SEASONAL POPULATION DENSITY DISTRIBUTION OF COPEPODS, EUPHAUSIIDS, AMPHIPODS AND OTHER HOLOPLANKTON ON THE KODIAK SHELF

by

AlIan H. Vogel and Gregory McMurray

VTN Oregon, Inc.

Final Report
Outer Continental Shelf Environmental Assessment Program
Research Unit 608

February 1982

TABLE OF CONTENTS

List of Figures

Figure

List of Figures
(continued)

List of Figures
(continued)

List of Figures
(continued)

Figure

List of Figures
(continued)

Figure

List of Tables

List of Tables
(continued)

List of Tables
(continued)

List of Tables
(continued)

Table

List of Tables
(continued)

Table

Abstract

Over 800 zooplankton samples collected from four bays and the continental shelf off the Kodiak archipelago, Alaska, U.S. A. were analyzed for holoplankton species composition, distribution and abundance. The results of this analysis were compared to the distribution of marine animals belonging to higher trophic levels in an effort to assess the significance of selected holozooplankters to the pelagic food chain.

One hundred forty-six taxa were identified from these samples. Nine major taxonomic groups comprised over 90% of the taxa and 99% of the individuals found. Copepods were the most abundant group, including 53 of the taxa and 85% of the individuals collected. The predominant copepods were Pseudocalanus spp., Metridia pacifica, Acartia longiremis, Calanus spp. and Oithona spp. Euphausiids were numerically the second most abundant group and cnidarians had the second largest number of taxa. Common euphausiids included Euphausia pacifica and four species of Thysanoessa. Larvaceans and chaetognaths were the most abundant non-crustaceans. Other abundant zooplankton were the amphipod, Parathemisto pacifica, the cladoceran Podon leuckarti, the larvaceans Oikopleura spp., the chaetognaths, Sagitta spp. and the pteropod, Limacina helicina.

Four seasonal distribution patterns were observed. Characterized by period of greatest abundance, they were spring, summer, fall, and non-seasonal. The summer seasonal pattern was the most common. Spatial distribution patterns were weaker than seasonal ones. There were no important within-bay differences and the only obvious between-bay trend was towards increased densities of zooplankton in the southern bays. Offshore, the highest densities occurred in the nearshore area off the southern bays and over Kiliuda Trough. The lowest observed densities were usually over North Albatross Bank. The most distinct offshore zone was the continental slope.

Comparison of the distribution of larger pelagic animals to that of holozooplankton suggested a relationship between copepods, euphausiids and cladocerans with ichthyoplankton, capelin, herring, Atka mackerel, shearwaters, and the humpback and minke whales. Predation by the capelin and Atka mackerel appeared strong enough to cause a decrease in zooplankton densities.

1.0 INTRODUCTION

The oil embargo of 1973-74 brought home graphically to many Americans their dependency upon foreign oil. Out of this realization came the resolve, expressed in Project Independence and similar official pronouncements, to once again obtain energy self-sufficiency. One of the programs initiated as a consequence was an increased rate of exploration for oil and natural gas deposits on the outer continental shelf areas of this country.

In response to this exploration program and the legal mandate of the National Environment Policy Act of 1969, the Outer Continental Shelf Environmental Assessment Program (OCSEAP) was developed. Its purpose is to provide a comprehensive study program for the protection of the marine and coastal environments which might be endangered or damaged during the proposed oil and gas exploration and extraction. The primary objectives of the Alaskan OCS environmental studies have been to provide background information to enable managers to adequately protect the environment and to characterize the ecological systems under potential impact. Much of the effort expended has been oriented towards the identification of key species and determination of their ecological requirements, including habitat needs, trophic status, and critical lifecycle periods.

1.1 Specific Task Orientation

The Kodiak Continental Shelf area is biologically highly productive, supporting commercial fisheries and shell fisheries, the sea otter, small populations of six rare and endangered species of cetaceans, and high densities of marine birds. This region has one of the three largest salmon fisheries in Alaska. It is also potentially an important oil and natural gas area. The lease areas are in zones of high geological hazard with earthquakes, tsunamis, vulcanism and submarine landslides all likely factors. It has been estimated that over the 25 year lifespan of the extraction of oil and natural gas from sale area #46 there will be 1.1 major accidents (BLM, 1980). Natural gas is considered much more likely to be discovered than oil. Its natural volatility is higher than that of crude oil and the region impacted might be much smaller. But microcrustaceans, the predominant taxa of zooplankton, are very sensitive to these hydrocarbons (Mironov 1968, 1970 ; Nelson-Smith 1972) as are some larval fishes (BLM, 1980; SAI, 1978). As a consequence, the potential for conflict between fossil fuel extraction and commercial fisheries is great.

The potential for conflict between the productive environment and possible fossil fuel extraction has resulted in a number of OSCEAP studies in the Kodiak area. Previous studies have dealt with: the distribution, abundance and catch statistics of the commercially important species of fish, decapod crustaceans and mollusks; distribution and abundance of larval and juvenile stages of commercially important fish; and the distribution of forage fish, pelagic larvae of crab and shrimp, and ichthyoplankton. Similar data analysis on the holoplanktonic crustaceans and other zooplankters is the substance of this report.

1.2 Study Objectives

The purpose of the present study is to provide data on the seasonal distribution and abundance of major zooplankton species/taxa that are principal food items for fish and bird species of commercial, ecological or aesthetic significance.

Specific task objectives for this study are to:

a. Determine the taxonomic composition and seasonal abundance of pelagic copepods, copepodite stages, and other holoplankters, such as euphausiids and amphipods, which are important as food for fish, birds and mammals;

b. Describe the numerical abundance and frequency of occurrence of selected plankton taxa considered important as food sources to the commerically harvested fish species and the numerically dominant bird and mammal species; and

c. Provide input toward synthesis of data on the trophic structure and food relations in the nearshore areas of the Kodiak Shelf.

These objectives were met utilizing two general methods of approach. The major method was the direct identification and enumeration of holoplankton samples. The second method was through comparison of. the stomach contents analysis with the results of these direct counts. The latter approach was especially important in identifying the key zooplankton taxa. The bulk of this report is devoted to a discussion of the zooplankton samples.

1.3 Description of Study Area

1.3.1 Geomorphology (Bathymetry and Geography)

The Kodiak Archipelago is located on the northwestern edge of the Gulf of Alaska, south of Cook Inlet and the Kenai Peninsula. The largest islands in the archipelago are Kodiak (9,293 km2) and Afognak (1,813 km2). The topography of the area, both above and below sea level, is extremely rugged and its composition varied. Numerous deep-mouthed bays and rocky headlands characterize the highly irregular coastline of the islands. There are mountains over 1,200 m arising adjacent to bays with depths of over 150 m. Offshore, the mid-shelf region is composed of a series of troughs and banks varying 200 m or more in depth between nearby locations. Substrates vary from hard rock to soft mud and include unconsolidated sands and gravels throughout the area, both on land and under water. The region has considerable seismic activity and changes in topography are not uncommon. The climate is cold maritime with cloudy skies, moderately heavy precipitation (140 cm/year) and mild temperatures for the latitude (56 to 59°N). Air temperatures average 15°C in the summer and -5° in the winter (AEIDC 1974). Terrestrial vegetation grades from heavy coniferous forest in the northeast to moist tundra in the extreme southwest (Viereck and Little 1972). Sitka spruce is predominant around Izhut Bay on Afognak, while Sitka alder, willow and tundra plants, e.g., sedges and other annuals, are the main vegetation surrounding Chiniak, Kiugnak and Kiliuda Bays on Kodiak.

The offshore study area extended seaward from the east side of the archipelago to the 2,000 m depth contour and included a small area southwest of Kodiak Island and northwest of the Trinity Islands in Shelikof Strait (Figure 1.3-1). The main portion was divided into three regions: 1) nearshore, extending outward from land approximately five km and having stations with depths usually less than 100 m; 2) mid-shelf, a 65 to 90 km wide band of troughs and banks (four each in the study area); and 3) the continental slope, a zone beyond the mid-shelf gradually increasing in depth from 200 to 2,000 m. Nearshore stations frequently overlapped or were located nearby the outer bay stations. Bank stations were similar in depth to the nearshore while trough station depths varied between 110 and 250 m. The troughs and banks of the mid-shelf were hydrographically different and were separated in the analyses of Dunn et al. (1979) and Kendall et al. (1980), producing the five distinct offshore hydrographic regions considered in this study (nearshore, mid-shelf banks, mid-shelf troughs, continental slope and the Shelikof Strait area). The total offshore area studied was 68,000 km2.

The onshore program examined three bays on Kodiak Island and one on Afognak Island (Figures 1.3-1 and 1.3-2). Chiniak Bay is a large, oPen bay on the northeast corner of Kodiak Island. The sampling stations began in Kalsin Bay, an 11 km long arm of Chiniak Bay, and swept out in a clock-wise fashion south of a number of islands into the main bay and then the open ocean. This sampling pattern was different from the other three bays where sampling stations were placed in the mid-channel, in side bays and off headlands. The depths observed for the Chiniak stations averaged 39 m for C 1 and between 130 and 165 m for the others. Kiliuda Bay was the longest sampled (24 km) and had a sill present off Coxcomb Point, indicating its glacial origin. Station depths averaged 70 m deep and varied between 32 and 131 m. Kaiugnak Bay, the furthest south, was 15 km long and characterized by an irregular bathymetry and shoreline. Station depths varied between 41 and 137 m. Both Kiliuda and Kaiugnak Bays had several side arms and lagoons. Izhut Bay was also highly irregular in its morphology. The inner portion of Izhut Bay had at least seven distinct side bays, lagoons or coves. It was 15 km long, averaged 135 m deep (mean station depths were 31 to 164 m) and exceeded 200 m in depth at the entrance. The inner stations in Kiliuda Bay were probably the most protected ones while the inner Izhut Bay stations, except Z8 in Kitoi Bay, were the least sheltered from the Gulf's storms.

1.3.2 Current Knowledge of Hydrography

The Alaska Current flows southwest along the continental slope off Kodiak at rates of up to 100 cm/s (Dunn et al. 1979). It is believed to extend to the bottom of the slope, though slowing with increasing depth. A smaller branch flows west through Kennedy Entrance, then southwest through Shelikof Strait at 30-40 cm/s (SAI 1980). The main portion of the Alaska Current is overlaid with a band of low salinity water, the Copper River plume.

There is a net southwest flow over the mid-shelf region of 2-3 cm/s, though surface eddying and turbulence with speeds to 30 cm/s has more impact on the area. A small surface inshore drift of 1-3 cm/s occurs in Kiliuda Trough, through the speed and duration are quite variable (SAI 1980). An inwardly-directed bottom current of 3-10 cm/s is also present there and similar bottom currents have been hypothesized for Chini ak and Stevenson Troughs (SAI 1980).

Vertical mixing of offshore waters is due to tides, winds and thermal convection. Tides over the Kodiak Shelf are mixed, semi-diurnals with a mean range of 2 m at Kodiak. The variability in range extends from 0.4 to 4.2 m. The winds in the lease area average 5 to 6.5 m/s in the summer and 9.5 to 10.5 during the winter. Wind direction is predominantly from the southwest May through September and from the north and west-northwest otherwise. There is weak upwelling June to August and very strong downwelling throughout the remainder of the year (SAI 1980). The upwelling index varies between +10 in July and August to -120 in January (Ingraham et al. 1976). Complete vertical mixing over the banks is observed, while the water column in the troughs is stratified throughout the year below 150 m (Dunn et al. 1979; SAI 1980). Four vertical layers (surface, thermocline, temperature-minimum and temperature-maximum) were observed during periods of stratification by Dunn et al . (1979).

The distribution of surface salinity indicates high runoff diluting coastal waters to as low as 29^{o}/oo off the Kenai Peninsula. The Copper River plume also produces low surface salinities along the slope while the mid-shelf region has typical values of 32.3^{o}/oo. Oceanic surface salinities beyond the plume are in excess of 32.6^{o}/oo (Dunn et al. 1979; SAI 1980). Bottom salinities decrease from 33.80/oo on the slope to 32.5^{o}/oo nearshore, This decrease is depth related as the troughs maintain bottom salinities greater than 32.60/oo while the adjacent banks have values between 32.3 and 32.40/oo. The complete and frequent mixing over the banks contributes to the lower bottom salinities observed.

Offshore surface temperatures are a function of seasonality and no consistent horizontal pattern is apparent. The recorded range is 4.5° to 14°C. Inshore surface water temperatures in the winter of 1°C and ice formation in the more protected inlets are common. Sumner surface temperatures can exceed 14°C at the heads of some inlets, though maxima of 10° to 12°C are more common (Rogers et al. unpublished NODC data). Bottom temperatures below 2°C are found in the nearshore on the east side of the Kodiak Archipelago. The bottom water warms to over 5°C in the outer parts of the troughs and along the 200 m contour of the slope (SAI 1980). The temperature at the 2,000 m contour is 3"C. The low bottom temperatures of the nearshore are anomalous as these values are not reached in the bays and fjords off Shelikof Strait or Kennedy Entrance.

Light hydrocarbons, principally methane, vary seasonally between. 150 and 2,000 nl/l (Cline et al. 1978). Surface concentrations of methane south of Chiniak Trough are 200 to 300 nl/l. Bottom concentrations have a similar distributions, though with higher values (Cline et al. 1978). Portlock Bank, the northern most one, has the lowest values. Ethane and propane are similarly distributed while ethene and propene concentrations have a different distribution. Cline et al . (1978) hypothesize that ethene concentrations may be controlled by primary productivity *or* by the same processes controlling primary production.

Heavy metals (cadmium, copper, lead, mercury, nickel, silver and zinc) measured in the water column over the Kodiak Shelf were evenly distributed and lower than oceanic means (SAI 1980).

1.4 Current Knowledge of Kodiak Plankton Ecology

This literature review of plankton ecology from the Kodiak Shelf area covers the distribution and abundance of zooplankton in the region and what has been learned concerning the lower trophic level dynamics of the pelagic community in that part of the Pacific.

1.4.1 Review of Zooplankton Distribution and Abundance Near Kodiak Island

No zooplankton measurements were made in the continental shelf area directly east of the Kodiak Island prior to the OCSEAP investigations with the exception of a pair of biomass estimates from the Central and South Albatross Banks (AEIDC 1974). The nearest location sampled for zooplankton species enumeration was east of Kennedy Passage in the Gulf of Alaska (northeast of Kodiak, Damkaer 1977). Thus, information about the distribution, abundance and trophic interactions of the zooplankton of the Kodiak Continental Shelf has been largely gained by inference from nearby or similar areas. The three relevant regions studied were Cook Inlet, Prince William Sound and the northeast Gulf of Alaska (AEIDC 1974; Cooney 1975, 1976; Cooney et al ., 1973, 1978; Damkaer 1976, 1977) . Less important data sources included studies of the east Bering Sea (Motoda and Minoda 1974), around Amchitka Island in the Aleutians (McAl ister and Favorite 1977}, the central gyre of the Gulf of Alaska (Gul 1 and, 1972; Johnson and Brinton 1963; LeBrasseur, 1965; Marlowe and Miller 1975; NORPAC Committee, 1960), and northern southeast Alaskan waters (Wing and Reid, 1972).

Mean settled volumes of zoopl ankton from Cook Inlet coll ected in 1976 varied between one and 31 ml m^{-3} (Damkaer 1977). Values from the open waters of the Inlet and outside in the Gulf of Alaska peaked at 11 ml m^{-3} during the summer. In Prince William Sound, Damkaer (1976) found that settled volume varied between 0.1 and 7.4 ml m^{-3} depending upon season and time of day. NORPAC (1960) biomass values for zooplankton collected northeast of Kodiak Island were about 2.0 ml m^{-3} while north of Afognak Island this value increased to 0.4 ml m^{-3}. It should be noted that these values are based upon very few samples. The biomass estimate from South Albatross Bank (Hokkaido University data cited in AEIDC, 1974) was over 500 mg wet weight m^{-3} while the estimate from the Central Bank was considerably less. Biomass tended to decrease offshore.

nearshore region, becoming common farther offshore in the fall and having their highest densities over the entire study area during the late winter. T. longipes, T. inspinata and E. pacifica were primarily found in the slope with a similar seasonal pattern. The distribution over the study area of both T. longipes and E. pacifica was closely related to the apparent distribution on the shelf of deep (>200 m) oceanic waters with temperatures <5.0°C and salinities ≥32.6‰. The remaining two species, T. oculatus and Stylocheiron sp., were found infrequently year-round along the slope. The latter species was apparently brought into the area by the Alaska Current. Diel vertical migration was observed for adult T. inermis and T. spinifera while larval stages remained on the upper 50m throughout the day.

Euphausiid length-weight frequencies were presented in Table 10 and Figures 48 through 50 in Kendall et al. (1980). The five most abundant species, T. inermis, T. longipes, E. pacifica, T. spinifera and T. raschii, were measured. The data supported Ponomareva's (1963) contention that boreal euphausiids have a biennial life cycle. The large reproductive individuals were 25-27 mm long for T. inermis, 25-29 mm for T. longipes, 21-25 mm for E. pacifica, 25-31 mm for T. spinifera and 19-20 mm long for T. raschii. Mean lengths were between 16.1 and 16.8 mm for all species except T. raschii which averaged 14.0 mm. Mean weights varied more; T. inermis, T. raschii and E. pacifica averaged between 14 and 18 mg, while T. longipes and T. spinifera were 26 and 23 mg, respectively. Mean values were strongly biased toward non-sexually reproductive individuals because members of the first year class far outnumbered the second year group for all species measured.

The analysis of inshore Kodiak invertebrate holozooplankton reported by Roger, et al. (1979a,b) was even shorter than that provided by Kendall et al. (1980) and Dunn et al. (1979). Copepods, euphausiids and the larval stages of barnacles and decapods predominated in all bays sampled. Larvaceans, gastropod and cladocerans were also common on occasion.

Copepods averaged 87% by number of the total holozooplankton in Izhut and Kiliuda Bays. The predominant species found by Rogers et al. (1979a,b) at station 2 in these two bays from R/V Commando cruises 78-1, 3, 5, 7 and 9 were Pseudocalanus spp. (77.6% of the total numbers of copepods), Acartia longiremis (10.7%), Calanus marshallae (4.3%), Acartia tumida (2.0%), Metridia pacifica (1.5%), and Centropages abdominalis (1.3%). Other common species included Calanus plumchrus, C. cristatus, Oithona spp., Microcalanus sp., Eucalanus bungii, Epilabidocera longipedata and Monstrilla spp.

Rogers et al. (1979a,b) examined euphausiids from eight stations in the four bays (stations 1 and 3 in each bay). The same set of species as found by Dunn et al. (1979) and Kendall et al. (1980) offshore, except for Stylocheiron sp., was found in the four bays. The dominant species were T. inermis (50%), and T. raschii (46.5%). T. spinifera and E. pacifica comprised an additional 3.2%. Mean adult euphausiid densities in Izhut Bay were significantly higher (95% level of confidence) than in the other three bays. Densities of larval stages were lowest in Izhut. The average density of T. raschii decreased southward from Izhut to Kaiugnak Bays, going from 284 to 41 per 1000 m3. No other horizontal patterns were noted. T. raschii was collected in greater numbers during the spring and summer than in fall and winter; no other seasonal patterns were found. Diel vertical patterns for the four common euphausiids were similar to those found offshore by Dunn et al. (1979) and Kendall et al. (1980).

1.4.2 Plankton Trophic Dynamics of South Central Alaska and the Kodiak Shelf Area

While studies of the trophic dynamics of marine zooplankton are in their early stages, a wide array of marine animals have been found which feed upon various components of this assemblage. A partial list of planktivores by food organism is present in Table 1.4-1 (Sources:

Raymont 1963; Russell-Hunter 1970; SAI 1979 a,b). The principal planktivores in the northeast Pacific are juvenile salmonids, pollock and Pacific Ocean perch; adult capelin, herring, Pacific sand lance and smelt; shearwaters; and baleen whales. The major food organisms are copepods; euphausiids; fish, barnacle and decapod larvae; amphipods; larvaceans; cladocerans and mysids.

Juvenile salmonids in the 0-150 mm size range are mainly planktivorous. Juvenile Oncorhynchus gorbuscha (pink salmon) off Kodiak feed upon copepods, amphipods, euphausiids, cladocerans, barnacle cyprids and larvaceans (Gosho 1977; Harris and Hartt 1977; Rogers et al. 1979a,b). High electivities are exhibited for larvaceans, copepods, cladocerans and barnacle cyprids (Bailey et al. 1975; Cooney et al. 1978). These zooplankton comprise 53.4% by weight of the diet of O. gorbuscha juveniles (Rogers et al. 1979b). O. keta (chum salmon) juveniles consume less zooplankton than young O. gorbuscha. Specimens from the Kodiak bays had a diet which was 27.6% zooplankton by weight (Rogers et al. 1979b). Harris and Hartt (1977), however, suggest that pelagic chum juveniles near Kodiak eat mostly calanoid copepods. Higher percentages and stronger electivities for zooplankton. consumption also have been demonstrated for this salmonid by Bailey et al. (1975) and Cooney et al. (1978). The diet of juvenile O. kisutch (coho salmon) collected by Rogers et al. (1979b) was 26.7% euphausiids by weight, indicating a very high selectivity for that group of zooplankton. Feeding habits of juvenile O. nerka (sockeye salmon) and O. tshawytscha (chinook salmon) in the Kodiak Shelf area have not been studied. The former species is known to be predominantly planktivorous when in freshwater though (Hart 1973).

Pelagic forage fish, fed upon by subadult salmonids, other commercial fisheries species, marine birds, some toothed whales and pinnipeds, consume enormous quantities of the larger holozooplankton. Nearly 100% of the diet of Mallotus villosus (capelin) from the Kodiak area was calanoid copepods and euphausiids (Harris and Hartt 1977; Rogers et al. 1979b). The remainder was an occasional decapod or fish larva. Food habits of osmerids, other than the capelin, from off Kodiak have not been examined. Hart (1973) indicates that all Pacific species of this family studied to date are exclusively planktivorous, with copepods, euphausiids, diatoms, crustacean eggs and ichthyoplankton as major foods. The other osmerids are much less numerous than the capelin, however. Young Clupea harengus pallasi (Pacific herring) feed exclusively upon copepods. Harris and Hartt (1977) found that 99% by weight of the gut contents of young Pacific herring collected in Kodiak bays were calanoids. The remaining 1% were harpacticoids. Wespestad and Barton (1979) found that larval and juvenile Pacific herring fed on copepods, diatoms, cladocerans, amphipods and decapod, barnacle and pelecypod larvae. Hardy (1965) reported that the Atlantic subspecies initially feed on Pseudocalanus, then included the larger calanoids and other zooplankton as it grew. Adults fed upon large zooplankton, such as the large Calanus species, Sagitta, Limacina and larval fish, e.g. young ammodytids. Ammodytes hexapterus (Pacific sand lance) was essentially planktivorous throughout its lifecycle off Kodiak, feeding mainly on calanoid copepods (40.1% by weight, Rogers et al. 1979b; 75%, Harris and Hartt 1977) and planktonic crustacean larvae. This preference occurred even in specimens collected in bottom trawls (Harris and Hartt 1977; Rogers et al. 1979b; Simenstad et al. 1978).

Juvenile demersal species of fish, particularly walleye pollock, eat sizable numbers of holoplankton. Theragra chalcogramma (walleye pollock) under 150 mm long from the Kodiak area eat 32.4% euphausiids, 22.4% mysids, 12.9% calanoids and 1.8% other zooplankton (Rogers et al. 1979b). In the 150 to 300 mm long size group, these organisms made up 29.7% of the gut contents by weight. Dependence upon zooplankton dropped to 2.9% in the adult pollock collected off Kodiak. Gadus macrocephalus (Pacific cod) and Microgadus proximus (Pacific tomcod) ate less zooplankton as juveniles in the 0-150 mm size class than did pollock, 9.6% and 37.9% by weight, respectively. The juvenile tomcod ate mainly mysids and euphausiids while juvenile cods were less specialized. The diet of pleuronectids in the 0-150 mm size range averaged 6.4% zooplankton by weight (Rogers et al. 1979b). Euphausiids, calanoid copepods and mysids were the main food items. Sebastes alutus (Pacific Ocean perch) of Kodiak feed mainly upon large calanoid copepods and euphausiids seasonally just before spawning; however, quantitative studies have not been published (SAI 1980). It may be inferred from the depths at which the larvae occurred (offshore surface waters, about 0-50 m) and at which juvenile stages occurred (125-150 m), that they are mainly planktivorous, but this is unproven. The depth distribution by age for Anoplopoma fimbria (sablefish or blackcod) suggests that the larvae are planktivorous and the juveniles may be (SAI 1980). Zooplankton comprised 1.7% by weight of the diet of subadult (length >151 mm) sablefish. Gut contents of juvenile (0-150 mm) greenings averaged 12.2% zooplankton (Rogers et al. 1979b).

The short-tailed shearwater and the small alcid species, among the marine avifauna, are essentially planktivorous. Euphausiids comprise 45% of the annual diet of the short-tailed shearwater and 75% in the spring (Sanger et al. 1978). This shearwater is the most abundant species of marine bird off Kodiak, 56.3% by numbers and 48.2% of the biomass (Sanger et al. 1979). An additional 30% of its diet by weight and the bulk (65%) of the sooty shearwater's is the planktivorous capelin. This implies that at least 59% of the biomass of marine avifauna east of Kodiak Island is, or only one step removed from being, directly dependent upon the zooplankton. The diet of the next three most common pelagic birds, the Common Murre, the Tufted Puffin and the Black-legged Kittiwake, are 55-65% capelin and 8-12% sand lance (another planktivore), and the latter two species of birds also consume 5-10% euphausiids. The exclusively planktivorous small alcids, Cassin's, Parakeet, Crested, Least and Whiskered Auklets, are also among the 20 most common species of birds offshore. As a result over 95% of the offshore Kodiak avian biomass and most of the common species are dependent upon zooplankton, either directly upon euphausiids or through planktivorous forage fish.

Six of the seven species of baleen whales known to occur off Kodiak live on euphausiids and copepods (Pike 1960; Nemato 1970; Nishiwaki 1972). Sei, blue and right whales live entirely on these zooplankters, while minke, fin and humpback whales add small, gregarious fish to their diet as well. Recent estimates suggest there are about 57,500 baleen whales of these species in the North Pacific at this time, consuming about 700 kilograms of food per day apiece (SAI 1980). The concentration of these whales off Kodiak is not presently known. Distribution of sightings, however, reveal a distinct pattern of occurrences related to bottom depths between 100 and 200 m with some out to the 2000 m contour, so a seasonal census should be possible to obtain and dependence upon Kodiak zooplankton calculated.

Ichthyoplankton past the yolk-sac stage and decapod zoea also graze upon zooplankton, though direct studies from the Kodiak area are not extant. Atlantic herring are known to eat diatoms, copepod nauplii, and small copepods, e.g. Pseudocalanus, Acartia and Oithona, initially (Hardy 1965). Unpublished gut content analyses of Pacific herring from southeast Alaska added small cladocerans and barnacle nauplii to this list. Cancer magister zoea have been found to eat diatoms, copepod eggs and copepod and barnacle nauplii (Lough 1975). It may be assumed that other ichthyoplankton and decapod zoeae feed upon similar types of plankton.

Zooplankton of the Kodiak Shelf are the only link between primary productivity there and almost all offshore organisms of higher trophic levels. The predominant commercial fisheries off Kodiak are for salmon, halibut, decapod crustaceans, herring, pollock, Pacific Ocean perch and sablefish. These fish, with the exceptions of halibut and sablefish, feed mainly on zooplankton as juveniles or throughout their life cycle, and/or are part of the zooplankton early in their life-cycle. Over 95% of the biomass of offshore marine birds is dependent upon euphausiids or planktivorous forage fish. The six rare and endangered species of baleen whales present feed mainly upon copepods and euphausiids. Therefore, over the Kodiak Shelf area, the bulk of all energy fixed by the phytoplankton and utilized by the trophic levels containing the species of commercial, ecological and/or aesthetic significance and importance is funnelled through the marine zooplankton of that area. Consequently, the population dynamics and sensitivity to pollution of zooplankton represent a potentially limiting factor for the entire pelagic ecosystem of the Outer Kodiak Continental Shelf.

2.0 METHODS AND MATERIALS

2.1 Field Methods

2.1.1 Field Gear and Sampling Procedures

Four types of sampling gear were used to collect the zooplankton analyzed in this study: 1) a Sameoto neuston sampler (Sameoto and Jaroszynski 1969) with a mouth opening of 0.3 m high by 0.5 m wide; 2) paired aluminum MARMAP bongo nets (Smith and Richardson 1977) with an interior diameter of 0.6 m; 3) a mechanical opening-closing Tucker trawl (Clark 1969), with an aperture of 1.0 m2 containing three or five nets; and 4) an epibenthic sled (a Tucker trawl mounted on skis). Net mesh pore size was 505 micrometers for all samplers except one bongo net where 333 micrometer mesh was used. All gear types were metered so the length of haul and volume of water filtered could be measured.

Sampling procedures followed MARMAP survey guidelines (Smith and Richardson 1977; Rogers et al. 1979; Kendall et al. 1980). At each station sampled a neuston tow was taken first, followed by an STD cast and an oblique bongo tow. Tucker trawls and epibenthic sled samples completed the sampling series at selected stations. Samplers were towed for about 10 minutes at a speed of 1 m per second. The rate of net retrieval for bongo and offshore Tucker trawls was 20 m per minute. The depths sampled were O to 1 m for the neuston sampler; O to 5-10 m above the bottom in shallow waters (< 200 m) and O to 200 m in deeper waters for the bongo nets; 10, 30, 50, 70 and 90 m for the inshore Tucker trawls; two or three oblique sampling depth zones related to the thermocline depth for the offshore Tuckers; and O to 1 m above the ocean floor for the epibenthic sleds.

For the diel studies, Tucker and neuston samples were collected every four hours for 24 hours on three offshore cruises and twice daily during all inshore cruises. Tows were made every four hours offshore and twice daily inshore. Ancillary physical-chemical data (mainly salinity, or conductivity, and temperature) was also collected for the diel series.

Samples were preserved in the field with a 5% formalin solution, buffered with sodium tetraborate at saturation. The samples were then shipped to a commercial sorting center where plankton displacement volumes were determined and various components removed for identification. Fish larvae and eggs were removed from the 505 urn samples and 500 invertebrate zooplankters were taken from the 333 urn bongo samples for major category identification. Two hundred adult euphausiids were also removed from each offshore 333 bongo sample, then identified, counted, and measured for length and wet weights. A like number was processed from the 505 bongo samples collected at stations 1 and 3 in each inshore bay. Five hundred decapod larvae were also removed from the 333 bongo samples. The remaining organisms were stored in buffered formalin at the Northwest and Alaska Fisheries Center.

2.1.2 Timing and Location of Sampling Effort

Samples from four offshore and 12 inshore cruises were analyzed. A summary of cruise dates and identifications is listed in Table 2.1-1. The offshore cruises were from 28 March to 20 April 1978, 19 June to 9 July 1978, 25 October to 17 November 1978 and 13 February to 11 March 1979. The inshore cruises were every two weeks from late March through August 1978 and once in November 1978 and in March 1979. There were five cruises each in spring and summer. Station locations are presented in Figures 2.1-1 through 2.1-5.

The offshore stations ranged from the nearshore over the bank and trough region of the midshelf and out to the continental slope (Figures 2.1-1 through 2.1-4). Most of the offshore stations were located to the southeast of Kodiak and Afognak Islands over the proposed lease area. However, six stations were southwest of Kodiak Island and Kennedy and Stevenson Entrances, between Afognak Island and the Kenai Peninsula, were also investigated. Offshore stations varied in number between 85 and 98 per cruise.

Initially five stations were established in Izhut, Chiniak, Kiliuda and Kaiugnak Bays (Figure 1.3-2). These were linearly arranged along the main axis of each bay and in front of the adjacent headlands. The outer three bay stations and the nearshore stations of the offshore cruises were placed in close proximity to each other. Three additional stations were added to both Izhut and Kiliuda Bays in May 1978 and station Chiniak 5 was deleted after August 1978. Twenty-six stations per cruise were sampled during the peak of the inshore program.

2.2 Laboratory Procedures

2.2.1 Sample Selection

Over 2800 zooplankton samples from 124 stations were collected off Kodiak Island during 1978 and in March 1979. A reduction of the number of samples and stations for zooplankton enumeration was necessary. Eight hundred eighteen were finally counted. The sample selection design had to meet the following criteria:

a. Spatial distribution covered the entire study area and maximized resolution in the areas of interest; Kiliuda Bay, Izhut Bay and the adjoining shelf waters.

b. Seasonal data was as complete as possible.

c. Information about key selected species was maximized.

The sampling program, which used four different gear types, and sampled at different times of the year, locations and depths, was approached as a stratified, nested-ANOVA sampling design (Sokal & Rohlf 1969), which enabled relative ease of sample selection.

The listed criteria suggested that an optimal selection of samples was one that included analysis of the entire sample set collected by one gear type, in order to maximize seasonal and horizontal distributional data and analysis of samples col lected by all gear-types, at selected stations to maximize vertical distributional data and resolution within the areas of interest. The alternative approach of selecting a large number of stations for analysis of samples collected by all gear-types, but not examining all possible stations collected, would weaken horizontal resolution in favor of vertical resolution. Since much of the area is relatively shallow compared to the known vertical migration range of zooplankton, most of the potentially observed vertical differences would be more a diel function (a lower priority topic) rather than actual vertical separation of species. The neuston sampler, Tucker trawl and epibenthic sled all were used to measure vertical patterns, depth localized populations, or diel migration.

Bongo nets, however, were used to collect samples for biomass and horizontal spatial distribution of organisms. Thus, the highest priority for enumeration was awarded the bongo samples, with less effort on the other gear types. The 333 urn Bongo samples were preferred to the 505 urn Bongo samples because of the lower escapement rates for immature and smaller forms (Jacobs and Grant 1978).

Final selection of stations where the collections by all gear types were analyzed was dependent upon the distribution of samples between stations as taken by the limiting gear type. Although the epibenthic sled was used the least number of times inshore, Tucker trawls were taken only at two stations; Kiliuda 2 and Izhut 2. Consequently, the bulk of the remaining samples analyzed came from these two bay stations. The Tucker trawls were limited to the Kiliuda 2 day series while night neuston and epibenthic sled samples series came from Izhut 2 to balance emphasis on the two bays. Inshore 505 bongos were analyzed from only these two stations. The inshore day neuston samples were selected to include Izhut 3, Kiliuda 1 and Kiliuda 3. Samples from all cruises were enumerated in each gear set, since seasonality was also an important topic.

Offshore eight neuston and eight bongo 505 samples, two from each cruise, and three Tucker trawl samples were also enumerated. The purpose of these samples was to obtain comparative information for sampling efficiency with the 333 Bongo data. A total of 818 samples was analyzed.

2.2.2 Selection of Key Species

Besides the predominant species, selected key zooplankters were enumerated. These key species included organisms: a) for which important commercial species exhibit high electivities (Ivlev 1961); b) that are major competitors for zooplankton with the commercial fish and shellfish species; c) that are predators of the planktonic lifestages of the commercially important species; d) that are possible keystone predators; or e) that have been shown to be particularly sensitive to pollution, especially hydrocarbons and trace metals in the water column.

The key species were selected by analyzing direct stomach content data, and by an extensive literature review on pelagic food web trophic dynamics, competition in the marine zooplankton, and marine pollution indicators. Key food species are arbitrarily defined here as those which make up more than two percent of the zooplankton component from the stomach contents analysis or comprise greater than two percent of the total volume of food.

The predominant species of copepods included Pseudocalanus spp., Acartia longiremis, Acartia tumida, Centropages abdominalis, Scolecithrella minor and Oithona spp. High electivity organisms included the three larger Calanus spp. (C. cristatus, C. marshallae and C. plumchrus), Metridia spp., probably Eucalanus bungi and Epilabidocera longipedata, Limacina helicina, the euphausiids, the larvaceans, and the cladocerans. Other high electivity organisms not analyzed here were mainly benthic, e.g. harpacticoid copepods, gammarid amphipods, mysids and meroplankton. Predators included the amphipods, **cnidarians** and chaetognaths. Species of **Conchoecia**, an **ostracod**, were also abundant compared to some of these groups, and were thus included.

2.2.3 Counting Methodology

Zooplankton samples went through six basic processing stages after receipt; inventory, biomass estimation, rough sorting, taxonomic identification, enumeration of important species, and conversion of the raw data into population density estimates. At the same time the samples were inventoried, they were checked for an adequate preservative concentration [following the recommended levels from the UNESCO (1968) Study], then stored in a safe location until processing. Biomass was estimated using the settled sample volume. The unsorted samples were poured into 500 ml pharmaceutical graduated cylinders and allowed to settle for several hours. The rarer forms were removed during rough sorting and placed in preservative-filled, sealed glass vials. These rarer zooplankters were subsequently identified and counted under a binocular dissecting microscope at 32X magnification.

Samples were sequentially divided with a **Folsom** plankton splitter until 400-600 copepods were obtained. All questionable identifications were placed in separate vials for later identification. Reference specimens were stored. The zooplankton in the split fraction were counted according to the following procedures:

1) A minimum of 400 **(± <5%)** copepods were identified to species and tallied as adults or copepodites; **Calanus** spp. copepodites were further separated into developmental stages.

2) Amphipods *were* enumerated in five groups; Parathemisto sp., **Cyphocaris** sp., **Primno** sp., gammarids and others. Specimens of Parathemisto sp. and Cyphocaris sp. were saved for species identi-

fication. The majority of the specimens in these two genera were Parathemisto pacifica and Cyphocaris challenger. Identification of all gammarids was verified to sub-order and the specimens saved for future species identification. The remaining amphipods were identified to species, except where taxonomic problems existed (e.g. the genus Hyperoche).

3) Larval euphausiids from all *inshore* stations were counted by stage. Two hundred adult and late juvenile (length > 11.0 mm) euphausiids were identified to species from stations Izhut 2, 5 and 6 and Kiliuda 2 and 5 from each cruise to supplement previous data from these bays.

4) Chaetognaths were routinely identified to genus. The first 25 specimens from each sample were further identified to species.

5) Larvaceans were enumerated as Oikopleura spp., Fritillaria borealis or unidentifiable due to physical condition of the specimen.

6) Other routinue counting categories were Conchoecia spp., Evadne spp., Podon spp., and Limacina helicina. Species identification of each was attempted on a cruise-by-cruise basis. Other ostracods, cladocerans and pelagic mollusks were saved for later identification as were cnidarians, mysids and pelagic polychaetes.

Assurance of quality was obtained through periodic, random audits of the extent of adherence to standard procedures and the reproducibility of the data. These audits consisted of independent re-analysis or reprocessing of the sample or data by two researchers, one a senior level scientist. The acceptable level of error between the original and rework results for identification and enumeration of samples was ±10%. Five percent of all samples were audited and the results logged. An additional five percent were counted in triplicate to verify the calculated level of confidence of the enumerations. Internal, blind verification of difficult identifications was routinely done, and all questionable identifications were submitted to outside recognized authorities on the appropriate taxonomic group.

2.2.4 Verification of Subsampling Procedures

2.2.4.1 General Considerations

Two analytical problems must be solved to provide the optimal sample aliquot size. These are finding the number of individuals which must be counted in order to tally all of the species present, and making an accurate determination of the percent contribution of each species to the total sample. The most accurate way to answer these questions is to count the entire sample, or secondarily, to take replicated sub-samples. However, time considerations make these methods unfeasible; hence the need to count a single, large sample.

Calculation of the contribution of any one species to the total sample population is considerably less difficult and susceptible to error than determination of the number of species in a sample from an aliquot. Once the level of variation is chosen for the former calculation, determination of the number of individuals to be counted is easily obtained. Since the organisms have been randomly distributed by the plankton splitter (Jacobs & Grant 1978), the counts of each subsample should obey the Poisson distribution (Elliott 1971). Under these conditions the sample variance equals the sample mean (Snedecor & Cochran 1967) and the optimal number to be counted equals the reciprocal of the square of the desired confidence level (Cassie 1971; Watt 1968). For the 0.95 level of confidence it is 400 organisms. With only 300 organisms the resulting confidence level is 94.3%. Subsample size of 300-600 organisms has been frequently used in zoo-plankton studies (e. g., Peterson & Miller 1976; McAlister & Favorite 1977). Repeated splitting until each common organism has numbers in a given subaliquot between 100 and 200 (Jacobs & Grant 1978) is a common alternative.

Various methods of determining the number of species in a sample from an aliquot or in a population from a sample have been used in diversity studies (Pielou 1969, 1975). For a large sample (number of individuals is greater than 1,000) and for an association of species which obeys the discrete lognormal distribution, Preston's (1948) canonical index or the modification of Patrick, et al. (1954) provide a simple and relatively accurate means to obtain the theoretical total number of species present (Pielou 1969). Pielou (1975) has also demonstrated that the assemblage does not have to obey a discrete lognormal distribution of numbers and species to have an estimate made of the theoretical total number of species; it is merely more mathematically complicated to obtain.

Sanders (1969 as reviewed in MacArthur 1972) demonstrated for benthic invertebrates that a subsample of 400 individuals randomly drawn from a sample of over 2,000 will tend to include at least 75 to 80% of the total number of species present and that the rate of addition of new species is drastically reduced beyond that subsample size. Dennison and Hay (1967, as reported in Douglas et al. 1978), using binomial sampling theory, estimated that a minimum of 300 specimens must be counted in order to detect a species that constitutes 1% of the total population with a 95% level of confidence. Although direct verification through use of zooplankton counts has not been reported, other types of organisms with similar sized species assemblages tend toward a consistent pattern which can be utilized in counting zooplankton.

2.2.4.2 Level of Accuracy Obtained

The subsampling technique was verified through statistical analysis of the samples recounted in triplicate. The results from the 40 samples indicated that the Folsom plankton splitters used had an average coefficient of variation equaling 7.5% for total numbers subsampled. This variation was randomly distributed between the splitters used and among the counters. A comparison was made between the observed and expected (according to the Poisson distribution) relative abundance of the numbers of copepod species tallied in each **subsample.** Agreement between observed and expected values was excellent. The average number counted in the **subsamples** was 534 **copepods.** The calculated level of confidence that all species with an abundance greater than 1% of the total had been tallied in any given **subsample** was 95.67%. The observed value from the 40 recounted samples was 95.71%.

Individual audits for identification verification yielded an average variation between counters of 5.5% with a 1.8% coefficient of variation. Much of the variation observed was due to differences in the identification of Cal anus copepodite stages to species.

The smal 1 size of the **subsampl** es indicated that, as suggested by Sanders, a large percentage of the total number of species present in each sample would not be observed by the counters, thus biasing the counts toward the more abundant species. Preliminary analysis of some of the recounted samples strongly supported this hypothesis. The densities of the missed species were so low, however, that to increase the individual sample size to include the bulk of them would have reduced the number of samples counted to an eighth or less the amount actually enumerated. Counting a large number of samples increased the probability of observing rare species, counteracting this problem for the data set as a whole.

2.3 Data Reduction and Management

Counts were tallied on pre-coded data sheets designed to be keypunching forms (see Appendix 2 for an example of each type of data sheet). The coding format followed the November 1978 edition of NODC File Type 124-Zooplankton, except where a modification in Record Type E was required to handle the enumeration of Calanus spp. copepodite stages.

This expansion, and the parallel separation of all copepods into adults by sex and copepodites, was deleted in the final digital data tape submitted to NOAA/OMPA. The original data set with copepodite counts is on disc file at VTN and on the data sheets submitted to NOAA/OMPA.

The keypunched counts were sorted by cruise, gear and station. Verification of the keypunched cards was performed as was an initial editing of the data. The sorted cards were then stored on a magnetic tape. The magnetic tape was used to create a disc file on which a second edit of the data was made. Densities as numbers per m3 were calculated, then added to the final tape. This tape was then submitted to NOAA/OMPA for a third edit and was used to generate contour maps of zooplankton densities.

The density data was transferred to $\log_{10}$ (numbers m^{-3} + 0.0001) with zeros set to equal -4.0000. This was done because zooplankton densities are very patchy, thus a difference in the transformed data was more likely to be an actual difference, not the biasing effect of a patch. A second reason for this transformation was to partially standardize the graphics with those of Dunn et al. (1979) and Kendall et al. (1980) so enabling easier comparisons and providing a more consistent Kodiak Shelf data base for other scientists.

2.4 Data Analysis

2.4.1 Statistical Computations

The sampling program, as noted earlier, is an example of a stratified, nested-ANOVA sampling design. This design enables numerous statistical tests to be performed on the data (Hicks 1964). A brief selection of potential tests (from Draper and Smith 1966; Pielou 1969; Snedecor and Cochran 1967; and Sokal and Rohlf 1969) includes: nested and two-way analyses of variance between treatments; correlation and multiple linear regression analyses between species and between species, numbers and physical-chemical parameters; residual aria"lysis; canonical variate analysis; and species-abundance relations.

The statistical tests selected were:

1) Multiple correlation on 20 key groups with physical-chemical parameters and holoplanktonic predators (5 independent variables);

2) Establishment of mean densities, rank order by abundance for each location, and rank order by abundance and frequency of occurrence by season for each of the key species in each of the bays of interest;

The statistical tests were primarily run on the 333 urn Bongo data set (636 samples). Some statistical comparisons were performed on the neuston and Tucker trawl data sets. These analyses were limited to t-tests comparing means of different subsets of data.

The statistical analyses were performed on the Statistical Analysis System's (SAS) set of programs on an IBM 370 computer at Mellonics Information Center in Canoga Park, California. Contour maps of all zooplankton except Calanus spp. stages were generated from this study's data by the National Oceanographic Data Center, the EDIS Data Center of NOAA in Washington, D.C. Other visual graphics and maps were produced by VTN's environmental drafting department.

Locations compared included stations within bays, bays with other bays and different areas offshore. These offshore areas included the "nearshore", the mid-shelf banks and troughs, and the continental slope previously compared by Dunn, et al. (1979) and Kendall, et al. (1980), plus a fifth area southwest of Kodiak Island. The offshore areas are delineated in Figure 2.4-1.

2.4.2 Data Limitations

Reliability of species density values decrease with decreasing count size. This problem is especially acute for the predacious non-copepods, particularly the amphipods. The small size of the subsample also increases the probability that not all of the rarer species were observed. This was demonstrated for inshore euphausiids and Sagitta, where one and two species, respectively, known to occur off Kodiak Island were not tallied.

Identification limitations occurred due to the condition of some of the samples caused by length of time in storage, length of time out of the preservative and failure on occasion to buffer the preservative in the field. The sampling procedures used also tended to damage certain taxa, e.g. cnidarians, larvaceans and salps, more than organisms with hard exoskeletons. A second type of limitation for accurate identification was the confused taxonomic state of some of the groups. Examples of this category included the genera Pseudocalanus, Metridia, and Hyperoche. Separation by species of young Calanus copepodites (I-III) was a third limitation. While stages were easy to distinguish, species separation within a stage is largely based upon size. The larger three species overlap in the early stages and the C. marshallae accessory photoreceptor, an important character for separation of species, is very difficult to see in CI and CII stages. Total length of copepodite stages in the Kodiak populations differed from populations found elsewhere in the northeast Pacific, thus compounding the identification problem. Separation of all stages and species, except C. marshallae I and C. plumchrus I, was eventually attained; but the reliability of the other separations done earlier is not perfect.

Euphausiid data was excluded from computer analysis except for samples collected in Izhut and Kiliuda Bays. This action was taken to avoid redundancy in data analysis, since Rogers et al. (1979a, b) had previously analyzed some of the inshore samples for euphausiids and Dunn et al. (1979) had likewise analyzed all the offshore samples. Further, euphausiids had been removed from many of the samples being processed in this study (Kendall, personal comm.).

There were several minor limitations to the data or its analysis. Missing information and information not obtainable limited certain types of data analysis. Trophic dynamics were the main example of this problem. A few samples were also missing or improperly collected, i.e. several times the bongo nets hit the bottom, collecting mud and benthic organisms, but were not retaken, and the resultant samples could not be analyzed.

3.0 RESULTS AND DISCUSSION

3.1 Species Composition

A total of 146 zooplankton taxa was identified from the Kodiak Shelf and Izhut, Chiniak, Kiliuda and Kaiugnak Bays. A taxonomic listing of all zooplankton identified is presented in Table 3.1-1. The predominant group was the Crustacea, represented by 95 taxa and comprising over 90% of the numbers collected. Copepods, followed by euphausiids, were the most abundant crustacean holoplankters. Amphipods were abundant, as were cladocerans in the bays and ostracods over the shelf. Important non-crustacean holoplankters were larvaceans, pteropods, chaetognaths, and cnidarians. These nine major taxonomic groups comprised over 90% of the taxa and 99% of the individuals found.

Copepods were the most abundant taxonomic group, including 53 of the taxa and 85% of the individuals collected. Eighteen species of calanoid copepods were present over the shelf and 16 species were present in the bays throughout the year. *Pseudocalanus* spp., *Metridia* spp. (primarily *M. pacifica*) and *Acartia longiremis* were the most abundant calanoid copepods found in both the shelf and bay plankton. *Scolecithricella minor* was common offshore, while *Acartia tumida* and *Centropages abdominalis* were numerous in the bays. Five species of the genus *Calanus* were observed. *Calanus plumchrus* was the most common species offshore and C. *marshallae* was most common in the bays. *Oithona* spp. (primarily *O. spinirostris*) were the only common cyclopoid copepods in the samples. All other cyclopoid copepods observed belonged to the family Oncaeidae and were either deep-water forms (Heron and Damkaer 1969) or small species of the genus *Oncaea*. This genus was probably undersampled due to the mesh size of the gear used. Harpacticoid and monstrilloid copepods were present in small numbers. *Harpacticus* sp. (inshore) and *Microsetella* sp. (offshore) were the most common harpacticoid copepods found. This copepod assemblage is similar to that found by Threlkeld (1973a, b) in the northeast Pacific using similar sampling gear and mesh size and to that reported by Damkaer (1977) from Prince William Sound and the Gulf of Alaska.

The second most common group was the euphausiids. Six species of euphausiids were identified in samples taken from nine stations in Kiliuda and Izhut Bay. Thysanoessa inermis was the most common, followed by T. raschii. Euphausia pacifica, Thysanoessa longipes, T. spinifera and T. inspinata occurred infrequently. Rogers, et al.. (1979) also found that T. inermis and T. raschii were the most common euphausiids in these bays. They likewise identified the same less common euphausiids reported here.

Amphipods were the third largest group of crustaceans collected. The most abundant species were Parathemisto pacifica and Cyphocaris challengeri. Other common hyperiid amphipods were Primno macropa, Hyperia medusarum hystrix, Phronima sedentaria and Scina spp. Sanger (1972) observed a similar pelagic amphipod assemblage in the southeastern Bering Sea with the same relative densities of these species. Another species of Parathemisto, P. gracilipes, was observed in the current study. This species has not been previously reported from this area; its North Pacific range had been limited to the East China and Yellow Seas (Bowman 1960).

Other crustacean holoplankton included five species of cladocerans and four species of ostracods. The most common species were the cladoceran, Podon leuckarti, and the ostracod, Conchoecia alata minor.

Common non-crustacean holoplankters were the chaetognaths, cnidarians, larvaceans, and pteropods. The most common chaetognaths were Sagitta elegans, S. scrippsae and Eukrohnia hamata. Eukrohnia bathypelagica also was observed in some offshore samples. These specimens represent a small range extension northward for this species. Thirty-four species of cnidarians were identified. The most abundant of these were Aglantha digitale and Rathkea octopunctata. The genera Eutonina, Sarsia and Phialidium were also common. All of the larvaceans found belonged to the three species: Oikopleura labradoriensis, O. dioica and Fritillaria borealis. The only common pteropod was Limacina helicina. Other pelagic molluscs collected included Clione limacina, Clio sp. and squids.

Other animals observed in the plankton included: holoplanktonic salps, polychaetes and ctenophores; meroplanktonic barnacle, decapod, polychaete and fish larvae; and epibenthic mysids and cumaceans. All pelagic polychaetes found belonged to either the genus Tomopteris or the species Pelagobia longicirrata. The most common mysids were Acanthomysis spp., collected in the bays. Cumaceans were represented by Cumella sp.

3.2 Patterns of Holozooplankton Abundance and Distribution

3.2.1 Spatial Distribution

3.2.1.1 Inshore

No statistically significant ($p < 0.05$) horizontal within-bay differences in abundance were found in the nine zooplankton groups examined. One general trend was apparent in the entire data set: a gradient existed from the innermost bay stations to those outside and subject to more oceanic conditions. This gradient was expressed in two ways. First, zooplankton numbers tended to increase earlier in the spring at the inner-bay stations than at the other stations. Second, zooplankton numbers tended to reach a lower maximum density at the inner-bay stations than at the other stations. This fact may be explained by hypothesizing that copepod nauplii and early copepodite stages were probably more common in the inner bay and, as they are small, passed through the 333 um mesh net.

One statistically significant ($p < 0.05$) horizontal between-bay difference was found; the cnidarians had a greater mean density in Kaiugnak Bay (0.151 m^{-3}) than in Izhut Bay (0.010 m^{-3}). A generally north-south trend in density gradient between bays seemed to be present. Densities of copepods, cladocerans, larvaceans, cnidarians and pteropods were greater in the southern bays than farther north, while euphausiids, ostracods and chaetognaths exhibited the opposite pattern. Amphipods lacked a north-south trend. The increase in numbers of copepods, cladocerans, larvaceans and pteropods in the southern bays may be due to more phytoplankton being present, if primary productivity in Kodiak bays is light-limited and consequently would be less light-limited further south. Ostracods may be brought inshore out of the Gulf by a branch of the Alaska current which comes from the northeast off Kodiak. There is no apparent explanation for the distribution of the other four groups.

Diel vertical distribution of zooplankton collected in neuston samples and with the Tucker trawl was examined at Kiliuda Bay Station" L2. During the period between May and July 1978, the mean density of copepods at O, 10 and 30 m was an order of magnitude less than their mean density at 70 and 90 m. The mean density at the 50 m depth stratum during this period fluctuated between those of the other strata. No other statistically significant patterns were found.

3.2.1.2 Offshore

For statistical analysis, the shelf was divided into the four areas defined by Dunn, et al. (1979) and Kendall , et al . (1980) plus a fifth area southwest of Kodiak Island (Figure 2.4-1). Statistically significant (p <0.05) density differences for all cruises combined occurred between the slope and the other four shelf areas in four taxa: _Eukrohnia hamata, Conchoecia_ spp. and the aetideid and euchaetid copepods. Analysis by individual cruise resulted in 47 statistically significant (p <0.05) differences; 40 of these separated the sl ope from the other shelf areas. Four of the remaining significant differences separated the southwest stations from the nearshore, bank and trough stations. These 47 differences are further discussed separately under their appropriate taxon heading in Section 3.2.3.

3.2.1.3 Neuston Population Trends

Diel neuston populations differed greatly from those collected by either the bongo nets or Tucker trawls. Densities were much lower at the surface than in the water column and there was a predominance of males in the neuston samples, mostly Acartia longiremis, A. tumida and Epilabidocera longipedata. The low densities observed in these samples were due to the near absence of Acartia spp. females, Pseudocalanus spp., Metridia spp., Calanus spp., and Oithona spp. which were the predominant taxa collected by the bongo nets and Tucker trawls. Both the pelagic hyperiid and epibenthic gammarid amphipods maintained the same densities throughout the water column and thus comprised a greater percentage of the surface zooplankton compared to deeper populations. Chaetognaths were absent from diel neuston samples. There was an increase of all zooplankton in the night neuston samples over the diel populations although not to the same densities as lower in the water column. Numbers of female Acartia spp. and Epilabidocera longipedata greatly increased at night. No other differences between the holozooplankton collected with neuston samplers and in bongo nets or Tucker trawls were clearly present.

3.2.2 Seasonality

Seasonality was the dominant factor exhibited in the abundance of zooplankton on the Kodiak Shelf and in the bays studied. Four general seasonal patterns were observed in Tables 3.2-1 to 3.2-57. (A density of zero is assigned a value of -4.0 in Tables 3.2-7 through 3.2-57.) The most common pattern found was an increase in population density throughout the spring into summer, a maximum sometime between mid-June and August, and a decline in November. The second most common pattern was characterized by high densities in March and April, and a decrease to no individuals in August and November. The least common seasonal pattern exhibited minimum densities in March and maximum densities in November. The fourth pattern found was the lack of seasonal change in density. These patterns will be referenced in subsequent discussion as summer, spring, fall and non-seasonal patterns, respectively.

The copepods, with few exceptions, followed a summer seasonal pattern of peak density as did the cladocerans and the larvaceans. The euphausiids tended to have a summer density peak although this pattern was not as distinct as that of the preceding groups. Ostracods and pteropods from the shelf were non-seasonal, but ostracods collected inshore occurred mainly from March through early June, and pteropods tended to have a summer density peak. Amphipods and cnidarians were non-seasonal. Chaetognaths exhibited a fall pattern of maximum density.

An interesting seasonal pattern for Calanus spp. appeared when the inshore data was divided into adult, late copepodite (IV and V) and early copepodite (I to III) stages (Tables 3.2-15 to 3.2-18). Adult Calanus plumchrus occurred earlier in the southern bays than in the northern bays, but there were no differences in timing for Calanus marshallae adults or C. cristatus late copepodites. The peak density of C. plumchrus late copepodites was a brief, large and well-defined pulse early in the year in all bays, while late copepodites of C. marshallae exhibited a less well defined peak. The early copepodites of C. plumchrus and C. marshallae had a hi-modal seasonal pattern, suggesting that two separate cohorts developed.

The seasonal dominance tables ranked by density (Tables 3.2-1 and 3.2-2) demonstrated relative changes in abundance by season. There were three patterns observed: species which were always relatively common, e.g., Pseudocalanus spp. and Metridia spp; species which were always present, though relatively uncommon, e.g., aetideids; and species which changed seasonally in relative abundance, e.g., Centropages abdominalis and Conchoecia spp. Examination of the seasonal dominance tables ranked by frequency of occurrence (Tables 3.2-3 and 3.2-4) revealed less variability in species rank order than did those ranked by density. The three patterns were much less apparent.

3.2.3 Distribution of Selected Taxa

3.2.3.1 Total Copepods (Tables 3.2-7 and 3.2-8; Figures 3.3-1 to 3.3-4)

Total copepods inshore averaged 183.1 individuals m^{-3} with a maximum density of 3,281.9 m^{-3} in Chiniak Bay during July 1979. Over the shelf the geometric mean for all samples was 37.9 copepods m^{-3}. The highest mean densities occurred in early July (872.2 and 271.1 m^{-3} inshore and offshore, respectively). The lowest mean densities were likewise collected simultaneously in early March 1979 (1.5 and 3.8 m^{3}, respectively).

The horizontal distribution patterns observed were a composite of the five to ten most common species found. These usually included *Pseudocalanus* spp., *Metridia* spp., *Acartia* spp., *Calanus* spp. and *Oithona* spp. The most notable offshore patterns were high densities over Kiliuda Trough and the adjacent areas, particularly the nearshore, and low densities over North Albatross Bank during spring and summer.

3.2.2.2 *Calanus cristatus* (Tables 3.2-9, 3.2-10, 3.2-15 to 3.2-19; Figure 3.3-5)

Calanus cristatus Stages IV-V were present in small numbers throughout most inshore cruises. The largest numbers (mean densities of 9.41 and 8.20 m^{-3}) were found at Kaiugnak Bay during April and May 1978. A similar but smaller peak (3.33) occurred during March (2CM) at Kiliuda Bay. For all other cruises in the inshore study area, the mean density ranged between 0.0 and 1.8 m^{-3}. Early copepodites of this species followed a similar pattern, but preceeded Stages IV and V by two to four weeks. C *cristatus* adults were not present in the bay zooplankton samples.

The largest numbers of adults and late copoodites of C. cristatus occurred offshore during the summer (2.17 m^{-3}) while early copopodites were most numerous during the spring (5.36 m-3). Offshore this was the tenth most abundant species. The distribution of Stages IV and V during the summer was concentrated over the troughs and the earlier copepodites were similarly distributed.

3.2.2.3 Calanus plumchrus (Tables 3.2-11, 3.2-12, 3.2-15 to 3.2-19)

The population of Calanus plumchrus Stages IV-V followed a similar pattern of occurrence to C. cristatus at Chiniak, Kaiugnak and Kiliuda Bays, but with larger population peaks. Smaller numbers generally were present in Izhut Bay with the exception that during June (6CM) the mean density of 18.47 m^{-3} was highest of the four bays. The greatest densities (197.6 and 202.9 m^{-3}) were present during mid-April' (2 CM) and late April to early May (3 CM) at Kaiugnak Bay. Smaller population peaks occurred in Kiliuda Bay during April (54.76 m^{-3}) and in Chiniak Bay (35.97 m^{-3}) during the next cruise (3CM). Kaiugnak Bay showed a rapid decline in numbers after late April. Adults were present in very small numbers on 21 occasions throughout mid-May to August (cruises 4CM-19CM). Largest numbers were found during mid-July (8CM) when Chiniak C5 had 8.37 m^{-3} and Izhut Z2 had 6.09 m^{-3}.

Adults were absent from March to May (cruises 1CM-3CM) in all bays and were absent in Kaiugnak and Kiliuda Bays from early July (7CM) through the remainder of the sampling. No pattern of abundance by station location in any of the bays was apparent for this species. C. plumchrus Stages IV, V, and adults combined in Table 3.2-2 (seasonal dominance) ranked third in abundance during April and early May (2CM and 3CM).

Calanus plumchrus adults and late copepodites averaged 7.55 m^{-3} over the four offshore cruises. They were collected in their greatest numbers (11.85 m^{-3}) during spring and were least abundant in the fall (0.12 m^{-3}). This species was the third most abundant holoplankter collected over the shelf. Calanus plumchrus was uniformly distributed offshore.

3.2.2.4 Calanus marshallae (Tables 3.2-13 to 3.2-19)

Calanus marshallae Stages IV and V followed a later cycle of abundance than did C. cristatus and C plumchrus. The peak population density was reached between late June and August (7CM-9CM) in all four bays. Largest mean densities were recorded during June (7CM) at Kaiugnak Bay (37.72 m^{3}) and Kiliuda Bay (20.3). Stations with the highest population densities were Kaiugnak G2 with 121.6 m3 and Kiliuda L4 with 113.47 m^{-3}. Numbers remained high during July (8CM) and early August (9CM) in Kaiugnak Bay. Population peaks at Chiniak Bay occurred during July (23 .89 m^{-3}) and November (22.82 m^{-3}). Lower numbers were found at Izhut Bay throughout the sampling period with the highest mean density of 4.30 m^{-3} recorded in late July. A smaller population peak for Stages IV-V which occurred during April (3CM-4CM) led into an adult population peak during May (5CM-6CM) in all bays. The highest mean adult densities were seen during late May (6CM) in Chiniak Bay (6.06 m^{-3}) and Izhut Bay (5.24 m^{-3}). Similar numbers were recorded at Kil iuda Bay during May (5.67 and 4.46 m^{-3}). No adult popul ation peak was evident following the larger population peaks of Stages IV-V during July and earl y August (7CM-9CM). No pattern of abundance by station location in any of the bays was apparent for this species. Stages IV-V and adults were combined in one category (Table 3.2-2) for a rank order of seventh or above for seasonal dominance on all inshore cruises except the first two.

Calanus marshallae was the sixth most abundant species collected offshore. It had an average density of 1.88 individuals m^{-3}. The highest observed density by cruise was 3.62 m^{-3} during the summer and the lowest by cruise occurred in spring (0.26 m^{-3}). The troughs had the greatest mean density during the summer (4.05 m^{-3}) and had the lowest during the spring (0.004 m^{-3}) among the different areas. There were no patterns of horizontal distribution found offshore.

3.2.2.5 Calanus copepodites I-III (Tables 3.2-15 and 3.2-16)

Copepodite stages 1-111 of C. plumchrus, C. marshallae and C. spp. (other than C. cristatus) were combined in this study. Two peaks were evident, (March-April) 1CM-3CM, and June (7CM). These peaks led into the Stages IV-V peaks of the three species of Calanus. Highest mean densities were recorded in Kaiugnak Bay during late March (167.9 m^{-3}) and remained high during April. The second population peak occurred during June (7 CM) with highest numbers at Kil iuda Bay (210.9 m^{-3}). This peak may have been largely comprised of C. marshallae as there was no corresponding increase in C. plumchrus IV-V during July and August (Cruises 8CM-1OCM). As shown in Table 3.2-2, this category was the most abundant group in late March and second during April and early May.

The early copepodites of Calanus spp. averaged 18.04 m^{-3} offshore with their greatest collected density in spring (53.41 m^{-3}) and with the lowest during the fall (0.82 m^{-3}). This group followed the same offshore horizontal pattern as its most common species did as adults and late copepodites, i.e., none were found.

3.2.3.6 Pseudocalanus spp. (Tables 3.2-20 and 3.2-21; Figure 3.3-6 to 3.3-9)

Pseudocalanus spp. was the most common taxon found in the study area. Three forms occurred, but species identification was not assigned pending expected publication of a revision of the genus (B. Frost, personal communication). The geometric mean densities were 42.4 individuals m^{-3} in the bays and 8.7 m^{-3} over the shelf. The highest densities were found in Chiniak Bay during July and August (446.3 to 525.2 m^{-3}). Kaiugnak Bay had higher densities in March and April 1978 (91.7 to 181.7 m^{-3}) than the other bays, while Kil iuda Bay had relatively high densities in November 1978 and March 1979 (4.2 and 3.0 m^{-3}, respectively). The lowest monthly densities were found in March 1979 (0.4 m^{-3}). Chiniak Bay had the lowest average density (22.4 m^{-3}), though none of the four bays were significantly different.

Offshore there were significantly more _Pseudocalanus_ spp. during the summer (205.5 m^{-3}) than the other sampling periods. The geometric mean density during February-March 1979 was 0.8 m^{-3}, the lowest observed. The only statistically significant ($p < 0.05$) areal difference found was between the continental slope and the southwest area during the spring 1978 cruise. Higher densities characterized Kiliuda Trough, the southern nearshore area and North Albatross Bank during the spring, fall and winter cruises. There were minimal changes throughout the year over the shelf except during the summer.

3.2.3.7 _Metridia_ spp.(Tables 3.2-22 and 3.2.23; Figures 3.3-10 to 3.3-13)

Metridia spp. was the third most abundant taxon inshore, with a geometric mean of 1.6 individuals m^{-3}, and the second most common offshore with a mean density of 5.1 m^{-3}. The principal species was _M. pacifica_. The highest densities occurred during April (8.7 m^{-3} for all bays, 35.4 m^{-3} in Kaiugnak Bay) . The lowest monthly density inshore was 0.08 m^{-3} during March 1979. Chiniak Bay had both the single lowest monthly value (0.01 m^{-3}), and the highest bay average (3.1 m^{-3}) · Izhut Bay was the least densely populated with a geometric mean of 0.67 m^{-3}.

There were no significant differences between offshore cruises for _Metridia_ spp. The greatest observed mean density was attained during the summer (10.38 m^{-3}) and the least in winter (0.78 m^{-3}). The only significant areal difference was between the continental slope (15.78 m^{-3}) and the troughs (3.02 m^{-3}) and nearshore (2.40 m^{-3}) during the winter. High densities of *Metridia* spp. were found over South Albatross Bank and nearshore to Kiliuda and Kaiugnak Bays in June and July, while lower densities occurred over North Albatross Bank.

3.2.3.8 *Acartia longiremis* (Tables 3.2-24 and 3.2-25; Figures 3.3-14 to 3.3-17)

Acartia longiremis was the second most abundant species inshore with a geometric mean of 10.07 individuals m^{-3} and fourth most abundant over the shelf averaging 0.40 m^{-3}. The highest mean density inshore occurred during August (163.98 m^{-3}) and the lowest was 0.05 m^{-3} in March 1979. The single highest density by cruise and bay was 249.34 m^{-3} during early August in Kaiugnak Bay and the lowest density was 0.003 m^{-3} in Izhut Bay during April. There were no significant differences found between bays though the densities tended to increase from north to south.

Acartia longiremis was significantly more abundant during the summer and fall offshore cruises (11.28 m^{-3}) than in either the spring (0.02 m^{-3}) or late winter (0.01 m^{-3}). The species was significantly less common over the slope than elsewhere during the fall cruise. No other areal differences by cruise were found. The offshore distribution maps for this species indicated high densities in the nearshore, adjacent to Kiliuda and Kaiugnak Bays, which extended over Middle Albatross Bank and arts of Kiliuda Trough.

3.2.3.9 *Acartia tumida* (Tables 3.2-26 and 3.2-27; Figures 3.3-18 to 3.3-19)

This species was eighth most abundant on the average inshore and eighteenth most abundant offshore, with the mean densities of 0.105

and 0.003 m^{-3} respectively. The highest densities inshore occurred in April and early June, earlier than *A. longiremis*. The highest inshore density was 104.21 m^{-3} in Kaiugnak Bay during April. None was found inshore during November.

Offshore, *Acartia tumida* had a similar horizontal distribution to *A. longiremis*; however, it was absent in November and too scarce in February-March 1979 for a contour plot to be made. *A. tumida* attained its offshore maximum observed density during the June-July 1978 cruise (1.06 m^{-3}).

3.2.3.10 *Acartia clausi* (Table 3.2-28)

This species of *Acartia* occurred mainly at the inner bay stations. Its frequency of occurrence was 67% at Izhut Bay Stations Z6 and Z8 and 56% at Kiliuda Bay Station L6. Kaiugnak Bay lacked stations close to the shore or freshwater inputs, so the appearance of this species was limited to the innermost station, G1. *A. clausi* reached its maximum density during August. The highest density observed was 234.1 m^{-3} at Station 28.

3.2.3.11 *Eucalanus bungii* (Tables 3.2-29 and 3.2-30, Figures 3.3-20 to 3.3-23)

Eucalanus bungii was most abundant between late June and November throughout the study area. It attained maximum densities of 8.0 m^{-3} in Kaiugnak Bay during late August and 23.7 m^{-3} in the trough stations during the summer cruise. During this cruise *E. bungii* was significantly less abundant in the southwest area than over the troughs and continental slope. No other patterns in the data were noted for this species.

3.2.3.12 Epilabidocera longipedata (Tables 3.2-31 and 3.2-32; Figure 3.3-24)

This large calanoid copepod had an interesting vertical distribution pattern (Section 3.2.1); males were predominant in the day neuston samples. Females appeared in night neuston samples and were found deeper in the water column during the day.

E. longipedata was absent during March and April and attained its maximum density collected with bongo nets during November (3.7 individuals per 1000 m3 inshore and 6.5 per 1000 m3 offshore). The August and November inshore cruises were the only cruises to average densities significantly different from zero. The areas of greatest abundance were Izhut Bay and North Albatross Bank.

3.2.3.13 Centropages abdominalis (Table 3.2-33 and 3.2-34; Figures 3.3-25 and 3.3-26)

Mean densities of Centropages abdominalis were 0.25 individuals m^{-3} inshore and 0.004 m^{-3} offshore. However, this difference was not statistically significant as the data were highly variable and this species is strongly seasonal.

C. abdominalis exhibited a summer predominance pattern with a maximum mean density inshore during August of 23.78 m^{-3} and during the offshore summer cruise of 9.05 m^{-3}. It was more common in the southern than northern bays during 11 of the 12 inshore cruises. Offshore the only significant difference found was between the slope and nearshore zones during November. Relatively high densities occurred over North Albatross Bank during the summer cruise. During summer and fall C. abdominalis was relatively dense in the nearshore zone off the southern bays.

3.2.3.14 Scolecithricella minor (Tables 3.2-35 and 3.2-36; Figures 3.3-27 to 3.3-30)

Scolecithricella minor reached its maximum density during March and April inshore, then declined to very low densities by late July. A similar, though less obvious, seasonal pattern prevailed offshore. Mean observed densities were 0.01 m^{-3} and 0.10 m^{-3} for bay and shelf samples, respectively. The maximum densities were 1.37 m^{-3} and 2.72 m^{-3}, respectively. The same pattern of offshore areal differences observed in Centropages abdominalis in November held for S. minor.

3.2.3.15 Oithona spp. (Tables 3.2-37 and 3.2-38; Figures 3.3-31 to 3.3-34)

Oithona spinirostris and O. helgolandica together were the seventh most common taxon in the bays with a geometric mean density of 0.16 m^{-3}, and were the fifth most common over the shelf (0.13 m^{-3}). The period of greatest average abundance inshore was in August when the mean density for all bays was 2.83 m^{-3}. Kaiugnak Bay had the highest single abundance (8.4 m^{-3}) during late August. The southern bays had higher mean densities than the northern ones, although the highest single abundance observed in any bay was in Izhut Bay during late April (34.2 m^{-3}). The lowest mean monthly density (0.06 m^{-3} in 1978, 0.05 m^{-3} in 1979) of Oithona spp. inshore occurred in March.

Offshore, there were more Oithona spp. individuals m^{-3} during November than during the other cruises. This density (1.47 m^{-3}) was close to the inshore value (1.53 m^{-3}) during November. The only significant offshore areal difference observed was between the nearshore (0.13 m^{-3}) and slope zones (1.28 m^{-3}) during the winter cruise. There was also a consistently high density in the area south of Kaiugnak and

Kiliuda Bays during the spring, summer, and fall cruises. No other differences were apparent.

3.2.3.16 Total Euphausiids (Table 3.2-39)

Euphausiids were enumerated in Kiliuda and Izhut Bays. There was a higher density of both adult euphausiids and larval stages in Izhut Bay than in Kiliuda Bay. When all stages were combined, the euphausiids were the second most abundant major taxonomic group in both the inshore and offshore areas (Rogers et al. 1979b, Dunn et al. 1979, Kendall et al . 1980). The highest densities found offshore were over the inner midshelf where the nearshore species and the ones characteristic of the slope and outer midshelf, overlapped in distribution (Dunn et al. 1979, Figures 30 to 47).

3.2.3.17 Total Amphipods (Tables 3.2-40 and 3.2-41; Figures 3.3-35 to 3. 3-38)

The only common amphipod collected in most of the study area was Parathemisto pacifica. Over the slope zone, however, Cyphocaris challenger and Primno macropa comprised ten to twenty percent of the total numbers collected. Few benthic gammarid amphipods were observed in any samples. The patterns observed, consequently, were largely those of P. pacifica.

The mean densities observed were 0.04 m^{-3} and 0.09 m^{-3} inshore and offshore respectively. Parathemisto pacifica was significantly more common inshore between July and November than between March and June.

3.2.3.18 Total Ostracods (Tables 3.2-42 and 3.2-43; Figures 3.3-39 to 3.3-42)

Ostracods, like amphipods, were predominantly one species, Conchoecia alata minor. C. alata minor was most common during March over the entire study area. It was absent from mid-July through August in the bays and was rare during the summer offshore cruise. The geometric mean densities were 0.4 and 5.2 individuals per 1000 m3 inshore and offshore, respectively. Ostracods were significantly more abundant over the continental slope than elsewhere over the shelf during the summer and fall cruises. They tended to be less common southeast of Kiliuda and Kaiugnak Bays.

3.2.3.19 Total Cladocerans (Tables 3.2-44 and 3.2-45)

Cladocerans were absent offshore, except for a few specimens collected at nearshore and bank stations during the summer and fall cruises. Inshore this taxonomic group was third most abundant after copopods and euphausiids; however, during their increase in July and August, Podon spp. and Evadne spp. became more abundant than the copepods and euphausiids combined at seven of the inner bay stations. The maximum density (2,438 m^{-3} was found at Izhut Bay Station Z8 during early August.

3.2.3.20 Larvaceans (Tables 3.2-46 to 3.2-49; Figures 3.3-43 to 3.3.46)

Three species of larvaceans were identified from the Kodiak samples. The genus Oikopleura was the ninth most abundant taxon inshore and twelfth most abundant offshore. Larvaceans were the fourth most common major taxonomic group throughout the study area. Numbers of larvaceans averaged 0.08 m^{-3} in the bays and 0.03 m^{-3} over the shelf. The largest mean inshore Oikopleura density was 68.82 individuals m^{-3} in Kiliuda Bay during early August. A second, smaller density maximum of Oikopleura spp. was observed in April. These two population maxima reflected the presence of two species of Oikopleura in the samples. O.

labradorensis was the only species found off of Kodiak during April, while *O. dioica* was more common during the summer and was primarily responsible for the early August peak. The third larvacean species, *Fritillaria borealis,* was two orders of magnitude less numerous inshore than *Oikopleura* spp.

The largest geometric mean density of larvaceans collected offshore was 0.24 m^{-3} during the June-July 1978 cruise. There were no significant differences in offshore density between either cruises or areas. Larvaceans tended to be more abundant in the southwest area during the summer cruise and over the Kiluda Trough and Southern Middle Albatross Bank throughout the year than elsewhere offshore.

3.2.3.21 *Limacina helicina* (Tables 3.2-50 and 3.2-51; Figures 3.3-47 to 3.3-50)

This species was the only pelagic mollusc commonly found. It had a geometric mean density of 0.05 m^{-3} inshore and 0.10 m^{-3} over the shelf. This was high enough to make the major taxonomic group of pteropods the sixth most common group inshore and seventh offshore. *Limacina helicina* attained its largest observed density during late August inshore and during November offshore. There were no significant seasonal or areal differences, nor were there any consistent spatial patterns offshore.

3.2.3.22 Chaetognaths (Tables 3.2-52 to 3.2-55; Figures 3.3-51 to 3.3-54)

Chaetognaths were the third most abundant major taxonomic group offshore and seventh most abundant inshore. The highest densities found were in the November samples. The November inshore densities were significantly higher than the inshore densities at other times of the year. Kiliuda Bay and the southwest area offshore had the highest mean densities in November (2.11 and 1.83 m^{-3}, respectively). The highest mean density by cruise moved southward through each bay from March through July for all chaetognaths. After July the highest mean density returned northward for Eukrohnia hamata. There was no clear pattern for Sagitta spp. during this period. The sampling frequency offshore was insufficient to detect any similar trends. The most consistent off-shore spatial features were density depressions over the slopeside edges of North and South Albatross' Banks.

3.2.3.23 Cnidarians (Tables 3.2-56 and 3.2-57; Figures 3.3-55 to 3. 3-58)

Differences in the density of cnidarians tended to be small and statistically insignificant. The mean density of this taxonomic group throughout the study area was 0.03m^{-3}. Cnidarians were slightly more common in the bays and the nearshore than over the midshelf and continental slope; however, the only significant difference found was a higher density in February-March 1979 over the slope(0.41m^{-3}) than in the nearshore area (0.06m^{-3}). The highest geometric mean density observed inshore was 4.73m^{-3} during mid-June in Kiliuda Bay.

3.3 Relationships Between Holozooplankton Patterns, Bathymetry and Hydrography

The abundance of 20 important taxa of holozooplankton, as measured by $\log_{10}$ (numbers per m^3 + 0.0001), was correlated with salinity and temperature at 25 m and depth of the water column at the sampling location. Correlations were considered significant when $p \leq 0.05$.

Two broad contrasts were observed: increasing abundance with high temperatures and low salinities or with low temperatures and high salinities (probably a seasonality response); and a deep-water versus shallow water/inshore response. Some groups (discussed below) responded to only one set of contrasts and others to both; five groups, cnidarians, euphausiids, Limacina helicina, Epilabidocera longipedata and Oithona spp., exhibited no significant correlations with the selected factors.

Increased abundance occurred with high temperatures and low salinities for Calanus marshallae, Pseudocalanus spp., the larvaceans and total copepods. Taxa increasing in abundance with these factors along with a shallow water station location were Acartia longiremis, Centropages abdominalis and the cladocerans, while taxa significantly associated with high temperatures, low salinities and a deep station location were Eucalanus bungii and the amphipods. All of these organisms can be considered late spring-summer dominants with variable depth responses.

The alternative pattern of an increase in abundance with decreasing temperature and increasing salinity may be due either to cross-correlation with increasing station depth or a winter predominance pattern. These factors were not separable for Calanus cristatus or the ostracods. The increase of Calanus plumchrus, however, was related only to decreasing temperature and increasing salinity, while Acartia tumida is correlated to these two trends and decreasing station depth. These last two species may be true winter-early spring predominants. The abundance of the remaining two taxa, Metridia spp. and the chaetognaths, were correlated only with increasing depth.

Analysis of these correlations suggest that seasonality of hydrographic characteristics is more important than bathmetry for the holozooplankton though there were station depth relationships in selected groups. These are not strong correlations as the water temperature and salinity measurements came from a single depth and were not available for offshore. No apparent correlation between the abundance of any of the groups and water column hydrocarbon (primarily methane) concentrations was found; however, the latter data were sparse, so a strong correlation would have had to be present for it to be detected.

3.4 Relationships Between Holozooplankton Patterns and the Distribution of Higher Trophic Levels

3.4.1 Holozooplankton Predators

Extensive investigations of the relative impact of different types of planktivores upon zooplankton have been performed in freshwater ecosystems (Zaret 1980). Comparable marine examples were almost nonexistent. Marine studies have been more oriented toward plankton consumption rates and electivities by fisheries stocks as fry or forage species (Cushing 1968). Relative impacts of and competition by invertebrate predators, marine birds and baleen whales have been less documented. Cnidarians in inshore locations, e.g., Saanich Inlet (Huntley and Hobson 1978), however, have been found to control zooplankton numbers rather than fish. Centropages abdominalis and Metridia spp. were the only important holozooplankton negatively correlated with cnidarians in this study. More taxa were significantly positively correlated with cnidarian densities, suggesting that cnidarians may be relatively unimportant to the groups they covary with off Kodiak. A similar relationship prevailed with chaetognaths, another important invertebrate planktivore, with *Acartia tumida* being the only common copepod negatively correlated with chaetognath density. The lack of negative correlations between invertebrate planktivores and their prey off Kodiak Island suggests that these predators may comprise a relatively minor foodweb component in the study area.

3.4.2 Ichthyoplankton and Decapod Larvae

Rogers et al. (1979a) reported total ichthyoplankton densities in excess of 1 m^{-3} from early July (Cruise 7CM) through August (10 CM) at many of the bay stations. The innermost stations in Izhut (Z1, Z6, Z7, and Z8) and Chiniak (C1) during July reached densities over 10 per m^3. Density contrasts were greatest within Izhut and Chiniak Bays as the outer stations there had the smallest numbers of fish larvae collected. Osmerids, including capelin, comprised 90% of the ichthyoplankton collected inshore.

Dunn et al. (1979) reported that offshore ichthyoplankton was most abundant in the summer, and that marked seasonal predominance of different taxa occurred. Fall and winter samples were dominated by larval capelin and Irish lords, spring by sandlance and pollock fry and summer by larval rockfish and bathymasterids (ronquils and searchers). Kiliuda Trough had the highest concentrations of total ichthyoplankton throughout the year, though capelin were commonest over North Albatross Bank and substantial numbers of several species were collected in the nearshore zone.

The inshore zooplankton were most abundant during mid-summer, the period of greatest total ichthyoplankton abundance within the bays. Changes in zooplankton densities between bay stations (i.e., spatial or horizontal variability) seemed to be inversely related to the changes in density of ichthyoplankton at those stations. Offshore zooplankton were abundant over Kiliuda Trough and positively related to total ichthyoplankton. This pattern was not apparent for copepods over North Albatross Bank. The variable relationship between total ichthyoplankton and the major zooplankton taxa may be due to feeding by larval capelin upon zooplankton as well as the distribution and abundance of this species in the ichthyoplankton.

Dunn et al. (1979) analyzed the decapod larvae from both sections of the Kodiak Shelf area. All decapod larvae had either a spring, summer, or intermediate seasonal distribution pattern, similar to that of most of the zooplankton groups. No horizontal distributional relationships were apparent between decapod larvae and any major group of zooplankton.

The lack of any strong relationship in horizontal distribution, either positive or negative, implied that any predation by decapod larvae probably had a minor impact upon zooplankton populations and that probably no major zooplankton taxon was particularly important to the decapod larvae off Kodiak.

3.4.3 Juvenile Fish

Insufficient data was available for direct comparisons of Kodiak Shelf zooplankton densities and juvenile fish populations. There appeared to be a weak relationship offshore between the described distribution of juvenile pollock and catch rates of adult pollock (SAI 1980) and the distribution of copepods and euphausiids, particularly Euphausia pacifica and Thysanoessa spinifera. These species are food items of juvenile pollock (Rogers, et al. 1979b).

3.4.4 Planktivorous Forage Fish

Herring were concentrated in the bays and nearshore area of the Kodiak archipelago (SAI 1980). High densities were found in all four bays studied (Harris and Hartt 1977; Rogers et al. 1979a; SAI 1980). This distribution was strongly related to the high densities of copepods and cladocerans found in the bays. Copepods and cladocerans are important food items of the herring (Wespestad and Barton 1979).

Capelin were the most common fish collected in the pelagic zone of the Kodiak bays studied by Harris and Hartt (1977) and were one of the most abundant pelagic species found offshore, except over the slope (SAI 1980). Smelt larvae, probably capel in, predominated in the ichthyoplankton of the four bays studied (Rogers, et al. 1979a). The highest density of larval capelin in the bays was June through August (Rogers, et al. 1979a). The adults moved into the bays in May (Harris and Hartt 1977)., coinciding with a drop in bay zoopl ankton density in May and then a subsequent increase June through August when the adults were spawning, but not eating.

Offshore, the greatest density of larval capelin was from September onward over North Albatross Bank (Kendall, et al. 1980). Little density information was available on the seasonal distribution of the post-1 arval stages offshore (SAI 1980). There appeared to be a positive relationship between capelin and the zooplankton horizontal distribution inshore, and an inverse relationship seasonally. This relationship was not as well-defined, but appeared to exist offshore as well.

Atka Mackerel were found only in the epipelagic zone over the continental slope of the Kodiak Shelf (SAI 1980). Larval Atka mackerel were most abundant over the slope, Kiliuda Trough and the southern part of Middle Albatross Bank in the surface waters during the fall and winter (Dunn, et al . 1979; Kendall , et al . 1980). This is the same area where the euphausiids, Thysanoessa longipes and Euphausia pacifica, attained their greatest densities (mean densities of 137 and 59 per 1000 m^3, respectively, Dunn et al. 1979). Nothing is known about the food habits of the Atka mackerel; however it is believed to retain the food preferences of the pelagic juveniles of other species in its family (Kendall , et al . 1980). Pelagic specimens of this family in Kodiak bays ate mainly calanoid copepods, decapod zoea and euphausiids (Harris and Hartt 1977). There was an inverse relationship between the densities of copepods, Thysanoessa longipes and Euphausia pacifica and the density of larval Atka mackerel during the fall and winter.

Pacific sand l ante were found throughout. the study area (SAI 1980), though this species was more abundant as adults in the nearshore area (Macy, et al . 1978). This distribution was weakly related to the distribution of copepods, an important food item of sand lance (Harris and Hartt 1977; Rogers, et al. 1979b).

3.4.5 Marine Birds

The distribution and abundance of shearwaters in the spring and summer off Kodiak Island (SAI 1980) was positively related to the distribution and abundance of euphausiids (Kendall, et al. 1980) and less strongly, though positively, related to the density of total copepods. The bulk of the diet of shearwaters off Kodiak was composed of euphausiids and capelin (Sanger, et al. 1978). Since the capelin off Kodiak fed calanoid copepods and euphausiids {Harris and Hartt 1977; Rogers et al. 1979b), the relationships observed were probably casually-determined.

The distribution of flocks of two of the three next most common pelagic birds, the Tufted Puffin and the Black-legged Kittiwake,(SAI 1980) relate strongly to the described distribution of larval capelin off-shore of Kodiak (Kendall, et al. 1980) and weakly to the distribution of euphausiids and copepods. There was insufficient distributional data available for other birds (e.g., the small alcids) to compare distributions to zooplankton data.

3.4.6 Baleen Whales

Five species of baleen whales have been observed in the study area: the humpback, minke, fin, sei and blue whales (NODC file data; SAI 1980). A total of 198 indiv·duals were counted; humpback and minke whales were the most abundant species. The distribution of humpback and minke whale sightings were concentrated over the troughs, particularly Kiliuda, and the southe'n part of Middle Albatross Bank (SAI 1980). There was an apparent relationship between this distribution and spring-summer populations of euphausiids and copepods, especially late copepodites of Calanus cristatus. Euphausiids, copepods and planktivorous forage fish are the sole food items of humpback and minke whales (Nemato 1970; Nishiwaki 1972), suggesting a casual relationship.

3.5 Significance of Selected Holozooplankton to the Trophic Dynamics of the Kodiak Shelf

The copepods, euphausiids and cladocerans inshore appeared to be major prey for higher trophic levels. Chaetognaths, larvaceans and amphipods may also have some value as food. The distribution of cnidarians, pteropods and ostracods apparently had little relationship to the presence of higher predators, mainly because their biomass was relatively insignificant compared to the other groups.

The distribution of the larger copepods (Calanus spp., Metridia spp. and possibly Eucalanus bungi and Epilabidocera longipedata) along with that of the most abundant taxon of smaller copepod, Pseudocalanus spp., seemed to be related to the distribution of higher predators. The distribution of the smaller, less common copepods did not appear to be as closely related to the distribution of the higher predators. Relationships between euphausiids and higher predators were also apparent, e.g., Thysanoessa longipes, T. spinifera and Euphausia pacifica with the Atka mackerel and pollock.

The higher predators related to zooplankton distribution and abundance included holoplanktonic cnidarians and chaetognaths, ichthyoplankton, herring, capelin, Atka mackerel, shearwaters and two species of baleen whales (the humpback and minke). The spatial distribution of juvenile salmonids was also probably related to zooplankton distribution and abundance, given what the Kodiak stocks are known to eat. The capelin and Atka mackerel were the only predators related to obvious decreases in zooplankton densities. Since no information on feeding rates of planktivorous predators is available, we can not be certain at this time which predators have the greatest effect on Kodiak zooplankton population dynamics, despite these suggestive relationships.

3.6 Recommendations for Future Studies

Future studies concerning the zooplankton of the Kodiak shelf area should first address objectives which were not met by the present study . This would include both further analysis of the existing data sets and additional data collection. Hydrocarbon toxicity studies are lacking for the majority of the Kodiak shelf zooplankton. Future studies should also address the actual development of the oil and gas lease areas and should include an appropriate monitoring program.

The present study succeeded in describing the distribution and abundance of holozooplankton over the Kodiak shelf, but was largely unsuccessful in establishing the relationship of the holozooplankton to biotic and abiotic environmental factors. Future studies should specifically investigate and assess the importance of these relationships.

Our results suggested that the patterns of distribution and abundance of holozooplankton over the Kodiak shelf are mainly controlled by biotic environmental factors (disregarding seasonality). Food availability for the zooplankton should be better described, and should include information on both phytoplankton and microzooplankton. Even more important, though, is information concerning the predation selectivity of the predator species of interest in the study area. These include ichthyoplankton, capelin, herring and pelagic juvenile fish. The food habits of the Atka mackerel are completely unknown and may bear significantly on the Kodiak shelf zooplankton.

The present study has identified the key zooplankton species on the Kodiak shelf. These are the copepods, Calanus cristatus, C. plumchrus, C. marshallae, Pseudocalanus spp., Metridia pacifica, Acartia longiremis and Oithona spp.; the euphausiids, Euphausia pacifica, Thysanoessa inermis, T. raschii, T. spinifera and T. longipes; the amphipod, Parathemisto pacifica; the cladoceran, Podon leuckarti; the chaetognaths, Sagitta elegans and S. scrippsae; and the larvaceans, Oikopleura spp. Very little data exists on the toxicity of hydrocarbons to the 17 key taxa listed above. Laboratory toxicity studies are needed for the most important zooplankton species, and for larval fish and decapods and juvenile salmonids. Larval forms studied should include those of the herring, capelin, shrimp, and King, Tanner and Dungeness crabs.

Some of the remaining objectives of the present study could be met with a comparison of the existing but unavailable biological data sets with the zooplankton data generated here. Such a study would require a substantial amount of effort to get all of the existing data sets (e.g., birds, ichthyoplankton) into a single data base for statistical comparisons. The National Oceanic Data Center might be used since OCSEAP data are at least compatible to this system.

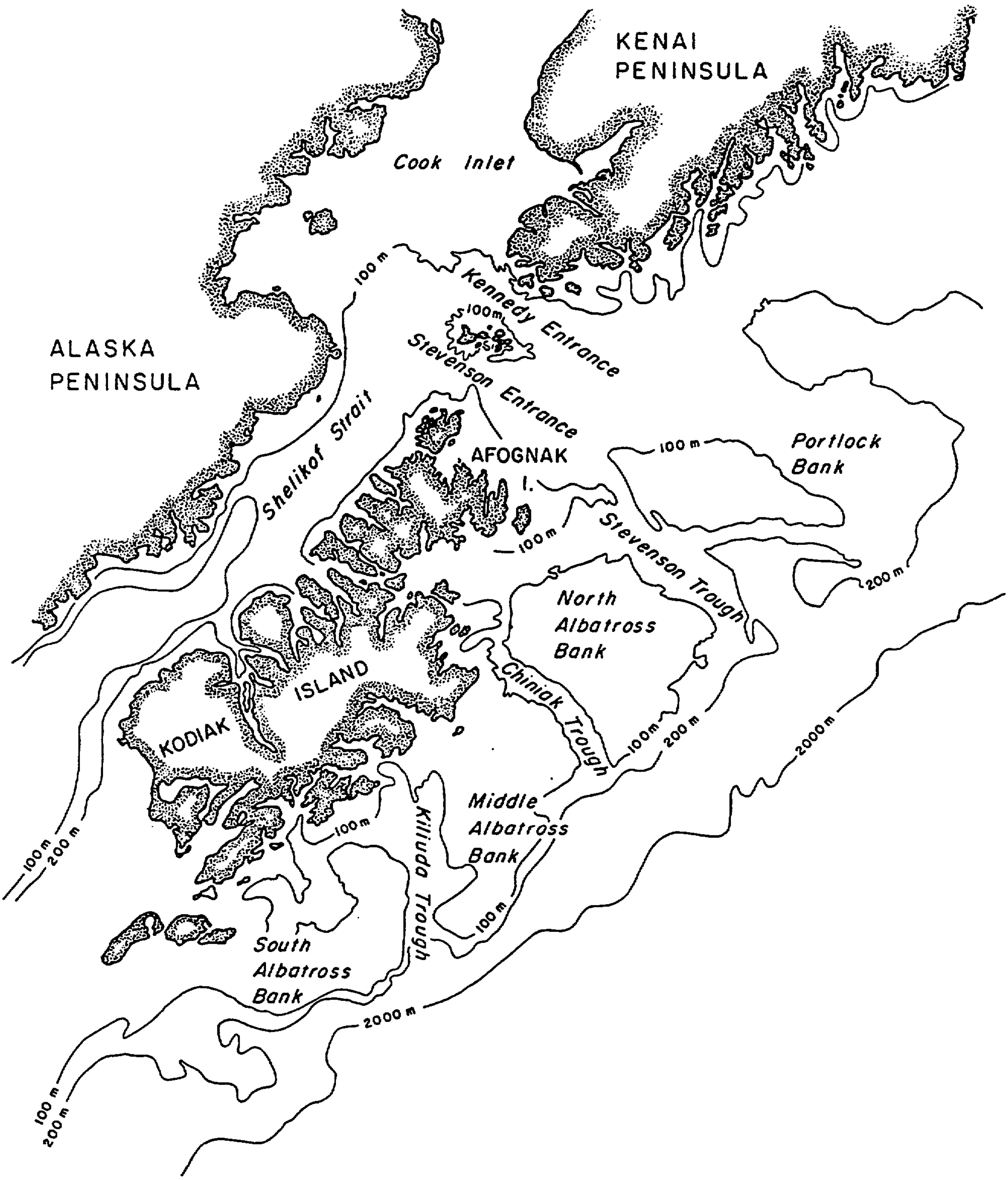
4.0 ACKNOWLEDGMENTS

We would like to thank Kathryn Garrison of the Fisheries Research Institute and Jerry Hornof of the School of Oceanography from the University of Washington, along with Arthur W. Kendall, Jr. and his co-workers at NOAA's Northwest and Alaska fisheries Center, for assistance in obtaining the samples and field notes, patience with our questions and sage advice on some of the problems resulting from field conditions when the samples were collected.

Thanks are in order to the following persons in our laboratory for their hard work and dedication in counting and identification of the samples: Harold B. Batchelder, Richard E. Conway, Joan D. Flynn, Judith L. Froggatt, Douglas A. Milward, Margaret C O'Brien, and Ronald A. Simmons. Data management and processing were handled internally by Margaret C. O'Brien and Williey D. Knox and by John J. Audet, Michael L. Crane, Dean Dale and Sid Halminski of NOAA. Assistance in data analysis was provided by Joan D. Flynn, Williey D. Knox, Margaret C. O'Brien, and Ronald A. Simmons. Barbara J. Priest prepared some of the graphs used in this report. Thanks are due to all of these people.

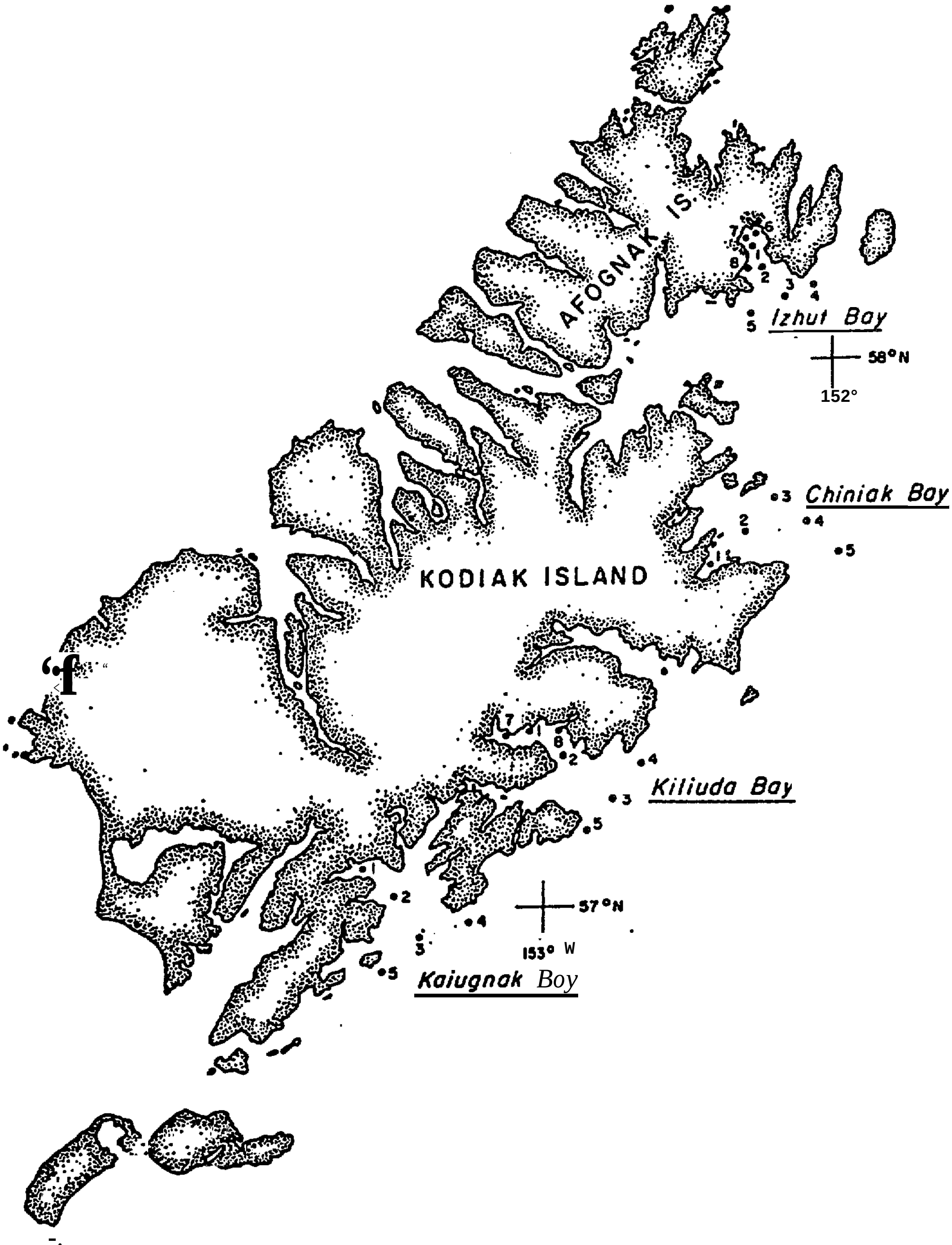
We thank Dr. William T. Petereson of SUNY-Stony Brook and Jeffrey Cordell of the University of Washington for taxonomic verification of _Calanus_ spp. and identification of _Harpacticus_ sp., respectively. Dr. Peterson also critically reviewed the manuscript.

We also wish to acknowledge the support received from Dr. Steven T. Zimmerman, our NOAA Technical Contact Officer in Juneau. Finally, a word of thanks is in order to our spouses and friends and the administrative staff of VTN Oregon who cheerfully supported us during the writing and editing of this report.



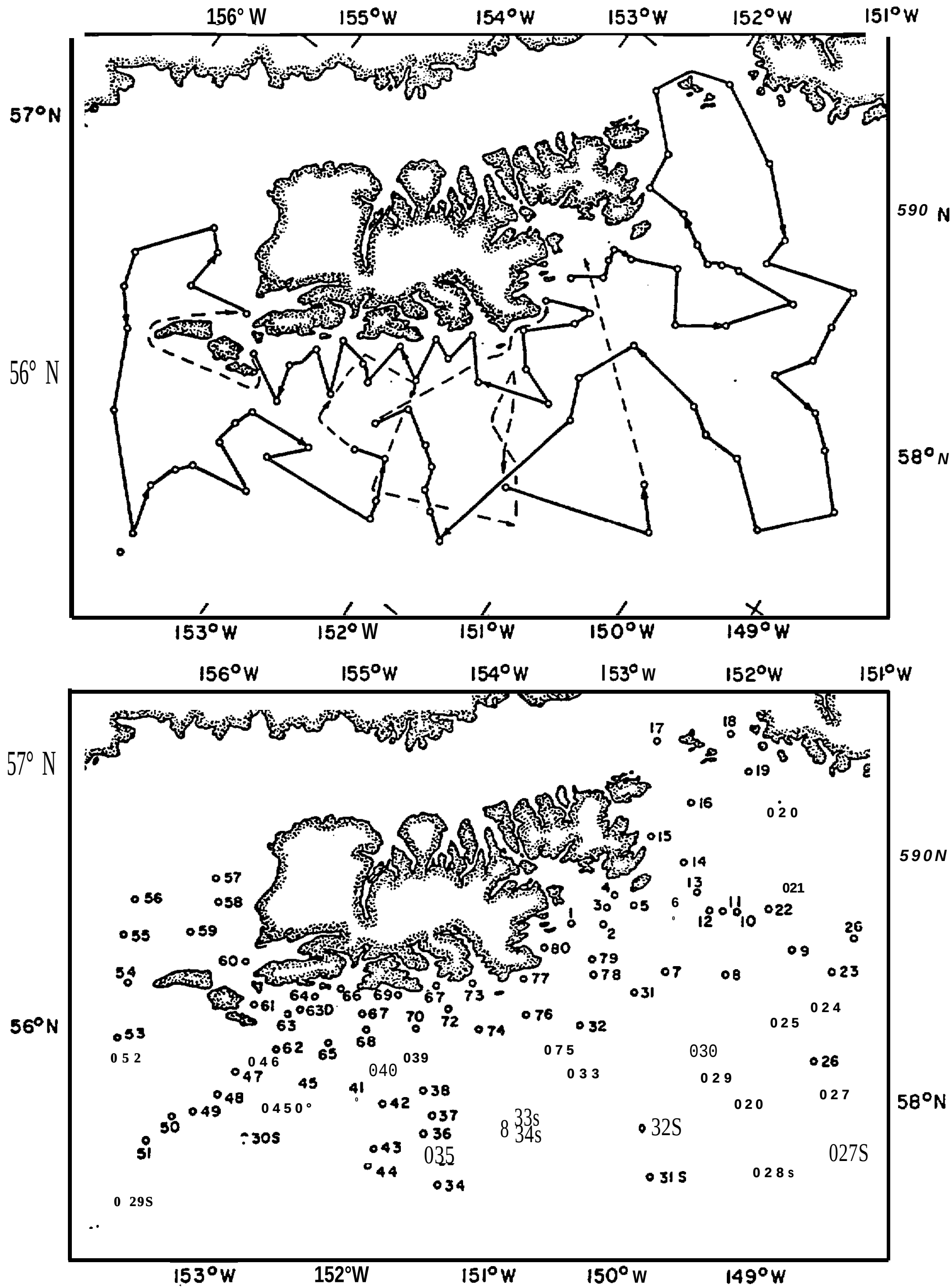
Kodiak Island study area depicting general bathymetry.

Figure 13-1



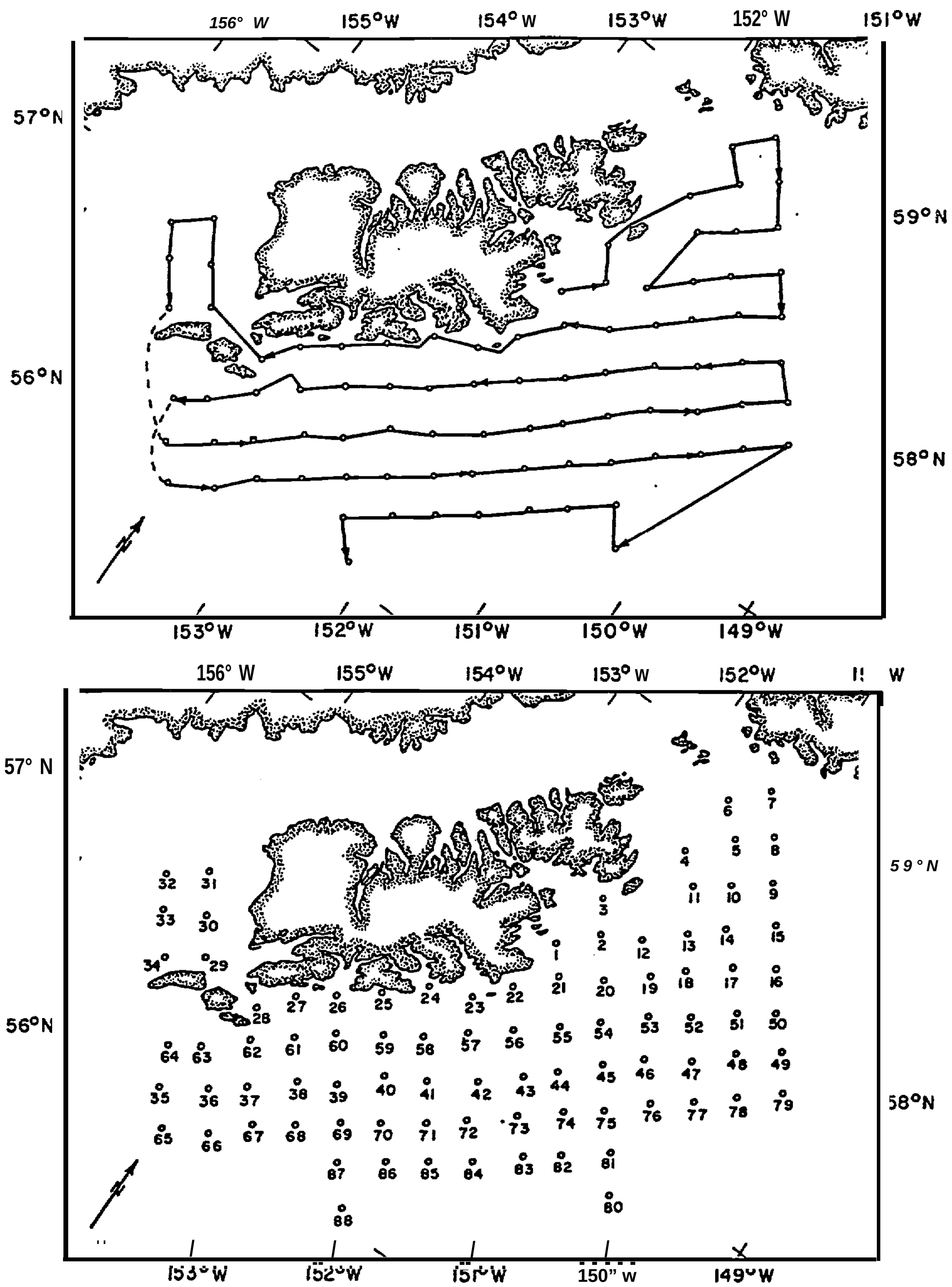
Bays and sampling locations of the inshore region of the Kodiak Island study area.

Figure 1.3-2



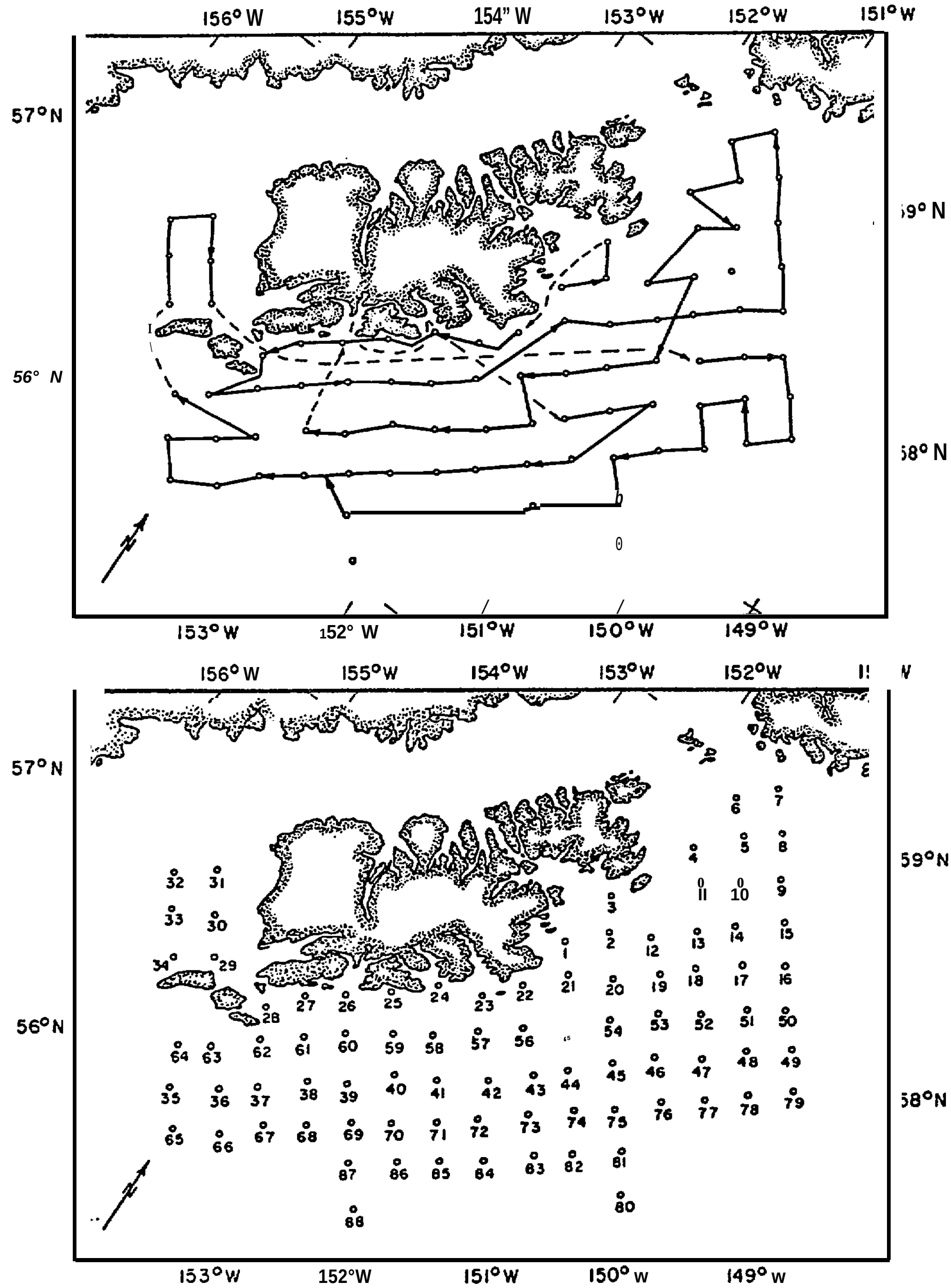
Cruise track (top) and station locations (bottom) for cruise 4DI78, spring 1978 (after Dunn et al. 1979).

Figure 2.1-1



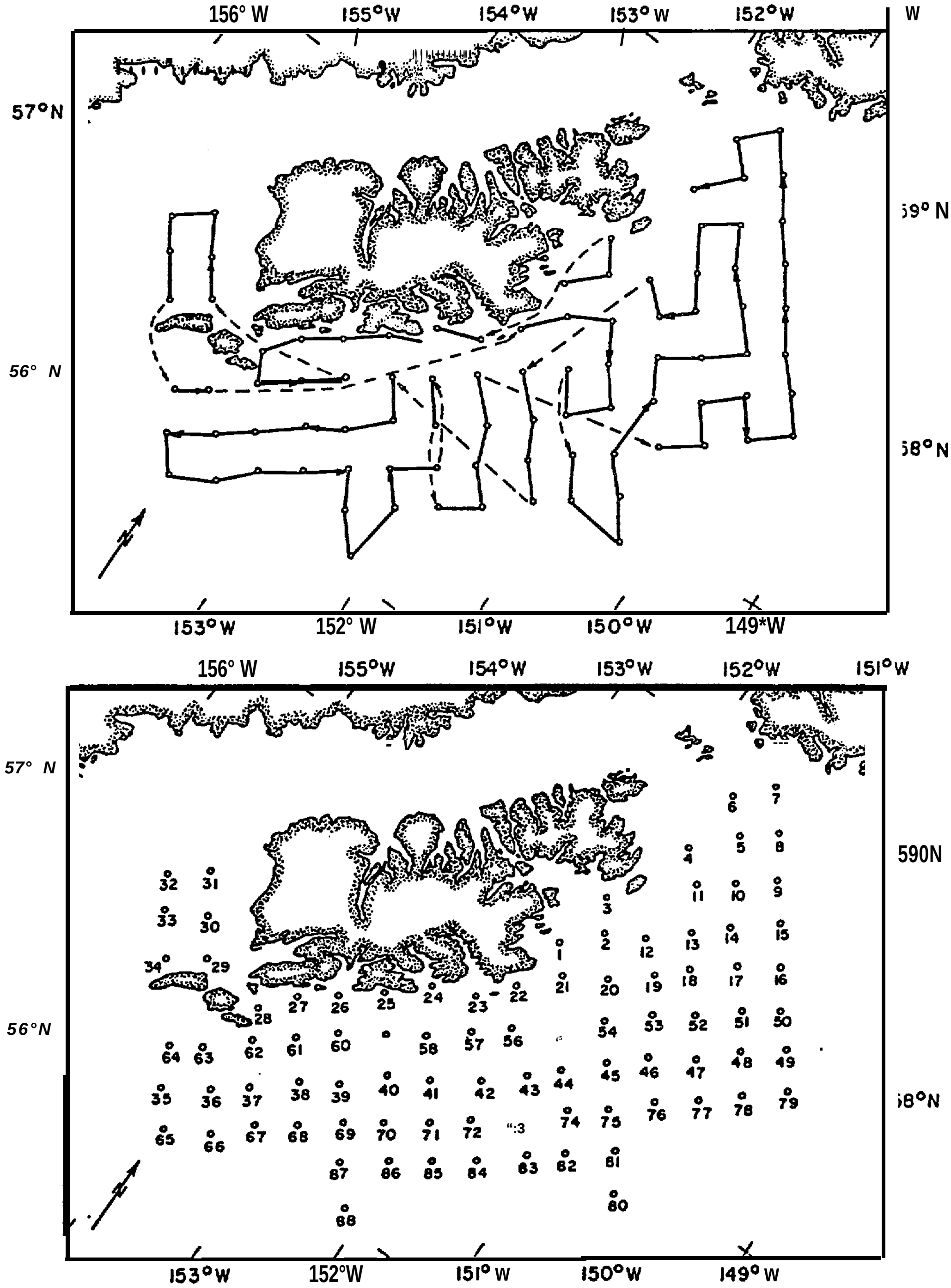
Cruise track (top) and station locations (bottom) for cruise 2MF78, summer 1978 (after Dunn et al. 1979).

Figure 2.1-2



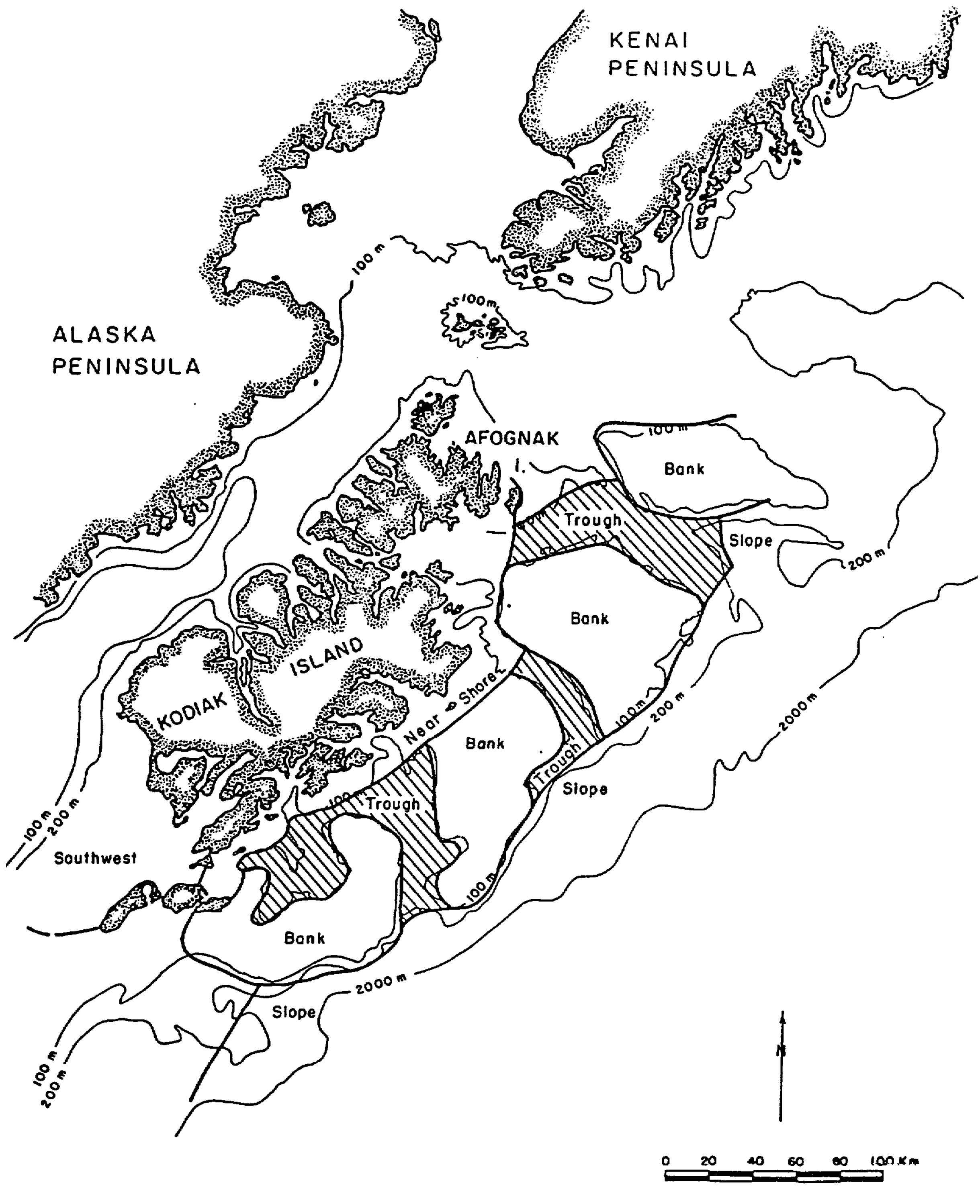
Cruise track (top) and station locations (bottom) for cruise 1WE78, fall 1978 (after Dunn et al. 1979).

Figure 2.1-3



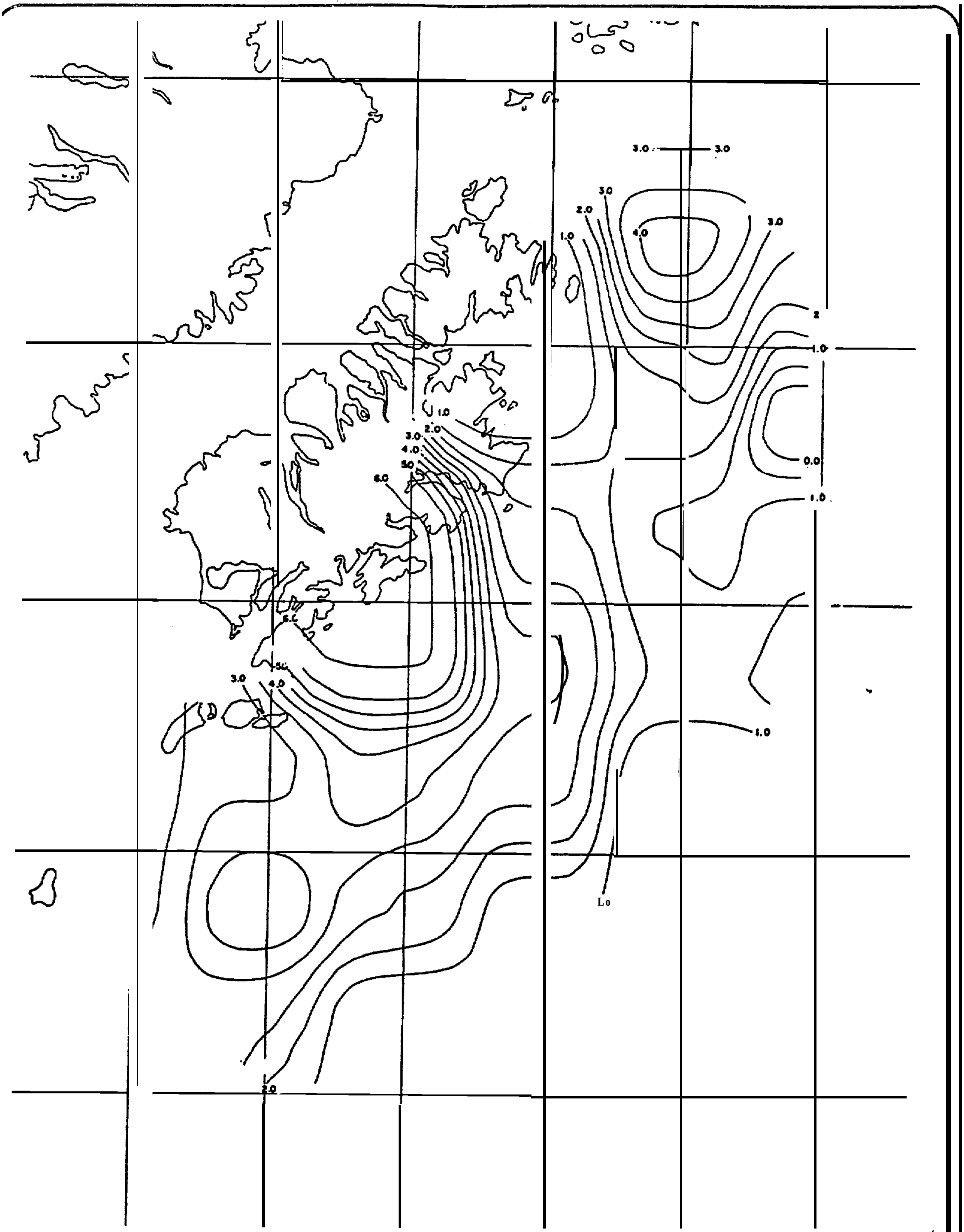
Cruise track (top) and station locations (bottom) for cruise IMF79, winter 1979 (after Dunn et al. 1979).

Figure 2.1-4



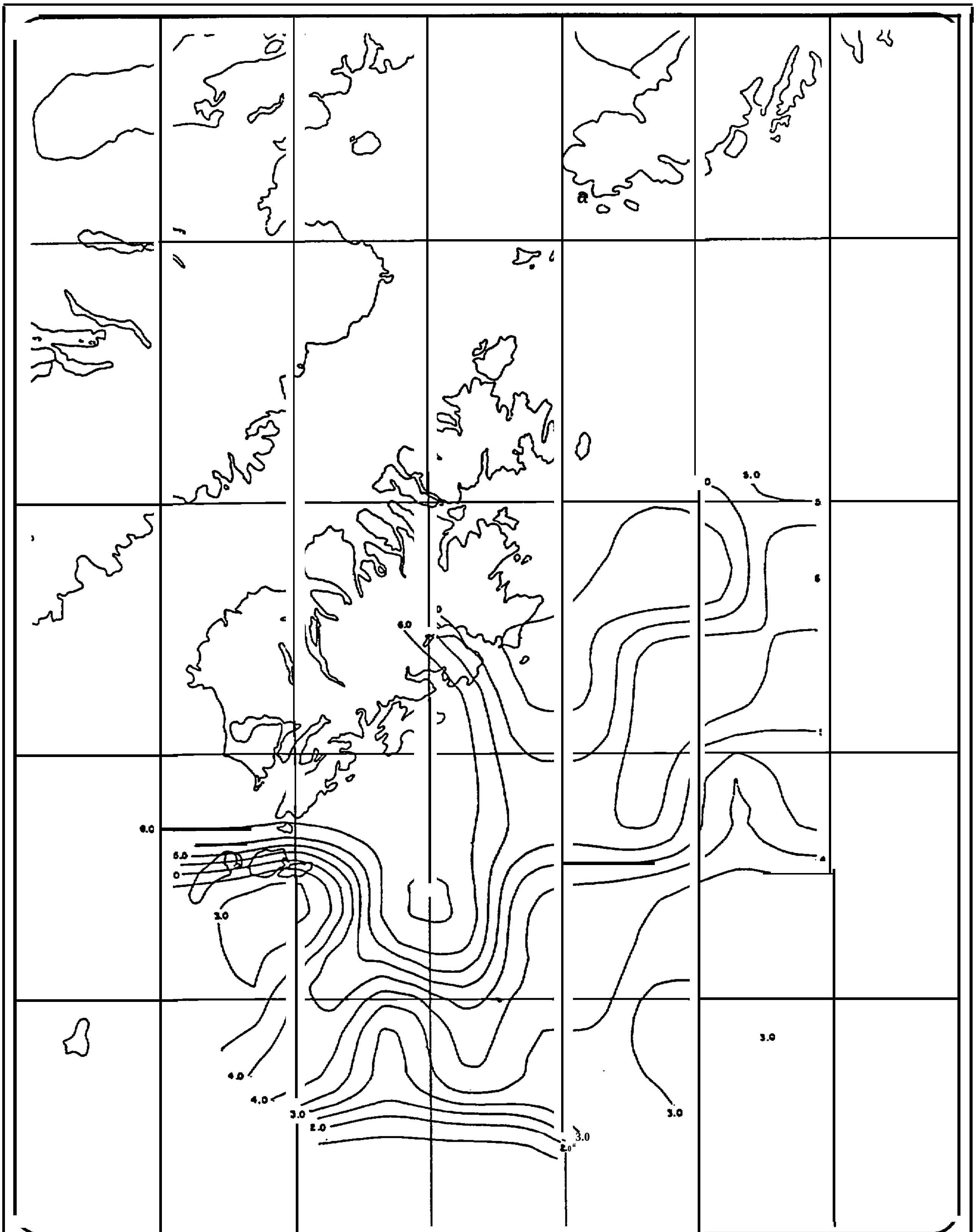
Offshore subareas of the Kodiak Island study area.

Figure 2.4-1



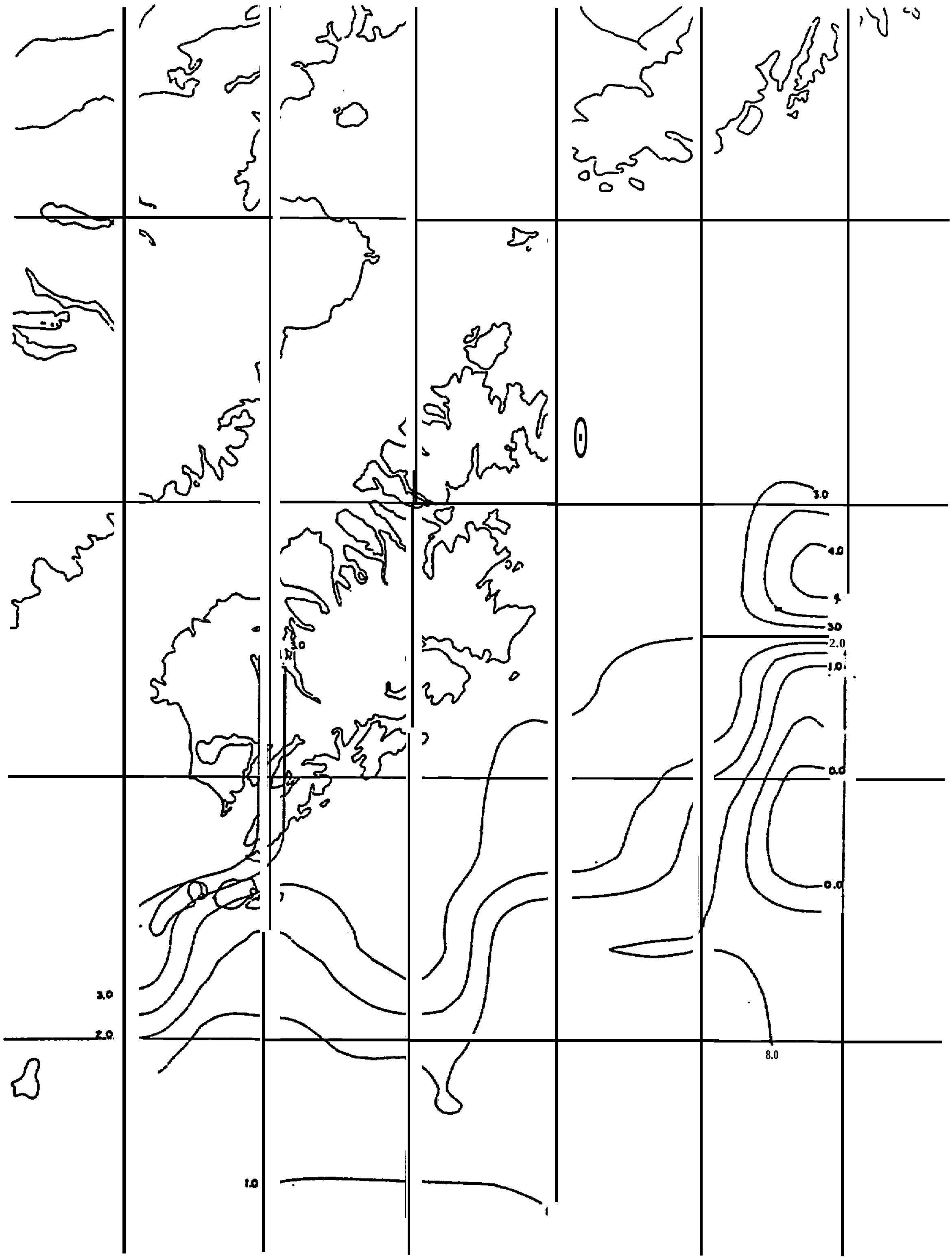
Distribution and abundance of total copepods in bongo tows from cruise 40178.

Figure 3.3-1



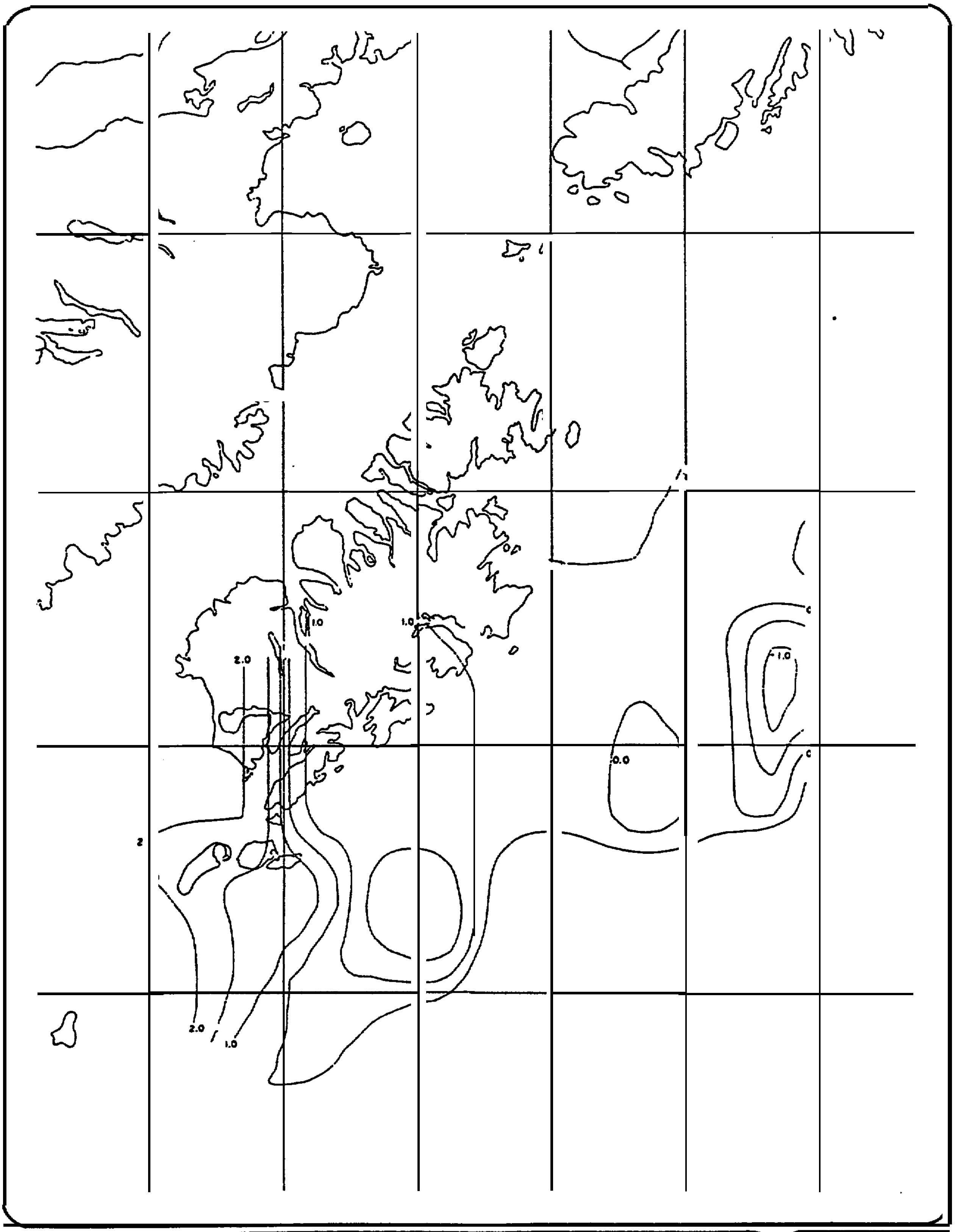
Distribution and abundance of total copepods in bongo tows from cruise 2MF78.

Figure 3.3-2



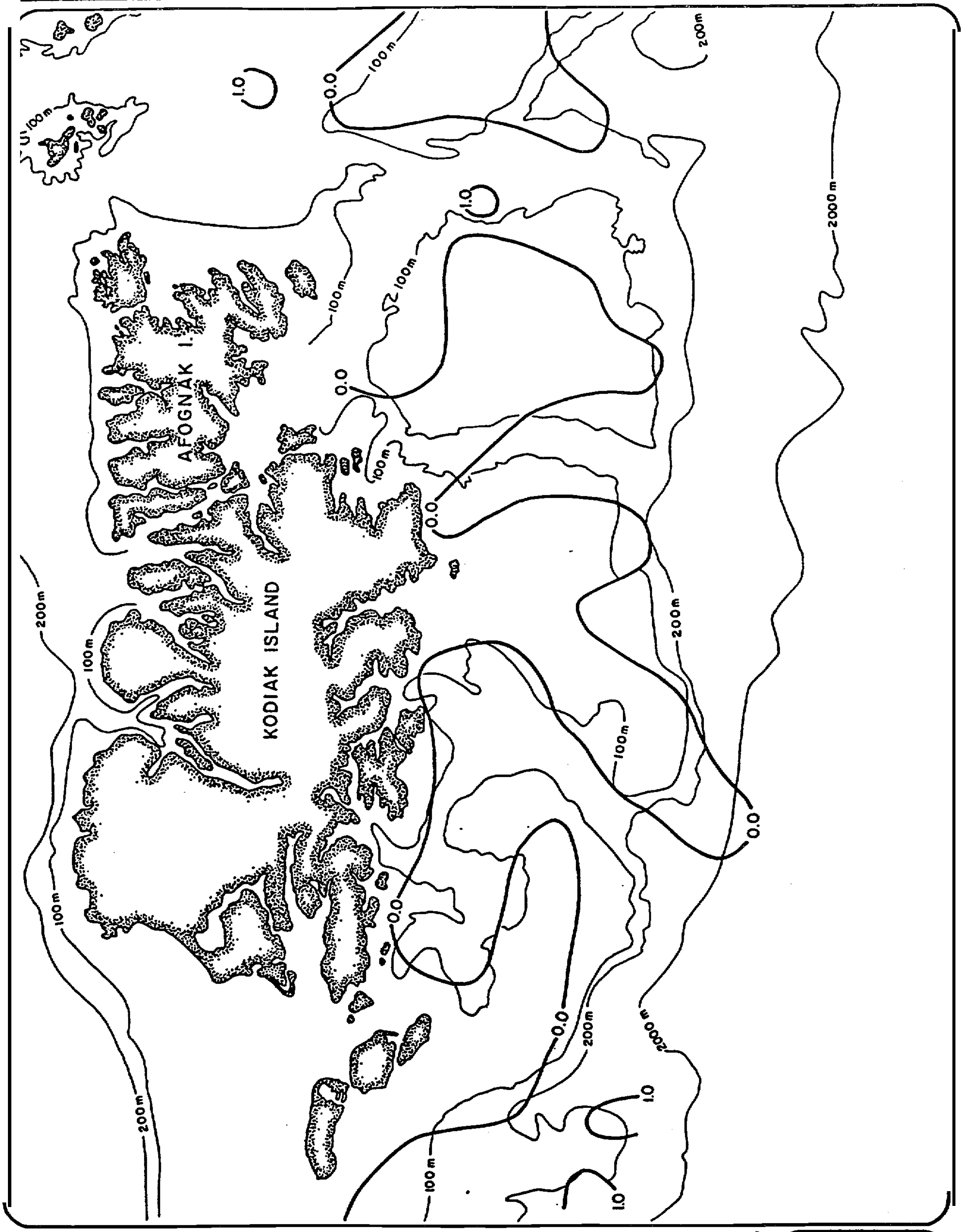
Distribution and abundance of total copepods in bongo tows from cruise 1WE78.

Figure 3.3-3



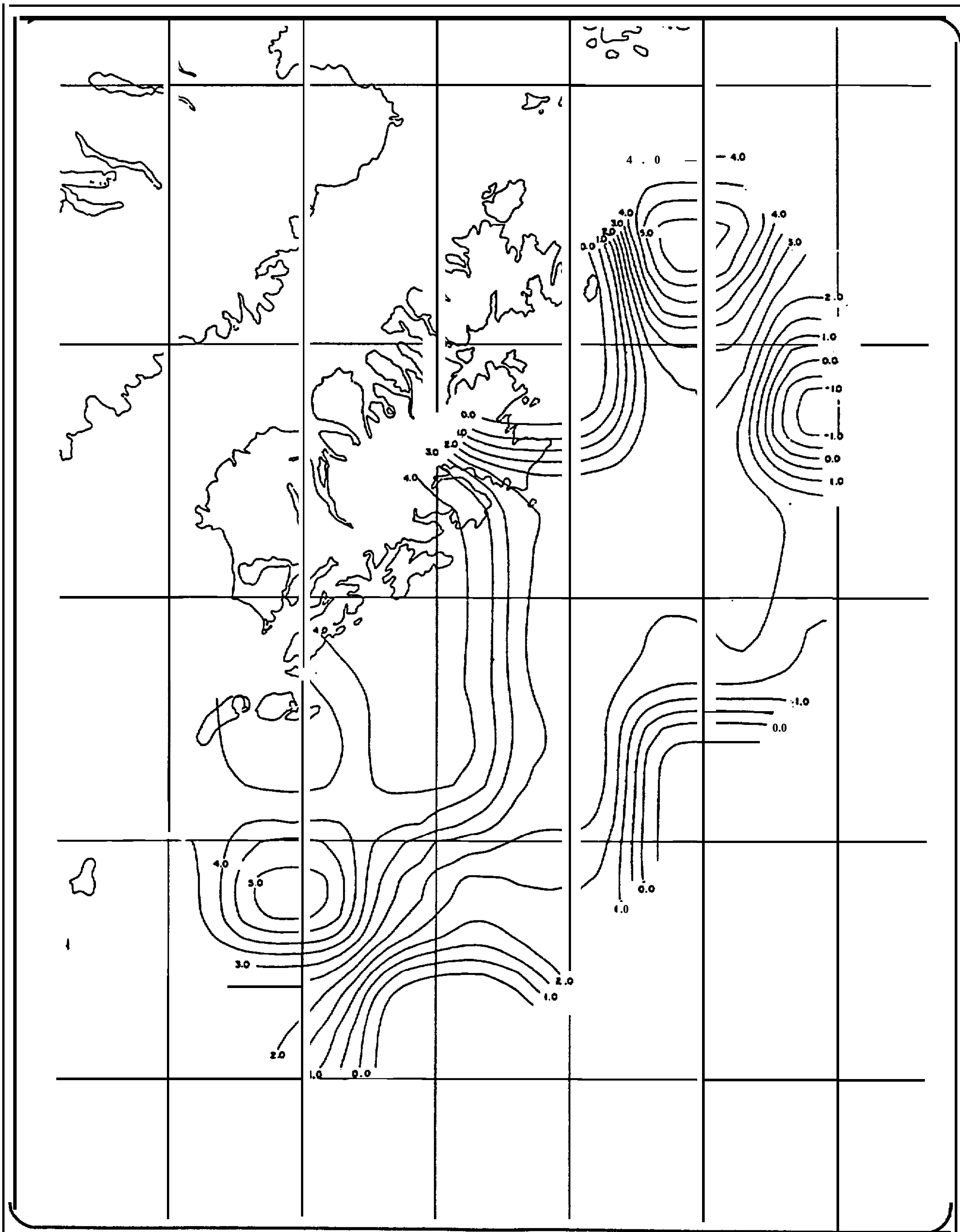
Distribution and abundance of total copepods in bongo tows from cruise 1MF79.

Figure 3.3-4

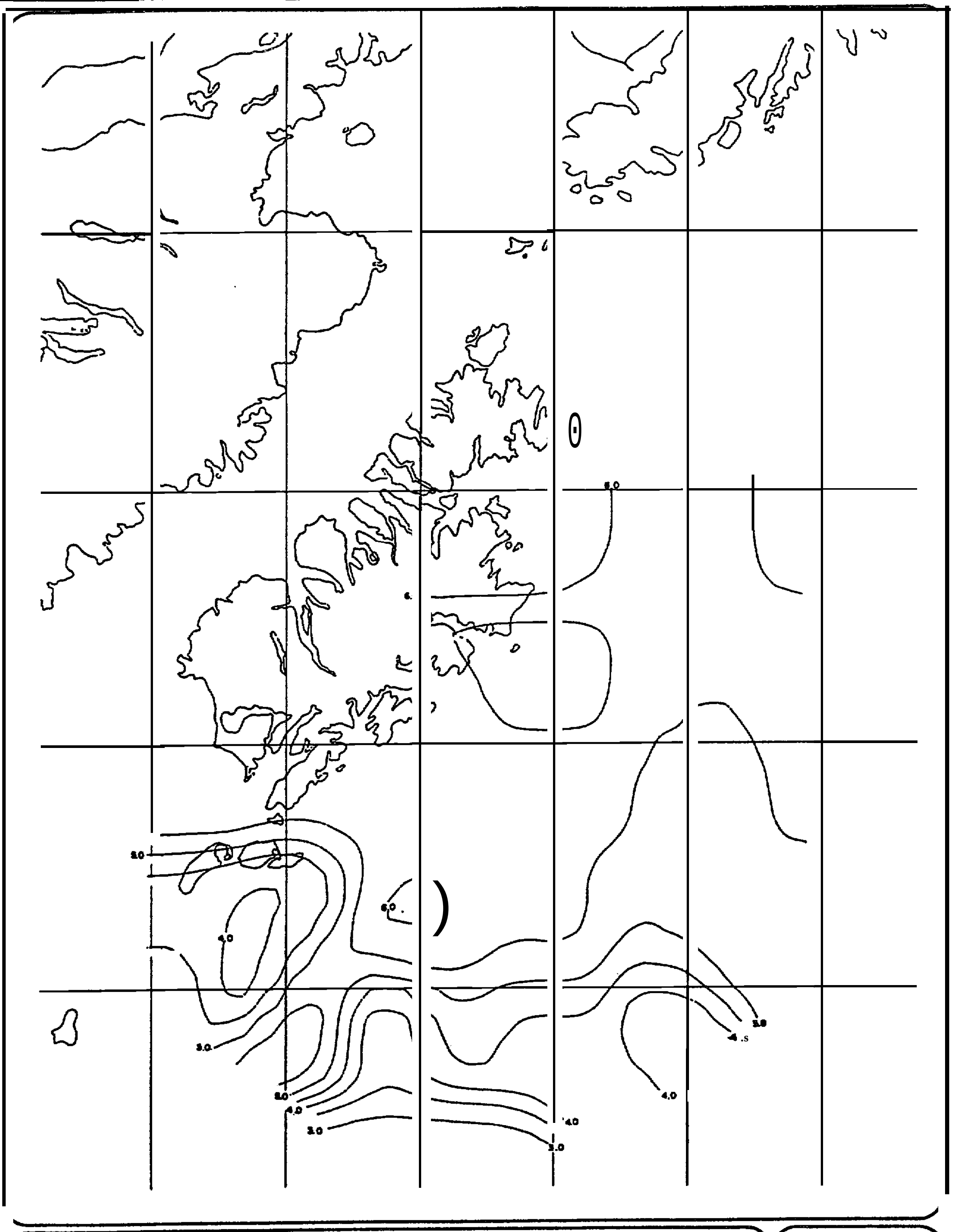


Distribution and abundance of <u>Calanus cristatus</u> copepodite stages IV and V in bongo tows from cruise 2MF78.

Figure 3.3-5

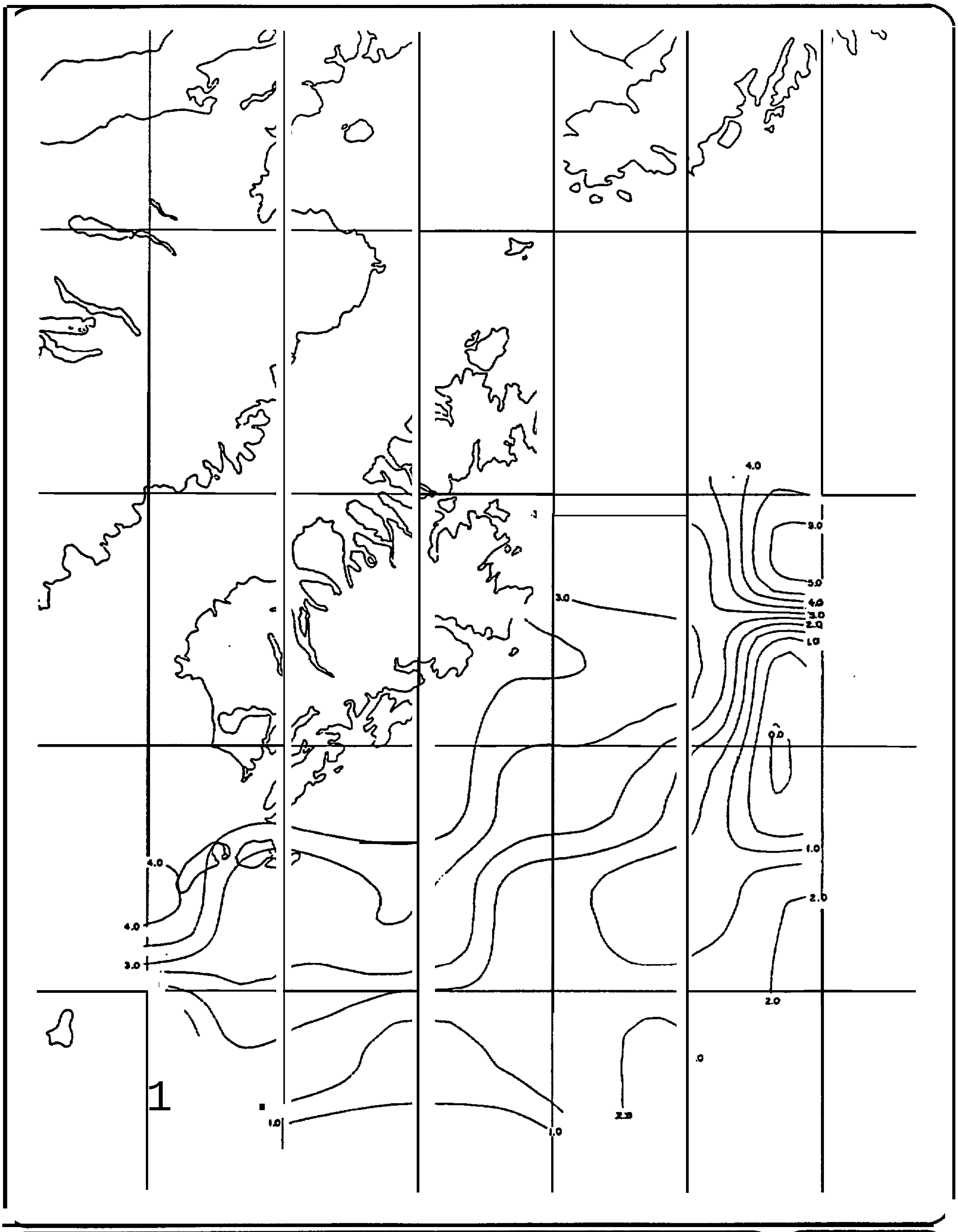


Distribution and abundance of Pseudocalanus spp. in bongo tows from cruise 4DI78.	Figure 3.3-6



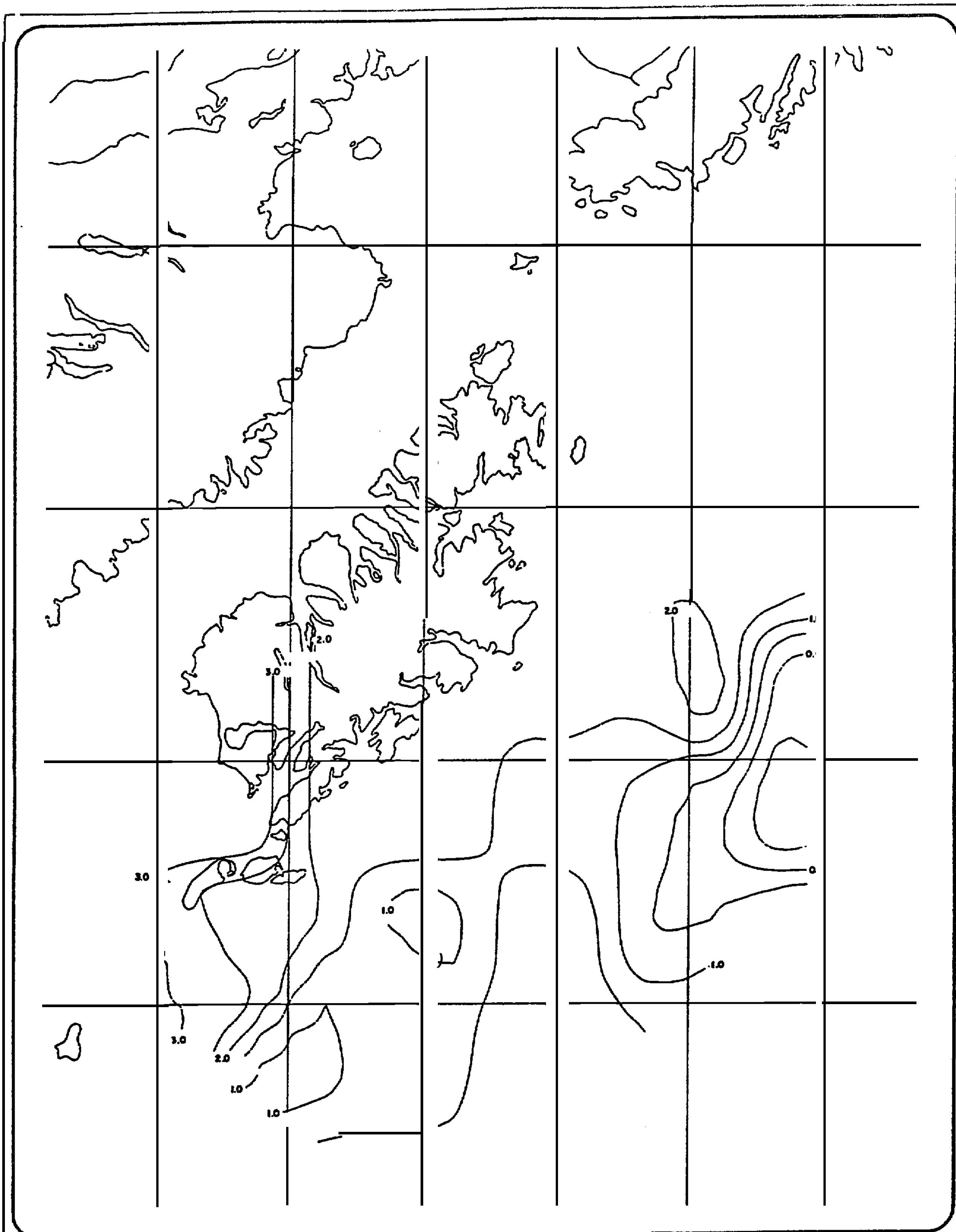
Distribution and abundance of *Pseudocalanus* spp. in bongo tows from cruise 2MF78.

Figure 3.3-7



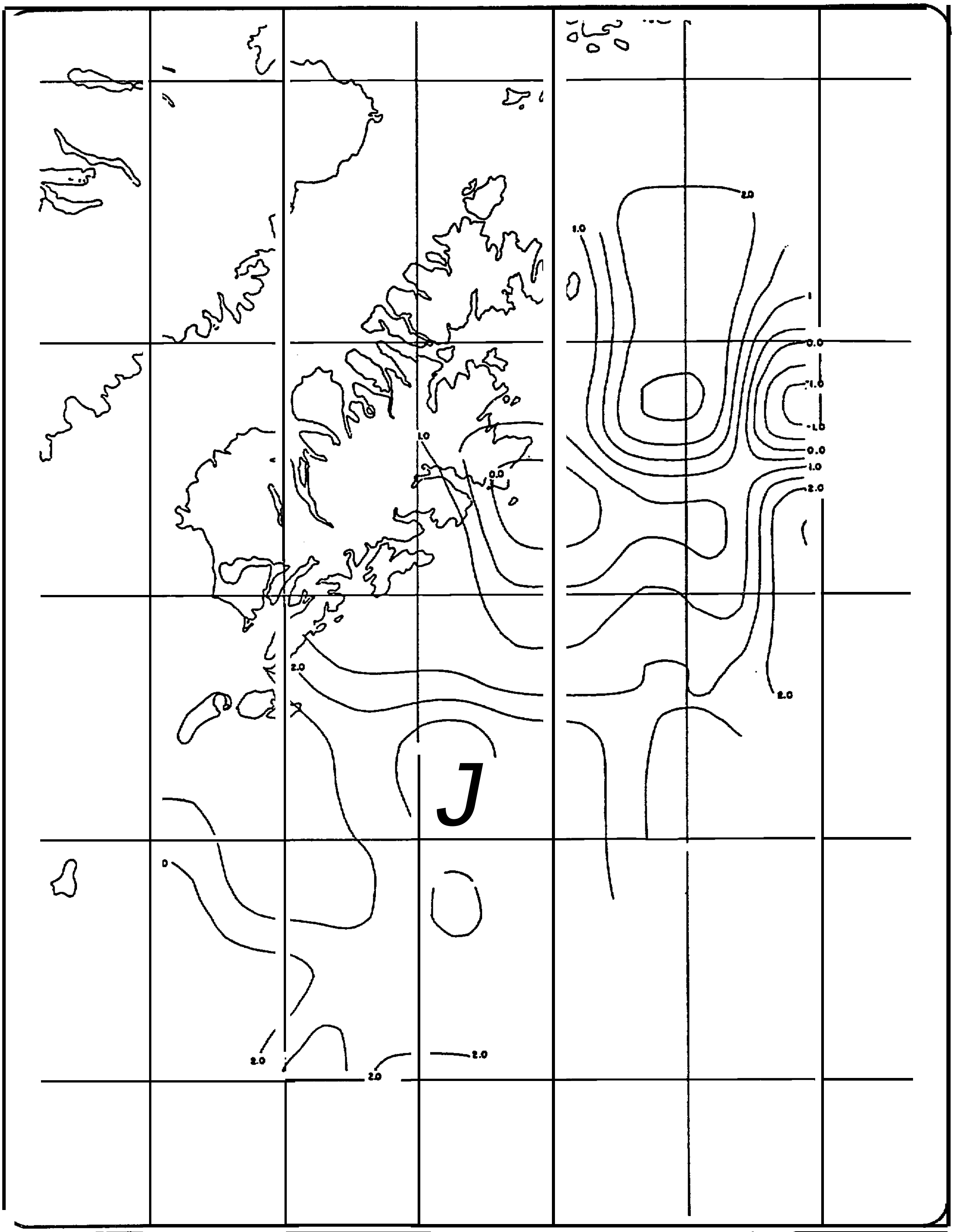
Distribution and abundance of *Pseudocalanus* spp. in bongo tows from cruise 1WE78.

Figure 3.3-8



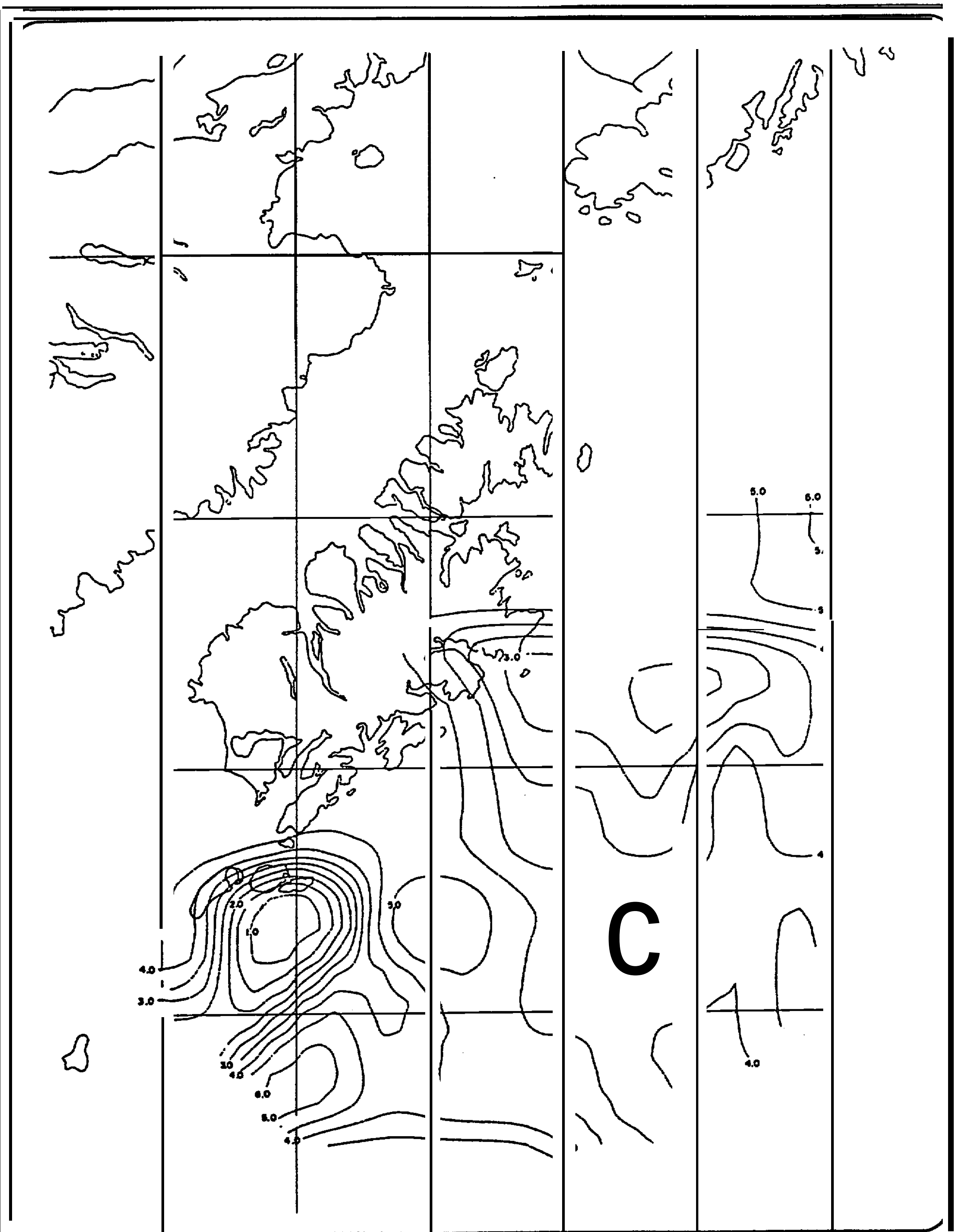
Distribution and abundance of *Pseudocalanus* spp. in bongo tows from cruise 1MF79.

Figure 3.3-9



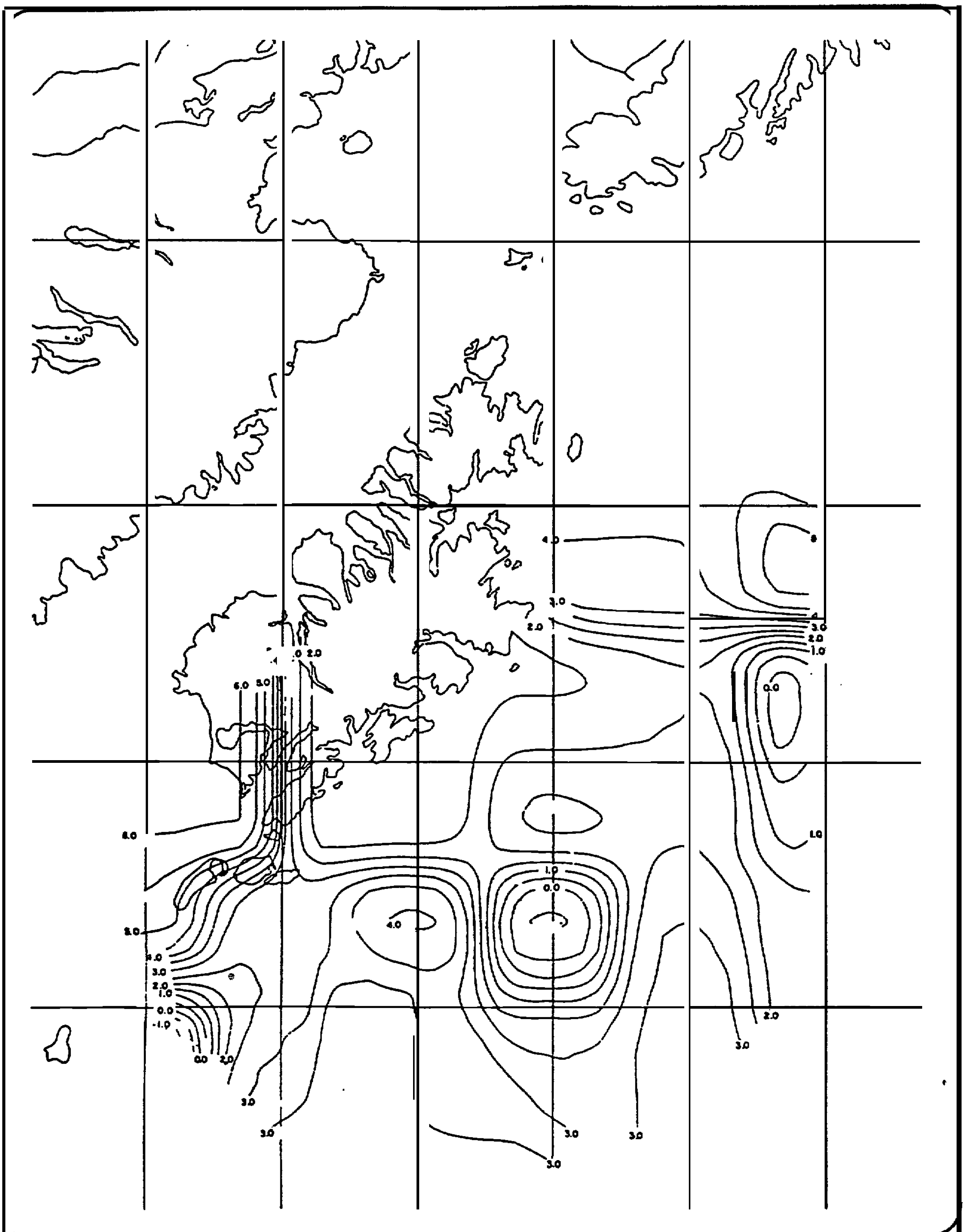
Distribution and abundance of Metridia spp. in bongo tows from cruise 40178.

Figure 3.3-1o



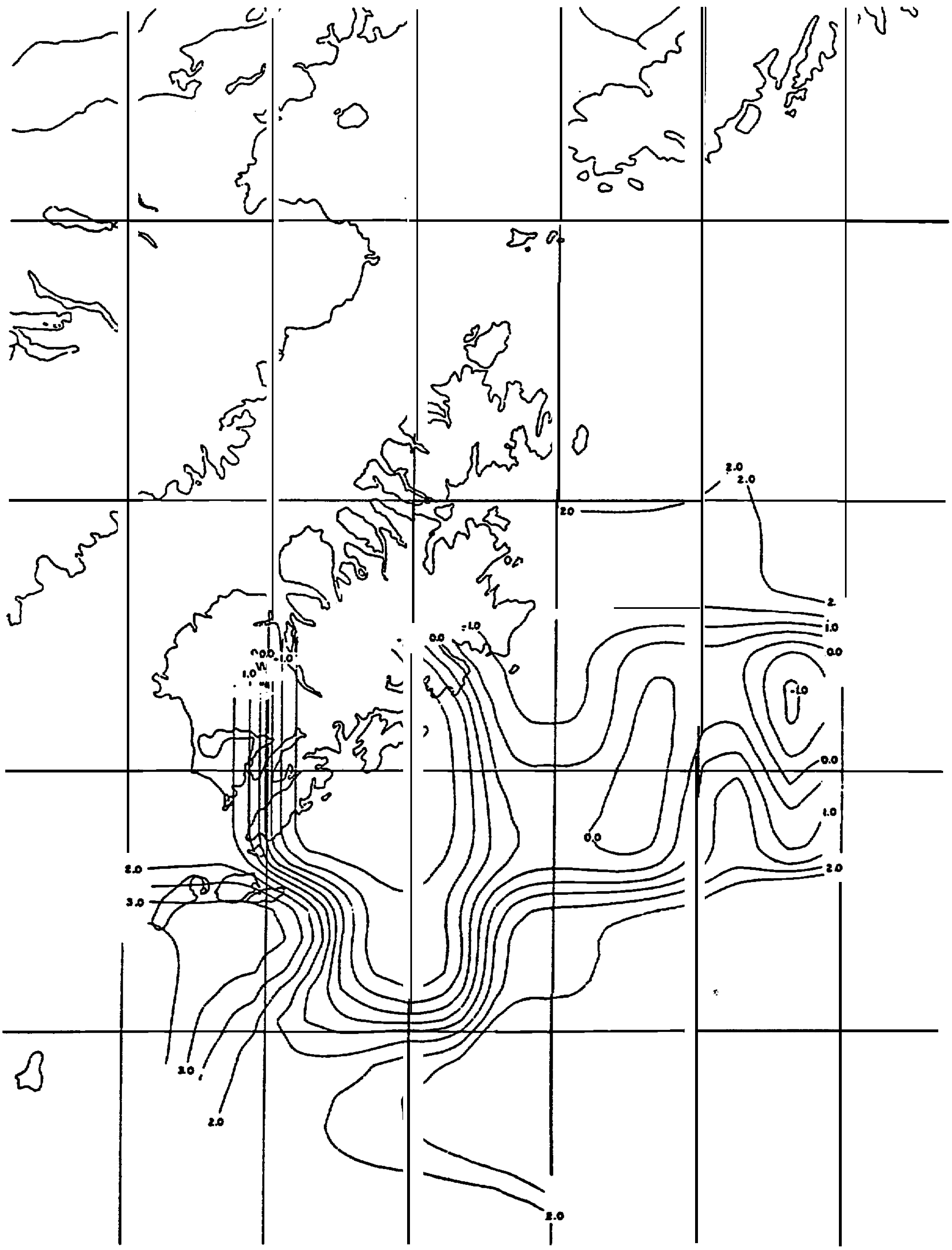
Distribution and abundance of Metridia spp. in bongo tows from cruise 2MF78.

Figure 3.3-11



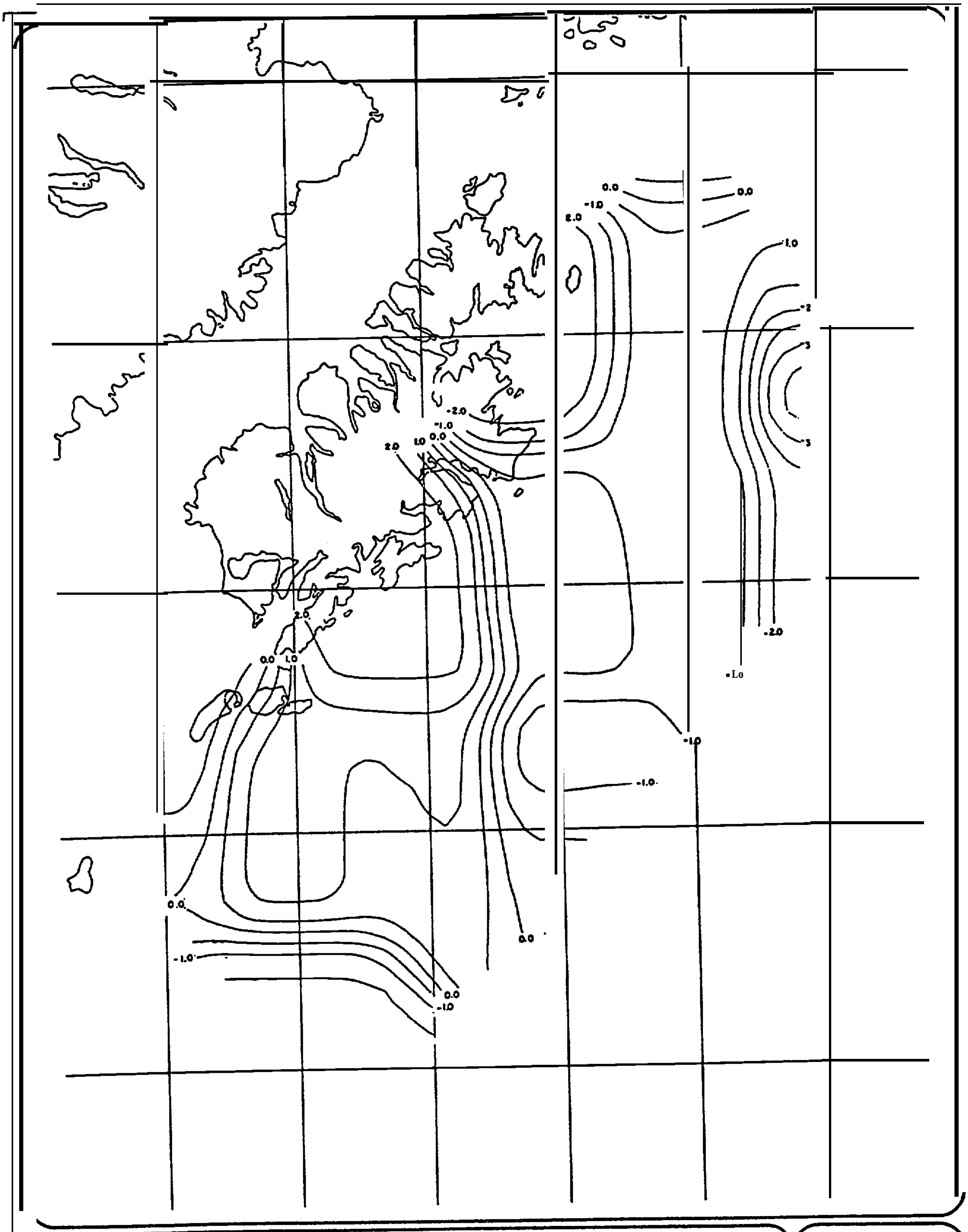
Distribution and abundance of *Metridia* spp. in bongo tows from cruise 1WE78.

Figure 3.3-12



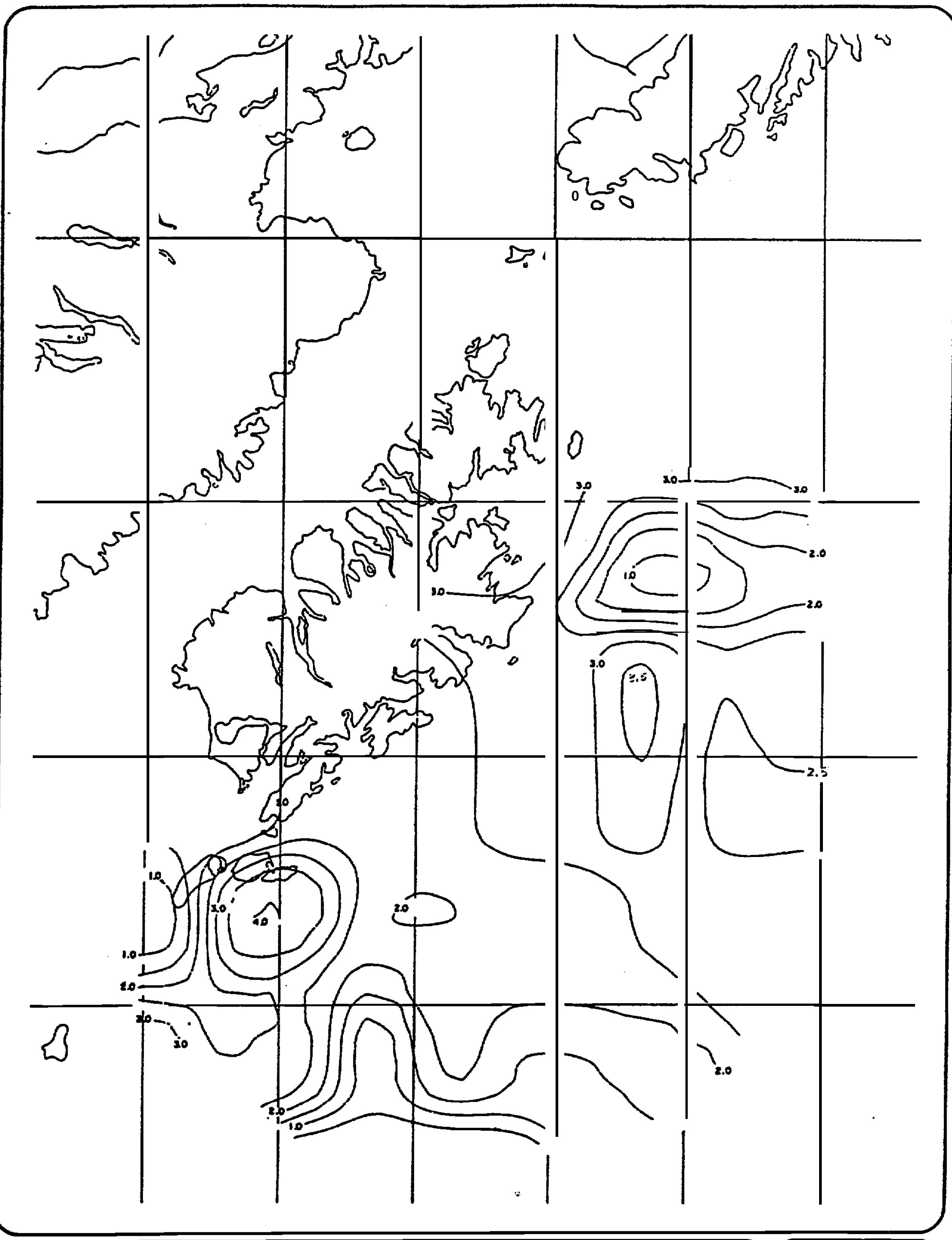
Distribution and abundance of Metridia spp. in bongo tows from cruise 1MF79.

Figure
3.-3-13

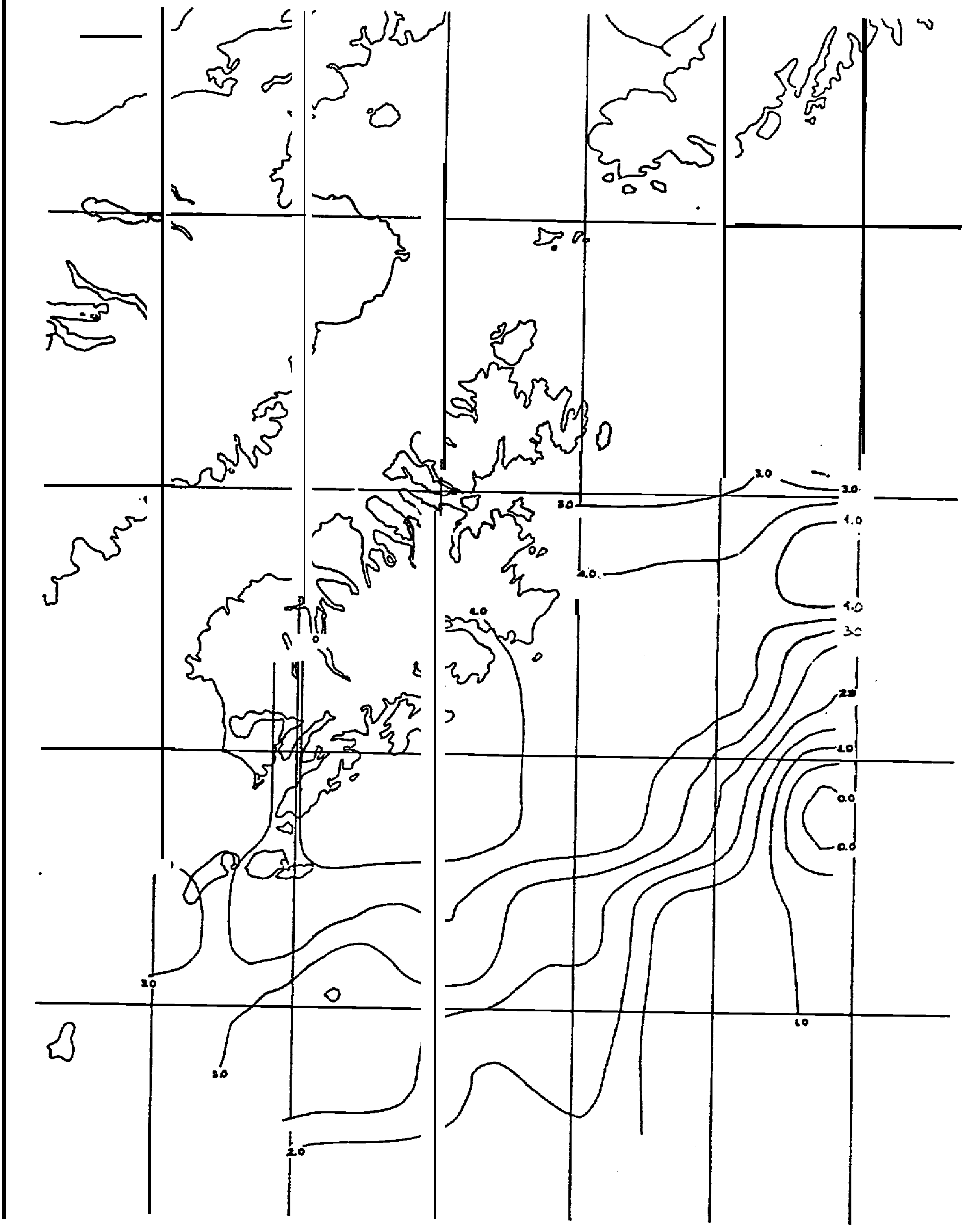


Distribution and abundance of *Acartia longiremis* in bongo tows from cruise 4DI78.

Figure 3.3-14

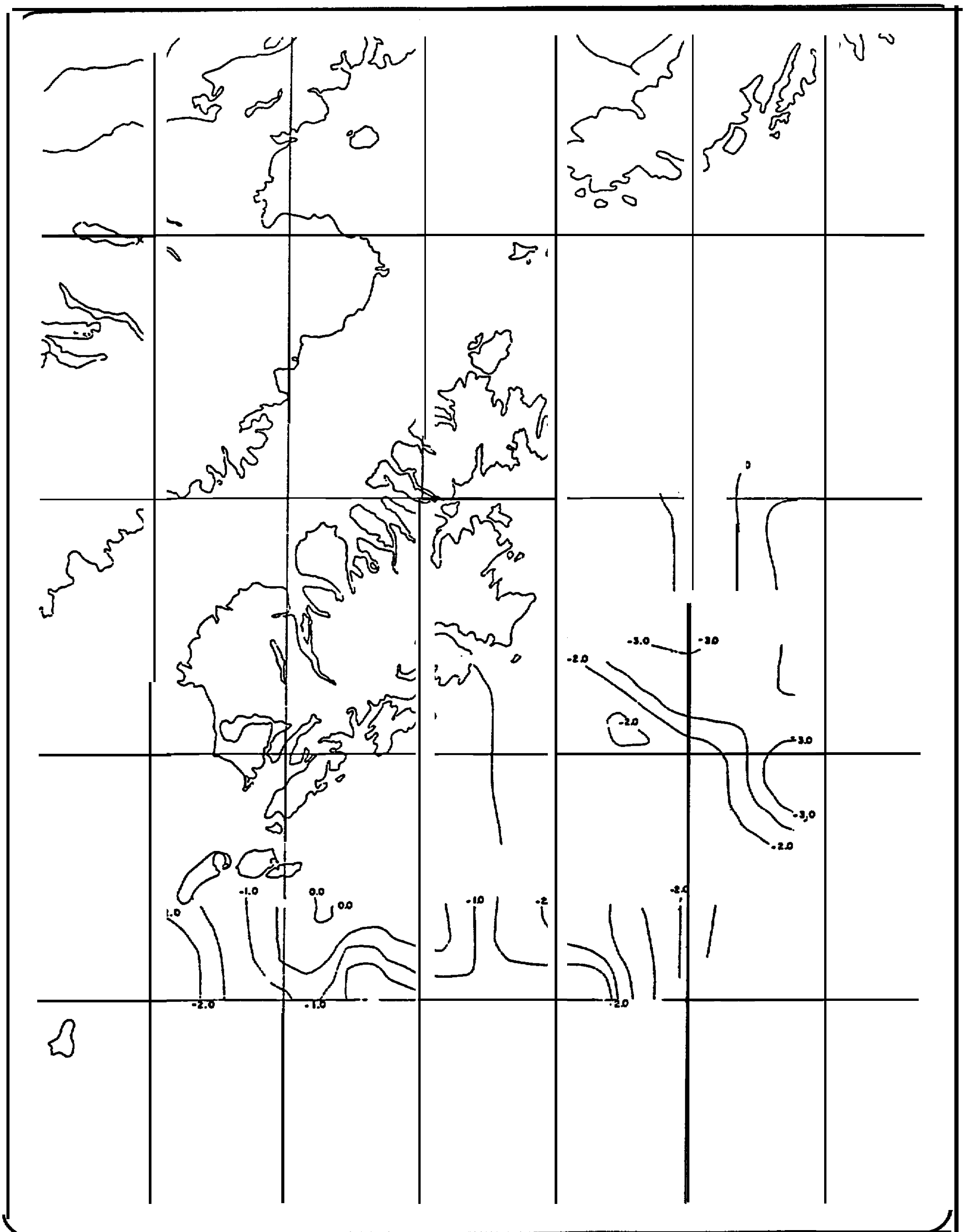


Distribution and abundance of *Acartia longiremis* in bongo tows from cruise 2MF78.	Figure 3.3-15



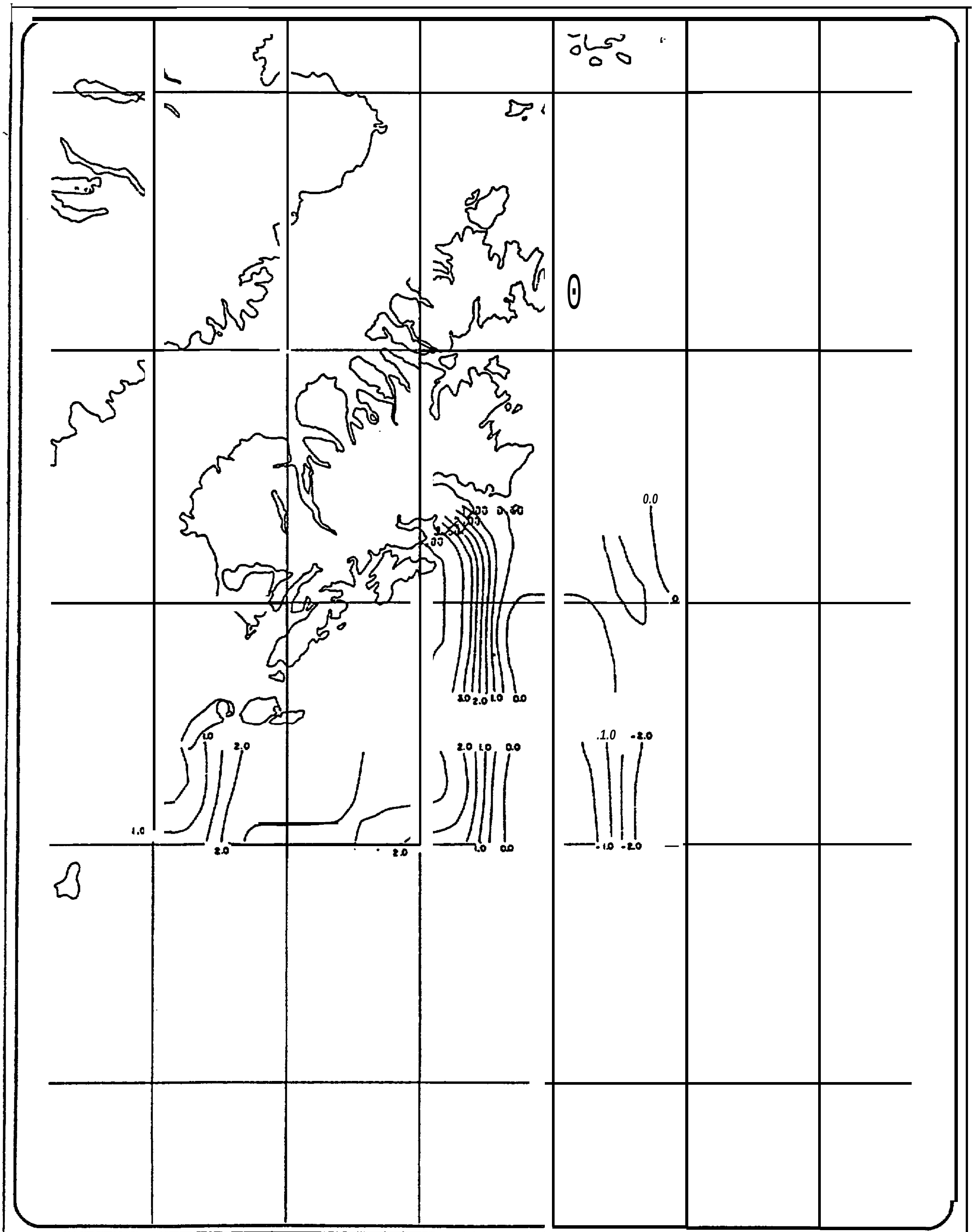
Distribution and abundance of *Acartialongiremis* in bongo tows from cruise 1WE78.

Figure 3.3-16



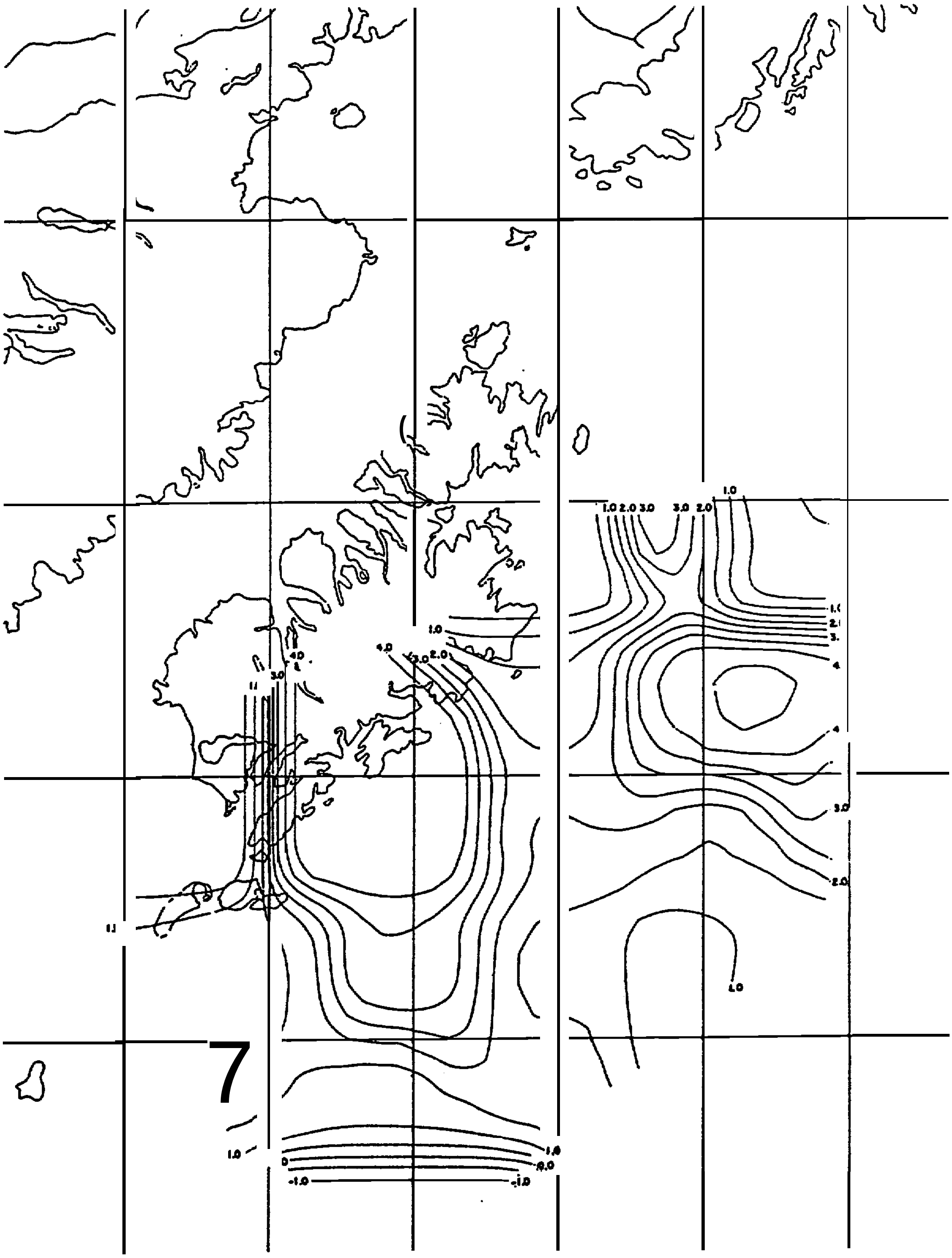
Distribution and abundance of *Acartia longiremis* in bongo tows from cruise 1MF79.

Figure 3.3-17



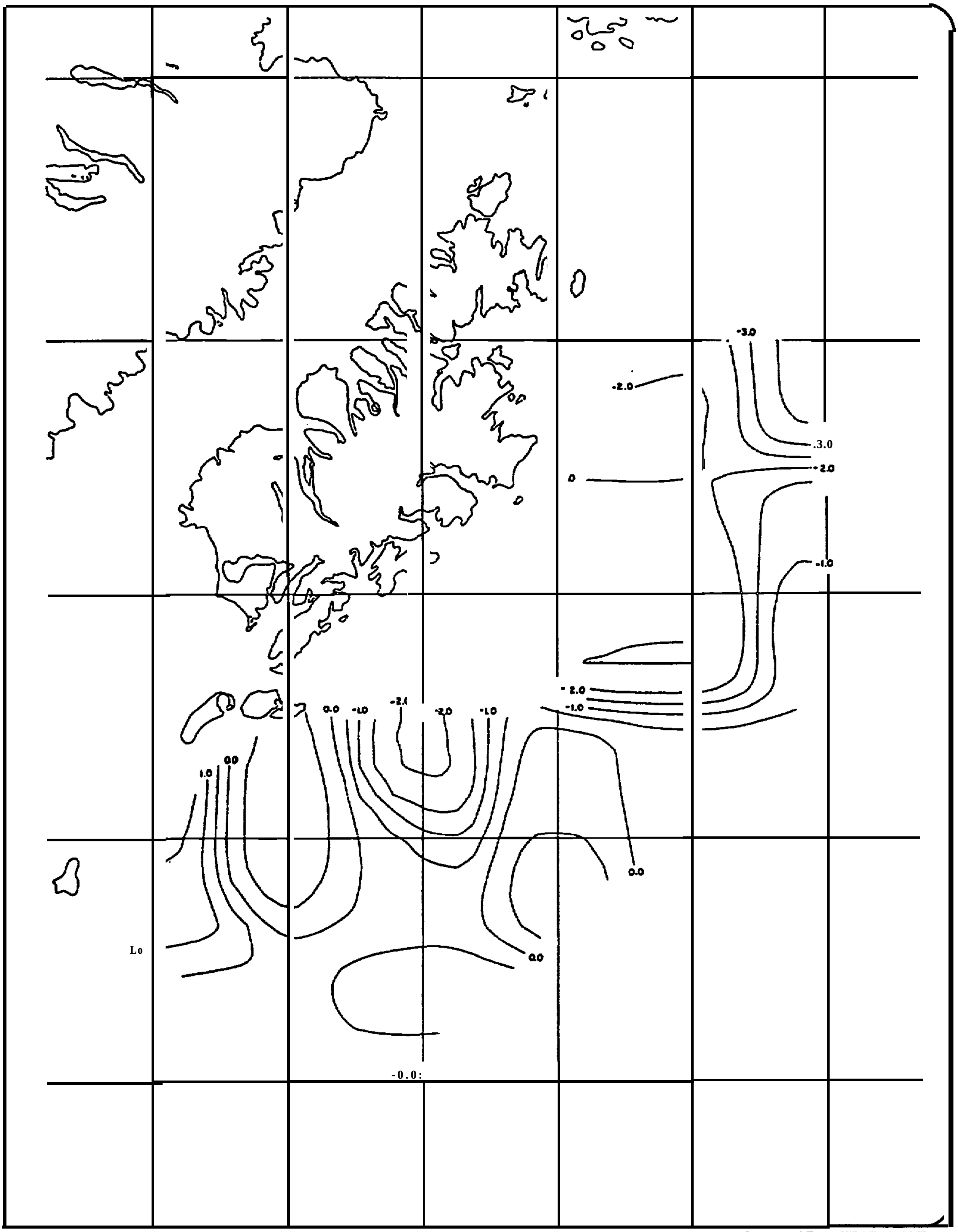
Distribution and abundance of *Acartia tumida* in bongo tows from cruise 40178.

Figure 3.3-18



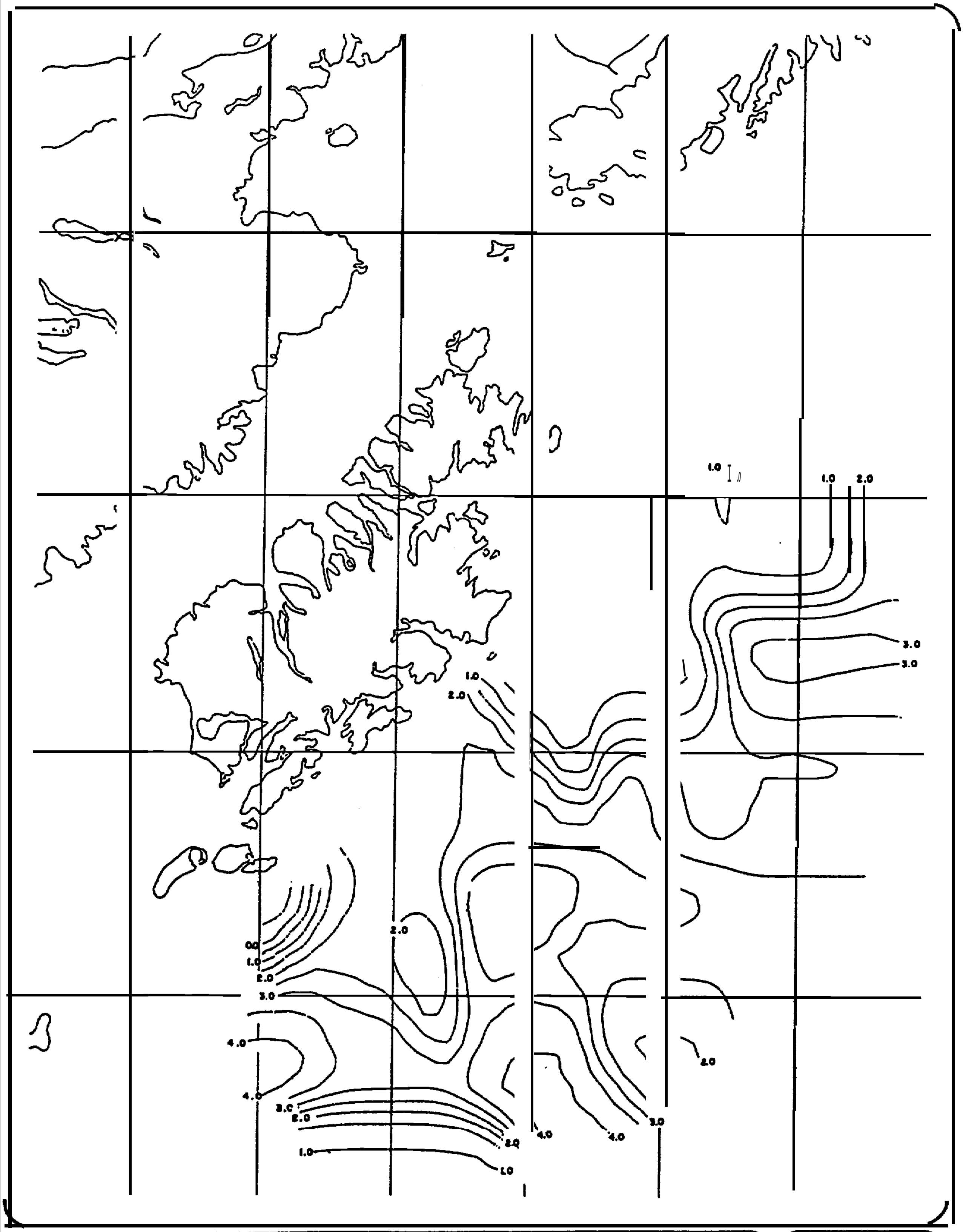
Distribution and abundance of *Acartia tumida* in bongo tows from cruise 2MF78.

Figure 3.3-19



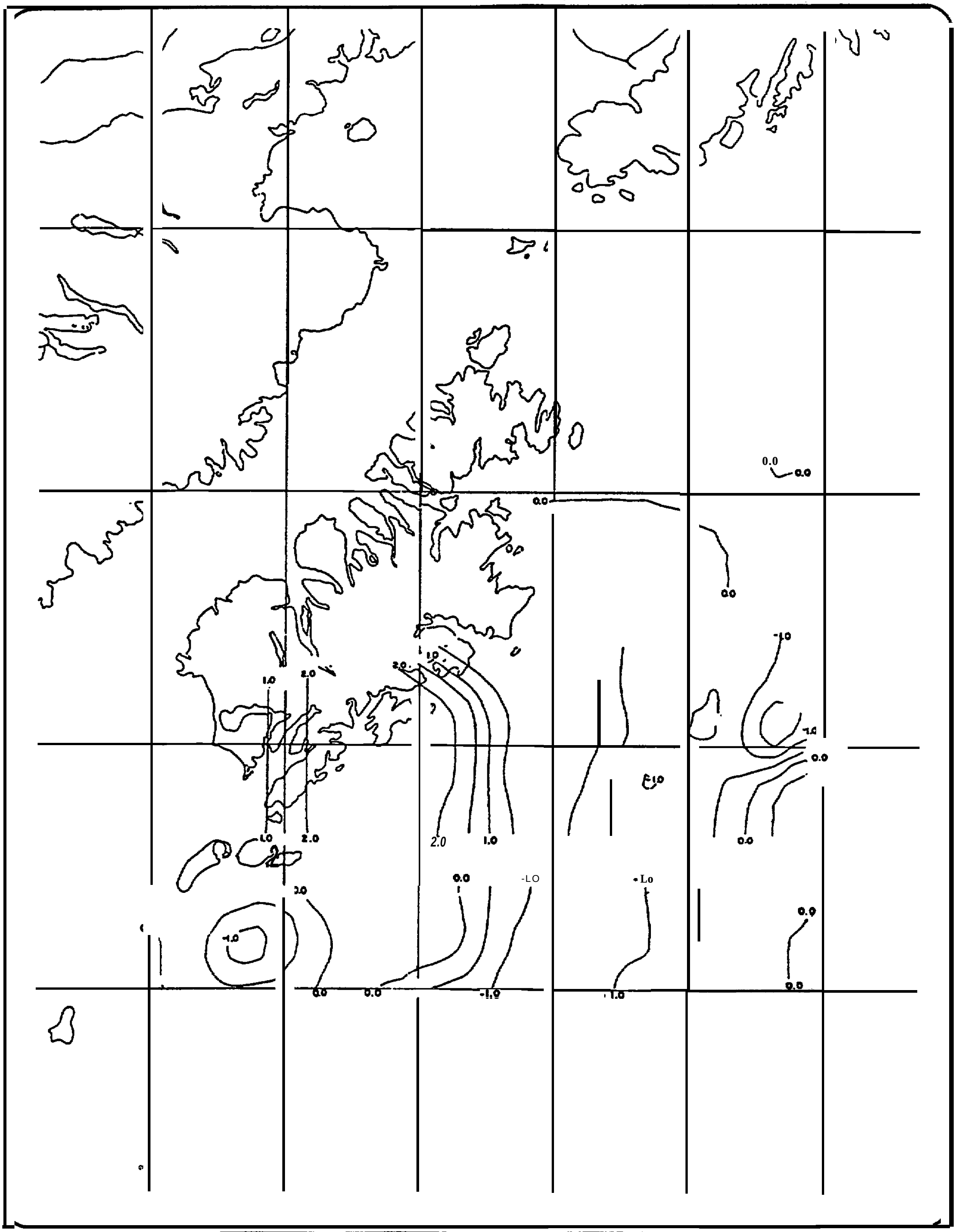
Distribution and abundance of Eucalanus bungii in bongo tows from cruise 4DI78.

Figure 3.3-20



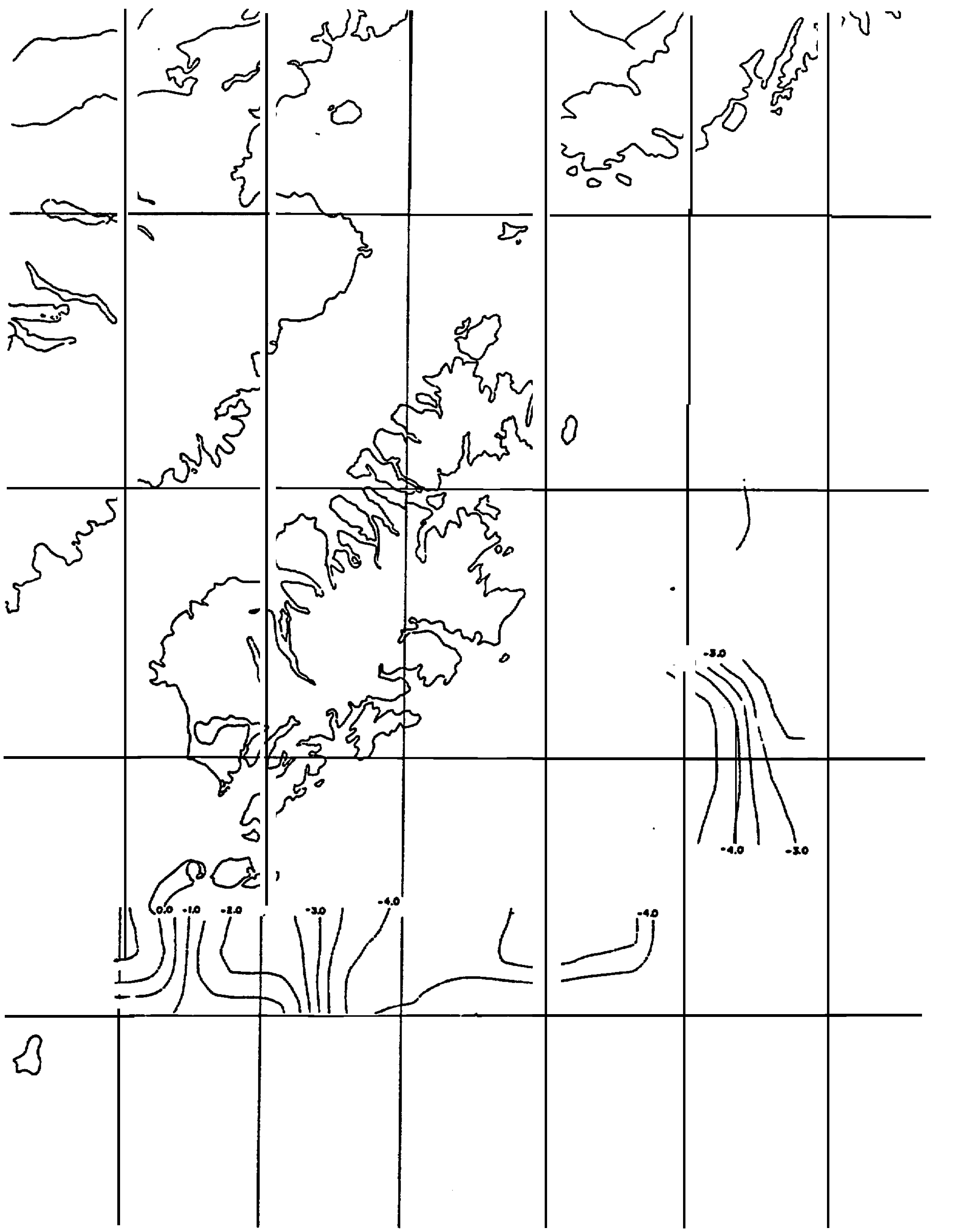
Distribution and abundance of *Eucalanus bungii* in bongo tows from cruise 2MF78.

Figure 3.3-21



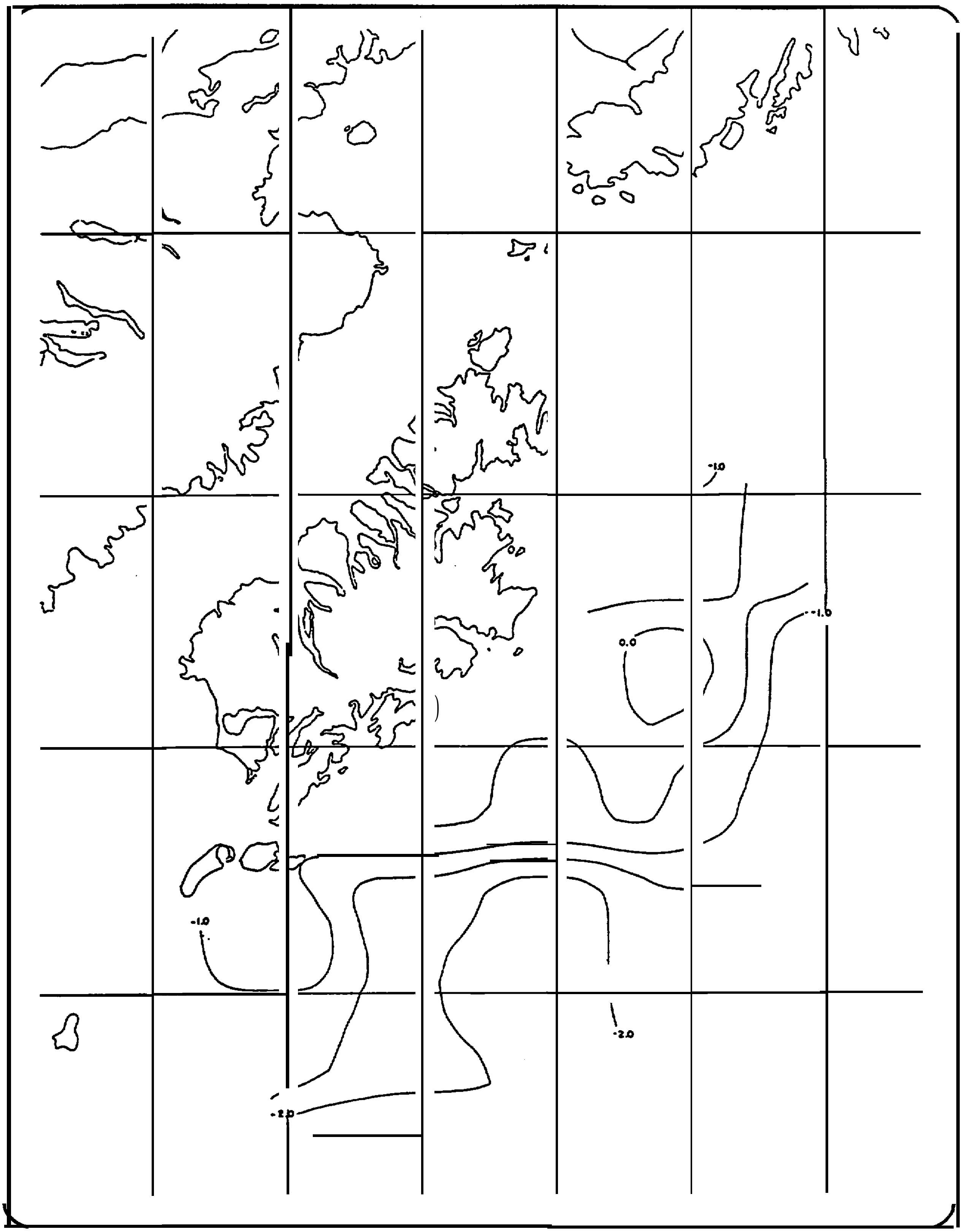
Distribution and abundance of Eucalanus bungii in bongo tows from cruise 1WE78.

Figure 3.3-22



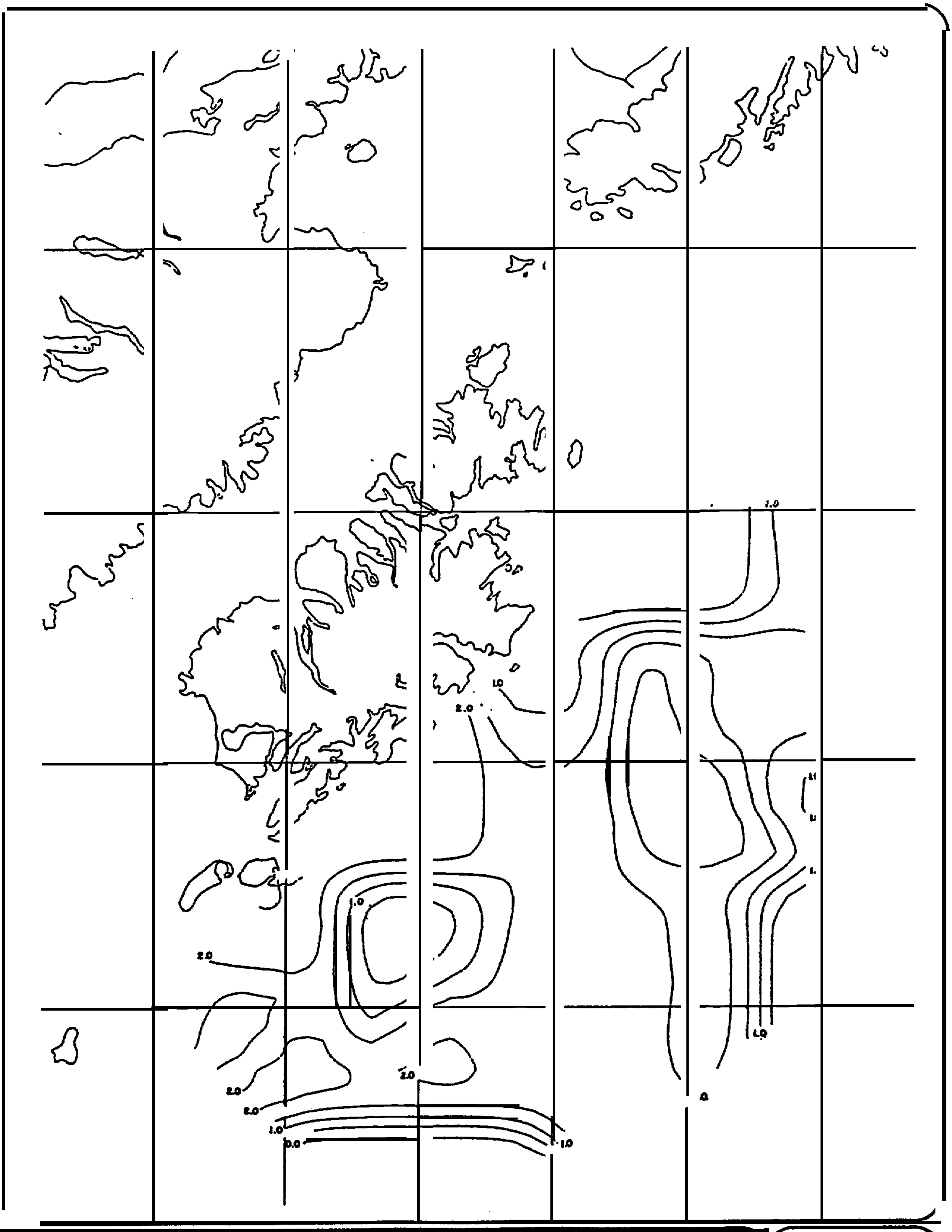
Distribution and abundance of *Eucalanus bungii* in bongo tows from cruise 1MF79.

Fi ure 3?3-23



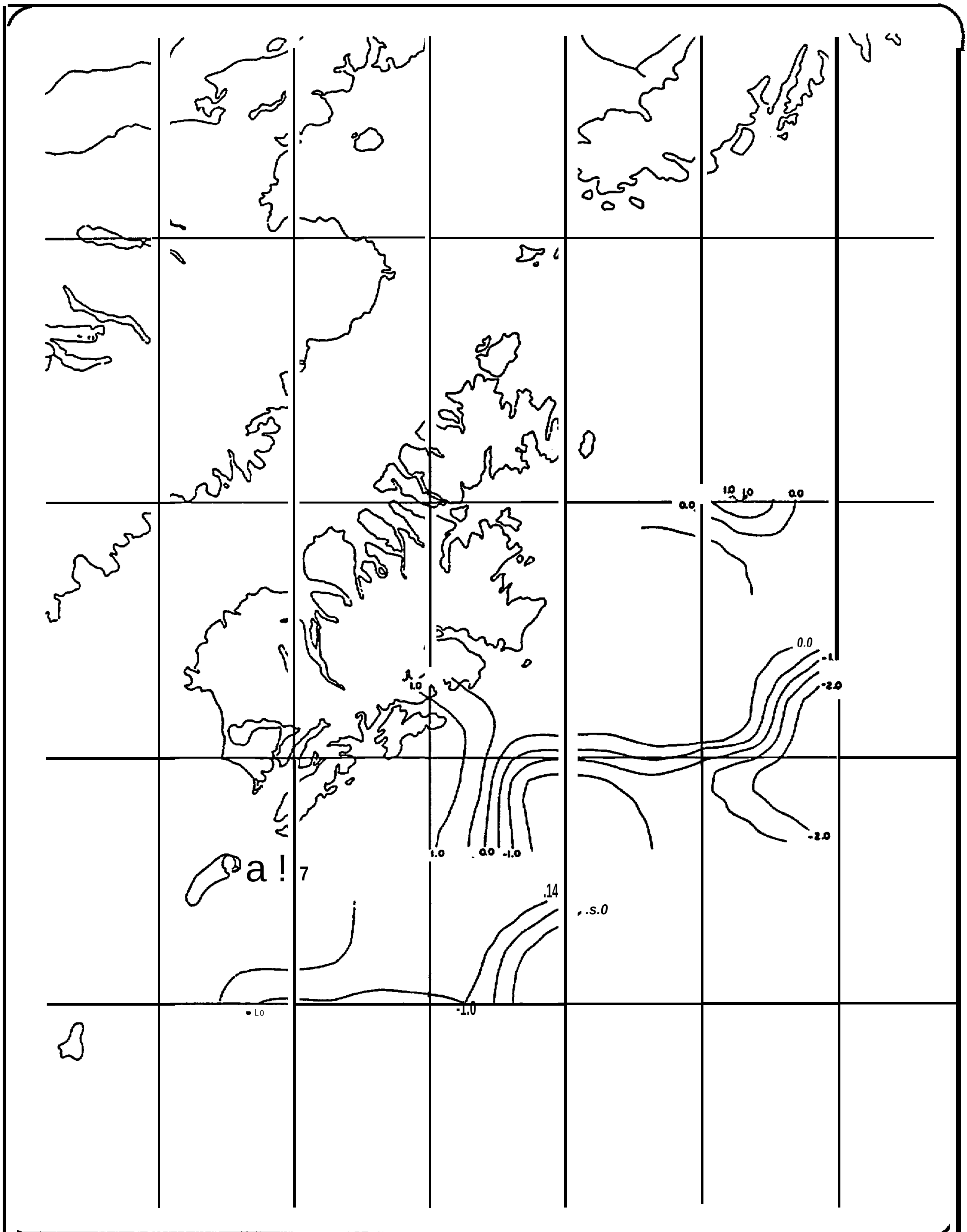
Distribution and abundance of *Epilabidocera longipedata* in bongo tows from cruise 4DI78.

Figure 3.3-24



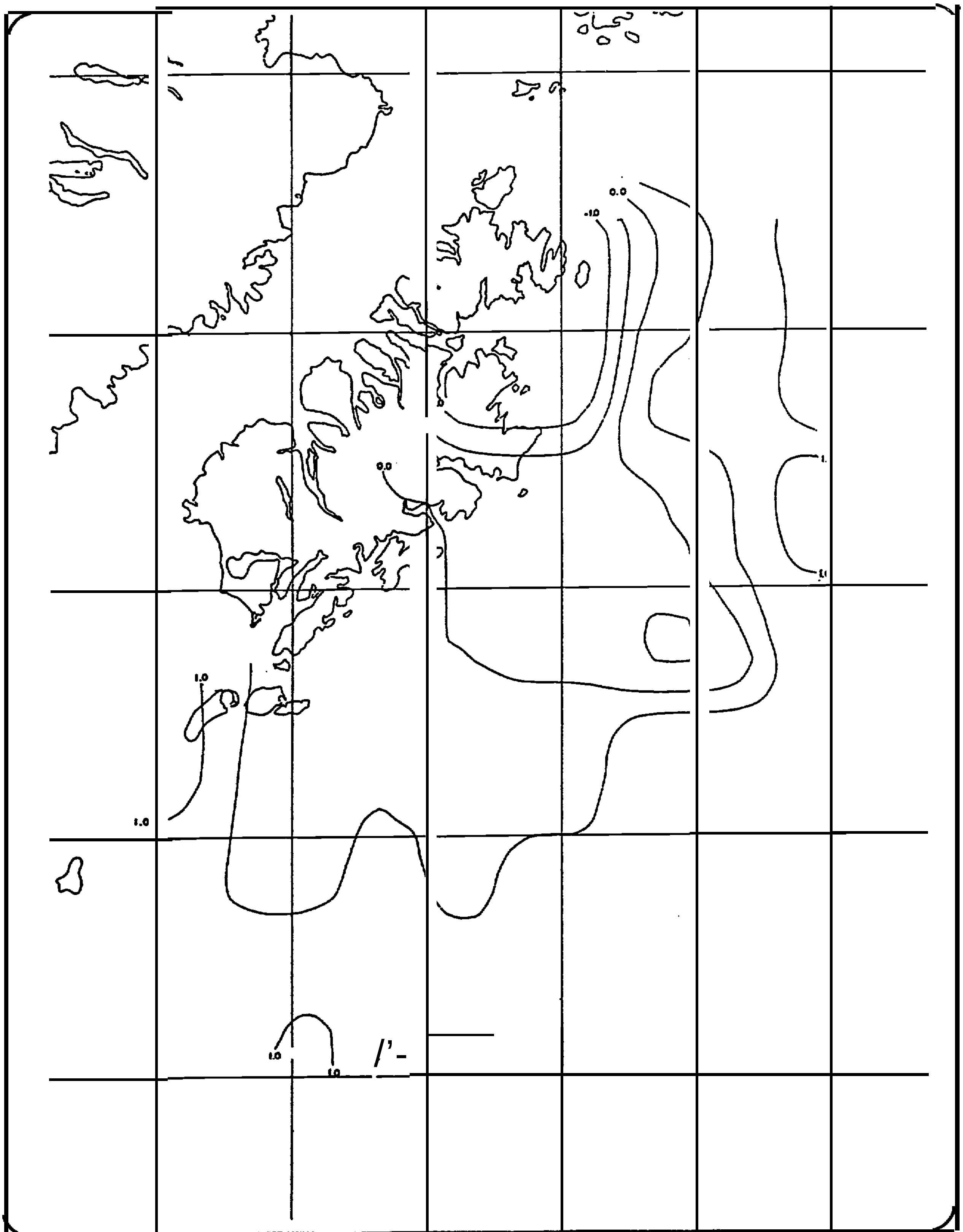
Distribution and abundance of *Centropages abdominalis* in bongo tows from cruise I-7G-

Figure 3.3-25

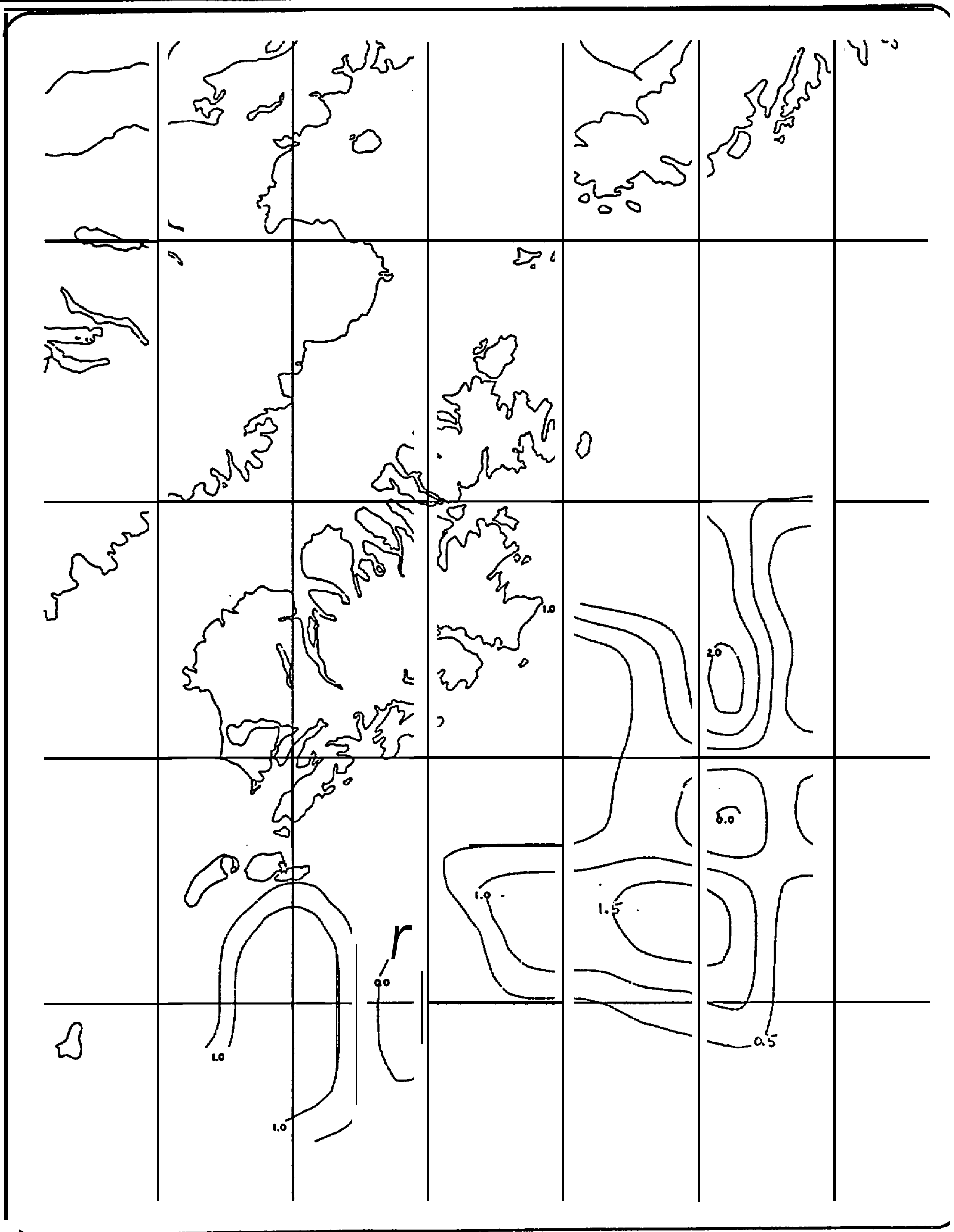


Distribution and abundance of *Centropages abdominal is* in bongo tows from Cruise 78.

Figure 3.3-26

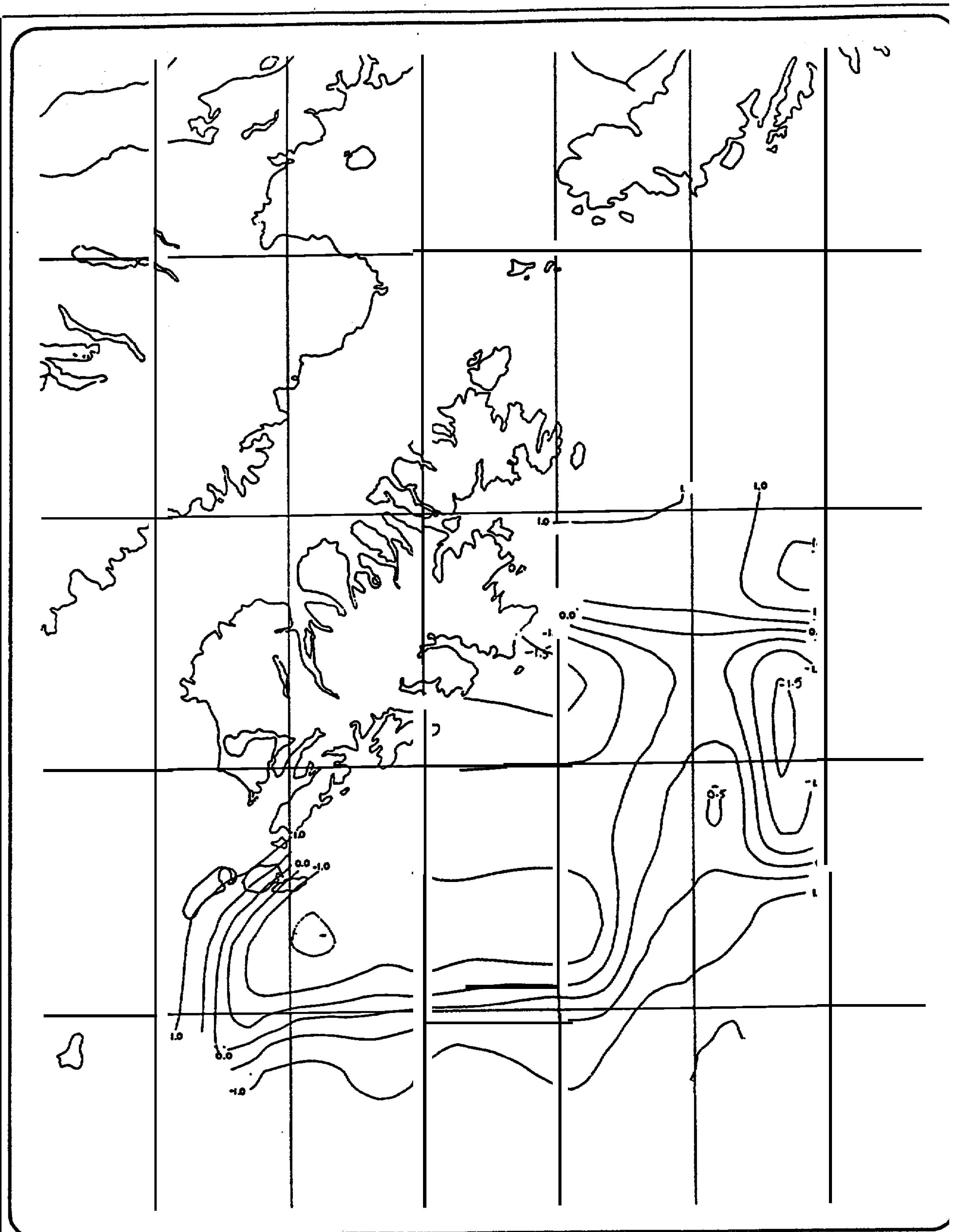


Distribution and abundance of Scolecithricella minor in bongo tows from cruise 4DI78.



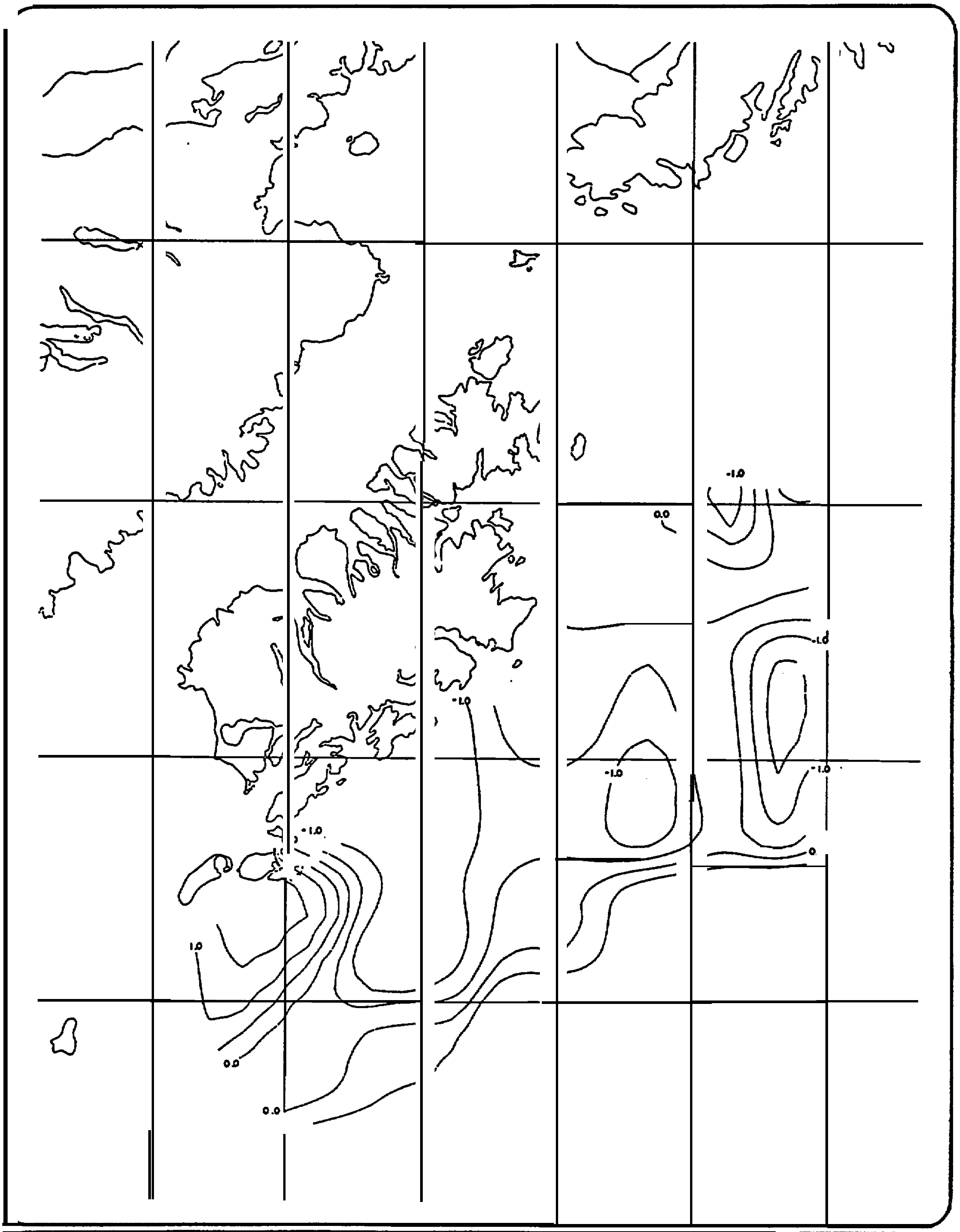
Distribution and abundance of *Scolecithricella minor* in bongo tows from cruise 2MF78.

Figure 3.3-28



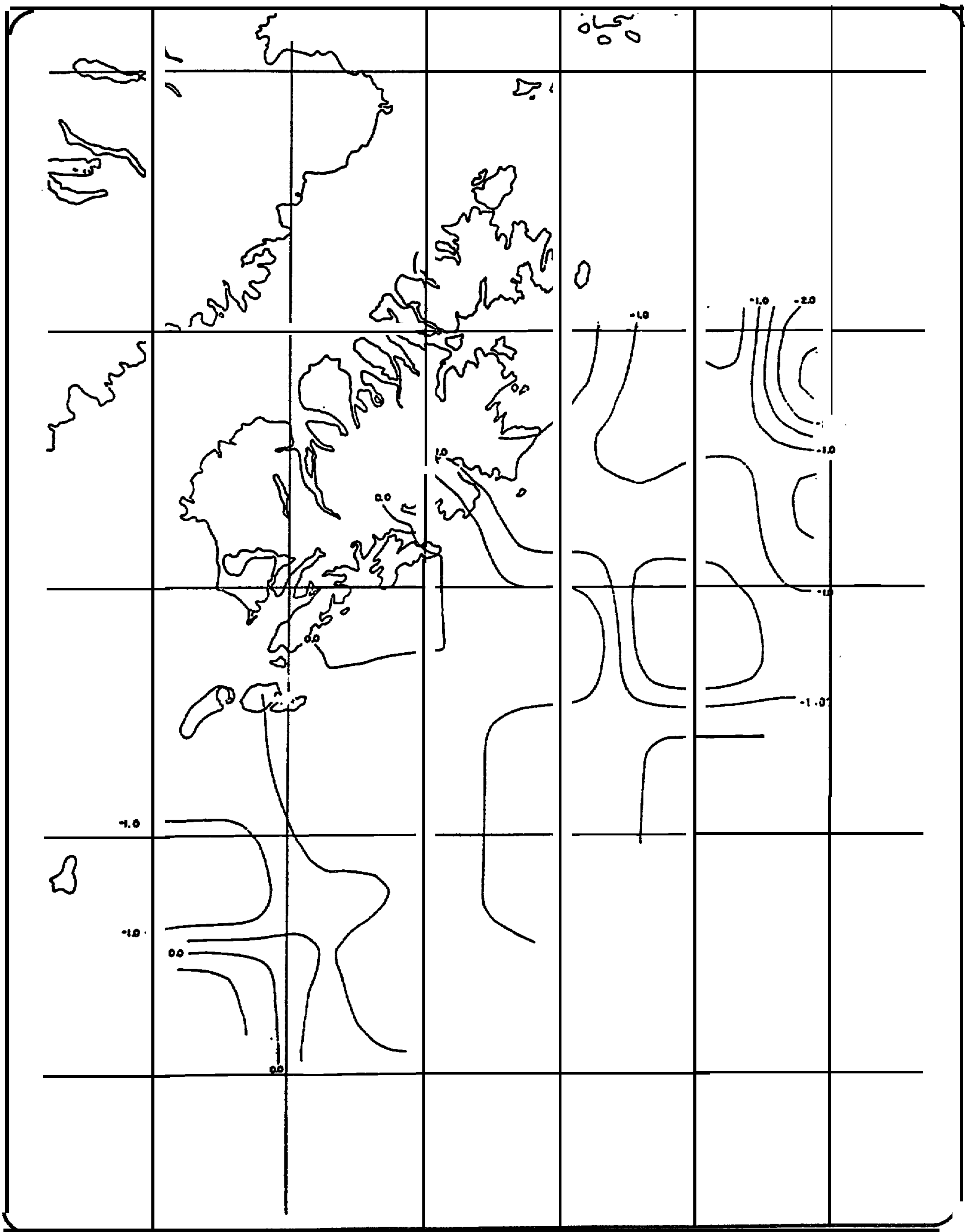
Distribution and abundance of <u>Scolecithricella minor</u> in bongo tows from cruise TWE78.

Figure 3.3-29



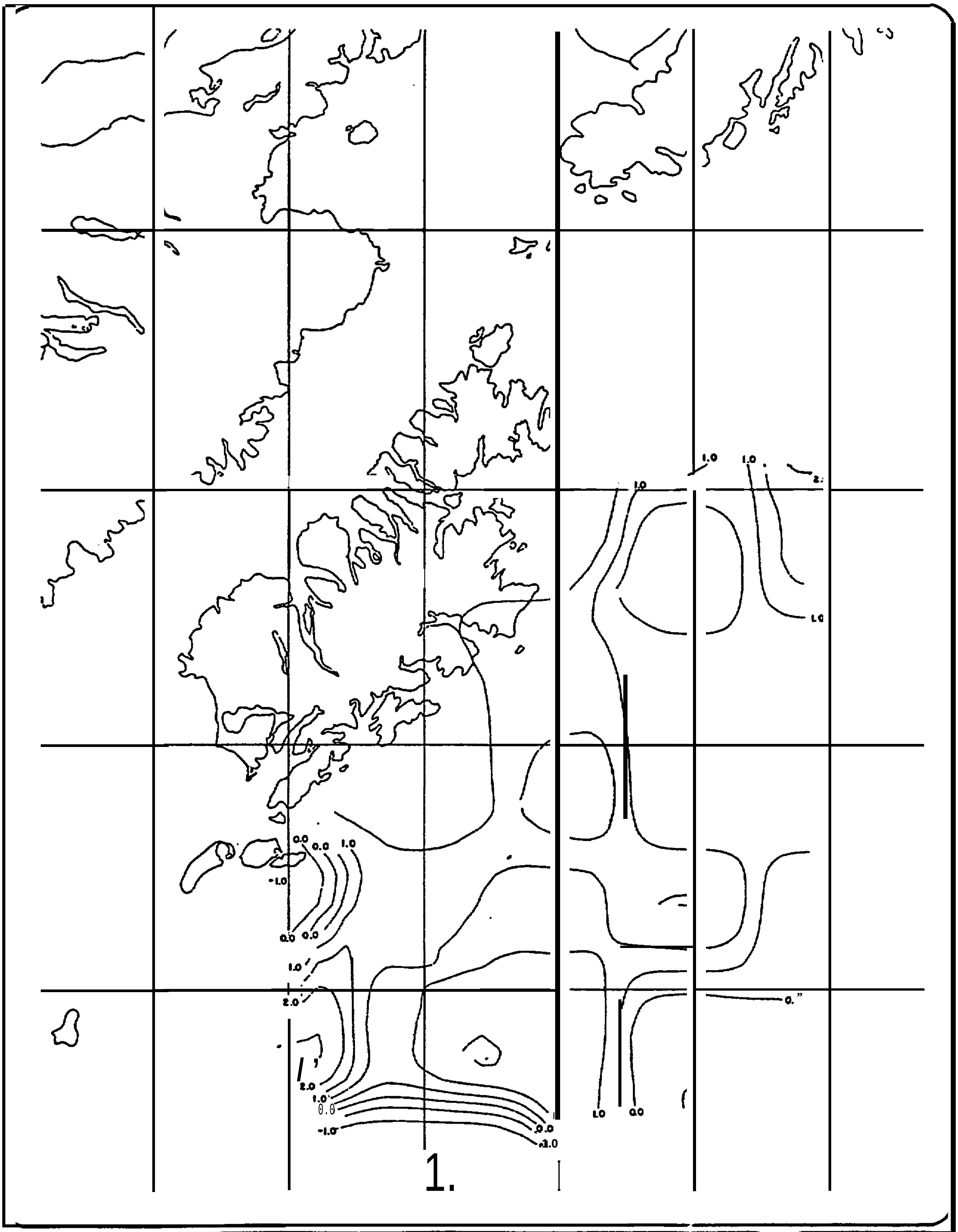
Distribution and abundance of Scolecithricella minor in bongo tows from cruise TMF79.

Figure 3.3-30



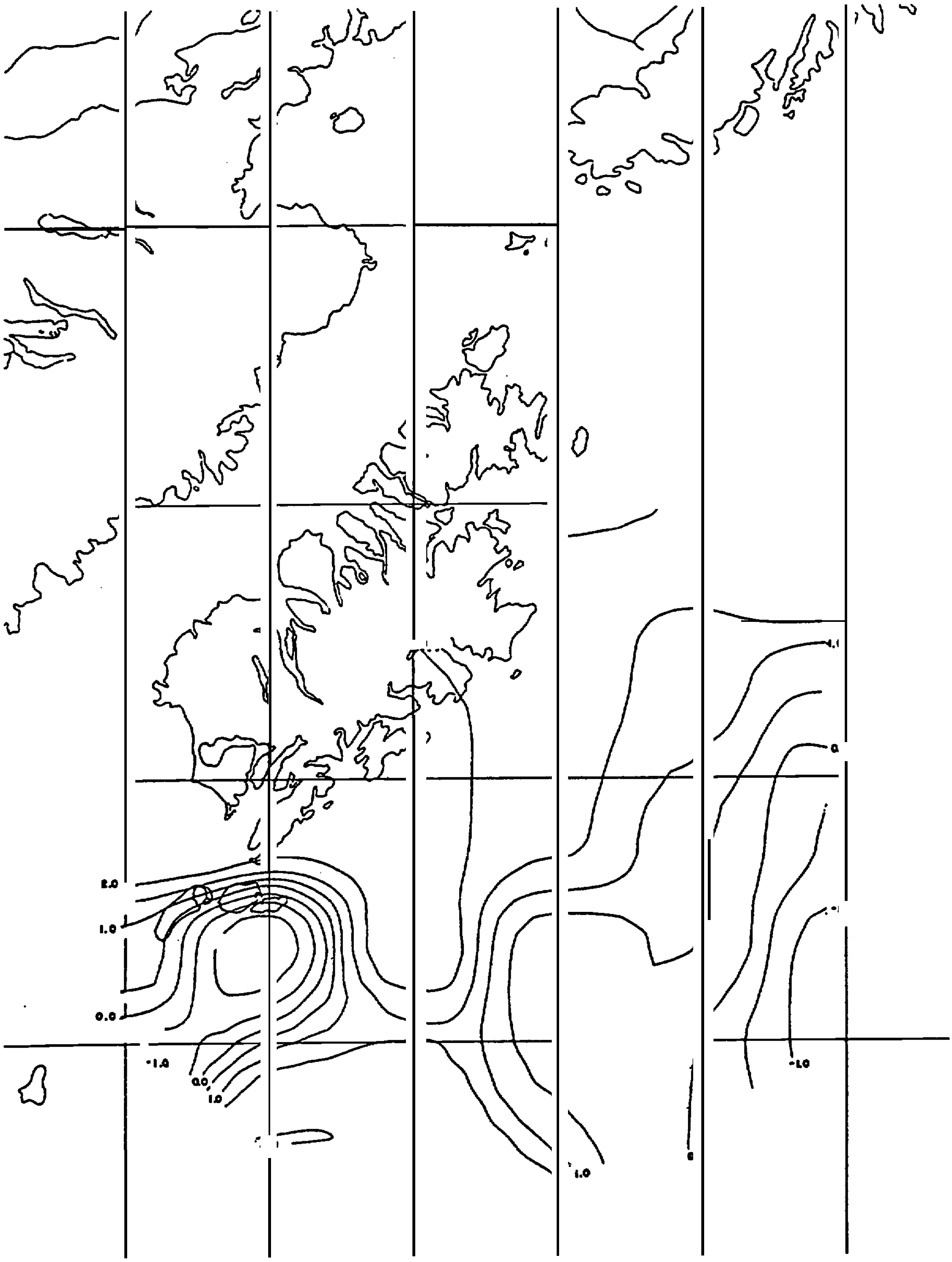
Distribution and abundance of <u>Oithona</u> spp. in bongo tows from cruise 40178.

Figure 3.3-31



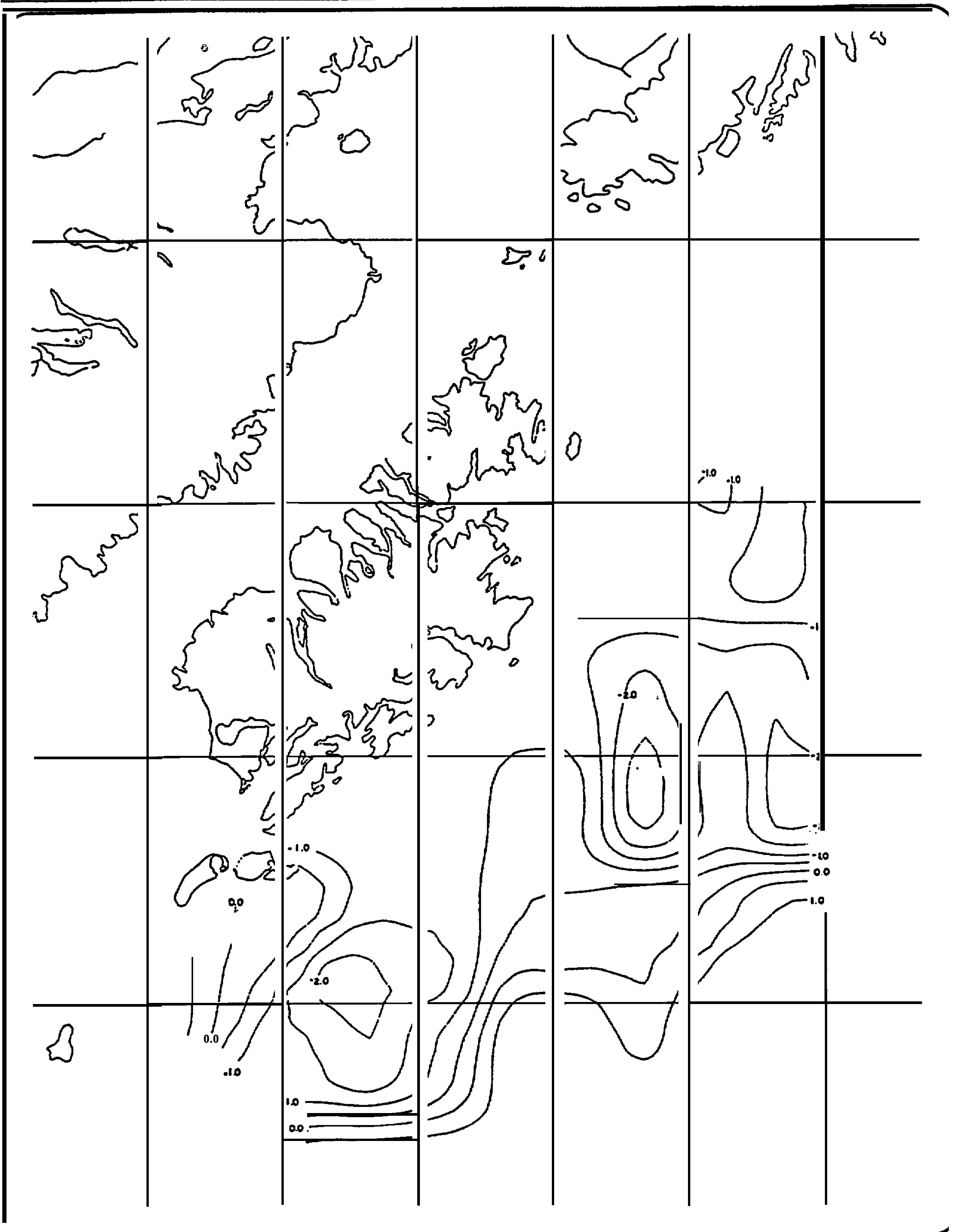
Distribution and abundance of Oithona spp. in bongo tows from cruise 2MF78.

Fi ure 3.%32



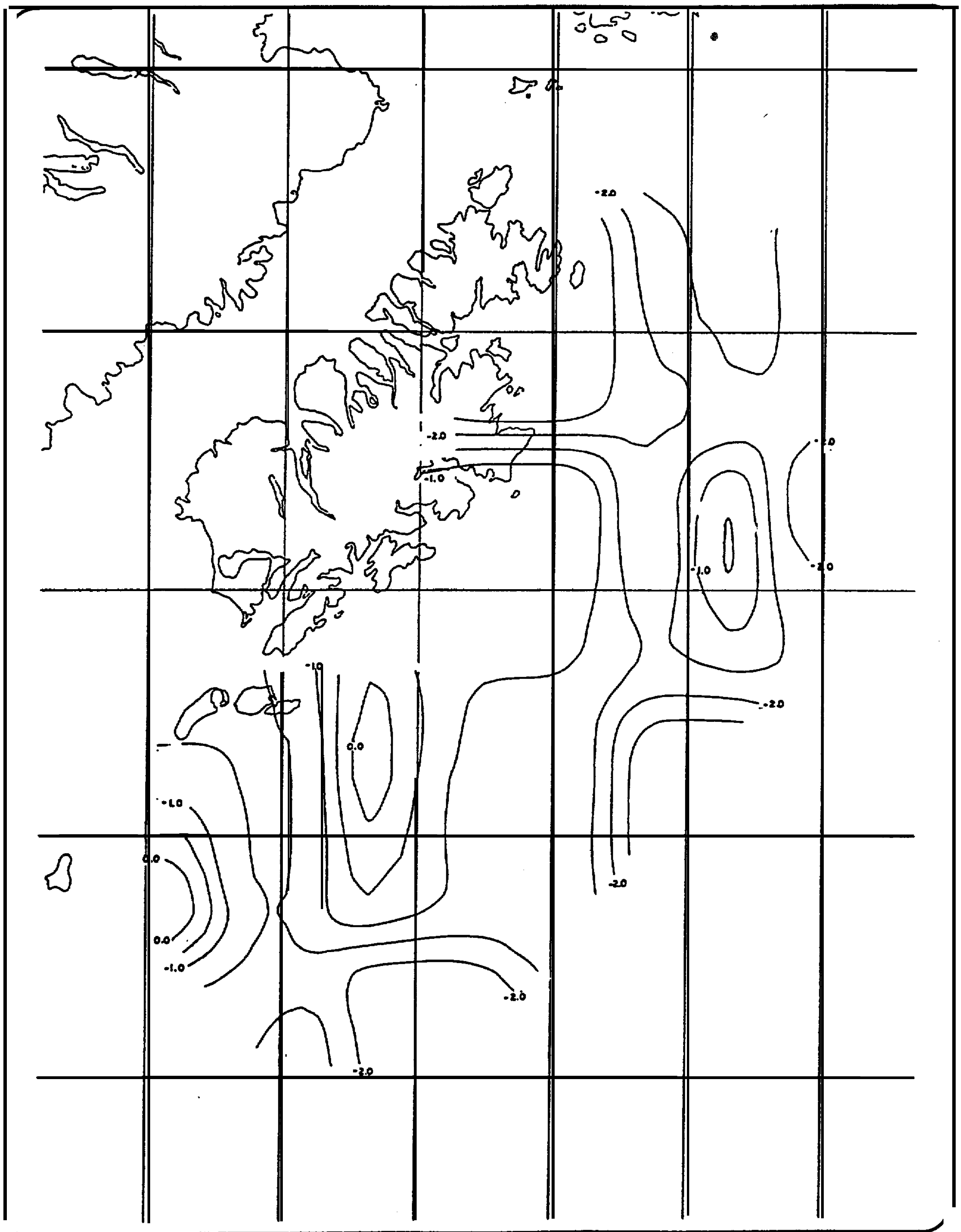
Distribution and abundance of Oithona spp. in bongo tows from cruise 1WE78.

Figure 3.3-33



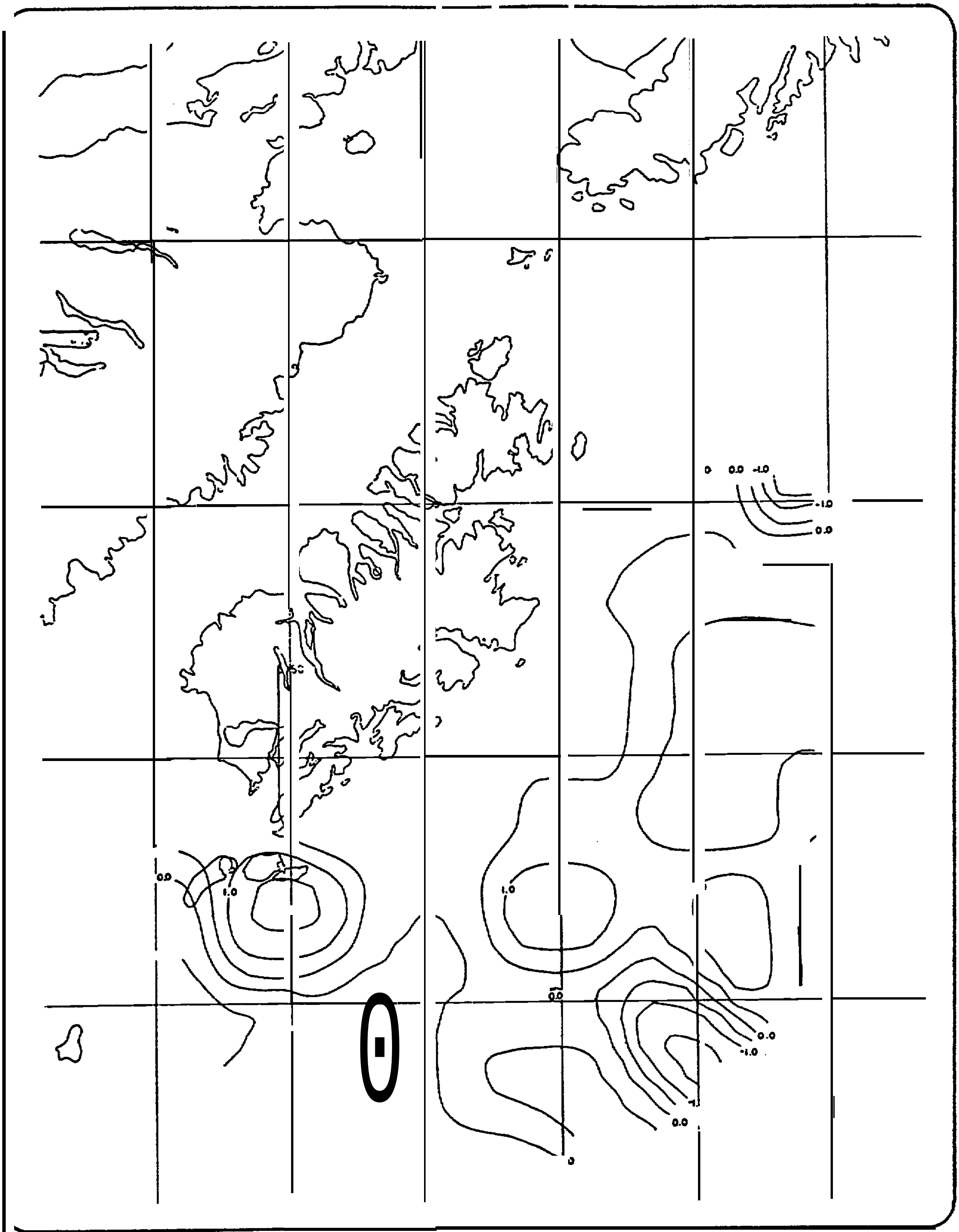
Distribution and abundance of *Oithona* spp. in bongo tows from cruise 1MF79.

Figure 3.3-34



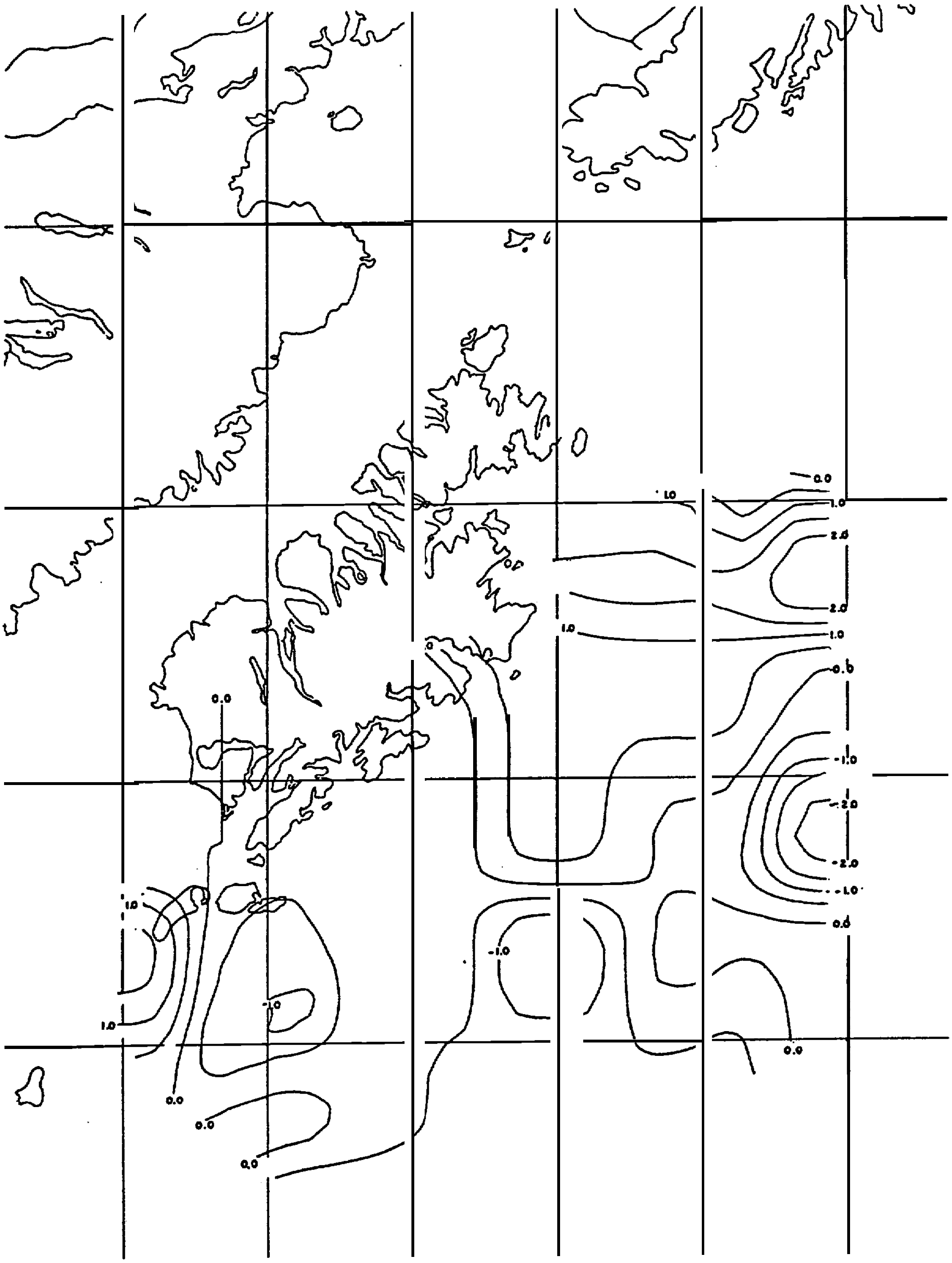
Distribution and abundance of total amphipods in bongo tows from cruise 4DI78.

Figure 3.3-3s



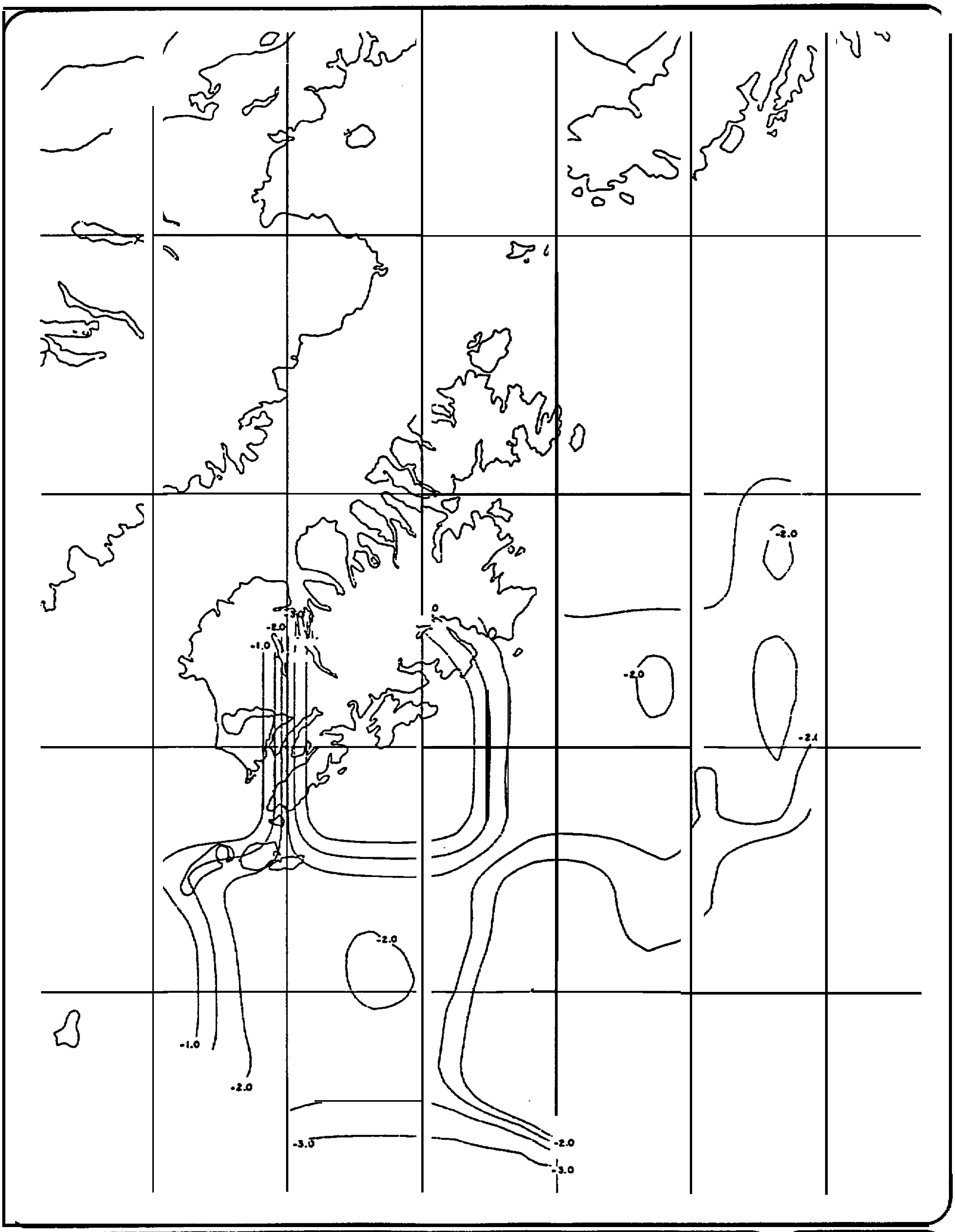
Distribution and abundance of total amphipods in bongo tows from cruise 2MF78.

Figure 3.3-36



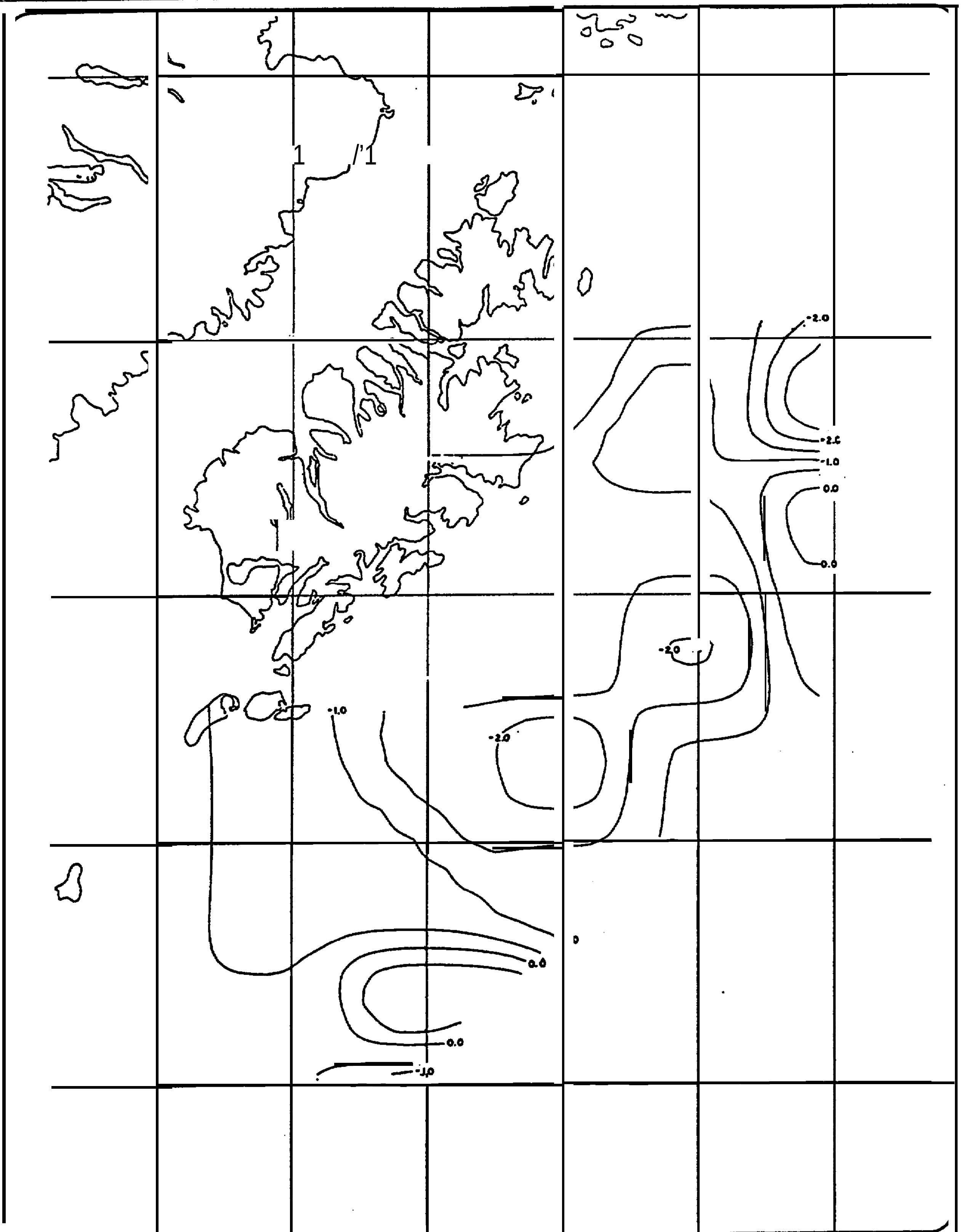
Distribution and abundance of total amphipods in bongo tows from cruise 1WE78.

Figure 3.3-37



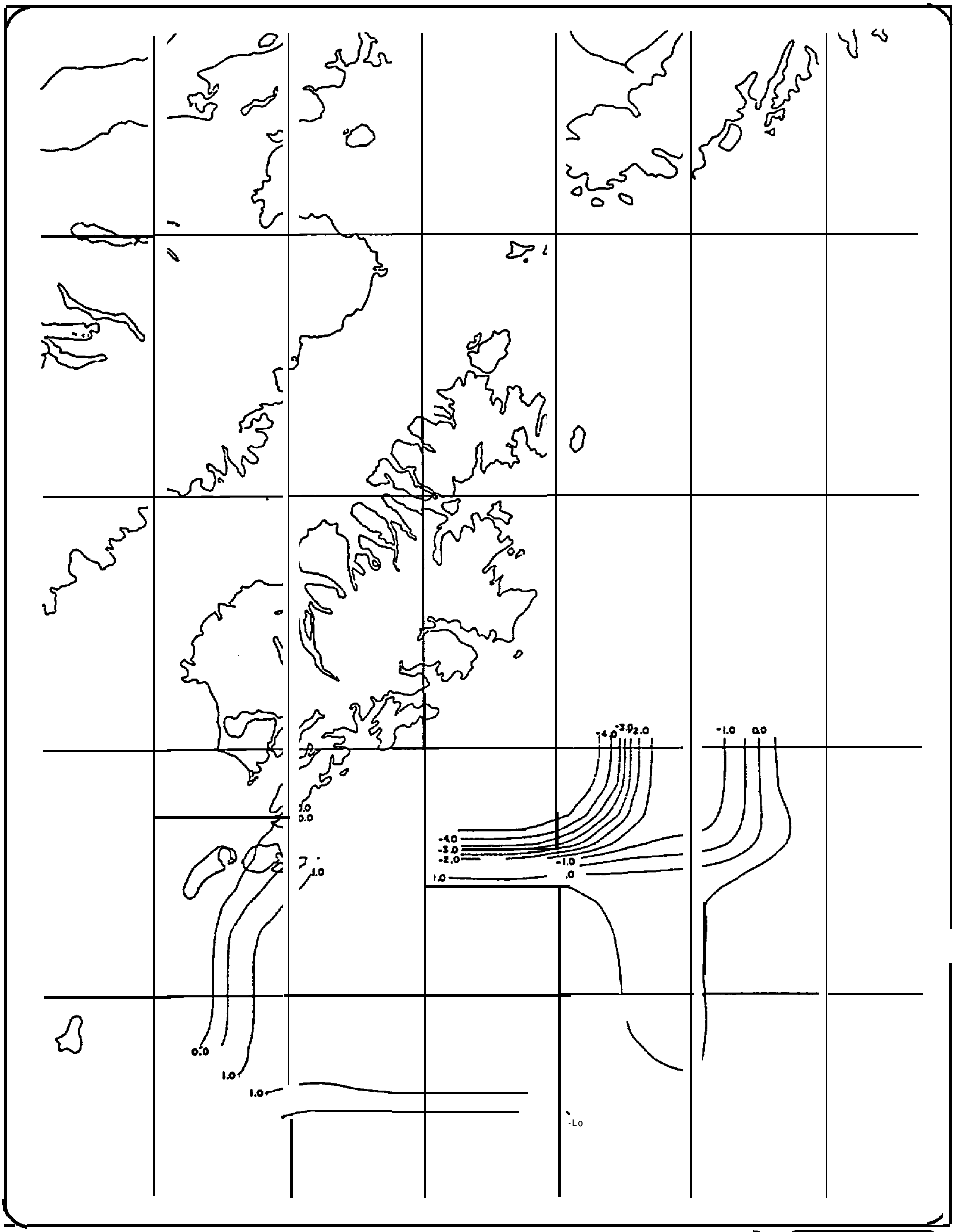
Distribution and abundance of total amphipods in bongo tows from cruise 1MF79.

Figure 3.3-38



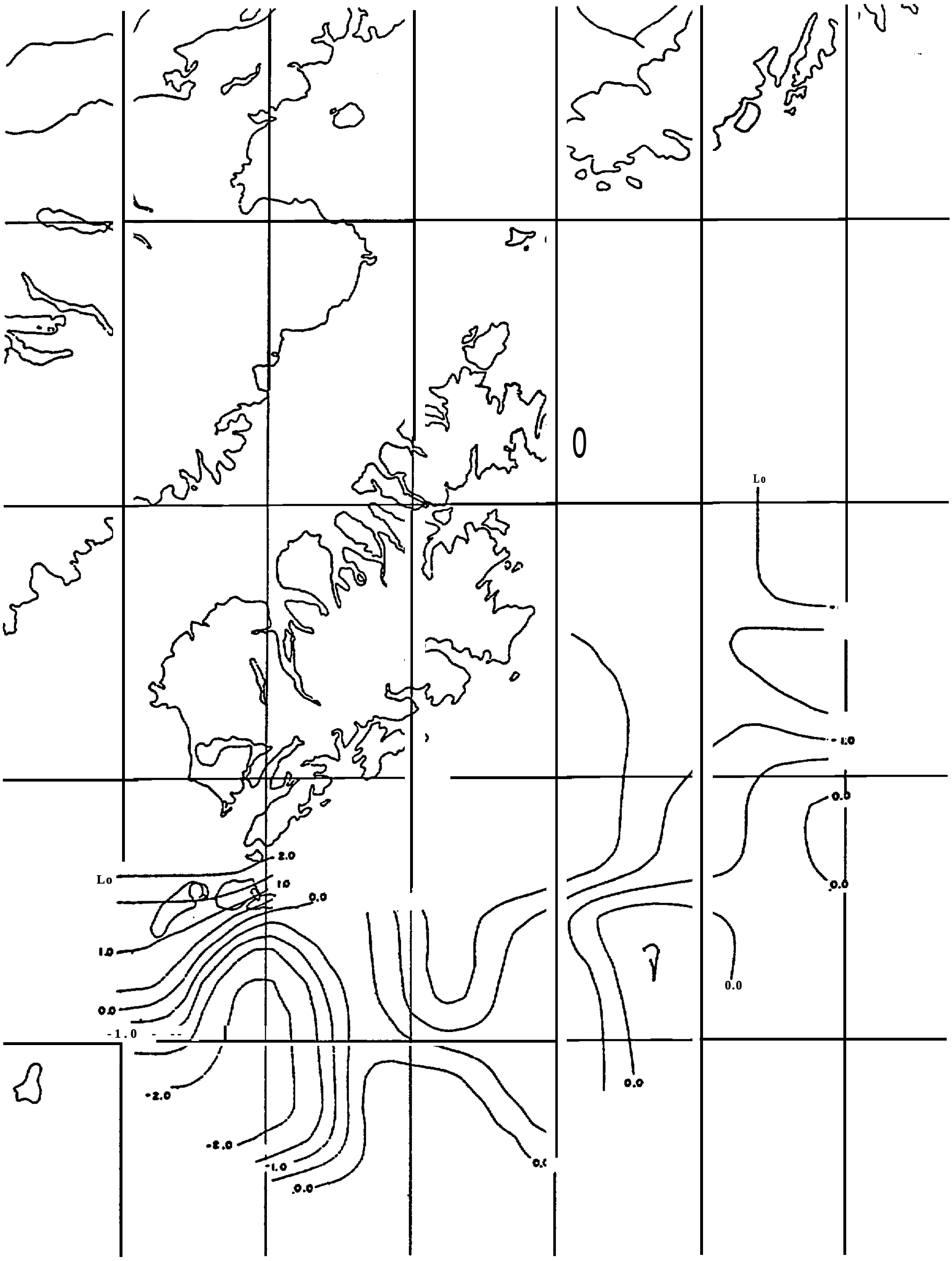
Distribution and abundance of total ostracods in bongo tows from cruise 4DI78.

Figure 3.3-39



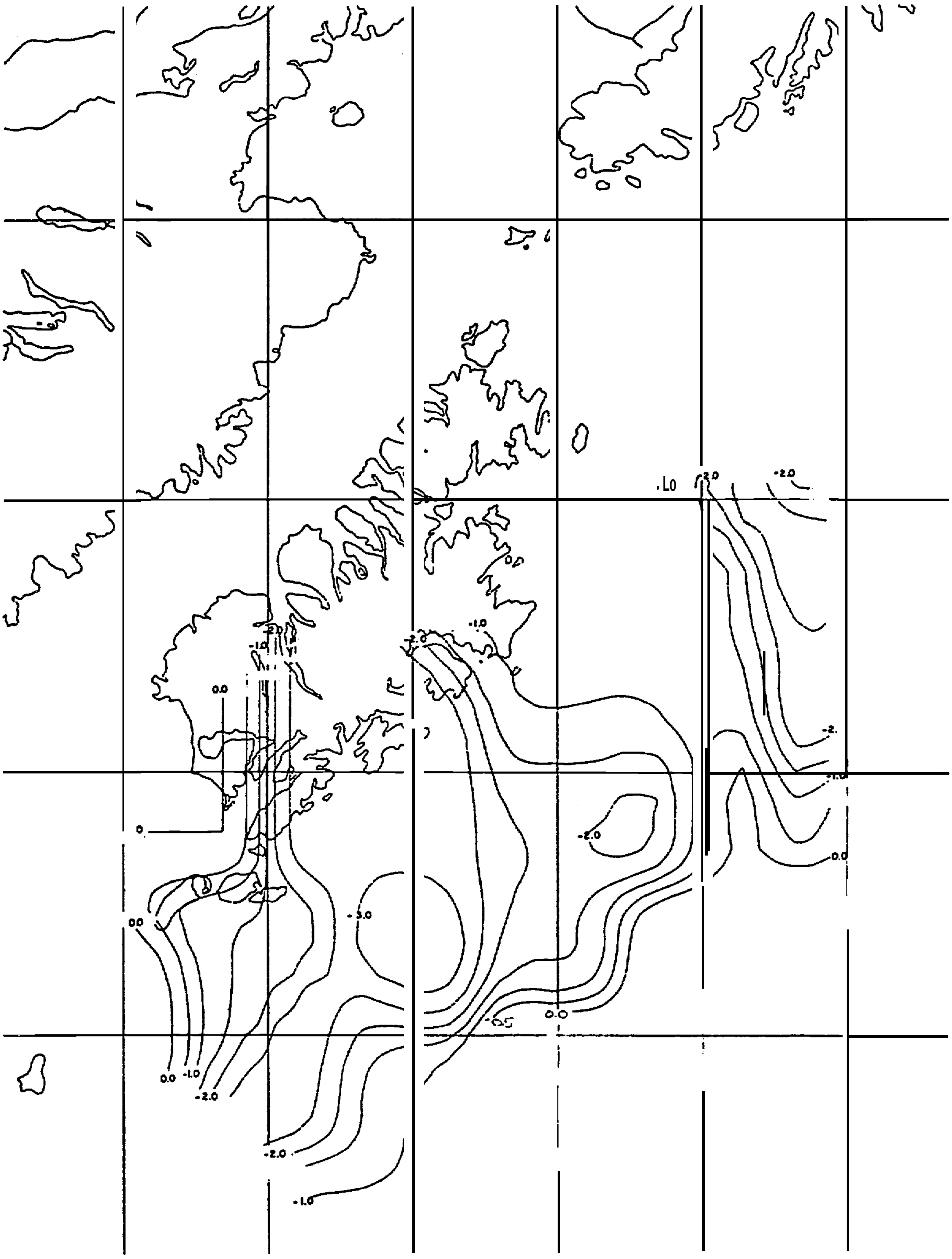
Distribution and abundance of total ostracods in bongo tows from cruise 2MF78.

Figure 3.3-40



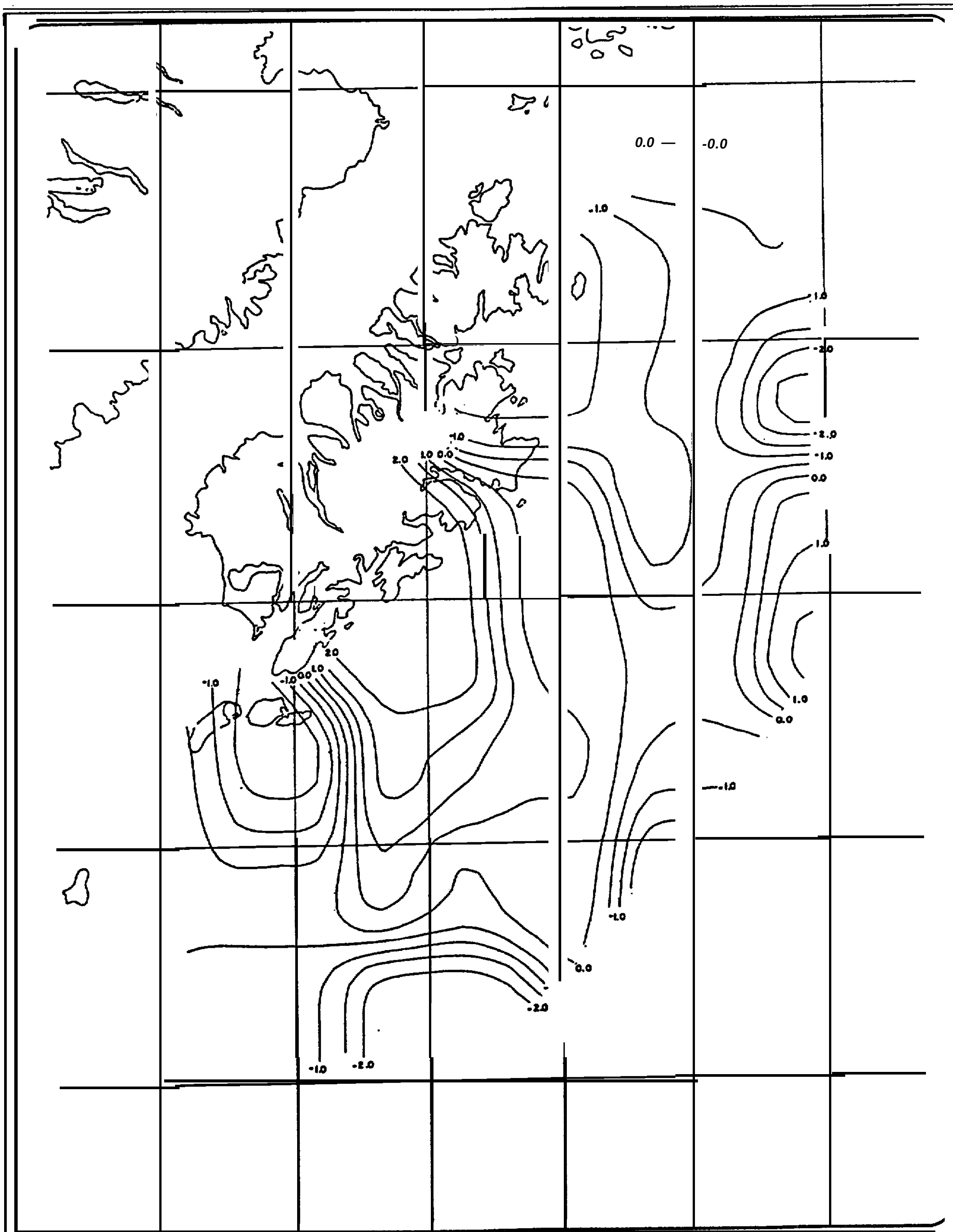
Distribution and abundance of total ostracods in bongo tows from cruise 1WE78.

Figure 3.3-41



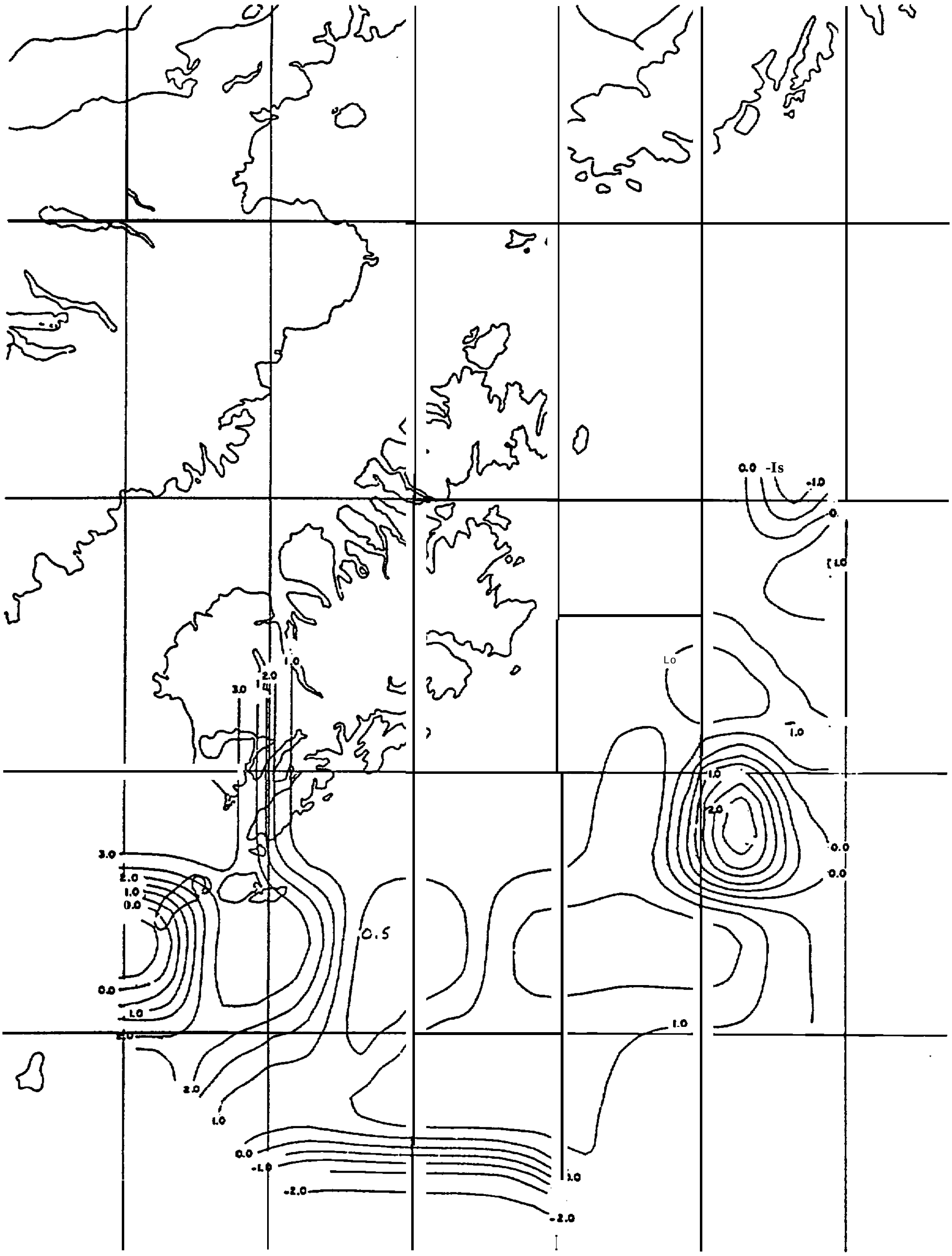
Distribution and abundance of total ostracods in bongo tows from cruise 1MF79.

Fi ure 3.%42



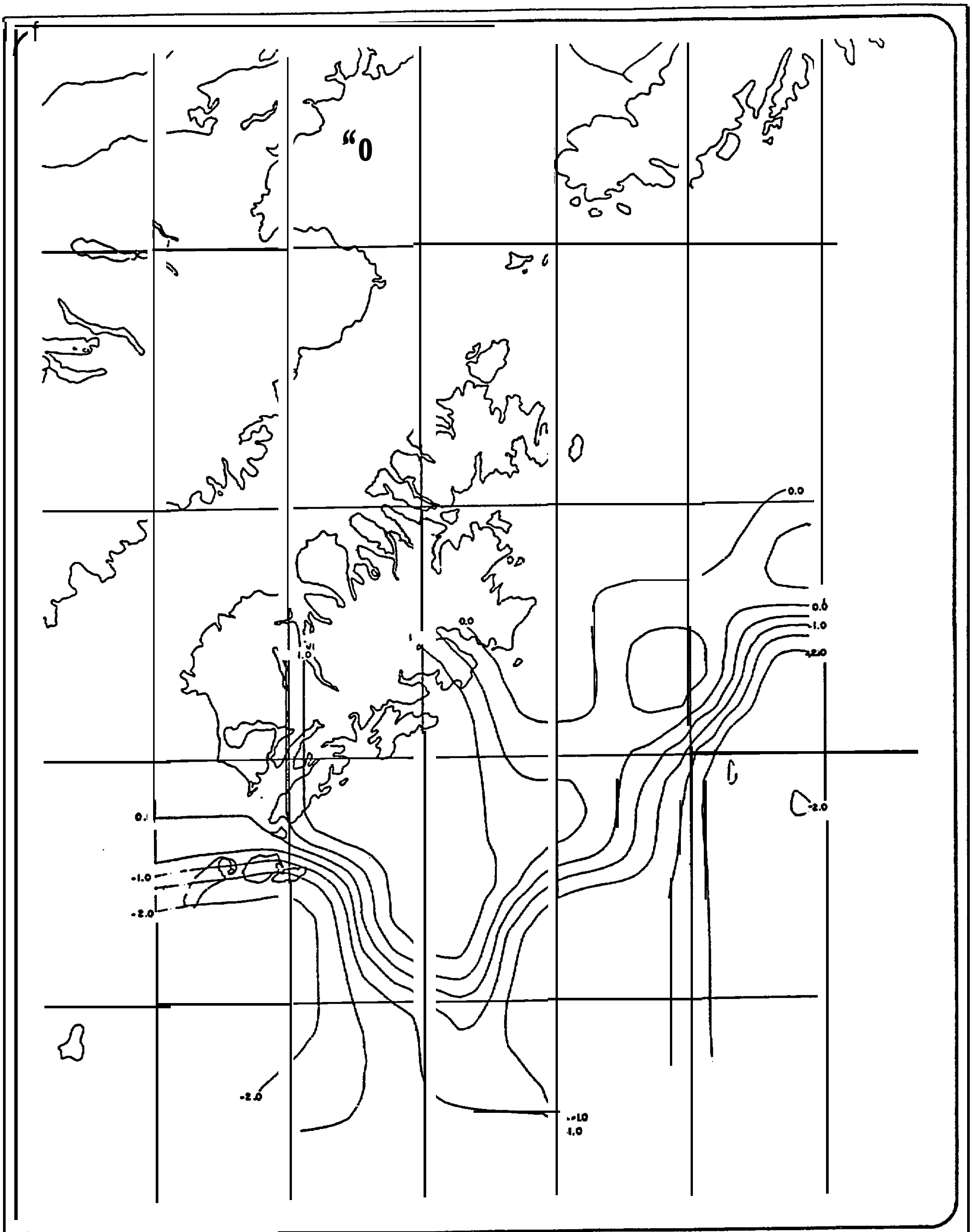
Distribution and abundance of total larvaceans in bongo tows from cruise 40178.

Figure 3.3-43



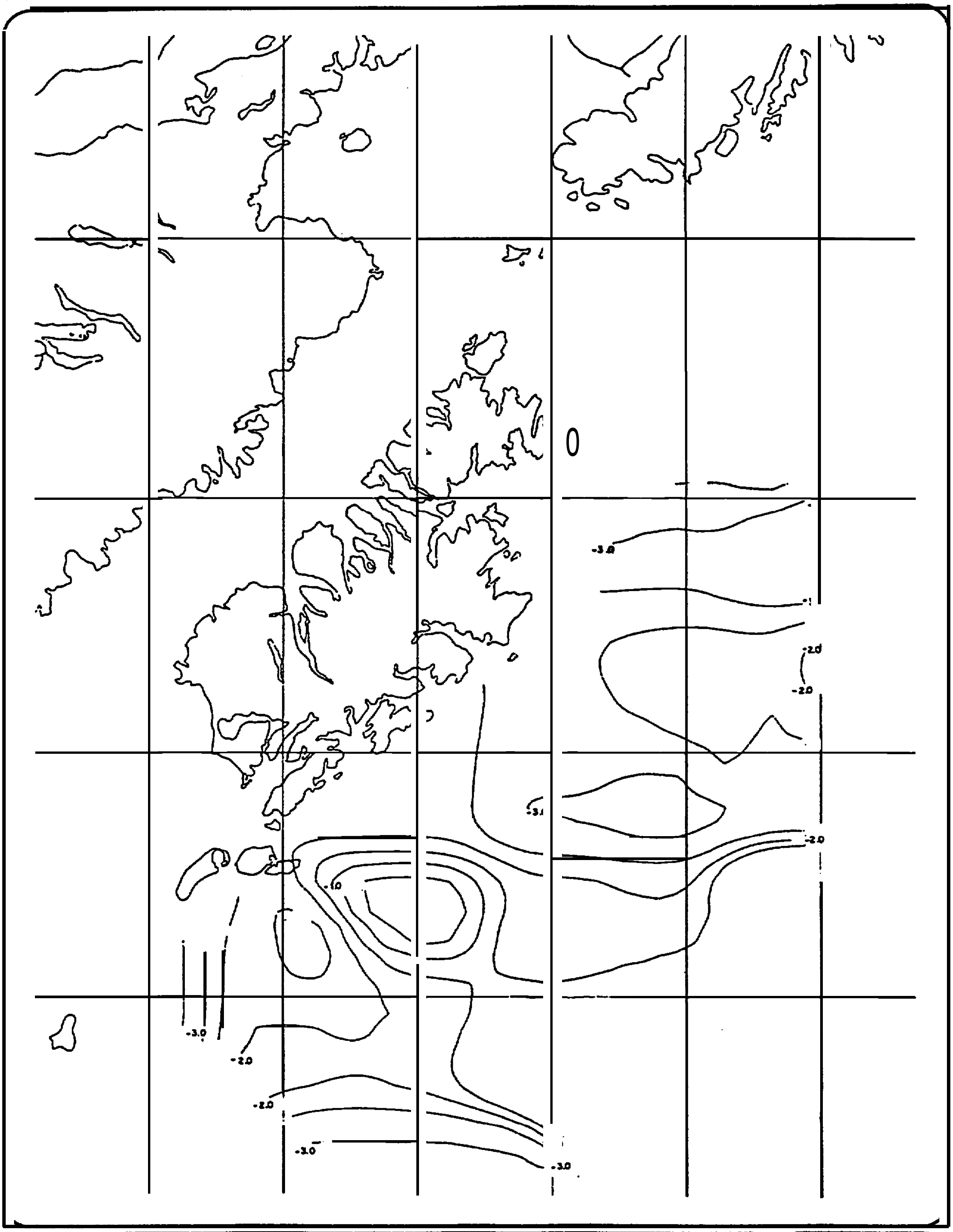
Distribution and abundance of total larvaceans in bongo tows from cruise 2MF78.

Figure 3.3-44



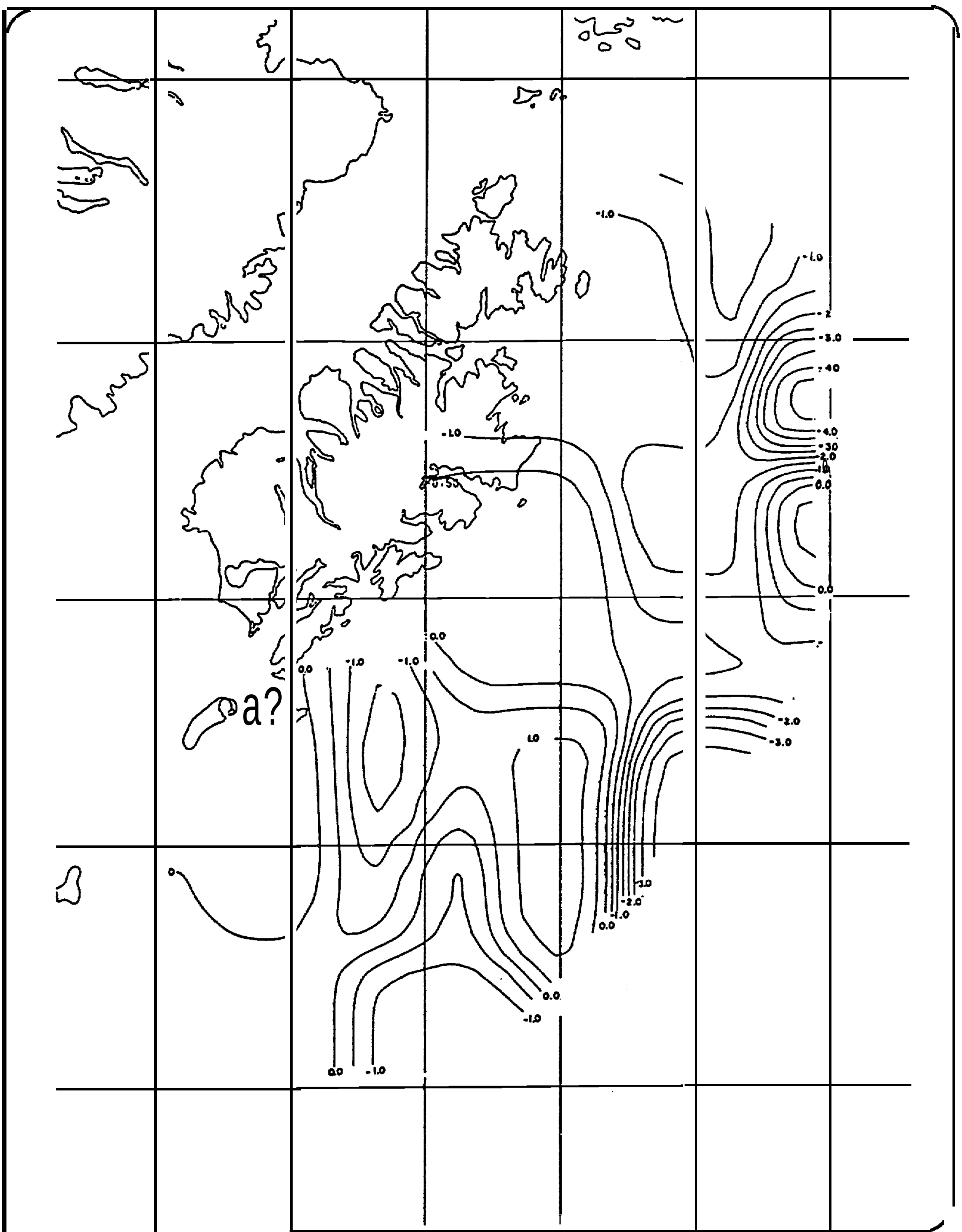
Distribution and abundance of total larvaceans in bongo tows from cruise 1WE78.

Figure 3.3-45



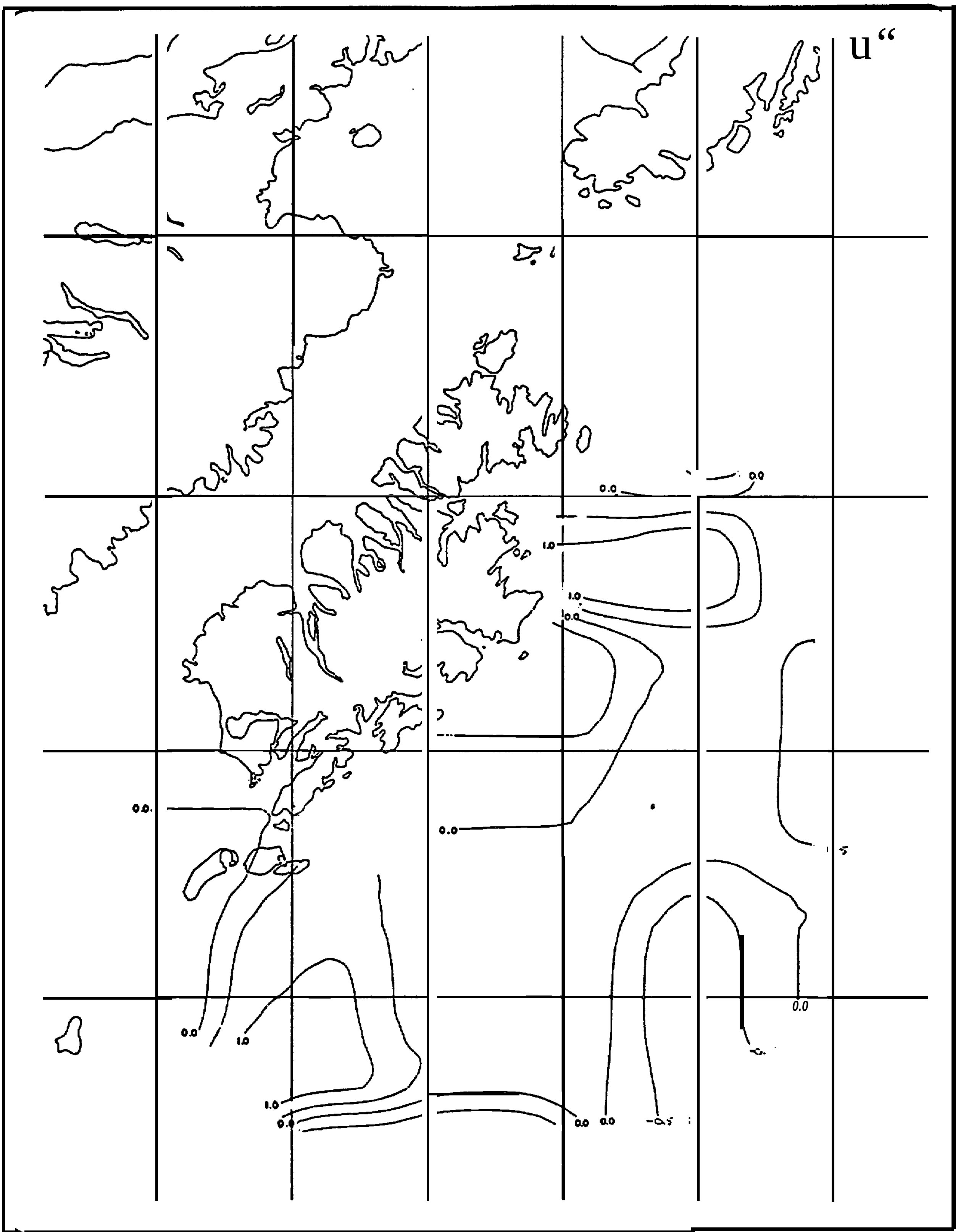
Distribution and abundance of total larvaceans in bongo tows from cruise 1MF79.

Figure 3.3-46



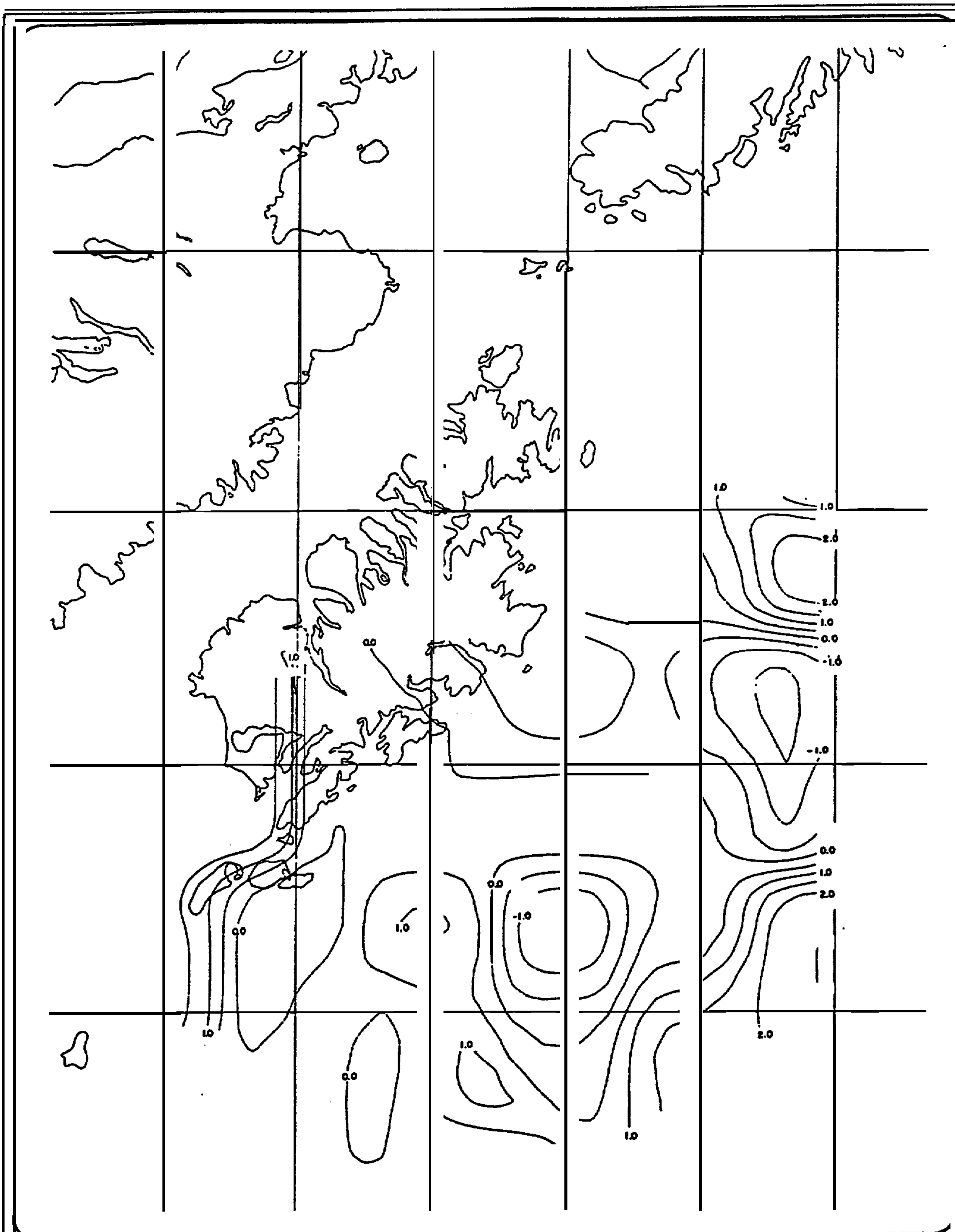
Distribution and abundance of *Limacina helicina* in bongo tows from cruise 4D178.

Figure 3.3-47



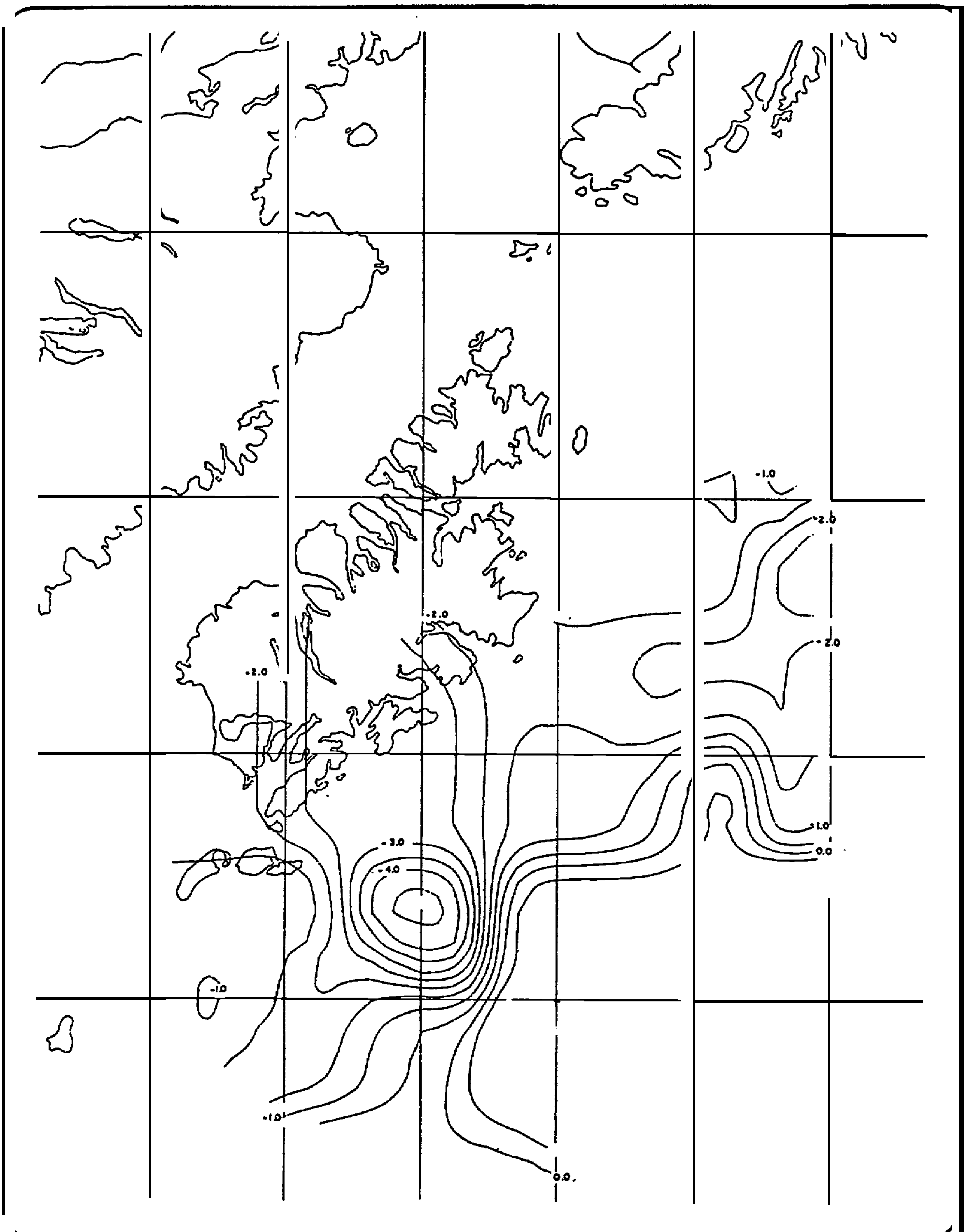
Distribution and abundance of <u>Limacina helicina</u> in bongo tows from cruise 2MF78.

Figure 3.3-48



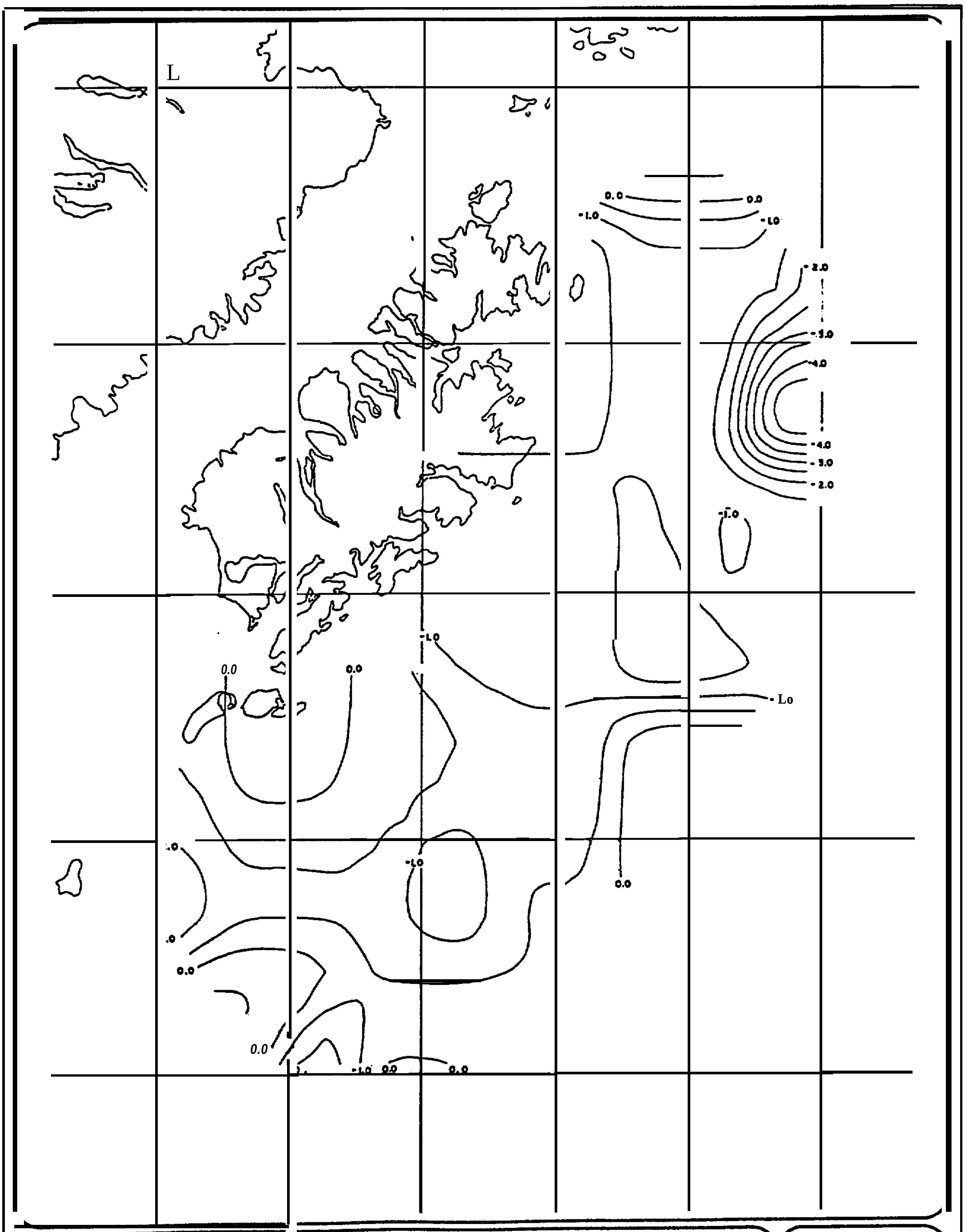
Distribution and abundance of *Limacina helicina* in bongo tows from cruise 1WE78.

Figure 3.3-49



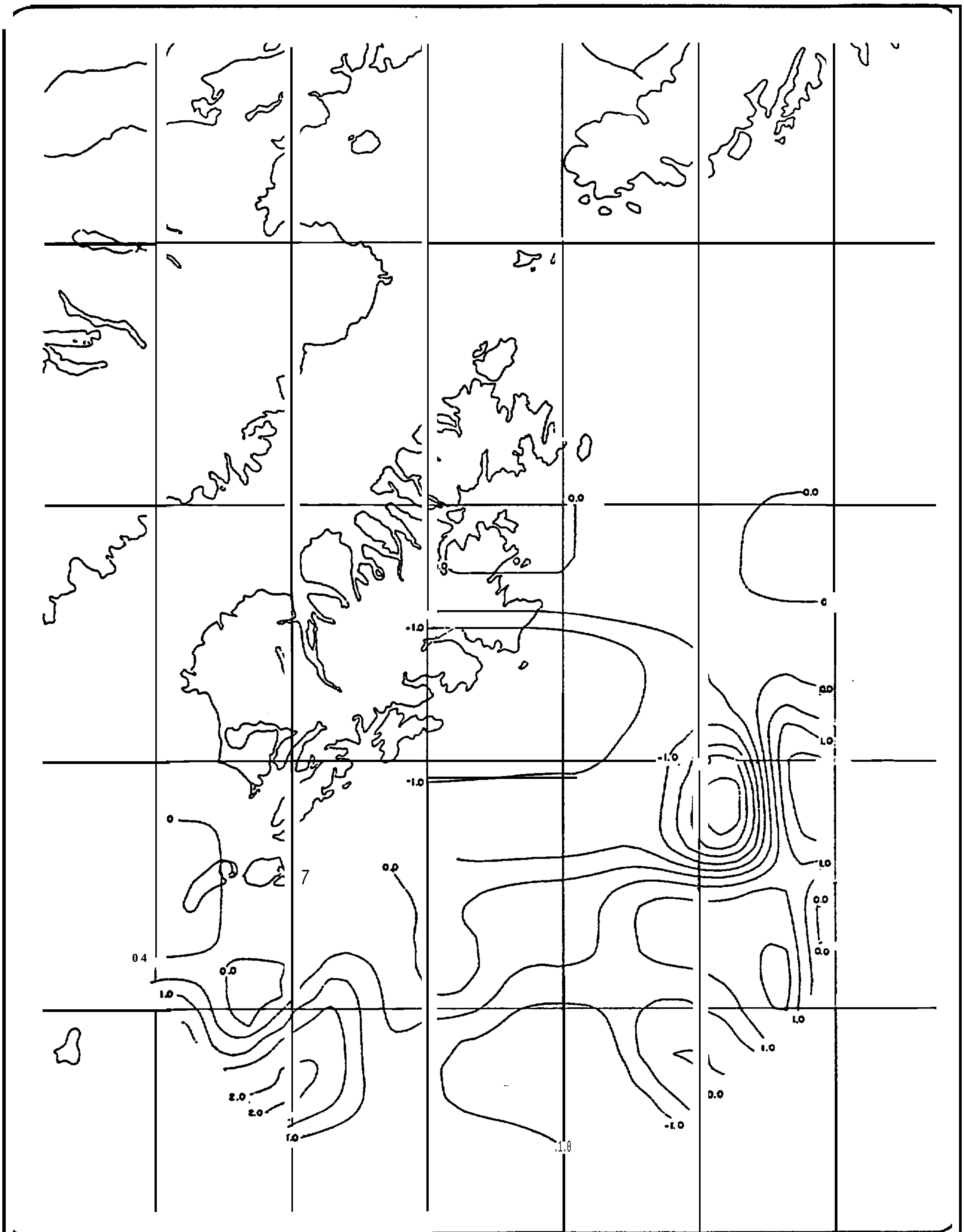
Distribution and abundance of *Limacina helicina* in bongo tows from cruise 1MF79.

Figure 3.3-50



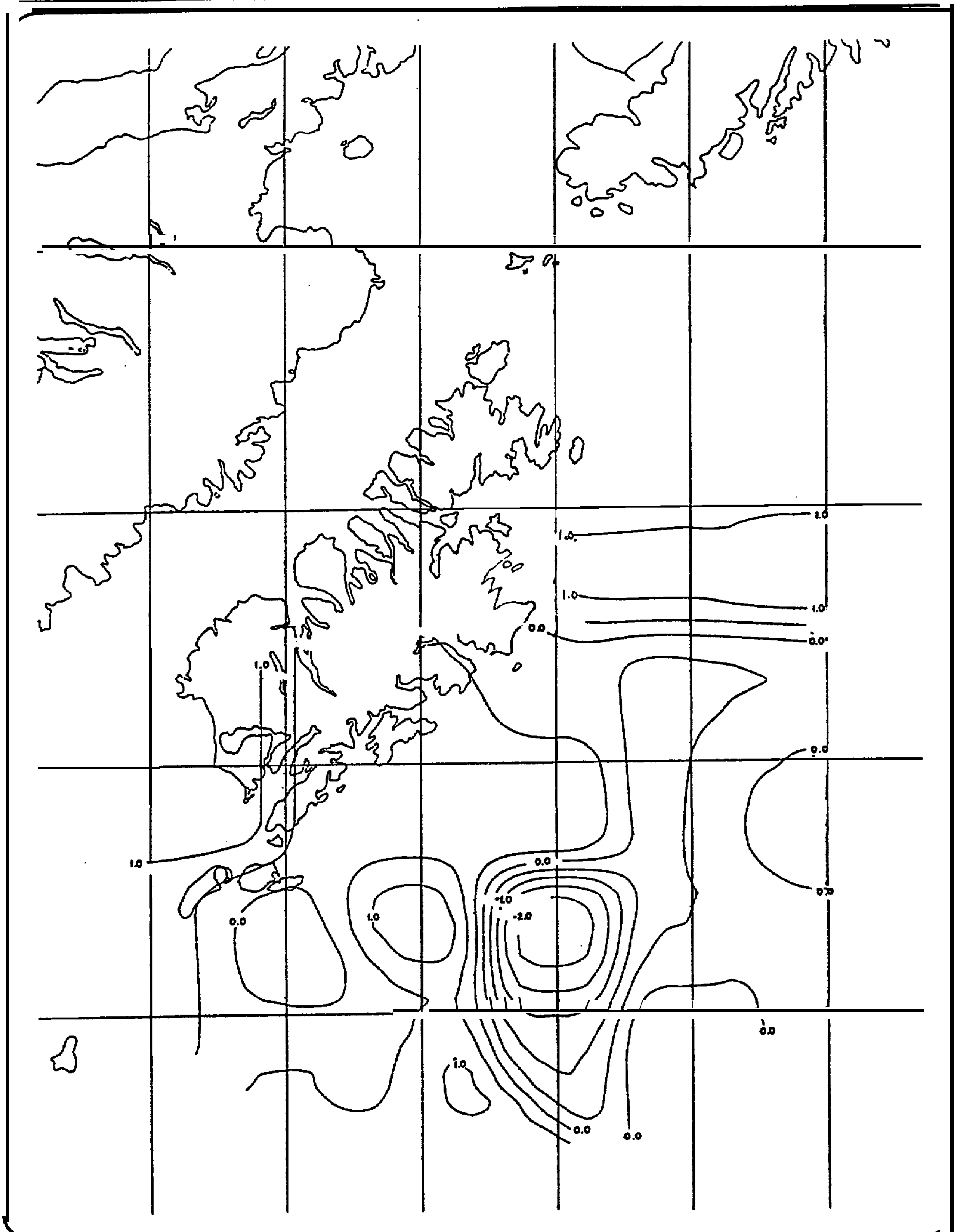
Distribution and abundance of total chaetognaths in bongo tows from cruise 4DI78.

Figure 3.3-51



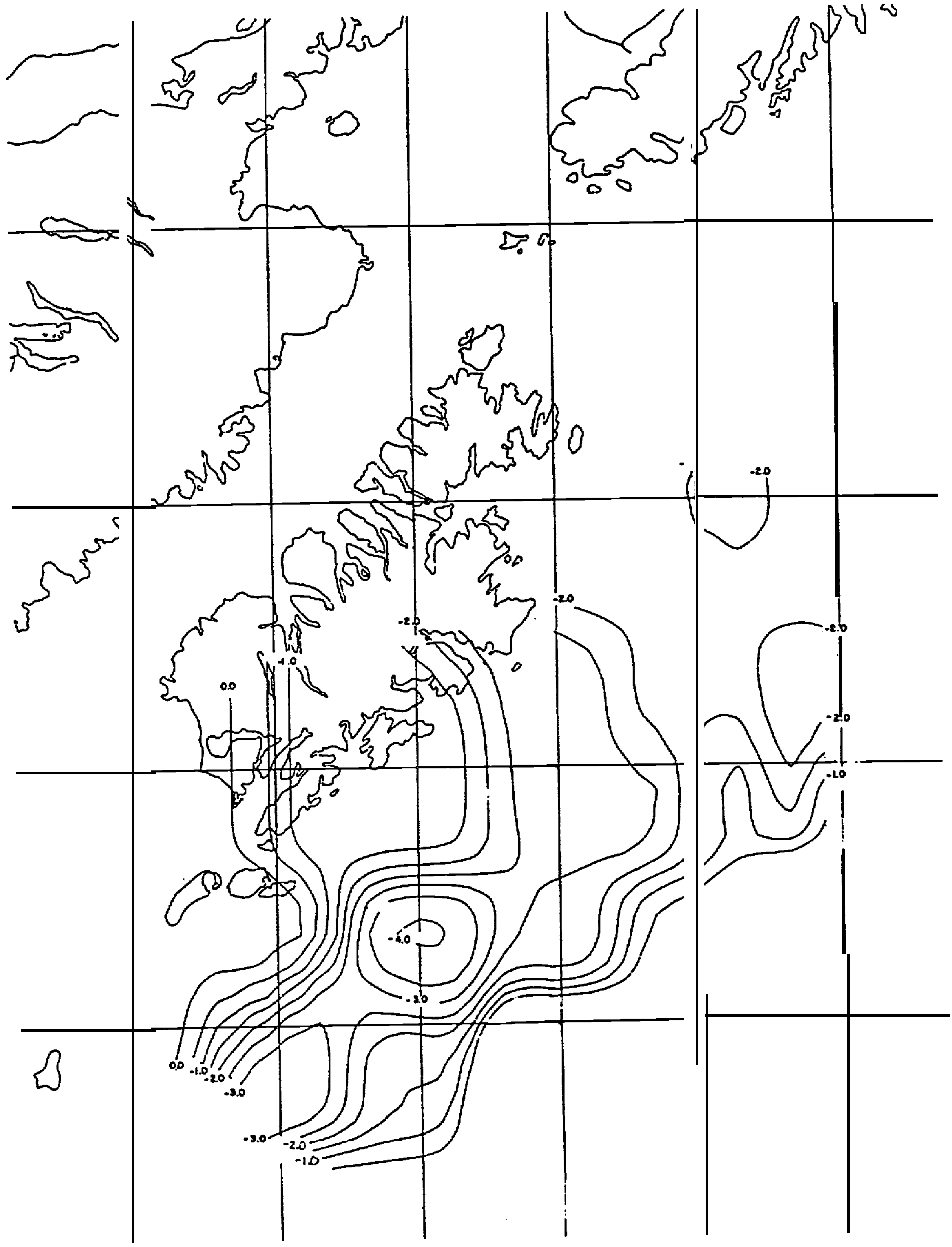
Distribution and abundance of total chaetognaths in bongo tows from cruise 2MF78.

Figure 3.3-52



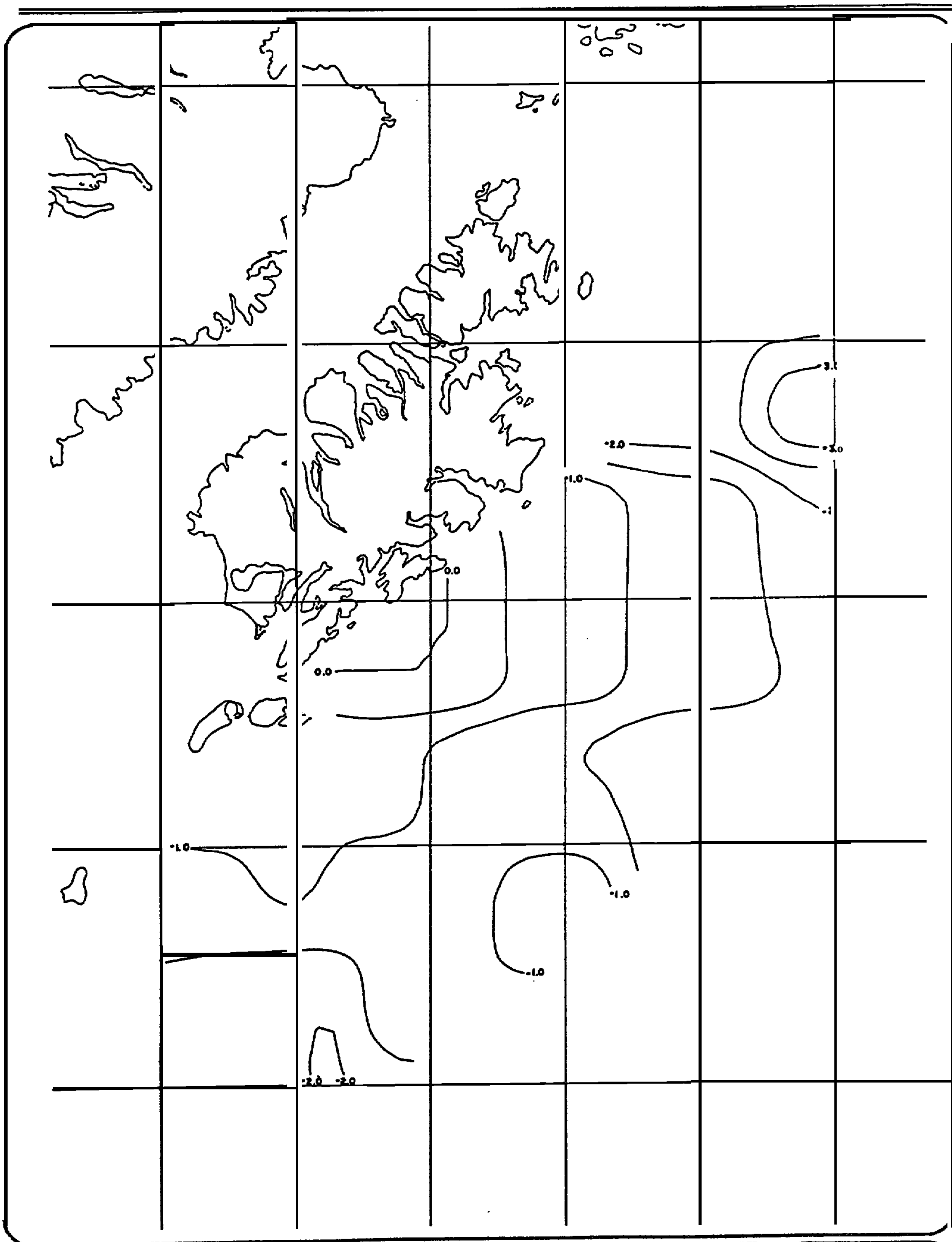
Distribution and abundance of total chaetognaths in bongo tows from cruise 1WE78.

Figure 3.3-53



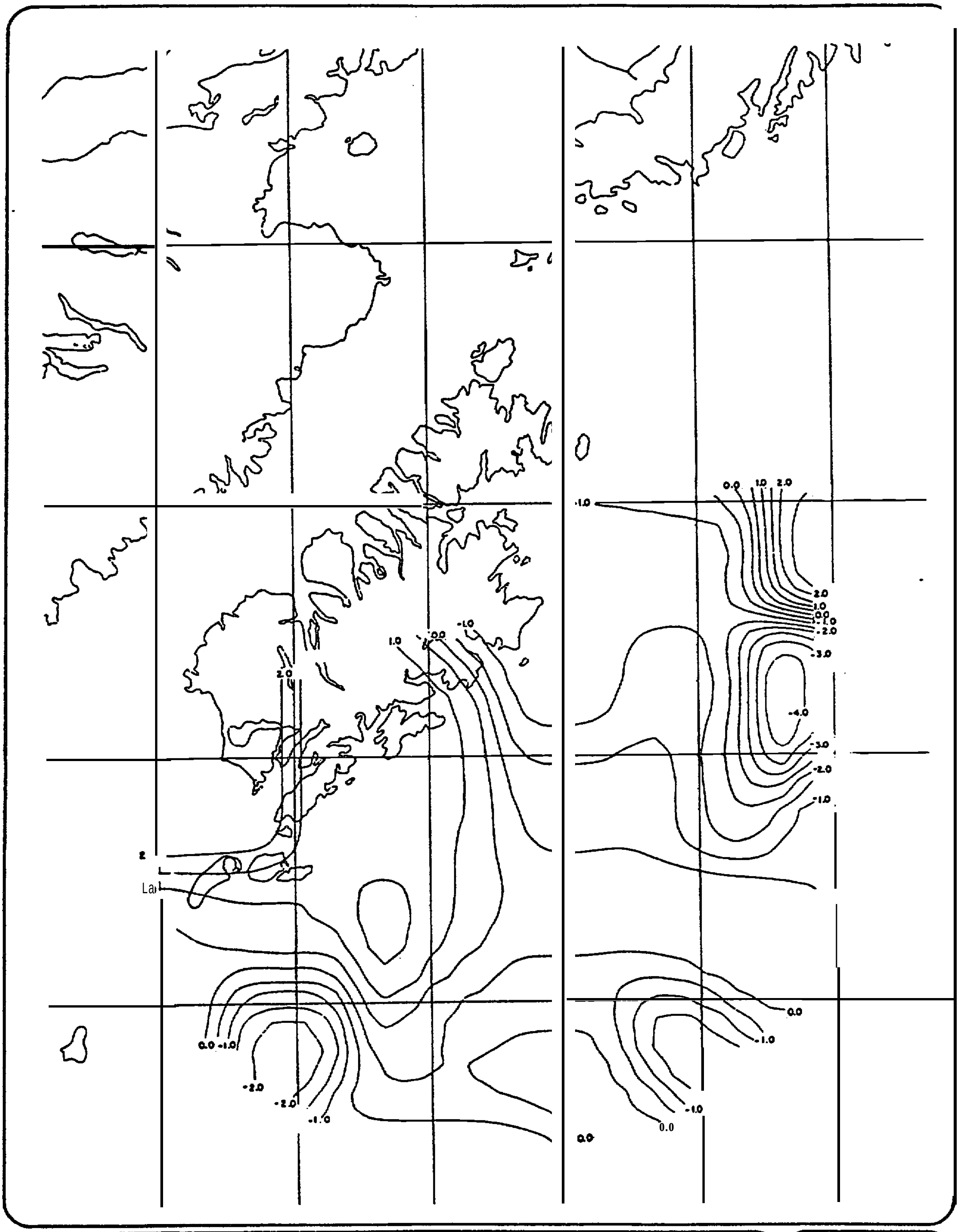
Distribution **and** abundance of total **chaetognaths** in bongo tows from cruise **1MF79.**

Figure 3.3-54



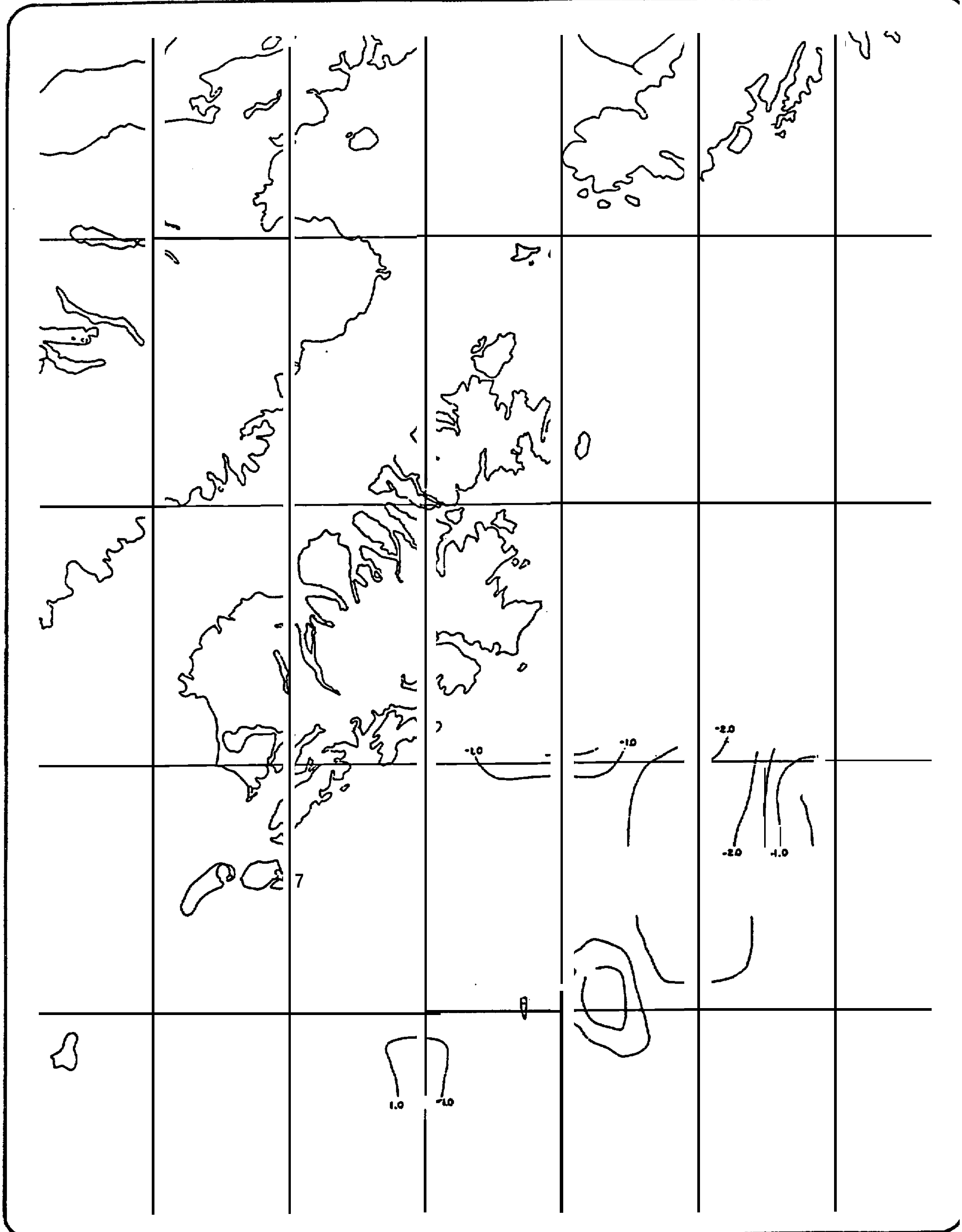
Distribution and abundance of total cnidarians in bongo tows from cruise 4DI78.

Figure 3.3-55



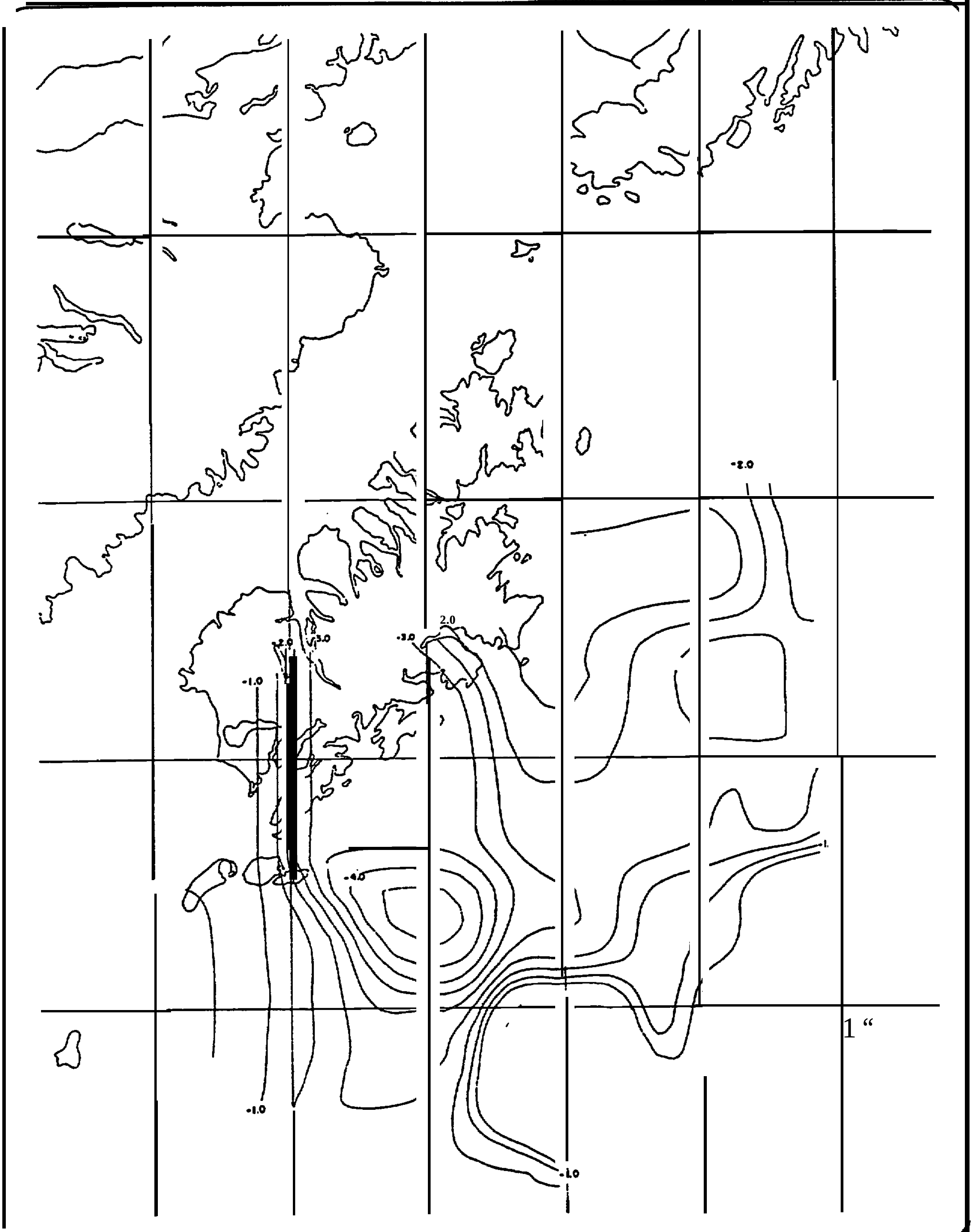
Distribution and abundance of total cnidarians in bongo tows from cruise 2MF78.

Figure 3.3-56



Distribution and abundance of total cnidarians in bongo tows from cruise 1WE78.

Figure 3.3-57



Distribution and abundance of total cnidarians in bongo tows from cruise 1MF79.

Figure 3.3-58

6.0 TABLES

Table 1.4-1 Planktivorous Organisms off Kodiak Island classified by known food sources.

Calanoid Copepods	Harpacticoid Copepods	Euphausiids	Decapod Larvae
juvenile salmonids	juvenile salmonids	pollock	Pacific Ocean perch
capelin	capelin	Pacific Ocean perch	herring
herring	Pacific sand lance	yellow Irish lord	smelt
Pacific sand lance	juv. whitespotted greenling	yellowfin sole	juvenile pink salmon
juv. whitespotted greenling	juv. masked greenling	rex sole	pandalid shrimp
juvenile pollock	juvenile pollock	flathead sole	
juvenile rock sole	Pacific cod	juvenile arrowtooth flounder	
juvenile yellowfin sole		short-tailed shearwater	
gray whale		tufted puffin	
sei whale		black-legged kittiwake	
fin whale		minke whale	
right whale		fin whale	
		blue whale	
		humpback whale	

Fish Larvae	Mysids	Pelagic Amphipods
juvenile salmonids	sand sole	juvenile chum salmon
Pacfic sand lance	pollock	herring
juv. whitespotted greenling		

Table 2.1-1 Summary of Kodiak shelf plankton cruise dates and identifications.

	Cruise Identification	VTN Number	Sampling Period
Offshore:	4DI 78	02	28 Mar - 20 Apr 1978
	2MF78	03	18 Jun - 9 Jul 1978
	1 WE78	04	25 Ott - 25 Nov 1978
	1 MF79	05	13 Feb - 11 Mar 1979
Inshore:	1 CM78	11	29 Mar - 8 Apr 1978
	2CM78	12	10 - 17 Apr 1978
	3CM78	13	21 Apr - 1 May 1978
	4CM78	14	3-28 May 1978
	5CM78	15	31 May - 6 Jun 1978
	6CM78	16	14-26 Jun 1978
	7CM78	17	28 Jun - 18 Jul 1978
	8CM78	18	21-29 Jul 1978
	9CM78	19	1-9 Aug 1978
	10CM78	20	15-21 Aug 1978
	11 CM78	21	4-13 Nov 1978
	1CM79	22	4-16 Mar 1979

Vessel Key: DI = Discoverer
MF = Miller Freeman
WE = Wecoma
CM = Commander

Table 3.1-1 Zooplankton species identified in samples from the Kodiak shelf.

CNIDARIA
- Rathkea octopunctata
- Bougainvilla sp.
- Euphysa flammea
- Hybocodon prolifer
- Sarsia tubulosa
- S. princeps
- S. rosaria
- Leuckartiara octona
- L. nobilis
- L. breviconis
- Halimedusa typus
- Stomotoca atra
- Polyorchis penicillatus
- Obelia sp.
- Phialidium gregarium
- Aequorea aequorea
- Melicertum octopunctata
- Halistaura cellularia
- Tiaropsidium sp.
- Staurophora mertensi
- Eutonina indicans
- Gonionemus vertens
- Proboscidactyla flavicirrata
- Aglantha digitale
- Aegina sp.
- Lensia sp.
- Muggiacea atlantica
- Dimophyes arctica
- Vogtia serrata
- Agalma elegans
- Nanomia sp.
- Periphylla periphylla
- Cyanea capillata
- Scyphozoan Type A

CTENOPHORA

POLYCHAETA
- Pelagobia longicirrata
- Tomopteris septrionalis
- T. pacifica
- T. planktonis

MOLLUSCA
- Limacina helicina
- Clio sp.
- Clione limacina

CLADOCERA
- Daphina schodleri
- Evadne nordmanni
- Evadne tergestina
- Podon leuckarti
- P. polyphemoides

OSTRACODA
- Philomedes sp.
- .. trituberculatus
- Conchoecia alata minor
- . elegans

COPEPODA
- Calanus cristatus
- C. marshallae
- C. pacificus
- C. plumchrus
- C. tenuicornis
- Eucalanus bungii
- Clausocalanus arcuicornis
- Microcalanus spp.
- Pseudocalanus spp.
- Spinocalanus sp.
- Aetideids
- Aetideus armatus
- Bradyidius saanichi
- Gaetanus armiger
- Gaidius sp.
- G. variabilis
- Pseudochirella sp.
- Euchaetids
- Pareuchaeta elongata
- Lophothrix frontalis
- Racovitzanus antarcticus
- Scaphocalanus sp.
- Scolecithricella minor
- S. ovata

Table 3.1-1 (continued)

COPEPODA (continued)
- Undinella sp.
- Metridia curticauda
- M. okhotensis
- M. pacifica
- Pleuromamma scutullata
- Centropages abdominalis
- Limnocalanus macrurus
- Eurytemora americana
- E. pacifica
- Lucicutia flavicornis
- L. ovaliformis
- Heterorhabdus tanneri
- Heterostylites sp.
- Haloptilus pseudooxycephalus
- Candacia columbiae
- Pachyptilus pacificus
- Epilabidocera longipedata
- Acartia clausi
- m i -
- 7$. tumi da
- Tortanus discaudatus
- Microsetella sp.
- Harpacticus sp.
- Tisbe sp.
- Lubbockia sp.
- Oncaea conifers
- O. boreal is
- Oithona helgolandica
- O. spinirostris
- Monstrilla helgolandica
- M. longiremis
- M. wandelii
- M. canadiensis
- Cymbasoma rigidum

CUMACEA
- Cumella sp.

MYSIDACEA
- Acanthomysis nephrophthalma
- A. pseudomacropa
- Neomysis kadiakensis
- Holmesiella anomala
- Pseudomma truncatum

ISOPODA
- Isopod sp. 1 (copepod parasite)
- Isopod sp. 2

AMPHIPODA
- Calliopius laeviuscula
- Cyphocaris challenger
- Hyperia mmedusarum hystrix
- Hyperoche sp.
- Parathemisto gracilipes
- P. pacifica
- Phronima sedentaria
- Primmo macropa
- Scina stebbingi
- S. rattrayi
- Lanceola pacifica
- Vibilia australis
- Paraphronima sp.
- Caprella sp.

EUPHAUSIACEA
- Euphausia pacifica
- Thysanoessa inermis
- T. inspinata
- T. longipes
- T. raschii
- T. spinifera

CHAETOGNATHA
- Eukrohnia hamata
- E. bathypelagica
- Sagitta elegans
- S. scrippsae

LARVACEA
- Oikopleura dioica
- O. labradoriensis
- Fritillaria borealis

THALIACEA
- Salpa fusiformis

Table 3.2-1 Seasonal dominance of selected taxa expressed as rank order by cruise offshore.

Rank	4 DI 78	2 MF 78	1 WE 78	1 MF 79
1	Calanus plumchrus	Pseudocalanus spp.	Acartia longiremis	Pseudocalanus spp.
2	Pseudocalanus spp.	Metridia spp.	Metridia spp.	Metridia spp.
3	Metridia spp.	Calanus plumchrus	Pseudocalanus spp.	Scolecithricella minor
4	Calanus cristatus	Acartia longiremis	Oithona spp.	Calanus plumchrus
5	Limacina helicina	Eucalanus bungii	Calanus marshallae	Conchoecia spp.
6	Scolecithricella minor	Acartia tumida	Parathemisto pacifica	Calanus marshallae
7	Oikopleura spp.	Centropages abdomi nalis	Limacina helicina	Limacina helicina
8	Sagitta spp.	Calanus marshallae	Sagitta spp.	Sagitta spp.
9	Oithona spp.	Oikopleura spp.	Scolecithricella minor	Oithona spp.
10	Cnidarians	Parathemisto pacifica	Eucalanus bungii	Cnidarians
11	Acartia longiremis	Oithona spp.	Calanus pacificus	Parathemisto pacifica
12	Parathemisto pacifica	Cnidarians	Eukrohnia hamata	Calanus cristatus
13	Acartia tumida	Calanus cristatus	Centropages abdomi nalis	Acartia longiremis
14	Calanus marshallae	Limacina helicina	Oikopleura spp.	Eukrohnia hamata
15	Fritillaria borealis	Scolecithricella minor	Calanus cristatus	Calanus pacificus
16	Conchoecia spp.	Sagitta spp.	Epilabidocera longipedata	Aetideids
17	Eucalanus bungii	Eukrohni a hamata	Calanus tenuicornis	Oikopleura spp.
18	Calanus pacificus	Fritill aria borealis	Calanus plumchrus	Euchaetids
19	Eukrohonia hamata	Conchoecia spp.	Cnidarians	Fritillaria borealis
20	Aetideids	Aetideids	Conchoecia spp.	Eucalanus bungii
21	Euchaetids	Euchaetids	Aetideids	Gammarid amphipods
22	Calanus tenuicornis	Oncaea spp.	Tortanus discaudatus	Cyphocaris challenger
23	Candacia columbiae	Calanus pacificus	Euchaetids	Candacia columbiae
24	Pleuromamma scutull ata	Racovitzanus antarcticus	Racovitzanus antarcticus	Racovitzanus antarcticus
25	Gammarid amphipods	Pleuromamma scutullata	Plausocalanus arcuicornis	Pleuromamma scutullata
26	Racovitzanus antarcticus	Gammarid amphipods	Fritillaria borealis	Lucicutia flavicornis
27	Centropages abdominalis	Scolecithricella ovata	Cyphocaris challenger	Calanus tenuicornis
28	Euphausiids	Monstrilla spp.	Scolecithricella ovata	Mysids
29	Oncaea spp.	Heterorhabdus tanneri	Gammerid amphipods	Scolecithricella ovata
30	Cyphocaris challenger	Candacia columbiae	Heterorhabdus tanneri	Primno macropa

Table 3.2-2 Seasonal dominance of selected taxa expressed as rank order by cruise inshore.

Rank	1 CM 78	2 CM78	3 CM78	4 CM 78
1	Calanus copepodites I-III	Pseudocalanus spp.	Pseudocalanus spp.	Pseudocalanus spp.
2	Pseudocalanus spp.	Calanus copepodites I-III	Calanus copepodites I-III	Acartia longiremis
3	Metridia spp.	Calanus plumchrus	Calanus plumchrus	Calanus marshallae
4	Acartia longiremis	Acartia tumida	Acartia tumida	Acartia tumida
5	Acartia tumida	Metridia spp.	Metridia spp.	Metridia spp.
6	Oikopleura spp.	Calanus cristatus	Acartia longiremis	Centropages abdominalis
7	Calanus plumchrus	Oikoplerua spp.	Euphausiids	Calanus copepodites I-III
8	Calanus cristatus	Scolecithricella minor	Centropages abdominalis	Oithona spp.
9	Cnidarians	Acartia longiremis	Limacina helicina	Limacina helicina
10	Scolecithricella minor	Limacina helicina	Oithona spp.	Medusae
11	Limacina helicina	Euphausiids	Medusae	Scolecithricella minor
12	Oithona spp.	Sagitta spp.	Oikopleura spp.	Calanus plumchrus
13	Parathemisto pacifica	Oithona spp.	Calanus marshallae	Euphausiids
14	Sagitta spp.	Calanus marshallae	Scolecithricella minor	Oikopleura spp.
15	Calanus marshallae	Cnidarians	Calanus cristatus	Calanus cristatus
16	Euphausiids	Parathemisto pacifica	Parathemisto pacifica	Parathemisto pacifica
17	Conchoecia spp.	Centropages abdominalis	Sagitta spp. "	Acartia clausi
18	Calanus pacificus	Conchoecia spp.	Fritillaria borealis	Fritillaria borealis
19	Fritillaria borealis	Mysids	Eukrohonia hamata	Calanus plumchrus
20	Centropages abdominalis	Calanus pacificus	Microcalanus spp.	Eucalanus bungii
21	Eukrohonia hamata	Polychaetes	Polychaetes	Eukrohonia hamata
22	Aetideids	Eukrohonia hamata	Conchoecia spp.	Sagitta spp.
23	Polychaetes	Podon spp.	Calanus pacificus	Tortanus discaudatus
24	Mysids	Harpacticoid copepods	Tortanus discaudatus	Epilabidocera longipedata
25	Tortanus discaudatus	Aetideids	Epilabidocera longipedata	Podon spp. " "
26	Eucalanus bungii	Euchaetids	Acartia clausi	Polychaetes
27	Microcalanus sp.	Fritillaria borealis	Mysids	Harpacticoid copepods
28	Acartia clausi	Acartia clausi	Podon spp.	Microcalanus spp.
29	Evadne spp.	Microcalanus spp.	Gammarid amphipods	
30	Harpacticoid copepods	Tortanus discaudatus	Eurytemora spp.	

Tab-e 3.2-2 (continued)

	5 CM78	6 CM78	7 CM 78	8 CM78
1	Pseudocalanus spp.	Pseudocalanus spp.	Pseudocalanus spp.	Pseudocalanus spp.
2	Acartia longiremis	Acartia tumida	Acartia longiremis	Acartia longiremis
3	Acartia tumida	Acartia longiremis	Centropages abdominalis	Calanus marshallae
4	Metridia spp.	Calanus marshallae	Acartia tumida	Centropages abdominalis
5	Calanus marshallae	Metridia Spp.	Calanus marshallae	Metridia spp.
6	Centropages abdominalis	Calanus plumchrus	Euphausiids	Podon spp.
7	Calanus copepodites I-III	Cnidarians	Metridia spp.	Oikopleura spp.
8	Calanus plumchrus	Centropages abdominalis	Cnidarians	Parathemisto pacifica
9	Oikopleura spp.	Eucalanus bungii	Parathemisto pacifica	Eucalanus bungii
10	Oithona spp.	Scolecithricella minor	Podon spp. "	Oithona spp.
11	Cnidarians	Oikopleura spp.	Eucalanus bungii	Limacina helicina
12	Parathemisto pacifica	Calanus cristatus	Oithona spp.	Sagitta spp .
13	Scolecithricella minor	Sagitta Spp.	Calanus plumchrus	Euphausiids
14	Sagitta spp.	Oikopleura spp.	Calanus copepodites I-III	Acartia tumida
15	Euphausiids	Parathemisto pacifica	Oikopleura spp.	Acartia clausi
16	Calanus cristatus	Euphausiids "	Limacina helicina	Calanus plumchrus
17	Fritillaria borealis	Podon sp.	Scolecithricella minor	Evadne spp.
18	Tortanus discaudatus	Fritillaria borealis	Sagitta spp.	Cnidarians
19	Podon spp.	Harpacticoids	Calanus cristatus	Eurytemora spp.
20	Eucalanus bungii	Tortanus discaudatus	Fritillaria borealis	Epilabidocera longipedata
21	Acartia clausi	Eukrohnia hamata	Tortanus discaudatus	Tortanus discaudatus
22	Harpacticoids	Polychaetes	Acartia clausi	Mysids
23	Cumaceans	Gammarid amphipods	Eukrohnia hamata	Aetideids
24	Limacina helicina	Cumaceans	Calanus pacificus	Oncaea Spp.
25	Aetideids	Eurytemora spp.	Harpacticoids	Harpacticoids
26	Eurytemora spp.	Racovitzanus antarcticus	Evadne sp.	Calanus cristatus
27	Microcalanus sp.	Acartia clausi	Aetideids	Calanus copepodites I-III
28	Epilabidocera longipedata	Conchoecia spp.	Mysids	
29	Monstrilla spp.	Calanus pacificus	Eurytemora Spp .	
30	Eukrohnia hamata	Limacina helicina	Euchaetids	

Table 3.2-2 (continued)

Rank	9 CM 78	10 CM78	11 CM 78	1 CM79
1	Acartia longiremis	Acartia tumida	Acartia longiremis	Pseudocalanus spp.
2	Pseudocalanus spp.	Pseudocalanus spp.	Metridia spp.	Metridia spp.
3	Podon spp.	Centropages abdominalis	Pseudocalanus spp.	Calanus marshallae
4	Centropages abdominalis	Podon spp.	Oithona spp.	Calanus copepodites I-III
5	Oikopleura spp.	Limacina helicina	Calanus marshallae	Acartia longiremis
6	Calanus marshallae	Oikopleura spp.	Sagitta spp.	Oithona spp.
7	Oithona spp.	Calanus marshallae	Parathemisto pacifica	Scolecithricella minor
8	Metridia spp.	Oithona spp.	Limacina helicina	Cnidarians
9	Limacina helicina	Metridia spp.	Calanus pacificus	Parathemisto pacifica
10	Parathemisto pacifica	Evadne spp.	Eucalanus bungii	Sagitta spp.
11	Evadne spp.	Parathemisto pacifica	Cnidarians	Calanus cristatus
12	Sagitta spp.	Sagitta spp.	Scolecithricella minor	Limacina helicina
13	Cnidarians	Eucalanus bungii	Tortanus discaudatus	Calanus pacificus
14	Eucalanus bungii	Acartia clausi	Centropages abdominalis	Conchoecia spp.
15	Calanus plumchrus	Cnidarians	Euphausiids	Acartia tumida
16	Acartia clausi	Euphausiids	Epilabidocera longipedata	Euphausiids
17	Euphausiids	Calanus plumchrus	Oikopleura spp.	Calanus plumchrus
18	Fritillaria borealis	Tortanus discaudatus	Eukrohnia hamata	Eukrohnia hamata
19	Tortanus discaudatus	Calanus copepodites I-III	Fritillaria borealis	Oikopleura spp.
20	Calanus copepodites I-III	Fritillaria borealis	Calanus cristatus	Harpacticoid copepods
21	Epilabidocera longipedata	Acartia tumida	Conchoecia spp.	Fritillaria borealis
22	Acartia tumida	Epilabidocera longipedata	Harpacticoid copepods	Tortanus discaudatus
23	Gammarid amphipods	Gammarid amphipods "	Mysids " "	Gammarid amphipods
24	Eurytemora spp.	Eurytemora spp.	Calanus plumchrus	Mysids "
25	Harpacticoid copepods	Aetideids	Aetideids	Centropages abdominalis
26	Mysids	Eukrohnia hamata	Gammarid amphipods	Eucalanus bungii
27	Oncaea spp.	Calanus cristatus	Monstrilla spp.	Cumaceans
28	Microcalanus sp.	Scolecithricella minor	Podon spp.	Euchaetids
29	Aetideids	Mysids	Evadne spp.	Aetideids
30	Scolecithricella minor		Racovitzanus antarcticus	Racovitzanus antarcticus

Table 3.2-3 Seasonal dominance of selected taxa expressed as rank order by frequency of occurrence offshore.

	4 DI 78		2 MF 78		1 WE 78		1 MF 79
1	Metridia spp.	1	Pseudocalanus spp.	1	Pseudocalanus spp.	1	Metridia spp.
2	Calanus cristatus	2	Metridia spp.	1	Metridia spp.	2	Pseudocalanus spp.
3	Pseudocalanus spp.	2	Acartia longiremis	1	Acartia longiremis	2	Scolecithricella minor
4	Calanus plumchrus	4	Calanus plumchrus	1	Parathemisto pacifica	4	Conchoecia spp.
5	Limacina helicina	5	Eucalanus bungii	5	Oithona spp.	5	Sagitta spp.
6	Scolecithricella minor	6	Centropages abdominalis	6	Calanus marshallae	6	Calanus plumchrus
7	Oikopleura spp.	7	Acartia tumida	7	Limacina helicina	7	Calanus marshallae
8	Sagitta spp.	8	Parathemisto pacifica	8	Sagitta spp.	7	Limacina helicina
9	Cnidarians	9	Calanus marshallae	9	Eucalanus bungii	9	Oithona spp.
10	Oithona spp.	10	Oikopleura spp.	10	Scolecithricella minor	10	Cnidarians
11	Parathemisto pacifica	11	Oithona spp.	11	Centropages abdominalis	11	Parathemisto pacifica
12	Acartia longiremis	12	Cnidarians	11	Oikopleura spp.	12	Calanus cristatus
13	Calanus marshallae	13	Calanus cristatus	13	Calanus pacificus	13	Acartia longiremis
14	Fritillaria borealis	14	Limacina helicina	14	Calanus cristatus	13	Eukrohnia hamata
15	Acartia tumida	15	Scolecithricella minor	14	Eukrohnia hamata	15	Calanus pacificus
16	Conchoecia spp.	16	Sagitta spp.	16	Epilabidocera longipedata	16	Aetideids
17	Eucalanus bungii	17	Eukrohnia hamata	17	Calanus tenuicornis	17	Oikopleura spp.
18	Calanus pacificus	18	Fritillaria borealis	18	Cnidarians	18	Euchaetids
18	Eukrohnia hamata	19	Conchoecia spp.	19	Calanus plumchrus	19	Fritillaria borealis
20	Aetideids	20	Aetideids	20	Conchoecia spp.	20	Eucalanus bungii
20	Euchaetids	21	Euchaetids	21	Aetideids	21	Gammarid amphipods
22	Calanus tenuicornis	22	Oncaea spp.	22	Tortanus discaudatus	22	Cyphocaris challenger
23	Candacia columbiae	23	Calanus pacificus	23	Euchaetids	23	Racovitzanus antarcticus
24	Pleuromamma scutullata	24	Cyphocaris challenger	24	Clausocalanus arcuicornis	24	Candacia columbiae
25	Gammarid amphipods	24	Racovitzanus antarcticus	25	Racovitzanus antarcticus	25	Pleuromamma scutullata
26	Centropages abdominalis	26	Gammarid amphipods	26	Fritillaria borealis	26	Lucicutia flavicornis
27	Racovitzanus antarcticus	26	Pleuromamma scutullata	27	Cyphocaris challenger	27	Calanus tenuicornis
28	Cyphocaris challenger	28	Scolecithricella ovata	28	Scolecithricella ovata	28	Primno macropa
28	Euphausiids	29	Monstrilla spp.	29	Gammarid amphipods	28	Scolecithricella ovata
28	Oncaea spp.	30	Primno macropa	30	Heterorhabdus tanneri	30	Mysids
			Heterorhabdus tanneri				
			Candacia columbiae				

Table 3.2-4 Seasonal dominance of selected taxa expressed as rank order by frequency of occurrence inshore.

1 CM78		2 CM78		3 CM78		4 CM78	
1	Pseudocalanus spp.	1	Pseudocalanus spp.	1	Pseudocalanus spp.	1	Pseudocalanus spp.
1	Metridia spp.	1	Acartia longiremis	1	Metridia spp.	1	Acartia longiremis
1	Calanus copepodites I-III	1	Calanus copepodites 1-111	1	Acartia lonqiremis '	3	Calanus marshal lae
4	Acartia longiremis	1	Calanus plumchrus	1	Calanus copepodites I-III	4	Acartia tumida
5	Acartia tumida	5	Metridia spp.	1	Calanus plumchrus	5	Centropages abdominal is
6	Limacina helicina	6	Oikopleura spp.	6	Acartia tumi da	5	Oithona spp.
6	Oikopleura spp.	7	Calanus cristatus	7	Centropages abdomi nalis	7	Metridia spp.
6	Cnidarians	7	Scolecithricella minor	7	Limacina helicina	7	Limacina helicina
6	Calanus plumchrus	9	Acartia tumida	9	Oithona spp. .	7	Calanus plumchrus
10	Calanus cristatus	9	Euphausiids	10	Euphausiids	10	Cnidarians
10	Scolecithricella minor	9	Sagitta spp.	10	Cnidarians	10	Calanus copepodites 1-111
10	Parathemisto pacifica	12	Limacina helicina	12	Oikopleura spp.	12	Scolecithricella minor
13	Oithona spp. "	12	Oithona spp.	13	Calanus cri status	13	Euphausiids
14	Sagitta Spp .	14	Calanus marshal 1 ae	13	Calanus marshal 1 ae	14	Oikopleura spp.
15	Euphausiids	15	Parathemisto pacifica	13	Scolecithricella minor	15	Calanus cristatus
16	Calanus marshallae	15	Cnidarians	16	Parathemisto pacifica	16	Parathemisto pacifica
17	Conchoecia spp.	17	Centropages abdominalis	17	Sagitta spp.	17	Eukrohnia hamata
18	Calanus pacificus	18	Conchoecia spp.	18	Fritillaria borealis	18	Fritillaria boreal is
19	Fritillaria borealis	18	Mysids	19	Eukrohnia hamata	18	Eucalanus bungii
20	Centropages abdominalis	20	Calanus pacificus	19	Microcalanus spp.	18	Calanus pacificus
20	Eukrohnia hamata	2?	Eukrohnia hamata	21	Polychaetes	18	Tortanus discaudatus
22	Aetideids	21	Polychaetes	22	Conchoecia spp.	22	Epilabidocera longipedata
22	Polychaetes	23	Podon spp.	22	Calanus pacificus	23	Podon spp.
24	Eucalanus bungii	23	Harpacticoid copepods	24	Epilabidocera l ongi pedata	24	Harpacticoid copepods
24	Microcalanus sp.	25	Aetideids	24	Tortanus discaudatus	24	Polychaetes
24	Tortanus iscaudatus	26	Euchaetids	24	Mysids	26	Mysids
24	Mysids	27	Eucalanus bungii	27	Podon spp.	27	Eurytemora spp.
28	Evadne sp.	27	Cyphocaris challengeri	27	Gammarid amphipods	28	Evadne spp.
28	Harpacticoid copepods	27	Fritillaria borealis	27	Eurytemora spp.	28	Gammarid amphipods
28	Monstrilloid copepods	27	Microcalanus spp.	27	Aetideids	28	Monstrilloid copepods

Table 3.2-4 (continued

5 CM 78		6 CM 78		7 CM 78		8 CM 78	
1	Pseudocalanus spp.	1	Pseudocalanus spp.	1	Pseudocalanus spp.	1	Pseudocalanus spp.
1	Acartia longiremis	1	Calanus marshallae	1	Acartia longiremis	1	Acartia longiremis
3	Centropages abdominalis	3	Acartia longiremis	3	Centropages abdominalis	3	Calanus marshallae
4	Acartia tumida	4	Acartia tumida	4	Acartia tumida	4	Centropages abdominalis
5	Calanus marshallae	5	Cnidarians	5	Parathemisto pacifica	5	Metridia spp.
5	Metridia spp.	6	Calanus plumchrus	5	Euphausiids	6	Podon spp.
7	Oithona spp.	7	Metridia spp.	5	Cnidarians	7	Oikopleura spp.
7	Oikopleura spp.	8	Centropages abdominalis	8	Calanus marshallae	8	Parathemisto pacifica
7	Cnidarians	9	Calanus copepodite I-III	9	Metridia spp.	9	Eucalanus bungii
7	Calanus plumchrus	10	Eucalanus bungii	10	Eucalanus bungii	10	Oithona spp.
11	Calanus copepodites I-III	11	Scolecithricella minor	11	Oithona spp.	11	Limacina helicina
12	Parathemisto pacifica	12	Oikopleura spp.	11	Podon spp.	12	Sagitta spp.
13	Sagitta spp.	13	Calanus cristatus	12	Calanus copepodites I-III	13	Euphausiids
14	Scolecithricella minor	14	Oithona spp.	14	Calanus plumchrus	14	Acartia tumida
15	Euphausiids	15	Sagitta spp.	15	Scolecithricella minor	15	Evadne spp.
16	Tortanus discaudatus	16	Euphausiids	15	Limacina helicina	16	Calanus plumchrus
16	Calanus cristatus	17	Parathemisto pacifica	17	Sagitta spp.	17	Mysids
18	Fritillaria borealis	18	Podon spp.	17	Oikopleura spp.	18	Epilabidocera longipedata
19	Podon spp.	19	Fritillaria borealis	19	Calanus cristatus	19	Eurytemora spp.
20	Eucalanus bungii	20	Harpacticoid copepods	20	Tortanus discaudatus	20	Cnidarians
20	Harpacticoid copepods	21	Tortanus discaudatus	21	Fritillaria borealis	20	Tortanus discaudatus
22	Limacina helicina	22	Polychaetes	21	Eukrohnia hamata	22	Calanus cristatus
23	Cumaceans	22	Gammarid amphipods	23	Evadne spp.	22	Calanus copepodites I-III
24	Epilabidocera longipedata	24	Eukrohnia hamata	24	Calanus pacificus	22	Gammarid amphipods
24	Aetideids	25	Eurytemora spp.	24	Gammarid amphipods	25	Aetideids "
24	Eurytemora spp.	26	Cumaceans	25	Mysids "	25	Oncaea spp.
27	Calanus pacificus	27	Epilabidocera longipedata	27	Epilabidocera longipedata		
27	Mysids	27	Conchoecia spp.	27	Eurytemora spp.		
29	Eukrohnia hamata	27	Limacina helicina	29	Aetideids		
29	Microcalanus spp.	27	Calanus pacificus	30	Conchoecia spp.		

Table 3.2-4 (continued)

Rank	9 CM78		10 CM 78		11 CM78		1 CM79
1	Acartia longiremis	1	Pseudocalanus spp.	1	Acartia longiremis	1	Pseudocalanus spp.
1	Calanus marshallae	1	Acartia longiremis	2	Calanus marshallae	1	Metridia spp.
3	Pseudocalanus spp.	1	Centropages abdominalis	2	Metridia spp.	1	Acartia longiremis
4	Centropages abdominalis	4	Limacina helicina	2	Parathemisto pacifica	1	Oithona spp.
4	Oithona spp.	4	Podon spp.	2	Oithona spp.	5	Calanus marshallae
6	Podon spp.	4	Oikopleura spp.	2	Sagitta spp.	5	Scolecithricella minor
7	Oikopleura spp.	7	Oithona spp.	2	Calanus pacificus	5	Cnidarians
8	Parathemisto pacifica	8	Calanus marshallae	8	Pseudocalanus spp.	8	Calanus copepodites I-III
9	Limacina helicina	9	Parathemisto pacifica	8	Limacina helicina	8	Parathemisto pacifica
10	Metridia spp.	10	Evadne spp.	10	Eucalanus bungii	8	Sagitta spp.
11	Evadne spp.	11	Sagitta spp.	11	Cnidarians	11	Calanus cristatus
12	Sagitta spp.	11	Metridia spp.	12	Scolecithricella minor	12	Limacina helicina
13	Cnidarians	13	Eucalanus bungii	13	Centropages abdominalis	14	Conchoecia spp.
14	Eucalanus bungii	14	Euphausiids	14	Tortanus discaudatus	14	Calanus pacificus
15	Calanus plumchrus	15	Cnidarians	15	Euphausiids	15	Acartia tumida
15	Euphausiids	16	Calanus plumchrus	16	Epilabidocera longipedata	16	Calanus plumchrus
17	Calanus copepodites I-III	17	Tortanus discaudatus	17	Oikopleura spp.	16	Eukrohnia hamata
18	Epilabidocera longipedata	18	Calanus copepodites I-III	18	Calanus cristatus	16	Euphausiids
18	Fritillaria borealis	19	Epilabidocera longipedata	18	Fritillaria borealis	19	Oikopleura spp.
18	Tortanus discaudatus	20	Acartia tumida	20	Eukrohnia hamata	20	Fritillaria borealis
21	Acartia tumida	21	Eurytemora spp.	21	Conchoecia spp.	21	Eucalanus bungii
21	Gammarid amphipods	22	Gammarid amphipods	22	Harpacticoid copepods	21	Gammarid amphipods
23	Calanus cristatus	23	Calanus cristatus	23	Mysids	23	Tortanus discaudatus
23	Scolecithricella minor	23	Scolecithricella minor	24	Calanus plumchrus	24	Centropages abdominalis
25	Microcalanus spp.	23	Mysids	24	Podon spp.	24	Racovitzanus antarcticus
		24	Eukrohnia hamata	24	Gammarid amphipods	24	Aetideids
				24	Aetideids	27	Euchaetids
				24	Monstrilla spp.	28	Primno macropa
				29	Hyperia medusarum	28	Cyphocaris challengeri
				29	Racovitzanus antarcticus	28	Evadne spp.
				29	Oncaea spp.	28	Eurytemora spp.

Table 3.2-5 Mean rank order of selected taxa offshore.

1	Pseudocalanus spp.
2	Metridia spp.
3	Calanus plumchrus
4	Acartia longiremis
5	Oithona spp.
6	Calanus marshallae
7	Scolecithricella minor
8	Limacina helicina
9	Parathemisto pacifica
10	Calanus cristatus
11	Sagitta spp.
12	Oikopleura spp.
13	Eucalanus bungii
14	Cnidarians
15	Eukrohnia hamata
16	Conchoecia spp.
17	Centropages abdominalis
18	Acartia tumida
19	Calanus pacificus
20	Fritillaria borealis
21	Aetideids
22	Euchaetids
23	Calanus tenuicornis
24	Epilabidocera longipedata
25	Racovitzanus antarcticus
26	Gammarid amphipods
27	Cyphocaris challenger
28	Candacia columbiae
29	Pleuromamma scutullata
30	Clausocalanus arcuicornis

Table 3.2-6 Location-specific rank order of selected taxa inshore.

Rank	Chiniak Bay	Kaiugnak Bay	Kiliuda Bay	Izhut Bay
1	Pseudocalanus spp.	Pseudocalanus spp.	Pseudocalanus spp.	Pseudocalanus spp.
2	Acartia longiremis	Acartia longiremis	Acartia longiremis	Acartia longiremis
3	Metridia spp.	Metridia spp.	Metridia spp.	Metridia spp.
4	Calanus marshallae	Calanus marshallae	Calanus marshallae	Calanus marshallae
5	Acartia tumida	Centropages abdominalis	Centropages abdominalis	Oithona spp.
6	Oikopleura spp.	Acartia tumida	Oithona spp.	Centropages abdominalis
7	Parathemisto pacifica	Oithona spp.	Oikopleura spp.	Euphausiids
8	Centropages abdominalis	Limacina helicina	Cnidarians	Parathemisto pacifica
9	Oithona spp.	Calanus copepodites I-III	Acartia tumida	Calanus copepodites I-III
10	Calanus plumchrus	Cnidarians	Euphausiids	Oikopleura spp.
11	Sagitta spp.	Calanus plumchrus	Calanus copepodites I-III	Acartia tumida
12	Calanus copepodites I-III	Oikopleura spp.	Limacina helicina	Calanus plumchrus
13	Limacina helicina	Parathemisto pacifica	Podon spp.	Limacina helicina
14	Scolecithricella minor	Eucalanus bungii	Calanus plumchrus	Scolecithricella minor
15	Cnidarians	Sagitta spp.	Sagitta spp.	Cnidarians
16	Podon spp.	Calanus cristatus	Scolecithricella minor	Sagitta spp.
17	Calanus cristatus	Podon spp.	Parathemisto pacifica	Calanus cristatus
18	Eucalanus bungii	Scolecithricella minor	Eucalanus bungii	Podon spp.
19	Calanus pacificus	Euphausiids	Calanus cristatus	Calanus pacificus
20	Euphausiids	Calanus pacificus	Tortanus discaudatus	Acartia clausi
21	Conchoecia spp.	Evadne spp.	Evadne spp.	Fritillaria borealis
22	Tortanus discaudatus	Fritillaria borealis	Fritillaria borealis	Eucalanus bungii
23	Eukrohnia hamata	Conchoecia spp.	Acartia clausi	Tortanus discaudatus
24	Aetideids	Epilabidocera longipedata	Eukrohnia hamata	Gammarid amphipods
25	Acartia clausi	Eukrohnia hamata	Calanus pacificus	Conchoecia spp.
26	Fritillaria borealis	Tortanus discaudatus	Mysids	Eukrohnia hamata
27	Harpacticoid copepods	Polychaetes	Polychaetes	Epilabidocera longipedata
28	Evadne spp.	Acartia clausi	Epilabidocera longipedata	Eurytemora spp.
29	Gammarid amphipods	Gammarid amphipods	Harpacticoid copepods	Evadne spp.
30	Mysids	Oncaea spp.	Conchoecia spp.	Mysids

Table 3.2-7 Geometric means and standard deviations of the $\log_{10}$ abundance of total Copepods by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	1.9655	2.6110	2.4185	2.4324
	0.0843	0.1782	0.2856	0.0968
KIAUGNAK BAY	2.8435	3.0129	2.6843	1.8917
	0.0622	0.1084	0.3238	0.0567
KILIUDA BAY	2.7680	2.6924	2.6288	2.0.374
	o .2211	0.2117	0.1527	0.1403
IZHUT BAY	1● 891A	2.032'4	1.9924	1.2293
	o .0s83	(),()s90	0.0820	0.8754

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	2.3016	2.7002	2.9772	3.0875
	0.2084	0.0566	0.0461	0.1275
KIAUGNAK BAY	2.0348	2.6656	2.90s4	2.5284
	0.1473	0.1262	0.1488	0.0601
KILIUDA BAY	1.9633	2.7418	2.8479	2.6507
	0.1041	0.2186	0.1981	0.1.472
IZHUT BAY	2.3289	2.1489	3.0287	2.6028
	0.1197	0.2785	0.0671	0.2138

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	2,918S	3.0970	2.3630	-0.s148
	0.1568	0.0933	0.2047	1.0677
KIAUGNAK BAY	2.9189	2.4867	1.2732	0.1255
	0.0851	0.1084	0.0ss6	1.0354
KILIUDA BAY	2.4674	2.5623	1.6786	1.4564
	0.1597	0.1852	0.1.053	0.2715
IZHUT BAY	2.7466	2.8654	1.8925	-0.0749
	0.0712	0.1556	0.2421	0.5732

Table 3.2-8 Geometric means of the $\log_{10}$ abundance of total Copepods by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	2.0623	0.5195	1.9584	0.9223
	STD	0.1473	2.8618	0.5291	2.4529
	STDERR	0.0557	1.0118	0.2160	1.0014
	NUMBER	7	8	6	6
BANK	MEAN	1.1161	2.7901	1.7652	0.0575
	STD	2.2434	0.2218	0.3077	1.9794
	STDERR	0.5016	0.0463	0.0656	0.4127
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	1.4955	2.6899	1.9892	0.9119
	STD	1.9801	0.2384	0.2034	0.2085
	STDERR	0.6262	0.0754	0.0643	0.0659
	NUMBER	10	10	10	10
SLOPE	MEAN	0.9988	2.4794	1.4746	1.4908
	STD	1.8409	0.3331	0.6226	0.3305
	STDERR	0.4339	0.0745	0.1392	0.0954
	NUMBER	18	20	20	12
TROUGH	MEAN	1.9484	2.6911	1.8508	0.2698
	STD	0.5744	0.2186	0.3268	1.8431
	STDERR	0.1436	0.0584	0.0873	0.4926
	NUMBER	16	14	14	14

Table 3.2-9 Geometric means and standard deviations of the $\log_{10}$ abundance of *Calanus cristatus* by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-1.7780	-1.4770	-1.7916	-2.3415
	0.9144	1.0630	0.9268	1.0158
KIAUGNAK BAY	-0.1833	1.0021	-1.5082	-1.7369
	0.9582	0.1326	1.0995	0.9320
KILIUDA BAY	0.2837	0.6979	0.0172	-2.2478
	0.0955	0.0845	0.1809	0.6637
IZHUT BAY	-1.3966	-0.6659	-2.7263	-3.3605
	1.0718	0.8479	0.7804	0.6395

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-2.5723	-1.6573	-1.4270	-4.0000
	0.8745	0.9565	1.0531	0.0000
KIAUGNAK BAY	-2.4985	-1.4604	-3.0685	-4.0000
	0.9233	1.0372	0.9315	0.0000
KILIUDA BAY	-3.5796	-2.9556	-2.9367	-4.0000
	0.4204	0.6848	0.6984	0.0000
IZHUT BAY	-2.5826	-1.8763	-2.9720	-3.4819
	0.6924	0.8161	0.6730	0.5181

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-4.0000	-4.0000	-3.3442	-2.7724
	0.0000	0.0000	0.6558	0.7119
KIAUGNAK BAY	-4.0000	-4.0000	-2.9177	-1.1215
	0.0000	0.0000	0.6628	0.7255
KILIUDA BAY	-3.5058	-3.5s.49	-3.5943	-1.0793
	0.4942	0.4851	0.4057	0.4540
IZHUT BAY	-4.0000	-4.0(?00	-2.3966	-2.4741
	0.0000	0.0000	0.6345	0.3435

Table 3.2- Geometric means of the $\log_{10}$ abundance of *Calanus cristatus* by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	0.5966	-3.4226	-2.7115	-2.5222
	STD	0.4989	1.4144	2.0204	1.6252
	STDERR	0.1886	0.5774	0.8248	0.6635
	NUMBER	7	6	6	6
BANK	MEAN	-0.1902	-2.5923	-2.3774	-2.5422
	STD	1.7531	2.1797	1.8360	1.8633
	STDERR	0.3920	0.4545	0.3914	0.3885
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	0.2640	-1.9349	-3.6893	-2.2526
	STD	1.5800	2.1896	0.9322	1.2427
	STDERR	0.4996	0.6924	0.3107	0.3930
	NUMBER	10	10	9	10
SLOPE	MEAN	0.2050	0.3085	-0.3638	-0.7679
	STD	1.5858	1.0456	1.3188	1.9693
	STDERR	0.3738	0.2338	0.2949	0.5462
	NUMBER	18	20	20	13
TROUGH	MEAN	0.2161	0.2205	-1.5623	-1.7450
	STD	1.3199	1.2403	1.6433	1.8359
	STDERR	0.3300	0.3315	0.4392	0.4907
	NUMBER	16	14	14	14

Table 3.2-11 Geometric means and standard deviations of the $\log_{10}$ abundance of *Calanus plumchrus* by cruise and location inshore.

CRUISE NO.

	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	0.9752	1.4940	1.4416	0.1583
	0.3292	0.2091	0.2451	1.0482
KIAUGNAK BAY	2.2134	2.1738	1.3396	0.6567
	0.0861	0.2433	0.6241	0.2026
KILIUDA BAY	1.9517	1.8685	1.6441	-0.8348
	0.0794	0.1100	0.0726	0.7264
IZHUT BAY	1.6570	1.5038	1.1100	0.1826
	0.1073	0.3883	0.1507	0.8544

CRUISE NO.

	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	0.5422	-0.0491	0.4208	-2.0541
	0.3487	0.9939	1.1099	1.2036
KIAUGNAK BAY	-0.9201	0.8069	-1.7585	-3.0665
	1.2859	0.1977	1.3778	0.9335
KILIUDA BAY	-1.7620	0.0925	-1.9211	-4.0000
	0.8504	0.6546	1.0178	0.0000
IZHUT BAY	0.8627	0.1162	-0.7982	-3.3715
	0.2229	0.7185	0.9388	0.6285

CRUISE NO.

	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-2.0499	-1.9737	-3.0609	-2.0986
	1.1970	1.2422	0.9391	0.6669
KIAUGNAK BAY	-3.0693	-1.6417	-4.0000	-0.3620
	0.9307	0.9872	0.0000	0.9175
KILIUDA BAY	-1.3621	-2.9597	-3.5714	-0.6163
	0.7871	0.6820	0.4286	0.2889
IZHUT BAY	-1.8378	-2.3827	-4.0000	--1.781?
	0.8190	0.7893	0.0000	0.3526

Tab'e 3.2- 2 Geometric means of the $\log_{10}$ abundance of Calanus plumchrus by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF78
SOUTH WEST	MEAN	1.5998	0.4298	-1.3285	-1.7136
	STD	0.1385	0.9522	2.1331	1.7880
	STDERR	0.0523	0.3887	0.8709	0.7300
	NUMBER	7	6	6	6
BANK	MEAN	0.7369	1.0222	-2.9372	-1.2923
	STD	2.1439	1.6221	1.6189	1.6200
	STDERR	0.4794	0.3382	0.3451	0.3378
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	0.6703	0.1751	-3.1748	-1.7985
	STD	2.5228	2.2421	1.6375	1.2562
	STDERR	0.7978	0.7090	0.5458	0.3972
	NUMBER	10	10	9	10
SLOPE	MEAN	0.5780	1.3366	-1.5485	0.5774
	STD	1.7530	0.3941	1.6675	0.6186
	STDERR	0.4132	0.0881	0.3729	0.1786
	NUMBER	18	20	20	12
TROUGH	MEAN	1.0193	1.4932	-2.9813	-1.2725
	STD	2.0687	0.2814	1.6817	1.5221
	STDERR	0.5172	0.0752	0.4495	0.4068
	NUMBER	16	14	14	14

Table 3.2-13 Geometric means and standard deviations of the $\log_{10}$ abundance of ***Calanus marshallae*** by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-1.2805	-1.4400	-2.1309	1.1079
	1.1401	1.0558	1.1510	0.1913
KIAUGNAK BAY	-3.1975	-1.3100	-0.7081	0.6595
	0.8025	1.1033	0.8262	0.2418
KILIUDA BAY	-1.3850	-0.7635	0.1295	0.0295
	1.0863	0.8153	0.2843	0.5851
IZHUT BAY	-1.0683	-1.6687	-2.5385	0.2664
	0.7436	1.0047	0.8951	0.3333

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-0.0379	0.9912	-1.6733	1.4586
	1.0126	0.1068	1.4248	0.2109
KIAUGNAK BAY	0.8909	0.7663	1.6765	1.6228
	0.0915	0.1514	0.2378	0.0813
KILIUDA BAY	-0.3232	0.7834	-0.8954	1.3547
	0.5493	0.3288	1.1848	0.2332
IZHUT BAY	-0.1869	0.0592	-0.4309	0.0984
	0.5815	0.4194	0.7817	0.6729

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	1.0927	1.3522	0.8409	-2.0310
	0.2462	0.1389	0.5375	0.6945
KIAUGNAK BAY	1.4121	1.0974	0.1492	-1.2125
	0.1627	0.1930	0.1611	0.7968
KILIUDA BAY	1.1246	0.5816	0.0818	-0.8683
	0.1914	0.6897	0.2265	0.4675
IZHUT BAY	0.6912	-1.0186	-0.4462	-0.9239
	0.1698	0.8828	0.5879	0.4440

Table 3.2-14 Geometric means of the $\log_{10}$ abundance of *Calanus marshallae* by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-1.1284	-2.2572	0.3009	-0.0292
	STD	1.9719	2.0085	0.9085	2.0570
	STDERR	0.7453	0.8200	0.3709	0.8398
	NUMBER	7	6	6	6
BANK	MEAN	-2.3134	-1.1932	0.2873	-1.4525
	STD	1.7457	2.3551	0.4788	1.6427
	STDERR	0.3903	0.4911	0.1021	0.3425
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-2.3416	-0.1715	0.6853	-0.5684
	STD	1.7858	1.3770	0.4142	0.7426
	STDERR	0.5647	0.4355	0.1310	0.2348
	NUMBER	10	10	10	10
SLOPE	MEAN	-1.9161	-0.3872	-1.1476	-1.9600
	STD	1.5583	1.6095	1.3701	1.7087
	STDERR	0.3673	0.3599	0.3064	0.4272
	NUMBER	18	20	20	16
TROUGH	MEAN	-2.4404	0.6078	0.5546	-1.0407
	STD	1.8951	0.4648	0.4305	1.4091
	STDERR	0.4738	0.1242	0.1151	0.3766
	NUMBER	16	14	14	14

Table 3.2-15. Mean density (no. m^{-3}) of stages of *Calanus* species from bongo (333um) samples, all stations, Chiniak Bay, 1978-79.

Species/Stage	Year / Month / Cruise	1978											1979
	Month		April		May		June		July		August	Nov	March
	Cruise	1	2	3	4	5	6	7	8	9	10	11	1
Calanus cristatus													
Copepodite stages IV & V			0.04	0.65	0.41	0.06	0.32	0.27	-	-	-	-	0.01
Copepodite stages I, II, & III		0.37	2.12	-	0.16	0.09	0.16	1.02	-	-	-	0*01	0.01
Calanus plumchrus													
Adults					0.06	0.01	0.14	1.02	1.67	0.41	-	0.14	-
Copepodite stages IV & V		0.47	8.78	35.97	12.79	6.61	6.26	5*34	3.78	3.14	1.53	-	-
Calanus marshallae													
Adults		0.18	0.42	-	0.19	1053	6.06	0.72	0.52	2.60	1.94	0*01	0.05
Copepodite stages IV & V		1.11	0.11	1.15	6.66	4.74	2.81	2.64	23.89	10.79	12.74	22.82	0.01
Unidentified *Calanus*[1]													
Copepodite stages I, II & III		23.33	47.57	17.42	17.96	5.12	4.01	65.57	24.05	5.31	15.76	0.35	0.07

(-) indicates no animals found at any station

[1] **Predominantly *C. plumchrus* and *C. marshallae***

Table 3.2-16. Mean density (no. m^{-3}) of stages of **Calanus** species from bongo (333um) samples, all stations, Kaiugnak Bay, 1978-79.

Species/Stage	1978 April 1	1978 April 2	1978 May 3	1978 May 4	1978 June 5	1978 June 6	1978 July 7	1978 July 8	1978 August 9	1978 August 10	1978 Nov 11	1979 March 1
Calanus cristatus												
Copepodite stages IV & V	1.47	9.41	8.20	0.26	0.27	0.91	0.91	-			0.01	0.02
Copepodite stages 1, II, & 111	3.79	2.67	1.20	0.20	-	0.13	-	-			0.01	0.33
Calanus plumchrus												
Adults				0.13	0.06	0.40	-	-				
Copepodite stages IV & V	7.47	197.6	202.9	2.65	9.93	6.18	7.01	0.93	0.90	0.14	-	0.06
Calanus marshallae												
Adults	0.21	0.73	0.51	0.32	1.30	2.58	1.29	-	0.41	0.20	0.01	0.10
Copepodite stages IV & V		1.13	0.55	1.75	2.42	4.07	37.72	21.86	20.93	4.13	1.48	-
Unidentified **Calanus**[1] Copepodite stages I, 11 & III	167.9	68.26	89.50	11.06	14.44	3.38	71.40	23.06	11.33	14.75	0.32	6.08

(-) indicates no animals found at any station

[1] Predominantly C. plumchrus and C. marshallae

Table 3.2-17. Mean density (no. m^{-3}) of stages of Calanus species from bongo (333um) samples, all stations, Kiliuda Bay, 1978-79.

Species/Stage	Year	1978											1979
	Month	April			May		June		July		August	Nov	March
	Cruise	1	2	3	4	5	6	7	8	9	10	11	1
Calanus cristatus													
Copepodite stages IV & V		0.06	3.33	1.02	0.17	0.03	0.30	0.44	-	0.11	0.10	0.02	0.02
Copepodite stages I, II, & 111		2.03	2.03	0.35	-	-	0.12	0.11	-	-	-	-	0.31
Calanus plumchrus													
Adults					0.04	0.06	0.30	-	-	-	-	-	-
Copepodite stages IV & V		3.88	54.76	32.70	0.92	0.78	6.10	0.47	-	0.20	0.12	0.03	0.02
Calanus marshallae													
Adults		0.20	0.29	0.11	0.16	5.67	4.46	0.89	1.33	0.39	-	0.01	0.20
Copepodite stages IV & V		0.35	0.31	1.39	1.30	1.08	5.00	20.30	14.04	7.10	5.18	2.18	0.02
Unidentified Calanus[1]													
Copepodite stages I, II & III		93.61	39.63	15.26	4.61	1.47	10.42	210.9	30.77	15.20	19.77	0.31	1.66

(-) indicates no animals found at any station
[1] Predominantly C. plumchrus and C. marshallae

Table 3.2-18. Mean density (no. m^{-3}) of stages of Calanus species from bongo (333um) samples, all stations, Izhut Bay, 1978-79.

Species/Stage	Year	1978											1979
	Month	April		May		June		July		August		Nov	March
	Cruise	1	2	3	4	5	6	7	8	9	10	11	1
Calanus cristatus													
Copepodite stages IV & V			0.23	0.04	0.06	0.24	0.93	0.17	0.18	-	-	0.27	0.01
Copepodite stages I, II, & 111		1.86	1.32	0.03	0.04	-	-	0.15	-	-	-	0.01	-
Calanus plumchrus													
Adults						0.83	0.26	1.20	0.76	0.11	0.25	-	-
Copepodite stages IV & V		0.47	1.01	5.54	9.88	7.50	18.47	5.61	0.38	0.40	0.48	-	0.01
Calanus marshallae													
Adults		0.26	0.06	0.03	0*07	1.14	5.24	0.87	1.22	-	0.25	0.06	0.23
Copepodite stages IV & V			0.14	0.08	2.31	2.70	1.97	1.07	2.31	4.30	2.24	2.63	0.07
Unidentified Calanus[1] Copepodite stages I, 11 & III		51.69	69.91	13.10	8.13	6.42	0.58	5.16	8.23	4.09	4.61	0.23	0.01

(-) Indicates no animals found at any station

[1] Predominantly C. **plumchrus** and **C. marshallae**

Table 3.2-19. Mean density (no. m^{-3}) of stages of *Calanus* species from bongo (333um) samples, all stations, offshore 1978-79.

Year	1978			1979
Month	March-April	June-July	Ott.-Nov.	Feb.-March
	02 - 4DI678	03 - 2MF78	04 - 1WE78	05 - 1MF79
Calanus cristatus				
Adults	*	0.01		*
Copepodite stages IV & V	1.00	2.16	0.44	0.03
Copepodite stages I, II & III	5.36	0.60	0.16	1.27
Calanus plumchrus				
Adults	0.01	0.91	0.07	0.01
Copepodite stages IV & V	11.84	17.15	0.05	0.16
Calanus marshallae				
Adults	0.22	2.20	0.01	0.26
Copepodite stages IV & V	0.04	1.42	2.02	1.37
Unidentified *Calanus*[1]				
Copepodite stages I, II & III	53.41	16.05	0.82	1.86

(-) Indicates no animals found at any station

(*) Indicates mean density less than 0.01 m^{-3}

[1] Predominantly *C. plumchrus* and *C. marshallae*

Table 3.2-20 Geometric means and standard deviation of the $\log_{10}$ abundance of **Pseudocalanus** spp. by cruise and location inshore.

CRUISE NO.

	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	1.4206	1.8436	1.7798	2.1279
	0.1634	0.0625	0.1986	0.1258
KIAUGNAK BAY	1.9622	2.2593	2.2088	1.4080
	0.0622	0.0979	0.1693	0.1780
KILIUDA BAY	1.8135	1.9256	2.0587	1.4383
	0.1453	0.0928	0.1653	0.2732
IZHUT BAY	0.9713	`1.1776	1.3184	1.3420
	0.1302	0.0828	0.1047	0.3269

CRUISE NO.

	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	2.0135	2.4801	2.7203	2.7081
	0.1884	0.0930	0.1022	0.3189
KIAUGNAK BAY	1.6537	2.4968	2.6108	2.1107
	0.1750	0.1201	0.1729	0.1275
KILIUDA BAY	1.2167	2.3456	2.3653	2.0441
	0.1791	0.3262	0.3412	0.3555
IZHUT BAY	1.8139	1.4540	2.5171	2.144>4
	0.2258	0.5116	0.2323	0.4134

CRUISE NO.

	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	2.6496	2.7105	0.5389	-1.2387
	0.3130	0.3215	1.5151	0.92s'?
KIAUGNAK BAY	2.1142	1 ● '77AEl	0.0423	-0.2994
	0.2653	0.0541	0.1773	0.9352
KILIUDA BAY	1.6831	1.6187	0.6234	0.4788
	0.3722	0.4409	0.2791	0.1442
IZHUT BAY	1.5497	2.0540	0.2551	-0*3940
	0.7982	0.2816	0.6676	0.5480

Table 3.2-21 Geometric means of the $\log_{10}$ abundance of <u>Pseudocalanus</u> spp. by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	1.3918	1.6423	1.1688	0.3895
	STD	0.6351	0.8155	0.5251	2.1823
	STDERR	0.2400	0.3329	0.2144	0.8909
	NUMBER	7	6	6	6
BANK	MEAN	0.1707	2.5387	1.0744	-0.3782
	STD	2.2373	0.2642	0.4443	1.7748
	STDERR	0.5003	0.0551	0.0947	0.3701
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	0.6612	2.5245	1.3909	0.6687
	STD	1.8186	0.2099	0.3750	0.1989
	STDERR	0.5751	0.0664	0.1186	0.0629
	NUMBER	10	10	10	10
SLOPE	MEAN	-0.3705	2.1116	0.5922	-0.3758
	STD	1.7652	0.5482	0.6223	1.6400
	STDERR	0.4161	0.1226	0.1392	0.4383
	NUMBER	18	20	20	14
TROUGH	MEAN	1.0939	2.3659	1.1446	-0.0889
	STD	0.6730	0.2573	0.4291	1.7048
	STDERR	0.1683	0.0688	0.1147	0.4556
	NUMBER	16	14	14	14

Table 3.2-22 Geometric means and standard deviations of the $\log_{10}$ abundance of **Metridia** spp. by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	0.7139	0.2045	0.6480	0.9592
	0.2848	1.0618	0.3065	0.3440
KIAUGNAK BAY	1.2427	1.5489	0.6782	-0.3363
	0.2216	0.1075	0.4477	0.9315
KILIUDA BAY	1.0278	1.2824	1.4250	-1● 512e'-.
	0.2277	0.1868	0.1074	0.7531
IZHUT BAY	0.1386	0.8189	0.8913	0.5163
	0.3138	0.2192	0.1584	0.4428

	CRUISE NO.			
	5CM78	6CM78	7CM78	.CM78
CHINIAK BAY	1.1686	1.2868	-0.6224	()*4103
	0.4046	0.2917	1.3811	1.1283
KIAUGNAK BAY	-0.3722	0.6697	1.5303	1.0682
	0.9632	1.1707	0.2516	0.2807
KILIUDA BAY	-0.7952	0.8127	-1.1490	0.8158
	0.7286	0.7487	1.0801	0.3442
IZHUT BAY	0.8203	-1.2980	-1.2728	-().033s
	0.3998	1.0271	1.0316	0.8832

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	1.3066	0.5849	1.2915	-2.0123
	0.4102	1.1513	0.5519	0.6960
KIAUGNAK BAY	-0.7474	-0.0732	0.0081	-0.8528
	1.3421	1 +()21. 2	o .2955	0.7965
KILIUDA BAY	-0.2387	-0.3936	0.1457	-0.401s
	0.8382	0.8321	0.3577	0.2704
IZHUT BAY	-0.3060	-1 .3538	0.1404	-1.1431
	0.8127	1.0127	0.7348	0.4694

Table 3.2-23 Geometric means and of the $\log_{10}$ abundance of *Metridia* spp. by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	1.0443	0.1039	0.9554	0.5008
	STD	0.3883	2.2985	1.3270	2.2683
	STDERR	0.1467	0.9384	0.5418	0.9260
	NUMBER	7	6	6	6
BANK	MEAN	0.1231	0.9047	0.8723	-0.6636
	STD	1.8437	1.6786	0.5907	1.7727
	STDERR	0.4123	0.3500	0.1259	0.3696
	NUMBER	20	23	[illegible]2	23
NEAR SHORE	MEAN	0.0284	1.5198	0.9171	-0.1833
	STD	1.5400	0.6236	0.5636	0.6861
	STDERR	0.4870	0.1972	0.1782	0.2170
	NUMBER	10	10	0	10
SLOPE	MEAN	0.3296	1.8621	1.0796	1.0112
	STD	1.6210	0.2825	0.6322	0.4873
	STDERR	0.3821	0.0632	0.1414	0.1407
	NUMBER	18	20	[illegible]0	12
TROUGH	MEAN	0.8610	2.0945	1.2741	-0.3693
	STD	0.7317	0.3084	0.7598	1.6626
	STDERR	0.1829	0.0824	0.2031	0.4443
	NUMBER	16	14	[illegible]4	14

599

Table 3.2-24 Geometric means and standard deviations of the $\log_{10}$ abundance of ***Acartia longiremis*** by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	0.0919	-0.3281	-0.3054	1.0874
	0.3181	0.9565	0.9530	0.2341
KIAUGNAK BAY	0.5876	0.8607	1.1989	0.9659
	0.1801	0.2070	0.1339	0.0688
KILIUDA BAY	-0.1023	0.2627	0.7501	1.3363
	0.9882	0.2319	0.2486	o.1857
IZHUT BAY	-0.1070	-2.5569	0.7451	1.1330
	0.0865	0.8843	0.1072	0.1322

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	1.0487	1.1372	1.9701	2.2254
	0.2608	0.2196	0.1500	0.1964
KIAUGNAK BAY	1.1832	1.2348	1.7434	1.9163
	0.0903	0.0952	0.1917	0.1076
KILIUDA BAY	1.4018	0.8008	2.0207	?*.2134
	0.0653	0.713s"	0.1146	0.0740
IZHUT BAY	1.3663	1.3925	2.0783	1.7287
	0.1576	0.2366	0.2203	0.3096

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	2.1525	2.3446	2.0048	-1.4909
	0.1064	0.1343	0.1190	0.8510
KIAUGNAK BAY	2.3968	1..6755	0.7786	-1● S087
	0.1401	0.1316	0.1874	0.6346
KILIUDA BAY	2.0644	2.1152	1*3142	-0,2704
	0.1524	0.1957	0.109s	0.2362
IZHUT BAY	2.2453	2.2689	0.8702	-1.8963
	0.1714	0.1619	0.2289	0.3387

Table 3.2-25 Geometric means of the $\log_{10}$ abundance o *Acartia longiremis* by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-0.5849	0.8688	1.3230	-1.7030
	STD	1.5570	0.9444	0.3178	1.8089
	STDERR	0.5885	0.3856	0.1298	0.7385
	NUMBER	7	6	6	6
BANK	MEAN	-1.4859	1.6247	1.3513	-1.9916
	STD	1.9556	0.5213	0.3736	1.5720
	STDERR	0.4373	0.1087	0.0797	0.3278
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-0.5362	1.0616	1.5271	-0.8730
	STD	1.9364	0.4280	0.3269	1.1378
	STDERR	0.6123	0.1353	0.1034	0.3598
	NUMBER	10	10	10	10
SLOPE	MEAN	-3.2783	0.5684	0.4023	-3.2226
	STD	1.3991	1.6278	0.6634	1.4552
	STDERR	0.3298	0.3640	0.1483	0.3529
	NUMBER	18	20	20	17
TROUGH	MEAN	-1.3727	0.6880	1.2425	-1.9374
	STD	1.9084	1.4288	0.2513	1.6329
	STDERR	0.4771	0.3819	0.0672	0.4364
	NUMBER	16	14	14	14

Table 3.2-26 Geometric means and standard deviations of the log_{10} abundance of **Acartia tumida** by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAN BAY	-0.5192	0.8223	0.8022	0.9213
	0.9512	0.4851	0.3645	0.2481
KIAUGNAK BAY	1.2884	2.0179	1.6200	0.6596
	0.2086	0.1391	0.2799	0.2664
KILIUDA BAY	0.8889	0.9682	1.2266	-0.1691
	0.4969	0.3522	0.4340	0.8465
IZHUT BAY	-1.9469	0.4471	0.5017	0.5445
	0.8477	0.1927	0.1806	0.0974

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	1.3700	1.7718	0.6473	-1.2816
	0.2780	0.1370	1.1755	1.1189
KIAUGNAK BAY	0.6741	1.4426	0.6101	-4.0000"
	0.2934	0.1734	0.18,44	0.0000
KILIUDA BAY	-1.1204	0.4349	-0.6544	-2.s090
	0.8511	0.9736	0.9822	0.7823
IZHUT BAY	1.2218	0.9635	0.1897	-3.4533
	0.1887	0.3383	0.6266	0.5467

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-4.0000	-4.0000	-4.0000	-1 .8405
	0.0000	0.0000	0.0000	0.8521
KIAUGNAK BAY	-2.2323	-3.2111	-4.0000	-2.6625
	1.0833	0.7ss9	0.0000	0.s249
KILIUDA BAY	-3.5317	-2.9s68	-4.0000	-0.6296
	0.4683	0.6635	0.0000	0.2672
IZHUT BAY	-4.0000	-4.0000	-4.0000	-4 .0000
	0.0000	0.0000	0.0000	0.0000

Table 3.2-27 Geometric means of the $\log_{10}$ abundance of _Acartia tumida_ by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-0.6610	-0.3542	-4.0000	-4.0000
	STD	2.3049	1.8092	0.0000	0.0000
	STDERR	0.8712	0.7386	0.0000	0.0000
	NUMBER	7	6	6	6
BANK	MEAN	-1.8391	1.4207	-4.0000	-4.0000
	STD	2.2519	0.7613	0.0000	0.0000
	STDERR	0.5035	0.1587	0.0000	0.0000
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-0.6242	1.3419	-4.0000	-3.8018
	STD	2.4501	0.7572	0.0000	0.6268
	STDERR	0.7748	0.2394	0.0000	0.1982
	NUMBER	10	10	9	10
SLOPE	MEAN	-3.4561	-1.8873	-4.0000	-4.0000
	STD	1.2644	2.1940	0.0000	0.0000
	STDERR	0.2980	0.4906	0.0000	0.0000
	NUMBER	18	20	20	20
TROUGH	MEAN	-2.2956	-0.3209	-4.0000	-3.8350
	STD	2.0394	2.0726	0.0000	0.6173
	STDERR	0.5098	0.5539	0.0000	0.1650
	NUMBER	16	14	14	14

Table 3.2-28 Geometric means and standard deviations of Acartia clausi by cruise and location inshore.

	Cruise No.			
	1 CM78	2 CM78	3 CM78	4CM78
Chiniak Bay	-4.0000 0	-4.0000 0	-3.1174 0.8826	-3.0650 0.9350
Kiaugnak Bay	-4.0000 0	-4.0000 0	-4.0000 0	-4.0000 0
Kiliuda Bay	-3.0575 0.9425	-3.2340 0.7660	-4.0000 0	-2.0409 0.7455
Izhut Bay	-4.0000 0	-4.0000 0	-3.3310 0.6690	-1.7252 1.0175

	Cruise No.			
	5 CM78	6 CM78	7 CM78	8 CM78
Chiniak Bay	-4.0000 0	-4.0000 0	-3.0086 0.9914	-3.0432 0.9568
Kiaugnak Bay	-3.3666 0.6334	-4.0000 0	-4.0000 0	-4.0000 0
Kiliuda Bay	-3.3337 0.4364	-4.0000 0	-2.5111 0.7294	-3.0658 0.6143
Izhut Bay	-2.2822 0.8667	-3.3772 0.6228	-2.7115 0.8476	-2.3787 0/7970

	Cruise No.			
	9 CM78	10CM78	11CM78	1 CM79
Chiniak Bay	-0.9680 1.2409	-2.9530 1.0470	-4.0000 0	-4.0000 0
Kiaugnak Bay	-4.0000 0	-4.0000 0	-3.5597 0.4403	-3.4148 0.5852
Kiliuda Bay	-3.5918 0.9492	-1.9760 0.9368	-4.0000 0	-4.0000 0
Izhut Bay	-2.5610 0.9492	-1.5780 0.9368	-4.0000 0	-4.0000 0

Table 3.2-29 Geometric means and standard deviations of the log abundance of *Eucalanus bungii* by cruise and location inshore.

	CRUISE NO. 1CM78	2CM78	3CM78	4CM78
CHINIAN BAY	-3.342s	-3.3134	-3.2377	-5.297’4
	0.6574	0.6866	0,7623	0.7126
KIAUGNAK BAY	-4 .0000	-4 .0000	-4.0000	-1● g7A/)
	0.0000	0.0000	(?.0000	0,8775
KILIUDA BAY	-3•2483	-4.0000	-4.0000	-3.5952
	0.7517	0.0000	(2.0000	0.4048
IZHUT BAY	-4.0000	-4.0000	-4,(?000	-3.41.07
	0.0000	o.0000	0.0000	0.5893

	CRUISE NO. 5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-4.0000	-2.2113	-1.1492	-1.2696
	0.00’30	1.1125	1.1717	1.1248
KIAUGNAK BAY	-1.5681	0.8161	0.1716	-0.0762
	1.00’42	0.4548	1.0595	0.9915
KILIUDA BAY	-3. 1585	-0.2184	-0.2293	-0.4075
	0.5509	0.8453	0.8375	0.7532
IZHUT BAY	-4.0000	-2.6778	-2.9691	-1.2923
	0.0000	0.6511	0.6749	0.7972

	CRUISE NO. 9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-4.0000	-2.1334	-0.1s40	-4.0000
	0.0000	1.1434	0.0566	0 .0000
KIAUGNAK BAY	-2.0121	0.9022	-0.4382	-4 * 0000
	1.2177	0.1215	0.1281	0.0000
KILIUDA BAY	-0.7431	-0.1446	-0.0191	-3.4052
	0.7203	0.5842	0.1204	0.3907
IZHUT BAY	-3.0224	-2.4748	-1 .7365	-3.3309
	0.6400	0.7456	0.6844	0.3286

Table 3.2-30 Geometric means of the log_{10} abundance of <u>Eucalanus</u> <u>bungii</u> by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-2.4885	-3.4134	-2.1105	-1.1274
	STD	1.9155	1.4368	2.0937	1.4505
	STDERR	0.7240	0.5866	0.8547	0.5922
	NUMBER	7	6	6	6
BANK	MEAN	-3.5662	0.1750	-0.5028	-3.7309
	STD	1.0644	1.7425	0.8391	0.7108
	STDERR	0.2380	0.3633	0.1787	0.1482
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-3.6955	-0.6986	0.2137	-3.4101
	STD	0.9629	2.3784	0.3938	0.9502
	STDERR	0.3045	0.7521	0.1245	0.3005
	NUMBER	10	10	10	10
SLOPE	MEAN	-0.6065	0.9568	-0.8545	-3.1773
	STD	1.2911	0.3464	1.4076	1.3714
	STDERR	0.3043	0.0775	0.3147	0.3232
	NUMBER	18	20	20	18
TROUGH	MEAN	-3.2632	1.1252	-0.7908	-3.5108
	STD	1.3297	0.5677	1.4325	0.9898
	STDERR	0.3324	0.1517	0.3828	0.2645
	NUMBER	16	14	14	14

Table 3.2-31 Geometric means and standard deviations of the $\log_{10}$ abundance of **Epilabidocera** longipedata by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-4 ,0000	-4.0000	-3.3204	-4 .0000
	0.0000	0.0000	0.6796	0.0000
KIAUGNAK BAY	-4.0000	-4.0000	-3.2919	-4.0000
	0.0000	0.0000	0.7081	0.0000
KILIUDA BAY	-4.0000	-4.0000	-3.3235	-3.21.44
	0.000'0	0.0000	0.6765	0.5150
IZHUT BAY	-4.0000"	-4.0000	-4.0000	-2.2914
	0.0000	0.0000	0.0000	0.7787

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-3.4515	-4.0000	-4.0000	-4.0000
	0.5485	().0000	0.0000	0.0000
KIAUGNAK BAY	-4.0000	-4.0000	-4.0000	-4.0000
	0.0000	0.0000	0.0000	0.0000
KILIUDA BAY	-,3. 1871	--4.0000	-3.6267	-3.5337
	0.5326	0.0000	0.3733	0.4663
IZHUT BAY	-4.0000	-3.6241	-3.51$?0	-2.9860
	0.0000	0.3759	0.4820	0.6646

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-3.2598	-4 .0000	-3.1496	-4 .0000
	0.7402	0.0000	0.8504	0.0000
KIAUGNAK BAY	-3.0894	-4 .0000	-1.0325	-4 . 0000
	(?.910/)	0.0000	0.1550	0.0000
KILIUDA BAY	-3.5481	-4.0000	-2.7500	-4 .0000
	0.4519	0.0000	0.6119	0.0000
IZHUT BAY	-3.0174	-2.5178	-2.7765	-4.0000
	0.6433	0 .?26s	0.5994	0.0000

Table 3.2-32 Geometric means of the $\log_{10}$ abundance of Epilabidocera longipedata by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-4.0000	-3.4472	-2.6963	-4.0000
	STD	0.0000	1.3542	2.0374	0.0000
	STDERR	0.0000	0.5528	0.8318	0.0000
	NUMBER	7	6	6	6
BANK	MEAN	-4.0000	-3.8169	-1.6498	-4.0000
	STD	0.0000	0.8779	1.6905	0.0000
	STDERR	0.0000	0.1831	0.3604	0.0000
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-4.0000	-4.0000	-0.9712	-4.0000
	STD	0.0000	0.0000	1.8019	0.0000
	STDERR	0.0000	0.0000	0.6006	0.0000
	NUMBER	10	10	9	10
SLOPE	MEAN	-4.0000	-4.0000	-3.0908	-4.0000
	STD	0.0000	0.0000	1.4435	0.0000
	STDERR	0.0000	0.0000	0.3228	0.0000
	NUMBER	18	20	20	20
TROUGH	MEAN	-4.0000	-4.0000	-2.3093	-4.0000
	STD	0.0000	0.0000	1.7743	0.0000
	STDERR	0.0000	0.0000	0.4742	0.0000
	NUMBER	16	14	14	14

Table 3.2-33 Geometric means of the $\log_{10}$ abundance of <u>Centropages abdominalis</u> by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-3.3426	-2.2737	-0.9548	-0.4173
	0.6574	1.0649	0.8126	0.9471
KIAUGNAK BAY	-3.1590	0.6121	1.0240	-1.1834
	0.8410	0.2184	0.1707	0.7402
KILIUDA BAY	-2.4914	-2.3675	-0.5794	0.4362
	0.9283	0.9999	0.8571	0.1982
IZHUT BAY	-4.0000	-4.0090	-1.2412	0.0203
	0.0000	0.0000	0.7022	0.8723

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-1.1365	-0.3332	1.4777	-0.0397
	1.1998	0.9624	0.2146	1.0:324
KIAUGNAK BAY	0.1190	-0.4779	1.9790	1.3200
	0.1362	0.8831	0.1869	0.1075
KILIUDA BAY	0.3534	-0.9927	1.7635	1.1969
	0.0801	0.9135	0.1487	0.1204
IZHUT BAY	0.4972	-1.1802	0.6022	0.6867
	0.1560	0.8318	0.7040	0.2674

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	0.0509	1..26?3	-3.3442	-4.0000
	1.023,5	0.0951	0.6558	0.0000
KIAUGNAK BAY	2.3987	1.6724	-1.2449	-4 + 0000
	0.1209	0..2374	0.6982	0.0000
KILIUDA BAY	1.5235	1.8306	-0.8588	-2.8122
	0.1006	0.1245	0.4567	0.5799
IZHUT BAY	1.0779	1.1858	-1.7899	-3.7s25
	0.1703	0.2134	0.6555	0.2175

Table 3.2-34 Geometric means of the $\log_{10}$ abundance of Centropages abdominalis by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-4.0000	-0.2347	-1.4943	4.0000
	STD	0.0000	2.0939	2.0130	0.0000
	STDERR	0.0000	0.8548	0.8218	0.0000
	NUMBER	7	6	6	6
BANK	MEAN	-3.6348	0.7932	-1.1449	4.0000
	STD	1.1240	1.1432	1.7002	0.0000
	STDERR	0.2513	0.2384	0.3625	0.0000
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-3.6820	-0.8725	0.1108	-4.0000
	STD	1.0057	2.1853	0.3406	0.0000
	STDERR	0.3180	0.6911	0.1077	0.0000
	NUMBER	10	10	10	10
SLOPE	MEAN	-3.8318	0.6456	-3.2683	-3.8526
	STD	0.7136	2.0573	1.3037	0.6593
	STDERR	0.1682	0.4600	0.2915	0.1474
	NUMBER	18	20	20	20
TROUGH	MEAN	-3.6849	-0.0991	-2.1944	-3.8657
	STD	0.8846	1.7261	1.8933	0.5027
	STDERR	0.2212	0.4613	0.5060	0.1343
	NUMBER	16	14	14	14

Table 3.2-35 Geometric means and standard deviations of the log_{10} abundance of *Scolecithricella minor* by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-0.5317	0.5034	-1.6795	0.0290
	0.9026	0.2775	0.9787	0.2053
KIAUGNAK BAY	-1.4831	-1.3634	-3.3499	-2.6110
	1.0278	1.0788	0.6501	0.8506
KILIUDA BAY	0.0911	-0.4389	0.0516	-2.3246
	0.1561	0.8996	0.1358	0.6422
IZHUT BAY	-1.7476	0.1081	-0.7614	-1.3731
	0.9218	0.2197	0.8309	0.8550

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-3.2959	[illegible]	-2.2537	-4.0000
	0.7041	[illegible]	[illegible]	0.0000
KIAUGNAK BAY	-0.9204	-2.0358	-3.1287	-4.0000
	0.8164	1.2079	0.8713	0.0000
KILIUDA BAY	-2.5176	-1.3488	-1.7701	-4.0000
	0.7423	1.0072	0.8432	0.0000
IZHUT BAY	-1.6979	-0.5611	-2.3257	-4.0000
	0.8889	0.7932	0.8191	0.0000

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-4.0000	-4.0000	0.0839	-2.0622
	0.0000	0.0000	0.4231	0.6590
KIAUGNAK BAY	-4.0000	-4.0000	-1.6665	-1.2367
	0.0000	0.0000	0.5955	0.6929
KILIUDA BAY	-4.0000	-4.0000	-1.6278	-0.7642
	0.0000	0.0000	0.7091	0.1392
IZHUT BAY	-3.4931	-3.5853	-1.2637	-1.2979
	0.5069	0.4147	0.6924	0.5998

Table 3.2-36 Geometric means of the log $_{10}$ abundance of <u>Scolecithricella</u> <u>minor</u> by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-0.3073	-2.6217	-2.0811	-0.8831
	STD	1.6505	2.1387	2.2054	2.4657
	STDERR	0.6238	0.8731	0.9004	1.0066
	NUMBER	7	6	6	6
BANK	MEAN	-1.2153	-2.6996	-0.7984	-1.3687
	STD	1.9383	2.0323	1.3520	1.5280
	STDERR	0.4334	0.4238	0.2882	0.3186
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-1.2697	-2.7405	-2.1227	-0.5658
	STD	1.9026	2.0315	1.7831	0.3969
	STDERR	0.6017	0.6424	0.5944	0.1255
	NUMBER	10	10	9	10
SLOPE	MEAN	-0.4271	-0.6602	0.3601	0.4333
	STD	1.6568	1.7341	0.6019	0.3475
	STDERR	0.3905	0.3878	0.1346	0.1003
	NUMBER	18	20	20	12
TROUGH	MEAN	-0.4127	-0.8412	-0.1548	-0.8013
	STD	1.4611	2.0978	1.1540	1.4335
	STDERR	0.3653	0.5607	0.3084	0.3831
	NUMBER	16	14	14	14

Table 3.2-37 Geometric means and standard deviations of the $\log_{10}$ abundance of *Oithona* spp. by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-0.5121	-1.6413	-2.0227	-0.4967
	0.2285	0.9645	0.8155	0.9011
KIAUGNAK BAY	-0.7720	-0.5688	-0.8013	0.1079
	0.8112	0.8610	0.8275	0. 1295
KILIUDA BAY	-0.9418	-1.5681	-0.7310	-J .0136
	0.7726	1.0025	0.8220	0.6678
IZHUT BAY	-2.6343	-0.0025	1.5337	-0•2282
	0.8448	0.2055	0.0810	0.6594

	CRUISE NO.			
	5CM78	6CM78	7CM78	8 M78
CHINIAK BAY	-1.0173	-3.2178	-1 .9582	-2.9126
	1.2316	o .7822	3..2525	1.0874
KIAUGNAK BAY	0.4$576	-2.9146	-3.1287	0.2s00
	0.2881	1*0854	0.8713	0.1059
KILIUDA BAY	-2.1965	-0.5044	-0.6991	0.0132
	0.6940	0.7731	0.7355	0.6267
IZHUT BAY	-1.0664	-2.7761	-1.1886	-J. .8927
	0.6500	0.6527	0.8251	0.8002

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	0.7429	0,6758	0.5860	-2.1571
	0.1477	0.0944	0.0561	0.6263
KIAUGNAK BAY	-0.3136	0.924$5	0.0925	-1.3147
	0.930/)	0.1629	0.2064	0.6788
KILIUDA BAY	0.5274	0.8508	0.6436	-0.4289
	0.2256	0.2361	o* 1252	0.1179
IZHUT BAY	0.8450	-0.6383	-0.5831	-1.2795
	0.1794	0.7395	0.5558	0.4424

Table 3.2-38 Geometric means of the $\log_{10}$ abundance of Oithona spp. by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-1.9580	-3.2716	-0.1549	-2.0285
	STD	1.9251	1.3870	0.7685	2.1734
	STDERR	0.7276	0.4904	0.3137	0.8873
	NUMBER	7	8	6	6
BANK	MEAN	-2.0717	-0.8952	0.2855	-1.7354
	STD	1.8247	2.1353	0.3992	1.4246
	STDERR	0.4080	0.4452	0.0851	0.2971
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-2.6035	0.1002	0.6704	-1.8233
	STD	1.8164	1.4959	0.4434	1.5494
	STDERR	0.5744	0.4730	0.1402	0.4900
	NUMBER	10	10	10	10
SLOPE	MEAN	-0.8551	-0.5513	-0.3478	-0.5596
	STD	1.4750	1.8225	1.3418	1.5630
	STDERR	0.3477	0.4075	0.3000	0.4335
	NUMBER	18	20	20	13
TROUGH	MEAN	-0.8483	-0.4567	0.4964	-1.1452
	STD	1.3717	1.9515	0.3815	1.3495
	STDERR	0.3429	0.5216	0.1020	0.3607
	NUMBER	16	14	14	14

Table 3.2-39 Geometric means and standard deviations of the $\log_{10}$ abundance of total **Euphausiids** by cruise and **location** inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
KILIUDA BAY	-0.3918	-0.4395	1.0908	-1.0146
	0.3096	0.5245	0.4242	0.7083
IZHUT BAY	-2.4502	-0.9985	0.6153	-0.5563
	0.6558	0.7931	0.2970	0.9321

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
KILIUDA BAY	-1.8824	-1.6264	0.5052	-1.3968
	0.8134	0.9017	0.9975	0.9919
IZHUT BAY	-1.3082	-1.6665	1.3325	-1.0056
	0.7930	0.6946	0.3942	0.8992

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
KILIUDA BAY	-2.0893	-1.2902	-1.9368	-2.7042
	0.9375	1.0303	0.6085	0.6601
IZHUT BAY	-1.3798	-1.8200	-1.5677	-2.1932
	0.9964	0.8590	0.7594	0.5966

Table 3.2-40 Geometric means and standard deviations of the $\log_{10}$ abundance of **Parathemisto pacifica** by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-1.3350	-1.4883	-1.0645	-2.5080
	0.6860	1.0287	0.7754	0.9152
KIAUGNAK BAY	0.0440	-3.1986	-2.6194	-1.9288
	0.1450	0.8014	0.8479	0.8595
KILIUDA BAY	-2.5718	-0.8590	-2.3832	-3.6328
	0.8750	0.7886	0.9965	0.3672
IZHUT BAY	-1.0299	-1.2585	-2.5898	-2.3068
	0.7499	0.6922	0.8644	0.7623

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-1.0671	-2.3183	-1.3170	0.6847
	0.7485	1.0299	1.1008	0.1706
KIAUGNAK BAY	-1.7974	-3.1391	0.4269	-0.5519
	0.9033	0.8609	0.1571	0.8632
KILIUDA BAY	-1.6533	-2.9092	-1.1864	-3.0415
	0.5155	0.7143	0.8264	0.6373
IZHUT BAY	-3.6165	-2.8965	-1.1683	0.1698
	0.3835	0.5670	0.8355	0.2720

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-0+4295	0.1647	-0.0226	-2.0804
	"0.9174	1.0532	0.3186	0.6705
KIAUGNAK BAY	0.4882	-0.9525	-0.3451	-2.2244
	0.0557	o.7921	0.1535	0.7254
KILIUDA BAY	-1 .0804	-1.2981	-0.7503	-1.3469
	0.6480	0.7951	004947	0.4188
IZHUT BAY	0.0705	0.1514	0.3951	-1.6025
	0.5859	0.6108	0.2044	0.3583

Table 3.2-41 Geometric means of the $\log_{10}$ abundance of *Parathemisto pacifica* by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-1.6751	-0.0168	-0.0610	-2.1327
	STD	1.5948	0.8364	0.4592	2.0456
	STDERR	0.6028	0.3415	0.1875	0.8351
	NUMBER	7	6	6	6
BANK	MEAN	-2.0096	-0.8490	-0.1550	-1.5396
	STD	1.7862	2.0097	0.4455	1.3535
	STDERR	0.3994	0.4285	0.0950	0.2822
	NUMBER	20	22	22	23
NEAR SHORE	MEAN	-1.7026	-1.2633	0.1890	-1.7708
	STD	2.0093	2.0604	0.5306	1.5931
	STDERR	0.6354	0.6868	0.1678	0.5038
	NUMBER	10	9	10	10
SLOPE	MEAN	-2.0614	-0.1487	-0.1407	-1.6757
	STD	1.6035	1.3634	0.6889	1.6572
	STDERR	0.3780	0.3049	0.1540	0.4596
	NUMBER	18	20	20	13
TROUGH	MEAN	-1.1491	-1.0848	0.0947	-1.9177
	STD	1.4402	2.0371	0.4472	1.3859
	STDERR	0.3601	0.5650	0.1195	0.3704
	NUMBER	16	13	14	14

Table 3.2-42 Geometric means and standard deviations of the $\log_{10}$ abundance of **Conchoecia** spp. by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-0.8906	-1.5124	-3.2044	-4.0000
	0.8024	1.0244	0.7956	0.0000
KIAUGNAK BAY	-2.4280	-4.0000	-4.0000	-4.0000
	0.9632	0.0000	0.0000	0.0000
KILIUDA BAY	-3.2111	-2.5249	-4.0000	-4.0000
	0.7889	0.9033	0.0000	0.0000
IZHUT BAY	-2.6906	-2.6972	-1.7820	-3.5461
	0.8039	0.7992	0.9143	0.4539

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-3.1752	-4.0000	-3.1484	--4.0000
	0.8248	0.0000	0.8516	0.0000
KIAUGNAK BAY	-4.0000	--4.0000	-4.0000	-4.0000
	0.0000	0.0000	0.0000	0.0000
KILIUDA BAY	-4.0000	-4.0000	-4.0000	-4.0000
	0*0000	0.0000	0.0000	0.000’2
IZHUT BAY	-4.0000	-3.47s4	-4.0000	-4.0000
	0.0000	0.5216	0.0000	0.0000

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-4.0000	-4,0000	-4.0000	-2.1217
	0.0000	0.0000	0.0000	0.6467
KIAUGNAK BAY	-4.0000	-4.0000	-2.4551	-2.4s44
	0.0000	0.0000	0.6322	0.6286
KILIUDA BAY	-4.0000	-4.0000	-4.0000	-2.1638
	0.0000	0.0000	0.0000	0.5518
IZHUT BAY	-4.0000	-4.0000	-3.6585	-1.3794
	o.0000	0 * 0000	0.3415	0.5424

Table 3.2-43 Geometric means of the $\log_{10}$ abundance of <u>Conchoecia</u> spp. by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-1.8922	-2.9883	-1.9573	-0.7956
	STD	2.0390	1.8793	2.3177	1.6308
	STDERR	0.7707	0.6644	0.9462	0.6658
	NUMBER	7	8	6	6
BANK	MEAN	-3.3408	-4.0000	-3.4170	-1.6662
	STD	1.3598	0.0000	1.2695	1.3631
	STDERR	0.3041	0.0000	0.2707	0.2842
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-2.9355	-3.7879	-4.0000	-1.4944
	STD	1.7179	0.6706	0.0000	1.3834
	STDERR	0.5432	0.2121	0.0000	0.4375
	NUMBER	10	10	10	10
SLOPE	MEAN	-1.4821	0.0990	-0.5391	-0.0586
	STD	1.8959	1.0180	1.5126	0.3855
	STDERR	0.4469	0.2276	0.3382	0.1113
	NUMBER	18	20	20	12
TROUGH	MEAN	-2.5205	-4.0000	-3.3166	-1.4575
	STD	1.7966	0.0000	1.3624	1.1431
	STDERR	0.4491	0.0000	0.3641	0.3055
	NUMBER	16	14	14	14

Table 3.2-44 Geometric means and standard deviations of the $\log_{10}$ abundance of Podon spp. by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-4.0000	-3.3542	-3.1021	-[illegible].2808
	0.0000	0.6458	0.8979	0.7192
KIAUGNAK BAY	-4.0000	-2.3423	-4.0000	-4.0000
	0.0000	1.0029	0.0000	0.0000
KILIUDA BAY	-4.0000	-3.2559	-4.0000	-2.7046
	0.0000	0.7441	0.0000	0.6385
IZHUT BAY	-4.0000	-4.0000	-4.0000	-3.5485
	0.0000	0.0000	0.0000	0.4515

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-3.1386	-2.3011	-1.9414	0.3489
	0.8614	1.0477	1.3008	1.1648
KIAUGNAK BAY	-4.0000	-4.0000	-0.8531	0.6980
	0.0000	0.0000	1.2848	0.1815
KILIUDA BAY	-2.5530	-1.7521	1.9131	1.2562
	0.7251	0.8565	0.1482	0.7585
IZHUT BAY	-2.9353	-3.4525	-3.2505	-3.0251
	0.6988	0.5475	0.7495	0.8945

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	1.5043	1.4120	-4.0000	-4.0000
	0.5245	0.3807	0.0000	0.0000
KIAUGNAK BAY	2.1242	1.2458	-4.0000	-4.0000
	0.1262	0.3711	0.0000	0.0000
KILIUDA BAY	2.0822	2.3145	-3.1105	-4.0000
	0.1764	0.1240	0.5879	0.0000
IZHUT BAY	0.1349	0.9728	-4.0000	-3.5964
	0.9745	0.8082	0.0000	0.4036

Table 3.2-45 Geometric means and standard deviations of the $\log_{10}$ abundance of Evadne spp. by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAN BAY	-4.0000	--4.0'200	-4.0000	-4.0000
	0.0000	0.0000	0.0000	0 ,0000
KIAUGNAK BAY	-3.2}.'72	-4.0000	-4.0000	-4.(?000
	0.7808	0.(?0?0	0.0000	0.00(?0
KILIUDA BAY	-4.0000	-4.0000	-4.0000	-4.0900
	0.0000	0.0000	0.0000	0.0000
IZHUT BAY	-"4.0000	--4.0000	-4.0000	-4.000'3
	0.0000	0.0000	0.0000	0.0000

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-4.0000	-4."0000	-4.0000	-.4.0000
	0. 0000	0.0000	0.0000	0.0000
KIAUGNAK BAY	-4.0000	-4.0000	-4.0000	-4.0000
	0.0000	0.0000	0.0000	0.0000
KILIUDA BAY	-4.0000	-4.0000	-1.9519	-1.9448
	0.0000	0.0000	0.7754	0.7817
IZHUT BAY	-4.0000	-4.0000	-3.4207	-3.5285
	0.0000	0.0000	0.5793	0.4715

	CRUISE NO.			
	9CM78	1OCM-ZB	11CM78	1CM79
CHINIAK BAY	-1 .44s7	-2.1385	-4 .0000	-4 .0000
	1.0449	1.1404	0.0000	0.0000
KIAUGNAK BAY	0.7392	0.4929	-4,0000	-4 . 0000
	0.2240	0.2451	0.0000	0.0000
KILIUDA BAY	-0.5565	0.4339	-3.1507	-4.0000
	0.7576	0.6509	0.5560	0.0000
IZHUT BAY	-1● 964A	-0.6403	-4.0000	-4.0000
	1.0133	1.0247	0.0000	0.0000

Table 3.2-46 Geometric means and standard deviations of the log_{10} abundance of **Oikopleura** spp. by **cruise and location inshore.**

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-2.4271	-1.1171	-3.3692	-0.6453
	0.9632	0.7240	0.6378	0.8790
KIAUGNAK BAY	-0.6642	0.7978	-0.1585	-3.3810
	0.8393	0.0633	0.9819	0.6190
KILIUDA BAY	0.1355	-0.6510	0.2674	-2.6900
	0.1488	0.8593	0.2117	0.6398
IZHUT BAY	0.1605	0.0087	-0.6554	-2.4339
	0.1905	0.1643	0.8810	0.7392

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-0.5850	-0.5491	-0.2206	-0.9185
	0.9656	0.8638	0.9724	1.2626
KIAUGNAK BAY	-0.2743	-0.6264	-4.0000	-0.1992
	0.9445	0.8504	0.0000	0.9612
KILIUDA BAY	-0.9640	-2.2344	-2.3415	1.3180
	0.6990	0.8692	0.8126	0.2272
IZHUT BAY	-1.9237	-3.0282	-2*8598	-0.8527
	0.7963	0.6384	0.7518	0.9270

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	1.7744	1.4067	-1.1595	-3.5820
	0.4249	0.2851	0.9481	0.4180
KIAUGNAK BAY	(?.0025	0.2961	-2.7623	-3 .2945
	1.0188	0.1635	0.7582	0.7055
KILIUDA BAY	1.8377	1.1159	-2.8214	-2.5173
	0.1645	0.2950	0.5847	0.5649
IZHUT BAY	1.0443	0.2542	-3*0643	-3.4993
	0.7843	0.6162	0.4707	0.33s0

Table 3.2-47 Geometric means of the log_{10} abundance of Oikopleura spp. by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-1.3761	-0.9113	-2.8412	-3.6003
	STD	1.8264	2.6460	1.8135	0.9790
	STDERR	0.6903	0.9355	0.7403	0.3997
	NUMBER	7	8	6	6
BANK	MEAN	-0.6119	-0.1791	-1.5846	-2.9311
	STD	1.5944	1.8605	1.9331	1.3910
	STDERR	0.3565	0.3879	0.4121	0.2901
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-0.2242	-0.9217	-0.7208	-2.6214
	STD	1.4065	2.1322	1.7841	1.4712
	STDERR	0.4448	0.6743	0.5642	0.4652
	NUMBER	10	10	10	10
SLOPE	MEAN	-2.4117	-1.0759	-2.0153	-2.3333
	STD	1.8403	1.9828	1.7058	1.6513
	STDERR	0.4338	0.4434	0.3814	0.4264
	NUMBER	18	20	20	15
TROUGH	MEAN	-0.1001	-0.3886	-2.1938	-2.8908
	STD	1.2318	1.9833	1.9041	1.3342
	STDERR	0.3079	0.5301	0.5089	0.3566
	NUMBER	16	14	14	14

Table 3.2-48 Geometric means and standard deviations of the $\log_{10}$ abundance of *Fritillaria borealis* by cruise and station inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-3.4255	-4.0000	-4.0000	-2.3600
	0.5745	0.0000	0.0000	1.0169
KIAUGNAK BAY	-1.6002	-3.1295	-3.2919	-4,0$300
	0.9804	0.8705	0.7081	0.0000
KILIUDA BAY	-2.5225	-4.0000	-2.3372	-3.1671
	0.9050	0.0000	1.0211	0.5469
IZHUT BAY	-4.0000	-4.0000	0.1872	-3.3404
	0.0000	0.0000	0.1867	1 .0497

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-3.0650	-2.1299	-2.0424	-4+0000
	0.9350	1.1705	1.2228	0.0000
KIAUGNAK BAY	-2.3903	-4.0000	-4.0000	-4.0000
	1.0013	0.0000	0.0000	0.0000
KILIUDA BAY	-2.3890	-2.8665	-3.4571	-4,0000
	0.8208	0.7980	0.5429	0.0000
IZHUT BAY	-3.5036	-2.7376	-2.1547	-4.0000
	0.4964	0.8418	0.9088	0.0000

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-4.0000	-4.0000	-4.0000	-3.5820
	0.0000	0.0000	0.0000	0.4180
KIAUGNAK BAY	-2.9426	-2.5382	-2.1314	-4.0000
	1.0574	0.8973	0.7839	0.0000
KILIUDA BAY	-3.3624	-2.9390	-1.7404	-2.5897
	0.6376	0.6949	0.6905	0.4962
IZHUT BAY	-2.1435	-4.0000	-4 . 0000	-3.7009
	0.9263	0.0000	0.0000	0.2991

Table 3.2-49 Geometric means of the $\log_{10}$ abundance of Fritillaria borealis by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-3.0587	-2.4671	-4.0000	-4.0000
	STD	1.6134	2.3851	0.0000	0.0000
	STDERR	0.6098	0.9737	0.0000	0.0000
	NUMBER	7	6	6	6
BANK	MEAN	-1.8609	-1.0525	-2.7148	-2.5283
	STD	1.9413	2.2204	1.9573	1.6123
	STDERR	0.4341	0.4630	0.4173	0.3362
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-2.4575	-1.7667	-3.5708	-2.6294
	STD	2.0985	2.3678	1.2877	1.8237
	STDERR	0.6636	0.7488	0.4292	0.5767
	NUMBER	10	10	9	10
SLOPE	MEAN	-2.7300	-3.3724	-3.5629	-3.5073
	STD	1.8982	1.3964	1.0703	1.2500
	STDERR	0.4474	0.3122	0.2393	0.2795
	NUMBER	18	20	20	20
TROUGH	MEAN	-1.3371	-2.9399	-3.2729	-2.8511
	STD	1.9122	2.1187	1.4509	1.3828
	STDERR	0.4780	0.5662	0.3878	0.3696
	NUMBER	16	14	14	14

Table 3.2-50 Geometric means and standard deviations of the $\log_{10}$ abundance of Limacina helicina by cruise and location inshore.

	CRUISE No.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-1.9573	-0.7805	-0.8895	-0.8222
	0.8345	0.8107	0.8048	0.8356
KIAUGNAK BAY	-0.5817	-0.2995	0.6503	-0.3837
	0.8672	0.9336	0.2237	0.1618
KILIUDA BAY	-0.7358	-1.4125	-0.7053	-1.1.ss.0
	0.8219	1.0666	0.8330	0.6268
IZHUT BAY	-0.6023	-0.7749	-0.8133	-1..000s
	0.0744	0.8261	0.8928	0.6102

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-4.0000	-4.0000	-2.2916	-3.1034
	0.0000	0.0000	1●04A2	0.8966
KIAUGNAK BAY	-2.6485	-4.0(?00	-2.3562	-0.8535
	0.8283	0.0000	1.0085	0•7890
KILIUDA BAY	-3.3172	-3.5113	-1+8623	-0.6732
	0.4490	0.4887	0.s176	0.7293
IZHUT BAY	-4,0000	-4.0000	-2.9268	-1..2493
	0.0000	0.0000	o.7036	0.s0s2

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	0.4668	1.2225	0.1521	-2*4621
	0.1066	0.1869	0.3391	0.5658
KIAUGNAK BAY	0.9336	1.6686	-0.1655	-1●5464
	0.2566	0.1723	0.2935	0.6522
KILIUDA EfAY	-0.5775	0.5644	0.0418	-1.5500
	0.7532	0.6843	0.1705	0.5583
IZHUT BAY	-1.3948	1.4702	-1.0093	-2.3670
	0.7689	0.2060	0.6626	0.4924

Table 3.2-51 Geometric means of the $\log_{10}$ abundance of *Limacina helicina* cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-0.1227	-2.6511	-0.6907	-1.7507
	STD	0.6504	2.0973	1.7280	1.759s
	STDERR	0.2458	0.8562	0.7055	0.7184
	NUMBER	7	6	5	6
BANK	MEAN	-1.0295	-1.5488	-0.5899	-1.6ss4
	STD	1.7027	2.2154	1.4351	J.5245
	STDERR	0.3807	0.4619	(?.30s0	0.3179
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-0.8359	-2.8173	-0.0686	-1.7440
	STD	1.7810	1.9098	0.3047	1.2607
	STDERR	0.5632	0.6039	0.1016	0.3987
	NUMBER	10	10	9	J.o
SLOPE	MEAN	-1.3775	-1.99%52	0.2819	-001097
	STD	1.7568	2.0727	0.6534	0.5604
	STDERR	0.4141	0.4635	0.1461	0.1618
	NUMBER	18	20	20	12
TROUGH	MEAN	0.0887	-0.4676	0.1126	-1.6582
	STD	0.8902	1.5193	0.5642	1.8221
	STDERR	0.2225	0.4060	0.1508	0.4870
	NUMBER	16	14	14	14

Table 3.2-52 **Geometric** means and standard deviations of the $\log_{10}$ abundance of *Sagitta* spp. by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-0.9570	-0.3455	-1.7020	-2.5829
	0.7947	0.1094	0.9748	0.8713
KIAUGNAK BAY	-3,1975	-0.5189	-3.2695	-3.2253
	0. 8025	0.8764	0.7305	0.7747
KILIUDA BAY	-1.5120	-0.6878	-2.5636	-3.0898
	i .0172	0.8463	0.8855	0.5959
IZHUT BAY	-0.4625	-1.8850	-1.8698	-3.5485
	0.1434	0.8663	0.8712	0.4515

	CRUISE NO.			
	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-1.7789	-1.5911	-3*1484	-1.3252
	0.9472	0.9855	0.8516	1.1011
KIAUGNAK BAY	-2.4074	-2.3095	-2. 1559	-0.5891
	0.9752	1.0564	1.1296	0.8909
KILIUDA BAY	-1.5897	-1.5851	-1.9973	-2.1323
	0.7501	0.9204	0.8206	0.9203
IZHUT BAY	-2.6941	-3.5797	-3.1414	-2.8920
	0.6479	0.4213	0.5872	0.7254

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-0.5417	-0.324s	0.2482	-2.1813
	0.8820	0.9190	0.1066	0.6082
KIAUGNAK BAY	-1.9760	-0.4651	0.0757	-2.3664
	1.2408	0.9326	0.3637	0.6849
KILIUDA BAY	-2.2051	-1.0s87	0.3235	-0.8408
	0.8935	0.8633	0.1921	0.5493
IZHUT BAY	-0.4177	-1.2788	-0.821s	-1.9461
	0.5274	0.8056	0.4766	0.3289

Table 3.2-53 Geometric means of the $\log_{10}$ abunbdance of <u>Sagitta</u> spp. by cruise and location offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-0.7722	-1.0742	-0.5912	-0.6083
	STD	1.4568	1.9077	1.7627	1.7075
	STDERR	0.5506	0.6745	0.7196	0.6971
	NUMBER	7	8	6	6
BANK	MEAN	-1.6869	-2.8401	-0.7222	-2.0357
	STD	1.7733	1.7894	1.1693	1.3847
	STDERR	0.3965	0.3815	0.2493	0.2887
	NUMBER	20	22	22	23
NEAR SHORE	MEAN	-2.3266	-2.2012	-0.3290	-1.2713
	STD	1.8056	1.9668	1.3096	1.0317
	STDERR	0.5710	0.6219	0.4141	0.3263
	NUMBER	10	10	10	10
SLOPE	MEAN	-1.6779	-1.9867	-0.7612	-0.5361
	STD	1.5120	2.0760	1.4196	0.4555
	STDERR	0.3564	0.4642	0.3174	0.1315
	NUMBER	18	20	20	12
TROUGH	MEAN	-0.9538	-1.5123	-0.3140	-1.6026
	STD	1.3631	2.2093	1.1365	1.0730
	STDERR	0.3408	0.6378	0.3037	0.2868
	NUMBER	16	12	14	14

Table 3.2-54 Geometric means and standard deviations of the $\log_{10}$ abundance of *Eukrohnia hamata* by cruise and location inshore.

CRUISE NO.

	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-2.6955	-2.3633	-3.2044	-3.3021
	0.8082	1.0022	0.7956	0.6979
KIAUGNAK BAY	-3.2577	-4.0000	-3.3499	-4.0000
	0.7423	0.0000	0.6501	0.0000
KILIUDA BAY	-4.0000	-3.2669	-2.5126	-2.3431
	0.0000	0.7331	0.9109	0.6415
IZHUT BAY	-3.3214	-2.5569	-2.7263	-2.7066
	0.6786	0.8843	0.7804	0.8183

CRUISE NO.

	5CM78	6CM78	7CM78	8CM78
CHINIAK BAY	-4.0000	-4.0000	-4.J.652	-4.0000
	0.0000	0.0000	0.8348	0.0000
KIAUGNAK BAY	-3.4267	-3.2083	-4 .0000	-4.0000
	0.5733	0.7917	(?. 0000	0.0000
KILIUDA BAY	-4.0000	-3.0147	-1.8570	--4.0000
	0 .0000	0.6451	0.8195	0,0000
IZHUT BAY	-3.5488	-4.0000	-3.4207	-4 * 0000
	0.4512	0.0000	0.5793	0.0000

CRUISE NO.

	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-4.0000	-3.1439	-1.4428	-3.5079
	0.0000	0.8561	0.8979	0.4921
KIAUGNAK BAY	-4.0000	-4.0000	-3.4530	-3.4283
	0.0000	0.0000	0.5470	0.5717
KILIUDA BAY	-4.0009	-4,0000	-3.6118	-3.3623
	0 .0000	0.0000	0.3882	0.4192
IZHUT BAY	-4 .0000	-4,0000	-3.1041	-2.3907
	0.0000	0.0000	0.5868	0.5032

Table 3.2-55 Geometric means of the $\log_{10}$ abundance of Eukrohnia hamata by cruise and station offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-2.8073	-3.2672	-2.5973	-1.5897
	STD	2.0369	1.7949	2.1731	2.0090
	STDERR	0.7699	0.7328	0.8871	0.8202
	NUMBER	7	6	6	6
BANK	MEAN	-3.2118	-3.6174	-2.3166	-2.8194
	STD	1.4258	1.2682	1.7491	1.5464
	STDERR	0.3188	0.2644	0.3729	0.3224
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-3.0785	-2.9816	-3.6042	-2.4904
	STD	1.4989	1.7265	1.1874	1.3063
	STDERR	0.4740	0.5460	0.3958	0.4131
	NUMBER	10	10	9	10
SLOPE	MEAN	-1.6897	0.3068	0.0845	-0.5401
	STD	1.9314	1.0487	1.0289	1.6613
	STDERR	0.4552	0.2345	0.2301	0.4796
	NUMBER	18	20	20	12
TROUGH	MEAN	-2.9434	-2.2592	-1.9190	-2.5590
	STD	1.6339	2.0940	1.9598	1.5501
	STDERR	0.4085	0.5596	0.5238	0.4143
	NUMBER	16	14	14	14

Table 3.2-56 Geometric means and standard deviations of the $\log_{10}$ abundance of total Cnidarians by cruise and location inshore.

	CRUISE NO.			
	1CM78	2CM78	3CM78	4CM78
CHINIAK BAY	-1,7539	-0.2169	-0.7149	-1.6101
	0.9235	0.2229	0.8588	0.9850
KIAUGNAK BAY	0.1394	-1.3647	0.5487	-0.5588
	0.1530	1.0797	0.2701	0.1727
KILIUDA BAY	-1.2452	-1.5572	0.3242	0.1826
	1.1481	1.0059	0.2453	0.4307
IZHUT BAY	-0.3422	-3.3782	-3.4195	-1.s420
	0.0770	0.6218	0.5805	0.8412

	CRUISE NO.			
	5CM78	6CM78	7CM78	. CM78
CHINIAK BAY	-3.1386	0.4420	-0.7297	-4.0000
	0.8614	0.3087	1.3716	0.0000
KIAUGNAK BAY	-0.7954	-0.1718	-1.4813	-2.1334
	0.8029	0.9523	1.1243	1.1450
KILIUDA BAY	0.4039	0.6750	0.6252	-4.0000
	0.3622	0.2174	0.6850	0.0000
IZHUT BAY	-1.7350	-1.6634	-1.0013	-4.0000
	0.7033	0.8200	0.94s9	0.0000

	CRUISE NO.			
	9CM78	10CM78	11CM78	1CM79
CHINIAK BAY	-3.0792	-3* 1804	-2.8877	-3.2202
	0.9208	0.8196	1.1123	0.4526
KIAUGNAK BAY	-0.2383	-2.2054	0.0026	-1.5789
	0.9481	1.0992	0.233.7	0.6307
KILIUDA BAY	-2.9481	-2.7484	0.7929	-O* 1690
	0.6908	0.8358	0.2331	0.2628
IZHUT BAY	-1,0506	-2*6126	-1.8961	-1 ● 38AZ
	0.8803	0.5’130	0.6338	0.4033

Table 3.2-57 Geometric means of the $\log_{10}$ abundance of total Cnidarians by cruise and station offshore.

		CRUISE NO.			
		4DI78	2MF78	1WE78	1MF79
SOUTH WEST	MEAN	-0.8522	-1.0585	-2.8760	-2*1501
	STD	1.4349	2.4689	1.7438	2.0271
	STDERR	0.5423	0.8729	0.7119	0.8276
	NUMBER	7	8	6	6
BANK	MEAN	-2.0461	-0.6977	-3.1012	-1.6171
	STD	1.7894	2.2063	1.5067	1.31.33
	STDERR	0.4001	0.4601	0.3212	0.2745
	NUMBER	20	23	22	23
NEAR SHORE	MEAN	-1.4630	-0.4757	-2.8723	-2.1259
	STD	1.7812	1.8603	1.8220	1.3681
	STDERR	0,5,533	0.6577	0.5762	0.4326
	NUMBER	10	8	10	10
SLOPE	MEAN	-1.5659	-1.5539	-1.3820	-J. .1560
	STD	1.5887	1.9084	1.5924	1.6288
	STDERR	0.37.4.4	0.4267	0.3561	0.4517
	NUMBER	18	20	20	13
TROUGH	MEAN	-1.5s91	-1.7726	-2.4911	-1.5434
	STD	1.7412	2.0942	1.8105	1.3788
	STDERR	0.4353	0.6045	0.4839	0.3685
	NUMBER	16	12	14	14

7.0 REFERENCES

7.1 Text

Arctic Environmental Information and Data Center **(AEIDC).** 1974. The Western Gulf of Alaska; a summary of available knowledge. University of Alaska, Anchorage.

Bailey, J.E., **B.L.** Wing and **C.R.** Matheson. 1975. Zooplankton abundance and feeding habits of fry of pink salmon, **Oncorhynchus gorbuscha**, and chum salmon, **Oncorhynchus** keta, in Traitor's Cove, Alaska, with speculations on the carrying capacity of the area. **Fish.Bull.** 73:846-861.

Bowman, T.E. 1960. The Pelagic **Amphipod** genus Parathemisto **(Hyperi-idea: Hyperiidae)** in the North Pacific and adjacent Aretie Ocean Proc. of the U.S. Nat. Mus. **112:343-392.**

Bureau of Land Development (BLM). 1980. Proposed Outer Continental Shelf Oil and Gas Lease Sale 46, Western Gulf of Alaska - Kodiak. **U.S.D.I.** Draft Environmental Impact Statement.

Cassie, R.M. 1971. Sampling and Statistics. In: **Edmondson, W.T. and G.G. Winberg. (eds).** A Manual on Methods for the Assessment of Secondary Productivity in Fresh Maters, **IBP** Handbook No. 17, p. 174-209. **Blackwell** Scientific, Oxford and Edinburgh.

Clarke, **M.R.** 1969. A new **midwater** trawl for sampling discrete depth horizons. J. Mar. **Biol.** Ass. U.K. **49:945-960.**

Cline, J., R. Feely and **A.** Young. 1978. Identification of natural and **anthropogenic** petroleum sources in the Alaskan shelf areas utilizing low molecular weight hydrocarbons. NOAA/OCSEAP RU #153, Annual Report.

Cooney, **R.T.** 1975 . Environmental assessment of the northeastern Gulf of Alaska: zooplankton and **microplankton.** First Year Final Report, NOAA, Institute of Marine Sciences, University of Alaska.

Cooney, **R.T.** 1976. Zooplankton and **micronekton** in the **Bering-Chukchi/** Beaufort Seas. NOAA/OCSEAP RU # 156-D.

Cooney, R.T., **D.R.** Redburn and **W.E. Shiels.** 1973. **Ch.** 8. Zooplankton Studies. In: **D.W.** Hood, **W.E. Shiels** and **E.J. Kelley (eds.),** Environmental Studies of Port **Valdez.** University of Alaska, Institute of Marine Sciences. Occ. **Publ.** 3: 295-302, Fairbanks.

Cooney, R.T., D. Urquhart, R. Neve, J. Hilsinger, R. Clashy and D. Barnard. 1978. Some Aspects of the Carrying Capacity of Prince William Sound, Alaska For Hatchery Released Pink and Chum Salmon Fry. University of Alaska, Institute of Marine Sciences. Rept. R78-3, 98 p.

Cushing, D.H. 1968. Fisheries Biology. A Study on Population Dynamics. University of Wisconsin Press.

Damkaer, D.M. 1976. Initial Zooplankton Investigations. NOAA/OCSEAP RU # 156-B.

Damkaer, D.M. 1977. Initial Zooplankton Investigations in Prince William Sound, Gulf of Alaska and Lower Cook Inlet. NOAA/OCSEAP RU # 425a. Annual Report X: 137-274.

Douglas, R.G., L. Wall and M.L. Cotton. 1978. The influence of sample quality and methods on the recovery of live benthic foraminifera in the Southern California Bight. South. Calif. Baseline Study, Benthic II, Rept. 20.0, 37 p.

Draper, N.R. and H. Smith, Jr. 1966. Applied Regression Analysis. Wiley, New York.

Dunn, J.R., A. W. Kendall, Jr., R.J. Wolotira, Jr., J.H. Bowman, Jr., D.B. Dey, A.C. Matarese and J.E. Munk. 1979. Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Zone - Including Components of the Ichthyoplankton, Meroplankton and Holoplankton. NOAA/OCSEAP RU #551, Final Report.

Elliott, J.M. 1971. Some Methods for the Statistical Analysis of Samples of Benthic Invertebrates. Freshwater Biological Assoc. U.K. Scientific Publ. No. 25. Ambleside.

Gosho, M. E. 1977. The food and feeding habits of juvenile pink salmon in the estuaries of Kodiak Island, Alaska. M.S. Thesis, University of Washington, Seattle.

Gulland, H.E. (cd.). 1972. The Fisheries Resources of the Ocean. Fishing News Books, London.

Hardy, A. 1965. The Open Sea: Its Natural History. Houghton Mifflin.

Harris, C.K. and A.C. Hartt. 1977. Assessment of pelagic and nearshore fish in three bays on the east and south coasts of Kodiak Island, Alaska. NOAA/OCSEAP RU # 485, Final Report.

Hart, J.L. 1973. Pacific Fishes of Canada. Fish. Res. Bd. Can. Bull. 180.

Heron, G.A. and D.M. Damkaer. 1969. Five species of deepwater cyclopoid copepods from the plankton of the Gulf of Alaska. Smithson. Contrib. Zool., No. 20, 24 p.

Hicks, C.R. 1964. Fundamental Concepts in the Design of Experiments. Holt, Rinehart and Winston, New York.

Hood, D.W., K.V. Natarajan, D.H. Rosenberg and D.D. Wallein. 1968. Summary Report on Collier Carbon and Chemical Corporation Studies in Cook Inlet, Alaska. University of Alaska, Institute of Marine Sciences, College, Alaska. 16 p.

Huntley, M.E. and L.A. Hobson. 1978. Medusa predation and plankton dynamics in a temperate fjord, British Columbia. J. Fish. Res. Bd. Can. 35:257-261.

Ingraham, W.R., Jr., A. Bakum and F. Favorite. 1976. Physical Oceanography of the Gulf of Alaska. NOAA/OCSEAP RU # 357, Final Report.

Ivlev, V.S. 1961. Experimental Ecology of the Feeding of Fishes. Yale Univ. Press, New Haven.

Jacobs, F. and G.C. Grant. 1978. Guidelines for Zooplankton Sampling in Quantitative Baseline and Monitoring Programs. USEPA, Ecological Research Series, EPA-600/3-78-026, 52 p.

Johnson, M.W. and E. Brinton. 1963. Ch. 18, Biological species, water-masses and currents. In: M.H. Hill (cd.), The Sea, Vol. 2:381-414.

Kendall, A.W., Jr., J.R. Dunn, R.J. Wolotira, Jr., J.H. Bowerman, Jr., D.B. Dey, A.C. Matarese and J.E. Munk. 1980. Zooplankton, Including Ichtyoplankton and Decapod Larvae, of the Kodiak Shelf. Northwest Fisheries Center, Nat. Mar. Fish. Ser., NWAFC Processed Rept. 80-8.

LeBrasseur, R.J. 1965. Biomass Atlas of Net Zooplankton in the Northeastern Pacific Ocean, 1956-1964. Fisheries Research Board of Canada, Manuscript Report Series (Oceanography and Limnology) No. 201.

Lough, R.G. 1975. Dynamics of Crab Larvae (Anomura, Brachyura) Off the Oregon Coast, 1969-1971. Ph.D. Dissertation, Oregon State University, Corvallis.

MacArthur, R.H. 1972. Geographical Ecology, Patterns in the Distribution of Species. Harper and Row, New York.

McAlister, W.B. and F. Favorite. 1977. Oceanography. In: Merritt, M.L. and R.G. Fuller (eds.). The Environment of Amchitka Island, Alaska. Technical Information Center, U.S. Energy Research and Development Administration, p. 331-352.

Macy, P.T., J.M. Wall, N.D. Lampsakis and J.E. Mason. 1978. Resources of non-salmonid pelagic fishes of the Gulf of Alaska and eastern Bering Sea. Northwest Fisheries Center, Nat. Mar. Fish. Ser.

Marlowe, C.J. and C.B. Miller. 1975. Patterns of vertical distribution and migration of zooplankton at Ocean Station "P." Limnol. Oceanogr. 20:824-844.

Mironov, O.G. 1968. Hydrocarbon pollution of the sea and its influence on marine organisms. Helgoland. wiss. Meeresunters., 17:335-339.

Mironov. O.G. 1970. The effectof oil pollution on the flora and fauna of-the Black Sea. FAO tech. Conf. mar. Pollut., Rome, paper E-92.

Mot(da, S. and T. Minoda. 1974. Plankton of the Bering Sea. In: Hood, D.W. and E. J. Kelley (eds.). Oceanography of the Bering Sea. University of Alaska, Institute of Marine Sciences Occ. Publ. No. 2, Fairbanks. p. 207-241.

Nat" onal Academy of Sciences (NAS). 1969. Recommended Procedures for Measuring the Productivity of Plankton Standing Stocks and Related Oceanic Properties, NAS, Washington.

Nelson-Smith, A. 1972. Oil Pollution and Marine Ecology. Elek Science, London.

Nemato, T. 1970. Feeding patterns of baleen whales in the ocean. In: J.H. Steele (cd.). Marine Food Chains, Univ. Calif. Berkeley, p. 241-252.

Nishiwaki, M. 1972. General Biology. In: S.H. Ridgway (cd.). Mammals of the Sea: Biology and Medicine. C.C. Thomas, Springfield, p. 3-204.

NORPAC Committee. 1960. Oceanic Observations of the Pacific: 1955: the NORPAC Atlas. Univ. California Press and Univ. Tokyo Press, Berkeley and Tokyo.

Patrick, R., M.H. Hohn and J.H. Wallace. 1954. A new method for determining the pattern of the diatom flora. Nat. Natur. Acad. Nat. Sci. Phila. No. 259, 12 p.

Peterson, W.T. and C. Miller. 1976. Zooplankton along the Continental Shelf Off Newport, Oregon, 1969-1972: OSU Sea Grant Publ. No. ORESU-T-76-002 , Oregon State University, Sch. of Oceanography, Corvallis, 111 p.

Pielou, E.C. 1969. An Introduction to Mathematical Ecology. Wiley-Interscience, New York.

Pielou, E.C. 1975. Ecological Diversity. Wiley-Interscience, New York.

Pike, G.C. 1962. Migration and feeding of the gray whale (Eschrichtius gibbosus). J. Fish. Res. Bd. Can. 19:815-838.

Ponomareva, L.A. 1963. Euphausiids of the North Pacific. Their distribution and ecology. Izdatel' stro Akademi i Nauk SSR.

Preston, F.W. 1948. The commonness and rarity of species. Ecology 29:254-283.

Raymont, J.E.G. 1963. Plankton and Productivity in the Oceans. Pergamon Press, Oxford.

Rogers D.E., D. J. Rabin, B.J. Rogers, K.J. Garrison and M.E. Wangerin. 1979b. Seasonal composition and food web relationships of marine organisms in the nearshore zone off Kodiak Island - including ichthyoplankton, meroplankton (shellfish), zooplankton, and fish. NOAA/OCSEAP RU #553, Annual Report, 30 Sept. 1979.

Rogers, D.E., D.J. Rabin, B.J. Rogers, K.J. Garrison and M.E. Wangerin. Seasonsal composition and food web relationships of marine organisms in the nearshore zone off Kodiak Island - including ichthyoplankton, meroplankton (shellfish), zooplankton and fish. NOAA/OCSEAP RU # 553, Annual Report, 30 Sept. 1979.

Rosenburg, D.H., K.V. Natarajan and D.W. Hood. 1969. Summary Report on Collier Carbon and Chemical Corporation Studies in Cook Inlet, Alaska, Parts I and II, November 1968 to September 1969. University of Alaska, Institute of Marine Sciences, College, Alaska. Report 69-13.

Russell-Hunter, W.D. 1970. Aquatic Productivity. Macmillan, London.

Sameoto, D.D. and L.O. Jaroszynski. 1969. Otter surface sampler: a new neuston net. J. Fish. Res. Bd. Can. 25:2240-2242.

Sanders, H.L. 1969. Benthic marine diversity and the stability time hypothesis. In: Diversity and stability in ecological systems. Brookhaven Symp. Biol. 22.

Sanger, G.A. 1972. Pelagic Amphipod Crustaceans from the Southeastern Bering Sea. Northwest Fisheries Center, Nat. Mar. Fish. Ser. MARMAP Survey I, Report No. 1.

Sanger, G.A., V.F. Hironaka and A.K. Fukuyama. 1978. The feeding ecology and trophic relationships of key species of marine birds in the Kodiak Island area, May-September 1977. NOAA/OCSEAP RU # 341, Annual Report, 31 March 1978.

Science Applications, Inc. (SAX). 1978. Environmental Assessment of the Alaskan Continental Shelf, Interim Synthesis Report: Northeast Gulf of Alaska. NOAA/OCSEAP, Boulder. 199 p.

Science Applications, Inc. 1979a. Environmental Assessment of the Alaskan Continental Shelf, Kodiak Interim Synthesis Report, NOAA/OCSEAP, Boulder. 215 p.

Science Applications, Inc. 1979b. Environmental Assessment of the Alaskan Continental Shelf, Lower Cook Inlet Interim Synthesis Report, NOAA/OCSEAP, Boulder. 241 p.

Science Applications, Inc. 1980. Environmental Assessment of the Alaskan Continental Shelf, Kodiak Interim Synthesis Report, NOAA/OCSEAP, Boulder. 326 p.

Simenstad, C.A., R.M. Mayer and R.E. Nakatani. 1978. Nearshore fish and macroinvertebrate communities of Atta Island, Alaska. Univ. Washington, Fish. Res. Inst., Annual Report to U.S. Fish. Wildl. Serv.

Smith, P.E. and S.L. Richardson. 1977. Standard Techniques for Pelagic Fish Egg and Larva Surveys. UN FAO Fish. Tech. Paper 175, 100 p.

Snedecor, G.W. and W.G. Cochran. 1967. Statistical Methods, Sixth Edition. Iowa State University Prephs on oceanographic method-01 ogy. No. 2, D.J. Tranter (cd.). 174 p.

Sokol , R.R. and F.J. Rohlf. 1969. Biometry. W.H. Freeman, San Francisco.

Threlkeld, S.T. 1973a. Copepod diversity, abundance, and length patterns observed in the Northeastern Pacific Ocean, October-November 1971. Northwest Fisheries Center, National Marine Fisheries Service. MARMAP Survey I, Rept. 6.

Threlkeld, S.T. 1973b. The occurrence and distribution of five species of Monstrillidae (Copepoda :Monstrilloida) from near Kodiak Island, Alaska. Northwest Fisheries Center, National Marine Fisheries Service. MARMAP Survey I, Rept. 7.

UNESCO. 1968. Ecology and Resource Management, a quantitive approach. McGraw-Hill Books, New York.

Viereck, L.A. and E.L. Little, Jr. 1972. Alaska Trees and Shrubs. U.S. Forest Service, Agri. Handbook No. 410.

Watt, K.E.F. 1968. Ecology and Resource Management, a quantitive approach. McGraw-Hill Books, New York.

Wespestad, V.G. and L.H. Barton. 1979. Distribution and migration and status of Pacific herring. NOAA Northwest and Alaska Fisheries Center. Unpublished report. p. 166-212.

Wing, B.L. and G.M. Reid. 1972. Surface Zooplankton from Auke Bay and Vicinity, Southeastern Alaska, August 1962 to January 1964. National Marine Fisheries Service, Data Report 72.

Zaret, T.M. 1980. Predation and Freshwater Communities. Yale Univ. Press.

7.2 **Taxonomic**

1.1 General

Davis, C.C. 1955. The Marine and Freshwater Plankton. Michigan State University Press.

Fulton, J. 1968. A Laboratory Manual for the Identification of British Columbia Marine Zooplankton. Fish. Res. Bd. Canada. Tech. Rpt. 55.

Newell, G.E. and R.C. Newell. 1963. Marine Plankton, a Practical Guide. Hutchinson.

Shih, D.T., A.J.G. Figueria and E.H. Grainger. 1971. A Synopsis of Canadian Zooplankton. Fish. Res. Bd. Canada. Bull. 176.

1.2 Cnidaria

Mackie, G.O. 1974. Order Siphonophora. In: Kozloff, E.N., Keys to the Marine Invertebrates of Puget Sound, the San Juan Archipelago and Adjacent Regions. University of Washington Press. p. 20-21.

Russell, F.S. 1939-1963. Hydromedusae. Conseil Internat. L'Exploration Mer. Fiches D'Identification du Zooplankton, Sheets 2, 28-31, 51, 54, 99-102.

Russell, F.S. 1953. The Medusae of the British Isles. vol. 1. Anthomedusae, Leptomedusae, Limnomedusae, Trachymedusae and Narcomedusae. Cambridge Univ. Press.

Russell, F.S. 1970. The Medusae of the British Isles. vol. 2. Pelagic Scyphozoa. Cambridge Univ. Press.

Totton, A.K. 1965. A Synopsis of the Siphonophora. British Museum (Natural History).

1.3 Ctenophora

Mayer, A.G. 1912. Ctenophores of the Atlantic Coast of North America. Carnegie Institution.

1.4 Mollusca

McGowan, J.A. The Thecosomata and Gymnosomata of California. The Veliger, Vo. 3, Sppl. 103-127.

Tesch, J.J. 1949. Heteropoda. Dana Report No. 34.

Van der Spoel, S. 1967. Euthecosomata, a group with remarkable developmental stages (Gastropoda, Pteropoda). J. Noorduijn en Zoon N.V.

Van der Spoel, S. 1976. Pseudothecosomata, Gymnosomata and Heteropoda (Gastropoda). Bohn, Scheltema and Holkema.

1.5 Annelida

Berkeley, E. and C. Berkeley. 1948. Canadian Pacific Fauna. 9. Annelida. 9b (l). Polychaeta Errantia. University of Toronto Press for the Fisheries Research Board of Canada.

Dales, R.P. 1957. Pelagic polychaetes of the Pacific Ocean. Bull . Scripps Inst. Oceanogr. 7(2):99-168.

Tebble, N. 1962. The distribution of pelagic polychaetes across the north Pacific. Bull . Brit. Mus. (Nat. Hist.) 7(9):371-492.

1.6 Chaetoqnatha

Alvarino, A. 1965. Chaetognaths. Oceanogr. Mar. Biol. Annual Rev. 3:115-194.

Bieri, R. 1959. The distribution of the planktonic Chaetognatha in the Pacific and their relationship to the water masses. Limnol. Oceanogr. 4:1-28.

Lea, H.E. 1955. The chaetognaths of western Canada costal waters. J. Fish. Res. Bd. Canada. 12(4):593-617.

1.7 Tunicata

Berrill, N.J. 1950. The Tunicata with an Account of the British Species. Ray Society.

Buckman, A. 1969. Appendicul aria. Conseil Internat. L' Expl oration Mer. Fiches D'Identification du Zooplankton. Sheet 7.

Harant, H. and P. Vernieres. 1938. Faune de France 33. Tuniciers. Fascicule 2: Appendiculaires et Thaliaces. Paul Lechevalier et Fils.

Kozloff, E.N. 1974. Keys to the Marine Invertebrates of Puget Sound, the San Juan Archipelago and Adjacent Regions. University of Washington Press.

Thompson, H. 1948. Pelagic Tunicates of Australia. Commonwealth Council for Scientific and Industrial Research, Australia.

Tokioka, T. 1967. Pacific Tunicata of the United States National Mu scum. Smithsonian Inst. U.S. Nat. Mus. Bull . 251, 247 p.

1.8 Cladocera

Brooks, J.L. 1957. The Systematic of North American Daphnia. Memoirs Corm. Acad. Arts Sci. 13. Yale Univ. Press.

Brooks, J.L. 1959. Ch. 27. Cladocera - In: Edmundson, W.T. (cd.), Freshwater Biology, Second Edition. Wiley. pp. 587-656.

Croce, N.P. 1974 . Cladocera. Conseil Internat. L'Exploration Mer. Fiches D'Identification du Zooplankton. Sheet 143.

Deevey, E.S., Jr. and G.B. Deevey. 1971. The American species of Eubosmina Seligo (Crustacea, Cladocera). Limnol . Oceanogr. 16: 01-218.

1.9 Ostracoda

Lucas, V.Z. 1931 . Some Ostracoda of the Vancouver Island region. Contrib. Can. Biol . Fish. (NS) 6:397-416.

McHardy, R.A. 1964. Marine ostracods from the plankton of Indian Arm, British Columbia, including a diminutive subspecies resembling Conshoecia alata major Rudjakov. J. Fish. Res. Bd. Canada 21(3): 5 -570.

McHardy, R.A. and B.M. Bary. 1965. Diurnal and seasonal changes in distribution of two planktonic ostracods, Conchoecia elegans and C. alata minor. J. Fish. Res. Bd. Cnada. 22:823-840.

Skogsberg, T. 1920. Studies on Marine Ostracods. Part I. (Cypridinids, Halocyprids and Polycopids). Almqvist & Wiksel 1 s Boktryckeri, A.B., Uppsala.

Smith, V.Z. 1952. Further Ostracoda of the Vancouver Island region. J. Fish. Res. Bd. Canada. 9:16-41.

1.10 Copepoda

Bradford, J.M. 1971. Aetideus and Euaetideus (Copepoda; Calanoida) from the Atlantic and Pacific Oceans. N.A. J. Freshwater Res. 5(1):12-40.

Bradford, J.M. and J.B. Jillett. 1974. A revision of generic definitions in the Calanidae (Copepoda, Calanoida). Crustacean 27:1-16.

Brodskii, K.A. 1950. Calanoida of the Far Eastern Seas and Polar Basin of the USSR. Izdatel' stov Akademii Nauk USSR. Translated from Russian by Israel Program for Scientific Translations, 1967.

Davis, C.C. 1949. The Pelagic Copepoda of the Northeastern Pacific Ocean. Univ. Wash. Publ. Biol. 14:1-118.

Fulton, J. 1972. Keys and References to the Marine Copepoda of British Columbia. Fish. Res. Bd. Canada Tech. Rept. 313.

Heron, G.A. 1964. Seven species of Eurytemora (Copepoda) from northwestern North America. Crustacean 7(3):199-211.

Heron, G.A. and D.M. Damkaer. 1969. Five species of deep-water cyclopoid copepods from the plankton of the Gulf of Alaska. Smithson. Contrib. Zool. 20, 24 p.

Isaac, M.J. 1975. Copepoda. Sub-order Monstrilloida. Conseil Internat. L'Exploration Mer. Fiches D'Identification du Zooplankton. Sheet 144-145.

Jaschnov, W.A. 1970. Distribution of Calanus species in the seas of the Northern Hemisphere. Int. Revue Ges. Hydrobiol. 55:197-212.

Olson, J.B. 1949. The Pelagic Cyclopoid Copepods of the Coastal Waters of Oregon, California and Lower California. Ph.D. Dissertation, UCLA. 256 p.

Park, 1.S. 1966. A new species of Bradyidius (Copepoda; Calanoida) from the Pacific Coast of North America. J. Fish. Res. Bd. Can. 23(6):805-811.

Park, T.S. 1968. Calanoid copepods from the Central North Pacific Ocean. U.S. Fish Wildl. Serv., Fish. Bull . 66(3):527-572.

Peterson, W.K. 1972. Distribution of Pelagic Copepoda off the Coasts of Washington and Oregon during 1961 and 1962. Chapter 15. In: A.T. Pruter and D.L. Alverson, eds., The Columbia River Estuary and Adjacent Ocean Waters, Bioenvironmental Studies, pp. 313-343. Univesity of Washington Press.

Peterson, W.T. 1980. Life history and ecology of Calanus marshallae frost in the Oregon Upwelling Zone. Ph.D. Dissertation, OSU. 200 p.

Peterson, W.T. 1981. Personal communication. Re: Separation of copepodite stages of Calanus cristatus, C. plumchrus, C. marshallae and C. pacificus and identification of C. pacificus.

Rose, M. 1933. Faune de France 26. Copepods Pelagiques. Paul Lechevalier.

Tanaka, O. 1957a. The pelagic copepods of the Izu Region, Middle Japan. Systematic account II 1. Family Aetideidae (Part 1). Publ . Seto Mar. Biol . Lab. 6(1):31-68.

Tanaka, O. 1957b. The pelagic copepods of the Izu Region, Middle Japan. Systematic account IV. Family Aetideidae (Part 2). Publ . Seto Mar. Biol . Lab. 6(3):45-83.

Tanaka, O. 1958. The pelagic copepods of the Izu Region, Middle Japan. Systematic account V. Family Euchaetididae. Publ. Seto Mar. Biol. Lab. 6(3):87-127.

Tanaka, O. 1961. The pelagic copepods of the Izu Region, Middle Japan. Systematic account VII. Family Scolecithricidae (Part 1). Publ. Seto Mar. Biol. Lab. 9(1):139-190.

Tanaka, O. 1962. The pelagic copepods of the Izu Region, Middle Japan. Systematic account VIII. Family Scolecithrididae (Part 2). Publ. Seto Mar. Biol. Lab. 10(1):35-90.

Tanaka, O. 1963. The pelagic copepods of the Izu Region, Middle Japan. Systematic account IX. Family Centropagidae, Pseudodiaptomidae, Temoridae, Metridiidae and Lucicutiidae. Publ. Seto Mar. Biol. Lab. 11(1):7-55.

Tanaka, O. and M. Omori. 1971. Additional reports on calanoid copepods from the Izu Region. Part 4. Haloptilus, Augaptilus, Centraugaptilus, Pseudaugaptilus, and Pachyptilus. Publ. Seto Mar. Biol. Lab. 19(4):249-268.

Threlkeld, S.T. 1973. Copepod diversity, abundance, and length patterns observed in the Northeastern Pacific Ocean, October-November 1971. Northwest Fisheries Center, National Marine Fisheries Service. MARMAP Survey I, Rept. 6.

Threlkeld, S.T. 1973. On the systematic and identification of North Pacific planktonic copepods. Northwest Fisheries Center, National Marine Fisheries Service. MARMAP Survey I, Rept. 3.

Threlkeld, S.T. 1973. The occurrence and distribution of five species of Monstrillidae (Copepoda:Montrilloida) from near Kodiak Island, Alaska. Northwest Fisheries Center, National Marine Fisheries Service. MARMAP Survey I, Rept. 7.

Vervoort, W. 1952. Aetideidae, Cons. Int. Explor. Mer., Fisches D' Identification du Zooplankton, Sheets 41, 45, 46.

Wells, J.B.J. 1970. Copepoda - I. Sub-order Harpacticoida. Conseil Internat. L'Exploration Mer. Fiches D'Identification du Zooplankton. Sheet 133.

Wells, J.B.J. 1976. Keys to Aid in the Identification of Marine Harpacticoid Copepods. University of Aberdeen, U.K., Dept. of zoology.

1.11 Amphipoda

Barnard, J.L. 1969. The families and genera of marine gammaridean amphipoda. Smithson. Inst., U.S. Nat. Mus. Bull. 271, 535 p.

Bowman, T.E. 1960. The pelagic amphipod genus Parathemisto (Hyperiidea: Hyperiidae) in the North Pacific and adjacent Arctic Ocean. Proc. U.S. Nat. Mus. 112:343-392.

Bowman, T.E. 1973. Pelagic amphipods of the genus Hyperia and closely related genera (Hyperiidea: Hyperiidae). Smithsonian Contr. Zool. No. 136, 76p.

Bowman, T.E. 1978. Revision of the pelagic amphipod genus Primno (Hyperiidea: Phrosinidae). Smithsonian Contr. Zool. No. 146, 64 p.

Bowman, T.E. 1979. Personal Communication. Re: Separation of Scina spinosa from S. borealis.

Bowman, T.E. and H.E. Gruner. 1973. The families and genera of Hyperiidea (Crustacea: Amphipoda). Smithsonian Contr. Zool. No. 146, 64 p.

Bowman, T.E. and J.C. McCain. 1967. Variation and distribution of the pelagic amphipod Cyphocaris challenger in the Northeast Pacific (Gammaridea: Lysianassidae). Proc. U.S. Nat. Mus. 122:1-14.

Hurley, D.E. 1956. Bathypelagic and other Hyperiidea from California waters. Allan Hancock Foundation Publ. Occasional Paper No. 18, 1-25.

Sanger, G.A. 1972. Pelagic Amphipod Crustaceans from the Southeastern Bering Sea. Northwest Fisheries Center, Nat. Mar. Fish. Serv. MARMAP Survey I., Rept. 1.

Sanger, G.A. 1973. Epipelagic Amphipods (Crustacea) off Washington and British Columbia, October-November 1971. Northwest Fisheries Center, Nat. Mar. Fish. Serv. MARMAP Survey I, Rept. 8.

Shih, C.T. 1969. The systematic and biology of the family Phronimidae (Crustacea: Amphipoda). Dana Report No. 74.

Wagler, Erich. 1926. Amphipoda 2: Scinidae der Deutschen Tiefsee-Expedition. In: Carl Chun (cd.), Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition aub dem Dampfer "Valdivia," 1898-1899, 20(6):320-445.

1.12 Cumacea

Gamo, S. 1967-1968. Studies on the Cumacea (Crustacea: Malacostraca) of Japan. Parts I-III. Publ. Seto Mar. Biol. Lab. 15(2):133-163, 15(4):245-274, 16(3):147-192.

Hart, J.F.L. 1931. Some Cumacea of the Vancouver Island region. Contr. Can. Biol. Fish. (NS) 6(3):23-40.

Hart, J.F.L. 1974. Order Cumacea. In: Kozloff, E.N. Keys to the Marine Invertebrates of Puget Sound, the San Juan Archipelago, and Adjacent Regions. University of Washington Press. p. 142-145.

1.13 Mysidacea

Banner, A.H. 1948-1950. A taxonomic study of Mysidacea and Euphausiacea (Crustacea) of the northeastern Pacific. Parts I-III. Trans Royal Can. Inst. 26:346-399, 27:65-125, 28:1-63.

Tattersall, W.M. 1951. A review of the Mysidacea of the United States National Museum. Smithsonian Inst., U.S. Nat. Mus. Bull . 201, 302 p .

Tattersall, W.M. and 0.S. Tattersall. 1951. The British Mysidacea. Ray Sot. Publ. 136:1-460.

1.14 Euphausiacea

Banner, A.H. 1950. A taxonomic study of Mysidacea and Euphausiacea (Crustacea) of the northeastern Pacific. Part III. Euphausiacea. Trans. Royal Can. Inst. 28:1-63.

Boden, B.P., M.W. Johnson and E. Brinton. 1955. The Euphausiacea (Crustacea) of the North Paci fic. Bu11. Scripps Inst. Oceanogr. 6(8):287-400.

Mauchline, J. 1971 . Euphausiacea. Conseil Internat. L'Exploration Mer. Fiches D'Identification du Zooplankton. Sheets 134, 135/7.

McLaughlin, P.A. 1980. Comparative Morphology of Recent Crustacea. W.F. Freeman and Company. p. 117-122.

Nemoto, T. 1963. A new species of euphausiid, Thysanoessa inspinata from the North Pacific. J. Oceanogr. Sot. Japan 19(1):41-47.

Ponomareva, L.A. 1963. Euphausiids of the North Pacific, their Distribution and Ecololgy. Akedemiya Nauk USSR, Inst. Okeanologii. Transl. from Russian by Israel Program for Scientific Translations, 1966.

1.15 Leptostraca

McLaughlin, P.A. 1980. Comparative Morphology of Recent Crustacea. W.F. Freeman and Company. p. 59-63.

8.0 APPENDIX

Sample Zooplankton Counting and Coding Sheets.

A. **Cruise Header**

1 2 34 56 7

1 2 4 T R K Z

LAB CRUISE NO. (8 9) [ ][ ]

RECORD TYPE (10) A

VESSEL (11 12 13 14 15 16 17 18 19 20 21)

FIELD CRUISE NUMBER (22 23 24 25 26 27)

CRUISE BEGAN (28 29 30 31 32 33 34 35 36) 7 / / -

CRUISE END (37 38 39 40 41 42 43 44) 7 / /

PROJECT (45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63) 608 KODIAK ZPLANKTN

INSTITUTION AND INVESTIGATORS (64 65 66 67 68 69 70 71 72 73 74 75 76 77) VTN-ORE. GMAV

B, Station Location and Date Collected

1	2	3	4	5	6	7
1	2	4	T	R	K	Z

LAB CRUISE NO. (8 9) [ ][ ]

RECORD TYPE (10) [ ]

STATION NUMBER (11 12 13 14 15) [ ]

LATITUDE (16 17 18 19 20 21 22) [5 | | N]

LONGITUDE (23 24 25 26 27 28 29 30) [1 | | W]

DATE COLL. (31 32 33 34 35 36) [ ]

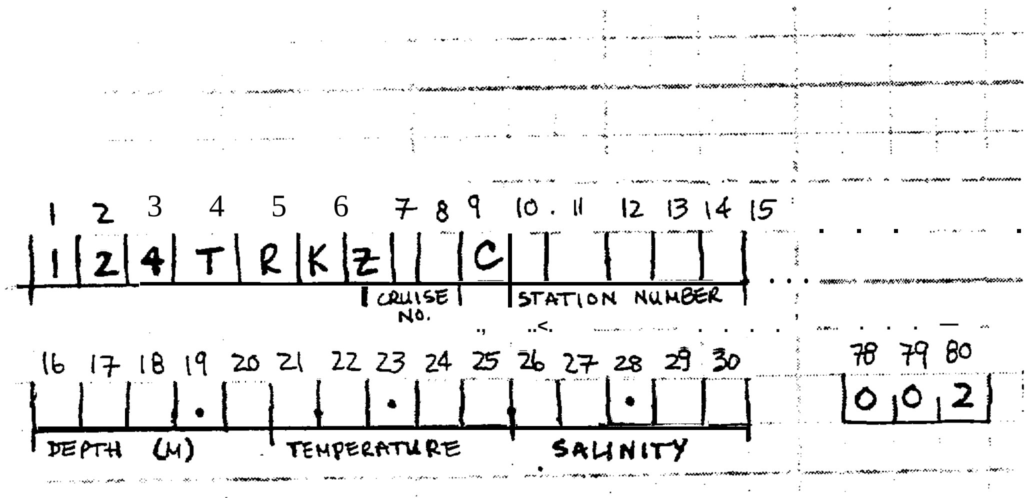
TIME COLL. (GMT) (37 38 39 40) [ ][ ][ ][ ]

STATION DEPTH (M) (41 42 43 44 45) [ ][ ][ ][ ][ ]

SAMPLE INTERVAL (UPPER, THEN LOWER IN M) (46 47 48 49 50 51 52 53) UPPER LOWER

CARD SEQUENCE NO IN SAMPLE (78 79 80) [0][0][1]

C. Water Chemistry



D. Gear and Haul Specifics

1	2	3	4-5	6	7	
1	2	4	T	R	K	Z

LAB CRUISE NUMBER. 8 9 [ ][ ] RECORD TYPE 10 [D] STATION NUMBER 11 12 13 14 15 [ ][ ] GEAR TYPE 16 17 [ ][ ]

MESH SIZE (IN UM) 18 19 20 21 [ ][ ][ ][ ] HAUL LENGTH (M) 22 23 24 25 [ ][ ][ ][ ] VOLUME OF WATER FILTERED (IN M³) 26 27 28 29 30 31 [ ][ ][ ][ ][ ][ ]

ORIGINAL SETTLED VOLUME (IN ML) 32 33 34 35 [ ][ ][ ][ ] SETTLED VOLUME (IN ML) VTN 62 63 64 65 [ ][ ][ ][ ]

78 79 80 [0][0][3]

E-1. Non-copepod Species Counting/Coding Form

1 2 3 4 5 6 7 8 9 10 11 | 12 13 14 15 — 1 2 4 T RK Z E — Cruise / Station

Gear Used ______ Mesh Used ______

	NODC Taxonomic Code 20 21 22 23 24 25 26 27 28 29	Subsample 34 35 36 37	Total Count 39 40 41 42
CNIDARIANS			
Rathkea octopunctata	3 7030 1 0 60 1		
Euphysa flammea	3 7 03030 1 0 1		
Sarsia	3 7 0 3 0 6 0 9 1		
Leuckartiara	3 7 03 1 2 0 2		
Phialidium	3 7 0 4 0 1 0 4		
*Eutonina indicans	3 704 1 30 30 1		
Proboscidactyla flavicirrata	3 7 0 5 0 6 0 2 0 1		
Aglantha digitale	3 7 1 1 0 1 0 2 0 1		
Dimophyes arctica	3 7 1 6 0 1 0 5 0 1		
Nanomia	3 7 1 7 0 1 0 3		
CTENOPHORE-	3 8 0		
ANNELIDS			
Tomopteris	5 00 1 2 00 1,		
MOLLUSCS			
Limacina helicina	5 1 1 3 01 0 1 02		
	5		
CHAETOGNATHS			
Sagitta elegans	8 3 000 0 0 3 0 3		
S. scrippsae	8 3 00 0 0 0 3 1 5		
S.	8 3 000 0 0 3		
Eukrohnia hamata	8 3 000 00 1 0 1		
TUNICATES			
Oikopleura	8 4 1 3 0 1 0 1		
Fritillaria borealis	8 4 1 3 0 2 0 1 0 1		
Unidentified larvacean	8 4 1 3		
Salpa	8 4 1 1 0 1		
CLADOCERANS			
Evadne nordmanni	6 1 0 9 0 5 0 1 0 1		
Podon	6 1 0 9 0 5 0 2		
	6 1 0		
OSTRACODS			
Conchoecia	6 1 1 1 0 5 0 1		
ISOPOD-	6 1 5 8		
CUMACEAN	6 1 5 4		
AMPHIPODS			
Parathemisto pacifica	6 1 7 0 0 1 1 0 0 3		
Hyperia	6 1 7 0 0 1 0 1		
Primno macropa	6 1 7 0 0 4 0 3 0 2		
Cyphocaris challenger	6 1 6 9 3 4 1 1 0 1		
	6 1		
MYSID	6 1 5 30 1		
EUPHAUSIIDS			
Euphausia pacifica	6 1 7 4 0 2 0 1 0 1		
Thysanoessa	6 1 7 4 0 2 0 9		
	6 1 7 4		
larvae	6 1 7 4		
MEROPLANKTON			
cirriped	6 1 3 4(		
Decapods	6 1		
	6 1		
Fish	8		

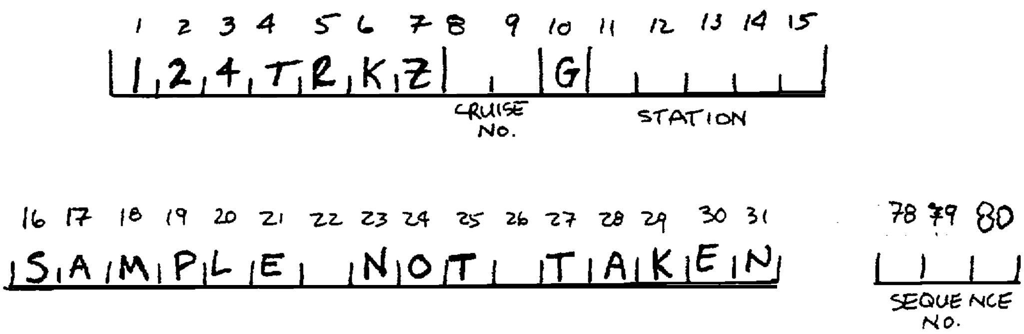
E-2. Expanded **Euphausiid** Coding Form

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2	4	T	R	K	Z			E					
							CRUISE NO			STATION				

34	35	36	37
SUBSAMPLE SIZE			

	20	21	22	23	24	25	26	27	28	29	52–56 ADULTS	57–61 JUVENILES	62–66 LARVAE	67–71 EGGS
E. pac.	6	1	7	4	0	2	0	1	0	1				
inermis	6	1	7	4	0	2	0	9	0	2				
inspirata	6	1	7	4	0	2	0	9	0	3				
longipes	6	1	7	4	0	2	0	9	0	5				
raschii	6	1	7	4	0	2	0	9	0	6				
spinifera	6	1	7	4	0	2	0	9	0	7				
Larvae	6	1	7	4	0	2	0	0	0	0				

F. Comment Cards



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2	4	T	R	K	Z			G					

CRUISE NO. (columns 8–9); STATION NO. (columns 10–15)

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
S	A	M	P	L	E		N	O	T			C	O	U	N	T	E	D			

78	79	80
0	0	4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2	4	T	R	K	E			G					
							CRUISE NO.		STATION NO.					

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
N	O		Z	O	O	P	L	A	N	K	T	O	N		P	R	E	S	E	N	T

78	79	80
0	0	4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2	4	T	R	K	Z			G					

CRUISE NO. (columns 8–9) STATION NO. (columns 11–15)

Columns 16–44: ANIMALS WITH DENSITY = O PRES

Columns 45–68: ENT BUT NOT QUANTITATIVE

G. Copepod Counting/Coding Form

ZOOPLANKTON COUNTING AND CODING SHEET
(each line = card)

1 2 3 4 5 6 7 8 9 1 0 1 1   1 2 1 3 1 4 1 5   Gear Used ________   Mesh Used _____

1 2 4 T R K Z J

Cruise   Station

Date Collected ____________   Date Examined ____________   Taxonomist ____________

♀	♂	c	Taxon	NODC Taxonomic Code (20-29)	Split Size 34353637	Total Count 39404142	A(IF 555 234	ADM 555 567	TCP 556 890	5 666 123	4 666 456	3 666 789	2 777 012	1 777 345
			Monstrilloids											
			M.	61220201										
			Harpacticoids											
				6119										
				6119										
			Cyclopoids											
			Oithona helgol.	6120090101										
			O. spinirostris	6120090104										
			Oncaea	6120010301										
				6120										
			Calanoids											
			Eucalanus bun.	6118030102										
			Pseudocalanus	6118050500										
			Aetideus	61180702										
			Gaetanus	61180710										
			Pareuch. elong.	6118080128										
			Racovitzanus	6118100301										
			Scolecit. minor	6118100504'										
			Metridia	6118160200										
			Pleuromamma											
			C. abdom.	6118170101										
			Candacia col.	6118260102										
			Epilabid. long.	6118270102										
			Acartia clausi	6118290101										
			A. longiremis	6118290103										
			A. tumida	6118290105										
			Tortanus disc.	6118300101										
				6118										
				6118										
				18										
				61 18										
				6118										

♀	♂	5	4	3	2	1	Family Calanidae	Code	Split Size	Total Count			(61 - 75)
							C. cristatus	6118010201					
							C. plumchrus	6118010206					
							C. marshallae	6118010204					
							C. pacificus	6118010205					
							C. tenuicornis	611801020/					
							C.	61180102					