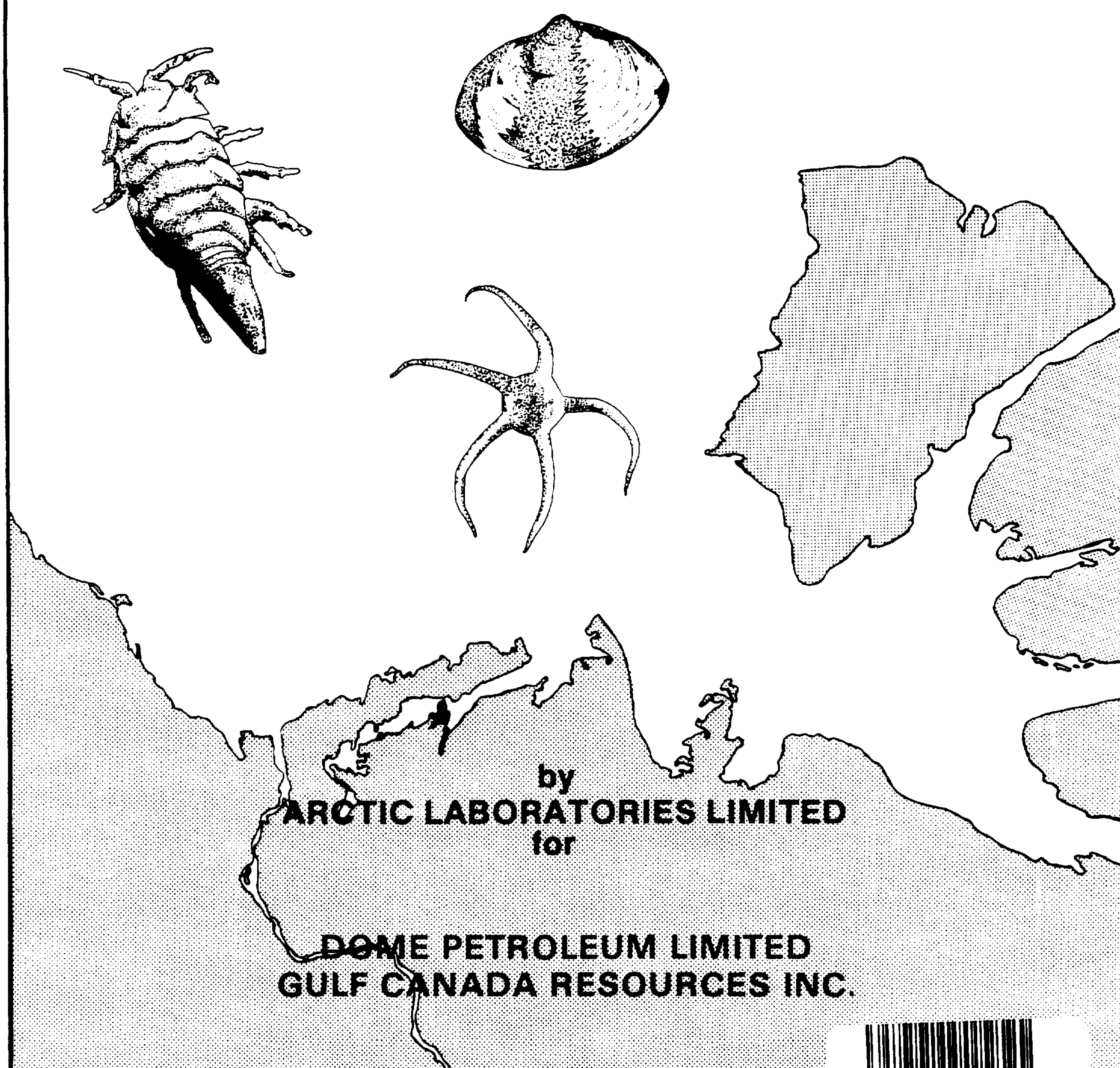
THE IMPACT OF GRAVEL DREDGING ON BENTHIC FAUNA NEAR HERSCHEL ISLAND, YUKON TERRITORY, 1981-1982



by
ARCTIC LABORATORIES LIMITED
for

DOME PETROLEUM LIMITED
GULF CANADA RESOURCES INC.

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THE IMPACT OF GRAVEL DREDGING ON BENTHIC FAUNA NEAR HERSCHEL ISLAND, YUKON TERRITORY, 1981 - 1982

by

W.A. HEATH AND D.J. THOMAS

A Report Prepared for
DOME PETROLEUM LIMITED

and

GULF CANADA RESOURCES INC.

ARCTIC LABORATORIES LIMITED
P.O. BOX 2630
INUVIK, N.W.T. X0E 0T0

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SUMMARY

A study of the initial and longer-term impacts on zoobenthos by marine gravel dredging on a shallow ridge near Herschel Island was performed in 1981 and 1982. This report compares the results of benthos surveys conducted in 1981 before dredging and immediately after dredging with sampling results obtained in 1982, one year after dredging. The volume of substrate dredged from this area (74,440 m^3) was low compared to volumes removed from other borrow areas for the construction of the Tarsiut N-44 island. The objectives of the study were to identify the physical types of substrate and the biological effects of gravel dredging by hopper dredges and to assess the potential for recolonization of dredge trenches by benthos.

The sampling program in 1982 consisted of diver-operated airlift sampling and video recording of the macrobenthos and benthic habitats at reference stations and dredging sites at the main and secondary dredging areas on the ridge. Remote video recordings and grab sampling were performed to identify dredge marks and to supplement diver sampling, respectively. The airlift and grab samples were analysed for taxonomic identities of benthos, wet and dry biomass, population density and benthic community associations. Physical and chemical measurements included bottom water salinity, particle size distributions and heavy metal concentrations in the sediments.

The effects of hopper dredging for gravel at the main and secondary dredging areas near Herschel Island were examined primarily in two areas of concern: (1) direct effects on benthic invertebrates, and (2) effects on benthic habitat (destruction, creation, alteration). Though not quantified, loss of benthos in the immediate vicinity of the dredging operations due to entrainment and smothering is the most immediate direct effect. This loss is not expected to be environmentally significant on a regional scale because only about 0.4% of the gravel ridge habitat near Herschel Island was directly disturbed by the gravel dredging operations. In addition, evidence suggests that recolonization of dredged areas by benthos from adjacent unaffected areas begins almost immediately. The disturbed habitat may recover to a productive state within a year, but development of a mature benthic community may take several more years.

Effects on benthic habitat were assessed in terms of changes in substrate texture caused by dredging. Of the three main possibilities of sediment-dredging interaction noted in the survey area:

(1) dredging of exposed gravel; (2) dredging of gravel overlain by sand; and (3) dredging of gravel overlain or combined with silt/clay, the greatest potential for longer-term habitat disruption is probably associated with (3) above, because after dredging has been completed some exposed gravel will clearly create a discontinuity in the benthic habitat. It must be pointed out, however, that although some physical and biological changes at the dredge sites will have occurred as the result of dredging activities, effects on habitat will probably be local only with affected areas being only a small proportion of the available habitat within the region.

Regional effects due to resettling of silt transported out of the dredging areas by water currents were not detectable at the nearby reference stations. Surrounding areas of Mackenzie Bay lie within the direct influence of the sediment plume of the Mackenzie River and therefore receive large inputs of silt annually, which probably mask any turbidity-related effects attributable to dredging operations.

The principal findings of this study were:

1. In all three sedimentary cases examined (dredging of (i) gravel; (ii) gravel overlain by sand (iii) gravel overlain by silt/clay), the initial direct impact on benthos was the very local removal of organisms and substrate along parallel trenches, causing discontinuities in faunal distributions and lowering total biomass in the dredged area. The paired dredged trenches were each about 4 m wide and up to 0.6 m deep. The depth of penetration of the trenches was apparently dependent on substrate firmness.

    - Where dredging occurred on exposed gravel or on sand overlying gravel, the secondary effects included agitation and resettling of fine sediment particles, such as fine sand and silt. The resettlement of a thin layer (up to 5 cm) of fine sand in the dredge trenches appeared to provide an important area for recolonization of infaunal benthos, such as polychaete worms, bivalves and amphipods. The overall impact of dredging on exposed gravel and on sand overlying gravel was a local disruption of benthos and substrate.

- In the case of dredging on silt-clay overlying or combined with gravel (Case 3), hopper dredging removed the substrate to a shallow depth (0.1 to 0.4 m) and resuspended the overlying sediment fines. Most of the silt-clay particles were carried away from the dredging area by currents, but a small amount of silt and fine sand tended to resettle in and near the dredge trenches. The longer-term impacts of dredging under Case 3 are potentially more disruptive to the benthos than those under the other sedimentary cases due to the exposure of the previously buried gravelly sediments. However, a high rate of fine sediment accumulation in the trenches appears to enhance recovery of the infaunal benthos.

2. Recolonization of the dredged trenches began almost immediately after dredging in each sedimentary case by resettling of survivors and immigration of mobile and drifting benthos from surrounding unaffected areas. One year after dredging, under sedimentary conditions of Case 3 (the only case for which both 1981 and 1982 samples could be obtained), recolonization of a dredge trench to a productive but not fully mature state by a diverse assemblage of polychaetes, amphipods and other epifauna had occurred, but abundance was low. Recolonization of ice scour trenches was also observed and appeared qualitatively similar to that of dredge trenches.

3. At some dredging sites in the secondary dredging area, the high frequency of ice scouring was detrimental to recolonization by benthos due to intensive reworking of the sediments. In depths over 10 m where hopper dredges operate and where ice scouring is most prevalent, the disruptive effects of dredging and ice gouging may be similar and can be overlapping. The reworking of the sea bottom causes substrate instability and therefore depresses the abundance of benthos and inhibits the development of a mature benthic community.

4. Factors related to sediment texture have a pronounced influence on benthic community structure on the shallow ridge in Mackenzie Bay.

5. Community associations of benthos observed at sites that had been disrupted by dredging were consistent with those observed at non-dredging reference sites.

6. Compared to other shallow (< 50 m) areas of the southern Beaufort Sea, the Herschel Island Gravel Borrow Area had relatively high faunal diversity, but low levels of biomass and population density. Epifauna were more prevalent near Herschel Island than in most other study areas, but these animals did not appear to be more adversely affected by dredging than infauna.

7. The concentrations of heavy metals in sediments collected near Herschel Island fall within the range considered representative of unpolluted coastal marine sediments and within the range of concentrations previously reported for other Beaufort Sea and Arctic locations.

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1. INTRODUCTION

1.1 Background and Scope of the Study

The construction of caisson-retained islands for offshore petroleum exploration in the Southern Beaufort Sea requires supplies of gravel and rock for control of wave-induced erosion. (For this purpose, gravel ideally has a mean particle size of about 5 cm, but ranges from 0.5 cm to 8 cm. Larger particles are rock.) The most economical source of such materials is from marine gravel deposits accessible to dredging vessels. This report examines the initial and longer-term impacts of gravel dredging on benthic macroinvertebrates at sites near Herschel Island, Y.T. (Figure 1a) based on underwater surveys in 1981 and 1982. It also considers the process of recolonization of benthos in dredged areas. Earlier reports (Heath 1981, Heath et al. 1982a) described preliminary results of benthos surveys on the gravel deposits near Herschel Island during July 1981 (before dredging) and September 1981 (immediately after dredging). These results are discussed in relation to the 1982 sampling results in this report. The project was undertaken on behalf of Dome Petroleum Limited and Gulf Canada Resources Inc. to fulfill the permit requirements for a dredging licence in the vicinity of Herschel Island.

The impacts of dredging on the zoobenthos were examined because the removal of sea-bed materials directly affects the benthic habitat and biota. Populations of zoobenthos also tend to display more spatial and temporal stability than do populations of fish, sea birds or marine mammals (Green, 1979). The limited mobility or sedentary habits of most benthic fauna makes it possible to sample the benthos with reasonable cost and precision. In addition, many members of the zoobenthos are important forage items in the diets of fish and marine mammals found in the nearshore waters of the southwestern Beaufort Sea (see Heath et al. 1982a and Section 3.1.4 for a summary).

1.2 Related Studies

This report is one of a series on the environmental impacts related to artificial island construction and associated marine dredging in the Beaufort Sea. A study of the impacts of island construction and substrate dredging at Tarsiut N-44 island site and South Tarsiut Borrow Area indicated that the region of altered benthic

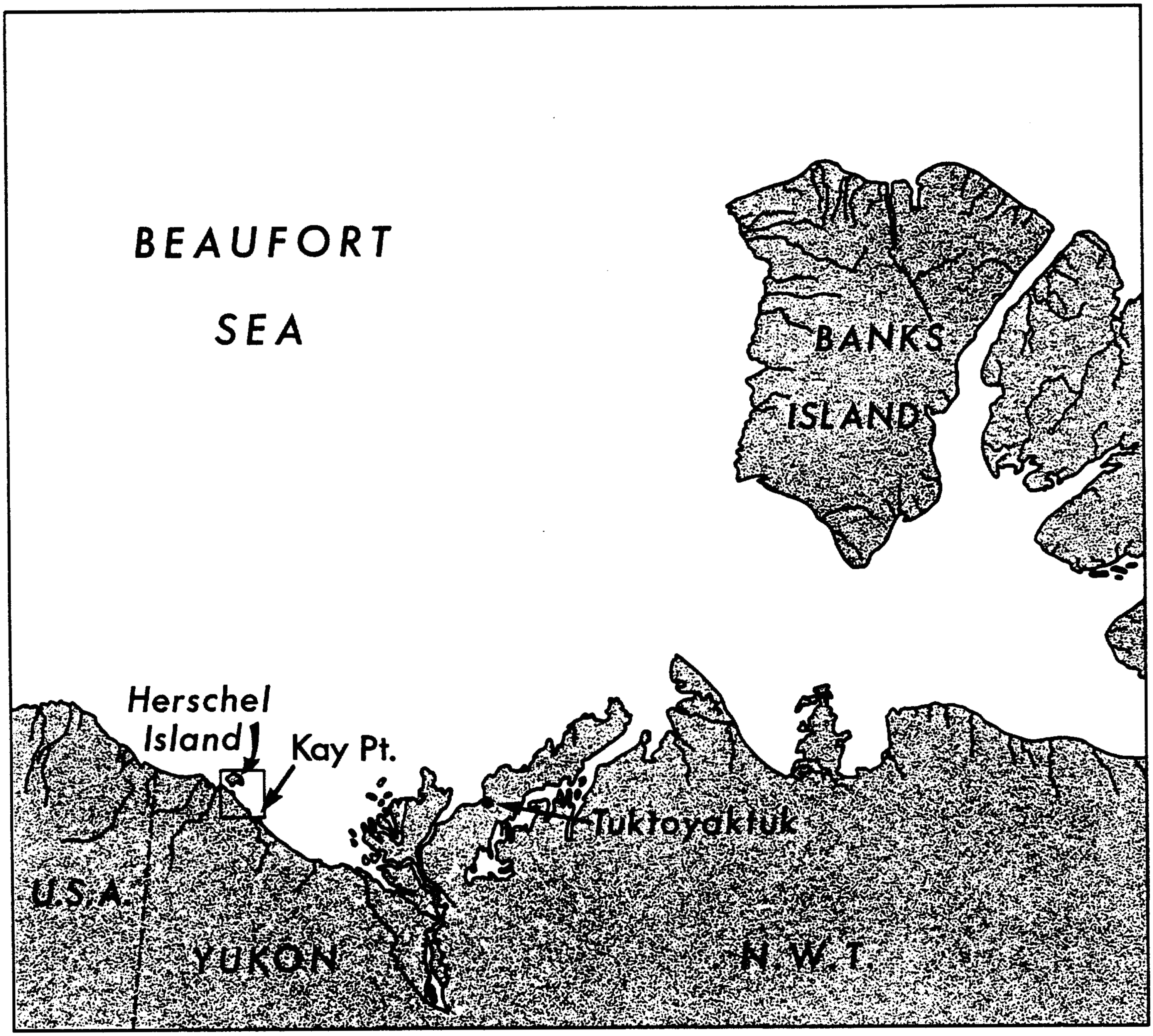


Figure 1a. Location map of Herschel Island Gravel Borrow Area in the Southern Beaufort Sea between Herschel Island and Kay Point, Yukon Territory.

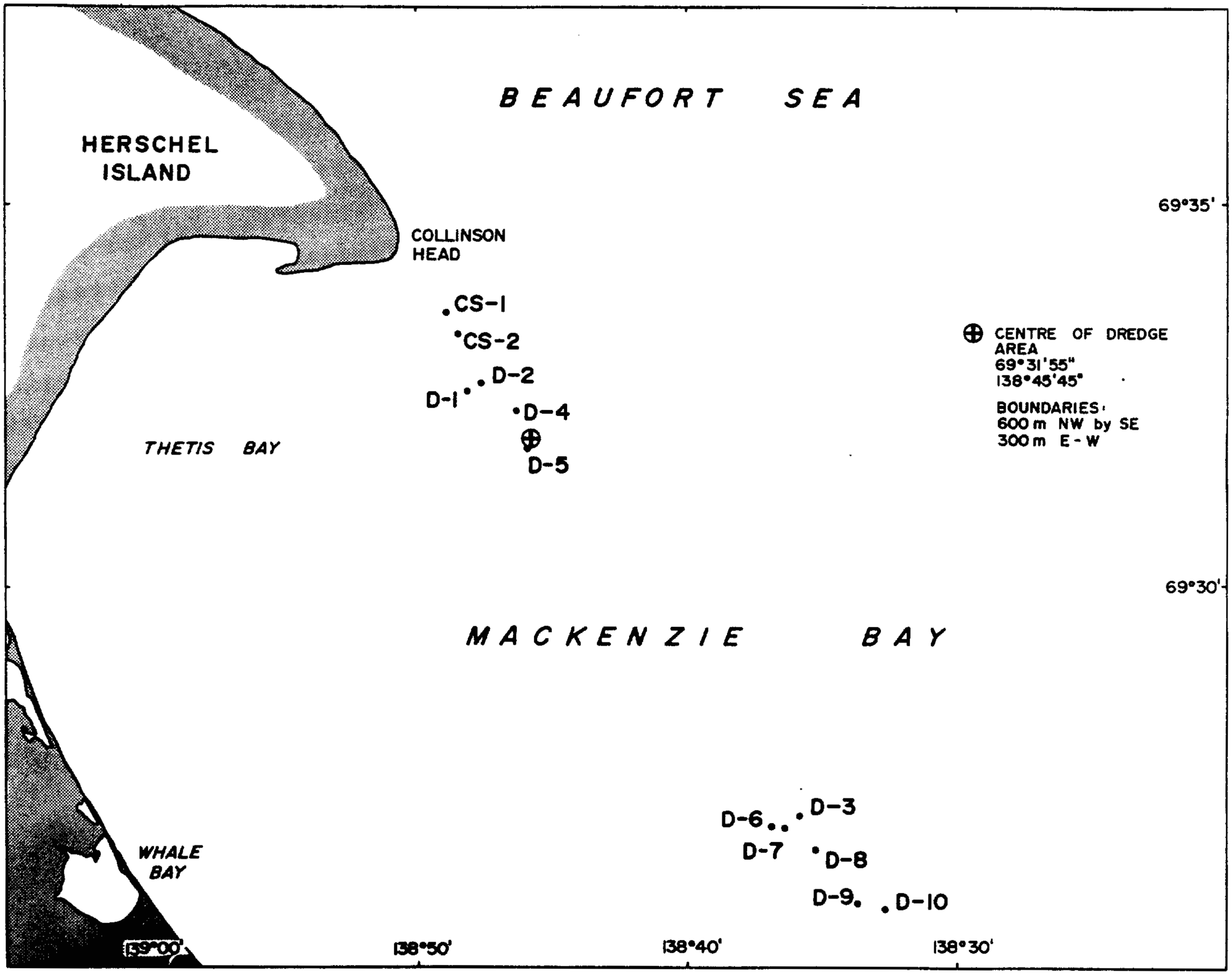


Figure lb. Positions of stations sampled in July 1981 during pre-impact underwater survey of gravel deposits near Herschel Island. Refer to Table 1A for station co-ordinates.

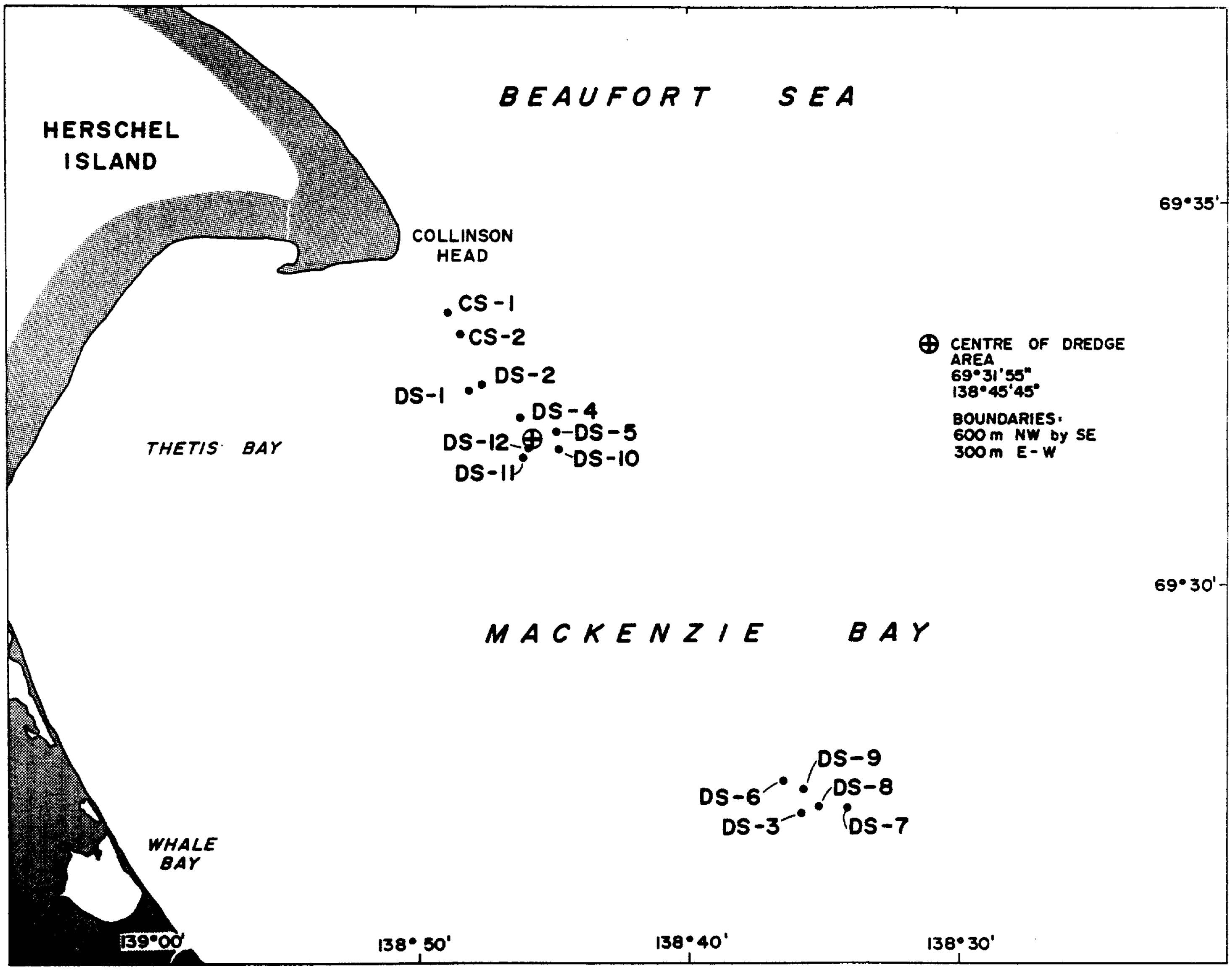


Figure 1c. Positions of stations sampled in September 1981 during post-impact underwater survey of Herschel Island dredging sites. Refer to Table 1B for station co-ordinates.

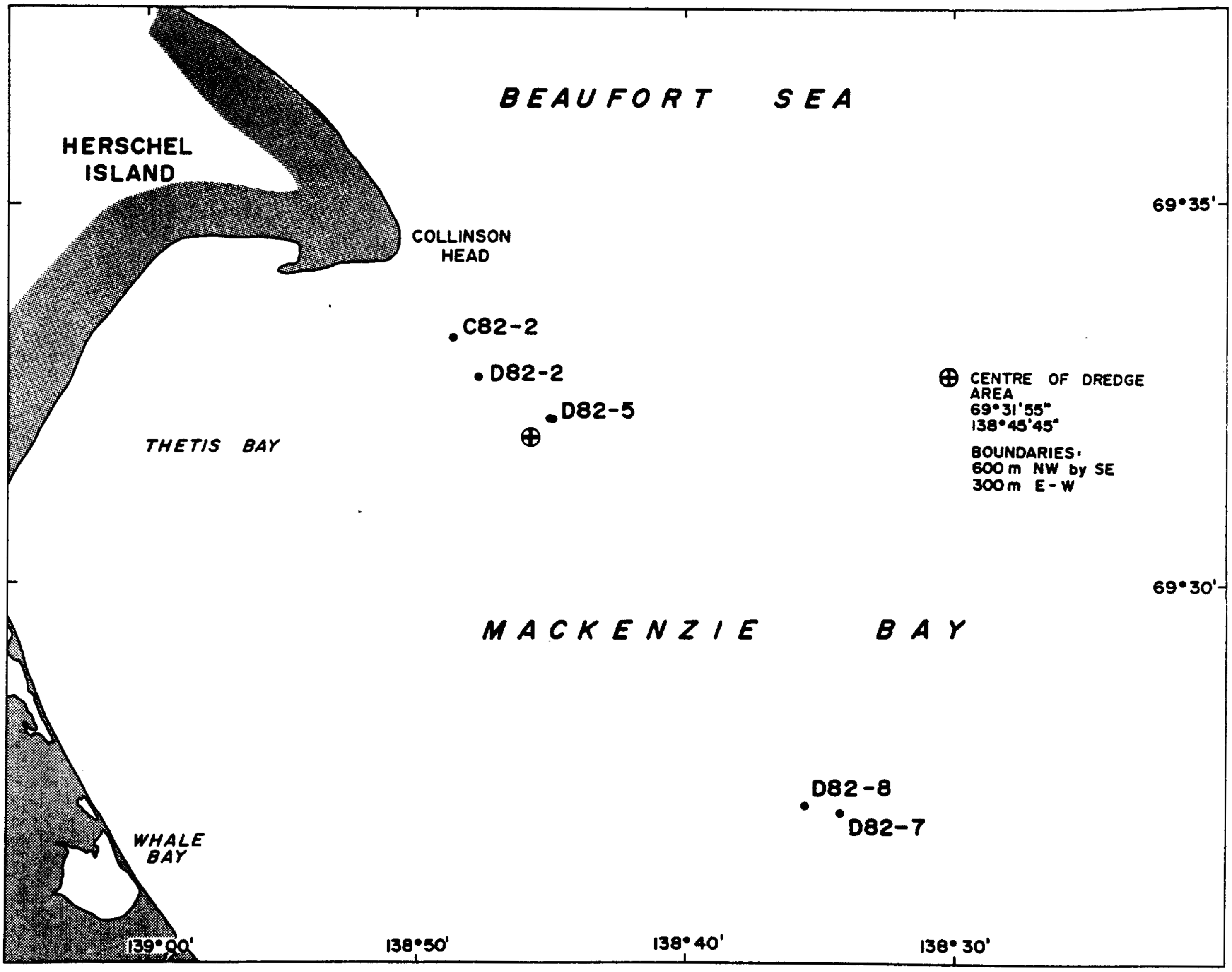


Figure 1d. Positions of stations sampled in July and September 1982 during post-impact underwater surveys of Herschel Island dredging sites. Refer to Table 1C for station co-ordinates.

habitat and depressed levels of benthos was confined to a zone around the island berm extending beyond 50 m but less than 500 m from the island caissons (Thomas et al. 1982; Heath and Thomas 1983b). The upper slopes of the berm were being recolonized by sparse populations of benthos with affinities for sandy sediments.

At the South Tarsiut Borrow Area distinctive species associations and lower levels of biomass and diversity were observed at borrow stations and a sandy reference station in relation to surrounding reference stations where muddy sediments prevailed. The impacts of dredging could not be distinguished from the influences of sediment composition and ice gouging with the remote sampling techniques used in the South Tarsiut area.

1.3 Physical Setting

The main gravel borrow area in Mackenzie Bay was located 5.5 km southeast of Herschel Island on a shallow ridge or sill aligned from Collinson Head on Herschel Island and Kay Point on the mainland Yukon coast (Figure 1a). The ridge divides the basin of Thetis Bay from the remainder of Mackenzie Bay. Water depths on the sill ranged from less than 7 m to 14.7 m. On the west side of the sill, the sea bottom sloped to between 50 and 80 m in the basin of Thetis Bay. East of the ridge, the sea bed descends into the Herschel Trench. Depths ranged from 11.3 to 12.8 m at sampling stations in the main dredging area in September 1981. Shallower gravel areas were present farther southeast on the sill (7.0 to 9.0 m, July 1981). The secondary dredging area, on the seaward side of the sill 18.5 km to the southeast of the main dredging area, was located in 11.3 to 14.6 m depth. The substrate there was of poor quality for construction purposes with a high proportion of clay binding the gravel particles (i.e., possibly a glacial till; Heath et al. 1982a).

Extensive ice gouging occurs on the Beaufort Sea continental shelf as a result of onshore and longshore movements of pressure ridge keels (Barnes and Reimnitz 1974; Pelletier and Shearer 1972). Ice covers the continental shelf until June or July. Landfast ice grows in thickness until the end of May and extends out to a depth of 20 to 30 m where it meets the moving ice of the transition zone, which has a prevailing westerly motion in winter and spring (Marko 1975). Pressure ridge keels in the moving ice zone plow the shelf sediments throughout the winter. The boundary of landfast ice is variable in western Mackenzie Bay, but generally converges on Herschel Island (Marko 1975). Ice scouring frequency was high on the eastern side of the ridge in Mackenzie Bay (personal observation).

During the arctic summer, the ice breaks up and the edge of the pack ice usually retreats beyond the shelf break. Drifting and grounded ice floes can be present on the continental shelf throughout the summer. In the vicinity of Kay Point and Herschel Island, prominent, well-defined streams and eddies are often characteristic of the floe ice and turbid water distributions (Marko 1975). During easterly winds, long streams of small ice floes have been observed moving past Herschel Island in an area of water convergence along the common boundary of a northwestward moving coastal current and an opposing southeastward flow farther offshore (Marko 1975; Herlinveaux and de Lange Boom 1975). In August and September 1982, heavy concentrations of ice floes moved into western Mackenzie Bay near Herschel Island (L. Pearson, pers. comm.).

Based on satellite imagery of Mackenzie Bay, Marko (1975) suggested that the northwestward coastal current moving past Kay Point and deflected north of Herschel Island may also be a main avenue for the turbid low-salinity surface waters of Mackenzie Bay to leave the continental shelf area and enter the deeper region of the Beaufort Sea. Turbid water flows near Herschel Island were observed in satellite images for July 1973-75 (Marko 1975; Herlinveaux and de Lange Boom 1975). During July 1982 sampling periods the turbid water conditions on the dredging sites seriously interfered with the video search and diving operations.

1.4 General Information about Arctic Dredging

Artificial exploration islands have been constructed in the Canadian sector of the Beaufort Sea by trailer suction hopper dredges and cutterhead suction dredges. Only the former type of dredges have been used for gravel dredging near Herschel Island.

Trailer suction hopper dredges (or hopper dredges) remove sediment from the sea bed by means of "dragheads" which trail below the moving dredge ship from both sides (Plate 1). The dragheads are mechanical scrapers, that contain teeth or water jets which loosen up the substrate. A suction pipe in the draghead draws in a water-sediment slurry which is discharged by powerful pumps into large bins or hoppers in the ship. Hopper dredges such as the "Geopotes X" and "Hendrik Zanen" have the capability of dredging in 10 m to 30 m water depth and have hopper capacities of 8900 and 5200 m^3, respectively.

Plate 1. View of draghead and suction pipe stored in davits aboard the hopper dredge "Geopotes X".

When the water-sediment slurry reaches the hoppers, it is allowed to overflow through ports. The heavier sediments settle to the bottom of the hopper (Herbich 1981). When the hoppers are full the dragheads are raised and the ship proceeds to the construction site. The finer sediments will also leak through the deposition doors located on the bottom of the dredge during the initial stages of filling. Thus, the vessel may have less fill to deposit at the construction site than the quantity which was initially loaded (Roberts and Tremont 1982).

The main effects that a hopper dredge may have on the benthic habitat are:

(1) disruption of sediments by draghead agitators (water jets, etc.);

(2) removal of sediments by suction pipe, producing parallel dredge trenches on the sea bed (Plate 2);

(3) suspension and redistribution of fine sediments by turbulence (see Figure 2) and leakage from hopper overflow ports. Fine sand will tend to resettle on the sea bottom along the path of the vessel, but silt and clay particles may be carried by currents a considerable distance before resettling (sand leakage from hopper dredge was observed directly by divers during this study);

(4) local deposition of sea bottom due to occasional rejection of unsuitable sediments from hoppers in areas of poor substrate quality during borrow site reconnaissance surveys.

1.5 Environmental Concerns at Dredging Sites near Herschel Island

The main environmental questions at dredging sites near Herschel Island were:

(1) What is the nature and significance of the effects on the benthos and substrate of the gravel deposits?

(2) What is the scale of disturbance to the benthic community in space (local vs. regional) and in time (short-term vs. long-term) due to gravel dredging?

(3) Will the benthos of the gravel bars recover to pre-impact levels of diversity and abundance in the dredged areas?

(4) What are the possible implications to higher levels of the marine food chain?

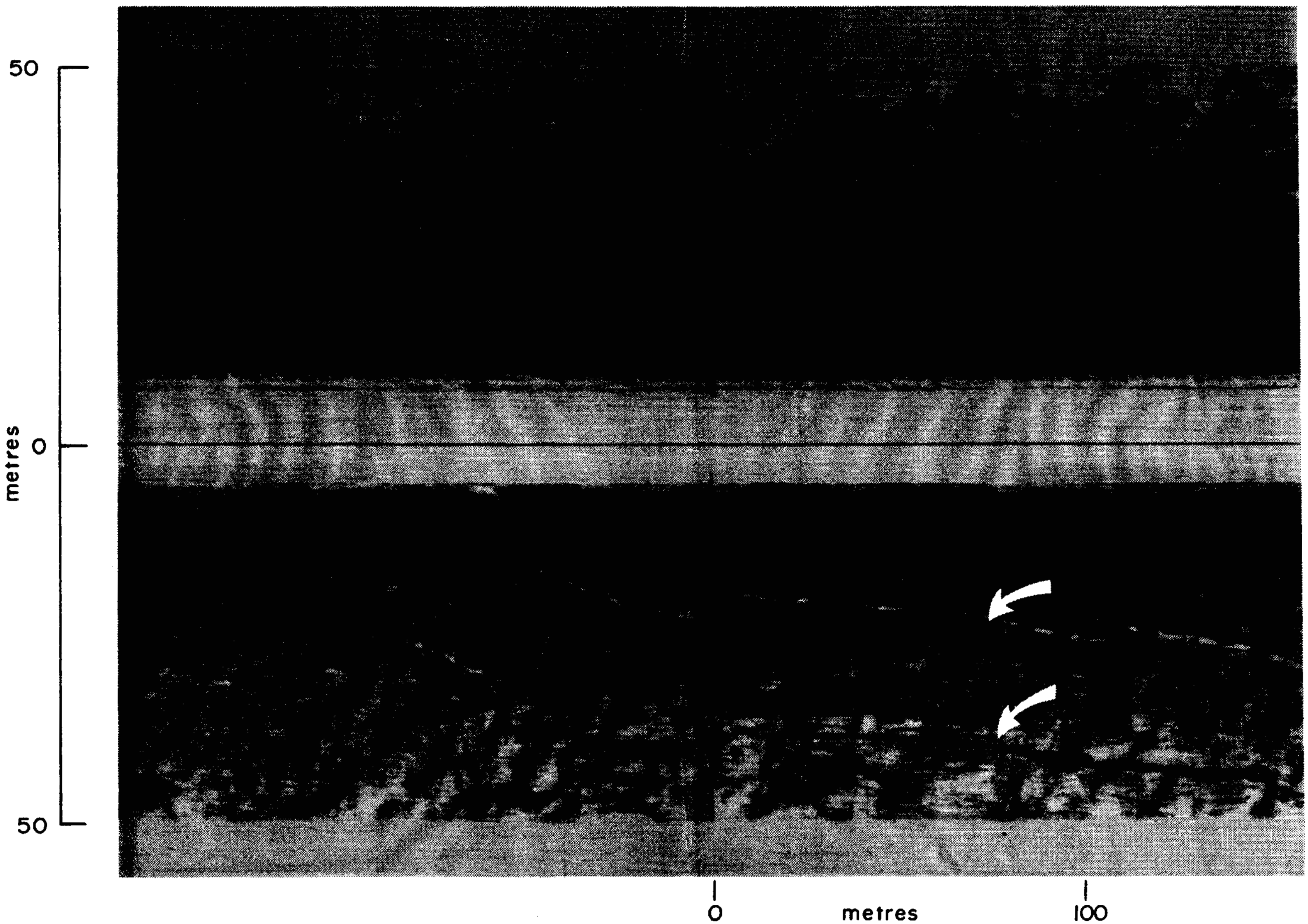


Plate 2. Example of side-scan sonar record indicating a set of parallel dredge trenches (arrow) left by a hopper dredge.

(5) How do the impacts on benthic habitat due to dredging compare with natural processes such as ice gouging, current and wave shifting and sedimentation?

(6) Is the gravel borrow area near Herschel Island unique to the southern Beaufort Sea in terms of observed benthic fauna and habitat or is it comparable to other areas in the Beaufort?

These environmental questions were examined by consideration of the following topics:

(a) the nature of impacts on the benthos and substrate;

(b) the "zones of influence" of impacts, spatial and temporal;

(c) significance of impacts;

(d) benthic recolonization of impacted areas;

(e) possible implications to higher levels of the marine food chain;

(f) comparison of dredging effects with natural processes;

(g) applicability of results obtained in this study area in relation to other Beaufort Sea areas.

The above topics are introduced and defined in the context of this study:

(a) The Nature of Impacts on the Benthos and Substrate

The impacts of trailer suction hopper dredging activities on the benthic environment occur primarily in two areas of concern: (i) direct effects on benthic invertebrates and (ii) effects on benthic habitat.

Direct effects on benthic invertebrates include:

(1) mortality and physical damage associated with entrainment during excavation or overburden stripping;

(2) suffocation and physical damage due to burial beneath resettled sediments adjacent to the dredging area; and

(3) changes in benthic community structure due to habitat disruption (short and long-term alteration of sedimentation rates, sediment mobility, sediment particle size, water quality (turbidity)).

Effects on benthic habitat can include habitat destruction (substrate removal or complete burial), habitat creation (for example, exposure of gravel surfaces in sand/silt environments) and habitat modification (sediment particle size changes, e.g., fine sediment deposition onto sand, gravel surfaces).

Evidence for the various effects noted above was inspected directly by divers and indirectly by examination for changes in faunal indices such as biomass, population density and diversity (number of taxa present) and in community structure (species composition) at dredging sites relative to reference sites.

(b) The "Zones of Influence" of Impacts

The "zone of influence" associated with trailer suction hopper dredging operations can be viewed as two zones within which dredging-related impacts on the benthic environment are discernible from background or reference conditions - a "high" impact zone and an "extended" impact zone. The "high" impact zone is associated with the direct removal of the substrate and is the zone within which most of the mortality or removal of benthic flora and fauna occurs and within which the most severe impacts on habitat occur. Although mortality can occur within the "extended" impact zone, the main effects in this zone are related to habitat alterations due to particle size modification of substrate. The spatial dimensions of each zone depend on the intensity of dredging activity and local oceanographic conditions. It should be noted that there is also a temporal context to the zone of influence. This refers to the length of time required for the recovery of the benthos and benthic habitat to a productive state.

(c) Significance of Impacts

The "significance" of impacts includes the notions of "statistical significance" and "ecological significance".

Testing an hypothesis for "statistical significance" involves reference to a probability level at which the detected difference between parameter means might be due to chance alone (e.g., $P < 0.05$) without any reference to actual ecological significance. If the statistical criteria indicate that the probability of a wrong decision due to chance (Type I error) is less than 5%, then the result is considered to be "statistically significant" at the 5% level.

Assignment of "ecological significance" is a more qualitative judgment of possible (or actual) effects on the structure and persistence of biotic communities. An effect which may be "statistically significant" is not necessarily "ecologically significant". Many ecological systems display "resilience", an ability to absorb change to biotic and environmental conditions and still persist (Holling 1973). Resilience is often high in populations which frequently experience periodic extreme fluctuations in numbers due to extreme variations in environmental conditions (e.g., Watt 1968). The benthic populations of the study area, therefore, would be expected to display the quality of resilience, given their persistence in the presence of ice scouring and the harsh physical conditions of an arctic estuary.

(d) Recolonization of Benthos in Affected Areas

Benthic recolonization refers here to the process of recovery by which populations of benthos re-establish themselves in impacted areas through immigration of adults from surrounding unaffected areas, via larval or juvenile settlement from other areas and through reproductive recruitment of early colonizing species within the impacted area. Benthic recolonization is influenced by properties of the impacted substrate (e.g., texture, stability), the rate of sedimentation subsequent to impact (Dunton and Schonberg 1979), extreme fluctuations in depth-associated water properties (e.g., Lee 1973), food or energy supply and biological interactions such as predation, herbivory and competition, and the growth rates of the species that settle (Dunton et al. 1982). These factors have been identified as important in the colonization and development of benthic communities in temperate and arctic regions by Dayton (1971), Foster (1975), Lee (1973) and Dunton et al. (1982).

(e) Possible Implications to Higher Levels of the Marine Food Chain

The benthos in arctic nearshore areas consists of primary and secondary producers which are consumed directly or indirectly by higher levels of the marine food chain. Patches of exposed rocks and gravel provide suitable substrates for sessile epifauna and associated epibenthos which may be a significant food resource for fish and marine mammals. Ringed seals and bearded seals were observed during this study near the gravel ridge in Mackenzie Bay, but the extent of their dietary use of the benthos on the gravel deposits is not known. During the winter months, ringed seals feed almost exclusively on fish, mainly arctic cod (T. Smith, in Kendel et al. 1975).

Along the nearby Yukon coastal margin, the concentration of fish is high in summer. Migrations of anadromous fish such as arctic char, cisco, least cisco and whitefish are known to occur through this area between early summer and late fall. The fish populations use areas such as bays and lagoons in Mackenzie Bay west of Kay Point and coastal waters of the Yukon mainland and Herschel Island as feeding areas (Kendel et al. 1975). Epibenthos such as amphipods, mysids, isopods and bivalves make up significant portions of the diets of anadromous and marine fish in these areas (see also Section 3.1.4). The availability of food organisms, however, is not a primary limiting factor on fish distribution (Kendel et al. 1975).

The gravel ridge in Mackenzie Bay may be used as a foraging area by migratory fish moving around Kay Point and Collinson Head. The gravel borrow area however, represents only a small portion of the ridge. During underwater surveys of the ridge, only small sculpins were observed.

(f) Comparison of Dredging Effects with Those of Natural Sedimentary Processes

The significance of dredging impacts to the ecology of the borrow area can be considered in the context of sedimentary processes affecting the local benthic habitat such as ice gouging and sediment redistribution. Marine dredging by hopper dredges disrupts and removes surface sediments and benthos along the parallel paths of the drag heads (Plate 2). Recent dredge trenches have steeper and more irregular edges than those of ice gouges. They also lack the berms of displaced sediment which are often associated with ice gouges (Figure 2). During dredging fine sediment is agitated into suspension by turbulence from the dragheads. Fine sand resettles into and near the dredge trenches while silt particles may be carried considerable distances from the dredging area by currents (Heath et al. 1982a).

In contrast, when ice keels excavate gouges, they may displace sediments laterally (Figure 2b). The extent of substrate disruption by blunt ice keels, in particular, may include a zone or berm of considerable width on both sides of the excavation (Reimnitz et al. 1977). Ice gouges may occur individually or in multiple parallel groups characteristic of those produced by the grounding of multikeeled pressure ridges (Reimnitz and Barnes 1974). In depths over 10 m where ice scouring is most prevalent in the Mackenzie Bay region (Lewis and Forbes 1975), the reworking of the sediments by scouring tends to keep the substrate unstable and limits the abundance of benthos. The ice scour frequency in Mackenzie Bay is about 10 per km (Pelletier and Shearer 1972).

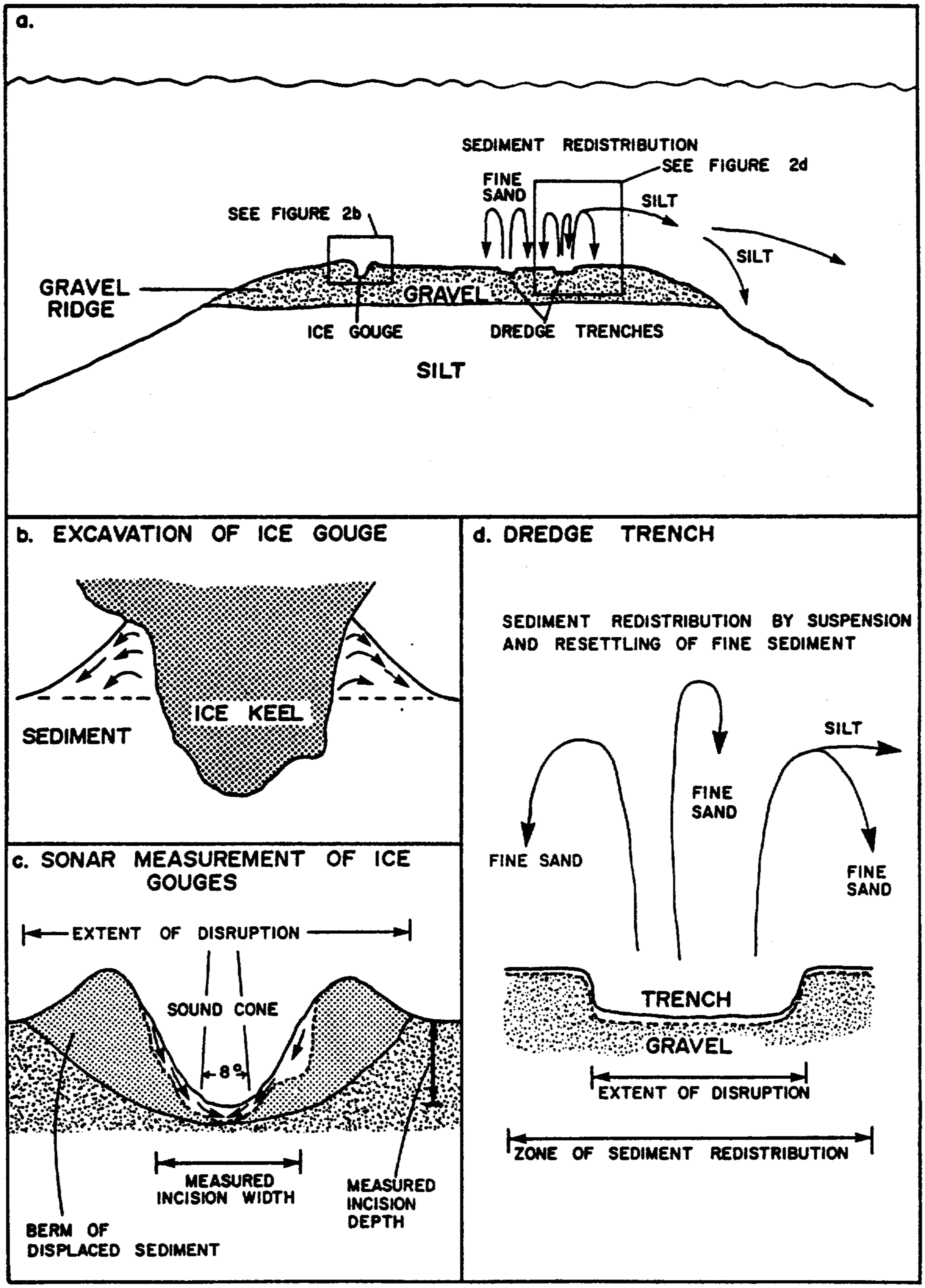


Figure 2. Schematic Diagram of Hopper Dredging and Ice Gouging. (a) Dredge trenches and ice gouges on a gravel ridge; (b) Excavation of idealized gouge by grounding of a pressure ridge ice keel; (c) Same gouge after keel has gone by and inward slumping occurred (b and c after Reimnitz et al. 1977); (d) Idealized dredge trench and schematic representation of sediment redistribution. The dotted line represents sediment surface immediately following dredging; solid line is sediment surface following resettling of fine sediments suspended during dredging activities.

Although dredge trenches and ice gouges have different characteristics of formation, they are both disrupted depressions in the substrate from which benthos has been removed (Plate 3a and 3b). Sediment redistribution by siltation, action of waves and bottom currents, and slumping of edges (Plate 4) will tend to level the scars left by dredging and ice gouging (cf. Lewis and Forbes 1975). These sedimentary processes combined with recolonization of benthos will tend to gradually return the distrubed seabed to a productive state resembling that present before dredging occurred.

(g) Generality of the Herschel Island Borrow Area in Relation to other Beaufort Sea Areas

The gravel deposits on the sill in Mackenzie Bay near Herschel Island are unlike most other substrate borrow areas in the Canadian sector of the Beaufort Sea, both in the range of coarseness of the surficial sediments and the bathymetry of the surrounding seafloor. Benthic zonation maps given by Wacasey (1975) indicated that this ridge lies within the "Transitional Zone" of zoobenthos distribution, although the observed characteristics of depth, salinity and benthic biomass on the sill (Heath et al. 1982a) corresponded more closely to those described for the shallower "Estuarine Zone" (0-15 m) of zoobenthos distribution in the Southern Beaufort Sea. The presence of exposed gravel, cobble and scattered larger rocks, however, has provided substrates for sessile epifauna that are seldom observed at other sites in the Beaufort. The diversity of infauna from grab and airlift samples was also higher near Herschel Island than at most other sites in the Beaufort Sea (see also Section 3.5). The presence of deeper areas on both sides of the sill probably has a strong influence on the nature of the fauna of the ridge and its slopes, thus resulting in similarities with the "Transitional" zone benthos of the 15-30 m depth range.

The gravel deposits on the ridge between Herschel Island and Kay Point are among the few accessible marine sources of gravel for offshore construction in the Canadian sector of the Beaufort Sea. Other gravel-bearing borrow sites include South Tarsiut Borrow Area (Heath and Thomas 1983b) and the southwest margin of Banks Island (Heath et al. 1982b, Heath and Thomas 1984). Pelletier (1975) found that gravel was the chief constituent of sediment samples in only two local areas in the southern Beaufort Sea:

(a) an area northwest of Herschel Island (42 - 62 m depth); and

Plate 3a. A sharply defined edge of a dredge trench is shown at the intersection with a smooth, shallow shallow ice scour (upper centre) at station D-82-8.

Plate 3b. A shallow ice scour is represented by parallel groves in clay which has been smeared along the bottom at

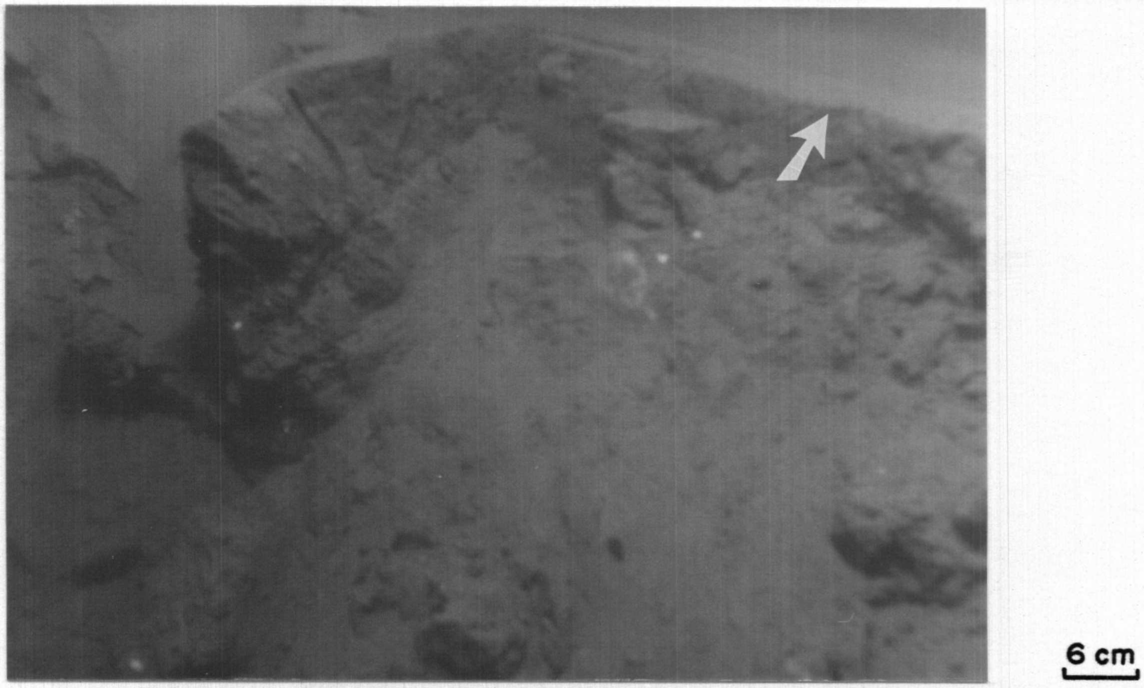


Plate 4. Slumping sides of a dredge trench at D-82-8. An ice scour traverses the upper right edge of the photograph. (See arrow.)

(b) a small area on the extreme eastern end of the shelf off the Baillie Islands.

The first area is too deep for extraction by hopper dredges used in the Beaufort Sea. Exploratory sampling for gravel near the Baillie Islands revealed no substantial deposits of gravel suitable for offshore construction (Thomas 1983).

The hard substrates provided by exposed gravel and cobble on the ridge in western Mackenzie Bay are populated by attached epifauna such as sea anemones, sponges, soft coral and hydroids (Heath et al. 1982a) which are absent in the soft sediments covering most of the Beaufort Sea continental shelf (Beaufort EIS, 1982). Attached epifauna similar to those observed in Mackenzie Bay have been noted at other locations in the Western Arctic Ocean. For example, sessile epifauna have been encountered in the Chukchi-Beaufort region, most frequently between Point Hope and Point Barrow, Alaska. The "Boulder Patch" in Stefansson Sound, Alaska also supports abundant soft corals, hydroids, sea anemones, sponges and other epifauna (Dunton and Schonberg 1979, Dunton et al. 1982). In the Canadian sector of the Beaufort the only other borrow site observed to have significant surficial hard substrates and associated sessile epifauna is near the Rufus River off the southwest coast of Banks Island (Heath et al. 1982b, Heath and Thomas 1984).

1.6 Sampling Objectives and Strategy

The specific objectives of the study were:

(a) to make direct observations of the benthos and benthic habitat before and after dredging (immediately following and one year after dredging) in order to assess the initial and longer term impacts of hopper dredging; and

(b) to examine recent and one year-old dredge trenches for evidence of recolonization by benthos.

The sampling strategy adopted to meet these objectives was to employ diver-operated optical recording and sampling techniques, such as underwater video and still photography, and airlift sampling of benthos. Conventional benthos sampling by grab sampler was performed to supplement the quantitative sampling of benthos.

The design of the impact study was complicated by the fact that the exact location of the dredge trenches within the much larger gravel-bearing ridge dredging area was unknown until the dredging was completed. To allow for this, the pre-impact sampling stations were spread over the gravel deposits along the ridge (Figure 1B). Two reference stations were positioned in similar water depths, but just outside the potential dredging area.

The post-impact sampling program for stations other than reference stations was based on a searching strategy because:

i) the exact locations of dredge trenches were unknown; and

ii) the navigation aids available (radar and compass) did not permit precise positioning.

Searching of the bottom for dredge trenches was usually done while drifting by remote viewing from an underwater television camera suspended near the bottom. When dredge trenches were detected, the vessel was anchored so that diving observations could be made.

At dredged sites, the sampling plan was for a diver to survey the dredge trenches and surrounding area with underwater video and still cameras to record epibenthos and surficial sedimentary features. Quantitative samples of infauna were to be collected inside and outside the trenches by airlift sampler preferably, but if not feasible, then by grab sampler.

1.7 Sampling at Dredging Sites near Herschel Island in 1982

Attempts to conduct underwater surveys at the main dredging area near Herschel Island were thwarted by adverse conditions in July and September 1982. In July the diving biologists experienced very poor underwater visibility (20 cm or less) due to high silt concentrations in the water column (see Section 1.3). Consequently, it was not possible to locate any dredge trenches, although three dives were made as close to previous dredging station positions as could be determined with radar navigation. The sea bottom searches with diver-operated video camera and powerful illumination failed to find evidence of dredge trenches. Since there was total darkness on the bottom without the video floodlight, tasks other than close-up video photography could not be performed satisfactorily. Only qualitative observations from July 1982 sampling are presented in this report.

In September 1982 the second attempt to re-examine the dredging sites experienced much improved underwater visibility, but hazardous concentrations of drifting ice floes ruled out anchoring over the main dredging area to conduct diving operations. Two reference stations northwest of the main dredging area were relatively clear of large floes for long enough to permit diving surveys to be performed.

Following unsuccessful remote video searching for dredge trenches in the ice-infested main dredging area, the investigation was moved to the secondary dredging area 18.5 km southeast of the main dredging area. A search for dredge trenches and two dive surveys were performed before the increasingly heavy concentration of ice floes encroached on the secondary dredging area as well. Grab sampling at the last station (D82-7) was completed while drifting over the ridge with the moving ice.

2. METHODS

2.1 Sampling

Sampling procedures for the September 1982 survey were similar to those described by Heath et al. (1982a). Dredge sites were located by drifting in the research vessel "Sequel" over a site while observing the bottom topography with a remote video camera suspended just off the bottom. When dredge marks were detected the vessel was anchored so that a dive could be made. Dredge trenches were distinguished from ice scours on the basis of the irregular sides and bottom of the dredge cuts which lack the berms of displaced sediment typically found on either side of the more uniform ice gouges. Station positions are given in Table 1 and Figures 1b, c, d. At each station the sampling program involved the following procedures unless otherwise noted:

(a) a dive survey of the benthic habitat recorded with a black and white video camera; diver observations were also directly recorded;

(b) still photography of macrobenthos and surficial sediments with a Nikonos II camera;

(c) sampling of benthic infauna within a 0.5 m^2 quadrat with a 6.4 cm diameter (air lift) suction dredge (Plate 5) and by Van Veen grab (0.1 m^2). One diver-collected air lift sample and four grab casts were taken at each station while at anchor;

(d) a salinity sample of bottom water was collected with a messenger-closing water sampler lowered to within 1 m of the bottom. Salinity was determined in the laboratory with a Guildline Autosal 8400 salinometer.

The air-lifted benthic sample was retained in a net with 1 mm mesh apertures and was transferred to a jar containing 5-10% formalin immediately upon retrieval. A sediment sample was taken by the diver next to each sampled quadrat in a 470 cm^3 jar. The four Van Veen grab samples were processed separately. Subsamples for sediment particle size analysis and chemical analyses were first removed. Unless the remainder could be processed within six hours, it was stored in a plastic bag with 10% buffered formalin until it could be wet sieved through a 0.5 mm aperture screen to remove benthic infauna for taxonomic identification. The residues of all samples

TABLE 1

SAMPLING STATION LOCATIONS NEAR HERSCHEL ISLAND

A. JULY 1981

STATION	DATE SAMPLED	UTM* POSITION		GEOGRAPHICAL POSITION	
		NORTHING	EASTING	LAT. (N)	LONG. (W)
CS-1	25/07/81	7721336	351347	69° 33' 38"	138° 48' 58"
CS-2	25/07/81	7720816	351599	69° 33' 21"	138° 48' 32"
D-1	22/07/81	7719375	352053	69° 32' 36"	138° 47' 41"
D-2	22/07/81	7719459	352083	69° 32' 39"	138° 47' 39"
D-3	22/07/81	7708241	358908	69° 26' 51"	138° 36' 09"
D-4	25/07/81	7718750	352803	69° 32' 18"	138° 46' 29"
D-5	26/07/81	7717882	353098	69° 31' 50"	138° 45' 57"
D-6	26/07/81	7708300	358341	69° 36' 52"	138° 37' 02"
D-7	26/07/81	7708183	359127	69° 26' 50"	138° 35' 50"
D-8	26/07/81	7707513	359506	69° 26' 29"	138° 35' 11"
D-9	26/07/81	7706177	360481	69° 25' 48"	138° 33' 35"
D-10	26/07/81	7705908	361017	69° 25' 44"	138° 33' 44"

* Universal Transverse Mercator co-ordinates using 135°W as the central meridian.

TABLE 1 (continued)

SAMPLING STATION LOCATIONS NEAR HERSCHEL ISLAND

B. SEPTEMBER 1981

STATION	DATE SAMPLED	UTM* POSITION		GEOGRAPHICAL POSITION	
		NORTHING	EASTING	LAT. (N)	LONG. (W)
CS-1	12/09/81	7721268	351387	69° 33' 36"	138° 48' 54"
CS-2	12/09/81	7720691	351677	69° 33' 18"	138° 48' 24"
DS-1	13/09/81	7719380	351790	69° 32' 36"	138° 48' 06"
DS-2	13/09/81	7719545	352127	69° 32' 42"	138° 47' 36"
DS-3	13/09/81	7708697	359043	69° 27' 06"	138° 36' 00"
DS-4	13/09/81	7718473	352907	69° 32' 09"	138° 46' 18"
DS-5	14/09/81	7718227	353870	69° 32' 03"	138° 44' 48"
DS-6**	13/09/81	7709277	358685	69° 27' 24"	138° 36' 36"
DS-7**	13/09/81	7708624	360282	69° 27' 06"	138° 34' 06"
DS-8	14/09/81	7708666	359565	69° 27' 06"	138° 35' 12"
DS-9	14/09/81	7709055	359293	69° 27' 18"	138° 35' 39"
DS-10**	14/09/81	7717763	353842	69° 31' 48"	138° 44' 48"
DS-11	15/09/81	7717904	353068	69° 31' 39"	138° 46' 00"
DS-12	15/09/81	7717799	353247	69° 31' 48"	138° 45' 42"

* Universal Transverse Mercator co-ordinates using 135°W as the Central Meridian

** remote video survey

TABLE 1 (continued)

SAMPLING STATION LOCATIONS NEAR HERSCHEL ISLAND

C. SEPTEMBER 1982

STATION	DATE SAMPLED	UTM* POSITION		GEOGRAPHICAL POSITION	
		NORTHING	EASTING	LAT. (N)	LONG. (W)
C82-2	03/09/82	7720579	351475	69° 33' 14"	138° 48' 42"
D82-2	03/09/82	7719364	352050	69° 32' 36"	138° 47' 42"
D82-7	04/09/82	8708645	359367	69° 27' 05"	138° 35' 30"
D82-8	05/09/82	7708350	360200	69° 26' 57"	138° 34' 12"

* Universal Transverse Mercator co-ordinates using 135° W as the Central Meridian.

20 cm

Plate 5. Two airlift samplers with filtration nets attached and sampling quadrat being lowered to the bottom.

were preserved in 5-10% formalin buffered with sodium borate and stained with Rose Bengal. These infaunal samples were later transferred to 70% isopropyl alcohol and sorted, identified, counted and weighed in the laboratory. The systematics of taxonomic groups in this report follows Barnes (1980). A list of references used in identifying the benthos is given in Appendix B.

2.2 Benthic Biology

2.2.1 Community Analyses

The data on the taxonomic composition of the benthic samples (Appendix A) were analysed for community associations by reciprocal averging ordination (Hill 1973, Gauch 1977) and correspondence analysis (Benzecri 1973, Greenacre and Degos 1977, Greenacre 1978). Rare species, defined as those species occurring in less than five samples, were excluded from the ordination procedure. Species with less than 1.5% of the total population density were treated as "supplementary variables" in the correspondence analysis (see Appendix C.1 for details).

The ordination analysis was performed with the ORDIFLEX program, CEP-25A (Gauch 1977, Cornell Ecology Program Series) on log (X + 1)-transformed data.

The correspondence analysis was computed on a program written by N. Tabet of Laboratoire de Statistique Mathematique de J.-P. Benzecri, Université de Paris. Descriptions of reciprocal averaging ordination and correspondence analysis are provided in Appendix C.1.

2.2.2 Statistical Testing of Hypotheses

Analysis of variance (ANOVA) procedures (e.g., Snedecor 1946; Peng 1967) were used to test hypotheses in comparing means for sample (station) groups. When significant variation between means was detected by one-way classification ANOVA, the contrasting means were tested by an a posteriori test known as Scheffe's S or Gabriel's SS-STP (Scheffe 1959; Sokal and Rohlf 1969). Examples of the above methods are given in Appendix D.1. The sequence of the tests is indicated by a numeric suffix with ANOVA; thus ANOVA1, ANOVA2 ...

2.3 Sediment Geochemistry

2.3.1 Total Metals in Sediments

2.3.1.1 Instrumentation

A Perkin-Elmer Model 703 atomic absorption spectrophotometer with automatic deuterium arc background correction was employed in the flame mode to analyse sediment digests for iron, copper, zinc and chromium. Nickel, cadmium and lead were analysed by flameless AA using the HGA-500 heated graphite furnace and AS-1 auto sampler accessories interfaced to the 703.

A Laboratory Data Control U.V. Monitor with 30-cm pathlength cell was used to analyse for mercury.

2.3.1.2 Procedures

A. Total Chromium, Iron, Nickel, Copper, Zinc, Cadmium and Lead in Sediments

These elements were determined by a modification of the method described by Buckley and Cranston (1971).

Sediments are dried overnight at 70°C and gently crushed in an agate mortar. Approximately 1.0 g of sediment is weighed into acid-cleaned Teflon bombs and wetted with 1 mL of aqua regia and 6 mL of HF. The bombs are sealed and heated at 100°C for at least an hour. Following a cooling period, the contents of the bombs are washed into acid-cleaned and Milli-Q water rinsed polyethylene bottles containing 5.6 g boric acid and 20 mL Milli-Q water. The sample solutions are thoroughly shaken and transferred to glass volumetrics and brought to 30 mL with Milli-Q water. For storage, the samples are returned to polyethylene bottles.

The concentrations of Cr, Fe, Cu and Zn are then determined by aspirating the acidified samples directly into the flame using the method of standard additions while Ni, Cd and Pb are determined by injecting sediment digest into the graphite furnace. Results are corrected for sample blanks carried through the procedure.

B. Total Mercury in Sediments

Samples for mercury analysis were prepared for analysis by the method described by Agemian and Chau (1976):

Approximately 0.2-0.3 of dry sediment is added to a 500-mL Pyrex glass-stoppered flask and washed down to the bottom of the flask with mercury-free tap water. The flask is then placed into a cold water bath and 15 mL of sulphuric acid-nitric acid (2 + 1) slowly added followed by shaking. After standing for about five minutes, the flask is placed in a water bath at a temperature of 50-60°C and digested for 2 hours. Following a 30 minute cooling period, 10 mL of 6% (w/v) potassium permanganate solution are added while cooling the flask in a cold water bath. After an additional 30 minute period, 5 mL of a 5% (w/v) potassium persulphate solution are added, the solution swirled and allowed to stand overnight. The following day, 10 mL of a 6% (w/v) solution of hydroxylammonium hydrochloride solution are added and the solution stirred until clear. Five ml of mercury-free nitric acid are then added and the sample diluted to 500 mL with tap water. The sample is divided into two 250-mL portions and mercury determined by the cold vapour flameless atomic absorption (at 254 nm) method of Bothner (1974) according to the following procedure.

The air space above the sample solution is purged with N_2 gas for one minute to remove traces of chlorine gas because chlorine absorbs at 253.7 nm. Just prior to analysis, 10 mL of a 20% (w/v) stannous chloride solution are added, the diffuser inserted, the sample shaken for 30 seconds, let stand for 30 seconds and purged with N_2 gas at a flow rate of 0.4 L/min for approximately 1 minute. The peak height is measured in mm. Peak heights from two 250 ml aliquots are averaged for each sample.

The instrument settings were:

U.V. Monitor (Laboratory Data Control, Riviera Beach, Florida - 30 cm path length cell)

Range - 0.02 Absorbance

Recorder (Fisher Recordall - Series 5000)
Range - 1 mv Full Scale (25 cm)
Chart Speed - 5 cm/minute

Nitrogen gas (Grade G) flow rate - 0.4 L/minute

Between samples, the system is purged between samples using tap water. The 6 cm (length) x 2 cm (diameter) polyethylene drying tube is re-packed with fresh ACS grade magnesium perchlorate after analysis of approximately 50 aliquots. Glass wool is used at each end of the drying tube to prevent $Mg(ClO_4)_2$ from entering the U.V. gas cell.

Total reagent blanks are determined as follows: To a 500-mL flask containing 250 mL tap water are added 5 mL of nitric acid/dichromate, 2.5 mL of hydroxylamine hydrochloride, 5 mL of persulphate and 5 mL of permanganate solutions. After gentle swirling, 10 mL of stannous chloride solution are added and the mercury purged with N_2 gas. Precision of peak heights was ± 5-10% at a blank level of <4 ng/L.

The recorder span factor (ng Hg/mm peak height) is determined by spiking each 3-5 aliquots of 250 mL of tap water, containing 5 mL nitric acid/dichromate solution, with 5 ng Hg. Standard spiked samples are analysed prior to every run (approximately 9 samples).

2.3.1.3 Precision and Accuracy

Precision

Precision values were determined for replicate sediment samples. They are expressed as percent relative standard deviation (i.e., $\frac{\sigma}{\bar{X}}$ x 100%) in the following table:

Element	**% Relative Standard Deviation**	
	Sediment	**Number of Samples**
Cr	± 8	11
Fe	± 10	10
Ni	± 11	10
Cu	± 3	9
Zn	± 3	9
Cd	± 7	6
Hg	± 8	8
Pb	± 12	6

Accuracy

An estimate of analytical accuracy for the methods used to determine the metal content of sediment was made by analysing 2 reference materials with certified metal content. Both reference materials, distributed by the National Research Council of Canada, are marine sediment, BCSS-1 from the Baie des Chaleurs and MESS-1 from the Miramichi River estuary. The results obtained for these reference materials were as follows:

1. Standard Reference Material BCSS-1

Element	NRC Certified Concentration ±σ	Measured Concentration ±σ (n = 4)	Percent Deviation
Cr (μg/g)	123 ± 14	90.3 ± 8.8	- 27%
Fe (%)	3.29 ± 0.10	3.30 ± 0.15	+ 0.3%
Ni (μg/g)	55.3 ± 3.6	51.6 ± 5.9	- 7%
Cu (μg/g)	18.5 ± 2.7	18.0 ± 0.5	- 3%
Zn (μg/g)	119 ± 12	111 ± 3	- 7%
Cd (μg/g)	0.25 ± 0.04	0.27 ± 0.03	+ 8%
Hg (μg/g)	0.129 ± 0.012	0.127 ± 0.012	- 2%
Pb (μg/g)	22.7 ± 3.4	16.6 ± 2.3	- 27%

2. Standard Reference Material MESS-1

Element	NRC Certified Concentration ±σ	Measured Concentration ±σ (n = 4)	Percent Deviation
Cr (μg/g)	71 ± 11	51.0 ± 1.8	- 28%
Fe (%)	3.05 ± 0.18	2.99 ± 0.10	- 2%
Ni (μg/g)	29.5 ± 2.7	28.7 ± 3.1	- 3%
Cu (μg/g)	25.1 ± 3.8	25.9 ± 0.5	+ 3%
Zn (μg/g)	191 ± 17	206 ± 12	+ 8%
Cd (μg/g)	0.59 ± 0.10	0.55 ± 0.04	- 7%
Hg (μg/g)	0.171 ± 0.014	0.170 ± 0.008	- 1%
Pb (μg/g)	34.0 ± 6.1	24.8 ± 4.9	- 27%

No corrections were applied to the Cr and Pb data to adjust for the apparent under-recovery of these metals by our analytical procedure because there is no evidence to indicate that metals in the sediment samples collected near Herschel Island respond to the analytical procedure exactly as do the metals in the certified reference materials.

2.3.2 Sediment Grain Size

After drying in air to constant weight, fifty grams sediment are put into a beaker of distilled water and soaked until the particle aggregations become soft. After soaking, the sediment is washed through a nest of seven square mesh woven wire cloth sieves having average mesh openings of 2.0 mm, 850 µm, 425 µm, 250 µm, 150 µm, 75 µm and 38 µm. The retained sediment is transferred quantitatively to drying dishes and dried in an oven at 110°C for 24 h. The dried sediment fractions are then weighed and the amount passing through the 38 µm sieve calculated by subtracting the sum of the weights of sediment retained on the other six sieves from 50 g. The results are then expressed as a "% finer than" fraction for each sieve size.

3. RESULTS AND DISCUSSION

3.1 Benthic Biology

The observations and quantitative results obtained from the dredging areas on the ridge near Herschel Island have indicated the effects of dredging under several types of sedimentary conditions of the benthic habitat. In this section, first the types of sedimentary conditions at dredging stations will be described and compared with those of reference stations, and secondly, the effects of dredging under the different sedimentary conditions will be examined with reference to the schematic model depicted in Figure 2. Finally, general effects of dredging on faunal indices and community structure will be considered. Detailed results of community analyses and statistical tests of hypotheses are presented in Appendices C.2 and D.1.

3.1.1 Sedimentary Conditions of Benthic Habitat

The ridge between Herschel Island and Kay Point represents a heterogeneous sedimentary environment as shown by the wide range of particle size distributions for sediment samples collected in 1981 and 1982 (Figure 3, Table 2). Depth and salinity at sampled sites are presented in Table 3.

The effects of gravel dredging operations on benthic habitat near Herschel Island can be assessed in terms of the nature and scale of changes in substrate texture caused by dredging. Three distinct types of sedimentary conditions were noted at the dredging stations sampled during this study:

(1) exposed gravel (e.g., Plate 6a, samples 39 and DS-11; greater than 33% gravel, less than 17% silt);

(2) sand over gravel (e.g., Plate 6b, sample 35; less than 33% gravel, less than 17% silt);

(3) clay or silt over gravel (e.g., Plate 6c, samples 17, 36, 37, 50, 51, 54-59; greater than 30% silt).

Dredging stations and non-dredging or reference stations can be classified according to the three basic sedimentary types noted above in order to examine dredging effects under each case (Table 4). The associated values for benthic faunal

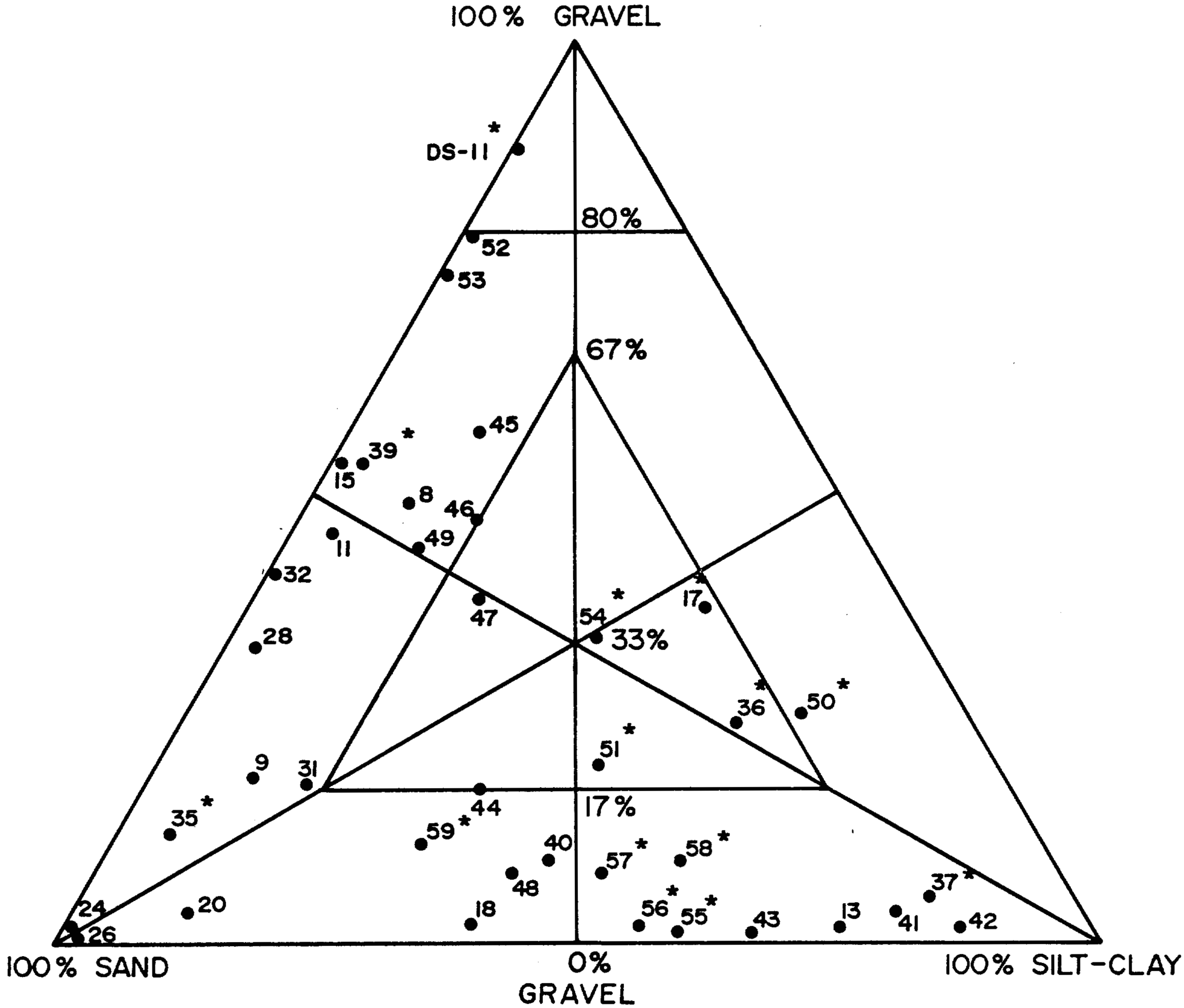


Figure 3. Ternary diagram of sediment particle size distributions for samples from the Herschel Island Gravel Borrow Area in 1981 and 1982. Points are labelled by sample numbers assigned in Table 2. Samples from dredging areas are indicated by an asterisk.

TABLE 2.

BENTHIC HABITAT CHARACTERISTICS

STATION	SAMPLE NUMBER	DEPTH	% SILT-CLAY	% SAND	% GRAVEL	ICE (I) OR DREDGE (D)
A. JULY, 1981						
CS - 1	1, 2	12.0	St/Gr			-
CS - 2	4, 5	12.0	St-C/Gr			-
D - 1	8	10.0	10	41	49	-
D - 2	11, 12	10.0	5	49	46	-
D - 3	15, 16	7.6	1	46	53	I
D - 4	18, 19	11.5	40	59	1	-
D - 5	22, 23	11.8	-	-	Gr	I
D - 6	24, 25	7.0	1	99	0	I
D - 7	26, 27	8.0	1	99	0	I
D - 8	28, 29	9.0	2	65	33	-
D - 9	30, 31	7.3	17	67	16	-
D -10	32, 33, 34	7.6	0	59	41	I
B. SEPTEMBER, 1981						
CS - 1	3	12.5	St/Gr	-	-	-
CS - 2	6, 7	12.2	-	-	Gr	I
DS - 1	9, 10	12.2	7.8	71.7	20.5	-
DS - 2	13, 14	14.0	76.9	22.8	0.5	-
DS - 3	17	11.3	43.6	20.0	36.4	D
DS - 4	20, 21	13.7	13.2	86.7	3.2	-
DS - 5	35	12.8	5.2	81.5	13.6	D
DS - 6*	-	11.6	-	Sd/Gr	-	I
DS - 7*	-	10.1	St-C/Gr	-	-	I
DS - 8	36	11.3	52.6	23.7	23.7	I + D
DS - 9	37	14.6	81.5	14.6	3.9	D
DS -10**	38	13.2	-	Sd/Gr	-	I
DS -11	-	12.8	1.2	10.4	88.4	D
DS -12	39	12.8	3.1	44.2	52.7	D
C. SEPTEMBER 1982						
C82 -2a	40	11.9	42.7	49.2	8.1	I
-2b	41	11.9	81.4	18.0	0.6	
-2c	42	11.9	87.5	12.5	0	
-2d	43	11.9	69.1	30.3	0.6	
-3e	44	11.9	34.3	48.9	16.8	
	mean ± S.D.		63.0 ± 23.5	31.8 ± 17.0	5.2 ± 7.3	
D82 -2a	45	11.0	13.6	31.2	56.0	-
-2b	46	11.0	16.7	36.0	47.3	
-2c	47	11.0	22.8	39.5	37.7	
-2d	48	11.0	39.5	53.2	7.3	
-2e	49	11.0	14.1	42.7	43.2	
	mean ± S.D.		21.3 ± 10.8	40.5 ± 83	38.3 ± 18.6	
D82 -7a	50	10.4	58.8	16.1	25.1	I + D
-7b	51	10.4	42.6	37.5	19.9	
-7c	52	10.4	1.1	19.3	79.6	
-7d	53	10.4	0.9	25.8	73.7	
-7e	54	10.4	35.0	30.9	34.1	
	mean ± S.D.		27.7 ± 25.8	25.9 ± 8.7	46.5 ± 28.1	
D82 -8a	55	11.0	60.1	39.6	0.3	I + D
-8b	56	11.0	55.4	41.3	2.8	
-8c	57	11.0	48.8	43.7	7.5	
-8d	58	11.0	54.4	36.7	8.9	
-8e	59	11.0	29.9	59.4	10.6	
	mean ± S.D.		49.7 ± 11.8	50.1 ± 13.8	6.0 ± 4.3	

* remote video only
** remote video and grab sample

st = silt
Gr = gravel

c = clay
/ = over

TABLE 3.

BOTTOM WATER PROPERTIES

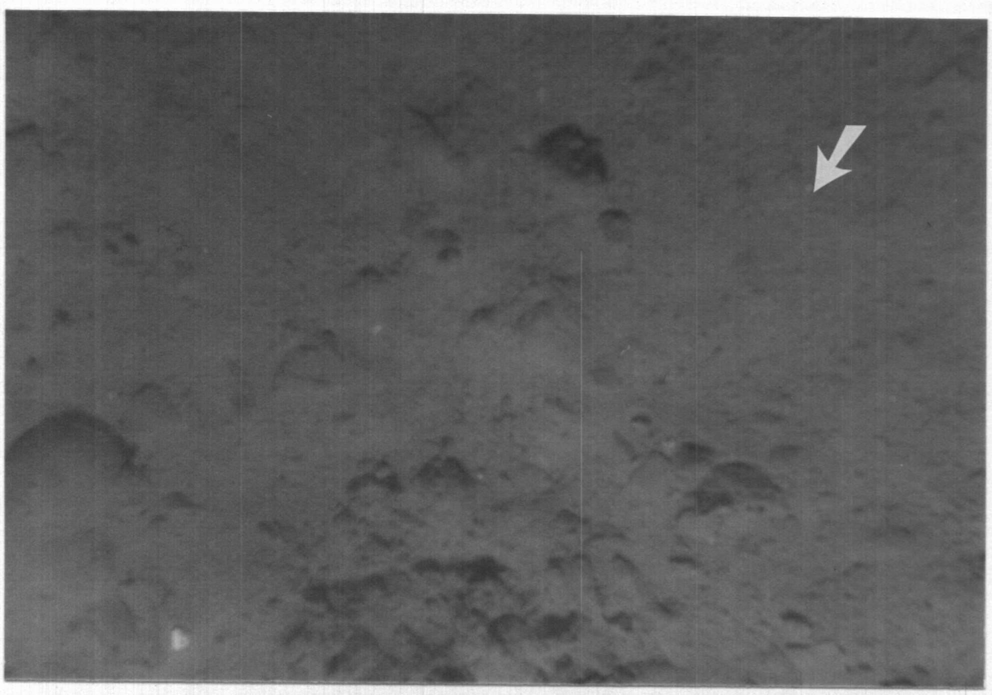
STATION	DESIGNATION	DEPTH (m)	SALINITY (o/oo)
A. SEPTEMBER 1981			
CS-2	Reference	12.2	29.65
DS-2	Reference	12.2	29.66
DS-3	Preliminary	11.3	30.44
DS-4	Preliminary	13.7	30.68
DS-5	Dredged	12.8	30.92
DS-8	Dredged	11.3	30.90
DS-9	Dredged	14.6	31.12
DS-10	Preliminary	13.2	30.54
B. SEPTEMBER 1982			
C82-2	Reference	11.9	30.49
D82-2	Reference	11.0	29.53
D82-7	Dredged	10.4	29.30
D82-8	Dredged	11.0	28.86

Plate 6a. Example of Case 1, exposed gravel substrate.

Plate 6b. Example of Case 2, sand over gravel. A dredge trench is shown,

20 cm

Plate 6c. Example of Case 3, silt over gravel. A shallow dredge trench is shown revealing gravel below a surficial layer of silt.



6 cm

Plate 6d. A relatively undisturbed area of sea bottom at Station D-82-8. A thin layer of silt overlies a clay-gravel till. (See arrow).

TABLE 4.

CLASSIFICATION OF DREDGING AND REFERENCE STATIONS BY SEDIMENTARY CONDITIONS

STATUS	STATION	SAMPLE NUMBER	% SAND/ % GRAVEL	POPULATION DENSITY (N-m2)	WET BIOMASS (g.m-2)	NO. OF TAXA
CASE 1: Exposed Gravel						
Dredging	DS -11	DS-11	10.4 / 88.4	N/A	N/A	N/A
	DS -12	39 (T)	44.2 / 52.7	280	16.9	14
Reference	D -1	8	41.0 / 49.0	380	5.6	52
	CS -2a	6	Gr	168	29.1	38
	-2b	7	Gr	202	1.8	39
	D82 -2a	45	31.2 / 56.0	4380	13.2	64
	-2b	46	36.0 / 47.3	7520	52.7	82
	-2c	47	39.5 / 37.7	11450	54.0	75
	-2d	48	53.2 / 7.3	6210-	34.1	85
	-2e	49	42.7 / 43.2	3608	11.9	90
CASE 2: Sand over Gravel						
Dredging	DS -5	35	81.5 / 13.6	2125	91.5	52
Reference	DS -10	38	Sd / Gr	1428	7.2	45
	DS -4a	20	86.7 / 3.2	869	15.3	46
	-4b	21		1850	17.3	41
	DS -1a	9	71.7 / 20.5	424	3.5	44
	-1b	10		434	6.8	40
CASE 3: Silt over Gravel						
Dredging	DS -3	17	20.0 / 36.4	244	0.3	27
	DS -8	36	23.7 / 23.7	676	5.8	39
	DS -9	37	14.6 / 3.9	913	3.1	37
	D82 -7a	50	16.1 / 25.1	200	0.3	10
	-7b	51	37.5 / 19.9	380	1.0	19
	-7e	54	30.3 / 34.1	438	4.8	60
	D82 -8a	55	39.6 / 0.3	50	0.4	10
	-8b	56	41.3 / 2.8	290	1.3	19
	-8c	57	43.7 / 7.5	1800	12.5	27
	-8d	58	36.7 / 8.9	930	18.0	33
	-8e	59 (T)	59.4 / 10.6	138	0.8	29
Reference	DS -2	13	22.8 / 0.5	212	7.6	33
	C82 -2a	40	49.2 / 8.1	2070	12.3	445
	-2b	41	18.0 / 0.6	1450	6.1	37
	-2c	42	12.5 / 0.	1130	4.0	30
	-2d	43	30.3 / 0.6	1020	1.6	29
	-2e	44	48.9 / 16.8	492	4.5	68

N/A - Not available
Gr - Gravel observed, no sediment sample
Sd/Gr - Sand over gravel observed, no sediment sample
(T) - Sample from dredge trench

indices are also provided for comparison in Table 4. A complete summary of benthic faunal indices for all sampling stations is given in Table 5.

The dredging stations with exposed gravel or sand over gravel are located in the main dredging area. The corresponding reference stations are situated nearby (Figure 1c). These types of dredging sites were not re-sampled in 1982 due to adverse conditions, but the reference station D82-2 was revisited.

The dredging stations with silt or clay overlying and often binding the gravel particles are located in the secondary dredging area about 19 km southeast of the main dredging area (Figure 1c and 1d). The reference stations with similar sediment conditions are located near the main dredging area (Figures 1c and 1d). Stations with this sedimentary condition were sampled in 1981 and 1982.

3.1.2 Impacts on Benthos and Subsequent Recolonization

The potential effects of dredging on the benthic community are linked directly to the type of habitat modification or destruction caused by the dredging. The types of changes in habitat conditions are described below for each sedimentary case. In general, the greatest change in substrate condition occurs when dredging removes a layer of silt to extract the gravel beneath. A lesser change in substrate condition results when gravel is extracted from beneath a surficial layer of sand.

In each dredging case, the benthos and substrate are removed by the suction pipes, producing two parallel trenches on the sea bed to a depth dependent on the firmness of the sediments (see Figures 2a and 2d). As indicated above, this process leads to the inevitable loss of benthic invertebrates from the area, either as the result of mortality during entrainment or mortality during transport to the deposition site. Diver observations indicated that the loss of benthos (considered the primary effect of dredging) was confined largely to the actual area of the dredge trenches. This loss of benthos is not expected to be environmentally significant on a regional scale because only about 0.4% of the gravel ridge habitat near Herschel Island was actually excavated by the gravel dredging operation.

CASE 1. Dredging Exposed Gravel

In Case 1, where dredging takes place on a seabed of exposed gravel, the secondary effects include agitation and resettling of fine sediment particles such as

TABLE 5.

SUMMARY OF BENTHIC FAUNAL INDICES

STATION	SAMPLE NUMBER	POPULATION DENSITY (N m^{-2})	WET BIOMASS (G m^{-2})	NO. OF TAXA
A. JULY 1981				
CS - 1	1	1,954	7.95	90
	2	1,188	4.03	78
CS - 2	4	176	0.36	28
	5	456	1.31	55
D - 1	8	380	5.59	52
D - 2	11	362	5.18	40
	12	70	0.36	23
D - 3	15	222	0.98	20
	16	234	5.05	28
D - 4	18	254	1.22	18
	19	50	1.10	10
D - 5	22	1,019	17.48	72
	23	74	0.50	20
D - 6	24	734	17.80	39
	25	424	12.65	38
D - 7	26	438	4.36	26
	27	662	2.56	26
D - 8	28	489	3.10	50
	29	764	7.26	60
D - 9	30	160	1.89	20
	31	96	2.99	24
D - 10	32	78	1.63	14
	33	106	2.89	15
	34	192	5.57*	25
Overall Mean ± S.D.		**482.6 ± 464**	**4.74 ± 4.91**	**36.3 ± 21.7**

* contribution of single large specimen removed to reduced biasing of biomass estimate.

TABLE 5. (continued)

SUMMARY OF BENTHIC FAUNAL INDICES

STATION	SAMPLE NUMBER	POPULATION DENSITY (N m^{-2})	WET BIOMASS (g m^{-2})	NO. OF TAXA
B. SEPTEMBER 1981				
CS - 1	3	2,126	12.5	82
CS - 2	6	168	29.1	38
	7	202	1.8	39
DS - 1	9	424	3.5	44
	10	434	6.8	40
DS - 2	13	212	7.6	33
DS - 3	17	244	0.3	27
DS - 4	20	869	15.3	46
	21	1,850	17.3	41
DS - 5	35	2,125	91.5	52
DS - 8	36	676	5.8	39
DS - 9	37	913	3.1	37
DS - 10	38	1,428	7.2	45
DS - 12	39	280	16.9	14
Overall Mean ± S.D.		**845.7 ± 739.4**	**15.6 ± 23.2**	**41.2 ± 14.9**

TABLE 5. (continued)

SUMMARY OF BENTHIC FAUNAL INDICES

STATION	SAMPLE NUMBER	N/M^2	WET BIOMASS (g m^{-2})	NO. OF TAXA Sample^{-1}	NO. OF TAXA Total V.V.	VOLUME (L)	DRY BIOMASS (g m^{-2})
C. September 1982							
C-82-2	40	2,070	12.3	45		8.0	0.64
	41	1,450	6.1	37	71	7.5	0.70
	42	1,130	4.0	30		6.5	0.65
	43	1,020	1.6	29		5.0	0.17
	44	492	4.5	68		-	0.36
	Mean ± S.D.	1,232.4 ± 581.5	5.7 ± 4.0	41.8 ± 16		6.75 ± 1.32	0.50 ± 0.23
D-82-2	45	4,380	13.2	64		2.0	0.59
	46	7,520	52.7	82	129	2.5	3.94
	47	11,450	54.0	75		2.5	1.89
	48	6,210	34.1	85		1.5	3.88
	49	3,608	11.9	90		-	2.33
	Mean ± S.D.	6,633.6 ± 3098.2	33.2 ± 20.4	792 ± 10.1		2.13 ± 0.48	2.53 ± 1.42
D-82-7	50	200	0.3	10		8.0	0.01
	51	380	1.0	19	33	2.0	0.04
	52	530	0.8	14		2.0	0.04
	53	150	0.2	9		3.0	<0.01
	54	438	4.8	60		-	1.22
	Mean ± S.D.	339.6 ± 160.5	1.4 ± 1.9	22.4 ± 21.4		5.0 ± 2.9	0.29 ± 0.52
D-82-8	55	50	0.4	10		11.5	0.03
	56	290	1.3	19	50	3.5	0.09
	57	1,800	12.5	27		6.0	5.77
	58	930	18.0	33		12.0	1.25
	59	138	0.8	29		-	0.10
	Mean ± S.D.	641.6 ± 733.5	6.6 ± 8.1	23.6 ± 9.2		8.3 ± 4.2	1.45 ± 2.47
	Overall Mean ± S.D.	**2211 ± 3029**	**11.7 ± 16.5**	**41.8 ± 27.3**			**1.19 ± 1.61**

fine sand and silt. Fine sand tends to resettle on the sea bed along the dredge trench and nearby (Figure 2d), but silt is often carried by currents a considerable distance from the site before resettling. At dredging stations DS-11 and DS-12, a thin layer of fine sand (up to 5 cm deep) had resettled into the dredge trenches (Heath et al. 1982). This sandy layer appeared to be an important substrate zone for recolonization of infaunal benthos such as polychaete worms, bivalves, and amphipods which were observed in the trenches within a few days after dredging.

Diver-directed grab sampling at DS-12 indicated that a small but significant number of infaunal species, especially bivalves, apparently resettled and survived the disruption or move into the trenches almost immediately after dredging (Table 4, Case 1). Although the biomass at DS-12 was similar to the mean biomass for all concurrently sampled stations, it was dominated (96%) by three specimens of the infaunal clam, Thracia sp., and eleven specimens of epifaunal tunicates. The remaining 4% of total biomass was contributed by 12 other taxa. Thus, the zoobenthos in the DS-12 trench was impoverished in diversity, but not in biomass, when compared to undredged stations (Table 4). It appears that robust specimens of bivalves can survive the agitation by the draghead and be redeposited in the trenches. Loosely attached epifauna such as the tunicates are likely swept by currents into the trenches where they tend to collect.

Areas adjacent to the trenches also received a thin layer of sand, but its limited thickness (less than 5 cm) did not appear to have a negative effect on benthos. The lack of detrimental smothering effects is to be expected at low accumulation levels because sand is generally abundant in gravelly sediments and can be easily burrowed through or shed by the benthos of gravel substrates. The overall impact of dredging in Case 1 is, apparently, to produce a local disturbance of benthos and substrate which will tend to be repaired by natural sedimentary processes and recolonization.

CASE 2. Dredging Gravel Overlain by Sand

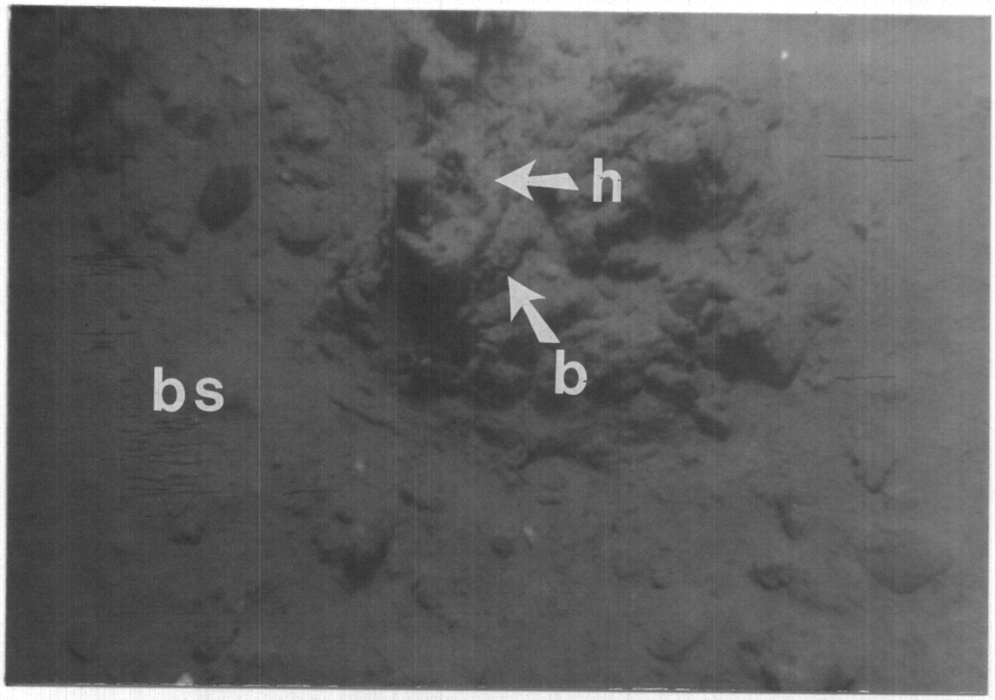
In Case 2, where a layer of sand overlies the gravel deposit (e.g. DS-5) dredging will initially remove the sand layer, but some of the suspended sand will resettle in or close to the trenches. The surficial sediments in the trenches, although disturbed and redistributed, will be similar in composition to those present before dredging. Smothering effects in adjacent zones due to resettling of loose sand were not apparent at station DS-5 (Heath et al. 1982a). Benthos adjacent to the trenches was healthy and relatively abundant. Epifauna such as soft coral, isopods and starfish were observed along with infauna such as polychaetes, sipunculids, bivalves and brittle stars (Heath et al. 1982a). The longer-term impacts of dredging would not be expected to be serious due to a high potential for recolonization under this sedimentary condition.

CASE 3. Dredging Gravel Overlain by Silt/Clay

For Case 3, (Plate 6d) where silt overlies the gravel (which may also be combined with clay), there are observations for the secondary dredging area from before, immediately after and one year after dredging. Hopper dredging removed the gravel (and clay where present) to a shallow depth (0.1 to 0.4 m) and resuspended the overlying silt. Much of the silt was carried away from the dredging area by currents, but a small amount of silt and fine sand resettled in and near the dredge trenches (Figure 2d). The surficial sediments in the trenches in Case 3 often consisted of exposed gravel or clay-gravel till (e.g., stations DS-8, D82-8, Plate 3a). There were no apparent smothering effects on benthos in areas near the trenches due to settlement of silt (Plate 7a). After a year, a thin layer of silt was present in dredge trenches at Stations D82-7 and D82-8.

Early evidence of recolonization by benthos was limited to sightings of mobile benthos such as isopods (Heath et al. 1982). Airlift sampling done one year after dredging indicated that recolonization was proceeding with the settlement of 29 species of benthos. This level of diversity was within the range of values observed in grab samples from that station. Similarly, levels of population density and biomass were within the ranges of grab sample values, but at the low end of the ranges (Table 4). It is concluded, therefore, that this habitat, disrupted earlier by dredging, had recovered within a year to a productive state, but that the development of a mature benthic community was incomplete when compared to reference areas (see section 3.1.3). Many of the common infaunal species found outside the trenches were also present in the sample from the trench (e.g., Ampharete acutifrons, Pholoe sp., Pygospio elegans). The infauna of the trench consisted of 10 species of polychaete worms represented in small numbers. The epifauna comprised nine species of amphipods, two species of cumaceans, a tunicate and several small specimens of the isopod, Mesidotea sibirica.

Examples of large epifauna observed at the Case 3 stations D82-8 and D82-7 are provided in Plates 7(a), (b), (c), (d) and 8(a), (b), (c) and (d).

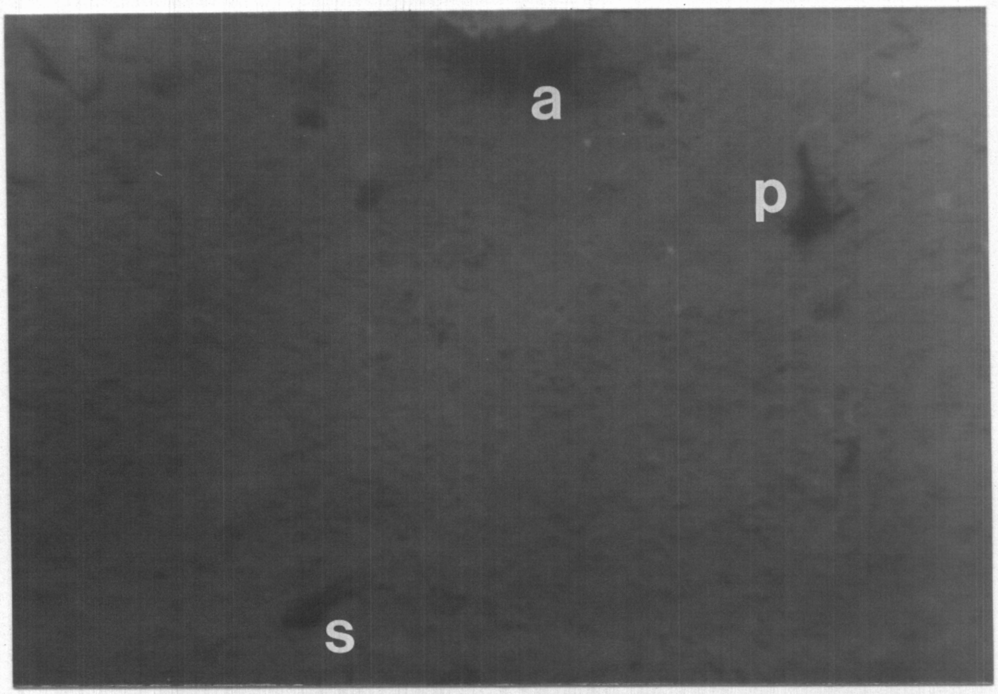


6 cm

Plate 7a. Epifauna at Station D-82-8 included brittle stars (left centre), hydroids, and barnacles on small rocks (upper centre). (bs = brittle star, h = hydroids and b = barnacles)

5 cm

Plate 7b. An outcropping of gravel at D-82-8. Barnacles are present on a rock in the upper right. (See arrow.)



6 cm

Plate 7c. Undisturbed sediments at D-82-8 with a small sculpin (lower left), tube-dwelling polychaeta (upper right) and fringe of a large sea anemone (top).
(s = sculpin, p = polychaete, a = anemone)

6 cm

Plate 7d. Isopod, Mesidotea sp. crossing a disturbed area of substrate at D-82-8. (See arrow.)

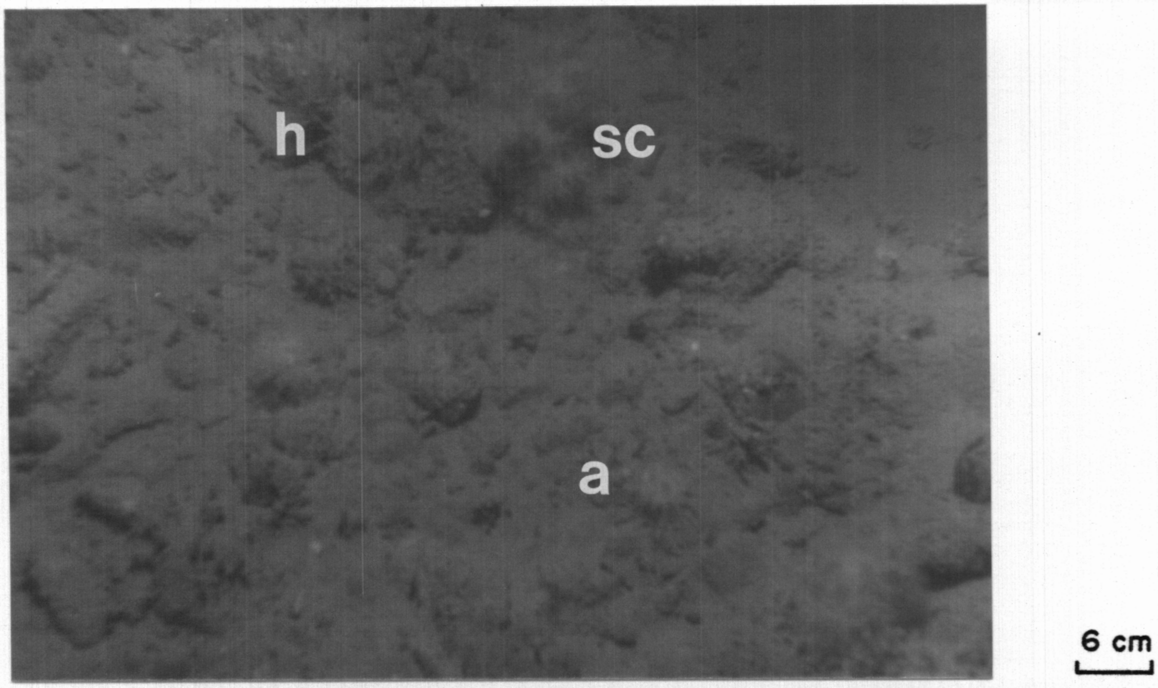


Plate 8a. Epifauna at Station D-82-7 are represented by pink soft coral, Gersemia rubiformis, (lower right and upper centre), burrowing anemone (lower right) and hydroids on rocks (upper left centre). (sc = soft corral, a = anemone, h = hydroids)

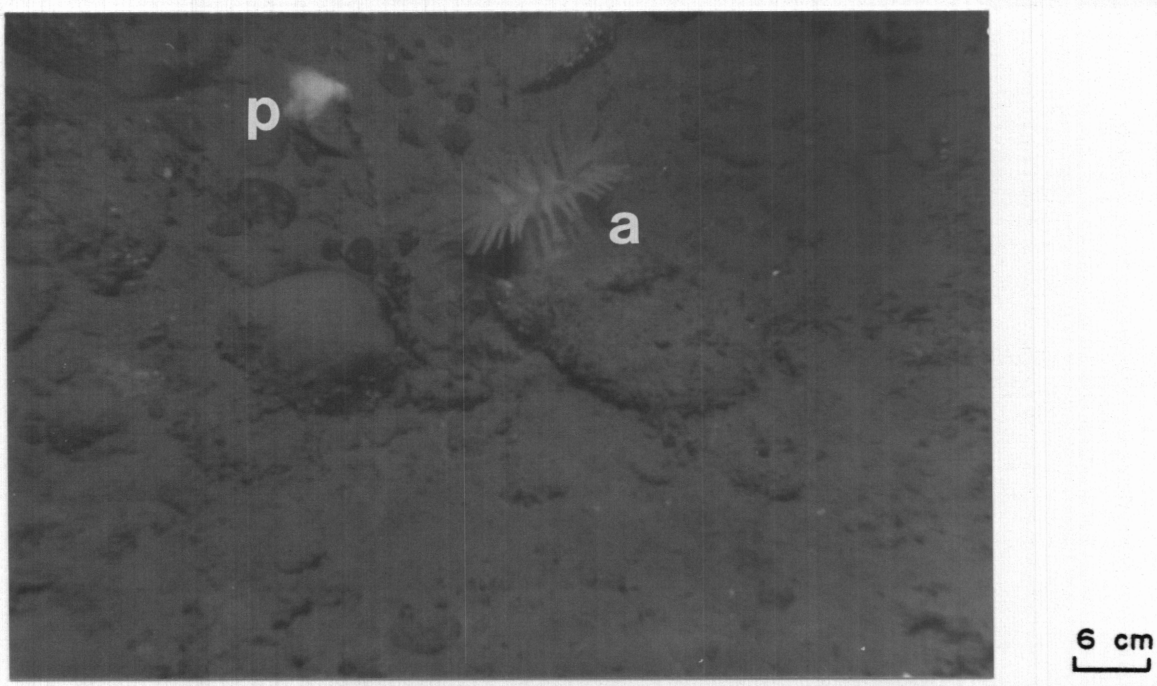
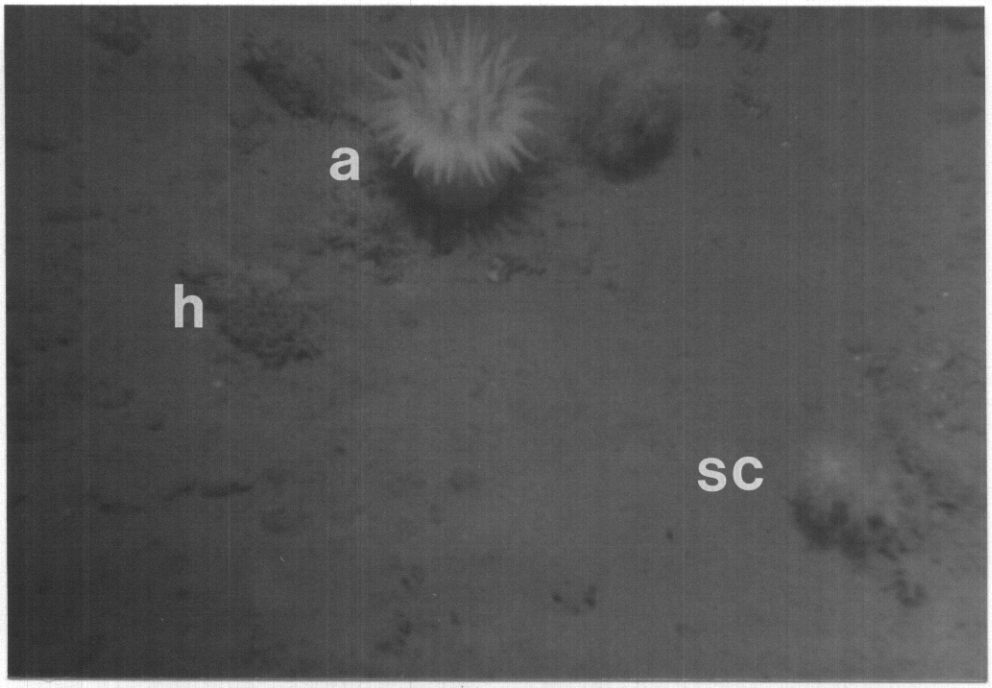


Plate 8b. Anemone and tube-dwelling polychaete (left) on rocks at D-82-7. (a = anemone, p = polychaete)



6 cm

Plate 8c. Anemone (upper centre), soft coral, Gersemia rubiformis (upper and lower right) and dense clusters of hydroids covering rocks (left centre) at D-82-7. (a = anemone, sc = soft coral, h = hydroids)

6 cm

Plate 8d. Isopod, Mesidotea sp. scrambling over gravelly substrate at D-82-7. (See arrow.)

The longer-term impacts of hopper dredging in Case 3 depend to a great extent on the rates of sedimentation or sediment redistribution in the dredging area. If the buildup of fine sediment in the trenches is very slow then sessile epifaunal species may attach to exposed rock and gravel, but recolonization by infaunal species characteristic of the area may be retarded. A higher rate of accumulation of sediment in the trenches would favour the infaunal species instead of sessile epifauna (e.g., D82-8).

In summary, dredging under the three sedimentary cases examined near Herschel Island caused only local disruptions of benthos and benthic habitat in the main and secondary dredging areas. According to diver observations, the amount of resuspended sediment which resettled near the trenches did not appear to suffocate epibenthos or infauna, but may have provided a favourable substrate for recolonization by infauna in the trenches. Unfortunately, due to environmental conditions in the field which severely limited post-dredging (1982) observations and sampling of dredged areas (refer to Section 1.7), the only data available for assessment of the extent of benthos recolonization at one year after initial dredging correspond to Case 3 described above. In that case, disturbed benthic habitat appeared to return to a productive but not fully mature state within a year of disruption by dredging. Although no 1982 data are available for Cases 1 and 2, it is expected that rates of benthos recolonization in those Cases would be similar to that observed for Case 3 because (1) early recolonization patterns observed in 1981 following initial dredging were very similar at all sites; and (2) the physical processes and oceanographic environments in all areas were also very similar. Regional effects due to increased sedimentation were not apparent at surrounding reference stations.

3.1.3 Faunal Indices and Community Structure

A statistically significant depression of average zoobenthos abundance at dredging stations was not apparent in 1982, one year after dredging had occurred. A comparison of levels of faunal indices at stations sampled in 1982 indicated that mean levels of population density and biomass were (statistically) significantly higher only at reference station D82-2 than at other stations (Table 4, Part C, $P < 0.01$, ANOVA1-3, Appendix D.1). Although the mean densities and biomass were observed to be low at the dredged stations, D82-7 and D82-8, the levels of these faunal indices were similar to the mean levels at stations sampled earlier in that vicinity; D-7 and

D-8 (July 1981) and DS-8 (September 1981; see Figure 4A). Similarly, the means for density and biomass at D82-7 and D82-8 were not (statistically) significantly different from those of the second reference station C82-2 ($P > 0.05$, ANOVA1-3).

The local depression of zoobenthos abundance in the dredge trench sampled at D82-8 was still indicated in 1982 by a comparison of faunal indices derived for samples taken before dredging (D-8a, b) and for those taken one year after dredging (D82-8e; Figure 4B). The values of the faunal indices from the dredge trench sample were at the low end of the wide range of values observed from remotely collected grab samples taken while at anchor at Station D82-2. The presence in the trench of 29 species of benthos, despite the relatively low levels of biomass and population density, suggests that recovery of the benthic community was progressing; this benthic community, however, was of lower complexity than that observed at reference stations with similar sedimentary conditions (e.g., C82-2, D-8).

Community analyses indicated that dredging did not markedly alter the benthic community structure of dredged areas relative to reference sites. The results of reciprocal averaging (RA) ordination and correspondence analysis (CA) indicated that benthic community structure in samples from dredged areas followed a pattern of close interaction with sediment properties similar to that of samples from reference stations. Both of the independent statistical techniques (Appendix C.2) indicated that certain benthic species tended to be associated with particular sediment types. For example, the amphipods, Apherusa jurinii and Gammarus locusta, the bivalve Thyasira gouldii and the polychaete, Scolecolepides sp. (Figure 5) tended to be associated with the sandy and gravelly samples ($P < 0.05$, ANOVA8). At the opposite end of the sediment gradient, species such as the polychaetes, Ampharete acutifrons (Figure 5; $P < 0.05$, ANOVA8), Pholoe sp. and Pygospio elegans and the bivalve, Macoma crassula, tended to be closely associated with the muddy sediments of most samples from reference stations and secondary dredging stations (see Figure 5). Epifauna such as Ascidiacea, sabellid polychaetes and the isopod, Mesidotea sibirica, were encountered in a wide spectrum of sediment conditions (Figure 5).

3.1.4 Possible Implications of Gravel Dredging to Higher Trophic Levels

Although direct utilization of the benthos by fish and marine mammals was not observed in this study, numerous sightings and several video recordings of ringed

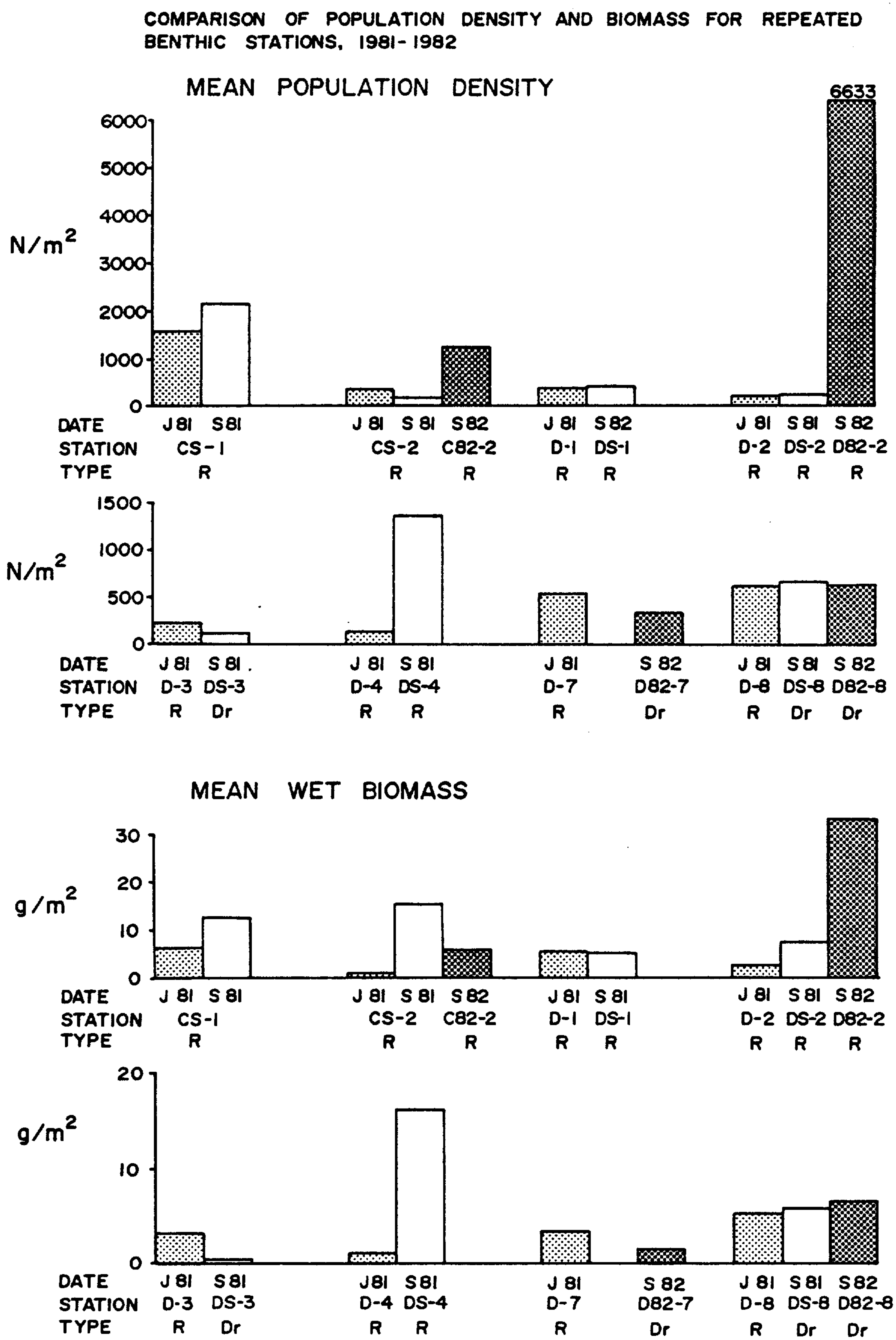


Figure 4A. Comparison of population density and biomass for repeated benthic stations near Herschel Island, 1981 - 1982. Reference stations are denoted by R and dredged stations are denoted by Dr.

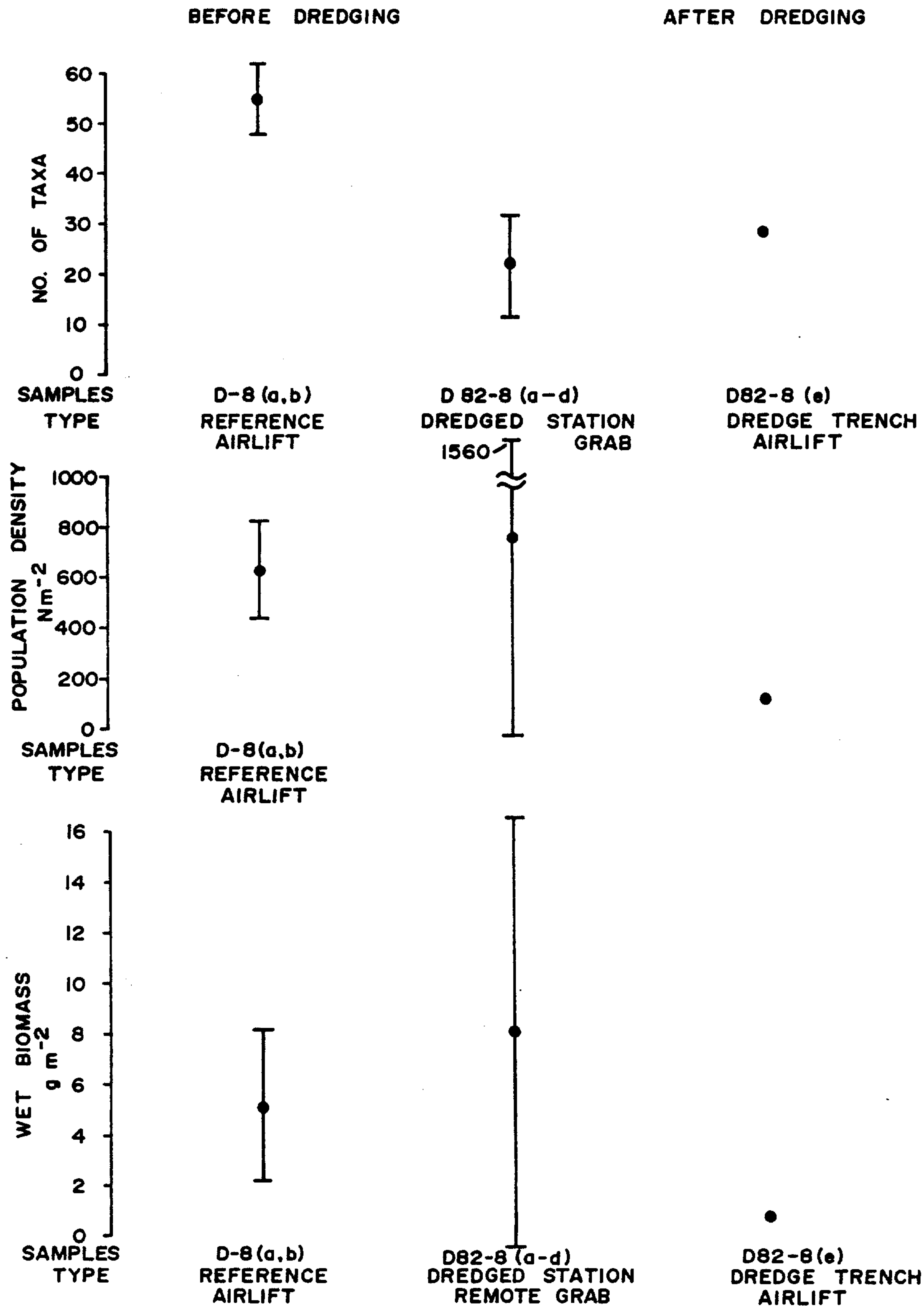


Figure 4B. Comparison of benthic faunal indices for samples from Station 8 taken before and one year after dredging.

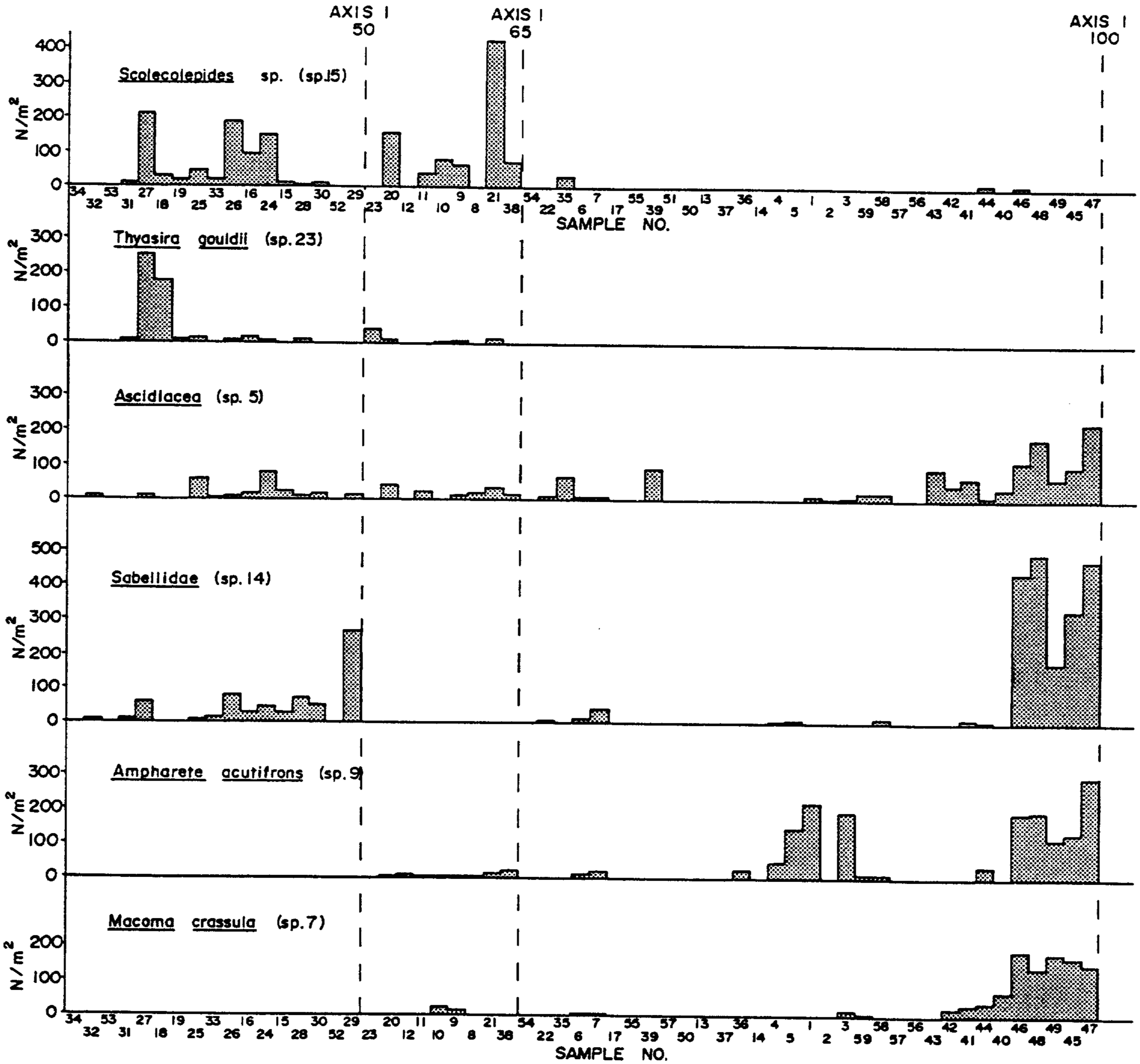


Figure 5. Distribution of representative species of benthos in samples from the Herschel Island Gravel Borrow Area, 1981 and 1982. Numbers after taxonomic name refer to number assigned in Table C.2-1 (Appendix C.2) and employed in the species ordination and correspondence analysis. Axis 1 scores refer to species ordination (Figure C.2-1).

seals, bearded seals and polar bears were made in Mackenzie Bay when heavy concentrations of ice floes accumulated in the area (e.g., September 1982). Diving observations of fish on the Mackenzie Bay ridge were limited to small sculpins.

Fisheries studies conducted along the Yukon and Alaskan coasts indicate that benthos found on the ridge, such as amphipods, isopods, bivalves and mysids, are important dietary items for several species of fish and seals which frequent the nearshore waters of the Yukon coast (Table 6).

The limited amount of dredging, however, has not seriously impinged on the marine food chain in Mackenzie Bay. The amount of substrate removed (74,440 m^3) and the degree of disturbance on the ridge resulting during only about 12 loading trips by hopper dredges was relatively small compared to volumes of substrate removed from other borrow areas during the construction of the Tarsiut N-44 artificial island (Heath and Thomas 1983b). The total area of gravel substrate disturbed by dredging near Herschel was about 0.12 km^2, assuming the trenches were 4 m wide and 0.6 m deep. This represents about 0.4% of the total gravel habitat area on the ridge in Mackenzie Bay, based on reconnaissance surveys in 1981.

3.1.5 Comparison of Dredging and Ice Scouring near Herschel Island

Along the gravel ridge in Mackenzie Bay, evidence of ice scouring was frequently encountered during dives and remote television viewing of the sea bed. Scours were found at five of twelve pre-dredging stations, at five of fourteen stations immediately after dredging, and at three of four stations sampled one year after dredging (Table 2). Several ice scours were seen during drift searching near the main dredging area in September 1982. At the secondary dredging area ice gouges were frequently detected during drift searches also. At station D82-8 ice scours were found along with dredge trenches (Plate 3a). Diver observations indicated that in several cases dredge trenches had subsequently been over-scoured by grounding ice. Where the density of disruption was greatest, it became difficult to distinguish dredge trenches from ice gouges (e.g., Plate 4).

Based on observations such as these, it may be concluded that over the total area of the gravel ridge in Mackenzie Bay, ice scours are detected more frequently than dredge trenches, which are localised to the main and secondary dredging areas. The extent of disturbance to benthos by dredging and ice scouring is often similar, based on qualitative and photographic observations, although different mechanisms

TABLE 6.

SUMMARY OF FOOD ITEMS IN THE DIETS OF FISH (from Bendock 1979, Kendel et al. 1975) AND SEALS (from Burns 1978) INHABITING THE NEARSHORE WATERS OF THE WESTERN BEAUFORT SEA

COMMON NAME	SCIENTIFIC NAME	FOOD ITEMS IN STOMACH CONTENTS
arctic char	Salvelinus alpinus	Amphipods, cod, mysids, isopods
least cisco	Coregonus sardinella	Mysids, amphipods, dipterans, isopods, copepods
arctic cisco	Coregonus autumnalis	Mysids, amphipods, copepods, fish, crustacea, vegetation
broad whitefish	Coregonus nasus	Chironomid larvae, amphipods
humpback whitefish	Coregonus clupeaformis	Dipterans, amphipods, fish
arctic cod	Boreogadus saida	Zooplankton, mysids
fourhorn sculpin	Myoxocephalus quadricornis	Immature isopods, amphipods, juvenile cod
boreal smelt	Osmerus eperlanus	Mysids, amphipods, isopods, fish
arctic flounder	Liopsetta glacialis	Amphipods, mysids, juvenile isopods, bivalves
bearded seal	Erignathus barbatus	Crabs, shrimp, bivalves, benthic and demersal fish

are involved in the formation of each type of depression. It is therefore considered that the degree of overall impact of dredging on the benthos and higher trophic levels in MacKenzie Bay is qualitatively comparable to that of ice scouring. The benthos of the area appears to be able to recolonize the disturbed sea bottom in relatively short periods of time when conditions of sediment redistribution are favourable. Continued or cyclical substrate instability, however, depresses the abundance of benthos and inhibits the development of a mature benthic community (cf. Carey and Ruff 1977).

3.1.6 Comparison of the Benthos of the Herschel Island Gravel Borrow Area with that of Other Study Areas in the Southern Beaufort Sea

The benthos of the gravel bearing ridge near Herschel Island was very diverse in taxonomic composition compared to other Beaufort Sea areas; 328 taxa were identified in the samples from 1981 and 1982 (Appendix A). The major taxonomic groups included 97 polychaetes, 68 amphipods, 33 bivalves, 29 gastropods, 11 isopods, 11 tanaids and 16 hydroids. In comparison, Wacasey (1975) recognized about 337 species of invertebrates from 82 stations on the Beaufort Sea continental shelf from Herschel Island to Cape Dalhousie during 1971-1975.

In the present study, the average faunal diversity (no. of taxa/sample) did not vary significantly between the sampling periods ($P > 0.05$; ANOVA4 and -5). Compared to other shallow (< 50 m) areas of the Southern Beaufort Sea, the Herschel Island Gravel Borrow Area had relatively high faunal diversity, but low levels of biomass and population density (Table 7). Epifauna were more prevalent near Herschel Island than in other areas sampled in the Beaufort Sea, but these organisms did not appear to be more adversely affected by dredging than were the infauna of the area. The instability and heterogeneous nature of sediments on the Mackenzie Bay ridge apparently limit the abundance of associated benthos, but offer a diverse environment for opportunistic species of epifauna and infauna.

Dredging in other areas of the Beaufort Sea would probably result in similar physical disturbances to those observed in this study, that is, removal of substrate and alteration of benthic habitat. Direct mortality and severe habitat disruption would be associated primarily with the excavated ("high impact") area, whereas effects within the "extended" impact zone would be largely related to habitat disruption alone. The size of the impact zone would be related directly to the scale of the dredging activities. The dynamics and nature of the recolonization process would probably be site-specific, depending on local substrate types, energy in the

TABLE 7.

COMPARISON OF BENTHIC FAUNAL INDICES FOR SOUTHERN BEAUFORT SEA STUDY AREAS*

AREA	DATE	MEAN DEPTH (m)	DIVERSITY (No. taxa/sample)	DRY BIOMASS (g m^{-2})	WET BIOMASS (g m^{-2})	REFERENCE+
Kaglulik C-24	1977	32.0 ± 0	33.0 ± 2.6	24.81 ± 16.19	not determined	1
Kaglulik A-75	1977	26.8 ± 0	22.7 ± 2.4	15.01 ± 7.16	not determined	1
Tarsiut A-25	July 1978	18 m	16 ± 0	1.83 ± 1.16	not determined	2
Uviluk	Aug. 1980	28.3 ± 1.1	51.0 ± 12.1	3.02 ± 1.65	16.64 ± 10.20	3
Kaglulik	Aug.-Sept. 1980	26.8 ± 9.3	42.5 ± 15.6	10.18 ± 9.03	53.73 ± 43.78	3
East Tarsiut	Sept. 1981	16.7 ± 4.1	20.8 ± 9.6	not determined	4.26 ± 4.03	4
East Tarsiut	July 1982	17.7 ± 6.2	14.2 ± 7.9	0.71 ± 0.73	5.69 ± 5.32	5
South Tarsiut	Sept. 1981	9.6 ± 1.9	22.4 ± 3.9	not determined	16.39 ± 12.90	4
South Tarsiut	July 1982	9.0 ± 1.8	14.6 ± 8.6	2.16 ± 2.27	15.27 ± 16.2	5
Tuk Harbour	July 1980	9.4 ± 6.9	13.1 ± 6.8	2.75 ± 3.11	12.32 ± 12.63	6
Tuk Harbour	Sept. 1980	8.4 ± 5.5	19.7 ± 4.6	4.01 ± 3.24	20.51 ± 13.55	6
Banks Island	July 1981	10.9 ± 4.7	44.0 ± 13.3F	not determined	41.57 ± 29.35	7
This study						
Herschel Island	July 1981	9.5 ± 2.0	36.3 ± 21.7	not determined	4.74 ± 4.91	
	Sept. 1981	12.5 ± 1.2	41.2 ± 14.9	not determined	15.62 ± 23.18	
	Sept. 1982	11.1 ± 0.6	41.8 ± 27.3	1.19 ± 1.61	11.72 ± 16.48	

* values expressed are the mean and standard deviation values for all samples at each site.
F refers to number of families rather than species
\+ References for data sources:

1. Thomas 1978a
2. Thomas 1978b
3. Heath and Thomas 1983a
4. Thomas et al. 1982
5. Heath and Thomas 1983b
6. Thomas et al. 1981
7. Heath et al. 1982b

benthic environment and the composition of benthic communities established before dredging occurred. Based on the observations made during this study and the experience gained in other coastal areas where the effects of dredging activities on benthic invertebrates have been investigated (Herbich 1981; Levings 1982; U.S. Army Corps of Engineers 1975), it is expected that regardless of substrate type any environmentally significant impacts associated with the dredging operations would be confined largely to the area directly within and immediately adjacent to those dredging activities.

3.2 Sediment Geochemistry

The concentrations of heavy metals in sediments collected in 1982 at 4 stations near Herschel Island are given in Table 8. The values fall within the range considered representative of unpolluted coastal marine sediments and within the range of concentrations previously reported for other Beaufort Sea and Arctic locations (Table 9). Inspection of the results in Table 8 indicates that there is poor agreement of metal concentrations among replicate grabs at Station D-82-2. The variability in the replicate samples, however, can be explained by the large differences in sediment particle size among replicates (Table 10 and Figures 6a, 6b, 6c and 6d). 5A, 5B, 5C, and 5D). The metal and sediment texture results re-affirm the same trend noted on numerous previous surveys in the Beaufort Sea (for example, Thomas and Heath, 1982; Thomas et al., 1981; Erickson et al., 1982; Heath and Thomas, 1983); namely, that for uncontaminated sediments the highest metal contents usually occur in samples rich in fine (clay/silt-sized) particles and the lowest metal contents usually occur in samples rich in coarse (sand-sized) particles.

There are probably two main factors responsible for the poor sampling replicability (which has led to the variable results):

1) The area sampled has been dredged and scoured by ice. Sediment obtained from within a dredge or scour trench would be expected to have a different texture (and hence heavy metal content) than sediment obtained from outside a dredge or scour trench; and

TABLE 8

HEAVY METAL CONCENTRATIONS IN SEDIMENT COLLECTED NEAR HERSCHEL ISLAND, 1982

STATION	ELEMENT CONCENTRATION ($\mu g\ g^{-1}$ dry weight except Fe in %)							
	Cr	Fe	Ni	Cu	Zn	Cd	Hg	Pb
D-82-2B	54	1.99	28	8.3	65	0.10	0.037	3.7
D-82-2C	**64 ± 7**	**2.17 ± 0.12**	**28 ± 2**	**12.4 ± 1.1**	**63 ± 4**	**0.14 ± 0.02**	**0.029 ± 0.003**	**4.2 ± 0.6**
D-82-2D	78	2.25	26	15.5	71	0.19	0.017	4.5
D-82-2E	52	1.93	26	14.2	55	0.10	0.036	4.5
D-82-7A	68	3.68	34	36	124	0.29	0.078	6.9
D-82-8A	70	3.40	34	32	115	0.46	0.065	5.4
C-82-2A	74	2.68	27	23	89	0.13	0.040	5.0
Mean Value ($\bar{X}$)	65.7	2.59	29	20.2	83.1	0.20	0.043	4.9
Range (r)	52-78	1.93-3.68	26-34	8.3-36	63-124	0.10-0.46	0.017-0.078	3.7-6.9

TABLE 9

A COMPARISON OF THE CONCENTRATIONS OF SELECTED METALS IN THE SEDIMENTS IN THE VICINITY OF HERSCHEL ISLAND WITH THOSE OF OTHER BEAUFORT SEA AND ARCTIC LOCATIONS

Area		Cr $\mu g\ g^{-1}$	Fe (%)	Ni $\mu g\ g^{-1}$	Cu $\mu g\ g^{-1}$	Zn $\mu g\ g^{-1}$	Cd $\mu g\ g^{-1}$	Hg $\mu g\ g^{-1}$	Pb $\mu g\ g^{-1}$
This study	$\bar{x}$	65.7	2.59	29	20.2	83.1	0.20	0.043	4.9
	r	52-78	1.93-3.68	26-34	8.3-36	63-124	0.10-0.46	0.017-0.078	3.7-6.9
Tarsiut A-25 1978[1]	$\bar{x}$	136.5	2.76	100	30.5	138.5	0.22	0.082	12
	r	134-139	2.74-2.78	97-104	29-31	138-139	0.21-0.23	0.077-0.085	11-13
Tarsiut N-44 1981[2]	$\bar{x}$	78	2.88	42	21	100.5	0.21	0.061	17.5
	r	23-119	0.81-4.30	5.1-69	3.6-30	18-146	0.072-0.29	0.006-0.151	7-24
South Borrow Area, 1981[2]	$\bar{x}$	89	2.54	27.8	19.5	99	0.21	0.049	13.4
	r	35-125	1.13-3.92	10-43	6.0-37	38-159	0.096-0.43	0.015-0.091	7.8-20
Tarsiut N-44 1982[3]	$\bar{x}$	86	-	54	24	110	0.36	0.077	-
	r	13-125		15-81	4-32	28-149	0.04-0.67	0.016-0.106	
South Borrow Area, 1982[3]	$\bar{x}$	74	-	43	20	104	0.41	0.053	-
	r	31-118		27-60	8-33	42-156	0.10-0.69	0.017-0.092	
Uviluk, 1982[3]	$\bar{x}$	56	-	33	16	83	0.20	0.045	-
	r	13-93		7-58	2-28	18-140	0.04-0.33	0.003-0.008	
Average Unpolluted World Coastal Ocean[4]	r	10-191	< 1-7	2-310	5-133	5-200	0.2-3.0	< 0.02-2.0[5]	2-50
Beaufort Sea Shelf[6]	r	-	-	~47	~57	~98	-	-	-
Arctic Ocean[7] (Canada Basin)	r	80-160	-	41-110	30-125	83-156	-	-	-
Dome Petroleum Site Survey, 1977[8]	r	16-118	2.68-5.14	-	15-34	37-128	< 2	0.049-0.088	< 3-11.3

1. Thomas 1978b
2. Thomas et al. 1982
3. Heath and Thomas, 1983
4. Calvert and Price 1971, Gross 1967, Glagoleva 1970, Kochenov et al. 1965, Hirst 1962, Moore 1963, Summerhayes 1971, White 1970, Riley and Chester 1971, Roth and Hornung 1977.
5. Royal Society of Canada 1971, D'Itri 1971
6. Hermann 1974
7. Naidu et al. 1976
8. Thomas 1978a

TABLE 10

PARTICLE SIZE DISTRIBUTION OF SEDIMENTS COLLECTED NEAR HERSCHEL ISLAND, 1982

	PERCENT FINER THAN						
U.S. STANDARD MESH SIZE	10	20	40	60	100	200	400
MEAN PARTICLE DIAMETER (μm)	2000	850	425	250	100	75	38
SAMPLE							
D-82-2A	43.9	40.6	36.7	29.3	23.7	12.7	6.2
D-82-2B	52.7	50.9	48.5	40.1	32.0	16.7	8.9
D-82-2C	62.3	60.1	56.7	44.4	37.8	22.8	15.0
D-82-2D	92.7	91.3	87.5	74.1	64.5	39.5	26.3
D-82-2E	56.8	51.7	45.9	31.3	20.7	14.1	9.3
D-82-7A	74.9	73.5	71.2	67.5	64.7	58.8	50.6
D-82-7B	80.1	74.7	66.0	53.8	47.5	42.6	36.1
D-82-7C	20.4	14.2	8.8	2.8	1.3	1.1	1.0
D-82-7D	26.7	19.2	11.5	3.0	1.4	0.9	0.7
D-82-7E	65.9	61.6	55.5	46.4	40.2	35.0	29.0
D-82-8A	99.7	99.0	96.0	89.1	77.1	60.1	47.2
D-82-8B	97.2	96.0	93.1	86.3	76.0	55.9	44.7
D-82-8C	92.5	87.1	80.9	70.3	61.1	48.8	38.3
D-82-8D	91.1	88.1	83.3	75.0	66.5	54.5	41.7
D-82-8E	89.4	79.2	65.5	51.0	40.7	29.9	22.0
C-82-2A	91.9	87.3	82.6	73.2	68.8	42.7	25.8
C-82-2B	99.4	98.8	97.7	95.2	92.9	81.4	72.6
C-82-2C	100.0	99.8	99.4	98.4	97.2	87.5	77.7
C-82-2D	99.4	98.1	96.4	92.7	89.5	69.0	53.0
C-82-2E	83.2	79.4	72.8	60.2	56.2	34.3	25.8

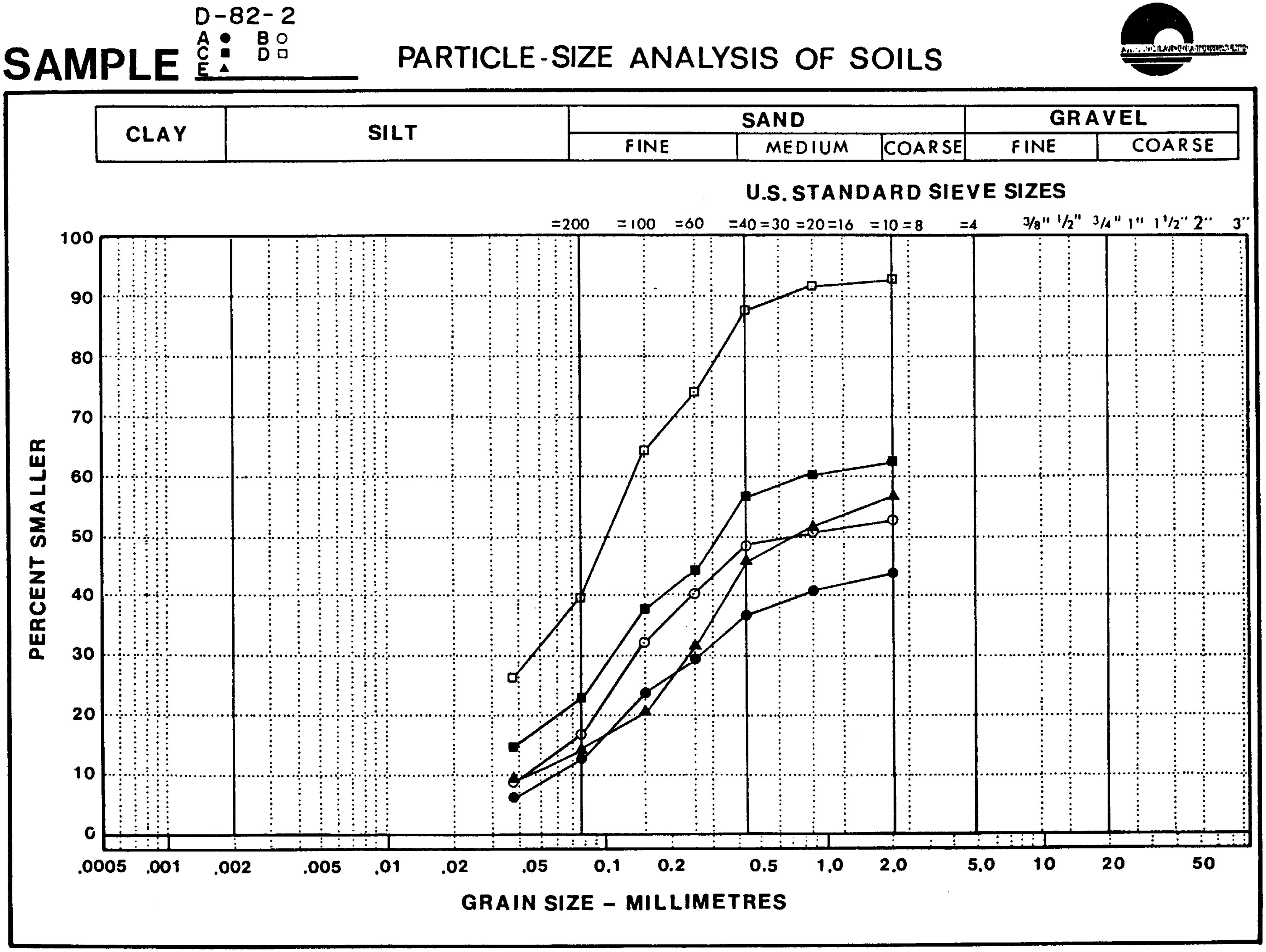


Figure 6a Particle size distribution of replicate sediment samples at Station D-82-2.

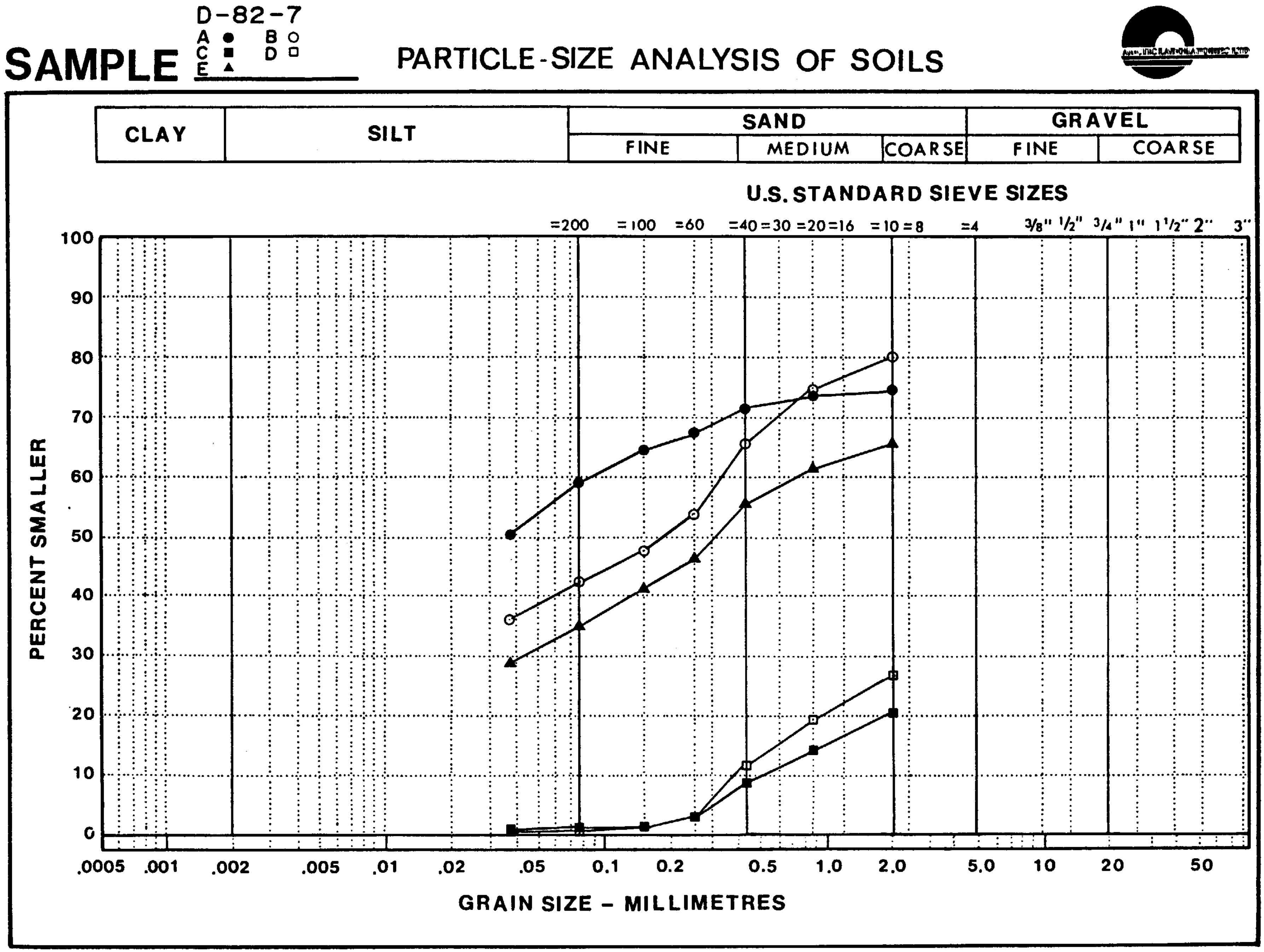


Figure 6b Particle size distribution of replicate sediment samples at Station D-82-7.

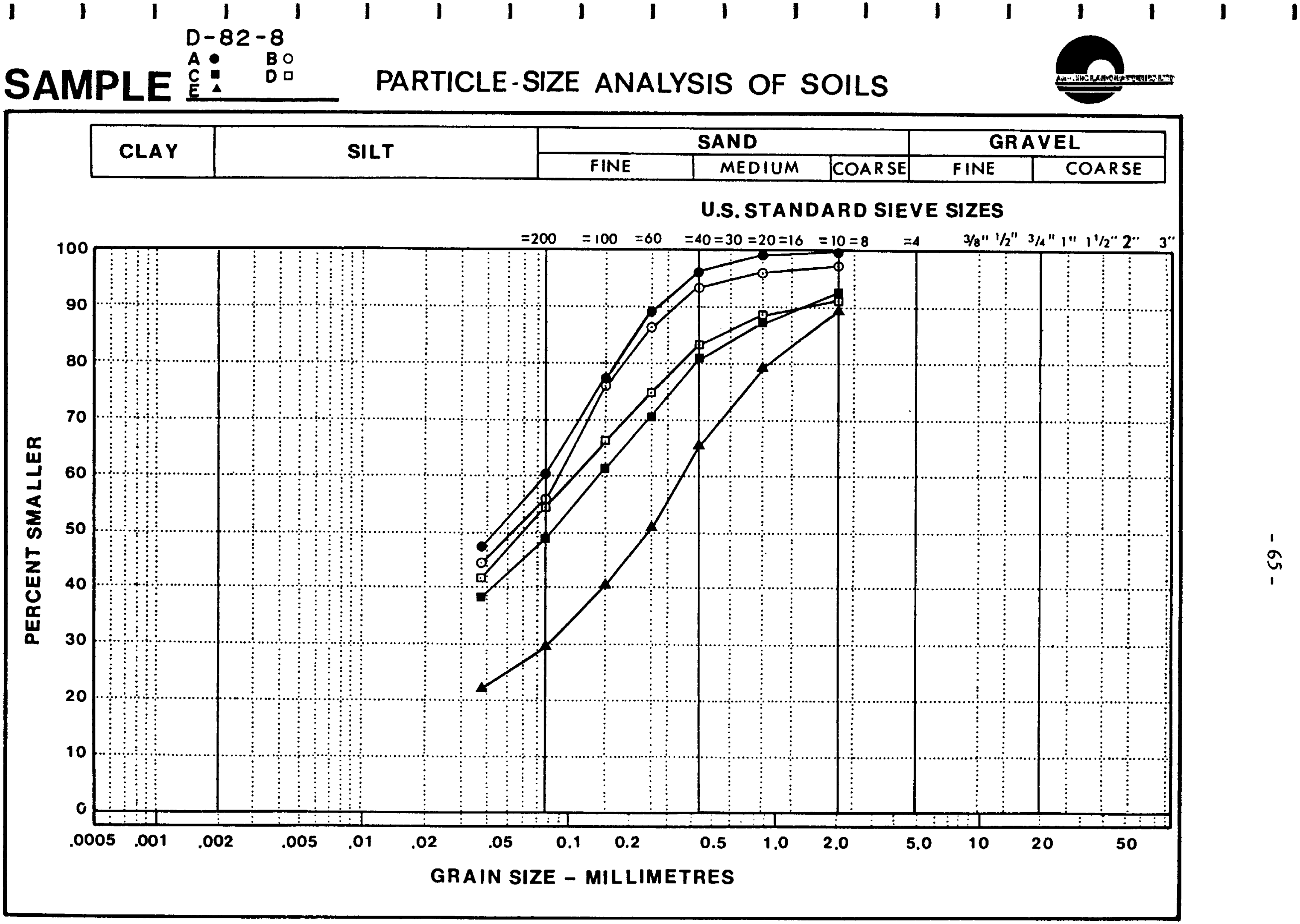


Figure 6c Particle size distribution of replicate sediment samples at Station D-82-8.

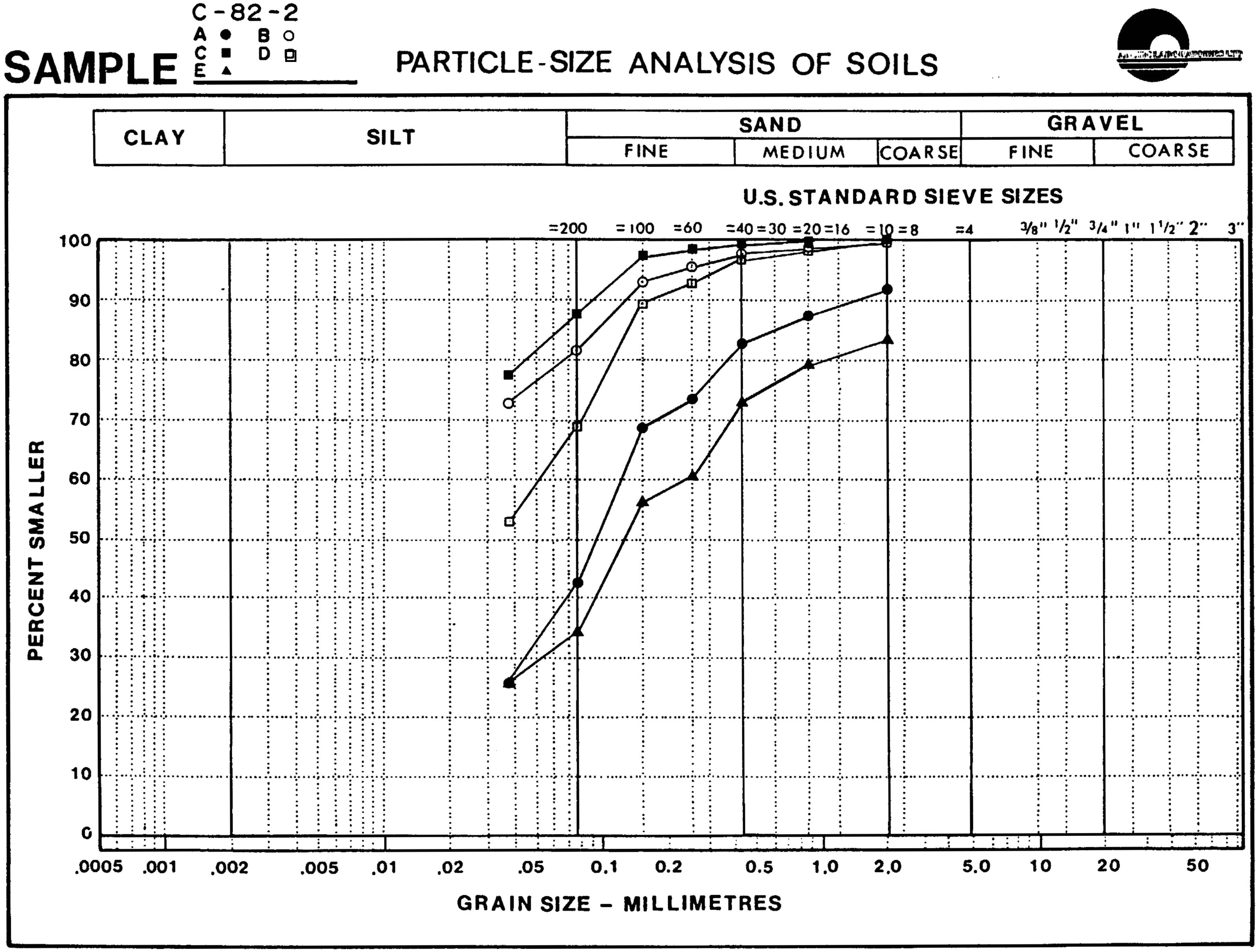


Figure 6d Particle size distribution of replicate sediment samples at Station C-82-2.

2) Holding station position during the survey period was not possible. When environmental conditions prevented anchoring on the sampling location, the M. V. SEQUEL drifted so that replicate samples could not be taken at a single position. Even at stations where the vessel was anchored, considerable vessel drift occurred. An example of this is station D-82-7: During the time required to collect four grab samples, the SEQUEL drifted onto a gravel bar when its anchor was raised to avoid ice floes (the changes in sediment texture among replicate sediment samples during this period are clearly evident in Figure 6b).

4. CONCLUSIONS

1. In all three sedimentary cases examined (dredging of (i) gravel; (ii) gravel overlain by sand (iii) gravel overlain by silt/clay), the initial direct impact on benthos was the very local removal of organisms and substrate along parallel trenches, causing discontinuities in faunal distributions and lowering total biomass in the dredged area. The paired dredged trenches were each about 4 m wide and up to 0.6 m deep. The depth of penetration of the trenches was apparently dependent on substrate firmness.

   - Where dredging occurred on exposed gravel or on sand overlying gravel, the secondary effects included agitation and resettling of fine sediment particles, such as fine sand and silt. The resettlement of a thin layer (up to 5 cm) of fine sand in the dredge trenches appeared to provide an important area for recolonization of infaunal benthos, such as polychaete worms, bivalves and amphipods. The overall impact of dredging on exposed gravel and on sand overlying gravel was a local disruption of benthos and substrate.

   - In the case of dredging on silt-clay overlying or combined with gravel (Case 3), hopper dredging removed the substrate to a shallow depth (0.1 to 0.4 m) and resuspended the overlying sediment fines. Most of the silt-clay particles were carried away from the dredging area by currents, but a small amount of silt and fine sand tended to resettle in and near the dredge trenches. The longer-term impacts of dredging under Case 3 are potentially more disruptive to the benthos than those under the other sedimentary cases due to the exposure of the previously buried gravelly sediments. However, a high rate of fine sediment accumulation in the trenches appears to enhance recovery of the infaunal benthos.

2. Recolonization of the dredged trenches began almost immediately after dredging in each sedimentary case by resettling of survivors and immigration of mobile and drifting benthos from surrounding unaffected

areas. One year after dredging, under sedimentary conditions of Case 3 (the only case for which both 1981 and 1982 samples could be obtained), recolonization of a dredge trench to a productive but not fully mature state by a diverse assemblage of polychaetes, amphipods and other epifauna had occurred, but abundance was low. Recolonization of ice scour trenches was also observed and appeared qualitatively similar to that of dredge trenches.

3. At some dredging sites in the secondary dredging area, the high frequency of ice scouring was detrimental to recolonization by benthos due to intensive reworking of the sediments. In depths over 10 m where hopper dredges operate and where ice scouring is most prevalent, the disruptive effects of dredging and ice gouging may be similar and can be overlapping. The reworking of the sea bottom causes substrate instability and therefore depresses the abundance of benthos and inhibits the development of a mature benthic community.

4. Factors related to sediment texture have a pronounced influence on benthic community structure on the shallow ridge in Mackenzie Bay.

5. Community associations of benthos observed at sites that have been disrupted by dredging were consistent with those observed at non-dredging reference sites.

6. Compared to other shallow (< 50 m) areas of the southern Beaufort Sea, the Herschel Island Gravel Borrow Area had relatively high faunal diversity, but low levels of biomass and population density. Epifauna were more prevalent near Herschel Island than in most other study areas, but these animals did not appear to be more adversely affected by dredging than infauna.

7. The concentrations of heavy metals in sediments collected near Herschel Island fall within the range considered representative of unpolluted coastal marine sediments and within the range of concentrations previously reported for other Beaufort Sea and Arctic locations.

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APPENDIX A

TAXONOMIC IDENTIFICATIONS BY STATION/SAMPLE

APPENDIX A. FAUNISTIC COMPOSITION OF BENTHOS SAMPLES FROM THE GRAVEL BORROW AREA NEAR HERSCHEL ISLAND, JULY AND SEPTEMBER, 1981; SEPTEMBER, 1982

NOTE: Reference Stations for July and September 1981 sampling periods are labelled CS-1 and CS-2; reference stations in September 1982 are labelled C82-2 and D82-2.

Other stations for 1981 are denoted by "D"- for July and by "DS"- for September.

Dredging stations sampled in 1982 are indicated as D82-7 and D82-8.

Station positions are provided in Table 1. Only Stations CS-1, CS-2, D-1, D-2, D-3 and D-4 for July 1981 are comparable to their September 1981 counterparts CS-1, CS-2, DS-1, DS-2, DS-3 and DS-4 because station positions were revisited as nearly as possible with the navigational aids available. Other station pairs are not comparable, since September 1981 sampling sites had to be relocated to permit examination of dredging impact.

+ Pelagic species (i.e. copepods, chaetognaths, larvaceans, etc.) found in the samples are included in the tables, but their numbers or biomass are not included in the station totals. Mollusc wet biomass figures include calcified parts, but the specimens are decalcified prior to dry biomass determination.

* Wet Biomass figures only determined to the Family level.

M Specimens retained for museum purposes; no dry weight determined.

The pelecypod, Thyasira gouldii, was reported as the synonymous T. flexuosa in samples from 1981 (Heath et al. 1982a).

STATION: HERSCHEL ISLAND CS-1

		JULY (CS-1)				SEPTEMBER (CS-1)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida									
Class: Oligochaeta		6		0.002					
Class: Polychaeta									
Family:									
Ampharetidae	Ampharete acutifrons	216		0.230		182		0.246	
	Asabellides sibirica		234		0.372				
	Family Total	216	234	0.230	0.372	182		0.246	
Apistobranchidae	Apistobranchus ornatus	2	6	0.002	0.006				
Capitellidae	Capitella capitata					2		< 0.001	
Cirratulidae	Chaetozone sp.	4	24	0.008	0.146	2			
	Cirratulus cirratus	2				16			
	Tharyx multifilis	38		0.086					
	Family Total	44	24	0.094	0.146	18		0.310 *	
Dorvilleidae	Dorvillea sp.	12	10	0.014	0.016				
Flabelligeridae	Flabelligera affinis	2	2	0.056	0.026				
Hesionidae	Castalia aphroditoides	62	34	0.080	0.098	70		0.140	
	Unidentified species		8		0.004				
	Family Total	62	42	0.080	0.102	70		0.140	
Lumbrineridae	Lumbrineris similabris	12	16	0.020	0.040	2		0.024	
Maldanidae	Microclymene sp.	38	38	0.026	0.054	12		0.022	

STATION: HERSCHEL ISLAND CS-1

		JULY (CS-1)				SEPTEMBER (CS-1)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida									
Class: Polychaeta									
Family:									
Nephtyidae	Nephtys sp.	44	18	0.092	0.060	20		0.054	
Nereidae	Nereis zonata	20	6	0.198	0.072	38		0.644	
Orbiniidae	Leitoscoloplos pugettensis	12	4	0.124	0.022				
	Scoloplos sp.		2						
	Family Total	12	6	0.124	0.022				
Phyllodocidae	Eteone longa		2		0.004				
	Phyllodoce groenlandica	2		0.002					
	Unidentified					2		0.001	
	Family Total	2	2	0.002	0.004	2		0.001	
Polynoidae	Antinoella sarsi					2			
	Harmothoe extenuata					10			
	Harmothoe imbricata	2		0.656		2			
	Hesperonoe sp.	6	2	0.014	0.004	4			
	Melaenis loveni		2		0.216				
	Family Total	8	4	0.670	0.220	18		1.596 *	
Sabellidae	Chone infundibuliformis					2			
	Chone sp.					2			
	Euchone analis	2	4	0.001	0.001				
	Potamilla neglecta					4			
	Family Total	2	4	0.001	0.001	8		1.248 *	
Serpulidae			2		0.002				
Sigalionidae	Pholoe sp.	70	46	0.106	0.062	38		0.016	

STATION: HERSCHEL ISLAND CS-1

		JULY (CS-1)				SEPTEMBER (CS-1)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida **Class:** Polychaeta **Family:**									
Spionidae	Dispio sp.	2	2	0.002					
	Polydora sp.		2		0.002				
	Prionospio cirrifera	20	8	0.038	0.028				
	Prionospio steenstrupi	4	6	0.004	0.012				
	Pygospio elegans	2		0.001		4		< 0.001	
	Scolecolepides sp.					2		< 0.001	
	Unidentified		2		0.002				
	Family Total	28	20	0.045	0.044	6		< 0.001	
Syllidae	Autolytus sp.	2	2	0.001	0.002	32			
	Exogone sp.	26	2	0.006	0.001	52			
	Family Total	28	4	0.007	0.003	84		0.034 *	
Terebellidae	Scionella japonica	4		0.024					
Trichobranchidae	Terebellides stroemi	4	2	0.038	0.002				
Annelid Fragments and Nematodes		present	present	0.032	0.040	present		0.078	
Phylum: Arthropoda **Class:** Cirripedia **Order:** Thoracica **Family:**									
Balanidae	Balanus balanoides	present							
Class: Copepoda **Order:** Calanoida + **Family:**									
Calanidae	Calanus sp.	10	2	0.016	0.010	70		0.268	
Order: Cyclopoida						2		0.001	

STATION: HERSCHEL ISLAND CS-1

		JULY (CS-1)				SEPTEMBER (CS-1)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Arthropoda **Class:** Malacostraca **Order:** Amphipoda **Family:**									
Ampeliscidae	Ampelisca eschrichti	44		0.018					
	Bybilis gaimardi	34	34	0.352	0.558	174		0.514	
	Family Total	78	34	0.370	0.558	174		0.514	
Aoridae	Leptocheirus aberrans					4			
Caprellidae		6	4	0.020	0.004	12		0.040	
Corophiidae	Erichthonius difformis	66	22	0.102	0.058				
	Erichthonius hunteri	52		0.218		98		0.210	
	Erichthonius sp. (juveniles)	376		0.018					
	Family Total	494	22	0.338	0.058	98		0.210	
Eusiridae	Rhachtropis helleri		2		0.004				
Gammaridae	Gammarus locusta					8			
	Melita dentata	12	56	0.092	0.124	72			
	Family Total	12	56	0.092	0.124	80		0.782 •	
Haustoriidae	Pontoporeia femorata		4		0.026				
	Pontoporeia sp.					2		0.012	
	Family Total		4		0.026	2		0.012	
Ischyroceridae	Ischyrocerus megacheir	86	54	0.412	0.284	162		0.194	

STATION: HERSCHEL ISLAND CS-1

		JULY (CS-1)				SEPTEMBER (CS-1)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Arthropoda									
Class: Malacostraca									
Order: Amphipoda									
Family:									
Lysianassidae	Anonyx nugax		2		0.012				
Oedicerotidae	Aceroides latipes	24	20	0.212	0.076	28		0.080	
	Halicreion longicaudatus					4		< 0.001	
	Monoculodes longirostris		14		0.002				
	Paroediceros lynceus	8		0.002		14		< 0.001	
	Family Total	32	34	0.214	0.078	46		0.080	
Paramphithoidae	Paramphithoe boeckii					14		0.032	
	Paramphithoe polyacantha	2	2	0.400	0.132				
	Family Total	2		0.400	0.132	14		0.032	
Pleustidae	Stenopluestes malmgreni	60	12	0.046	0.010	22		0.032	
Podoceridae	Dulichia monacantha	20	32	0.012	0.012	12		0.016	
Stenothoidae	Metopa alderi					48			
	Metopa borealis					16			
	Metopa longicornis					180			
	Metopa pusilla	16	2	0.010	0.001				
	Family Total	16	2	0.010	0.001	244		0.130 •	
Order: Cumacea									
Family:									
Diastylidae	Brachydiastylis resima	54	50	0.094	0.068	56			
	Diastylis edwardsi					12			
	Diastylis oxyrhyncha	6	2	0.124	0.082	10			
	Diastylis sulcata					24			
	Diastylis tumida	16	20	0.088	0.180				
	Family Total	76	72	0.306	0.330	102		0.294 •	

STATION: **HERSCHEL ISLAND CS-1**

		JULY (CS-1)				SEPTEMBER (CS-1)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Arthropoda									
Class: Malacostraca									
Order: Cumacea									
Family:									
Leuconidae	Leucon fulvus					18			
	Leucon nasica	12		0.002		12			
	Leucon nasicoides	2		0.001					
	Family Total	14		0.003		30		0.010 •	
Order: Isopoda									
Family:									
Arcturidae	Arcturus beringanus	2	4	0.001	0.002				
	Arcturus longispinus					4		0.004	
	Pleuroprion intermedium	4		0.174					
	Family Total	6	4	0.175	0.002	4		0.004	
Idoteidae	Mesidotea sibirica	8	4	0.036	0.042				
	Synidotea bicuspida	20	24	0.476	0.248	62		3.024	
	Family Total	28	28	0.512	0.290	62		3.024	
Jaeropsidae	Jaeropsis sp.		2		0.001	12		0.002	
Munnidae	Munna kroyeri	62	36	0.032	0.026	282		0.144	
	Pleurogonium spinosissmum	4	2	0.001	0.002	16		0.006	
	Family Total	66	38	0.033	0.028	298		0.150	
Order: Mysidacea						2		0.858	

STATION: **HERSCHEL ISLAND CS-1**

			JULY (CS-1)				SEPTEMBER (CS-1)			
			Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
		Genus Species	A	B	A	B	A	B	A	B
Phylum: **Class:** **Order:**	Arthropoda Malacostraca Tanaidacea	Leptognathia gracilis	142	70	0.006	0.006	24		0.002	
Class:	Ostracoda	Hemicythere sp.	2		0.002					
Class: **Family:**	Pycnogonida									
Ammotheidae		Achelia spinosa		2		0.046				
Nymphonidae		Nymphon grossipes	4		0.012		2		0.020	
Arthropod Fragments					0.024	0.016			0.184	
Phylum: **Subphylum:** **Class:**	Chordata Urochordata Ascidiacea		6	2	0.296	0.002	4		0.218	
Class:	Enteropneusta		2		0.044					
Phylum: **Class:** **Order:**	Cnidaria Anthozoa Actinaria		4	6		0.032	2			
Order: **Family:**	Alcyonacea									
Nepthyidae		Gersemia sp.	present	present			present			

STATION: HERSCHEL ISLAND CS-1

	Genus Species	JULY (CS-1) Number/m^2 A	B	Wet Biomass (g/m^2) A	B	SEPTEMBER (CS-1) Number/m^2 A	B	Wet Biomass (g/m^2) A	B
Phylum: Cnidaria									
Class: Anthozoa									
Order: Unidentified		6		0.060		4		0.008	
Class: Hydrozoa									
Family:									
Corynidae	*Coryne tubulosa*	present							
Eudendriidae	*Eudendrium annulatum*	present							
	Eudendrium capillare	present							
	Unidentified species		present						
Lafoeidae			present						
Class: Scyphozoa									
Order: Stauromedusae									
Family: Haliclystidae	*Lucernia quadricornis*					4		0.046	
Phylum: Echinodermata									
Class: Stelleroidea									
Subclass: Asteroidea						10		0.326	
Subclass: Ophiuroidea									
Family:									
Ophiolepididae	*Anthophiura* sp.	44	74	0.008	0.018				
Unidentified Ophiuroid						12		0.004	

STATION: HERSCHEL ISLAND CS-1

	Genus Species	JULY (CS-1) Number/m2 A	JULY (CS-1) Number/m2 B	JULY (CS-1) Wet Biomass (g/m2) A	JULY (CS-1) Wet Biomass (g/m2) B	SEPTEMBER (CS-1) Number/m2 A	SEPTEMBER (CS-1) Number/m2 B	SEPTEMBER (CS-1) Wet Biomass (g/m2) A	SEPTEMBER (CS-1) Wet Biomass (g/m2) B
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**									
Bicellariellidae	Caulibugula	present							
Flustridae	Carbasea carbasea	present							
Scrupariidae	Eucratea loricata		present						
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Opisthobranchia **Order:** Thecosomata		8	10	0.032	0.036	2		0.002	
Subclass: Prosobranchia **Family:**									
Buccinidae	Buccinum sp.	2	2	1.498	0.112	2		0.274	
Diaphanidae	Diaphana minuta		4		0.004				
Naticidae	Lunatia pallida					2		0.096	
Philinidae	Philine sp.		4		0.020				
Retusidae	Retusa obtusa	12	22	0.032	0.042				
Rissoidae	Cingula castanea	12	12	0.062	0.054				

STATION: HERSCHEL ISLAND CS-1

		JULY (CS-1)				SEPTEMBER (CS-1)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Mollusca									
Class: Gastropoda									
Family:									
Trochidae	Margarites costalis					10		0.110	
	Margarites helicinus	4		0.036					
	Solariella obscura	4	6	0.056	0.034				
	Family Total	8	6	0.092	0.034	10		0.110	
Turridae	Oenopota cinerea	2		0.132					
	Oenopota reticulata	4		0.028					
	Oenopota sp.		2		0.114	2		0.062	
	Propebela sp.	2	10	0.004	0.028				
	Family Total	8	12	0.164	0.142	2		0.062	
Gastropod Fragments					0.018				
Class: Pelecypoda									
Family:									
Astartidae	Astarte crenata					2		0.008	
	Astarte montagui	8		0.214		6		0.044	
	Family Total	8		0.214		8		0.052	
Hiatellidae	Hiatella arctica	2	2	0.008	0.024	12		0.116	
Lyonsiidae	Lyonsia arenosa	2		0.278					

STATION: HERSCHEL ISLAND CS-1

	Genus Species	JULY (CS-1) Number/m^2 A	B	JULY (CS-1) Wet Biomass (g/m^2) A	B	SEPTEMBER (CS-1) Number/m^2 A	B	SEPTEMBER (CS-1) Wet Biomass (g/m^2) A	B
Phylum: Mollusca									
Class: Pelecypoda									
Family:									
Myidae	Mya truncata	2		0.082					
Mytilidae	Musculus sp.					2		0.001	
Nuculanidae	Nuculana pernula	8		0.050		22		0.116	
	Portlandia arctica					40		0.716	
	Portlandia sulcifera		6		0.022				
	Yoldiella fraterna	22	4	0.062	0.014	16		0.008	
	Yoldiella frigida		28		0.090				
	Yoldiella lenticula	2		0.008					
	Family Total	32	38	0.120	0.126	78		0.840	
Tellinidae	Macoma crassula					10		0.198	
	Macoma moesta	6		0.022		8		0.260	
	Family Total	6		0.022		18		0.458	
Thraciidae	Thracia sp.					2		0.002	
Thyasiridae	Axinopsida orbiculata	12	8	0.042	0.026	12		0.042	
Veneridae	Liocyma fluctuosa		2		0.001	8		0.020	
Unidentified Juvenile Pelecypoda		2		0.002					
Pelecypod Fragments				0.002					

STATION: HERSCHEL ISLAND CS-1

		JULY (CS-1)				SEPTEMBER (CS-1)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Nemertea		12	18	0.018	0.016	2		0.001	
Phylum: Porifera						18			
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**									
Fischerinidae	<u>Cornuspira</u> <u>foliacea</u>	present	present						
Miliolidae	<u>Miliolina</u> <u>seminulum</u>		present						
Unidentified Foraminifera						present			
Phylum: Sipuncula		10	4	0.028	0.006	6		0.058	
STATION TOTAL:		1954	1188	7.95	4.03	2126		12.53	

STATION: HERSCHEL ISLAND CS-2

		JULY (CS-2)				SEPTEMBER (CS-2)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida									
Class: Polychaeta									
Family:									
Ampharetidae	*Ampharete acutifrons*	46	134	0.034	0.116		6		
	Melinna elizabethae						2		
	Fragments			0.006					
	Family Total	46	134	0.040	0.116		8		0.001 *
Apistobranchidae	*Apistobranchus ornatus*		2		0.001				
Arabellidae	*Arabella* sp.		2		0.004				
Capitellidae	*Capitella capitata*	4	2	0.004	0.001				
Cirratulidae	*Chaetozone setosa*		2				2		0.002
	Chaetozone spinosa		14						
	Family Total		16		0.028		2		0.002
Dorvilleidae	*Dorvillea* sp.	2		0.004					
Flabelligeridae	*Diplocirrus longisetosus*		4		0.002				
Hesionidae	*Castalia aphroditoides*		2		0.006				
	Unidentified genus		2		0.004	6	8	0.002	0.012
	Family Total		4		0.010	6	8	0.002	0.012
Lumbrineridae	*Lumbrineris* sp.	4	2	0.012	0.002		4		0.002
Maldanidae			fragments		0.002		2		0.002
Nephtyidae	*Nephtys* sp.		2		0.002				
Nereidae	*Nereis zonata*	2		0.006					
Orbiniidae	*Leitoscoloplos pugettensis*		2		0.002				

STATION: HERSCHEL ISLAND CS-2

	Genus Species	JULY (CS-2) Number/m² A	JULY (CS-2) Number/m² B	JULY (CS-2) Wet Biomass (g/m²) A	JULY (CS-2) Wet Biomass (g/m²) B	SEPTEMBER (CS-2) Number/m² A	SEPTEMBER (CS-2) Number/m² B	SEPTEMBER (CS-2) Wet Biomass (g/m²) A	SEPTEMBER (CS-2) Wet Biomass (g/m²) B
Phylum: Annelida									
Class: Polychaeta									
Family:									
Phyllodocidae	Phyllodoce greonlandica						2		0.104
Polynoidae	Antinoella sarsi					2		0.004	
	Hesperonoe sp.		2		0.002				
	Unidentified species	2		0.010					
	Family Total	2	2	0.010	0.002	2		0.004	
Sabellidae		2	4	0.001	0.001	2	24	0.001	0.008
Serpulidae							2		0.002
Sigalionidae	Pholoe sp.					10	10	0.008	0.010
Spionidae	Dispio sp.	6	8	0.006	0.008				
	Polydora sp.		2		0.001				
	Prionospio cirrifera	2	8	0.004	0.012				
	Pygospio elegans						2		< 0.001
	Scolecolepides sp.					2		0.004	
	Family Total	8	18	0.010	0.021	2	2	0.004	< 0.001
Syllidae	Exogone sp.	2		0.001					
Terebellidae	Nicolea zostericola		2		0.006				
Trichobranchidae	Terebellides stroemi		4		0.014				
Trochochaetidae	Trochochaeta multisetosa		2		0.001				
Annelid Fragments and Nematodes		present	present	0.022	0.010	present	present	0.014	0.001

STATION: HERSCHEL ISLAND CS-2

	Genus Species	JULY (CS-2) Number/m2 A	B	Wet Biomass (g/m2) A	B	SEPTEMBER (CS-2) Number/m2 A	B	Wet Biomass (g/m2) A	B
Phylum: Arthropoda									
Class: Copepoda									
Order: Calanoida									
Family:									
Calanidae +	_Calanus_ sp.		2		0.004	34	38	0.232	0.136
Class: Malacostraca									
Order: Amphipoda									
Family:									
Ampeliscidae	_Byblis gaimardi_		2		0.001		4		0.006
	Haploops sp.		8		0.001				
	Family Total		10		0.002		4		0.006
Calliopiidae	_Apherusa jurinii_						4		0.024
Caprellidae		2	2	0.001	0.002		2		0.001
Corophiidae	_Erichthonius difformis_		4		0.008		4		0.004
Gammaridae	_Melita dentata_		2		0.024	10	8	0.046	0.020
Haustoriidae	_Pontoporeia femorata_		2		0.018				
Isaeidae	_Protomedeia fasciata_		10		0.004				
Ischyroceridae	_Ischyrocerus anguipes_	10		0.018					
	Ischyrocerus megacheir		8		0.068				
	Ischyrocerus sp.					14	4	0.012	0.006
	Family Total	10	8	0.018	0.068	14	4	0.012	0.006

STATION: **HERSCHEL ISLAND CS-2**

		JULY (CS-2)				SEPTEMBER (CS-2)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Arthropoda									
Class: Malacostraca									
Order: Amphipoda									
Family:									
Lysianassidae	*Boeckosimus plautus*					12		0.094	
	Orchomene amblyops						6		0.022
	Family Total					12	6	0.094	0.022
Oedicerotidae	*Aceroides latipes*		16		0.044				
	Paroediceros lynceus					24	20	0.222	0.036
	Family Total		16		0.044	24	20	0.222	0.036
Podoceridae	*Dulichia monacantha*	10		0.002					
Stenothoidae	*Metopa alderi*						4		
	Metopa pullisa		2		0.001				
	Metopa sinuata						20		
	Metopa sp.					2		0.002	
	Family Total		2		0.001	2	24	0.002	0.010 *
Order: Cumacea									
Family:									
Diastylidae	*Brachydiastylis resima*	10	12	0.008	0.008	2	4		
	Diastylis edwardsi					2	4		
	Diastylis oxyrhyncha	4		0.048		8	4		
	Diastylis tumida	18	18	0.098	0.066	10			
	Family Total	32	30	0.154	0.074	22	12	0.064 *	0.038 *
Leuconidae	*Leucon nasica*						2		0.001

STATION: HERSCHEL ISLAND C-2 and CS-2

			JULY (CS-2)				SEPTEMBER (CS-2)			
			Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
		Genus Species	A	B	A	B	A	B	A	B
Phylum:	Arthropoda									
Class:	Malacostraca									
Order:	Isopoda									
Family:										
	Idoteidae	Mesidotea sibirica		2		0.042	2		18.302	
		Synidotea bicuspida						4		0.028
		Family Total		2		0.042	2	4	18.302	0.028
	Munnidae	Munna kroyeri	8	6	0.002	0.001				
		Pleurogonium spinosissmum		2		0.001				
		Family Total	8	8	0.002	0.002				
Order:	Mysidacea						2		1.376	
Order:	Tanaidacea	Leptognathia gracilis	20	70	0.002	0.002		4		0.001
Class:	Ostracoda	Leptocythere sp.		4		0.002				
		Fragments				0.001				
Arthropod Fragments					0.001				0.072	0.022
Phylum:	Chordata									
Subphylum:	Urochordata									
Class:	Ascidiacea						4	4	0.226	0.022
Subphylum:	Vertebrata									
Class:	Osteichthyes									
Family:										
	Liparidae	Liparis sp.					2		7.916	

STATION: HERSCHEL ISLAND C-2 and CS-2

	Genus Species	JULY (C-2) Number/m^2 A	B	Wet Biomass (g/m^2) A	B	SEPTEMBER (CS-2) Number/m^2 A	B	Wet Biomass (g/m^2) A	B
Phylum: Cnidaria									
Class: Anthozoa									
Order: Actiniaria		2			0.004	12	6		0.044
Order: Alcyonacea									
Family:									
Nepthyidae	Gersemia sp.		present			present	present		
Class: Hydrozoa									
Family:									
Eudendriidae						present			
Phylum: Echinodermata									
Class: Echinoidea						2		0.004	
Class: Stelleroidea									
Subclass: Asteroidea						2		0.001	
Subclass: Ophiuroidea									
Family:									
Ophiolepididae	Anthophiura sp.	6		0.001					
	Astrophiura sp.		2		0.002				
	Family Total	6	2	0.001	0.002				
Unidentified Ophiuroid			22		0.010	6	2	0.006	0.002

STATION: HERSCHEL ISLAND CS-2

		JULY (CS-2)				SEPTEMBER (CS-2)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**									
Scrupariidae	Eucratea loricata					present			
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Opisthobranchia **Order:** Nudibranchia						2		0.508	
Order: Thecosomata		4	2	0.008	0.008	2		0.024	
Subclass: Prosobranchia **Family:**									
Buccinidae	Buccinum polare						2		1.258
Cylichnidae	Scaphander punctostriatus		2		0.004				
Retusidae	Retusa obtusa	2	14	0.014	0.036	6	6	0.006	0.024

STATION: HERSCHEL ISLAND CS-2

		JULY (CS-2)				SEPTEMBER (CS-2)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**									
Trochidae	Margarites olivaceus						10		0.042
	Margarites sp.	2		0.002					
	Solariella obscura		10		0.312				
	Family Total	2	10	0.002	0.312		10		0.042
Turridae	Oenopota cinerea					4	6	0.046	0.058
	Propebela sp.		4		0.022				
	Family Total		4		0.022	4	6	0.046	0.058
Turritellidae	Tachyrhynchus reticulatus					2		0.048	
Class: Pelecypoda **Family:**									
Astartidae	Astarte montagui		4		0.120				
Hiatellidae	Hiatella arctica						2		0.002
Nuculanidae	Portlandia arctica	2	12	0.044	0.258	2		0.006	
	Yoldiella fraterna					2		0.008	
	Yoldiella lenticula		2		0.002				
	Family Total	2	14	0.044	0.260	4		0.014	

STATION: HERSCHEL ISLAND CS-2

		JULY (CS-2)				SEPTEMBER (CS-2)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Mollusca **Class:** Pelecypoda **Family:**									
Tellinidae	Macoma crassula					2	2	0.024	0.002
Thyasiridae	Axinopsida orbiculata	2	6	0.001	0.008				
Veneridae	Liocyma fluctuosa		2		0.002	4		0.014	
Phylum: Nemertea		4	2	0.002	0.001	2		0.042	
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**									
Fischerinidae	Cornuspira foliacea	present	present			present	present		
Miliolidae	Miliolina seminulum		present						
Phylum: Sipuncula						2		0.006	
STATION TOTAL:		176	456	0.36	1.31	168	202	29.12	1.82

STATION: HERSCHEL ISLAND D-1 and DS-1

		JULY (D-1)				SEPTEMBER (DS-1)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida									
Class: Polychaeta									
Family:									
Ampharetidae	<u>Ampharete</u> <u>acutifrons</u>	18		0.078		2	2	0.001	0.001
Capitellidae	<u>Capitella</u> <u>capitata</u>	2		0.001		2		0.001	
Cirratulidae	<u>Chaetozone</u> <u>setosa</u>	58				54	28	0.198	0.096
	<u>Chaetozone</u> <u>spinosa</u>	10							
	<u>Tharyx</u> <u>multifilis</u>	2							
	Family Total	70		0.190		54	28	0.198	0.096
Dorvilleidae	<u>Dorvillea</u> sp.	2		0.001					
Hesionidae	<u>Castalia</u> <u>aphroditoides</u>	10		0.016		2		0.008	
Nephtyidae	<u>Nephtys</u> <u>longosetosa</u>						2		1.262
Opheliidae	<u>Travisia</u> <u>forbesii</u>	2		0.292					
Orbiniidae	<u>Scoloplos</u> <u>acmeceps</u>					2		0.001	
Phyllodocidae	<u>Eteone</u> <u>longa</u>					8			
	<u>Phyllodoce</u> <u>groenlandica</u>	4		0.776		2			
	Family Total	4		0.776		10		0.020 *	
Polynoidae	<u>Melaenis</u> <u>loveni</u>	2		0.124					
Sabellidae	<u>Chone</u> sp.	16				18	2		
	<u>Euchone</u> <u>analis</u>	10							
	Family Total	26		0.014 *		18	2	0.014 *	0.001 *

STATION: HERSCHEL ISLAND D-1 and DS-1

		JULY (D-1)				SEPTEMBER (DS-1)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida									
Class: Polychaeta									
Family:									
Scalibregmidae	<u>Scalibregma</u> <u>inflatum</u>					2	2	0.004	0.004
Sigalionidae	<u>Pholoe</u> sp.	2		0.001			2		0.001
Spionidae	<u>Dispio</u> sp.	28				78	92		
	<u>Prionospio</u> <u>cirrifera</u>	2				4	10		
	<u>Pygospio</u> <u>elegans</u>					2			
	<u>Scolecolepides</u> sp.					64	74		
	Fragments					present	present		
	Family Total	30		0.130 *		148	176	0.454 *	0.706 *
Syllidae	<u>Autolytus</u> sp.	8		0.002					
	<u>Exogone</u> sp.	2		0.001		2		0.001	
	Family Total	10		0.003		2		0.001	
Terebellidae	<u>Nicolea</u> <u>zostericola</u>	2		0.180					
	<u>Pista</u> <u>cristata</u>					2			
	Family Total	2		0.180		2			
Unidentified Annelid							2		0.004
Annelid Fragments and Nematoda		present		0.034		present	present		0.022
Phylum: Arthropoda									
Class: Copepoda									
Family:									
Calanidae +	<u>Calanus</u> sp.	2		0.002					
	Family Total	2		0.002		32	14	0.114	0.016

STATION: HERSCHEL ISLAND D-1 and DS-1

	Genus Species	JULY (D-1) Number/m2 A	B	JULY (D-1) Wet Biomass (g/m2) A	B	SEPTEMBER (DS-1) Number/m2 A	B	SEPTEMBER (DS-1) Wet Biomass (g/m2) A	B
Phylum: Arthropoda									
Class: Malacostraca									
Order: Amphipoda									
Family:									
Ampeliscidae	Byblis gaimardi					8		0.012	
Calliopiidae						2	4	0.001	0.004
Caprellidae		6		0.114					
Corophiidae	Erichthonius hunteri	18		0.038		38		0.080	
Gammaridae	Melita dentata	6		0.060					
	Unidentified	4		0.018					
	Family Total	10		0.078					
Ischyroceridae	Ischyrocerus anguipes	8		0.060		12	2	0.006	0.001
Lysianassidae	Hippomedon holbolli					2		0.116	
	Orchomonella minuta	4		0.020					
	Unidentified						2		0.012
	Family Total	4		0.020		2	2	0.116	0.012
Oedicerotidae	Acanthostepheia behringiensis					4			
	Monoculodes borealis					20	16		0.056
	Monoculodes longirostris	10		0.478					
	Family Total	10		0.478		24	16	0.968 *	0.056

STATION: HERSCHEL ISLAND D-1 and DS-1

		JULY (D-1)				SEPTEMBER (DS-1)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Arthropoda **Class:** Malacostraca **Order:** Cumacea **Family:**									
Diastylidae	Diastylis oxyrhyncha	4		0.142			10		0.026
	Diastylis sp.					6		0.002	
	Family Total	4		0.142		6	10	0.002	0.026
Leuconidae	Leucon nasica					4	2	0.002	0.001
Order: Isopoda **Family:**									
Idoteidae	Mesidotea sibirca	18		0.502					
Order: Tanaidacea	Leptognathia gracilis	2		0.001			2		0.001
Arthropod Fragments								0.008	0.008
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		8		0.588		6		0.870	
Phylum: Cnidaria **Class:** Anthozoa **Order:** Actiniaria		14		0.068		2	8		
Order: Alcyonacea **Family:**									
Nepthyidae	Gersemia sp.	present							
Unidentified Anthozoan						2	6	0.006	2.214

STATION: HERSCHEL ISLAND D-1 and DS-1

	Genus Species	JULY (D-1) Number/m2 A	B	Wet Biomass (g/m2) A	B	SEPTEMBER (DS-1) Number/m2 A	B	Wet Biomass (g/m2) A	B
Phylum: Cnidaria									
Class: Hydrozoa									
Family:									
Campanulariidae						present			
Campanulinidae	<u>Lafoeina maxima</u>					present			
Eudendriidae	<u>Eudendrium</u> sp.	present							
Sertulariidae	<u>Abietinaria</u> sp.	present							
Phylum: Echinodermata									
Class: Stelleroidea									
Subclass: Ophiuroidea									
Family:									
Ophiolepididae	<u>Anthophiura</u> sp.	20		0.008					
	<u>Astrophiura</u> sp.	12		0.058					
	Family Total	32		0.066					
Unidentified Ophiuroid						16	46	0.422	1.780
Phylum: Ectoprocta									
Class: Gymnolaemata									
Family:									
Bicellariellidae	<u>Bugula</u> sp.						present		
Scrupariidae	<u>Eucratea loricata</u>	present				present	present		
	Unidentified species						present		

STATION: HERSCHEL ISLAND D-1 and DS-1

		JULY (D-1)				SEPTEMBER (DS-1)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Mollusca									
Class: Gastropoda									
Subclass: Prosobranchia									
Family:									
Buccinidae	Buccinum sp.	2		0.002					
Diaphanidae	Diaphana minuta	2		0.024					
Retusidae	Retusa obtusa	12		0.046		20	26	0.040	0.074
Turridae	Oenopota sp.					2	2	0.002	0.002
	Propebela sp.	2		0.014		2		0.010	
	Family Total	2		0.014		4	2	0.012	0.002
Trochidae	Margarites olivaceus	2		0.004					
Gastropod Fragments				0.002					
Class: Pelecypoda									
Family:									
Astartidae	Astarte crenata	2		0.198		2		0.022	
	Astarte montagui	2		0.066			4		0.070
	Family Total	4		0.264		2	4	0.022	0.070
Cardiidae	Clinocardium ciliatum	2		0.004					
Myidae	Mya truncata					2	4	0.010	0.012
Mytilidae	Crenella faba						2		0.002
Pandoridae	Pandora glacialis	4		0.316			2		0.036

STATION: HERSCHEL ISLAND D-1 and DS-1

		JULY (D-1)				SEPTEMBER (DS-1)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Mollusca **Class:** Pelecypoda **Family:**									
Pectinidae	Delectopecten greenlandicus	4		0.042			6		0.002
Tellinidae	Macoma crassula					10	18	0.150	0.302
	Macoma moesta	18		1.044					
	Family Total	18		1.044		10	18	0.150	0.302
Thraciidae	Thracia sp.	2		0.004			12		0.018
Thyasiridae	Axinopsida orbiculata						2		0.006
	Thyasira flexuosa					6	2	0.020	0.004
	Family Total					6	4	0.020	0.010
Veneridae	Liocyma fluctuosa	6		0.010		10	18	0.004	0.048
Phylum: Nemertea							16		0.004
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**									
Fischerinidae	Cornuspira foliacea	present				present	present		
Miliolidae	Miliolina seminulum					present	present		

STATION: HERSCHEL ISLAND D-1 and DS-1

	JULY (D-1)				SEPTEMBER (DS-1)			
	Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
Genus Species	A	B	A	B	A	B	A	B
Phylum: Sipuncula	6		0.008		4	4	0.002	0.002
STATION TOTAL:	380		5.59		424	434	3.45	6.78

STATION: HERSCHEL ISLAND D-2 and DS-2

		JULY (D-2)				SEPTEMBER (DS-2)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida									
Class: Polychaeta									
Family:									
Ampharetidae	Ampharete acutifrons	10	2	0.006	0.004	4		0.008	
Capitellidae	Barantolla americana					4		0.008	
Cirratulidae	Chaetozone setosa	10							
	Chaetozone spinosa	20							
	Family Total	30		0.100 •					
Flabelligeridae	Brada sp.					2			
Hesionidae	Castalia aphroditoides		2		0.010				
Lumbrineridae	Lumbrineris sp.					2		0.001	
Maldanidae	Microclymene sp.	2		0.002					
Nephtyidae	Nephtys cornuta					2		0.130	
	Fragment								
Orbinidae	Leitoscoloplos pugettensis					2		0.004	
Phyllodocidae	Eteone sp.		2		0.004				
Polynoidae	Antinoella sarsi		2		0.012	2		0.088	
Sabellidae	Chone sp.	76	6			2		0.001	
	Euchone analis	6	2						
	Family Total	82	8	0.034 •	0.001 •	2		0.001	

STATION: HERSCHEL ISLAND D-2 and DS-2

		JULY (D-2)				SEPTEMBER (DS-2)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida **Class:** Polychaeta **Family:**									
Sigalionidae	<u>Pholoe</u> sp.	2		0.002		2		0.002	
Spionidae	<u>Dispio</u> sp.	46	6	0.250	0.006	2			
	<u>Prionospio</u> <u>cirrifera</u>	2		0.004					
	<u>Pygospio</u> <u>elegans</u>	6		0.002					
	<u>Scolecolepides</u> sp.	40	2		0.006	2			
	Unidentified and Fragments	present							
	Family Total	94	8	0.256	0.012	4		0.022 *	
Syllidae	<u>Exogone</u> sp.	6		0.002					
Annelid Fragments and Nematodes		present	present	0.022	0.006	present		0.012	
Phylum: Arthropoda **Class:** Copepoda **Order:** Calanoida **Family:**									
Calanidae +	<u>Calanus</u> sp.	4	2	0.002	0.004				
	Family Total	4	2	0.002	0.004	10		0.086	
Class: Malacostraca **Order:** Amphipoda **Family:**									
Ampeliscidae	<u>Bybilis</u> <u>gaimardi</u>	6	6	0.006	0.004				
Caprellidae	**Family Total**	12		0.088					

STATION: HERSCHEL ISLAND D-2 and DS-2

		JULY (D-2)				SEPTEMBER (DS-2)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Arthropoda									
Class: Malacostraca									
Order: Amphipoda									
Family:									
Corophiidae	Erichthonius difformis		12		0.018				
	Erichthonius sp.	2		0.002					
	Family Total	2	12	0.002	0.018				
Gammaridea	Melita dentata		10		0.060				
Isaeidae						26		0.026	
Ischyroceridae	Ischyrocerus anguipes	10		0.002					
Lysianassidae	Boeckosimus edwardsii					12			
	Hippomedon holbolli					2			
	Orchomenella minuta	2		0.002					
	Family Total	2		0.002		14		0.386 *	
Oedicerotidae	Monoculodes longirostris	14	2	1.094	0.004				
	Family Total	14	2	1.094	0.004	2		0.001	
Phoxocephalidae	Paraphoxus oculatus		2		0.002				
Pleustidae	Stenopleustes sp.		2		0.080				
Ampeliscidae	Haploops sp.					2		0.002	
Order: Cumacea									
Family:									
Diastylidae	Brachydiastylis resima					2			
	Diastylis oxyrhynchus					60			
	Family Total					62		0.308 *	

STATION: HERSCHEL ISLAND D-2 and DS-2

	Genus Species	JULY (D-2) Number/m² A	B	Wet Biomass (g/m²) A	B	SEPTEMBER (DS-2) Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Arthropoda **Class:** Malacostraca **Order:** Cumacea **Family:**									
Leuconidae	Leucon nasica					2		0.001	
Phylum: Arthropoda **Class:** Malacostraca **Order:** Isopoda **Family:**									
Idoteidae	Mesidotea sibirica					2		0.048	
Order: Tanaidacea	Leptognathia gracilis					8		0.001	
Class: Ostracoda						44		0.002	
Arthropod Fragments								0.010	
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		12		0.660					
Phylum: Cnidaria **Class:** Anthozoa **Order:** Actiniaria		4	2	0.024	0.002				
Order: Alcyonacea **Family:**									
Nepthyidae	Gersemia sp.	present							

STATION: HERSCHEL ISLAND D-2 and DS-2

	Genus Species	JULY (D-2) Number/m^2 A	JULY (D-2) Number/m^2 B	JULY (D-2) Wet Biomass (g/m^2) A	JULY (D-2) Wet Biomass (g/m^2) B	SEPTEMBER (DS-2) Number/m^2 A	SEPTEMBER (DS-2) Number/m^2 B	SEPTEMBER (DS-2) Wet Biomass (g/m^2) A	SEPTEMBER (DS-2) Wet Biomass (g/m^2) B
Phylum: Cnidaria **Class:** Anthozoa **Order:** Actiniaria	Unidentified	4	2			6		0.012	
Class: Hydrozoa **Family:**									
Campanulariidae	Campanularia sp.	present	present						
Campanulinidae	Lafoeina maxima	present	present						
Lafoeidae	Grammaria stentor	present							
Phylum: Echinodermata **Class:** Stelleroidea **Subclass:** Ophiuroidea **Family:**									
Ophiolepididae	Astrophiura sp.	4		0.014					
Unidentified Ophiuroid						2		0.001	
Phylum: Ecotprocta **Class:** Gymnolaemata **Family:**									
Bicellariellidae	Bugula sp.	present							
Scrupariidae	Eucratea loricata	present	present						

STATION: HERSCHEL ISLAND D-2 and DS-2

	Genus Species	JULY (D-2) Number/m^2 A	B	Wet Biomass (g/m^2) A	B	SEPTEMBER (DS-2) Number/m^2 A	B	Wet Biomass (g/m^2) A	B
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**									
Buccinidae	Buccinum polare	2		2.066					
Retusidae	Retusa obtusa	30	4	0.072	0.016				
Trochidae	Margarites olivaceus	4		0.008					
Turridae	Propebela sp.					4		3.056	
Turritellidae	Tachyrhynchus reticulatus	2		0.020					
Phylum: Mollusca **Class:** Pelecypoda **Family:**									
Astartidae	Astarte montagui					6		3.424	
Myidae	Mya truncata	6		0.064					
Nuculanidae	Portlandia arctica					2		0.022	
Pectinidae	Delectopecten greenlandicus	2		0.006					
Tellinidae	Macoma moesta	8	2	0.596	0.118				

STATION: HERSCHEL ISLAND D-2 and DS-2

		JULY (D-2)				SEPTEMBER (DS-2)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Mollusca **Class:** Pelecypoda **Family:**									
Thyasiridae	<u>Axinopsida orbiculata</u>					2		0.004	
Veneridae	<u>Liocyma fluctuosa</u>	8		0.018					
Phylum: Nemertea		2	4	0.001	0.006				
Phylum: Porifera		2		0.012					
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**									
Fischerinidae	<u>Cornuspira foliacea</u>	present	present			present			
	<u>Dentalina obliqua</u>					present			
Miliolidae	<u>Miliolina seminulum</u>					present			
Phylum: Sipuncula						2		0.010	
STATION TOTAL:		362	72	5.18	0.36	212		7.59	

STATION: **HERSCHEL ISLAND D-3 and DS-3**

		JULY (D-3)				SEPTEMBER (DS-3)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Annelida									
Class: Polychaeta									
Family:									
Ampharetidae	Ampharete sp.	18	18	0.010	0.014				
Cirratulidae	Chaetozone setosa	16	4	0.012					
	Chaetozone spinosa		4						
	Family Total	16	8	0.012	0.028 *				
Dorvilleidae			2		0.001	5		<0.001	
Hesionidae	Castalia aphroditoides	4	2	0.018	0.006				
Nephtyidae	Nephtys longosetosa		2		3.520				
Ophelliidae	Euzonus yasudia	2	4	0.008	0.006				
Paraonidae	Aricidea suecica					5			
Phyllodocidae	Eteone longa	2		0.024		5			
	Phyllodoce groenlandica		2		0.770	5			
	Family Total	2	2	0.024	0.770	10		<0.001 *	
Sabellidae	Chone sp.	30	30	0.008	0.008				
Sigalionidae	Pholoe sp.					5		<0.001	
Sphaerodoridae	Sphaerodoropsis minuta		2	0.004		5		<0.001	
Spionidae	Dispio sp.					2			
	Prionospio cirrifera		4			10			
	Pygospio elegans	2							
	Scolecolepides sp.	10	94						
	Unidentified					6			
	Family Total	12	98	0.504 *	0.282 *	18		0.026 *	

STATION: HERSCHEL ISLAND D-3 and DS-3

	Genus Species	JULY (D-3) Number/m2 A	JULY (D-3) Number/m2 B	JULY (D-3) Wet Biomass (g/m2) A	JULY (D-3) Wet Biomass (g/m2) B	SEPTEMBER (DS-3) Number/m2 A	SEPTEMBER (DS-3) Number/m2 B	SEPTEMBER (DS-3) Wet Biomass (g/m2) A	SEPTEMBER (DS-3) Wet Biomass (g/m2) B
Phylum: Annelida									
Class: Polychaeta									
Family:									
Syllidae	Exogone sp.	2	4	0.002					
	Unidentified species		4						
	Family Total	2	8	0.002	0.002 •				
Terebellidae	Polycirrus medusa		2						
Annelid Fragments and Nematodes		present	present	0.016	0.016	present		0.005	
Phylum: Arthropoda									
Class: Copepoda									
Order: Calanoida									
Family:									
Calanidae +	Calanus sp.	8	10	0.014	0.014				
Class: Malacostraca									
Order: Amphipoda									
Family:									
Ischyroceroidae	Ischyrocerus anguipes		4		0.001				
Lysianassidae	Boeckosimus sp.					5		0.005	
Oedicerotidae	Paroediceros lynceus	4	2	0.008	0.002				
	Fragments		2		0.001				
	Family Total	4	4	0.008	0.003				
Stenothoidae	Metopa sp.	2		0.001					
Unidentified Amphipod						5		<0.001	

STATION: HERSCHEL ISLAND D-3 and DS-3

			JULY (D-3)				SEPTEMBER (DS-3)			
			Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
		Genus Species	A	B	A	B	A	B	A	B
Order:	Cumacea									
Family:										
	Diastylidae	*Brachydiastylis resima*					5			
		Diastylis oxyrhyncha					15			
		Family Total					20		0.080 *	
	Leuconidae	*Leucon nasica*					5		<0.001	
Phylum:	Arthropoda									
Class:	Malacostraca									
Order:	Tanaidacea	*Leptognathia gracilis*					5		<0.001	
Arthropod Fragments									0.070	
Phylum:	Chordata									
Subphylum:	Urochordata									
Class:	Ascidiacea		18	16	0.260	0.182				
Phylum:	Cnidaria									
Class:	Anthozoa									
Order:	Actiniaria			2		0.004				
Class:	Hydrozoa									
Order:	Campanulariidae	*Obelia* sp.		present						
		Unidentified species	present							
Order:	Campanulinidae	*Lafoeina maxima*	present	present			present			
Order:	Lafoeidae						present			

STATION: HERSCHEL ISLAND D-3 and DS-3

		JULY (D-3)				SEPTEMBER (DS-3)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Ectoprocta									
Class: Gymnolaemata									
Family:									
Bicellariellidae	Bugula sp.							present	
Scrupariidae	Eucratea loricata	present				present			
Phylum: Mollusca									
Class: Gastropoda									
Subclass: Prosobranchia									
Family:									
Retusidae	Retusa obtusa	2	14	0.004	0.022	5		<0.001	
Turridae	Juvenile					5		<0.001	
Class: Pelecypoda									
Family:									
Astartidae	Astarte montagui		2		0.004				
Myidae	Mya truncata	4		0.104					
Nuculanidae	Yoldiella fraterna					20		0.145	
Tellinidae	Macoma moesta		2		0.128				
Thraciidae	Thracia sp.		2		0.014				
Thyasiridae	Thyasira flexuosa		10		0.018				
Veneridae	Liocyma fluctuosa					20		<0.001	

STATION: HERSCHEL ISLAND D-3 and DS-3

		JULY (D-3)				SEPTEMBER (DS-3)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Nemertea		2		0.008					
Phylum: Porifera		2		0.006					
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**									
Fischerinidae	<u>Cornuspira</u> <u>foliacea</u>					present			
	<u>Dentalina</u> <u>obliqua</u>					present			
Miliolidae	<u>Miliolina</u> <u>seminulum</u>					present			
Unidentified Foraminifera			present						
STATION TOTAL:		222	234	0.98	5.05	128	5	0.33	

STATION: **HERSCHEL ISLAND D-4 and DS-4**

		JULY (D-4)				SEPTEMBER (DS-4)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Phylum: Annelida									
Class: Polychaeta									
Family:									
Ampharetidae	Ampharete acutifrons					2	10	< 0.001	
	Ampharete sp.						10		
	Unidentified sp.					2	25		
	Family Total					4	45	< 0.001	0.055 *
Cirratulidae	Chaetozone/Tharyx complex	8		0.034		48	165	0.062	0.100
Maldanidae	Microclymene sp.					8			
	Unidentified						50	0.016	0.050
	Family Total					8	50	0.016	0.050
Nephtyidae	Nephtys longosetosa						10	0.684	2.460
Ophelliidae	Euzonus yasudai	2		0.114		2		<	0.001
	Travisia forbesii	2		< 0.001		2	20	0.168	0.145
	Family Total	4		0.114		4	20	0.168	0.145
Phyllodocidae	Eteone sp.	4		0.106		8	40	0.020	0.175
Polynoidae	Hesperonoe sp.					2	5	0.004	0.005
Sabellidae	Chone sp.					2	5		
Sphaerodoridae	Sphaerodoropsis minuta						115		0.040
Spionidae	Dispio sp.					86	85		
	Prionospio cirrifera					8	20		
	Prionospio sp.								
	Pygospio elegans					2			
	Scolecolepides sp.	28	18			156	435		
	Unidentified			0.258	0.186		3300.806		
	Family Total	28	18	0.258	0.186	252	870	0.806	3.280
Fragments and Nematodes		present		0.008				0.010 *	0.165 *

STATION: HERSCHEL ISLAND D-4 and DS-4

	Genus Species	JULY (D-4) Number/m2 A	B	JULY (D-4) Wet Biomass (g/m2) A	B	SEPTEMBER (DS-4) Number/m2 A	B	SEPTEMBER (DS-4) Wet Biomass (g/m2) A	B
Phylum: Arthropoda									
Class: Copepoda									
Order: Calanoida									
Family:									
Calanidae +	Calanus sp.	32	2	0.002	0.140				
	Family Total	32	2	0.002	0.140	10	4	0.036	0.001
Pseudocalanidae +	Pseudocalanus sp.		12		0.001				
Phylum: Arthropoda									
Class: Malacostraca									
Order: Amphipoda									
Family:									
Eusiridae	Pontogenia sp.					10		0.042	
Gammaridae						2		0.001	
Haustoriidae	Priscillina armata	6	8	0.038	0.026				
Isaeidae						4	8	0.002	0.012
Lysianassidae	Boeckosimus edwardsii		2		0.020	16	4	0.724	0.001
Oedicerotidae	Acanthostepheia behringiensis	4	6	0.014	0.840	12	5		
	Aceroides latipes					70	30		
	Monoculodes borealis	6		0.008		10			
	Paroediceros lynceus		2		0.004				
	Family Total	10	8	0.022	0.844	92	35	0.414 *	0.230 *

STATION: HERSCHEL ISLAND D-4 and DS-4

		JULY (D-4)				SEPTEMBER (DS-4)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Arthropoda **Class:** Malacostraca **Order:** Cumacea **Family:**									
Diastylidae	*Diastylis oxyrhyncha*					32	85	0.330	0.058
Leuconidae	*Leucon nasica*					4	8	0.004	0.004
Nannastacidae	*Campylaspis costata*					10		0.014	
Order: Isopoda **Family:**									
Munnidae	*Munna kroyeri*					2		0.002	
Phylum: Arthropoda **Class:** Malacostraca **Order:** Tanaidacea	*Leptognathia gracilis*					2	10	<0.001	<0.001
Class: Ostracoda	*Hemicythere* sp.						10		<0.001
Arthropod Fragments								0.086	0.008
Phylum: Chaetognatha +			2		0.002				
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		2		0.150		44	45	2.858	2.300
Phylum: Cnidaria **Class:** Hydrozoa one apparent species		present							

STATION: HERSCHEL ISLAND D-4 and DS-4

		JULY (D-4)				SEPTEMBER (DS-4)			
		Number/m2		Wet Biomass (g/m2)		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Echinodermata									
Class: Stelleroidea									
Subclass: Ophiuroidea									
Family:									
Ophiolepididae	Astrophiura sp.	4	2	0.002	0.002				
Unidentified Ophiuroid						5		0.520	
Phylum: Mollusca									
Class: Gastropoda									
Subclass: Opisthobranchia									
Order: Thecosomata						6		0.026	
Subclass: Prosobranchia									
Family:									
Diaphanidae	Diaphana minuta					4	5	0.014	0.005
Retusidae	Retusa obtusa	2		0.012		108	20	0.390	0.075
Trochidae	Margarites costalis						5		0.240
Turridae	Oenopota sp.					2		0.610	
	Propebela sp.					6	5	0.262	0.025
	Family Total					8	5	0.872	0.025
Class Pelecypoda									
Family:									
Astartidae	Astarte montagui		2		0.002	96	125	5.070	3.900
Myidae	Mya truncata					2		0.062	

STATION: HERSCHEL ISLAND D-4 and DS-4

		JULY (D-4)				SEPTEMBER (DS-4)			
		Number/m^2		Wet Biomass (g/m^2)		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B	A	B	A	B
Phylum: Mollusca									
Class Pelecypoda									
Family:									
Nuculanidae	Portlandia arctica					2	5	0.004	0.045
	Yoldiella fraterna					2	5	0.010	0.020
	Family Total					4	10	0.014	0.065
Nuculidae	Nucula belloti					2		0.060	
Pandoridae	Pandora glacilis						5		0.790
Phylum: Mollusca									
Class: Pelecypoda									
Family:									
Pectinidae	Delectopecten greenlandicus					6	30	0.002	0.040
Thraciidae	Thracia sp.	8		0.134		52	85	0.100	3.130
Thyasiridae	Thyasira flexuosa	172	10	0.326	0.022	12	25	0.026	0.055
Veneridae	Liocyma fluctuosa	4		0.018		20	15	0.864	0.020
Phylum: Nemertea						4		0.124	
Phylum: Protozoa									
Class: Sarcodina									
Order: Foraminifera									
Family:									
Elphidiidae	Elphidium arcticum						present		
Fischerinidae	Cornuspira foliacea	present	present			present	present		
	Dentalina obliqua						present		

STATION: HERSCHEL ISLAND D-4 and DS-4

	Genus Species	JULY (D-4) Number/m^2 A	B	Wet Biomass (g/m^2) A	B	SEPTEMBER (DS-4) Number/m^2 A	B	Wet Biomass (g/m^2) A	B
Phylum: Protozoa Class: Sarcodina Order: Foraminifera Family:									
Miliolidae	Miliolina seminulum	present	present			present	present		
one apparent species						present			
STATION TOTAL:		254	50	1.22	1.10	869	1850	15.26	17.33

STATION: HERSCHEL ISLAND D-5

	Genus Species	Number/m² A	Number/m² B	Wet Biomass (g/m²) A	Wet Biomass (g/m²) B
		JULY			
Phylum: Annelida					
Class: Polychaeta					
Family:					
Ampharetidae		30		0.014	
Cirratulidae		4		0.004	
Hesionidae	*Castalia aphroditoides*	2		0.010	
Maldanidae	*Praxillella praetermissa*	2		0.001	0.004
	Fragment	2	2		
Nephtyidae	*Nephtys cornuta*	2		0.002	
Nereidae		4		0.001	
Opheliidae	*Euzonus yasudai*		2		0.006
Phyllodocidae	*Mystides borealis*	2		0.002	
Polynoidae	*Eunoe* sp.	6			
	Harmothoe imbricata	2			
	Hesperonoe sp.		2		
	Unidentified	4			0.004
	Family Total	12	2	0.070 •	0.004
Sabellidae		44		0.008	
Sigalionidae	*Pholoe* sp.	6	2	0.010	0.008
	Fragments				
Spionidae	*Dispio* sp.	8			
	Polydora sp.	2			
	Pygospio elegans	12			
	Scolecolepides sp.	2			
	Unidentified and Fragments		present		
	Family Total	24		0.082 •	0.014 •
Syllidae	*Autolytus* sp.	34			
	Exogone sp.	2	2		0.001
	Family Total	36	2	0.088 •	0.001
Terebellidae	*Pista maculata*	2		0.088	
Annelid Fragments and Nematodes		present	present	0.212	0.006

STATION: HERSCHEL ISLAND D-5

		JULY			
		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B
Phylum: Arthropoda					
Class: Copepoda					
Order: Calanoida					
Family:					
Calanidae +	Calanus sp.	2	4	0.004	0.001
Pseudocalanidae +	Pseudocalanus sp.	4		0.002	
Class: Malacostraca					
Order: Amphipoda					
Family:					
Ampeliscidae	Ampelisca eschrichti	64		0.028	
	Byblis gaimardi	2		0.002	
	Family Total	66		0.030	
Calliopiidae	Apherusa megalops	14		0.006	
Caprellidae		42		0.048	
Corophiidae	Erichthonius difformis	234		0.142	
Gammaridae	Melita dentata	66		0.040	
Ischyroceridae	Ischyrocerus megacheir	116		0.526	
Lysianassidae	Anonyx nugax	2	2	0.018	0.344
	Orchomene sp.	4		0.014	
	Family Total	6	2	0.032	0.344

STATION: HERSCHEL ISLAND D-5

		JULY			
		Number/m²		Wet Biomass (g/m²)	
	Genus Species	A	B	A	B
Phylum: Arthropoda **Class:** Malacostraca **Order:** Amphipoda **Family:**					
Oedicerotidae	Bathymedon saussurei	2		0.002	
	Paroediceros lynceus	8	4	0.026	0.001
	Family Total	10	4	0.028	0.001
Phoxocephalidae	Paraphoxus oculatus	2		0.004	
Pleustidae	Stenopleustes malmgreni	8		0.008	
Stenothoidae	Metopa sinuata	24		0.002	
Order: Cumacea **Family:**					
Diastylidae	Brachydiastylis resima	2		0.001	
	Diastylis oxyrhyncha		2		0.001
	Family Total	2	2	0.001	0.001
Leuconidae	Leucon nasica	4		0.002	
Order: Isopoda **Family:**					
Idoteidae	Mesidotea sibirica	2		0.038	
	Synidotea bicuspida	14		2.860	
	Family Total	16		2.898	
Munnidae	Munna kroyeri	110		0.035	

STATION: HERSCHEL ISLAND D-5

	Genus Species	JULY Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Arthropoda Class: Malacostraca Order: Tanaidacea	Leptognathia gracilis	4		0.001	
Class: Ostracoda			2		0.001
Arthropod Fragments				0.004	
Phylum: Chordata Subphylum: Urochordata Class: Ascidiacea		6	2	0.236	0.018
Subphylum: Vertebrata Class: Osteichthyes Family:					
Zoarcidae	Gymnelis viridis	2		9.844	
Phylum: Cnidaria Class: Anthozoa Order: Actiniaria		6		2.140	
Order: Alcyonacea Family:					
Nepthyidae	Gersemia sp.	present			

STATION: HERSCHEL ISLAND D-5

		JULY			
		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B
Phylum: Cnidaria					
Class: Hydrozoa					
Family:					
Campanulinidae	Lafoeina maxima	present			
Four apparent species		present			
Phylum: Echinodermata					
Class: Stelleroidea					
Subclass: Asteroidea					
Family:					
Pterasteridae	Pteraster sp.	2		0.008	
Subclass: Ophiuroidea					
Family:					
Ophiolepididae	Anthophiura sp.	10		0.002	
	Astrophiura sp.		2	0.012	
	Family Total	10	2	0.014	
Phylum: Ectoprocta					
Class: Gymnolaemata					
Family:					
Bicellariellidae	Bugula sp.		present		
Scrupariidae	Eucratea loricata	present			
One apparent species		present			

STATION: HERSCHEL ISLAND D-5

		JULY			
		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Opisthobranchia **Order:** Thecosomata		2		0.014	
Subclass: Prosobranchia **Family:**					
Retusidae	Retusa obtusa	12	2	0.020	0.002
Trochidae	Margarites olivaceus	4		0.300	
	Margarites umbilicalis	4		0.002	
	Family Total	8		0.302	
Turridae	Propebella sp.	2		0.002	
Turritellidae	Tachyrhynchus reticulatus	4		0.102	
Class: Pelecypoda **Family:**					
Astartidae	Astarte crenata	2		0.096	
	Astarte montagui	4		0.024	
	Family Total	6		0.120	
Cardiidae	Clinocardium ciliatum	2		0.002	
Hiatellidae	Hiatella arctica	6		0.010	
Nuculanidae	Yoldiella lenticula	2		0.004	
Pectinidae	Delectopecten greenlandicus		2		0.001

STATION: HERSCHEL ISLAND D-5

	Genus Species	JULY Number/m^2 A	B	Wet Biomass (g/m^2) A	B
Phylum: Mollusca Class: Pelecypoda Family:					
Tellinidae	Macoma moesta	10		0.056	
Thraciidae	Thracia sp.	8	2	0.012	0.002
Thyasiridae	Thyasira flexuosa	6	42	0.010	0.076
Veneridae	Liocyma fluctuosa	26	2	0.056	0.008
Pelecypoda Fragments				0.001	
Phylum: Nemertea	Fragments			0.006	
Phylum: Porifera					
Apparent species		3		0.226	
Phylum: Protozoa Class: Sarcodina Order: Foraminifera Family:					
Fischerinidae	Cornuspira foliacea	present			
Miliolidae	Miliolina seminulum		present		
STATION TOTAL:		1019	74	17.48	0.50

STATION: HERSCHEL ISLAND D-6

	Genus Species	JULY Number/m^2 A	B	Wet Biomass (g/m^2) A	B
Phylum: Annelida					
Class: Polychaeta					
Family:					
Ampharetidae		10	2	0.004	0.002
Capitellidae	Capitella capitata	2	2	0.002	0.002
Cirratulidae		42	60	0.110	0.086
Hesionidae	Castalia aphroditoides	46	48	0.290	0.260
Polynoidae	Antinoella sarsi		6		
	Eunoe sp.	2			
	Melaenis loveni		2		
	Family Total	2	8	0.010 *	0.846 *
Sabellidae		46	2	0.006	0.002
Sigalionidae	Pholoe sp.	2		0.004	
Spionidae	Dispio sp.	116	32		
	Polydora quadrilobata	8	2		
	Prionospio cirrifera	12	4		
	Pygospio elegans	2			
	Scolecolepides	148	48		
	Unidentified and fragments	present	present		
	Family Total	286	86	1.222 *	0.310 *
Syllidae	Sphaerosyllis brandhorsti	2		0.002	
	Unidentified		2		
	Family Total	2	2	0.002	0.002
Annelid Fragments and Nematodes		present	present	0.022	0.212

STATION: HERSCHEL ISLAND D-6

		JULY			
		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B
Phylum: Arthropoda **Class:** Copepoda **Order:** Calanoida **Family:**					
Calanidae	Calanus sp.	38	32	0.168	0.142
Phylum: Arthropoda **Class:** Malacostraca **Order:** Amphipoda **Family:**					
Atylidae	Atylus carinatus	2	4	0.010	0.144
Calliopiidae	Apherusa megalops		2		0.001
Caprellidae		6	2	0.012	0.012
Corophiidae	Erichthonius difformis	2		0.002	
Gammaridae	Gammarus duebeni		34		1.842
	Gammarus relictus		2		1.430
	Family Total		36		3.272
Ischyroceridae	Ischyrocerus minuta	4		0.050	
Lysianassidae	Boeckosimus botkini	4	16	0.256	0.630
	Boeckosimus normani	2	8	0.010	0.048
	Family Total	6	24	0.266	0.678
Oedicerotidae	Bathymedon saussurei	64		0.012	
	Paroediceros lynceus	84	56	1.646	0.984
	Family Total	148	56	1.658	0.984

STATION: HERSCHEL ISLAND D-6

	Genus Species	JULY Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Arthropoda **Class:** Malacostraca **Order:** Cumacea **Family:**					
Diastylidae	Diastylis edwardsi		2		0.002
	Diastylis oxyrhyncha	16		0.214	
	Diastylis tumida		8		0.038
	Family Total	16	10	0.214	0.040
Order: Isopoda **Family:**					
Idoteidae	Synidotea bicuspida	2		0.006	
Arthropod Fragments					0.001
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		76	46	13.686	3.904
Class: Larvacea		4		0.004	
Subphylum: Vertebrata **Class:** Osteichthyes **Family:**					
Cottidae	Artediellus sp.		2		1.690
Phylum: Cnidaria **Class:** Hydrozoa **Family:**					
Campanulariidae	Obelia longissima	present			
	Unidentified species		present		

STATION: HERSCHEL ISLAND D-6

	Genus Species	Number/m² A	JULY B	Wet Biomass (g/m²) A	B
Phylum: Cnidaria **Class:** Hydrozoa **Family:**					
Campanulinidae	Lafoeina maxima	present	present		
Lafoeidae	Lafoea dumosa	present			
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**					
Scrupariidae	Eucratea loricata	present	present		
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**					
Cylichnidae	Scaphander punctostriatus	8	4	0.164	0.016
Retusidae	Retusa obtusa	14	4	0.042	0.030
Turridae	Propebela sp.	2		0.004	
Class: Pelecypoda **Family:**					
Astartidae	Astarte montagui		2		0.010
Hiatellidae	Hiatella arctica	2		0.001	
Myidae	Mya truncata		2		0.118

STATION: HERSCHEL ISLAND D-6

	Genus Species	Number/m² A	Number/m² B	JULY Wet Biomass (g/m²) A	Wet Biomass (g/m²) B
Phylum: Mollusca					
Class: Pelecypoda					
Family:					
Thraciidae	Thracia sp.		2		0.008
Thyasiridae	Thyasira flexuosa	2	16	0.002	0.026
Veneridae	Liocyma fluctuosa	2		0.002	
Phylum: Nemertea		4		0.012	
Phylum: Protozoa					
Class: Sarcodina					
Order: Foraminifera					
Family:					
Fischerinidae	Cornuspira foliacea	present	present		
Miliolidae	Miliolina seminulum		present		
Phylum: Sipuncula			2		0.002
STATION TOTAL:		734	424	17.80	12.65

STATION: HERSCHEL ISLAND D-7

	Genus Species	Number/m² A	Number/m² B	JULY Wet Biomass (g/m²) A	Wet Biomass (g/m²) B
Phylum: Annelida					
Class: Polychaeta					
Family:					
Ampharetidae		6	2	0.004	0.002
Cirratulidae		8	10	0.014	0.026
Dorvilleidae	Dorvillea sp.		2		0.004
Hesionidae	Castalia aphroditoides	6	2	0.018	0.008
Nephtyidae	Nephtys longosetosa	2		1.316	
Opheliidae	Euzonus yasudai	6	14	0.046	0.134
Phyllodocidae	Eteone sp.	2	6	0.020	0.074
	Phyllodoce groenlandica		fragment		
Polynoidae	Melaenis loveni	2		0.676	
Sabellidae		76	54	0.026	0.012
Sphaerodoridae	Sphaerodoropsis minuta		2		0.001
Spionidae	Dispio sp.	38	52		
	Prionospio cirrifera	8	2		
	Pygospio elegans	2			
	Scolecoloepides sp.	192	210		
	Fragments	present	present		
	Family Total	240	264	0.778 *	0.918 *
Annelid Fragments and Nematodes		present	present	0.026	0.022

STATION: HERSCHEL ISLAND D-7

	Genus Species	JULY Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Arthropoda **Class:** Copepoda **Order:** Calanoida **Family:**					
Calanidae +	Calanus sp.	14	8	0.022	0.048
Class: Malacostraca **Order:** Amphipoda **Family:**					
Lysianassidae	Boeckosimus botkini	2		0.224	
	Onismus litoralis	2		0.120	
	Family Total	4		0.344	
Oedicerotidae	Acanthostepheia behringiensis		2		0.004
	Monoculopsis sp.	2		0.001	
	Paroediceros lynceus	10	16	0.882	0.656
	Family Total	12	18	0.883	0.660
Order: Cumacea **Family:**					
Diastylidae	Diastylis edwardsi		2		0.004
Phylum: Chaetognatha +		2	2	0.020	0.006
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		8	4	0.056	0.060

STATION: HERSCHEL ISLAND D-7

	Genus Species	Number/m^2 A	Number/m^2 B	JULY Wet Biomass (g/m^2) A	JULY Wet Biomass (g/m^2) B
Phylum: Cnidaria **Class:** Hydrozoa **Family:**					
Campanulariidae			present		
Campanulinidae	Lafoeina maxima	present			
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**					
Scrupariidae	Eucratea loricata	present	present		
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**					
Cylichnidae	Scaphander punctostriatus		2		0.002
Retusidae	Retusa obtusa	8		0.010	
Class: Pelecypoda **Family:**					
Astartidae	Astarte montagui	18	6	0.018	0.010
Myidae	Mya truncata	32		0.001	
Thraciidae	Thracia sp.		2		0.001
Thyasiridae	Thyasira flexuosa	6	252	0.074	0.522

STATION: HERSCHEL ISLAND D-7

	Genus Species	JULY Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Nemertea		2	2	0.052	0.098
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**					
Miliolidae	Miliolina seminulum	present	present		
STATION TOTAL:		438	662	4.36	2.56

STATION: HERSCHEL ISLAND D-8

JULY

	Genus Species	Number/m^2 A	Number/m^2 B	Wet Biomass (g/m^2) A	Wet Biomass (g/m^2) B
Phylum: Annelida					
Class: Polychaeta					
Family:					
Ampharetidae		54	28	0.118	0.032
Capitellidae	Capitella capitata		4		0.004
Cirratulidae		6		0.040	
Hesionidae	Castalia aphroditoides	82	66	0.422	
	unidentified		4		
	Family Total	82	70	0.422	0.304 *
Orbiniidae	Leitoscoloplos panamensis		2		0.220
Polynoidae	Antinoella sarsi	2			
	Eunoe depressa		6		
	Eunoe sp.	2			
	Hesperonoe sp.	4	2		
	Family Total	8	8	0.084 *	0.028 *
Phyllodocidae	Eteone longa	2	2	0.002	0.006
Sabellidae		66	264	0.036	0.122
Scalibregmidae	Scalibregma inflatuma	4	14	0.028	0.058
Serpulidae		2	2	0.008	0.001
Sigalionidae	Pholoe sp.	4	6	0.004	0.004
Spionidae	Dispio sp.	4			0.012
	Polydora quadrilobata	2			
	Prionospio cirrifera	2	2		
	Pygospio elegans	6	2		
	Scolecolepides sp.	4	2		
	Unidentified and fragments	2			
	Family Total	16	10	0.012 *	0.012 *

STATION: HERSCHEL ISLAND D-8

		JULY			
		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B
Phylum: Annelida					
Class: Polychaeta					
Family:					
Syllidae	Autolytus sp.	2		< 0.001	
	Exogone sp.		6		0.002
	Family Total	2	6	< 0.001	0.002
Terebellidae		16	2	0.110	0.024
Annelid Fragments and Nematodes		present	present	0.058	0.054
Phylum: Arthropoda					
Class: Cirripedia					
Order: Thoracica					
Family:					
Balanidae	Balanus balanoides	present			
Class: Copepoda					
Order: Calanoida					
Family:					
Calanidae +	Calanus sp.	54	18	0.192	0.030
Class: Malacostraca					
Order: Amphipoda					
Family:					
Ampeliscidae	Ampelisca macrocephala		2		0.002
	Byblis gaimardi		14		0.254
	Family Total		16		0.256

STATION: HERSCHEL ISLAND D-8

	Genus Species	JULY Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Arthropoda Class: Malacostraca Order: Amphipoda Family:					
Calliopiidae	Apherusa megalops	56	18	0.056	0.004
Caprellidae			4		0.001
Corophiidae	Erichthonius difformis	20		0.012	
Gammaridae	Gammarus locusta	20	84	0.022	0.010
	Melita dentata	12	36	0.188	0.176
	Family Total	32	120	0.210	0.186
Ischyroceridae	Ischyrocerus anguipes		34		0.014
Lysianassidae	Boeckosimus botkini	8	2	0.262	0.004
	B. normani		4		0.006
	Orchomene amblyops		14		0.036
	Family Total	8	20	0.262	0.046
Oedicerotidae	Aceroides latipes	2		0.002	
	Paroediceros lynceus	26	24	0.416	0.152
	Family Total	28	24	0.418	0.152
Stenothoidae	Metopa pullisa	2	6	0.002	0.001

STATION: HERSCHEL ISLAND D-8

	Genus Species	JULY Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Arthropoda **Class:** Malacostraca **Order:** Cumacea **Family:**					
Diastylidae	Diastylis edwardsi	6	14	0.038	0.062
	Diastylis oxyrhyncha		6		0.008
	Family Total	6	20	0.038	0.070
Order: Isopoda **Family:**					
Idoteidae	Mesidotea sibirica	10		0.528	
Munnidae	Pleurogonium spinosissmum		8		0.002

STATION: HERSCHEL ISLAND D-8

	Genus Species	Number/m² A	Number/m² B	JULY Wet Biomass (g/m²) A	Wet Biomass (g/m²) B
Phylum: Arthropoda Class: Ostracoda		2		0.001	
Arthropod Fragments		present		0.004	
Phylum: Chaetognatha		2		0.040	
Phylum: Chordata Subphylum: Urochordata Class: Ascidiacea		4	4	0.034	0.046
Phylum: Cnidaria Class: Anthozoa Order: Actiniaria		16	20	0.184	4.662
Order: Alcyonacea Family:					
Nepthyidae	Gersemia sp.		present		
Class: Hydrozoa Family:					
Bougainvillidae	Perigonimus sp.		present		
Campanulariidae	Obelia longissma		present		

STATION: HERSCHEL ISLAND D-8

		JULY			
		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B
Phylum: Cnidaria **Class:** Hydrozoa **Family:**					
Campanulinidae	Lafoeina maxima	present	present		
Eudendriidae	Eudendrium capillare		present		
Haleciidae	Halecium sp.		present		
Sertulariidae	Sertularia sp.		present		
One apparent species			present		
Three apparent species		present			
Phylum: Echinodermata **Class:** Holothuroidea		4	4		0.040
Class: Stelleroidea **Subclass:** Ophiuroidea **Family:**					
Ophiuroidea	Anthophiura sp.	4	4	0.001	0.001
Unknown Echinoderm		4		0.002	

STATION: HERSCHEL ISLAND D-8

	Genus Species	JULY Number/m2 A	B	Wet Biomass (g/m2) A	B
Phylum: Ectoprocta					
Class: Gymnolaemata					
Family:					
Alderinidae			present		
Scrupariidae	Eucratea loricata	present	present		
Phylum: Mollusca					
Class: Gastropoda					
Subclass: Opisthobranchia					
Order: Thecosomata			2		0.034
Subclass: Prosobranchia					
Family:					
Buccinidae	Buccinum polare		4		0.268
Cylichnidae	Scaphander punctostriatus		2		0.002
Retusidae	Retusa obtusa	6	10	0.008	0.014
Trichotropidae	Trichotropis borealis		2		0.014
Trochidae	Margarites umbilicalis		2		0.006
Turridae	Oenopota sp.	2	2	0.162	0.080
Turritellidae	Tachyrhynchus reticulatus	2		0.222	

STATION: HERSCHEL ISLAND D-8

	Genus Species	JULY Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Mollusca **Class:** Pelecypoda **Family:**					
Hiatellidae	Hiatella arctica		8		0.060
Myidae	Mya truncata		2		0.022
Mytilidae	Musculus discors	2	4	0.006	0.002
Pectinidae	Delectopecten greenlandicus		2		0.060
Tellinidae	Macoma moesta	4	4	0.002	0.346
Thyasiridae	Thyasira flexuosa	12		0.026	
Phylum: Nemertea		2		0.001	
Phylum: Porifera		1			
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**					
Fischerinidae	Cornuspira foliacea		present		
STATION TOTAL:		489	764	3.10	7.26

STATION: HERSCHEL ISLAND D-9

		JULY			
		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B
Phylum: Annelida Class: Polychaeta Family					
Ampharetidae		4		0.004	
Cirratulidae		24	2	0.028	0.004
Hesionidae	Castalia aphroditoides	12	2	0.042	0.008
Phyllodocidae	Fragments			0.022	
Sabellidae		52	4	0.016	0.006
Scalibregmidae	Scalibregma inflatum	2		0.006	
Spionidae	Dispio sp.	2			
	Prionospio cirrifera	2			
	Scolecolepides sp	10	6		
	Unidentified and fragments		2		
	Family Total	14	8	0.128 •	0.032 •
Syllidae	Exogone sp.	4		0.004	
Terebellidae			2		0.004
Annelid Fragments and Nematodes		present	present	0.040	0.052
Phylum: Arthropoda Class: Cirripedia Order: Thoracica Family:					
Balanidae	Balanus balanoides		present		

STATION: HERSCHEL ISLAND D-9

	Genus Species	JULY Number/m² A	Number/m² B	Wet Biomass (g/m²) A	Wet Biomass (g/m²) B
Phylum: Arthropoda **Class:** Copepoda **Order:** Calanoida **Family:**					
Calanidae+	Calanus sp.	34	104	0.156	0.150
Class: Malacostraca **Order:** Amphipoda **Family:**					
Ampeliscidae	Byblis gàimardi	6		0.008	
Corophiidae	Erichthonius sp.	2	6	0.002	0.004
Gammaridae	Gammarus locusta	12	28	0.818	1.574
Lysianassidae	Koroga megalops		6		0.400
	Boeckosimus botkini		8		0.500
	Family Total		14		0.900
Oedicerotidae	Paroediceros lynceus	8	4	0.100	0.166
Order: Isopoda **Family:**					
Idoteidae	Mesidotea sibirica		4		0.214
Class: Ostracoda		6	4	0.001	0.001
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		8		0.474	

STATION: HERSCHEL ISLAND D-9

	Genus Species	JULY Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Cnidaria **Class:** Anthozoa **Order:** Actiniaria		4		0.004	
Class: Hydrozoa **Family:**					
Campanulariidae			present		
Campanulinidae			present		
Sertularidae		present	present		
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**					
Scrupariidae	<u>Eucratea loricata</u>	present	present		
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**					
Turridae	<u>Oenopota</u> sp.		2		0.002
Class: Pelecypoda **Family:**					
Thyasiridae	<u>Thyasira flexuosa</u>		14		0.022
Veneridae	<u>Liocyma fluctuosa</u>		2		0.001
Phylum: Nemertea		2		0.190	
STATION TOTAL:		160	96	1.89	2.99

STATION: HERSCHEL ISLAND D-10

	Genus Species	Number/m2 A	B	C	Wet Biomass (g/m2) A	B	C
		JULY					
Phylum: Annelida							
Class: Polychaeta							
Family:							
Ampharetidae		2			0.004		
Cirratulidae		2	4		0.004	0.010	
Hesionidae	Castalia aphroditoides	22	16	6	0.100	0.036	0.034
Phyllodocidae	Eteone longa			2			0.016
Sabellidae		4	6		0.002	0.004	
Serpulidae				2			0.004
Spionidae	Dispio sp.		14				
	Prionospio cirrifera		2				
	Scolecolepides sp.		18				
	Family Total		34			0.200 •	
Syllidae	Autolytus sp.			2			
	Exogone sp.			4			
	Family Total			6			0.002 •
Terebellidae			6	4		0.268	0.148
Annelid Fragments and Nematodes		present	present	present	0.006	0.028	0.128
Phylum: Arthropoda							
Class: Copepoda							
Order: Calanoida							
Family:							
Calanidae +	Calanus sp.	140			0.224		
	Family Total	140		18	0.224		0.050

STATION: HERSCHEL ISLAND D-10

		JULY					
		Number/m^2			Wet Biomass (g/m^2)		
	Genus Species	A	B	C	A	B	C
Phylum: Arthropoda							
Class: Malacostraca							
Order: Amphipoda							
Family:							
Atylidae	Atylus carinatus		2	2		0.210	0.012
Calliopiidae	Apherusa sp.	8		14	0.002		0.008
Gammaridae	Gammarus locusta	24		40	1.310		3.336
	Gammarus duebeni			16			0.038
	Unidentified species			2			0.006
	Family Total	24		58	1.310		3.380
Lysianassidae	Acanthogtepheia behringiensis	2		14	0.138		0.352
Oedicerotidae	Monoculodes sp.			2			0.004
	Paroediceros lynceus	6	24	58	0.010	0.088	0.654
	Family Total	6	24	60	0.010	0.088	0.658
Stenothoidae	Metopa longicornis			10			0.024
Unidentified Amphipod				2			0.004
Order: Cumacea							
Family:							
Diastylidae	Diastylis oxyrhyncha		2			0.020	

STATION: HERSCHEL ISLAND D-10

		JULY					
		Number/m^2			Wet Biomass (g/m^2)		
	Genus Species	A	B	C	A	B	C
Phylum: Arthropoda **Class:** Malacostraca **Order:** Isopoda **Family:**							
Idoteidae	Mesidotea entomon			2			13.554
	Mesidotea sibirica	2	8		0.044	2.012	
	Family Total	2	8	2	0.044	2.012	13.554
Arthropod Fragments					0.001		0.004
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		2	2		0.004	0.012	
Phylum: Cnidaria **Class:** Anthozoa **Order:** Actiniaria		2	2	2	0.004	0.004	0.550
Class: Hydrozoa **Family:**							
Campanulariidae				present			
Campanulinidae	Lafoeina maxima			present			
Sertularidae	Sertularia sp.			present			

STATION: HERSCHEL ISLAND D-10

		Number/m2 JULY			Wet Biomass (g/m2)		
	Genus Species	A	B	C	A	B	C
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**							
Scrupariidae	Eucratea loricata	present	present	present			
Phylum: Mollusca **Class:** Pelecypoda **Family:**							
Hiatellidae	Hiatella arctica	2		6	0.001		0.240
Mytilidae	Mytilus edulis			2			0.002
STATION TOTAL:		78	106	192	1.63	2.89	19.12

STATION: HERSCHEL ISLAND DS-5

		SEPTEMBER			
		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B
Phylum: Annelida					
Class: Polychaeta					
Family:					
Ampharetidae	Ampharete acutifrons	40		0.035	
Apistobranchidae	Apistobranchus ornatus	5			
Capitellidae	Capitella capitata	110		0.010	
Cirratulidae	Chaetozone/Tharyx complex	30		0.065	
Maldanidae	Praxillella praetermissa	5			
	unidentified	30			
	Family Total	35		0.010 *	
Orbiniidae	Leitoscoloplos pugettensis	5		0.010	
Phyllodocidae	Eteone longa	10			
	Phyllodoce groenlandica	5			
	Family Total	15		0.130 *	
Sabellidae	Chone sp.	120			
	Potamilla sp.	10			
	Family Total	130		0.065 *	
Scalibregmidae	Scalibregma inflatum	5		0.005	
Sigalionidae	Pholoe minuta	20		0.020	
Sphaerodoridae	Sphaerodoropsus minuta	5		0.005	
Spionidae	Dispio sp.	125			
	Pygospio elegans	5			
	Scolecolepides sp.	35			
	unidentified	75			
	Family Total	240		0.480 *	
Annelid Fragments and Nematodes				0.120	

STATION: HERSCHEL ISLAND DS-5

	Genus Species	SEPTEMBER Number/m2 A	B	Wet Biomass (g/m2) A	B
Phylum: Arthropoda Class: Malacostraca Order: Amphipoda Family:					
Ampeliscidae	Byblis gaimardi	5		0.470	
Lysianassidae	orchomonella minuta	10		0.005	
Order: Cumacea Family:					
Diastylidae	Diastylis sp.	15		0.020	
Order: Isopoda Family:					
Idoteidae	Mesidotea sibirica	10		67.820	
	Synidotea bicuspida	5		0.680	
	Family Total	15		68.50	
Order: Tanaidacea	Leptognathia gracilis	120		0.015	
Class: Ostracoda		30		0.010	
Arthropod Fragments				0.010	
Phylum: Chordata Subphylum: Urochordata Class: Ascidiacea		80		3.80	
Phylum: Cnidaria Class: Anthozoa Order: Alcyonacea Family:					
Nepthyidae	Gersemia sp.	present			

STATION: HERSCHEL ISLAND DS-5

		SEPTEMBER			
		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B
Phylum: Cnidaria					
Class: Anthozoa					
Order: Unidentified		15		5.940	
Class: Hydrozoa					
Family:					
Campanulinidae	Lafoeina maxima	present			
Sertulariidae		present			
Phylum: Ectoprocta					
Class: Gymnolaemata					
Family:					
Bicellariellidae	Bugula sp.	present			
Scrupariidae	Eucratea loricata	present			
One apparent species		present			
Phylum: Mollusca					
Class: Gastropoda					
Subclass: Prosobranchia					
Family:					
Diaphanidae	Diaphana minuta	10		< 0.001	
Retuidae	Retusa obtusa	25		0.045	
Trochidae	Margarites olivaceus	5		< 0.001	

STATION: HERSCHEL ISLAND DS-5

	Genus Species	SEPTEMBER Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**					
Turritellidae	Tachyrhynchus reticulatus	5		0.270	
Class: Pelecypoda **Family:**					
Astartidae	Astarte montagui	65		0.970	
Hiatellidae	Hiatella arctica	5		0.010	
Nuculanidae	Portlandia arctica	5		0.010	
Tellinidae	Macoma sp.	125		0.330	
Thraciidae	Thracia sp.	15		0.640	
Thyasiridae	Thyasira flexuosa	15		0.030	
Veneridae	Liocyma fluctuosa	320		9.180	
Juvenile Pelecypoda		5		< 0.001	
Phylum: Nemertea		75		0.025	
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**					
Fischerinidae	Cornuspira folicacea	present			

STATION: HERSCHEL ISLAND DS-5

		SEPTEMBER			
		Number/m^2		Wet Biomass (g/m^2)	
	Genus Species	A	B	A	B
Phylum: Protozoa Class: Sarcodina Order: Foraminifera Family:					
Elphiidae	Elphidium arcticum	present			
Miliolidae	Miliolina seminulum	present			
Phylum: Sipuncula		15		0.025	
Unidentified Phylum		15		0.430	
STATION TOTAL:		2125		91.47	

STATION: HERSCHEL ISLAND DS-8

	Genus Species	SEPTEMBER Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Annelida					
Class: Polychaeta					
Family:					
Ampharetidae	Ampharete acutifrons	20			
	Unidentified	15			
	Family Total	35		0.010 *	
Capitellidae	Capitella capitata	5		<0.001	
Cirratulidae	Chaetozone/Tharyx complex	5		0.005	
Cossuridae	Cossura soyeri	5		0.005	
Dorvilleidae		15		<0.001	
Flabelligeridae		5		<0.001	
Hesionidae	Fragment	5		<0.001	
Nephtyidae	Nephtys cornuta	15		0.005	
Orbiniidae	Leitoscoloplos panamensis	20		0.765	
Phyllodocidae	Eteone sp.	10			
	Phyllodoce groenlandica	5			
	Family Total	15		0.005	
Polynoidae	Melaenis loveni	5		0.025	
Sabellidae	Chone sp.	25		0.005	
Sigalionidae	Pholoe minuta	10		0.001	
Spionidae	Prionospio cirrifera	5		<0.005	
Terebellidae	Proclea graffi	5		<0.001	
Fragments and Nematodes		present		0.250	

STATION: HERSCHEL ISLAND DS-8

	Genus Species	SEPTEMBER Number/m² A	Number/m² B	Wet Biomass (g/m²) A	Wet Biomass (g/m²) B
Phylum: Arthropoda					
Class: Malacostraca					
Order: Amphipoda					
Family:					
Isaeidae	Protomedeia fasciata	15		0.010	
Lysianassidae	Orchomonella minuta	5		0.020	
Order: Cumacea					
Family:					
Diastylidae	Brachydiastylis resima	10			
	Diastylis oxyrhyncha	55			
	Family Total	65		1.450 *	
Order: Tanaidacea	Leptognathia gracilis	30		<0.001	
Class: Ostracoda		120		0.055	
Arthropod Fragments				0.220	
Phylum: Cnidaria					
Class: Anthozoa	Unidentified	5		1.130	
Class: Hydrozoa					
Family:					
Campanulinidae	Lafoeina maxima	present			
Lafoeidae		present			
Sertulariidae		present			

STATION: HERSCHEL ISLAND DS-8

	Genus Species	SEPTEMBER Number/m2 A	B	Wet Biomass (g/m2) A	B
Phylum: Echinodermata **Class:** Stelleroidea **Subclass:** Ophiuroidea **Family:**					
Ophiolepididae		10		<0.001	
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**					
Scrupariidae	Eucratea loricata	present			
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**					
Diaphanidae	Diaphana minuta	15		0.020	
Retusidae	Retusa obtusa	30		0.160	
Turridae	Oenopota sp.	10		0.290	
	Propebela sp.	5		0.010	
	Family Total	15		0.300	
Class: Pelecypoda **Family:**					
Myidae	Mya truncata	5		0.015	

STATION: HERSCHEL ISLAND DS-8

	Genus Species	SEPTEMBER Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Mollusca **Class:** Pelecypoda **Family:**					
Nuculanidae	Yoldiella fraterna	10		0.020	
Pectinidae	Delectopecten greenlandicus	20		0.005	
Tellinidae	Macoma sp.	30		0.015	
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**					
Fischerinidae	Cornuspira foliacea	present			
STATION TOTAL:		676		5.81	

STATION: HERSCHEL ISLAND DS-9

Family	Genus Species	SEPTEMBER Number/m^2 A	Number/m^2 B	Wet Biomass (g/m^2) A	Wet Biomass (g/m^2) B
Phylum: Annelida					
Class: Polychaeta					
Family:					
Ampharetidae	Ampharete acutifrons	25		0.025	
Capitellidae	Capitella capitata	5		<0.001	
Cirratulidae	Chaetozone/Tharyx complex	5		0.070	
Cossuridae	Cossura soyeri	15		0.005	
Dorvilleidae		5		<0.001	
Hesionidae	Castalia aphroditiodes	20		0.020	
Nephtyidae	Nephtys cornuta	15		0.005	
Paraonidae	Aricidea suecica	5		<0.001	
Phyllodocidae	Mystides sp.	5		0.038	
	Phyllodoce groenlandica	10			
	Family Total	15		0.050	
Polynoidae	Melaenis loveni	5		0.610	
Sabellidae	Chone sp.	20		0.005	
Sigalionidae	Pholoe minuta	90		0.015	
Spionidae	Dispio sp.	40			
	Polydora quadralobata	30			
	Unidentified	20			
	Family Total	90		0.045	
Fragments and Nematodes				0.335	

STATION: HERSCHEL ISLAND DS-9

		SEPTEMBER			
		Number/m2		Wet Biomass (g/m2)	
	Genus Species	A	B	A	B
Phylum: Annelida **Class:** Copepoda **Order:** Calanoida **Family:**					
Calanidae +		20		<0.001	
Phylum: Arthropoda **Class:** Malacostraca **Order:** Amphipoda **Family:**					
Isaeidae	Protomedia fasciata	5		0.005	
Ischyroceridae		5		<0.001	
Lysianassidae		5		<0.001	
Order: Cumacea **Family:**					
Diastylidae	Brachydiastylis resima	5			
	Diastylis edwardsi	5			
	Drastylis oxyrhyncha	115			
	Family total	125		0.510 *	
Leuconidae	Leucon fulvus	5		<0.001	
Order: Tanaidacea	Leptognathia gracilis	75		0.005	
Class: Ostracoda		5		<0.001	
Phylum: Echinodermata **Class:** Holothuroidea		5		0.040	

STATION: HERSCHEL ISLAND DS-9

	Genus Species	SEPTEMBER Number/m² A	B	Wet Biomass (g/m²) A	B
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**					
Retusidae	Retusa obtusa	5		0.005	
Turridae	Oenopota sp.	15		0.035	
Class: Pelecypoda **Family:**					
Hiatellidae	Hiatella arctica	5		0.165	
Nuculanidae	Portlandia arctica	15		0.235	
	Yoldiella fraterna	15		0.035	
	Family Total	30		0.270	
Pandoridae	Pandora glacialis	5		0.010	
Pectinidae	Delectopecten greenlandicus	5		0.005	
Tellinidae	Macoma sp.	5		<0.001	
Phylum: Nemertea		10		<0.001	
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**					
Fischerinidae	Cornuspira foliacea	present			
Phylum: Sipuncula		5		<0.001	
STATION TOTAL:		913		3.14	

STATION: HERSCHEL ISLAND DS-10

	Genus Species	SEPTEMBER Number/m² A	Wet Biomass (g/m²) A	
Phylum: Annelida				
Class: Polychaeta				
Family:				
Ampharetidae	Ampharete acutifrons	20		
	Unidentified	5		
	Family Total	25	0.010	*
Capitellidae	Capitella capitata	5	0.010	
Cirratulidae	Chaetozone/Tharyx complex	85	0.070	
Hesionidae	Castalia aphroditoides	5	<0.001	
Nephtyidae	Nephtys cornuta	5		
	Nephtys longosetosa	5		
	Family Total	10	1.985	*
Opheliidae	Travisia forbesii	5	0.015	
Paraonidae	Aricidea suecica	5	0.005	
Phyllodocidae	Phyllodoce groenlandica	5	<0.001	
	Unidentified species	25	0.015	
	Family Total	30	0.015	
Polynoidae	Hesperonoe adventor	5	0.025	
Sabellidae	Chone sp.	15	0.005	
Sphaerodoridae	Sphaerodoropsis minuta	40	0.010	
Spionidae	Dispio sp.	140		
	Polydora sp.	5		
	Prionospio cirrifera	10		
	Scolecolepides sp.	70		
	Unidentified	130		
	Family Total	355	0.295	*

STATION: HERSCHEL ISLAND DS-10

	Genus Species	SEPTEMBER Number/m^2 A	Wet Biomass (g/m^2) A
Phylum: Annelida **Class:** Polychaeta **Family:**			
Syllidae	Brania sp.	10	<0.001
Fragments and Nematodes			0.075
Phylum: Arthropoda **Class:** Malacostraca **Order:** Amphipoda			
Lysianassidae	Boeckosimus botkini	10	0.115
Oedicerotidae	Paroediceros lynceus	25	<0.001
Order: Cumacea **Family:**			
Diastylidae	Diastylis oxyrhyncha	45	0.120
Lampropidae		5	<0.001
Leuconidae	Leucon nasica	10	<0.001
Nannastacidae	Campylaspis costata	5	<0.001

STATION: HERSCHEL ISLAND DS-10

	Genus Species	SEPTEMBER Number/m^2 A	Wet Biomass (g/m^2) A
Phylum: Arthropoda **Class:** Malacostraca **Order:** Isopoda **Family:**			
Munnidae	Pleurogonium spinosissmum	5	<0.001
Order: Tanaidacea	Leptognathia gracilis	45	0.005
Class: Ostracoda		5	<0.001
Arthropod Fragments			0.010
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		15	0.155
Phylum: Cnidaria **Class:** Anthozoa			
Unidentified Anthozoan		5	0.015
Class: Hydrozoa **Family:**			
Campanulinidae	Lafoeina maxima	present	

STATION: HERSCHEL ISLAND DS-10

	Genus Species	SEPTEMBER Number/m^2 A	Wet Biomass (g/m^2) A
Phylum: Echinodermata **Class:** Stelleroidea **Subclass:** Ophiuroidea		5	0.010
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**			
Scrupariidae	Eucratea loricata	present	
Phylum: Mollusca **Class:** Gastropoda **Subclass:** Prosobranchia **Family:**			
Retusidae	Retusa obtusa	10	0.025
Turridae	Propebela sp.	5	0.050
Unidentified Juveniles		10	0.005
Class: Pelecypoda **Family:**			
Astartidae	Astarte montagui	20	0.065
Nuculanidae	Portlandia arctica	5	0.440
	Yoldiella fraterna	10	0.045
	Family Total	15	0.485

STATION: HERSCHEL ISLAND DS-10

		SEPTEMBER	
		Number/m^2	Wet Biomass (g/m^2)
	Genus Species	A	A
Phylum: Mollusca **Class:** Pelecypoda **Family:**			
Pectinidae	Delectopecten greenlandicus	15	0.005
Thyasiridae	Axinopsida orbiculata	5	0.010
	Thyasira flexuosa	110	0.130
	Family Total	115	0.140
Venereidae	Liocyma fluctuosa	20	0.015
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**			
Fischerinidae	Cornuspira foliacea	present	
STATION TOTAL:		1428	7.19

STATION: HERSCHEL ISLAND DS-12

	Genus Species	SEPTEMBER Number/m^2 A	B	Wet Biomass (g/m^2) A	B
Phylum: Annelida **Class:** Polychaeta **Family:**					
Phyllodocidae	Phyllodoce groenlandica	10		0.030	
Spionidae	Fragments			0.010	
Annelid Fragments and Nematodes				0.038	
Phylum: Arthropoda **Subclass:** Malacostraca **Order:** Tanaidacea	Leptognathia gracilis	10		<0.001	
Subclass: Ostracoda		30		<0.001	
Phylum: Chordata **Subphylum:** Urochordata **Class:** Ascidiacea		100		6.211	
Phylum: Cnidaria **Class:** Anthozoa **Order:** Alcyonacea **Family:**					
Nepthyidae	Gersemia sp.	present			

STATION: HERSCHEL ISLAND DS-12

	Genus Species	SEPTEMBER Number/m^2 A	B	Wet Biomass (g/m^2) A	B
Phylum: Cnidaria **Class:** Hydrozoa **Family:**					
Campanulinidae	Lafoeina maxima	present			
Phylum: Ectoprocta **Class:** Gymnolaemata **Family:**					
Scrupariidae	Eucratea loricata	present			
Phylum: Mollusca **Class:** Pelecypoda **Family:**					
Astartidae	Astarte montagui	30		0.471	
Tellinidae	Macoma sp. (juveniles)	20		<0.001	
Thraciidae	Thracia sp.	30		10.029	
Veneridae	Liocyma fluctuosa	50		0.067	
Phylum: Protozoa **Class:** Sarcodina **Order:** Foraminifera **Family:**					
Fischerinidae	Cornuspira foliacea	present			
STATION TOTAL:		**280**		**16.86**	

STATION: HERSCHEL ISLAND
C-82-2

SEPTEMBER, 1982

		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	ANNELIDA					
Class:	Oligochaeta		E	6	0.10	<0.01
Class:	Polychaeta					
Family:	Ampharetidae	Ampharete acutifrons	E	36	0.04	< 0.001
		Ampharete sp.	A	300	0.4	0.120
			B	30	0.1	< 0.001
			C	30	< 0.01	
			D	70	0.2	0.050
		Unidentified	B	30	< 0.01	
	Apistobranchidae	Apistobranchus ornatus	E	2	< 0.01	
	Cirratulidae	Chaetozone/Tharyx complex	A	270	1.10	M
			B	60	0.30	0.070
			C	10	< 0.01	
			D	20	< 0.01	
			E	12	0.06	0.018
	Dorvilleidae	Unidentified	E	2	< 0.01	
	Hesionidae	Oxydeomus sp.	E	8	< 0.01	
	Lumbrineridae	Lumbrineris sp.	A	20	< 0.01	
		Unidentified	E	2	< 0.01	
	Maldanidae	Clymenura sp.	E	8	< 0.01	M
		Unidentified sp. 1	A	10	0.10	< 0.001
		Unidentified sp. 2	A	80	0.10	< 0.001
		Unidentified	B	10	< 0.01	
		Unidentified	E	4	< 0.01	
	Nephtyidae	Nephtys cornuta	A	80	< 0.01	
			D	20	< 0.01	
		Nephtys cornuta franciscana	B	10	< 0.01	
			C	10	< 0.01	
			E	2	< 0.01	
		Nephtys longosetosa	E	2	0.52	0.100
		Nephtys sp.	C	10	2.60	0.640
	Nereidae	Unidentified	A	10	< 0.01	
	Orbiniidae	Leitoscoloplos panamensis	D	20	< 0.01	
			E	4	0.44	M
		Leitoscoloplos pugettensis	E	2	0.02	< 0.001
		Leitoscoloplos sp.	A	10	< 0.01	
			B	10	< 0.01	
	Phyllodocidae	Eteone sp.	E	2	< 0.01	
		Phyllodoce groenlandica	A	fragments	0.20	0.060
			E	2	< 0.01	
	Polynoidae	Antinoella sarsi	E	4	0.12	M
		Unidentified	E	2	< 0.01	M
	Sabellidae	Chone sp.	A	10	< 0.01	
			E	22	< 0.01	
		Unidentified	B	10	0.10	
			E	4	< 0.01	
	Sigalionidae	Pholoe sp.	A	10	< 0.01	
			B	10	< 0.01	
			D	10	< 0.01	
			E	6	< 0.01	
	Sphaerodoridae	Sphaerodoropsis minuta	A	10	< 0.01	
	Spionidae	Dispio sp.	E	36	0.04	0.010
		Prionospio cirrifera	E	2	< 0.01	
		Pygospio elegans	A	20	< 0.01	
		Scolecolepides sp.	E	12	0.10	0.026
	Spirorbidae		C	10	< 0.01	
	Sternaspidae	Sternaspis scutata	A	10	< 0.01	M
	Syllidae	Exogone sp.	E	2	< 0.01	
	Nematodes and Fragments		A	present	1.60	0.440
			B	present	0.30	0.100
			C	present	0.10	< 0.001
			D	present	0.20	0.080
			E	present	0.16	0.036

STATION: HERSCHEL ISLAND
C-82-2

SEPTEMBER, 1982

		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	ARTHROPODA					
Class:	Malacostraca					
Order:	Amphipoda					
Family:	Ampeliscidae	Byblis gaimardi	B	10	0.20	0.010
			D	10	0.10	< 0.001
			E	18	0.12	0.020
		Haploops tubicola	B	10	< 0.01	
	Atylidae	Atylus carinatus	E	2	< 0.01	
	Corophiidae	Erichthonius hunteri	A	10	< 0.01	
			B	30	0.10	< 0.001
			E	8	0.02	< 0.001
	Isaeidae	Photis sp.	E	2	< 0.01	
		Protomedeia sp.	A	20	< 0.01	
			B	10	< 0.01	
			E	44	0.06	0.004
		Unidentified	D	40	0.20	< 0.010
	Ischyroceridae	Ischyrocerus megacheir	A	10	< 0.01	
			B	10	< 0.01	
			E	8	< 0.01	
	Lysianassidae	Boeckosimus plautus	B	10	< 0.01	
		Boeckosimus sp.	E	4	< 0.01	
		Paralibrotus setosus	E	4	0.02	< 0.001
	Oedicerotidae	Monoculodes longirostris	E	10	0.02	
		Monoculodes sp.	E	6	< 0.01	
	Paramphithoidae	Paramphithoe sp. 1	E	2	0.18	M
	Unidentified Amphipoda		D	10	< 0.01	
Order:	Cumacea					
Family:	Diastylidae	Brachydiastylis resima	A	160	0.10	< 0.001
			B	60	< 0.01	
			C	20	< 0.01	
			D	40	< 0.01	
			E	6	< 0.01	
		Diastylis edwardsi	C	10	0.10	< 0.001
			E	4	0.02	< 0.001
		Diastylis oxyrhyncha	A	40	< 0.01	
			B	40	1.10	0.230
			C	30	0.10	< 0.001
			D	40	0.30	0.020
			E	38	0.14	0.026
	Leuconidae	Leucon nasica	E	6	< 0.01	
Order:	Isopoda					
Family:	Jaeropsidae		B	10	< 0.01	
			C	10	< 0.01	
	Munnidae	Munna sp.	E	2	< 0.01	
		Pleurogonium spinosissmum	E	4	< 0.01	
Order:	Tanaidacea	Leptognathia gracilis	A	60	< 0.01	
			B	30	< 0.01	
			D	40	< 0.01	
			E	12	< 0.01	
Class:	Ostracoda		A	590	0.10	< 0.001
			B	790	< 0.10	< 0.001
			C	750	0.10	< 0.001
			D	400	< 0.10	< 0.001
Fragments			A	present	< 0.01	
			D	present	< 0.01	
			E	present	0.02	< 0.001

STATION: HERSCHEL ISLAND
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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	CHORDATA					
Subphylum:	Hemichordata					
Class:	Ascidiacea		A	30	< 0.01	M
			B	60	< 0.01	M
			C	40	< 0.01	M
			D	80	< 0.01	M
			E	4	0.04	M
PHYLUM:	CNIDARIA					
Class:	Anthozoa					
Order:	Actiniaria		E	8	0.20	M
Order:	Alcyonacea					
Family:	Nepthyidae	Gersemia sp.	A	present	0.40	M
			B	present	0.10	M
			C	present	< 0.01	M
			D	present	< 0.01	M
			E	present	< 0.01	
PHYLUM:	ECHINODERMATA					
Class:	Stelleroidea					
Subclass:	Asteroidea					
	Juvenile		A	10	< 0.01	
Subclass:	Ophiuroidea					
Family:	Ophiolepididae	Ophiura sarsi	E	4	0.02	
		Stegophiura sp. 1	A	20	< 0.01	
			B	10	< 0.01	
PHYLUM:	ECTOPROCTA					
Class:	Cheilostomata					
Family:	Membraniporidae	Membranipora sp.	C	present		
PHYLUM:	MOLLUSCA					
Class:	Gastropoda					
Subclass:	Opistobranchia					
Order:	Thecosomata		B	20	0.30	M
			D	20	0.10	M
			E	2	0.01	M
Subclass:	Prosobranchia					
Family:	Cylichnidae	Cylichna alba	C	20	0.20	< 0.010
		Scaphander punctostriatus	D	10	0.10	< 0.010
			E	2	0.08	0.008
	Retusidae	Retusa obtusa	A	30	0.10	< 0.001
			B	30	0.10	< 0.001
			C	60	0.10	< 0.001
			D	50	< 0.01	
			E	10	0.02	< 0.001
	Rissoidae	Cingula castanea	A	30	0.20	M
			C	10	0.10	< 0.001
			E	2	< 0.01	
	Trochidae	Solariella obscura	A	10	< 0.01	
			E	4	< 0.01	
	Turridae	Oenopota novajasemliensis	C	10	0.20	M
		Oenopota turricula	E	2	0.04	0.002
		Oenopota sp.	E	4	0.26	0.008
	Juveniles		A	10	< 0.01	
			B	10	< 0.01	
			C	10	< 0.01	

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
Class:	Pelecypoda					
Family:	Astartidae	Astarte montagui	E	4	0.60	0.044
		Astarte sp.	C	10	< 0.01	
			D	20	< 0.01	
	Cardiidae	Clinocardium ciliatum	A	10	0.20	<0.001
	Lyonsiidae	Lyonsia arenosa	A	10	0.30	0.020
			C	10	0.10	<0.001
			E	2	< 0.01	
	Mytilidae	Musculus niger	A	10	0.10	<0.001
			B	10	0.20	<0.001
	Nuculanidae	Nuculana pernula	A	20	< 0.01	
			E	6	0.16	0.008
		Portlandia arctica	B	30	2.80	0.290
			C	10	0.10	<0.001
			D	10	0.30	0.020
		Portlandia frigida	B	10	0.10	<0.001
			C	10	0.10	<0.001
		Portlandia intermedia	A	30	0.20	M
			B	20	0.20	M
	Pandoriidae	Pandora glacialis	D	10	< 0.01	
	Pectinidae	Delectopecten greenlandicus	D	10	0.10	<0.001
	Tellinidae	Macoma calcarea	C	10	0.20	0.010
		Macoma crassula	A	70	7.10	M
			B	30	< 0.01	
			C	20	< 0.01	
			E	40	0.60	0.046
		Macoma sp.	C	20	< 0.01	
			D	50	< 0.01	
	Thraciidae	Thracia devexa	E	6	0.04	0.002
	Thyasiridae	Axinopsida orbiculata	B	20	< 0.01	
			D	10	< 0.01	
			E	14	0.06	0.002
	Veneridae	Liocyma fluctuosa	A	30	< 0.01	
			B	20	< 0.01	
			E	6	0.02	<0.001
	Unidentified		A	20	< 0.01	
			D	30	< 0.01	
PHYLUM:	NEMERTEA		E	4	< 0.01	
PHYLUM:	PROTOZOA					
Class:	Sarcodina					
Order:	Foraminifera					
Family:	Elphidiidae	Elphidium sp. 1	A-E	present		
	Fischerinidae	Cornuspira foliacea	A-E	present		
	Miliolidae	Quinqueloculina seminulum	A-E	present		
		Quinqueloculina sp. 1	A	present		
	Nodosariidae	Dentalina baggi	A	present		
			E	present		
		Dentalina pauperata	C	present		
		Dentalina sp. 1	A	present		
		Dentalina sp. 2	B	present		
PHYLUM:	SIPUNCULA		E	4	0.10	<0.001
STATION TOTALS			A	2070	12.3	0.64
			B	1450	6.1	0.70
			C	1130	4.0	0.65
			D	1020	1.6	0.17
			E	492	4.5	0.36
STATION VOLUME (Litres)			A	8.0		
			B	7.5		
			C	6.5		
			D	5.0		

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		Genus Species	Grab	Number/m2	Wet Biomass (g/m2)	Dry Biomass (g/m2)
PHYLUM:	ANNELIDA					
Class:	Oligochaeta		A	20	< 0.01	
			B	10	< 0.01	
			C	30	< 0.01	
			D	30	< 0.01	
			E	22	0.10	< 0.001
Class:	Polychaeta					
Family:	Ampharetidae	Ampharete acutifrons	A	130	0.10	< 0.001
			B	180	0.20	0.030
			C	290	0.20	0.040
			D	190	0.10	< 0.001
			E	112	0.12	0.026
		Ampharete sp.	A	110	0.10	< 0.001
			B	150	0.10	< 0.001
			C	90	< 0.01	
			D	140	0.10	< 0.001
			E	62	0.10	0.018
		Glyphanostomum pallescens	B	10	< 0.01	M
		Melinna elisabethae	B	10	< 0.01	
			C	20	< 0.01	
			D	10	0.10	< 0.001
			E	2	< 0.01	
	Apistobranchidae	Apistobranchus sp.	C	10	< 0.01	
	Capitellidae	Capitella capitata	E	4	< 0.01	
		Heteromastus sp.	A	10	< 0.01	
		Mediomastus sp.	C	30	< 0.01	
		Unidentified	B	10	< 0.01	
	Cirratulidae	Chaetozone setosa	A	20	< 0.01	
			C	30	< 0.01	
			E	2	< 0.01	M
		Chaetozone spinosa	C	190	0.30	0.080
		Chaetozone/Tharyx complex	A	60	0.10	< 0.001
			B	190	0.20	0.050
			D	130	0.10	< 0.001
			E	50	0.06	0.018
		Unidentified	C	20	< 0.01	M
	Dorvilleidae	Unidentified	D	20	< 0.01	
	Hesionidae		E	4	< 0.01	
		Castalia sp.	C	40	< 0.01	
			D	10	< 0.01	
		Unidentified	B	20	< 0.01	
			C	10	< 0.01	
			E	6	< 0.01	
	Lumbrineridae	Lumbrineris sp.	B	10	< 0.01	
	Maldanidae	Clymenura sp.	C	160	0.10	M
			D	70	0.10	< 0.001
			E	8	0.10	< 0.001
		Micromaldane sp. [1]	C	50	< 0.01	M
			D	10	< 0.01	
		Praxillella praetermissa	E	12	0.10	M
		Unidentified	B	50	0.10	< 0.001
	Nephtyidae	Nephtys cornuta	B	10	< 0.01	
			E	6	< 0.01	
	Nereidae	Cheilonereis sp.	C	20	0.10	M
			E	4	< 0.01	M
		Nereis zonata	A	10	0.30	0.050
		Nereis sp.	B	10	< 0.01	M
	Opheliidae	Ammotrypane cylindricaudatus	C	10	< 0.01	M
	Orbiniidae	Leitoscoloplos pugettensis	E	6	0.06	0.014
	Paraonidae	Aricidea sp.	C	10	< 0.01	
	Phyllodocidae	Eteone longa	B	10	< 0.01	
			C	30	< 0.01	
			D	10	< 0.01	M
			E	2	< 0.01	M

1 This genus is thought to be a juvenile of another yet undetermined genus, by some authors. (Day, 1966)

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	ANNELIDA					
Class:	Polychaeta					
Family:	Phyllodocidae	Mystides sp.	A	30	< 0.01	M
			B	90	0.10	M
			C	80	0.10	M
			D	20	< 0.01	M
			E	18	0.10	M
		Phyllodoce groenlandica	B	10	2.20	0.440
			D	10	0.10	< 0.001
			E	2	0.36	M
	Polynoidae	Harmothoe sp.	C	10	< 0.01	M
		Hesperonoe sp.	C	20	< 0.01	
		Melaenis loveni	D	10	2.10	0.340
		Unidentified	A	10	< 0.01	
	Sabellidae	Chone sp.	A	1490	0.30	0.110
			B	2300	0.10	M
			C	4190	0.90	0.270
			D	1250	0.30	0.070
			E	1708	0.30	0.080
		Euchone analis	A	20	< 0.01	
			B	60	0.20	0.040
			C	40	0.10	< 0.001
			D	10	< 0.01	
			E	14	0.02	M
		Euchone sp.	C	10	< 0.01	
		Laonome kroyeri	A	20	< 0.01	
			B	180	0.10	< 0.001
			C	180	< 0.01	
			D	100	< 0.01	
			E	32	0.10	M
		Unidentified	A	330	0.10	< 0.001
			B	430	0.10	< 0.001
			C	470	0.10	< 0.001
			D	490	< 0.01	
			E	176	0.04	0.010
	Serpulidae		A	20	< 0.01	M
	Sigalionidae	Pholoe sp.	A	130	< 0.01	
			B	170	< 0.01	
			C	210	0.10	< 0.001
			D	80	0.10	< 0.001
			E	46	0.10	< 0.001
	Sphaerodoridae	Sphaerodoropsis minuta	B	10	0.10	M
			C	10	< 0.01	M
			D	10	< 0.01	
			E	6	0.06	0.006
	Spionidae	Dispio sp.	A	10	< 0.01	
			B	10	< 0.01	
		Polydora sp.	A	10	< 0.01	
			C	20	< 0.01	
			D	10	< 0.01	
		Prionospio cirrifera	B	10	< 0.01	
			E	2	< 0.01	
		Pygospio elegans	A	210	< 0.01	
			B	630	0.10	< 0.001
			C	2770	0.10	< 0.001
			D	880	0.10	< 0.001
			E	410	0.04	0.006

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		Genus Species	Grab	Number/m2	Wet Biomass (g/m2)	Dry Biomass (g/m2)
PHYLUM:	ANNELIDA					
Class:	Polychaeta					
Family:	Spionidae	Pygospio sp. 1	D	30	< 0.01	M
		Scolecolepides sp.	B	10	< 0.01	
		Unidentified	A	10	< 0.01	
			B	40	< 0.01	M
			C	10	< 0.01	
			D	10	< 0.01	
			E	4	< 0.01	M
	Syllidae	Exogone sp.	A	20	< 0.01	
			B	60	< 0.01	
			C	80	< 0.01	M
			D	10	< 0.01	
			E	16	< 0.01	
Subfamily:	Eusyllinae		A	10	< 0.01	
			C	20	< 0.01	
	Terebellidae	Pista maculata	C	10	< 0.01	
		Pista sp.	B	10	< 0.01	
		Scionella japonica	E	2	0.20	0.030
		Unidentified	D	30	0.30	0.040
	Trichobranchidae	Terebellides stroemi	C	10	< 0.01	M
Fragments and Nematodes			A	present	0.30	0.090
			B	present	1.10	0.310
			C	present	1.30	0.370
			D	present	1.00	0.260
			E		0.26	0.086
PHYLUM:	ARTHROPODA					
Class:	Malacostraca					
Order:	Amphipoda					
Family:	Ampeliscidae	Byblis gaimardi	A	80	0.40	0.110
			B	330	0.40	0.050
			C	170	1.00	0.160
			D	80	0.10	< 0.001
			E	72	0.40	0.090
	Atylidae	Atylus carnatus	D	20	2.80	0.600
	Caprellidae	Caprella sp.	D	60	< 0.01	
		Tritella sp.	A	60	< 0.01	
			B	40	0.10	< 0.10
			D	40	< 0.01	
			E	2	< 0.01	
	Corophiidae	Erichthonius hunteri	A	20	0.10	< 0.001
			B	60	< 0.01	
			C	80	0.10	< 0.001
			D	180	0.30	< 0.001
			E	14	0.10	< 0.001
	Gammaridae	Melita dentata	A	40	0.10	< 0.001
			B	30	0.10	< 0.001
			C	20	0.10	< 0.001
			D	10	< 0.01	
			E	4	< 0.01	
	Isaeidae	Photis sp.	E	2	< 0.01	
		Unidentified	A	10	< 0.01	
			D	20	< 0.01	
			E	6	< 0.01	
	Ischyroceridae	Ischyrocerus megacheir	A	140	0.10	< 0.001
			B	170	0.10	< 0.001
			C	90	< 0.01	
			D	320	0.10	< 0.001
			E	32	< 0.01	

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	ARTHROPODA					
Class:	Malacostraca					
Order:	Amphipoda					
Family:	Lysianassidae	Anonyx nugax	C	10	< 0.01	
		Boeckosimus plautus	B	10	0.10	< 0.001
			E	6	0.06	0.002
		Boeckosimus sp.	A	10	< 0.01	
			C	10	< 0.01	
		Orchomene amblyops	B	150	0.20	< 0.001
			C	40	0.10	< 0.001
			D	40	0.10	< 0.001
			E	24	0.08	0.002
		Orchomene sp.	A	100	0.10	< 0.001
			B	210	< 0.01	
			C	70	< 0.01	
			D	90	< 0.01	
			E	12	0.10	< 0.001
	Oedicerotidae	Acanthostepheia behringiensis	E	2	0.10	< 0.001
		Aceroides latipes	E	2	< 0.01	
		Bathymedon sp.	A	60	< 0.01	
			B	10	< 0.01	
			E	8	0.10	< 0.001
		Monoculodes longirostris	A	20	< 0.01	
			B	10	< 0.01	
			C	30	0.10	< 0.001
			E	30	0.10	< 0.001
		Monoculodes sp.	A	10	< 0.01	
			D	40	< 0.01	
			E	10	< 0.01	
		Monoculopsis longicornis	B	50	< 0.01	
			C	30	< 0.01	
			D	20	< 0.01	
		Paroediceros lynceus	A	10	< 0.01	
			B	30	0.10	< 0.001
			C	10	< 0.01	
			E	2	0.10	< 0.001
	Paramphithoidae	Paramphithoe sp. 2	A	20	< 0.01	M
			E	6	0.10	< 0.001
		Stenopleustes sp.	C	60	0.10	M
			E	2	< 0.01	
	Podoceridae	Paradulichia typia	A	40	0.1	< 0.001
			B	10	< 0.01	
			E	2	< 0.01	
	Stenothoidae	Metopa sp.	A	20	< 0.01	
			B	30	< 0.01	
			D	30	< 0.01	
Order:	Cumacea					
Family:	Diastylidae	Brachydiastylis resima	B	10	< 0.01	
			C	30	< 0.01	
			D	130	0.10	< 0.001
			E	12	0.10	< 0.001
		Diastylis edwardsi	A	40	< 0.01	
			B	20	0.40	0.030
			C	10	0.10	< 0.001
			E	32	0.10	< 0.001
		Diastylis oxyrhyncha	A	40	0.10	< 0.001
			B	90	< 0.01	
			C	70	0.10	< 0.001
			D	40	0.30	0.100
			E	22	0.12	0.014
	Leuconidae	Leucon nasica	A	30	< 0.01	
			B	50	< 0.01	
			C	10	< 0.01	
			D	20	< 0.01	
			E	6	< 0.01	

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	**ARTHROPODA**					
Class:	Malacostraca					
Order:	Cumacea					
Family:	Nannastacidae	Campylaspis costata	D	10	< 0.01	
			E	2	< 0.01	
Order:	Isopoda					
Family:	Idoteidae	Mesidotea sp.	D	10	0.20	< 0.001
		Synidotea bicuspida	B	10	< 0.01	
			C	20	1.30	0.360
			D	10	0.10	< 0.001
			E	26	0.22	0.070
	Jaeropsidae	Jaeropsis sp.	B	20	< 0.01	
			C	20	< 0.01	
			D	20	< 0.01	
			E	4	< 0.01	
	Munnidae	Munna sp.	A	60	< 0.01	
			B	90	< 0.01	
			C	110	< 0.01	
			D	100	< 0.01	
		Pleurogonium spinosissmum	B	10	< 0.01	
			C	10	< 0.01	
			D	60	< 0.01	
			E	2	< 0.01	
Order:	Tanaidacea	Leptognathia gracilis	A	40	< 0.01	
			B	160	< 0.01	
			C	330	< 0.01	
			D	150	< 0.01	
			E	26	< 0.01	
Class:	Ostracoda		A	20	< 0.01	
			B	30	< 0.01	
			D	60	< 0.01	
Fragments:			A	present	< 0.01	
			B	present	< 0.01	
			C	present	< 0.01	
			D	present	< 0.01	
			E	present	< 0.01	
PHYLUM:	**CHORDATA**[2]					
Class:	Ascidiacea		A	10	< 0.01	M
			B	110	5.40	2.250
			C	150	5.90	M
			D	170	2.60	1.620
			E	60	2.06	1.154
PHYLUM:	**CNIDARIA**[2]					
Class:	Anthozoa					
Order:	Actiniaria		A	20	0.50	M
			B	270	25.80	M
			C	20	< 0.01	M
			D	120	12.70	M
			E	40	0.74	M
Order:	Alcyonacea					
Family:	Nephtyidae	Gersemia sp.	A	present	0.30	M
			B	present	7.30	M
			C	present	0.10	< 0.001
			D	present	1.70	M

2 Some sub-samples of grabs A&C were inadvertently mixed together. These results were not included in the population densities or biomass. The data for these samples are found after the station volumes.

STATION: HERSCHEL ISLAND
D-82-2

SEPTEMBER, 1982

		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
Class:	Hydrozoa					
Family:	Bougainvillidae	Perigonimus sp.	B	present		
	Campanulariidae	Obelia longissima	B	present		
			D	present		
	Campanulinidae	Lafoeina maxima	B	present		
			D	present		
			E	present		
	Lafoeidae		B	present		
	Sertulariidae	Abietinaria sp.	B	present		
	Unidentified hydroid sp. 1		B	present		
			D	present		
			E	present		
PHYLUM:	ECHINODERMATA					
Class:	Holothuroidea		B	present	< 0.01	M
Class:	Stelleroidea					
Subclass:	Asteroidea					
Family:	Asteriidae	Leptasterias polaris	C	10	7.30	M
Subclass:	Ophuiroidea	Stegophiura sp. 1	B	40	0.30	
			E	4	0.02	
		Juvenile	E	2	< 0.01	
PHYLUM:	ECTOPROCTA					
Class:	Gymnolaemata					
Order:	Cheilostomata					
Suborder:	Anasca					
Family:	Flustridae	Carbasea carbasea	B	present		
	Scrupariidae	Eucratea loricata	B	present		
			D	present		
			E	present		
	Scrupocellariidae	Scrupocellaria sp.	B	present		
			D	present		
			E	present		
Suborder:	Ascophora	Unidentified sp. 1	D	present		
		Unidentified sp. 2	D	present		
Order:	Ctenostomata					
Family:	Alcyonidiidae	Alcyonidium sp.	B	present		
Order:	Cyclostomata					
Family:	Crisiidae	Crisia sp.	B	present		
			D	present		

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	MOLLUSCA					
Class:	Gastropoda					
Subclass:	Opisthobranchia					
Order:	Thecosomata		C	10	< 0.01	
			D	10	< 0.01	
			E	2	< 0.01	
Subclass:	Prosobranchia					
Family:	Cancellariidae	Admete couthouyi	C	10	0.70	M
	Cylichnidae	Scaphander punctostriatus	E	2	0.02	< 0.001
	Diaphanidae	Diaphana minuta	B	10	0.10	M
			E	2	< 0.01	
	Naticidae	Lunatica pallida	B	90	< 0.01	
			C	10	26.00	M
			E	2	< 0.01	
	Retusidae	Retusa obtusa	A	190	0.30	0.040
			B	240	0.20	0.010
			C	170	0.20	0.010
			D	160	0.20	0.010
			E	38	0.10	0.008
	Trochidae	Solariella obscura	A	10	< 0.01	
			B	30	< 0.01	
			C	20	0.10	< 0.001
			E	18	0.30	0.040
		Oenopota turricula	A	30	0.20	
			D	20	0.10	
			E	14	0.04	< 0.001
		Oenopota sp.	C	20	< 0.01	
	Turritellidae	Tachyrhynchus reticulatus	A	40	0.60	
			B	10	< 0.01	
			C	20	0.50	M
			D	10	< 0.01	
	Juvenile		A	50	< 0.01	
	Unidentified		D	40	< 0.01	
Class:	Pelecypoda					
Family:	Astartidae	Astarte montagui	C	10	1.60	0.110
			D	10	0.10	< 0.001
	Cardiidae	Clinocardium ciliatum	A	10	3.30	0.240
			C	10	0.20	< 0.001
		Serripes groenlandicus	E	2	0.02	< 0.001
	Hiatellidae	Hiatella arctica	A	10	< 0.01	
			C	10	< 0.01	
	Lyonsiidae	Lyonsia arenosa	B	10	< 0.01	
			E	2	0.02	< 0.001
	Nuculanidae	Nuculana pernula	D	10	0.10	< 0.001
			E	18	0.18	M
		Portlandia arctica	E	2	< 0.01	
		Portlandia sp.	A	10	< 0.01	
			E	2	< 0.01	
	Pectinidae	Delectopecten greenlandicus	E	4	0.02	< 0.001
	Tellinidae	Macoma crassula	A	170	5.80	M
			B	190	6.70	0.700
			C	150	4.80	0.490
			D	130	7.50	0.840
			E	180	1.54	0.200
	Thraciidae	Thracia devexa	E	2	< 0.01	
		Thracia sp.	C	10	< 0.01	
	Veneridae	Liocyma fluctuosa	A	40	< 0.01	
			B	120	0.20	0.010
			C	70	0.10	< 0.001
			D	50	0.10	< 0.001
			E	70	0.48	0.040
	Unidentified		A	170	< 0.01	
			C	150	< 0.01	
			D	160	< 0.01	
			E	2	< 0.01	

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	Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM: NEMERTEA		A	10	0.10	< 0.001
		B	40	0.10	< 0.001
		C	110	0.10	< 0.001
		D	110	0.10	< 0.001
		E	22	2.40	0.420
PHYLUM: PORIFERA					
Class: Demospongia		E	present		
PHYLUM: PROTOZOA					
Class: Sarcodina		A	present		
Order: Foraminifera		B	present		
Family: Elphidiidae	Elphidium sp.	D	present		
Fisherinidae	Cornuspira foliacea	A-E	present		
Miliolidae	Quinqueloculina seminulum	A	present		
		C	present		
		E	present		
PHYLUM: SIPUNCULA		A	30	< 0.01	
		B	10	< 0.01	
		C	60	< 0.01	
		D	40	0.10	< 0.001
		E	14	0.06	0.010
Unknowns		A	30	0.10	M
		B	20	< 0.01	M
		D	40	0.20	M
STATION TOTAL		A	4,380	13.2	0.59
		B	7,520	52.7	3.94
		C	11,450	54.0	1.89
		D	6,210	34.1	3.88
		E	3,608	11.9	2.33
STATION VOLUME (Litres)		A	2.0		
		B	2.5		
		C	2.5		
		D	1.5		

RESULT OF D-82-2A AND D-82-2C COMBINED

	Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM: CHORDATA					
Subphylum: Urochordata					
Class: Ascidiacea		A & C^2	150	5.00	M
PHYLUM: CNIDARIA					
Class: Anthozoa					
Order: Actiniaria		A & C^2	340	34.30	M
Order: Alcyonacea					
Family: Nephtyidae	Gersemia sp.	A & C^2	present	97.10	M
Unknowns		A & C^2	30	1.10	M

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	**ANNELIDA**					
Class:	Polychaeta					
Family:	Ampharetidae	Ampharete acutifrons	E	2	< 0.01	
		Ampharete sp.	C	10	0.10	0.040
			E	8	0.10	
		Melinnampharete sp.	E	2	< 0.01	M
	Capitellidae	Capitella capitata	A	20	< 0.01	
			B	100	< 0.01	
	Cirratulidae	Chaetozone spinosa	B	10	< 0.01	
		Chaetozone sp.	C	20	< 0.01	
	Cossuridae	Cossura sp.	C	10	< 0.01	
	Hesionidae	Castalia aphroditoides	C	150	0.20	M
			D	60	< 0.01	M
			E	26	0.02	< 0.001
		Unidentified sp. 1	B	10	< 0.01	
			C	10	< 0.01	M
			D	10	< 0.01	M
			E	2	< 0.01	M
	Lumbrineridae	Lumbrineridae sp.	E	2	0.02	< 0.001
	Orbiniidae	Leitoscoloplos pugettensis	B	10	0.50	0.120
	Phyllodocidae	Eteone sp.	A	10	< 0.01	
			B	10	< 0.01	
		Phyllodoce groenlandica	A	10	< 0.01	
	Sabellidae	Chone sp.	C	140	0.10	< 0.001
			D	10	< 0.01	
			E	18	< 0.01	
		Euchone analis	C	10	< 0.01	M
	Serpulidae		E	2	< 0.01	M
	Sigalionidae	Pholoe sp.	A	10	< 0.01	
			E	14	< 0.01	
	Spionidae	Dispio sp.	C	60	0.20	< 0.001
			D	30	0.10	< 0.001
		Polydora quadrilobata	E	24	< 0.01	M
	Syllidae	Autolytus sp.	C	50	< 0.01	
			E	2	< 0.01	
		Exogone gemmifera	E	2	< 0.01	
		Exogone tatarica	E	2	< 0.01	
		Exogone sp.	B	10	< 0.01	M
			C	20	< 0.01	
	Terebellidae		E	2	< 0.01	
	Fragments and Nematodes		A	present	< 0.01	
			B	present	< 0.01	
			C	present	0.10	< 0.001
			D	present	< 0.01	
			E	present	0.08	0.024
PHYLUM:	**ARTHROPODA**					
Class:	Cirrepedia					
Order:	Thoracica					
Family:	Balanidae	Balanus sp.	E	64	0.68	0.392
Class:	Malacostraca					
Order:	Amphipoda					
Family:	Calliopiidae	Apherusa sp.	C	30	0.10	< 0.001
			D	40	0.10	< 0.001
			E	6	< 0.01	
	Caprellidae	Caprella sp.	E	2	< 0.01	
		Tritella sp.	E	6	< 0.01	
	Gammaridae	Melita dentata	E	10	0.04	< 0.001
	Isaeidae		A	110	0.20	0.010
			B	30	0.10	< 0.001
			E	20	0.06	0.002
	Ischyroceridae	Ischyrocerus megacheir	E	10	< 0.01	
	Lysianassidae	Anonyx nugax	E	2	2.26	0.608
		Boeckosimus edwardsi	B	20	0.30	0.060
			E	4	0.12	0.022
	Oedicerotidae	Paroediceros lynceus	E	86	0.34	0.056
	Podoceridae	Paradulichia typica	E	2	< 0.01	
	Stenothoidae	Metopa sp.	C	20	< 0.01	
			E	2	< 0.01	

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		Genus Species	Grab	Number/m²	Wet Biomass (g/m²)	Dry Biomass (g/m²)
PHYLUM:	ARTHROPODA					
Class:	Malacostraca					
Order:	Cumacea					
Family:	Diastylidae	Brachydiastylis resima	E	4	< 0.01	
		Diastylis oxyrhyncha	A	30	0.10	< 0.001
			B	30	0.10	< 0.001
			E	12	0.10	0.016
	Leuconidae	Leucon nasicoides	E	2	< 0.01	
Order:	Tanaidacea	Leptognathia gracilis	B	20	< 0.01	
			E	12	< 0.01	
Class:	Ostracoda		A	10	< 0.01	
			B	30	< 0.01	
Class:	Pycnogonida					
Family:	Nymphonidae	Nymphon sp.	E	2	< 0.01	
	Fragments		A	present	< 0.01	
			B	present	< 0.01	
			E	present	0.01	
PHYLUM:	CHORDATA					
Class:	Osteichthyes					
Family:	Cottidae		E	2	0.40	0.086
PHYLUM:	CNIDARIA					
Class:	Anthozoa					
Order:	Actiniaria		E	2	< 0.01	M
Class:	Hydrozoa					
Family:	Bougainvillidae	Perigonimus sp.	E	present		
	Campanulariidae	Campanularia sp.	E	present		
		Obelia sp.	D	present		
			E	present		
		Fragment	B	present		
	Campanulinidae	Lafoeina maxima	B	present		
			C	present		
			D	present		
			E	present		
	Eudendriidae	Eudendrium sp.	E	present		
	Sertulariidae	Sertularia sp.	E	present		
PHYLUM:	ECHINODERMATA					
Class:	Holothuroidea		E	10	< 0.01	M
Class:	Stelleroidea					
Subclass:	Ophiuroidea					
Family:	Ophiolepididae	Ophiura sarsi	E	10	0.12	M
	Juvenile		E	4	< 0.01	M
PHYLUM:	ECTOPROCTA					
Class:	Gymnolaemata					
Order:	Cheilostomata					
Suborder:	Anasca					
Family:	Scrupariidae	Eucratea loricata	D	present		
			E	present		
Suborder:	Ascophora		E	present		
	Unidentified sp. 2		E	present		
Order:	Cyclostomata					
Family:	Crisiidae	Crisia sp.	E	present		

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	MOLLUSCA					
Class:	Gastropoda					
Subclass:	Prosobranchia					
Family:	Buccinidae	Volutropsius sp. 1	E	14	0.02	< 0.001
	Retusidae	Retusa obtusa	E	4	< 0.01	
	Turridae	Oenopota arctica	E	4	0.04	< 0.001
Class:	Pelecypoda					
Family:	Hiatellidae	Hiatella arctica	E	10	0.26	0.014
	Pectinidae	Delectopecten greenlandicus	E	6	0.04	< 0.001
	Tellinidae	Macoma crassula	E	4	< 0.01	
	Thraciidae	Thracia devexa	E	2	< 0.01	
	Veneridae	Liocyma fluctuosa	E	4	< 0.01	
PHYLUM:	NEMERTEA		E	8	0.10	< 0.001
PHYLUM:	PROTOZOA					
Class:	Sarcodina					
Order:	Foraminifera					
Family:	Elphidiidae	Elphidium arcticum	B	present		
			E	present		
		Elphidium sp. 1	B	present		
			E	present		
	Fisherinidae	Cornuspira foliacea	A	present		
			B	present		
			E	present		
	Nodsariidae	Dentalina pauperata	B	present		
STATION TOTAL			A	200	0.3	0.01
			B	380	1.0	0.18
			C	530	0.8	0.04
			D	150	0.2	-
			E	438	4.8	1.22
STATION VOLUME (Litres)			A	8.0		
			B	7.0		
			C	2.0		
			D	3.0		

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		Genus Species	Grab	Number/m²	Wet Biomass (g/m²)	Dry Biomass (g/m²)
PHYLUM:	ANNELIDA					
Class:	Polychaeta					
Family:	Ampharetidae	Ampharete acutifrons	D	10	0.10	< 0.001
			E	10	0.10	< 0.001
		Ampharete sp.	C	30	< 0.01	
			D	140	0.20	0.030
			E	4	< 0.01	
		Melinna elisabethae	D	10	< 0.01	M
		Fragments	A		< 0.01	
	Amphictenidae (Pectinariidae)				< 0.01	
		Pectinaria hyperborea	D	10	0.60	M
	Capitellidae	Capitella capitata	B	10	< 0.01	
			C	20	< 0.01	
			D	10	< 0.01	
		Heteromastus sp.	D	10	0.10	M
	Cirratulidae	Chaetozone spinosua	C	10	0.10	< 0.001
			D	20	< 0.01	
	Cossuridae	Cossura sp.	D	10	< 0.01	
	Hesionidae	Castalia aphroditoides	B	20	< 0.01	
			C	40	< 0.01	
			E	16	0.02	< 0.001
	Maldanidae	Fragments	C	10	< 0.01	
			D	10	< 0.01	
	Nephtyidae	Nephtys cornuta	E	2	< 0.01	
	Nereidae	Nereis zonata	C	10	0.10	M
	Orbiniidae	Leitoscoloplos panamensis	B	10	0.30	0.060
			D	10	1.10	0.220
	Phyllodocidae	Eteone sp.	A	10	< 0.01	
			C	10	< 0.01	
		Phyllodoce groenlandica	C	20	< 0.01	
			E	2	0.10	M
	Polynoidae	Antinoella sarsi	E	2	< 0.01	
		Hesperonoe sp.	C	10	< 0.01	M
	Sabellidae	Chone sp.	C	30	< 0.01	
			D	10	< 0.01	
			E	2	< 0.01	
		Unidentified	D	10	< 0.01	
	Serpulidae		C	10	< 0.01	M
	Sigalionidae	Pholoe sp.	B	20	< 0.01	
			C	10	< 0.01	
			D	20	< 0.01	
			E	2	< 0.01	
	Spionidae	Polydora quadrilobata	A	10	< 0.01	
			E	4	< 0.01	
	Syllidae		C	10	< 0.01	
	Terebellidae	Streblosoma sp.	B	10	< 0.01	M
			E	2	< 0.01	M
	Fragments and Nematodes		A	present	< 0.01	
			B	present	< 0.01	
			C	present	0.10	< 0.001
			D	present	0.50	0.140
			E	present	< 0.01	
PHYLUM:	ARTHROPODA					
Class:	Cirripedia					
Order:	Thoracica					
Family:	Balanidae	Balanus sp.	C	1270	11.60	5.760
			D	350	1.40	0.690

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	ARTHROPODA					
Class:	Malacostraca					
Order:	Amphipoda					
Family:	Ampeliscidae	Byblis sp.	E	2	< 0.01	
	Atylidae	Atylus carinatus	B	10	< 0.01	
	Caprellidae	Tritella sp.	E	2	< 0.01	
	Gammaridae	Melita dentata	C	10	< 0.01	
	Isaeidae	Protomedia sp.	B	30	< 0.01	
			C	120	0.20	0.010
			D	30	< 0.01	
		Unidentified	A	10	0.10	< 0.001
	Ischyroceride	Ischyrocerus megacheir	E	2	< 0.01	
	Lysianassidae	Boeckosimus sp.	C	50	< 0.01	
			E	2	< 0.01	
		Orchomene sp.	A	10	< 0.01	
			B	10	< 0.01	
			D	30	< 0.01	
			E	2	< 0.01	
	Oedicerotidae	Monoculodes longirostris	E	6	0.10	0.010
		Monoculodes sp.	C	10	< 0.01	
			E	2	< 0.01	
		Paroediceros lynceus	D	10	< 0.01	
			E	2	0.04	0.002
		Unidentified	B	10	< 0.01	
	Podoceridae	Paradulichia typica	E	4	< 0.01	
Order:	Cumacea					
Family:	Diastylidae	Brachydiastylis resima	B	40	< 0.01	
			D	10	< 0.01	
		Diastylis edwardsi	D	10	0.10	< 0.001
			E	4	< 0.01	
		Diastylis oxyrhyncha	A	10	0.30	0.030
			D	20	0.10	< 0.001
			E	10	0.02	< 0.001
		Diastylis sp.	B	10	< 0.01	
	Leuconidae	Leucon nasica	B	10	< 0.01	
			D	10	< 0.01	
Order:	Isopoda					
Family:	Gnathidae	Gnathia stygia	C	10	< 0.01	M
	Idoteidae	Mesidotea sibirica	E	20	0.18	0.074
Order:	Mysidacea		E	8	0.06	0.010
Order:	Tanaidacea	Leptognathia gracilis	C	30	< 0.01	
			D	40	< 0.01	
Class:	Ostracoda		B	40	< 0.01	
			C	10	< 0.01	
			D	30	< 0.01	
Fragments			B	present	< 0.01	
			C	present	< 0.01	
			D	present	< 0.01	
			E	present	< 0.01	
PHYLUM:	CHORDATA					
Class:	Osteichthyes					
Family:	Liparidae		D	10	0.90	0.170
Class:	Ascidiacea		D	10	< 0.01	M
			E	2	< 0.01	M

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		Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM:	CNIDARIA					
Class:	Anthozoa					
Order:	Actiniaria		B	10	0.40	M
			C	10	0.40	M
			D	20	12.90	M
Order:	Alcyonacea					
Family:	Nephtyidae	Gersemia sp.	B	present		
			E	present		
Class:	Hydrozoa					
Family:	Campanulinidae	Lafoeina maxima	D	present		
			E	present		
	Sertulariidae	Abietinaria sp.	E	present		
PHYLUM:	ECHINODERMATA					
Class:	Stelleroidea					
Subclass:	Ophiuroidea					
Family:	Ophiolepididae	Ophiura sarsi	C	10	< 0.01	
			E	4	< 0.01	
PHYLUM:	ECTOPROCTA					
Class:	Gymnolaemata					
Order:	Cheilostomata					
Suborder:	Anasca					
Family:	Scrupariidae	Eucratea loricata	D	present		
	Unidentified sp. 1		D	present		
Suborder:	Ascophora					
	Unidentified sp. 1		D	present		
	Unidentified sp. 2		C	present		
	Unidentified sp. 3		C	present		
PHYLUM:	MOLLUSCA					
Class:	Gastropoda					
Subclass:	Prosobranchia					
Family:	Buccinidae	Volutropsius sp. 1	E	2	< 0.01	M
	Retusidae	Retusa obtusa	D	20	< 0.01	
			E	4	< 0.01	
	Trichotropidae	Trichotropis borealis	E	2	0.02	< 0.001
	Trochidae	Sollariella obscura	E	2	< 0.01	
	Turritellidae	Oenopota arctica	B	20	0.60	0.030
Class:	Pelecypoda					
Family:	Astartidae	Astarte sp.	D	10	< 0.01	
	Nuculanidae	Portlandia arctica	B	10	< 0.01	
			C	10	< 0.01	
			E	2	< 0.01	
	Pectinidae	Delectopecten greenlandicus	E	8	0.04	< 0.001
	Tellinidae	Macoma calcarea	D	10	< 0.01	
		Macoma crassula	E	4	0.08	0.004
		Macoma sp.	C	10	< 0.01	
	Unidentified		D	20	< 0.01	

STATION: HERSCHEL ISLAND
D-82-8

SEPTEMBER, 1982

	Genus Species	Grab	Number/m^2	Wet Biomass (g/m^2)	Dry Biomass (g/m^2)
PHYLUM: NEMERTEA		C	30	< 0.01	
		D	10	< 0.01	
PHYLUM: PROTOZOA					
Class: Sarcodina					
Order: Foraminifera					
Family: Elphiididae	Elphidium sp. 1	A-E	present		
Fisherinidae	Cornuspira foliacea	A-E	present		
Miliolidae	Quinqueloculina seminulum	B,D	present		
Nodosariidae	Dentalina baggi	A,D	present		
	Dentalina pauperata	B-E	present		
	Dentalina sp.	D	present		
STATION TOTAL		A	50	0.4	0.03
		B	290	1.3	0.09
		C	1800	12.5	5.77
		D	930	18.0	1.25
		E	138	0.8	0.10
STATION VOLUME (Litres)		A	11.5		
		B	3.5		
		C	6.0		
		D	12.0		

APPENDIX B.

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APPENDIX C.1

METHODS USED FOR COMMUNITY ANALYSIS

APPENDIX C.2

BENTHIC COMMUNITY ASSOCIATIONS

APPENDIX C1. Methods used for Community Analysis

The descriptions provided here are based on Hill (1973), Gauch (1977), Gauch et al. (1977), Greenacre and Degos (1977), Greenacre (1978) and cited references.

(a) Ordination

In ecology, ordination is used to arrange samples (or species) in relation to axes that correspond to either environmental gradients or other variables which have ecological meaning. The method is designed to express the observations in terms of as few variables as possible while still maintaining the integrity of the data. Specifically, ordination of a data set of n observations (samples) and variables (e.g., species abundance) transforms the data set into a matrix which preserves the information of the original number of variables. That is, the reduction in the number of variables is achieved in a way that minimizes the loss of information caused by the reduction.

Reciprocal averaging (RA) may be described as a weighed-average ordination obtained by successive approximations which reveal correspondences between two types of information, such as species and samples (Hill, 1973; Gauch et al., 1977). According to the "direct iteration" procedure as presented by Hill (reproduced here as part of Appendix C.1), species are weighted by positions along a proposed initial gradient and the weights are used to compute sample scores. These sample scores as weights are then used to derive a new and better calibration of the species. In return, the new species weights are used to improve the precision of the sample scores and so on. Consequently, the iterative calculations converge to a stable, optimal solution that does not depend on the initial arrangement. The process is called 'reciprocal averaging' because the species-scores are averages of the sample-scores and reciprocally the sample-scores are averages of the species-scores. It follows that, for reciprocal averaging species ordinations and sample ordinations come in dual pairs, neither of which has logical dominance (Hill, 1973). Gauch et al. (1977) compared the effectiveness of RA, principal components analysis (PCA) and polar ordination (PO) under a wide range of data set conditions. They concluded that RA is a preferred method for indirect ordination (based on species distributions alone) for revealing first, major direction of sample variation in response to environment. The method is heuristic and its results can be useful in forming hypotheses about the distribution and abundance of organisms in relation to environmental variables.

The relative advantages of RA and PCA have also been discussed by Tuxen (1973).

Examples of the use of ordination in benthic analysis are presented in Cassie and Michael (1968), Lie and Kelley (1970), Hughes and Thomas (1971a and b), and Conlan and Ellis (1979).

A worked example of ordination by reciprocal averaging (reproduced verbatim from Hill, 1973; for additional information consult Hill)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(R)	(1)	(2)	(2a)	(3)
(i)	1	0	0	1	1	0	0	1	4	100	52.5	55	44.3
(ii)	0	1	1	0	0	1	0	1	4	0	37.5	0	36.2
(iii)	1	1	0	0	0	1	1	0	4	100	65.0	100	63.4
(iv)	1	1	1	1	1	0	0	1	6	0	43.3	21	39.3
(v)	1	1	0	1	0	0	0	1	4	100	56.7	70	47.2
(vi)	1	0	0	0	1	0	0	0	2	0	46.7	33	46.0
(C)	5	4	2	3	3	2	1	4	24				
(1)	60.0	50.0	0.0	66.7	33.3	50.0	100.0	50.0					
(2)	55.8	47.8	10.5	48.7	36.3	50.0	100.0	36.5					
....	....	....	....	....	....	....	....	....					
(11)	31.8	50.5	48.4	19.7	10.0	86.0	100.0	32.7					
(11a)	24	52	42	11	0	8.4	100	25					

The calculations are represented schematically in the foregoing table. The data-matrix is given in the top left-hand corner, and (R) and (C) are the row (species) and column (stand) totals respectively. Column (1) is an arbitrarily chosen set of starting scores. In practice these should be chosen to reflect what is suspected of being the main gradient. A good choice will much reduce the amount of calculation required.

Row (1) is derived from column (1) by averaging. Thus the entry in row (1) column (v) is 33.3, being the average of 100, 0 and 0, which are the scores in column (1) corresponding to the non-zero entries of column (v). Column (2) is defined similarly. Thus the entry in column (2) row (i) is the average of 60.0, 66.7, 33.3 and 50.0 - these being the scores in row (1) corresponding to the non-zero entries of row (i). Column (2a) is derived from column (2) by rescaling, and is given by the formula:

$$\text{column (2a)} = 100 \times (\text{column (2)} - 37.5)/27.5.$$

This ensures that the range of column (2a) is 0 to 100, since 27.5 is the range of column (2) and 37.5 is its minimum value. By continuing in this manner, the following sequence of species (row) scores is obtained.

(1)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(8a)	(9a)	(10a)	(11a)	(12a)	(12)
100	55	30	8	0	0	0	2	3	4	5	5	23.5
0	0	0	6	23	40	52	60	66	70	72	73	55.9
100	100	100	100	100	100	100	100	100	100	100	100	68.6
0	21	11	0	3	10	14	18	21	23	25	26	33.2
100	70	40	18	12	16	19	24	26	28	29	30	35.1
0	33	36	26	16	10	5	0	0	0	0	0	20.9

It takes eleven iterations to reach stability of the scores, but this is the result of making a bad initial choice. Three or four iterations should normally suffice if a good initial choice is made. The final stand (column) scores are derived by rescaling row (11) to form row (11a) as indicated in the original table. The eigenvalue (latent root) corresponding to the first axis is a measure of how much the range of the scores contracts in one iteration. The range of column (12) (shown after column (12a)) is 47.7, and it is derived from column (11a) which has a range of 100. Hence the estimate of the eigenvalue is 0.477. These calculations should be done with the data on one piece of quadrille paper and the scores on another, matching the two side by side.

When the first axis has been obtained, the second is considered. A good starting point for the scores of the second axis is obtained by using a set of scores which were fairly near to the final ones for the first axis. In this case column (8a) is used. Before iteration, these scores have to be adjusted by subtracting a multiple of the final first axis. This multiple is estimated as follows.

z	R	Rz	$R\bar{z}$	x	y	(13)	(13a)	(14a)	(15a)
5	4	20	165	- 145	2	- 3.0	71	62	59
73	4	292	165	127	60	- 12.4	0	0	0
100	4	400	165	235	100	0.8	100	94	89
26	6	156	247	- 91	18	- 7.8	35	34	33
30	4	120	165	- 45	24	- 5.8	50	45	41
0	2	0	82	- 82	0	0 94	100	100	
	24	988		- 1					

The column z is the first axis; R is the row totals and y is the set of scores to be adjusted (in this case equal to column (8a)). Multiply R by z to form Rz. Form $\bar{z}$ a weighted mean value of z by taking $\bar{z} = \Sigma Rz / \Sigma R$.

In this case,

$$\bar{z} = 988/24 = 41.17.$$

Form a column $R\bar{z}$ by multiplying R by $\bar{z}$; then subtract $R\bar{z}$ to derive $x = Rz - R\bar{z}$. (A check at this point is that, apart from round-off error, x should sum to zero.) The multiple of z to be subtracted from y is given by

$$\Sigma xy / \Sigma xz,$$

which in this case is 0.992. Column (13) is therefore y - 0.992z, and after rescaling to derive column (13a) the iterations are continued in the usual way. The first axis will slowly re-establish itself if the appropriate multiple of z (i.e., $\Sigma xy' / \Sigma xz$) is not at intervals subtracted from subsequent scores y'; but this need not be done very often. The column (15a) derived after two iterations from (13a) has not been further corrected for the first axis, but it may nonetheless be taken as a reasonable estimate of the second. The estimate of the second eigenvalue, derived from column (15) (not shown), is 0.305.

These calculations are rather laborious. They would be worth the trouble if a good ordination were required in the absence of a computer.

(b) Correspondence Analysis

A detailed description of correspondence analysis was initially presented by Benzecri (1973) and an outline of the method was given by Teil (1975). Several demonstrations of the origin of the correspondence analysis problem have been presented by Hill (1974). Greenacre (1978) has provided a description of correspondence analysis as an objective method of graphical display for summarizing, simplifying and explaining non-negative data in a matrix form.

Correspondence analysis is a descriptive statistical method related to multidimensional scaling and PCA (Greenacre and Degos, 1977). The aim of all of these procedures is to represent a data set by a number of points in multidimensional space to permit a visual interpretation of patterns in the data. If the data points are imagined to occupy a space of high dimension, then each method tries to identify a subspace of much lower dimension in which the structure of the data is meaningfully represented and which is not too out of character with its true high dimensional structure. There are two major ways in which correspondence analysis distinguishes itself from the other methods. First, it supplies a distance function which defines the relative positions of the points in the space of the observations (i.e., between rows and between columns) and secondly, it defines criteria that determine the "optimal" subspace, one which gives a realistic picture of the true structure. The distance function used in correspondence analysis is the chi-square (χ^2) distance or chi-square metric.

To further the following description of correspondence analysis which is based on Greenacre and Degos (1977), we consider our observations form a n x m matrix of positive numbers (k_{ij}). In our case, this matrix consists of species abundances (no. m^{-2}) such that k_{ij} is the abundance of species j in the sample i.

Samples figure as rows and species as column of the matrix. First, we transform this matrix so that the sum of all its entries is one:

for all i and j: $f_{ij} = k_{ij} / \sum_i \sum_j k_{ij}$

The row and column sums of the matrix (f_{ij}) are written as follows:

for each row $i = 1....n$: $r_i \equiv f_{i.} = \sum_{j=1}^{m} f_{ij}$,

and for each column $j = 1....m$: $c_j \equiv f_{.j} = \sum_{i=1}^{n} f_{ij}$.

The square of the χ^2-distance between two rows i and i' is defined as:

$$d_{ii'}^2 = \sum_{j=1}^{m} \frac{1}{c_j} \left(\frac{f_{ij}}{r_i} - \frac{f_{i'j}}{r_{i'}} \right)^2 \quad (1)$$

This may be expressed as the quadratic form:

$$d_{ii'}^2 = (p_i - p_{i'})^t D_c^{-1} (p_i - p_{i'}), \quad (2)$$

where p_i is the m x 1 vector of elements f_{ij}/r, $j = 1,...,m$ and D_c is the diagonal matrix of column sums c_j.

In a completely symmetric manner the square of the χ^2-distance between two columns j and j' is defined as:

$$d_{jj'}^2 = \sum_{i=1}^{n} \frac{1}{r_i} \left(\frac{f_{ij}}{c_j} - \frac{f_{ij'}}{c_{j'}} \right)^2$$

$$= (q_j - q_{j'})^t D_r^{-1} (q_j - q_{j'}),$$

where q_j is the n x 1 vector of elements f_{ij}/c_j, $i = 1,....n$ and D_r is the diagonal matrix of row sums r_i.

Examining the χ^2 distance function **(2)** more closely, we note that, first, associated with each row i we have a m x 1 vector p_i which is the ith row of the maxtrix (f_{ij}) divided by its row sum r_i. We call p_i the <u>profile</u> of row i and r_i the <u>mass</u> of row i. Similarly the profile of column j, q_i, is the jth column of (f_{ij}) divided by its mass c_j. Therefore, the χ^2 distance between rows i and i' is a weighted sum of squares of the difference in profiles of the rows, where the weights are the inverse of the column sums (or masses). In parallel fashion, the χ^2 distance between columns j and j' is a weighted sum of squares of the difference in profiles of these columns, where the weights are the inverse of the row sums or masses. To generalize these definitions, we allow the row and column masses to be arbitrarily chosen. In this general setting, correspondence analysis is the special case when row and column masses are equal to the row and column sums, respectively. In comparison, PCA is the special case when all row and column masses are equal to one. The χ^2-distance under this condition reduces to the usual Euclidean distance defined between rows and between columns of the matrix (f_{ij}).

To proceed further in the description of correspondence analysis, we draw an analogy to certain concepts in mechanics, particularly the notions of the center of gravity and inertia. (The concept of mass has already been introduced.) Let us consider the rows (i). So far each of the n rows is represented as a point vector in a m-dimensional space. Interpoint distances are defined by the χ^2-distance of equation (1), and each point is assigned a certain mass r_i. As in mechanics, the center of gravity p of this cloud of points is defined as the weighted sum of the point vectors:

$$p = \sum_{i=1}^{n} r_i p_i$$

Substituting for p_i, the jth element of vector p is

$$\sum_{i=1}^{n} r_i \frac{f_{ij}}{r_i} = \sum_{i=1}^{n} f_{ij} = f_{.j} \equiv c_j.$$

Therefore the center of gravity p is the point vector of the column mass: p = c.

Again from mechanics we define the total inertial I of the cloud of points (understood, with respect to its center of gravity which becomes the new origin in space) as the weighted sum of squared distances of points from the center of gravity, the weights being the row masses:

$$I = \sum_{i=1}^{n} r_i(p_i - p)^t D_c^{-1}(p_i - p)$$

$$= \sum_{i=1}^{n} r_i \sum_{j=1}^{m} \frac{1}{c_j} \left(\frac{f_{ij}}{r_i} - c_j \right)^2$$

$$= \sum_{i=1}^{n} \sum_{j=1}^{m} \frac{(f_{ij} - r_i c_j)^2}{r_i c_j} \qquad (3)$$

The inertia can be considered as a measure of the dispersion of the points in space. Another interpretation of the total inertia is now clear: consider the matrix (f_{ij}) as a contingency table where the row and column sums are (r_i) and (c_j), respectively. The null hypothesis that row and column effects be independent is H_o: for all i and j $f_{ij} = r_i c_j$. The chi-square variate which tests this hypothesis is exactly the inertia defined in equation (3). The quantity I may be considered as a measure of the deviation in the data from this hypothesis.

Finally the inertia of the cloud of points along an axis u (or subspace S) is the total inertia of the orthogonal projections of these points onto the axis (or subspace). Here orthogonality is in the sense of the χ^2 metric.

Having defined the above concepts, a correspondence analysis may be defined as the identification of a subspace S along which the inertia is a maximum. The identification of the subspace S is carried out in much the same way as that of principal component axes (see Anderson 1958). A first axis through the origin (center of gravity) is defined as that axis along which the inertia is a maximum. The second axis is that one, among all axes orthogonal to the first one, along which the inertia is a maximum. And the third is chosen among all axes orthogonal to the first and second, etc. The idea is that we need only consider the subspace of the first few axes derived in this way, since this subspace reflects a sufficiently large percentage of the total inertia. In principal components analysis, where all the row and column masses are 1, the argument is identical, and the inertia reduces to the variance. Here total variance is systematically decomposed along a set of orthogonal axes, whereas in correspondence analysis it is the total inertia which is decomposed along the axes, termed the principal axes of inertia. Thus, it is the role of the masses which distinguishes correspondence analysis from principal components analysis. In both cases we are interested in the pattern of dispersion of points in space. Principal components analysis will indicate the axes of greatest spread purely from a point of view of relative distance, whereas the principal axes defined in correspondence analysis will be influenced both by the distances and the masses associated with the points.

The description above of correspondence analysis of the rows (i) holds in a similar and completely symmetric fashion for the analysis of the columns (j). The center of gravity of the points representing the columns is shown to be r, the vector of row sums (masses), and the total inertia of this cloud of points is identical to equation (3). (Note the symmetry of this formula in i and j.) This is the primary advantage of correspondence analysis - rows and columns are treated symmetrically. Intuitively we seem to have two separate problems; however, in correspondence analysis the solutions of both problems are linearly related so that one solution can be obtained from the other. To demonstrate this we simply mention the following relevant results.

First, the set of n points representing the rows in m-dimensional space and the set of m points representing the columns in n-dimensional space each occupy a subspace of dimension k which has its origin at the respective center of gravity of each set of points; where k is equal to the rank of the matrix of observation (f_{ij}) minus 1. (Hence if (f_{ij}) is of full rank, then $k = \min(n, m) - 1$.).

Second, in both of these subspaces the decomposition of inertia along the principal axes is identical. That is, suppose the total inertia I is decomposed along the k axes of the first subspace (subspace of rows) as follows:

$$I = \sum_{\alpha=1}^{k} \lambda_\alpha \text{ , where } \lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_k \geq 0$$

Then in the second subspace the inertia along the first principal axis is also λ_1, along the second λ_2, etc. The λ_α are termed the moments of inertia.

Third, suppose the coordinates of the points in the first subspace with respect to the principal axes are contained in a n x k matrix A (e.g., the ith row of A ($a_{i\alpha}$, $\alpha = 1,\ldots.k$) contains the coordinates of the point representing the ith row). Similary let B be the m x k matrix of coordinates of the points in the second subspace with respect to the k principal axes. Then the elements of A and B are linearly related as follows:

$$\text{for all} \quad i = 1,\ldots, n: a_{i\alpha} = \lambda_\alpha^{-\frac{1}{2}} \sum_{j=1}^{m} \left(\frac{f_{ij}}{r_i} \right) b_{j\alpha} \tag{4}$$

$$(\text{i.e., } A = D_r^{-1} F B D_\lambda^{-\frac{1}{2}});$$

$$\text{for all} \quad j = 1,\ldots, m: b_{j\alpha} = \lambda_\alpha^{-\frac{1}{2}} \sum_{i=1}^{n} \left(\frac{f_{ij}}{c_j} \right) a_{i\alpha} \tag{5}$$

$$(\text{i.e., } B = D_c^{-1} F^t A D_\lambda^{-\frac{1}{2}}).$$

where D_r and D_c are, as before, the diagonal matrices of row and column masses respectively. D_λ is the diagonal matrix of moments of inertia λ_α, and F is the n x m matrix (f_{ij}).

Because of the symmetry of these formulas, we are able to plot the points representing the rows and columns of the matrix F with respect to the same principal axes in one single subspace where the two origins are identified. Formula (4) states that the coordinates of the point i on axis α is, up to a constant of $\lambda_\alpha^{-\frac{1}{2}}$, at the center of gravity of the coordinates $(b_{j\alpha})$ weighted by the profile (f_{ij}/r_i). Thus a point i lies in the vicinity of those points j for which its profile values, f_{ij}/r_i, are high. A symmetric argument holds for formula (5). This result is an important characteristic of correspondence analyis.

Finally note that formulas (4) and (5) permit the addition a posteriori of new rows and columns to the graphical representation, termed supplementary elements. These are elements which for a certain reason we wish to include in the analysis without their contributing to the inertia and the calculation of the principal axes. They may be considered as points with zero mass.

In summary, therefore, the rows and columns of a data matrix (in our application, samples and species, respectively) are represented by two clouds of points in multidimensional space. The inertia of these clouds can be considered as a measure of dispersion or spread of these points, taking into account both their distances and their attributed masses. Correspondence analysis provides a visual interpretation of the relative positions of both these clouds in a common subspace of low dimension. A large percentage of the inertia is explained by this subspace which reflects the main directions of spread of these clouds.

APPENDIX C.2 Benthic Community Associations

Benthic Community Associations

A qualitative community analysis by the Zurich-Montpellier (Z-M) method on the 1981 Herschel Island benthic data (Heath et al. 1982a) suggested that there were recognizable groups of taxa or "communities" associated with sedimentary characteristics. This appendix presents the results of community analyses by reciprocal averaging ordination (RA) and correspondence analysis (CA) on the combined 1981 and 1982 faunal composition data, at the species level wherever practical. A comparison with the Z-M results described by Heath et al. (1982a) is also made.

The RA results indicated that 39.2% of the total variation among samples was accounted for by the first five axes. Of these the first two axes are most important and will be interpreted here. Gauch et al. (1977) have indicated from comparative studies of ordination techniques on known data sets that second and higher axes of RA should be interpreted with caution due to possible curvlinear relationships with lower axes. Thus, the principal emphasis is placed on interpretation of Axis 1 scores.

The ordination of sample scores (Figure C.2-1) shows a pronounced gradient of scores along Axis 1. Samples are generally grouped closely by station of origin. Samples with high Axis 1 scores (over 65) are from the reference stations, C82-2, D82-2, CS-1, CS-2, DS-2 and from the secondary dredging area stations, DS-3, DS-7, DS-8, DS-9, and D82-8. The three samples from D82-7 (50, 51, 54) taken while at anchor are also high on the Axis 1 gradient whereas the two samples (52, 53) taken while drifting over shallower areas of the gravel bar are ordinated much lower on Axis 1. Other samples at the low end of the gradient (0-50) are from July 1981 stations D-10, D-9, D-8, D-7, D-6, D-4 and D-3. The mid-section of the gradient (50-65) consists of samples from stations D-1, D-2, D-5, DS-2, DS-4, DS-5 and DS-10.

The samples along the gradient display no statistically significant pattern of distribution for the community variables of biomass or population density, possibly due to the "patchy" or "clumped" distribution of fauna within each sampling site.

A "least squares" linear regression analysis of Axis 1 sample scores on the silt-clay content of the benthic samples was highly significant ($r^2 = 0.60$, $n = 49$; $P < 0.01$) whereas the regression of the first axis scores on water depth was not

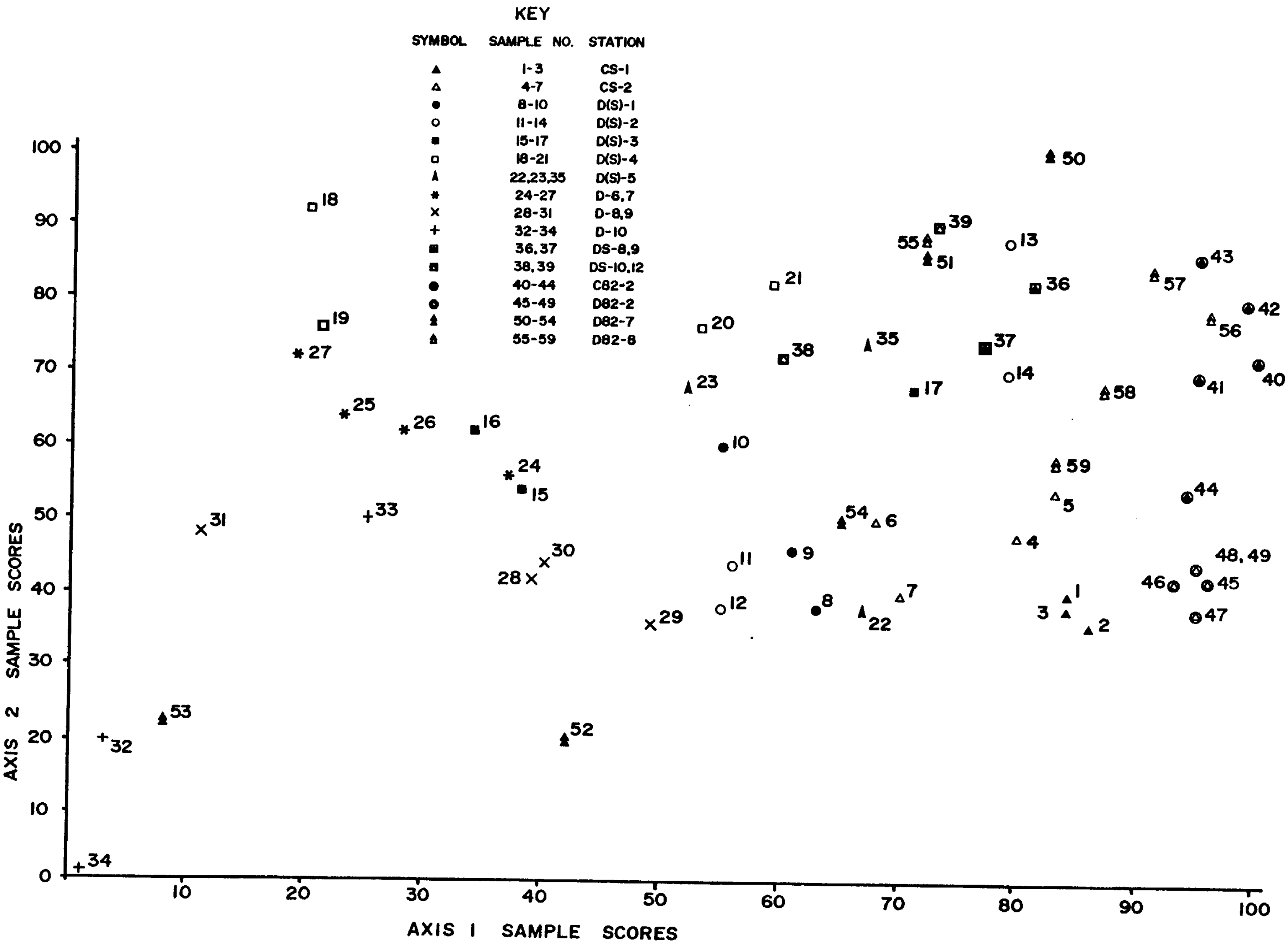

Figure C.2-1 Ordination of samples on the first two axes of variation determined by reciprocal averaging (RA) of benthos composition data for Herschel Island Gravel Borrow Area, 1981 and 1982.

significant (P > 0.05). This indicates that 60% of the variation in Axis 1 sample scores can be attributed to sediment particle size or related factors. The gradient evident along Axis 1 is thus inferred to be markedly influenced by sediment-faunal interactions.

The species ordination (Figure C.2-2) shows the association of abundant benthic species with certain regions of the indicated environmental gradient along Axis 1. The amphipods, Ampherusa derjugini and Gammarus locusta, the bivalve, Thyasira gouldii, and the polychaete, Scolecolepides sp., for example, are associated with the shallow, sandy and gravelly samples at the lower end of the Axis 1 gradient (low SC content). At the opposite end of the gradient, the muddy samples from reference stations and secondary dredging stations have associations with species such as the polychaetes, Ampharete acutifrons, Pholoe sp. and Pygospio elegans, and the amphipod, Ischyrocerus megacheir.

In Figure 4 representative species distributions in samples arranged along the Axis 1 gradient are presented. For example, the polychaete, Ampharete acutifrons (sp. 9, Table C.2-1) is significantly more abundant in muddy samples (65-100 on Axis 1; P < 0.005) than in sandy samples. In contrast to the polychaete, Scolecolepides sp. (sp. 15), and the bivalve, Thyasira gouldii (sp. 23), were significantly more common in sandier stations (0-65 on Axis 1; P < 0.005 ANOVA 4) than in muddy samples.

Taxa such as the Ascidiacea (sp. 5) and Sabellidae (sp. 14) were ordinated in the intermediate region between 50 and 65 on Axis 1. The ascidians, which are filter-feeding epifauna, were found in samples of all sediment types. The sabellid polychaetes were present in sandy samples from several stations and in samples from reference station D82-2 where a thin layer of silt covered the sand and gravel beneath. Taxa with a tolerance of a wide spectrum of sediment conditions, such as the ascidians, sabellid polychaetes and the ubiquitous isopod, Mesidotea sibirica (sp. 61) thus represent the intermediate interval (50-65) of the Axis 1 gradient.

A comparison of the ordination results with the Z-M results for 1981 (Heath et al. 1982a) indicates that groupings of stations are in reasonable agreement. On the basis of pooled samples of taxonomic families for each station, the Z-M method grouped the September 1981 stations DS-2, DS-3, DS-8 and DS-9 as Cluster M ("muddy" stations). A similar result was obtained by the RA technique which ordinated the individual samples of taxonomic species for the above stations into a compact interval between 72 and 82 on Axis 1 (Figure C.2-1). For this period the other major group of stations distinguished by Z-M analysis was Cluster S consisting

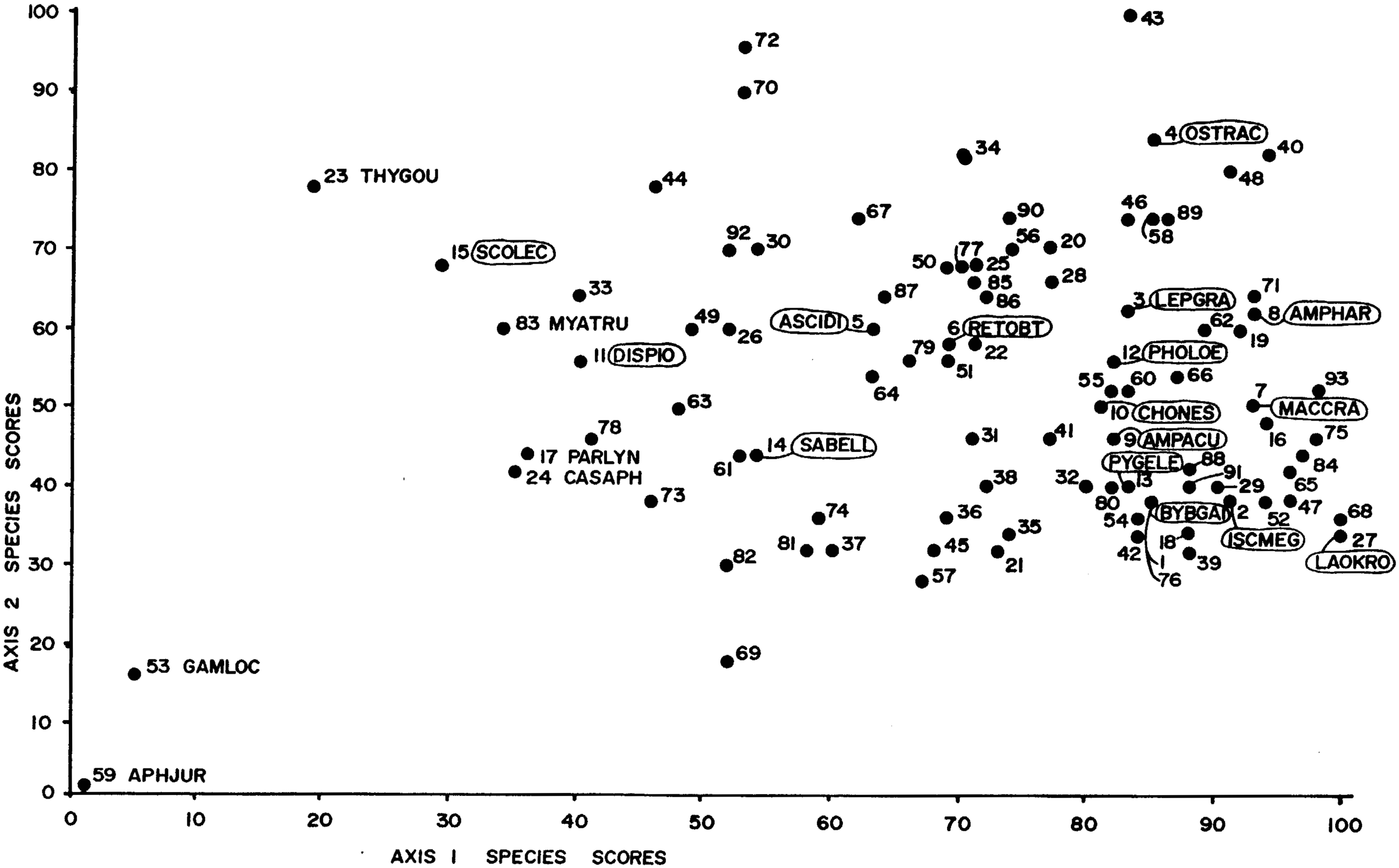

Figure C.2-2 Ordination of species on the first two axes of variation determined by reciprocal averaging (RA) of benthos composition data for Herschel Island Gravel Borrow Area, 1981 and 1982. Refer to Table C.2-1 for list of species numbers and acronyms used. Ellipses indicate "basic" species in correspondence analysis (cf. Figures C.2-3 and C.2-4).

TABLE C.2-1

LIST OF TAXA USED IN COMMUNITY ANALYSES OF HERSCHEL ISLAND DATA, THEIR ASSIGNED NUMBERS AND ACRONYMS FOR FIGURES C.2-2, -3 AND -4 AND THEIR DESIGNATIONS IN CORRESPONDENCE ANALYSIS

SPECIES NUMBER	TAXONOMIC NAME	ACRONYM (Figures) (C.2-2, -3, -4)	CA SPECIES DESIGNATION
1	Byblis gaimardi	BYBGAI (2); BGAI (3,4)	Basic
2	Ischyrocerus megacheir	ISCMEG (2); IMEG (3,4)	Basic
3	Leptognathia gracilis	LEPGRA (2); LGRA (3,4)	Basic
4	Ostracoda	OSTRAC (2); OSTR (3,4)	Basic
5	Ascidiacea	ASCIDI (2); ASCI (3,4)	Basic
6	Retusa obtusa	RETOBT (2); ROBT (3,4)	Basic
7	Macoma crassula	MACCRA (2); MCRA (3,4)	Basic
8	Ampharete sp.	AMPHAR (2); AMPH (3,4)	Basic
9	Ampharete acutifrons	AMPACU (2); AACU (3,4)	Basic
10	Chones sp.	CHONES (2); CHON (3,4)	Basic
11	Dispio sp.	DISPIO (2); DISP (3,4)	Basic
12	Pholoe sp.	PHOLOE (2); PHOL (3,4)	Basic
13	Pygospio elegans	PYGELE (2); PELE (3,4)	Basic
14	Sabellidae	SABELL (2); SABE (3,4)	Basic
15	Scolecolepides sp.	SCOLEC (2); SCOL (3,4)	Basic
16	Orchomene sp. 2	OH02 (3,4)	Supplementary
17	Parodicerous lynceus	PARLYN (2); PLYN (3,4)	Supplementary
18	Munna kroyeri	MKRO (3,4)	Supplementary
19	Brachydiastylis resima	BRES (3,4)	Supplementary
20	Diastylis oxyrhyncha	DOXY (3,4)	Supplementary
21	Actiniaria	ACTI (3,4)	Supplementary
22	Liocyma fluctuosa	LFLU (3,4)	Supplementary
23	Thyasira gouldii	THYGOU (2); TGOU (3,4)	Supplementary
24	Castalia aphroditoides	CASAPH (2); CAPH (3,4)	Supplementary
25	Chaetozone/Tharyx	CTHA (3,4)	Supplementary
26	Cirratulidae	CIRR (3,4)	Supplementary
27	Laonome kroyeri	LAOKRO (2); LKRO (3,4)	Supplementary
28	Spionidae	SPIO (3,4)	Supplementary
29	Erichthonius hunteri	EHUN (3,4)	Supplementary
30	Astarte montagui	AMON (3,4)	Supplementary
31	Nemertea	NEME (3,4)	Supplementary
32	Sipunculida	SIPU (3,4)	Supplementary
33	Ampharetidae	ADAE (3,4)	Supplementary
34	Capitella capitata	CCAP (3,4)	Supplementary
35	Euchone analis	EUCA (3,4)	Supplementary
36	Exogene sp.	EXOG (3,4)	Supplementary
37	Erichthonius difformis	EDIF (3,4)	Supplementary
38	Melita dentata	MDEN (3,4)	Supplementary

TABLE C.2-1 (continued)

LIST OF TAXA USED IN COMMUNITY ANALYSES OF HERSCHEL ISLAND DATA, THEIR ASSIGNED NUMBERS AND ACRONYMS FOR FIGURES C.2-2, -3 AND -4 AND THEIR DESIGNATIONS IN CORRESPONDENCE ANALYSIS

SPECIES NUMBER	TAXONOMIC NAME	ACRONYM (Figures)	CA SPECIES DESIGNATION
39	Orchomene ambylops	OAMB (3,4)	Supplementary
40	Protomedia fasciata	PFAS (3,4)	Supplementary
41	Diastylis edwardsi	DEDW (3,4)	Supplementary
42	Synidotea bicuspida	SBIC (3,4)	Supplementary
43	Macoma sp.	MACO(3,4)	Supplementary
44	Thracia sp.	THRA (3,4)	Supplementary
45	Chaetozone sp.	CHAE (3,4)	Supplementary
46	Maldanidae	MALD (3,4)	Supplementary
47	Mystides borealis	MBOR (3,4)	Supplementary
48	Nepthys cornuta	NCOR (3,4)	Supplementary
49	Prionospio cirrifera	PCIR (3,4)	Supplementary
50	Sphaerodoropsis minuta	SMIN (3,4)	Supplementary
51	Aceroides latipes	ALAT (3,4)	Supplementary
52	Tritella sp.	TRIT (3,4)	Supplementary
53	Gammarus locusta	GAMLOC (2); GLOC (3,4)	Supplementary
54	Monoculodes longirostris	MLON (3,4)	Supplementary
55	Leucon nasica	LNAS (3,4)	Supplementary
56	Balanus balanoides	BBAL (3,4)	Supplementary
57	Anthophiura sp.	AHOP (3,4)	Supplementary
58	Portlandia arctica	PARC (3,4)	Supplementary
59	Apherusa jurinii	APHJUR (2); AJUR (3,4)	Supplementary
60	Metopa sp.	METO (3,4)	Supplementary
61	Mesidotea sibirica	MSIB (3,4)	Supplementary
62	Gersemia sp.	GERS (3,4)	Supplementary
63	Lafoeina maxima	LMAX (3,4)	Supplementary
64	Ophiuroidea	OPHI (3,4)	Supplementary
65	Solariella obscura	SOBS (3,4)	Supplementary
66	Thecosomata	THEC (3,4)	Supplementary
67	Delectopecten greenlandicus	DGRE (3,4)	Supplementary
68	Oligochaeta	OLIG (3,4)	Supplementary
69	Autolytus sp.	AUTO (3,4)	Supplementary
70	Eteone sp.	ETEO (3,4)	Supplementary
71	Boeckosimus sp.	BOEC (3,4)	Supplementary
72	Boeckosimus edwardsii	BEDW (3,4)	Supplementary
73	Ischyrocerus anguipes	IANG (3,4)	Supplementary
74	Caprella spp.	CAPR (3,4)	Supplementary
75	Jaeropsis sp.	JAER (3,4)	Supplementary

TABLE C.2-1 (continued)

LIST OF TAXA USED IN COMMUNITY ANALYSES OF HERSCHEL ISLAND DATA, THEIR ASSIGNED NUMBERS AND ACRONYMS FOR FIGURES C.2-2, -3 AND -4 AND THEIR DESIGNATIONS IN CORRESPONDENCE ANALYSIS

SPECIES NUMBER	TAXONOMIC NAME	ACRONYM (Figures)	CA SPECIES DESIGNATION
76	Pleurogonium spinosissmum	PSPI (3,4)	Supplementary
77	Anthozoa	ANTH (3,4)	Supplementary
78	Eucratea loricata	ELOR (3,4)	Supplementary
79	Oenopota sp.	OENO (3,4)	Supplementary
80	Tachyrhynchus reticulatus	TRET (3,4)	Supplementary
81	Hiatella arctica	HARC (3,4)	Supplementary
82	Macoma moesta	MMOE (3,4)	Supplementary
83	Mya truncata	MYATRU (2); MTRU (3,4)	Supplementary
84	Nuculana pernula	NPER (3,4)	Supplementary
85	Yoldiella fraterna	YFRA (3,4)	Supplementary
86	Dorvillea sp.	DORV (3,4)	Supplementary
87	Hesperonoe sp.	HESP (3,4)	Supplementary
88	Hesionidae	HESI (3,4)	Supplementary
89	Leitoscoloplos pugettensis	LPUG (3,4)	Supplementary
90	Phyllodoce groenlandica	PGRO (3,4)	Supplementary
91	Polydora sp.	POLY (3,4)	Supplementary
92	Polydora quadrilobata	PQUA (3,4)	Supplementary
93	Monoculodes sp.	MOSP (3,4)	Supplementary

of "sandy" stations DS-10, DS-5, DS-4, DS-1, CS-1 and CS-2. These stations, with the exception of CS-1, were ordinated between 54 and 70 on Axis 1 (Figure C.2-1) indicating a similar relative position towards the sandier end of the environmental gradient. Similarly, for July 1981 the "sandy" stations D-10, D-7, D-4, D-6 and D-9 were grouped as Cluster A by Z-M analysis of families (Table 6, Heath et al. 1982a). In the RA results presented here these stations were ordinated between 2 and 40 at the end of Axis 1 (Figure C.2-1) corresponding to coarser grained sediments.

The remaining stations for July 1981 were grouped as Cluster I (Cs-1, CS-2, D-1, D-5, D-8) and Cluster G (D-2, D-3) by Z-M analysis. From the RA results (Figure C.2-1) these station clusters are not readily separable because the positions of the "gravelly" G stations overlap in the Axis 1 interval 34-86 with those of "intermediate" (gravel, sand and mud) stations of Cluster I. A possible explanation for this overlap is that of all the taxa sampled, the members of the infauna are more likely to be influenced by the proportions of sand and mud than by that of gravel since their lifestyle and/or feeding strategies often require penetration or even ingestion of the substrate. On the other hand, some sessile epifauna, such as soft coral, sea anemones, sponges and hydroids require larger gravel or rock for attachment. Because the infauna comprise the majority of the taxa sampled by grab and airlift, their distributions influence the analysis of community structure of the sampled benthos most strongly. Therefore, the effects of moderate proportion of gravel are not as likely to be reflected in the benthic community structure as are the effects of similar proportions of sand or mud.

The second method of community analysis, correspondence analysis (abbreviated here as CA), was employed with principal contribution from 15 of the most abundant taxa, referred to as "basic" species. The remaining 78 taxa were treated as "supplementary" species (see Appendix C.1 for details). Their positions relative to the basic species and samples have been provided a posteriori in graphical form (Figures C.2-3 and -4). The designations of the 93 taxa used in the analysis are listed in Table C.2-1.

The CA of the Herschel Island taxonomic data was interpreted by the method of principal axes (Greenacre 1978) which is mainly concerned with decomposing the total inertia (i.e. dispersion of the points in space, see Appendix C.1) into (a) "interpretable" or "non-random" inertia and into (b) "error" or "random" inertia. The interpretable inertia of the axes is then further partitioned into contributary parts due to samples and/or species to extend the interpretation. The first three principal

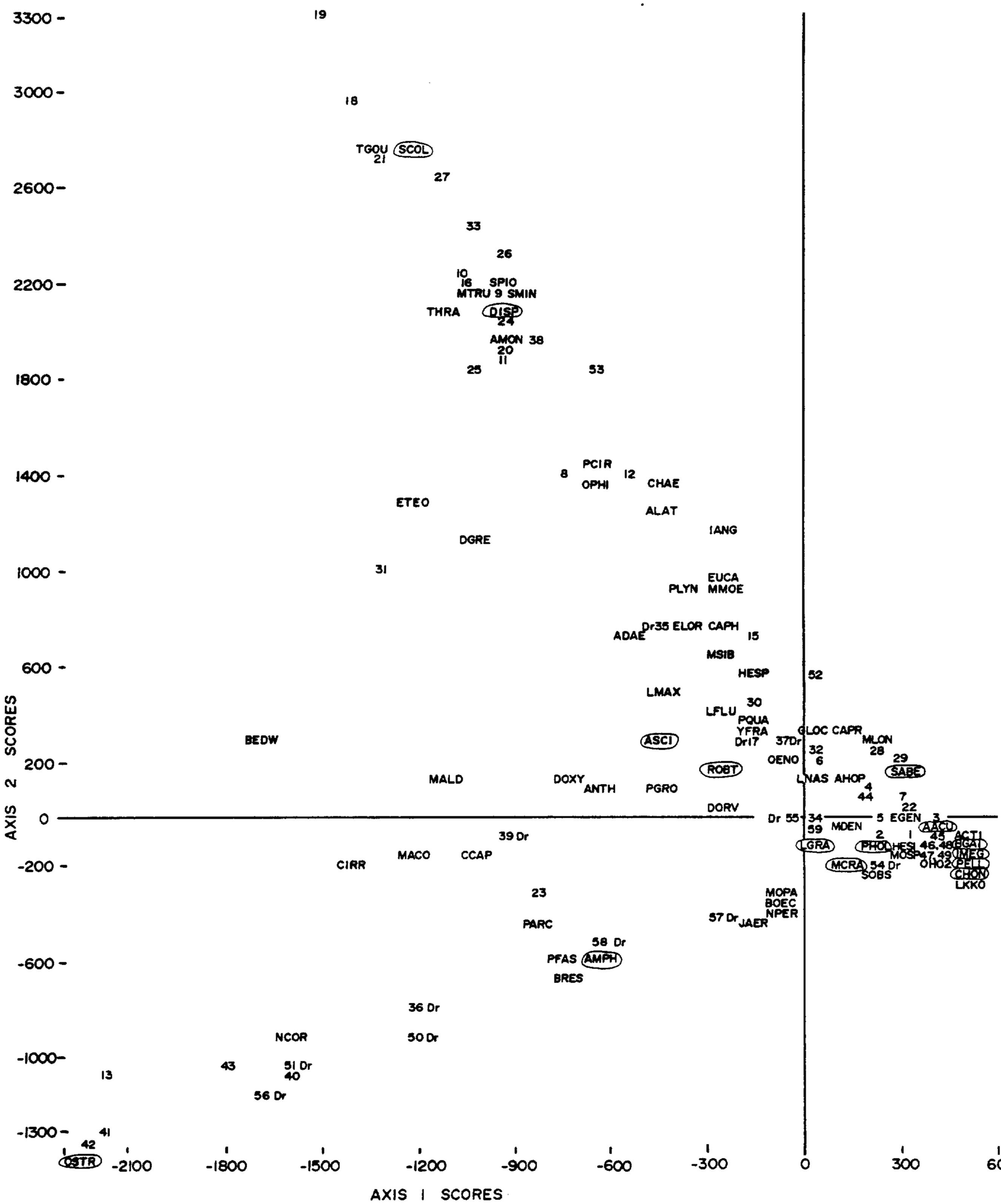

Figure C.2-3 Correspondence analysis for benthos samples from the Herschel Island Gravel Borrow Area, 1981 and 1982: plane of the first and second principal axes. The samples and their associated species are shown except where overlap of points prevents full representation. Basic species are indicated by an ellipse. Refer to Table C.2-1 for list of acronyms used in this figure.

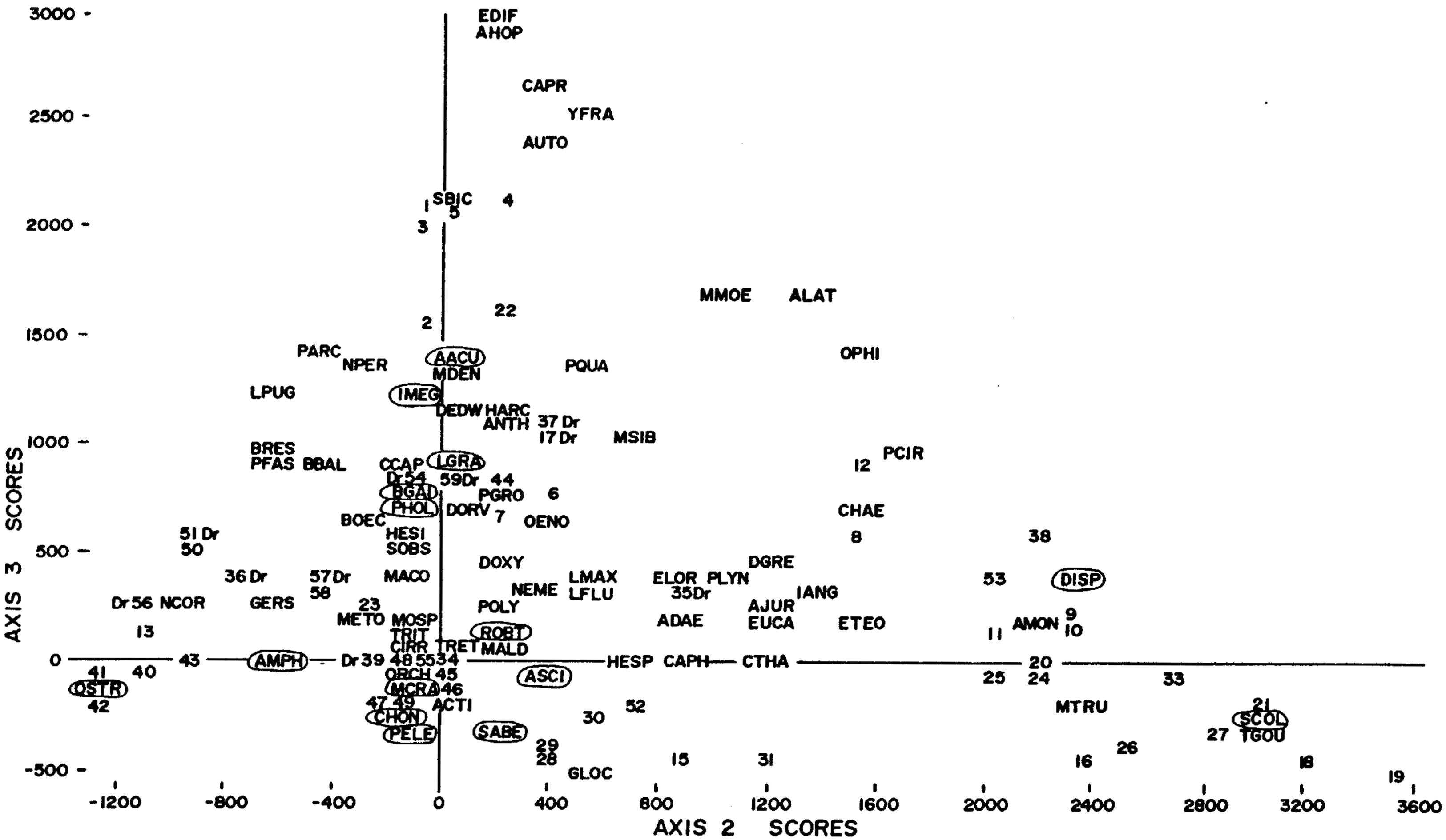

Figure C.2-4 Correspondence analysis for benthos samples from the Herschel Island Gravel Borrow Area, 1981 and 1982: plane of the second and third principal axes. The samples and their associated species are shown except where overlap of points prevents full representation. Basic species are indicated by an ellipse. Refer to Table C.2-1 for list of acronyms used in this figure.

axes accounted for 67.4% of the total inertia, as follows: Axis 1 (28.3%), Axis 2 (28.1%) and Axis 3 (11%). The fourth axis contributed only an additional 7%. Consequently, an attempt will be made to interpret only the first three axes.

As Greenacre (1978) has pointed out, in the interpretation of the graphical display of the points projected onto the various planes of the principal axes, it is important to remember that each axis has its particular orientation because the inertia of the cloud of points is a maximum.

The first and second principal axes describe a plane which accounts for 56.4% of the total inertia. This plane (Figure C.2-3) demonstrates the separation along Axis 2 of samples from sandy stations, D-4 (18, 19), DS-4 (20, 21), D-7 (26, 27), D-10 (33), DS-1 (9, 10) and others, from the muddier samples positioned near and below the origin. The sample points with high CA Axis 2 scores correspond with points having low Axis 1 scores in the RA ordination (Figure C.2-1). Stations represented by sample points near Figure C.2-3 origin include DS-2 (6, 7), CS-1 (1, 2), CS-2 (5), D-5 (22) and D82-2 (45-49). The latter stations (samples) generally had sediments with moderate proportions of sand, mud and/or gravel. In the RA ordination, the corresponding sample points had high Axis 1 scores (68-98) and intermediate Axis 2 scores (36-54).

In Figure C.2-3, the first axis shows the separation of samples from the muddy reference stations DS-2 (13), C82-2 (40-43) from those near the origin and above. Samples from the dredged stations DS-8 (36), D82-7 (50,51), D82-8 (56, 57, 58) and DS-12 (39) are positioned along Axis 1 between the origin and the low extremes. Interestingly, all of the above stations (samples) with low CA Axis 1 and 2 scores had high Axis 1 and 2 scores (upper right corner) in the RA ordination (Figure C.2-1).

The CA results indicate that the polychaetes, Chones sp. and Scolecolepides sp., and the Ostracoda contribute highly as basic species to the inertia of Axis 1 (Figure C.2-3). Scolecolepides sp., Dispio sp. and the Ostracoda are major contributors to the inertia of Axis 2. Secondary species associated with Axis 1 are the polychaetes, Nephtys cornuta, Cirratulidae and Laonome kroyeri. Notable secondary species associated with Axis 2 are the bivalves, Thyasira gouldii and Astarte montagui.

A comparison of the species ordination (Figure C.2-2) with the CA results (Figure C.2-3) indicates that in each case points representing species such as Scolecolepides sp., Thyasira gouldii and Dispio sp. are positioned in association with samples having mainly sandy sediments. For samples from the other extreme of the sediment spectrum, both techniques have corresponding points representing taxa such as the Ostracoda, Ampharete sp. and Macoma crassula. It appears that, although distance scaling and axes orientation are different in the results of the two techniques, many of the same key samples and species are grouped together similarly and are distinguished from other points.

The second and third principal axes of the CA form a plane which accounts for 38.1% of the total inertia (Figure C.2-4). Axis 2 again demonstrates the gradient from sandy samples and associated species such as Scolecolepides sp. and Dispio sp., to muddy samples and associated taxa such as Ostracoda and Ampharete sp. Along Axis 3, however, there is better resolution of the group of samples that appeared near the origin in Figure C.2-3. Note that now Axis 1 is orthogonal to the plane of Axes 2 and 3 (that is, Axis 1 passes through the origin perpendicular to the plane of the paper). Some of the samples and species that were projected onto the plane of Axes 1 and 2 near the origin in Figure C.2-3 are shown to have certain distinctions from those still near the origin in Figure C.2-4. For example, samples 1 to 5 and basic species such as Ampharete acutifrons and Leptognathia gracilis on Axis 3 are separated from samples 45 to 49 and species such as Macoma crassula near the origin. The RA ordinations of samples and species (Figures C.2-1 and -2) also show small scale separation between the above sample groups and their associated species.

In summary, the first three principal CA axes account for 67.4% of the total inertia of the points. The samples and their associated species have been positioned in a three-dimensional space which displays their inter-relationships. The most significant feature of the sample space is the polarization along Axis 2 between the sandy samples and their biota at the higher scores and the muddy samples and their associated species at the lower scores. Samples from dredged sites were generally intermediate in position along the axes. Replicate samples from most stations show reasonably consistent trends in basic species composition. The results of the CA analysis of the distribution of 15 basic species has many features in common with the results of the RA ordination of 93 species. This concordance in the results of independent statistical methods is strong evidence that the associations described between sample types and benthic species are real entities rather than spurious correlations.

APPENDIX D.1

STATISTICAL TESTS OF COMPARISONS BETWEEN MEANS OF FAUNAL INDICES FOR GROUPS OF HERSCHEL ISLAND STATIONS 1981 - 1982

APPENDIX D.2

BENTHIC SAMPLING METHODS AND VARIABILITY

APPENDIX D.1

STATISTICAL TESTS OF HYPOTHESES

The various hypotheses concerning comparisons of means for sample/station groups and sampling periods presented in Sections 3.1.3 and 3.1.6 are tested here by one-way classification ANOVA and/or Scheffe's S test. The sequence of tests follows that of the above sections, with similar notation.

ANOVA1: One-way classification ANOVA and Scheffe's S test; Population Density

H_0 ("null hypothesis"): The means for population density are not significantly different among the four 1982 stations.

H_1 ("alternate hypothesis"): There are significant differences in population density means among the 1982 stations.

Data: The population density data used in deriving the following ANOVA table are from Table 3C, Section 3.3.

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level	
					5%	0.1%
Station	3	1.32×10^8	4.41×10^7	16.81****	3.24	9.0
Residual	16	4.2×10^7	2.63×10^6			
Total	19					

Conclusion:

Since the observed $F = 16.81 > F_{cr} = 9.0$ at the 0.1% significance level, there is a highly significant difference ($P < 0.001$) denoted by **** among the means. To find which means are different Scheffe's S test was applied. The least significant difference (L.S.D.) is derived as:

$$L.S.D. = S \times s_{\bar{d}}$$

where $S = (df_{Stn} \times F_{cr})^{1/2}$ is the (critical sum of squares)$^{1/2}$

and $s_{\bar{d}} = (MS_{res} \; (\frac{1}{n_i} + \frac{1}{n_j})^{1/2}$ is the (standard error of $\bar{d} = \bar{X}_i - \bar{X}_j$)

The comparison of means and the corresponding L.S.D. values are tabulated below.

	I	II	III	IV	
Station	D82-2	C82-2	D82-8	D82-7	
Mean	6633.6	1232.4	641.6	339.6	N/m^2

(n_i, n_j) Observations	Comparisons	Differences	L.S.D.	Conclusions
5,5	I - IV	6294	5772	**
5,5	I - III	5992	5772	**
5,5	I - II	5401	4521	*
5,5	II - IV	893	4521	N.S.

** significant at the 99% level
* significant at the 95% level
N.S. not significant at the 95% level.

ANOVA2: One-way ANOVA and Scheffe's S test; Wet Biomass

H_0: The means for wet biomass are not significantly different among the four 1982 stations.

H_1: There are significant differences in wet biomass means among the 1982 stations.

Data: The wet biomass column from Table 3C, Section 3.3.

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level 5%	F_{cr} for Significance Level 0.1%
Station	3	3146.5	1048.8	41.6****	3.24	9.0
Residual	16	402.5	25.2			
Total	19					

Conclusion:

Reject H_0; the means are very significantly different ($P < 0.001$). To find which means are different we apply Scheffe's test:

	I	II	III	IV	
Station	D82-2	D82-2	C82-2	D82-7	
Mean	33.18	6.59	5.69	1.42	$g\ m^{-2}$

(n_i, n_j) Observations	Comparison	Difference	L.S.D.		Conclusion
5,5	I - IV	31.76	28.08	= 0.001	****
5,5	I - III	27.49	19.66	= 0.005	***
5,5	I - II	26.59	19.66		***
5,5	II - IV	5.17	9.91		N.S.

**** significant at the 99.9% level
*** significant at the 99.5% level
N.S. not significant at the 95% level

ANOVA3: One-way ANOVA and Scheffe's S test, Wet Biomass

H_0: The means for dry biomass are not significantly different among the four 1982 stations.

H_1: There are significant differences in dry biomass means among the 1982 stations.

Data: The dry biomass column of Table 3C, Section 3.3.

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level	
					5%	0.1%
Station	3	15.75	5.25	12.5****	3.24	9.0
Residual	16	6.74	0.42			
Total	19					

Conclusion:

Reject H_0; the means are very significantly different ($P < 0.001$). To find which means are different we apply Scheffe's S test:

	I	II	III	IV	
Station	D82-2	D82-8	C82-2	D82-7	
Mean	2.53	1.45	0.50	0.29	g m^{-2}

(n_i, n_j) Observations	Comparison	Difference	L.S.D.		Conclusion
5,5	I - IV	2.24	2.13	= 0.001	****
5,5	I - III	2.03	1.78	= 0.005	***
5,5	I - II	1.08	1.28	= 0.05	N.S.
5,5	II - IV	1.16	1.28		N.S.

**** significant at the 99.9% level
*** significant at the 99.5% level
N.S. not significant at the 95% level

ANOVA4: One-way ANOVA; Sample distributions for representative species.

H_0: The abundance of the following species does not differ significantly between the three sample intervals along Axis 1:

(a) Ampharete acutifrons AACU
(b) Scolecolepides sp. SCOL
(c) Thyasira gouldii TGOU

H_1: The abundance of the above species varies significantly between the three sample intervals along Axis 1: 0-50; 51-65; 66-100.

Data: Log (X + 1) transformed species abundance data from Appendix A; Figure 6.

Source of Variation		df	SS	MS	Observed F	F_{cr} for Significance Level 5%	
(a)	AACU						= 0.5%
	Interval	2	7.01	3.51	6.32***	3.15	5.85
	Residual	56	31.05	0.55			
	Total	58					
(b)	SCOL						= 0.1%
	Interval	2	15.82	7.91	19.14****	3.15	12.5
	Residual	56	23.14	0.41			
	Total	58					
(c)	TGOU						= 0.5%
	Interval	2	6.43	3.22	10.9***	3.15	8.56
	Residual	56	16.52	0.30			
	Total	58					

*** Significant at the 99.5% level.
**** Significant at the 99.9% level.

ANOVA5: One-way ANOVA; Faunal diversity for all samples

H_0: The overall means for faunal diversity are not significantly different among the three sampling periods.

H_1: The overall means for faunal diversity are significantly different among the three sampling periods.

Data: Table 3 A,B,C. No. of taxa.

Source of Variation	df	SS	MS	Observed F		F_{cr} for Significance Level	
						5%	1%
Period	2	352	176	0.35	N.S.	3.17	5.03
Residual	55	27848.2	506.3				
Total	57						

N.S. not significant at the 95% level ($P > 0.05$)

ANOVA6: One-way ANOVA; Faunal diversity for:

(a) reference station CS-2

(b) dredge station DS-8 (D82-8)

(c) dredge station D82-7

H_o: The mean faunal diversity does not differ significantly:

(a) at reference station CS-2, (C82-2)

(b) at D-8, DS-8, (D82-8)

(c) at D-7, D82-7

between sampling periods.

H_1: The mean faunal diversity differs significantly:

(a) at reference station CS-2 (C82-2)

(b) D-8, DS-8 (D82-8)

(c) D-7 (D82-7)

between sampling periods.

Data: Table 3 A,B,C. No. of taxa for:

(a) CS-2 (C82-2)

(b) D-8, DS-8, D82-8

(c) D-7 (D82-7)

6a. ANOVA Table for CS-2 (C82-2)

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level 5%	F_{cr} for Significance Level 1%
Period	2	6.66	3.33	0.14 N.S.	5.14	
Residual	6	1389.5	231.6			
Total	8					

N.S. not significant at the 95% level ($P > 0.05$).

6b. ANOVA Table for D-8, DS-8, (D82-8)

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level 5%	F_{cr} for Significance Level 1%
Period	2	493	246.5	3.20 N.S.	5.79	
Residual	5	385.2	77.0			
Total	7					

N.S. not significant at the 95% level ($P > 0.05$).

6c. ANOVA Table for D-7 (D82-7)

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level	
					5%	1%
Period	1	6.48	6.48	0.014 N.S.	7.71	
Residual	4	1829.2	457.3			
Total	5					

N.S. not significant at the 95% level ($P > 0.05$).

ANOVA7: One-way ANOVA; Faunal diversity:

(a) July 1981
(b) September 1981

H_0: The mean faunal diversity does not differ significantly between the reference station CS-1 and the other stations for:

(a) July 1981
(b) September 1981

H_1: The mean faunal diversity differs significantly between the reference station CS-1 and the other stations for:

(a) July 1981
(b) September 1981

Data: (a) Table 3A, No. of taxa. (b) Table 3B, No. of taxa.

7a. ANOVA Table for July 1981

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level	
					5%	2.5%
Station	1	1354.6	1354.6	5.07*	4.30	5.79
Residual	22	5881	267			
Total	23					

* Significant at the 95% level ($P < 0.05$).

7b. ANOVA Table for September 1981

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level	
					5%	0.1%
Station	1	6745.2	6745.2	74.7****	4.75	18.6
Residual	12	1082.9	90.2			
Total	13					

**** Significant at the 99.9% level ($P < 0.001$)

ANOVA8: One-way ANOVA; Faunal diversity: September 1982

H_0: The mean faunal diversity does not differ significantly between the reference station D82-2 and the other stations for September 1982.

H_1: The mean faunal diversity differs significantly between the reference station D82-2 and the other stations for September 1982.

Data: Table 3C, No. of taxa.

Source of Variation	df	SS	MS	Observed F	F_{cr} for Significance Level	
					5%	1%
Station	1	1245	1245	5.13*	4.41	8.28
Residual	18	4368.9	242.7			
Total	19					

* Significant at the 95% level ($P < 0.05$).

APPENDIX D.2 Benthic Sampling Methods and Variability

During the sampling programs on the gravel bars near Herschel Island, two benthic sampling methods have been used in response to substrate conditions and operating restrictions imposed by conditions in the field. This section compares the performance of the airlift suction sampler and the Van Veen grab (No. 214WA265, Kahlsico). The results of pooling or combining two or more samples from a given station are compared with the results of processing each sample separately.

In September 1982 a compressor breakdown part-way through the program made it necessary to conserve bottled air for diving. Therefore, airlift sampling was replaced by sampling with the Van Veen grab after one comparative sampling at DS-4 was completed. The airlift sample (20) had comparable biomass and diversity estimates to those of the Van Veen sample (21; two grab hauls combined). However, the estimate of population density for sample 20 was only 47% of that for sample 21 (Table 3B). This amount of variability, though, can occur between two samples collected by the same method (cf. samples 18, 19 and 22, 23, Table 3A), especially in heterogeneous sediments.

In September 1982, further comparisons were made between the Van Veen sampler and the airlift. Four grab hauls and one airlift sample at each station were processed separately. In all cases, the dry biomass estimate for the airlift sample was within the range of the estimates for the grab samples (Table 3C). In addition, the diversity of the airlift sampled benthos was similar or occasionally higher than that of the benthos from grab samples. For combined grab samples, the total diversity was higher than the airlift estimate at two stations, similar at one and lower at the other. Population density estimates for the airlift samples tended to be slightly lower than those of the grab samples at most stations. However, it is clear that the effect of drifting off station leads to higher sampling variability than does changing sampling methodology in a region of high sedimentary heterogeneity (cf. D82-7, Table 3C). The variance of the population density estimates significantly exceeded the means for all stations sampled in 1982. Therefore, the benthos on the gravel rdige was not randomly distributed; instead they were "clumped" or "patchy" in distribution. This inference applies whether the four replicate grab samples were considered with or without the airlift sample at each station. The direct observations of macrobenthos by the divers and video support the inference of patchiness in benthos distributions in the heterogeneous habitat of the gravel ridge (see also Heath et al. 1982a). The above comparisons indicate that there is reasonable compatibility between the results of the airlift and the Van Veen sampler in the generally muddy sediments that were sampled in 1982. This conclusion is supported by the relatively consistent positioning of the airlift sample points near those of corresponding "on station" grab sample points in the community analyses, notably the RA ordination (cf. Figure C.2-1).