-3					022-4				
REPLICATE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RHIZOPODA																				
Elphidiella arctica	10	110	23	19	51	74	74	100	29	58	132	133	46	100	7	19	195	82	45	178
Hippocrepina sp.		2		1		1		1	1	1	1						8	2	2	2
Cornuspira involvens		4	1	2	6			1	2		3	10	6	2		3	3	2	1	1
Triloculina sp.			1														1			5
Pseudopolymorphina sp.							1							1						
Bulimina auriculata																				
Bulimina sp.																				
Miliammina lata																			1	
Miliammina sp.														1						
Globulimina pacifica																				
Unidentified foraminiferan																				
PLATYHELMINTHES																				
Unidentified turbellaria						1														
NEMERTEA																				
Unidentified																				
NEMATODA																				
Unidentified		3										2					1	2		1
POLYCHAETA																				
Micronepthys sp.	5	1	18	4		10	4	2	8		17	7		1	2	1			23	
Lumbrinereis fragilis																				
Lumbrinereis sp.		2				2	1													
Praxillella praetermissa	1						1							1						
Praxillella sp.																				
Cirratulus sp.		2	5	1		2	5	4	6		6	12	1	2	2	1			3	1
Cossura longicirrata			2					1						1						
Thelepus sp.				2		3	2		2		3	6	1	1	1			1		

AUGUST, 1977	022-1					022-2					022-3					022-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
POLYCHAETA (cont'd)																				
Unidentified Terebellidae																				
Prionospio malmgrenis																				
Prionospio sp.?			8		1	2	1	1	12		8*	2			1					
Spio filicornis																				
Spio sp.																				
Nerinides sp.																				
Capitella capitata	1					1									2					
Scoloplos armiger	1	2	3		5	2			1		2	1					3			
Scoloplos sp.																				
Flabelligera affinis													1					2		
Protodorvillea gracilis																				
Protodorvillea sp.																				
Ampharete acutifrons																				
Asabellides sp.																				
Antinoe sarsi																				
Eteone barbata																				
Pectinaria hyperborea		1																		
Pectinaria sp.																				
Unidentified Opheliidae		1				1						1								
Unidentified Ariciidae																				
Unidentified Paraonidae																				
GASTROPODA																				
Diaphane sp.			1		1	1						2				1	3		2	
Admete sp.									1					1	1				2	
Neptunea sp.																				
Retusa obtusa		2	3		5	3	3	2	2	4		5	1	3	1	2	10	5	8	1
Clione sp.																				
Limacina helicina																				
Unidentified gastropod																				

AUGUST, 1977	022-1					022-2					022-3					022-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PELECYPODA																				
Portlandia yoldiella		5	6	1	8	2	3	7	3	6	13	19	2	13	8	1	19	20	8	8
Pandora glacialis											1									
Axinopsida sp.											2						1			
Cardita crebicostata																				
Cardita ventricosa																	1			
Macoma moesta									1											
Lucinoma sp.											1									
Unidentified pelecypod																				
OSTRACODA																				
Cythereis sp.	1	2	1		1	4	6	4		1	3	8	5	4	1	1	4	1	2	1
Loxoconcha sp.		2	2	1	4	4	2	10		6	4	3	2	3		1	1		1	1
COPEPODA																				
Metridia longa	1										1									1
Metridia glacialis	2	8	18	1		14	3		3		6	9		2		1			10	1
Calanus hyperboreus																				
Calanus glacialis																				
Pseudocalanus minutus																				
Unidentified calanoida																				
MALACOSTRACA																				
Unidentified Hyperiidae																				
Unidentified Calliopiidae																				
Orchomene sp.																			1	
Leucothoe sp.																				
Podoceropsis sp.																				
Diastylopsis sp.			2								1			1						
Unidentified cumacean																				
Undentified (Euphausia? sp.)																				
Saduria entomon											1						1			
Leptognathia sp.																	1			
SIPUNCULA																				
Unidentified																				

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AUGUST, 1977	022-1					022-2					022-3					022-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PRIAPULIDA																				
Priapulus sp.							1													
BRYOZOA																				
Buskia sp.	2											1								
Density organisms/m^2	1516					2056					2616					2844				
Biomass (wet) gm/m^2	2.490					1.943					1.854					1.948				

APPENDIX Va TOTAL BENTHIC INVERTEBRATE CATCH FROM EKMAN GRABS

STATION	112-1					112-2					112-3					112-4				
AUGUST, 1977																				
REPLICATE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RHIZOPODA																				
Elphidiella arctica	2	1		2	1	36	52	23	5	11	68	83	37	150	12					
Hippocrepina sp.																				
Cornuspira involvens						4	1	1		1	1	2	4	5	4					
Triloculina sp.						1							1	1						
Pseudopolymorphina sp.												1								
Bulimina auriculata																				
Bulimina sp.																				
Miliammina lata																		NO SAMPLES		
Miliammina sp.																				
Globulimina pacifica																				
Unidentified foramine-feran																				
PLATYHELMINTHES																				
Unidentified tur-bellaria												1								
NEMERTEA																				
Unidentified																				
NEMATODA																				
Unidentified											1				1					
POLYCHAETA																				
Micronepthys sp.	2		1	2			2			12	1	2	4	13	13					
Lumbrinereis fragilis																				
Lumbrinereis sp.										1		1	2	1						
Praxillella praeter-missa			1		1			1				1			1					
Praxillella sp.																				
Cirratulus sp.		1			1		2	2		11	4	7	2	3	4					
Cossura longicirrata						3				1				1	2					
Thelepus sp.				1					2	1	1	7	7		7					

AUGUST, 1977	112-1					112-2					112-3					112-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
POLYCHAETA (cont'd)																				
Unidentified Terebellidae																		NO SAMPLES		
Prionospio malmgrenis																				
Prionospio sp.?		1						2		1	3	7	2	5	4					
Spio filicornis																				
Spio sp.																				
Nerinides sp.																				
Capitella capitata					1	1	1						1							
Scoloplos armiger		2			1	2	2			1		1	1	1	2					
Scoloplos sp.																				
Flabelligera affinis						1														
Protodorvillea gracilis																				
Protodorvillea sp.																				
Ampharete acutifrons																				
Asabellides sp.																				
Antinoe sarsi										2										
Eteone barbata																				
Pectinaria hyperborea																				
Pectinaria sp.																				
Unidentified Opheliidae																				
Unidentified Ariciidae																				
Unidentified Paraonidae																				
GASTROPODA																				
Diaphane sp.							1		3		2		2							
Admete sp.									1											
Neptunea sp.																				
Retusa obtusa				1		1	1	7	5	3	1	1	1	3	3					
Clione sp.																				
Limacina helicina																				
Unidentified gastropod																				

AUGUST, 1977	112-1					112-2					112-3					112-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PELECYPODA																				
Portlandia yoldiella	2			1			9	1	8	5	7	4	6	8	5					
Pandora glacialis							1													
Axinopsida sp.																				
Cardita crebicostata																				
Cardita ventricosa																				
Macoma moesta															1					
Lucinoma sp.														1						
Unidentified pelecypod																				
OSTRACODA																				
Cythereis sp.						2	2	1	2	2	11	6	3	12	2			NO SAMPLES		
Loxoconcha sp.						6	2	3	1		5	6		4	2					
COPEPODA																				
Metridia longa			1			2				1										
Metridia glacialis																				
Calanus hyperboreus																				
Calanus glacialis	7	2	10	7	3						8	5	11		8					
Pseudocalanus minutus																				
Unidentified calanoida																				
MALACOSTRACA																				
Unidentified Hyperiidae																				
Unidentified Calliopiidae																				
Orchomene sp.												1			1					
Leucothoe sp.																				
Podoceropsis sp.																				
Diastylopsis sp.	1									1		6	3							
Unidentified cumacean																				
Undentified (Euphausia? sp.)																				
Saduria entomon						1		1												
Leptognathia sp.												1								
SIPUNCULA																				
Unidentified																				

AUGUST, 1977	112-1					112-2					112-3					112-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PRIAPULIDA																				
Priapulus sp.																				
BRYOZOA																				
Buskia sp.																				
Density organisms/m^2			226				1036					2492								
Biomass (wet) gm/m^2			1.338				3.070					3.291								

APPENDIX Va TOTAL BENTHIC INVERTEBRATE CATCH FROM EKMAN GRABS

STATION AUGUST, 1977	202-1					202-2					202-3					202-4				
REPLICATE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RHIZOPODA																				
Elphidiella arctica	16	2		7	24	22	32	3	15	70	1	5	67	14	55	17	8	1		1
Hippocrepina sp.		1								1										
Cornuspira involvens						2	1			1				1	1					
Triloculina sp.																1				
Pseudopolymorphina sp.													1							
Bulimina auriculata																				
Bulimina sp.																				
Miliammina lata																			NO SAMPLE	
Miliammina sp.																				
Globulimina pacifica																				
Unidentified foramineferan																				
PLATYHELMINTHES																				
Unidentified turbellaria															1					
NEMERTEA																				
Unidentified																				
NEMATODA																				
Unidentified	1	1				1			1				1							
POLYCHAETA																				
Micronepthys sp.	32	21	6	10	7	5	2	6	4	13		1	12	7	1	41	1	21		6
Lumbrinereis fragilis																				
Lumbrinereis sp.	1	1		1	3								2			1		1		
Praxillella praetermissa							1									1				
Praxillella sp.																				
Cirratulus sp.	6	5	3	5	2	2	4	1	2	4	2	4	3	6	1	17	10	10		1
Cossura longicirrata						1										5				
Thelepus sp.	2	2		1	2		3		3	4	1		6	3	1			2		

AUGUST, 1977	202-1					202-2					202-3					202-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
POLYCHAETA (cont'd)																				
Unidentified Terebellidae																				
Prionospio malmgrenis																				
Prionospio sp.?	13	3	2	7	3	3			2	3			2	3		43	7	25		5
Spio filicornis																				
Spio sp.																				
Nerinides sp.																				
Capitella capitata	2			1		1				1		1								
Scoloplos armiger		2	4	1	1	4	2		1	1						2	1	1		1
Scoloplos sp.																				
Flabelligera affinis																				
Protodorvillea gracilis																				
Protodorvillea sp.																				
Ampharete acutifrons																				
Asabellides sp.																				
Antinoe sarsi																				
Eteone barbata																				
Pectinaria hyperborea																				
Pectinaria sp.																				
Unidentified Ophelliidae								2									2	2		1
Unidentified Ariciidae																				
Unidentified Paraonidae																				
GASTROPODA																				
Diaphane sp.	1	1							2					2	1	3				
Admete sp.			1													1				
Neptunea sp.																				
Retusa obtusa	2	4	1	2	2		4		4	2			4	1	4	2				1
Clione sp.																				
Limacina helicina																				
Unidentified gastropod																				

AUGUST, 1977	202-1					202-2					202-3					202-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PELECYPODA																				
Portlandia yoldiella	5	2		1	2	1	7	2	9	3	2	2	3	2	2	10		5		3
Pandora glacialis																				
Axinopsida sp.																				
Cardita crebicostata																				
Cardita ventricosa																				
Macoma moesta															1					
Lucinoma sp.																				
Unidentified pelecypod																				
OSTRACODA																				
Cythereis sp.	4	1				1		2		9				1	4	28		1		4
Loxoconcha sp.	1				1	1	2		3	9			2	1	3	2		1		
COPEPODA																				
Metridia longa		1								1										
Metridia glacialis																				
Calanus hyperboreus																				
Calanus glacialis	10	7	4	6	15	7	6	5	3	16		1	3	4		1	5	7	NO SAMPLE	1
Pseudocalanus minutus																				
Unidentified calanoida																				
MALACOSTRACA																				
Unidentified Hyperiidae																				
Unidentified Calliopiidae																				
Orchomene sp.																				
Leucothoe sp.																				
Podoceropsis sp.																				
Diastylopsis sp.					1		1													
Unidentified cumacean																				
Undentified (Euphausia? sp.)																				
Saduria entomon																1		1		
Leptognathia sp.	1				1															
SIPUNCULA																				
Unidentified																				

AUGUST, 1977	202-1					202-2					202-3					202-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PRIAPULIDA																				
Priapulus sp.														1						
BRYOZOA																				
Buskia sp.						7								1						
Bensity organisms/m^2				1116					1324				992				1564			
Biomas (wet) gm/m^2				2.150					2.383				1.707				2.916			

APPENDIX Va

TOTAL BENTHIC INVERTEBRATE CATCH FROM EKMAN GRABS

STATION AUGUST, 1977	292-1					292-2					292-3					292-4				
REPLICATE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
RHIZOPODA																				
Elphidiella arctica	31	26	12	46	39	23	139	49	17	13	1	2		3	3	21	26	70	205	35
Hippocrepina sp.						1	1										1	1	3	
Cornuspira involvens				1	3		4	2	2							7		2	3	1
Triloculina sp.							1		1	1								1	1	
Pseudopolymorphina sp.							1												2	
Bulimina auriculata																				
Bulimina sp.																				
Miliammina lata																				
Miliammina sp.																				
Globulimina pacifica																				
Unidentified foramine-feran																				
PLATYHELMINTHES																				
Unidentified tur-bellaria									1									1		
NEMERTEA																				
Unidentified																				
NEMATODA																				
Unidentified	1	5		2		1		2	1					1		1	1	1		1
POLYCHAETA																				
Micronepthys sp.	12	12	15	15	2	13	7	12	4	3	2	2			5	3	2	4	1	5
Lumbrinereis fragilis																				
Lumbrinereis sp.	1		1	2			2	1	2							3				1
Praxillella praeter-missa		1	1	1	1		1	1	2											1
Praxillella sp.																				
Cirratulus sp.	6	6		2	2	6	5	9	6	7			1		1	6	1	1	2	5
Cossura longicirrata	1							2											1	
Thelepus sp.	1						6	1		1						5		2	1	3

AUGUST 1977	292-1					292-2					292-3					292-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
POLYCHAETA (cont'd)																				
Unidentified Terebellidae																				
Prionospio malmgrenis																				
Prionospio sp.?	12	3	3	2	2		5	6	3	1						2		4		3
Spio filicornis																				
Spio sp.																				
Nerinides sp.																				
Capitella capitata			2													1			1	1
Scoloplos armiger	1	2	2	1	1	1			1	1	2	1						1	1	1
Scoloplos sp.																				
Flabelligera affinis											1									
Protodorvillea gracilis																				
Protodorvillea sp.									1											
Ampharete acutifrons																				
Asabellides sp.																				
Antinoe sarsi	1																			
Eteone barbata																				
Pectinaria hyperborea																				
Pectinaria sp.																				
Unidentified Ophelliidae							1												2	
Unidentified Ariciidae																				
Unidentified Paraonidae																				
GASTROPODA																				
Diaphane sp.		3				2	1									2	1		3	2
Admete sp.			1														1		1	1
Neptunea sp.																				
Retusa obtusa	5	1	2	2	1	4	7	2		2						7	2	2	6	9
Clione sp.						1														1
Limacina helicina																				
Unidentified gastropod																				

AUGUST, 1977	292-1					292-2					292-3					292-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PELECYPODA																				
Portlandia yoldiella	3		2	2	7	2	6	1	4	4	1	1				12	18	9	14	9
Pandora glacialis																				
Axinopsida sp.																				
Cardita crebicostata																				
Cardita ventricosa																				
Macoma moesta																				
Lucinoma sp.																				
Unidentified pelecypod																				
OSTRACODA																			1	
Cythereis sp.	1			2	4	2	10	1	2	1	2					1	5		21	
Loxoconcha sp.	1	1		4	17	2	8	8	3	3	2						1	1	10	
COPEPODA																				
Metridia longa				1																
Metridia glacialis																				
Calanus hyperboreus			1	1	1															
Calanus glacialis	7	10	19	28	21	10	9	10	1	9	8	4	1		4					
Pseudocalanus minutus				2																
Unidentified calanoida																				
MALACOSTRACA																				
Unidentified Hyperiidae																				
Unidentified Calliopiidae																				
Orchomene sp.			1																	
Leucothoe sp.																				
Podoceropsis sp.																				
Diastylopsis sp.			1		1			1												
Unidentified cumacean																				
Undentified (Euphausia? sp.)																				
Saduria entomon					1	1												2		
Leptognathia sp.																			2	1
SIPUNCULA																				
Unidentified			1																	1

AUGUST, 1977	292-1					292-2					292-3					292-4				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
PRIAPULIDA																				
Priapulus sp.	1					1					1									1
BRYOZOA																				
Buskia sp.			1			1				5						1				
Density organisms/m^2	1748					1980					196					2384				
Biomass (wet) gm/m^2	2.461					2.518					0.611					2.882				

APPENDIX Vb

ANALYSIS OF VARIANCE OF BENTHOS BIOMASS

JULY, 1977

Source of Variation		Sum of squares (ss)	Degrees of freedom (df)	Mean square (ms)	F
A	Transect	1.021	3	0.340	1.258 ns
B	Distance	1.019	3	0.340	1.256 ns
A-B	Interaction	3.492	8	0.436	1.613 ns
	Explained	5.902	14	0.422	1.558 ns
	Residual	17.315	64	0.271	
	Total	23.217	78	0.298	

AUGUST, 1977

Source of Variation		Sum of squares (ss)	Degrees of freedom (df)	Mean square (ms)	F
A	Transect	0.203	3	0.068	0.443 ns
B	Distance	0.405	3	0.135	0.886 ns
A-B	Interaction	1.086	8	0.136	0.890 ns
	Explained	1.613	14	0.115	0.756 ns
	Residual	8.995	59	0.152	
	Total	10.607	73	0.145	

ns = Not significant at the 0.05 level

APPENDIX Vc CLUSTER ANALYSIS OF BENTHOS BY STATIONS

JULY, 1977

Step	Low	High	Distance Value
1	022-1	292-4	546.28
2	022-1	202-1	312.30
3	202-1	202-4	275.40
4	022-1	022-3	171.90
5	202-1	292-1	164.23
6	202-1	202-3	150.28
7	022-1	022-2	112.80
8	022-2	292-2	132.58
9	022-2	022-4	120.49
10	022-3	112-4	111.01
11	022-3	202-2	76.893
12	022-3	112-3	69.432
13	022-3	112-2	59.991
14	292-2	292-3	50.180
15	022-3	122-1	42.497

AUGUST, 1977

Step	Low	High	Distance Value
1	022-1	022-2	247.67
2	022-2	022-4	157.66
3	022-1	112-1	118.85
4	022-1	112-2	95.872
5	112-1	202-1	93.839
6	112-2	292-1	82.650
7	022-2	022-3	78.145
8	022-2	292-4	55.753
9	022-1	292-2	43.174
10	202-1	202-4	42.615
11	112-2	202-2	38.331
12	022-2	112-3	30.659
13	112-2	202-3	25.040
14	112-1	292-3	13.077

APPENDIX VI

a) List of common and scientific names of fish species captured by gillnet and plankton tows

b) Fish catch data

APPENDIX VIa LIST OF COMMON AND SCIENTIFIC NAMES OF FISH SPECIES CAPTURED BY GILLNET AND PLANKTON TOW DURING THIS STUDY, 1977

COMMON NAME	SCIENTIFIC NAME
Gill Net:	
Arctic cisco	*Coregonus autumnalis* (Pallas)
Arctic char	*Salvelinus alpinus* (Linnaeus)
Arctic cod	*Boreogadus saida* (Lepechin)
Ringtail snailfish	*Liparis rutteri* Gilbert and Snyder 1898
Fourhorn sculpin	*Myoxocephalis quadricornis quadricornis* (Linnaeus)
Least cisco	*Coregonus sardinella* Valenciennes
Plankton Tow:	
Ringtail snailfish	*Liparis rutteri* Gilbert and Snyder 1898
Flatfish	Pleuronectiformes
Fourhorn sculpin	*M. quad. quadricornis*
Giant wrymouth	*Delolepis gigantea* Kittlitz 1858
Wrymouth	Cryptacanthodidae

APPENDIX VIb

FISH CATCH DATA

Date	Station	Species	Length (mm)	Weight (g)	Sex	Maturity	Condition	Age	Gill Net Mesh Size
July 1977	022-3	0 catch							
	022-4	Fourhorn sculpin	173	69	M			3	2" sinking
	112-3	Arctic cisco	333	437	F	Mat.	Green	6	4" floating
			254	168	M	Mat.	Green	5	3" floating
			252	290	F	Mat.	Green	4	3" floating
			306	324	M	Mat.	Green	5	3" floating
			212	95	-	Imm.		2	3" floating
			265	181	-	Mat.	Green	4	3" floating
			252	142	F	Mat.	Green	3	3" floating
			266	194	F	Imm.		4	3" floating
		Least cisco	290	190	F	Mat.	Spent	4	3" floating
	112-4	0 catch							
	202-3	Arctic cisco	380	764	M	Mat.	Green	7	3" floating
			346	543	M	Mat.	Green	6	3" floating
			286	226	F	Mat.	Green	6	2" floating
			277	239	-	Imm.		6	2" floating
			330	491	F	Mat.	Ripening	7	2" floating
	202-4	Arctic cisco	270	191	M	Mat.	Green	4	2" sinking
			224	107	M	Mat.	Green	2	2" sinking
			310	295	M	Mat.	Green	3	2" sinking
			235	118	M	Mat.	Green	3	2" sinking
			257	174	M	Mat.	Green	4	2" sinking
July 1977	292-3	0 catch							
	292-4	Arctic cisco	303	354	M	Mat.	Green	4	2" floating

Date	Station	Species	Length (mm)	Weight (g)	Sex	Maturity	Condition	Age	Gill Net Mesh Size
Aug. 1977	022-3	0 catch							
	022-4	0 catch							
	112-3	Arctic char	373	1011.4	F	Mat.		2	3" floating
		Arctic cisco	382	848	F	Mat.		8	3" floating
	112-4	0 catch							
	202-3	Arctic cod	106	10.8		Imm.		1	1" sinking
	202-4	0 catch							
	292-3	0 catch							
	292-4	Arctic cisco	181	82.9				3	2" floating
		Ringtail snailfish	144	38.1					2" floating

ENVIROCON STUDY TEAM

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M.J. Justice	Secretarial

THE COVER

The cover features Isserk Artificial Island during construction in 1977. This view is synthesized from several different photographs by E. K. Langtry. The late evening sun appears to be dripping liquid sunlight into the sea. This can be seen as symbolic of the ancient sunlight whose energy is imprisoned in the liquid oil beneath the Beaufort Sea. The cover was designed and screen printed by MacGuth Specialty Printers.