DISTRIBUTION AND ABUNDANCE OF SOME EPIBENTHIC INVERTEBRATES OF THE NORTHEASTERN GULF OF ALASKA WITH NOTES ON THE FEEDING BIOLOGY OF SELECTED SPECIES

by

Howard M. Feder and Stephen C. Jewett

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

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SUMMARY OF OBJECTIVES, CONCLUSIONS, AND IMPLICATIONS WITH RESPECT TO OCS OIL AND GAS DEVELOPMENT

The objectives of this study were to obtain (1) a qualitative and quantitative inventory of dominant epibenthic species within the study area, (2) a description of spatial distribution patterns of selected benthic invertebrate species, and (3) preliminary observations of biological interrelationships between selected segments of the benthic biota.

The trawl survey was effective, and excellent spatial coverage was obtained, One hundred and thirty-three stations were successfully occupied, yielding a mean epifaunal invertebrate biomass of 2.6 g/m^2. Taxonomic analysis delineated 9 phyla, 19 classes, 82 families, 124 genera, and 168 species of invertebrates.

Three phyla—Mollusca, Arthropoda (Crustacean), and Echinodermata—dominated in species representation, with 47, 42, and 36 species taken, respectively. The same phyla dominated in biomass: Arthropoda contributed 71.4% of the total; Echinodermata, 19%; and Mollusca, 4.6%.

Snow crabs (*Chionoecetes bairdi*) contributed 66.2910 of the total epifaunal invertebrate biomass. Other arthropods of significant biomass were the pink shrimp (*Pandalus borealis)* and the box crab (*Lopholithodes foraminatus*).

Important echinoderms were the brittle star *Ophiura sarsi,* the sea stars *Ctenodiscus crispatus* and *Pycnopodia helianthoides,* and the heart urchin, *Brisaster townsendi.*

Of the molluscs, the scallop *Pecten caurinus* and the snails *Neptunea lyrata* and *Fusitriton oregonensis* dominated.

Some areas of biological interest were identified. Stations 74-C and D, south of Hinchinbrook Entrance, had a high diversity of fishes and invertebrates. Most species found here were abundant. Stations 94-A and B, located off Icy Bay, were characterized by an abundance of three species of fishes and the near absence of epifaunal invertebrates.

The highest biomass values for *Chionoecetes bairdi, Pandalus borealis, Ophiura sarsi,* and *Ctenodiscus crispatus* were recorded southeast of Kayak Island, in the vicinity of the Copper River delta. Large concentrations of fishes were also found here. The productivity of this area is thought to be enhanced by the nutrients supplied by the Copper River and/or the presence of clockwise and counter-clockwise gyres.

Limited trophic interaction data were compiled during this survey. However, inferences from other Outer Continental Shelf Environmental Assessment Program (OCSEAP) investigations suggest that food groups used by the dominant northeast Gulf of Alaska invertebrates are somewhat similar throughout their ranges.

A large number of the epifaunal species collected in the study area were either sessile or slow-moving forms. It is probable that many of these organisms prey upon deposit-feeding infauna as they do in the waters of Cook Inlet, Kodiak, the Bering Sea, and the southeast Chukchi Sea. Many of these epifaunal species would be affected by oil spills either because of their inability to leave the area or as a result of their food dependence on deposit-feeding species that incorporate sediment in the feeding process. Experimentation on toxic effects of oil on snow crabs, king crabs, and pandalid shrimps has been carried out by other investigators.

Initial assessment of the data suggests that a few unique, abundant, and/or large benthic species (snow crabs, shrimps, brittle stars, sea stars) are characteristic of the areas investigated and that these species may represent organisms that could be useful for monitoring purposes. Two biological parameters that should be addressed in conjunction with petroleum-related activities are feeding and reproductive biology of important species. It is suggested that an intensive program designed to examine these parameters be initiated well in advance of industrial activity in the oil lease areas.

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INTRODUCTION

General Nature and Scope of Study

The operations connected with oil exploration, production, and transportation in the northeast Gulf of Alaska (NEGOA) will present a wide spectrum of potential dangers to the marine environment (see Olson and Burgess [1967] and Malins [1977] for general discussion of marine pollution problems). Adverse effects on the marine environment cannot be quantitatively assessed, or even predicted, unless background data are recorded prior to industrial development. Insufficient long-term information about an environment, and the basic biology of species in that environment, can lead to erroneous interpretations of changes in species composition and abundance that might occur if the area becomes altered by industrial activity (see Baker [1976], Nelson-Smith [1973], Pearson [19'71, 1972, 1975], and Rosenberg [1973] for general discussions on benthic biological investigations in industrialized marine areas). Populations of marine species fluctuate over a time span of a few to 30 years (Lewis 1970 and personal communications), but such fluctuations are typically unexplainable because of absence of long-term data (Lewis 1970).

Benthic invertebrates (primarily the infauna but also sessile and slow-moving epifauna) are useful as indicator species for a disturbed area because they tend to remain in place, typically react to long-range environmental changes, and by their presence, generally reflect the nature of the substratum. Consequently, organisms of the infaunal benthos have frequently been chosen to monitor long-term pollution effects, and are believed to reflect the biological health of a marine area (see Pearson [1971, 1972, 1975] and Rosenberg [1973] for discussion of long-term use of benthic organisms for monitoring pollution). The presence of large numbers of benthic epifaunal species of actual or potential commercial importance (crabs, shrimps, snails, finfishes) in NEGOA further dictates the necessity of understanding benthic communities since many commercially important species feed on infaunal and small epifaunal residents of the benthos (see Zenkevitch [1963], Feder [1977a, 1978a], Feder et al. [1978], and Feder and Jewett [1977, 1978] for discussions of the interaction of commercially important species and the benthos). Any drastic changes in density of the food benthos could affect the health and numbers of these economically important species.

Experience in pollution-prone areas of England (Baker 1976; Smith 1968), Scotland (Pearson 1972, 1975), and California (Straughan 1971) suggests that at the completion of an exploratory study, selected stations should be examined regularly on a long-term basis to monitor species content, diversity, abundance, and biomass. Such long-term data acquisition in NEGOA should make it possible to differentiate between normal ecosystem variation and pollutant-induced alteration. Furthermore, intensive investigation of the food habits of benthic species of NEGOA are also essential in order to understand trophic interactions there and to predict changes that might take place once oil-related activities are initiated.

The intensive trawl study considered in this report delineates the major epifauna on the northeastern Gulf of Alaska shelf. The information obtained on faunal composition and abundance in this investigation now represents a general data base to which future changes can be compared. A major portion of this data is presented in Jewett and Feder (1976). Long-term studies on life histories and trophic interactions should ultimately define functional aspects of communities and ecosystems vulnerable to environmental damage, and should help determine rates at which damaged environments can recover.

Relevance to Problems of Petroleum Development

Lack of adequate data on a worldwide basis makes it difficult to predict the effects of oil-related activity on the subtidal benthos. However, the recent expansion of research activities in NEGOA should ultimately enable us to point with some confidence to certain species or areas there that might bear closer scrutiny once industrial activity is initiated. It must again be emphasized that a broad time frame is needed to comprehend long-term fluctuations in composition and density of benthic species; thus, it cannot be expected that short-term research programs will result in adequate predictive capabilities. Assessment of any ecological system must always be a continuing endeavour.

As indicated above, infaunal species tend to remain in place and, consequently, have been useful as indicator species for disturbed areas. Thus, close examination of stations with substantial complements of infaunal species is warranted (see Feder and Matheke [1979] for comments on infaunal benthos). Changes in the environment at these and other stations with a relatively large number of species might be reflected in a decrease in diversity of species with increased dominance of a few (see Nelson-Smith [1973] for further discussion of oil-related changes in diversity). Likewise, stations with substantial numbers of epifaunal species should be assessed 'on a continuing basis. The effect of loss or reduced numbers of specific epifaunal species to the overall trophic structure in NEGOA can be conjectured *on* the basis of available food studies (Feder 1977a, 1978a; Feder and Jewett 1977, 1978; Jewett 1978; Smith et al. 1978; Paul et al. 1979).

Data indicating the effect of oil on subtidal benthic invertebrates are fragmentary (Nelson-Smith 1973; Boesch et al. 1974; Malins 1977), but it is known that echinoderms are "notoriously sensitive to any reduction in water quality" (Nelson-Smith 1973). Echinoderms (ophiuroids: brittle stars; asteroids: sea stars; holothuroids: sea cucumbers) are conspicuous members of the benthos of NEGOA and could be affected by oil activities there. Two echinoderm groups, asteroids and ophiuroids, are often components of the diet of large crabs (Cunningham 1969; Feder 1977a, 1978b; G. Powell, ADF&G, pers. comm.) and a few species of demersal fishes (Smith et al. 1978; Wigley and Theroux 1965).

King crabs (*Paralithodes camtschatica*), snow crabs (*Chionoecetes bairdi*), and pandalid shrimps (e.g., *Pandalus borealis*) are conspicuous members of the shallow shelf of NEGOA and support commercial fisheries of considerable importance there. The effects of Cook Inlet crude oil water soluble fractions on the survival and molting of king crab and coonstripe shrimp (*Pandalus hypsinotus*) larvae were examined by Mecklenburg et al. (1976). Low concentrations (<0.54 ppm) of oil produced a moribund condition (cessation of swimming) in all larval stages and ultimately caused death. Molting of both species was permanently inhibited by exposing larvae for 72 hours at crude oil concentrations of 0.8 to 0.9 ppm. Larvae that failed to molt, died in 7 days. Laboratory experiments with postlarval C. *Bairdi* have shown that postmolt individuals lose most of their legs after exposure to Prudhoe Bay crude oil (Karinen and Rice 1974).

Little other direct data based on laboratory experiments are available for subtidal benthic species (see Nelson-Smith 1973). Thus, experimentation on toxic effects of oil on other common members of the subtidal benthos should be strongly encouraged in future Outer Continental Shelf (OCS) programs.

A direct relationship between trophic structure (feeding type) and bottom stability has been demonstrated (Rhoads 1974). After a diesel fuel spill, oil adsorbed onto sediment particles killed many deposit feeders living on sublittoral muds. Bottom stability was altered with the death of these organisms, and a new complex of species became established in the altered substratum. Many NEGOA infaunal species are deposit feeders; thus, oil-related mortality of these species could likewise result in a changed near-bottom sedimental y regime with subsequent alteration of species composition. An understanding of these species as well as epifaunal organisms and their interactions with each other is essential to the development of predictive capabilities required for the NEGOA outer continental shelf.

CURRENT STATE OF KNOWLEDGE

Little was known about the biology of the invertebrate benthos of the northeast Gulf of Alaska (NEGOA) at the time that OCSEAP studies were initiated there, although a compilation of *some* relevant data *on the* Gulf of Alaska was available (Rosenberg 1972). A short but intensive survey in the summer of 1975 added some benthic biological data for a specific area south of the Bering Glacier (Bakus and Chamberlain 1975). Results of the latter study are similar to those reported by Feder and Mueller (1975) in their OCSEAP investigation. Some scattered data based on trawl surveys by the Bureau of Commercial Fisheries (now National Marine Fisheries Service) were available, but much of the information on the invertebrate fauna was so general as to have little value.

In the summer and fall of 1961 and spring of 1962, otter trawls were used to survey the shellfishes and bottomfishes on the continental shelf and upper continental slope in the Gulf of Alaska (Hitz and Rathjen 1965). The surveys were part of a long-range program begun in 1950 to determine the size of bottomfish stocks in the northeastern Pacific Ocean between southern Oregon and northwest Alaska. Invertebrates taken in the trawls were of secondary interest, and only major groups and/or species were recorded. Invertebrates that comprised 27% of the total catch were grouped into eight categories: heart urchins (Echinodermata: Echinoidea), snow crab (*Chionoecetes biardi*), sea stars (Echinodermata: Asteroidea), Dungeness crab (Cancer *magister*), scallop (*Pecten caurinus*), shrimps (*Pandalus borealis, P. platyceros,* and *Pandalopsis dispar*), king crab (*Paralithodes camtschatica*), and miscellaneous invertebrates (e.g., sponges) (Hitz and Rathjen 1965). Heart urchins accounted for about 50% of the invertebrate catch and snow crab ranked second, representing about 22%. Approximately 20% of the total invertebrate catch was composed of sea stars.

Further knowledge of invertebrate stocks in the North Pacific is scant. The International Pacific Halibut Commission surveys parts of the Gulf of Alaska annually and records selected commercially important invertebrates; however, noncommercial species are discarded. The benthic investigations of Feder and Mueller (1975), Feder (1977a), and this report represent the first broad-based qualitative and quantitative examinations of the benthic infauna and epifauna on the shelf of the Gulf of Alaska. The history of commercial fisheries in the northeast Gulf of Alaska and data from fishing activities there have been reported by Ronholt et al. (1976).

Information in the literature has uncovered data that will aid in the interpretation of the biology of some dominant organisms in the Gulf of Alaska (see Feder 1977b).

Examination of trophic relationships of selected infaunal and epifaunal species was initiated in 1976 as a part of the lower Cook Inlet and Kodiak investigations (Feder 1977a; Feder and Jewett 1977). Food studies by Smith et al. (197'8) and the present report will contribute to an understanding of trophic relationships in NEGOA.

STUDY AREA

One hundred and forty stations were occupied in conjunction with the National Marine Fisheries Service Resource Assessment trawl survey (Ronholt et al. 1976) which sampled a grid extending from the western tip of Montague Island (148° W longitude) to Yakutat Bay (140° W longitude) (Fig. 1). Samples were taken to a maximum depth of approximately 500 meters (274 fathoms).

SOURCES, METHODS, AND RATIONALE OF DATA COLLECTION

Epifauna were collected from the MV *North Pacific* in the northeastern Gulf of Alaska from 25 April to 7 August 1975. One-hour tows (a standard tow) were made at predetermined stations (Fig. 1) using a commercial sized, 400-mesh Eastern otter trawl with a 12.2 meter horizontal opening. All invertebrates currently of noncommercial importance were sorted on shipboard, given tentative identifications, counted, and weighed, and aliquot samples were preserved and labeled for final identification at the Institute of Marine Science, University of Alaska. Hermit crab weights included shell weights. Counts and weights of commercially important invertebrate species were recorded by National Marine Fisheries Service personnel, and the data were made available to the benthic invertebrate program.

Biomass per unit area (g/m^2) was calculated as $W/(T_w(D \times 1000))$ where W = weight (grams), Tw = width of trawl opening (meters), and (Dx1000) = distance fished (kilometers x 1000). The data basis for all calculations of biomass per square meter are included with the station data submitted to the National Oceanographic Data Center. Data from selected stations are included in the Appendix.

When laboratory examination revealed more than a single species in a field identification, the counts and weights of the species in question were arbitrarily expanded from the laboratory species ratio to encompass the entire catch of the trawl.

Limited feeding data were obtained from stomach examinations and recorded whenever time permitted. The frequency of occurrence method was used.

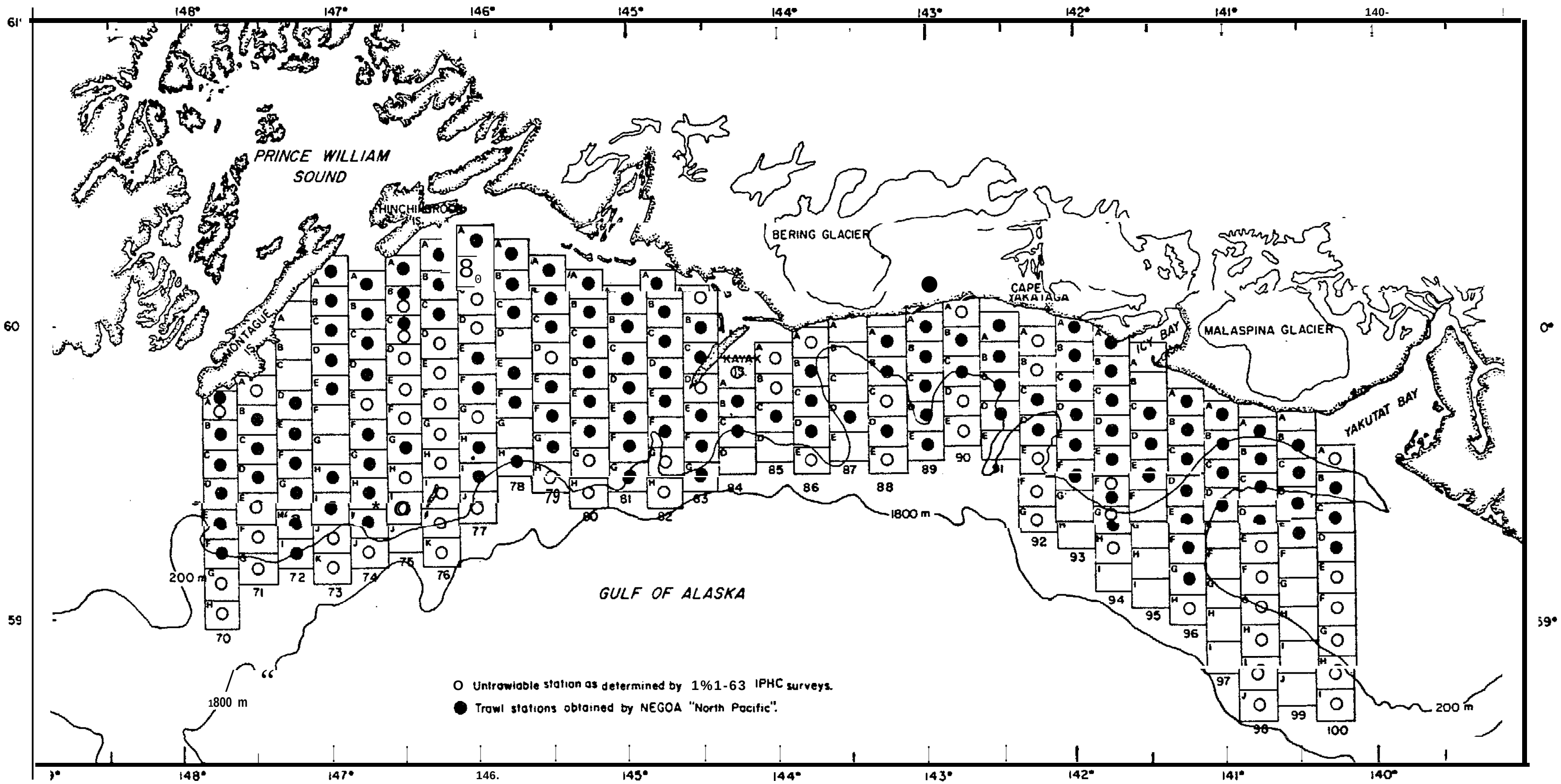

Figure L-Station grid established for the trawl survey on the continental shelf of the northeastern Gulf of Alaska, summer 1975

RESULTS

Distribution, Abundance, and Biomass

The benthic trawl program in the northeast Gulf of Alaska permitted the successful occupation of 133 stations. In 127.43 hours of trawling, 732.24 km were fished (8,933,328 m^2). The total epifaunal invertebrate biomass collected was 23,447,8 kg, yielding a mean of 2.6 g/m^2.

Taxonomic analysis delineated 9 phyla, 19 classes, 82 families, 1.24 genera, and 168 species of invertebrates. Three phyla—Mollusca, Arthropoda (Crustacean), and Echinodermata—dominated in species representation with 47, 42, and 36 species taken, respectively (Tables 1 and 2).

The same phyla also dominated in biomass: Arthropoda contributed 71.4910 of the total; Echinodermata, 19.0%; and Mollusca, 4.6% (Tables 2 and 3).

Of the crustaceans, the families Majidae, Pandalidae, and Lithodidae were most important in terms of biomass. The snow crab *Chionoecetes bairdi* (family Majidae) contributed 66.2% of the total epifaunal invertebrate biomass and 92.6% of the arthropod biomass (Table 3). This species was widely distributed over the area sampled; the greatest density was found at Station 82-A' (see Appendix) where 892 kg of C. *bairdi* (1,984 individuals) were taken in a standard tow, or 19.8 g/m^2 (Fig. 2). The mean catch per unit effort (CPUE) for C. *bairdi* was 122 kg/hr (268 lb/hr).

Pink shrimp (*Pandalus borealis*) were also widespread, and accounted for 2.9% of the total invertebrate biomass (Table 3). The highest biomass was taken at Station 83-C, where 2.4 g/m^2 or 167.7 kg (370 lb) were taken in a standard tow (Fig. 3). The mean CPUE was 5.3 kg/hr (11.7 lb/hr).

Of the lithode crabs, the box crab (*Lopholithodes foraminatus*) was most abundant. This crab was the third most important crustacean by weight (Table 3). The greatest density was found at Station 86-D, where 55 of these crabs weighed 25.4 kg (56 lb), the equivalent of 0.3 g/m^2 (Fig. 4). The average CPUE of *L. foraminatus* was 0.19 kg/hr (2 lb/hr).

Four echinoderm species—a brittle star (*Ophiura sarsi*), two sea stars (*Ctenodiscus crispatus* and *Pycnopodia helianthoides*), and the heart urchin (*Brisaster townsendi*)—were found in large quantities (Table 3). The percent-weight composition of sea stars as a percentage of all echinoderms and all invertebrates was 35.3% and 6.7%, respectively (Table 2). Brittle stars (Ophiuroidea) were the second largest class of echinoderms collected,

[1] The data from 14 stations (74-C, 74-D, 80-B, 81-D, 82-A, 83-C, 83-E, 86-D, 89-A, 93-C, 94-A, 94-B, 97-C, 99-D) referred to in the text are compiled separately in the Appendix.

Table 1. —Invertebrates taken by trawl from the northeast Gulf of Alaska, 25 April–7 August 1975.

Phylum Porifera

unidentified species

Phylum Cnidaria

Class Hydrozoa

unidentified species

Class Scyphozoa

Family Pelagiidae

Chrysaora melanaster Brandt

Class Anthozoa

Subclass Alcyonaria

Eunephthya rubiformis (Pallas)

Family Primnoidae

Stylatula gracile (Gabb)

Family Pennatulidae

Ptilosarcus gurneyi (Gray)

Family Actiniidae

Tealia crassicornis (O. F. Müller)

Phylum Annelida

Class Polychaeta

Family Polynoidae

Arctonoe vittata (Grube)
Eunoe depressa Moore
Eunoe oerstedi Malmgren
Harmothoe multisetosa Moore
Hololepida magna Moore
Lepidonotus squamatus (Linnaeus)
Lepidonotus sp.
Polyeunoa tuta (Grube)

Family Polynodontidae

Peisidice aspera Johnson

Family Euphrosinidae

Euphrosine hortensis Moore

Family Syllidae

unidentified species

Family Nereidae

Ceratonereis paucidentata (Moore)
Ceratonereis sp.
Cheilonereis cyclurus (Barrington)
Nereis pelagica Linnaeus
Nereis vexillosa Grube
Nereis sp.

Family Nephtyidae

unidentified species

Family Glyceride

Glycera sp.

Family Eunicidae

Eunice valens (Chamberlain)

Family Lumbrineridae

Lumbrineris similabris (Treadwell)

Phylum Annelida (continued)
- Family Opheliidae
  - *Travisia pupa* Moore
- Family Sabellariidae
  - *Idanthyrsus armatus* Kinberg
- Family Terebellidae
  - *Amphitrite cirrata* O. F. Müller
- Family Sabellidae
  - *Euchone analis* (Kröyer)
- Family Serpulidae
  - *Crucigera irregularis* Bush
- Family Aphroditidae
  - *Aphrodita japonica* Marenzeller
  - *Aphrodita negligens* Moore
  - *Aphrodita* sp.
- Class Hirudinea
  - *Notostomobdella* Sp.

Phylum Mollusca
- Class Polyplacophora
  - Family Mopaliidae
    - unidentified species
- Class Pelecypoda
  - Family Nuculanidae
    - *Nuculana fossa* Baird
  - Family Mytilidae
    - *Mytilus edulis* Linnaeus
    - *Musculus niger* (Gray)
    - *Modiolus modiolus* (Linnaeus)
  - Family Pectinidae
    - *Chlamys hastata hericia* (Gould)
    - *Pecten caurinus* Gould
    - *Delectopecten randolphi* (Dan)
  - Family Astartidae
    - *Astarte polaris* Dan
  - Family Carditidae
    - *Cyclocardia ventricosa* (Gould)
  - Family Cardiidae
    - *Clinocardium ciliatum* (Fabricius)
    - *Clinocardium fucanum* (Dan)
    - *Serripes groenlandicus* (Bruguière)
  - Family Veneridae
    - *Compsomyax subdiaphana* Carpenter
  - Family Mactridae
    - *Spisula polynyma* (Stimpson)
  - Family Myidae
    - unidentified species
  - Family Hiatellidae
    - *Hiatella arctica* (Linnaeus)

Phylum Mollusca (continued)
- Family Teredinidae
  - *Bankia setacea* Tryon
- Family Lyonsiidae
  - unidentified species
- Class Gastropoda
  - Family Bathybembix
    - *Solariella obscura* (Couthouy)
    - *Lischkeia cidaris* (Carpenter)
  - Family Naticidae
    - *Natica clausa* Broderip and Sowerby
    - *Polinices monteronus* Dan
    - *Polinices lewisii* (Gould)
  - Family Cymatiidae
    - *Fusitriton oregonensis* (Redfield)
  - Family Muricidae
    - *Trophonopsis stuarti* (Smith)
  - Family Buccinidae
    - *Buccinum plectrum* Stimpson
    - *Beringius kennicotti* (Dan)
    - *Colus halli* (Dan)
    - *Morrisonella pacifica* (Dan)
    - *Neptunea lyrata* (Gmelin)
    - *Neptunea pribiloffensis* (Dan)
    - *Plicifusus* sp.
    - *Pyrulofusus harpa* (Mörch)
    - *Volutopsius filosus* Dan
  - Family Columbellidae
    - *Mitrella gouldi* (Carpenter)
  - Family Volutidae
    - *Arctomelon stearnsii* (Dan)
  - Family Turridae
    - Oenopota sp.
    - *Aforia circinata* (Dan)
  - Family Dorididae
    - unidentified species
  - Family Tritoniidae
    - *Tritonia exsulans* Bergh
    - *Tochuina tetraquetra* (Pallas)
  - Family Flabellinidae
    - *Flabellinopsis* sp.
- Class Cephalopoda
  - Family Sepiolidae
    - *Rossia pacifica* Berry
  - Family Gonatidae
    - *Gonatopsis borealis* Sasaki
    - *Gonatus magister* Berry
  - Family Octopodidae
    - *octopus* Sp.

Phylum Arthropoda
- Class Crustacea
  - Order Thoracica
    - Family Lepadidae
      - *Lepas pectinata pacifica* Henry
    - Family Balanidae
      - *Balanus hesperius*
      - *Balanus rostratus* Hock
      - *Balanus* sp.
  - Order Isopoda
    - Family Aegidae
      - *Rocinela augustata* Richardson
    - Family Bopyridae
      - *Argeia pugettensis* Dana
  - Order Decapoda
    - Family Pandalidae
      - *Pandalus borealis* Kröyer
      - *Pandalus jordani* Rathbun
      - *Pandalus montagui tridens* Rathbun
      - *Pandalus platyceros* Brandt
      - *Pandalus hypsinotus* Brandt
      - *Pandalopsis dispar* Rathbun
    - Family Hippolytidae
      - *Spirontocaris lamellicornis* (Dana)
      - *Spirontocaris arcuata* Rathbun
      - *Eualus barbata* (Rathbun)
      - *Eualus macrophthalma* (Rathbun)
      - *Eualus suckleyi* (Stimpson)
      - *Eualus pusiola* (Kröyer)
    - Family Crangonidae
      - *Crangon communis* Rathbun
      - *Argis* sp.
      - *Argis dentata* (Rathbun)
      - *Argis ovifer* (Rathbun)
      - *Argis alaskensis* (Kingsley)
      - *Paracrangon echinata* Dana
    - Family Paguridae
      - *Pagurus ochotensis* (Benedict)
      - *Pagurus aleuticus* (Benedict)
      - *Pagurus kennerlyi* (Stimpson)
      - *Pagurus confragosus* (Benedict)
      - *Elassochirus tenuimanus* (Dana)
      - *Elassochirus cavimanus* (Miers)
      - *Labidochirus splendescens* (Owen)
    - Family Lithodidae
      - *Acantholithodes hispidus* (Stimpson)
      - *Paralithodes camtschatica* (Tilesius)
      - *Lopholithodes foraminatus* (Stimpson)
      - *Rhinolithodes wosnessenskii* Brandt
    - Family Galatheidae
      - *Munida quadri.spins* Benedict

Phylum Arthropoda (continued)
Family Majiidae
Oregonia gracilis Dana
Hyas lyratus Dana
Chionoecetes bairdi Rathbun
Chorilia longipes Dana
Family Cancridae
Cancer magister Dana
Cancer oregonensis (Dana)

Phylum Ectoprocta
unidentified species

Phylum Brachiopoda
Class Articulate
Family Cancellothyrididae
Terebratulina unguicula Carpenter
Family Dallinidae
Laqueus californianus Koch
Terebratalia transversa (Sowerby)

Phylum Echinodermata
Class Asteroidea
Family Asteropidae
Dermasterias imbricata (Grube)
Family Astropectinidae
Dipsacaster borealis Fisher
Family Benthopectinidae
Luidiaster dawsoni (Verrill)
Nearchaster pedicellaris (Fisher)
Family Goniasteridae
Ceramaster patagonicus (Sladen)
Hippasterias spinosa Verrill
Mediaster aequalis Stimpson
Pseudarchaster parelii (Düben and Koren)
Family Luiidae
Luidia foliolata Grube
Family Porcellanasteridae
Ctenodiscus crispatus (Retzius)
Family Echinasteridae
Henricia aspera Fisher
Henricia sp.
Poraniopsis inflata Fisher
Family Pterasteridae
Diplopteraster multipes (Sars)
Pteraster tesselatus
Family Solasteridae
Crossaster borealis (Fisher)
Crossaster papposus (Linnaeus)
Lophaster furcilliger Fisher
Lophaster furcilliger vexator Fisher
Solaster dawsoni Verrill

Table 1.—(continued)

Phylum Echinodermata (continued)

Family Asteridae

Leptasterias sp.

Lethasterias nanimensis (Verrill)

Stylasterias forreri (de Loriol)

Pycnopodia helianthoides (Brandt)

Class Echinoidea

Family Schizasteridae

Brisaster townsendi

Family Strongylocentrotidae

Allocentrotus fragilis (Jackson)

Strongylocentrotus droebachiensis (O. F. Müller)

Class Ophiuroidea

Family Amphiuridae

Unioplus macraspis (Clark)

Family Gorgonocephalidae

Gorgonocephalus caryi (Lyman)

Family Ophiactidae

Ophiopholis aculeata (Linnaeus)

Family Ophiuridae

Amphiophiura ponderosa (Lyman)

Ophiura sarsi Lütkin

Class Holothuroidea

Family Molpadiidae

Molpadia Sp.

Family Cucumariidae

unidentified species

Family Psolidae

Psolus chitinoides H. L. Clark

Class Crinoidea

unidentified species

Phylum Chordata

Class Phlebobranchia

Family Rhodosomatiidae

Chelyosoma columbianum Huntsman

Class Stolidobranchia

Family Pyuridae

Halocynthia helgendorfi igaboja Oka

Table 2.—Miscellaneous data for invertebrates collected by commercial trawl in the northeast Gulf of Alaska, 25 April-7 August 1975.

Phylum	Number of species	% of species	weight (kg)	% total weight
Mollusca	47	28.0	1,089.2	4.6
Arthropoda (Crustacea)	42	25.0	16,748.6	71.4
Echinodermata	36	21.4	4,462.0	19.0
Annelida	30	17.8	2.8	<0.1
Cnidaria	6	3.6	513.4	2.2
Brachiopoda	3	1.8	49.8	0.2
Chordata (Tunicata)	2	1.2	322.2	1.4
Ectoprocta	1	0.6	3.7	<0.1
Porifera	1	0.6	256.2	1.0
TOTAL	168	100.0	23,447.9	100.0

Phylum	Subgroup	Weight (kg)	% of phylum weight	% total weight
Arthropoda	Decapoda	16,692.60	99.7	71.4
Echinodermata	Asteroidea	1,575.99	35.3	6.7
	Ophiuroidea	1,492.81	33.5	6.4
	Holothuroidea	709.60	15.9	3.0
	Echinoidea	644.15	14.4	2.7
Mollusca	Gastropoda	557.70	51.2	2.4
	Pelecypoda	488,36	44.8	2.1
	Cephalopoda	36.91	3.4	0.1

Table 3. —Percentage composition by weight of leading invertebrate species collected during northeast Gulf of Alaska trawling investigations, 25 April–7 August 1975.

Phyla	% of total weight	Leading species	Average weight per individual	% of weight within phylum	% of weight from all phyla
Arthropoda	7’1.4	*Chionoecetes bairdi*	454 g	92.6	66.2
		Pandalus borealis	8 g	4.0	2.9
		Lopholithodes foraminatus	420 g	0.6	0.4
				97.2	69.5
Echinodermata	19.0	*Ophiura sarsi*	6 g	23.2	4.4
		Ctenodiscus crispatus	10 g	15.7	2.9
		Brisaster townsendi	10 g	11.2	2.1
		Pycnopodia helianthoides	482 g	10.3	2.0
				60.4	11.4
Mollusca	4.6	*Pecten caurinus*	350 g	43.4	2.0
		Neptunea lyrata	180 g	12.5	0.6
		Fusitriton oregonensis	100 g	11.5	0.5
	95.0			67.4	3.1

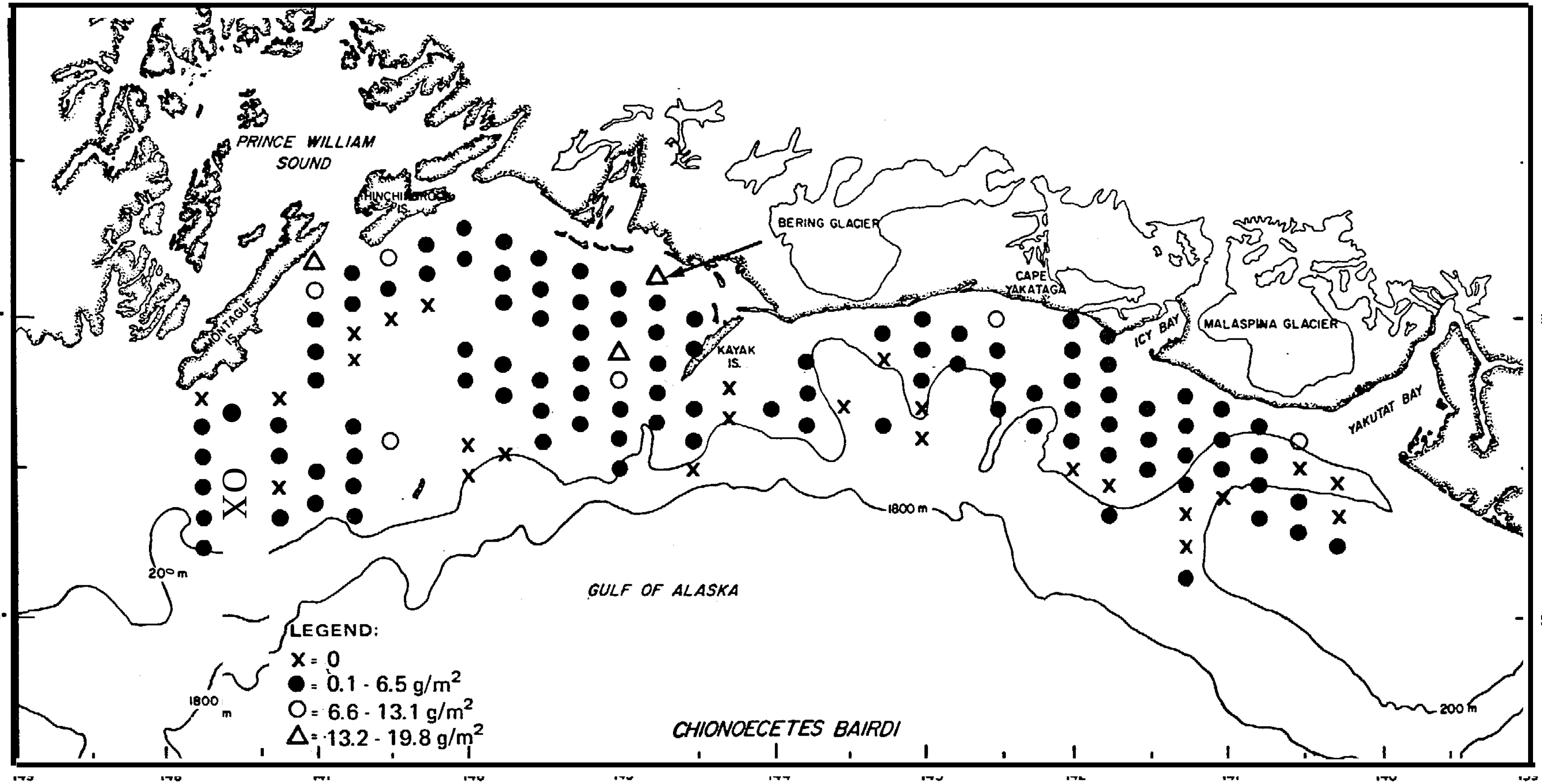

Figure 2.—Snow crab (*Chionoecetes bairdi*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *C. bairdi*.

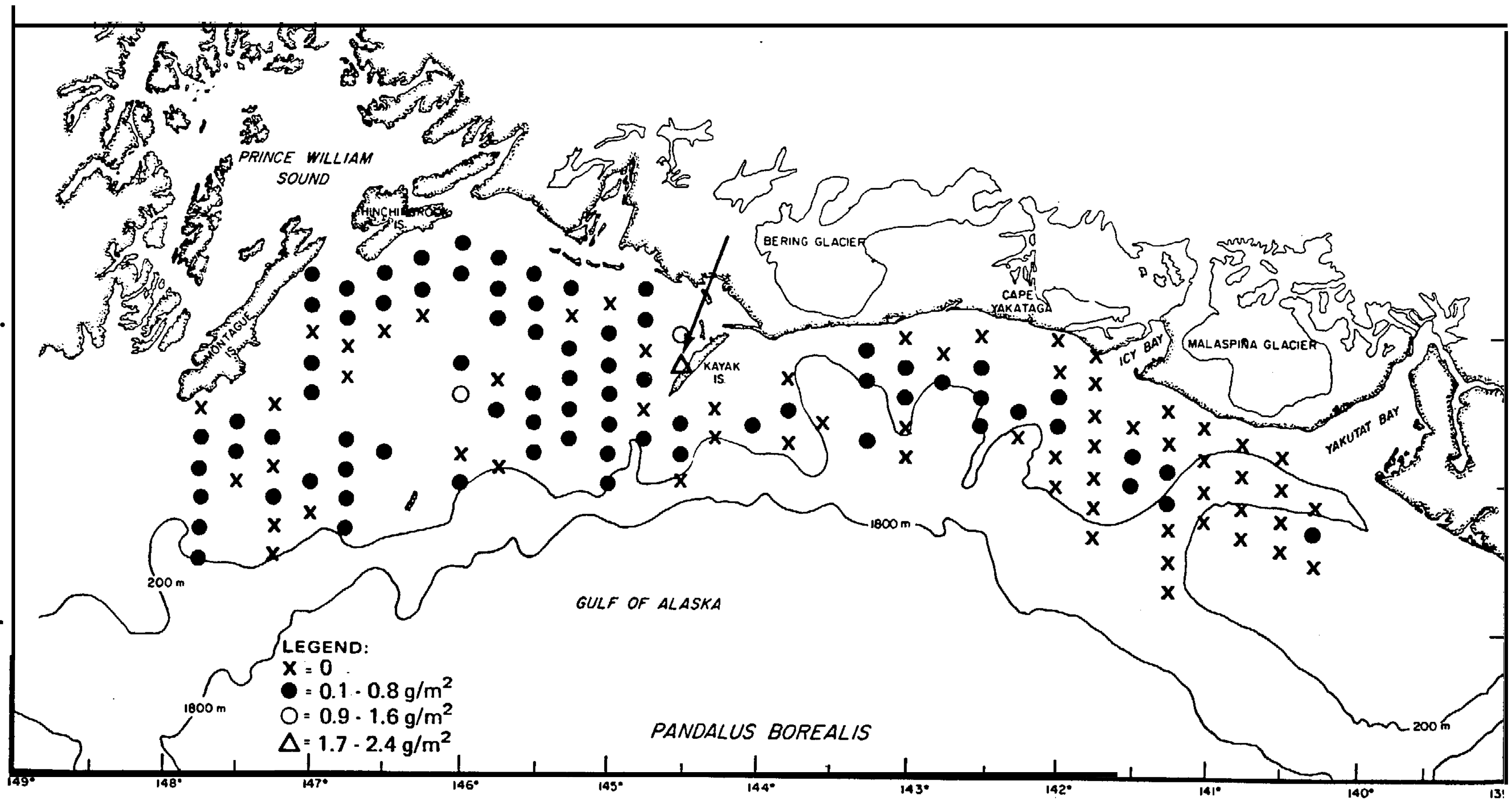

Figure 3.—Pink shrimp (*Pandalus borealis*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *P. borealis*.

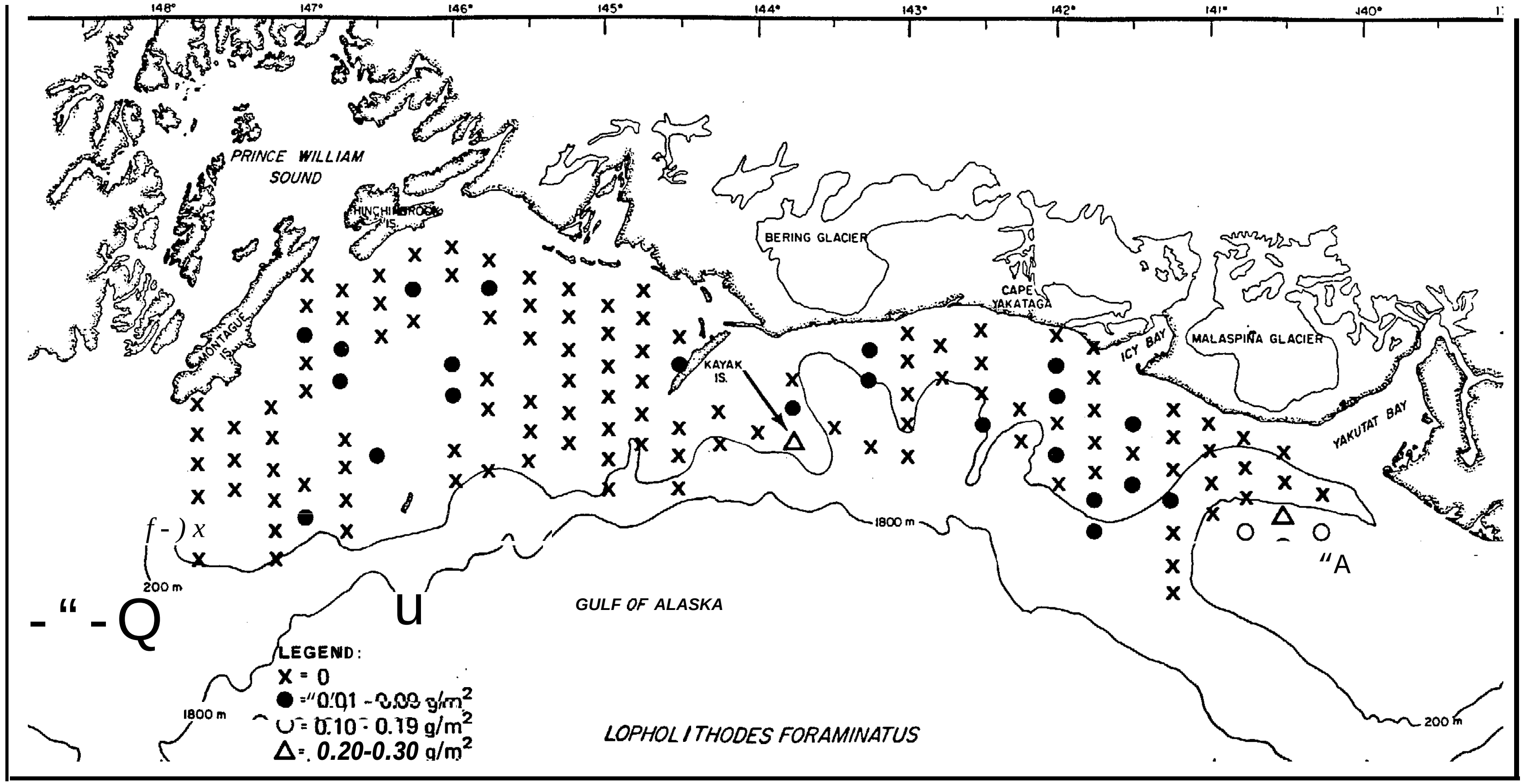

Figure 4.—Box crab (*Lopholithodes foraminatus*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *L. foraminatus*.

accounting for 33.5% of the echinoderm biomass and 6.4% of the total invertebrate biomass (Table 2). Sea cucumbers (Holothuroidea) and sea urchins and sand dollars (Echinoidea) comprised 15 .9% and 14.4% of the echinoderm biomass, respectively (Table 2). *Ophiura sarsi was* the most abundant echinoderm, comprising 23.2% of the echinoderm biomass and 4.4% of the total invertebrate biomass. The largest catch of this brittle star, at Station 81-D, was 750 kg (1,653 lb) in a l-hour tow, equivalent to 11.4 g/m^2 (Fig. 5). The average CPUE was 8.1 kg/hr (18 lb/hr). The greatest biomass for the small sea star *Ctenodiscus crispatus was* found at Station 80-B, with 0.8 g/m^2 or 55.8 kg (123 lb) taken per hour (Fig. 6). The average CPUE of this species was 5.5 kg/hr (12 lb/hr). *Pycnopodia helianthoides was* another widely distributed sea star. At Station 93-C, 170 of these large sea stars (average weight 0.453 kg) were taken (Fig. 7). At this station the biomass of *Pycnopodia was 1.3* g/m^2 or 85.5 kg/hr (188 lb/hr). The average CPUE was 3.6 kg/hr (8 lb/hr). The heart urchin (*Brisaster townsendi*) accounted for approximately 11% of the echinoderm biomass taken in the trawl survey (Table 3). Station 97-C yielded the largest catch of this urchin, at 2.9 g/m^2 or 213 kg/hr (469 lb/hr); this represented 21,272 urchins collected during the tow (Fig. 8). The average CPUE was 3.9 kg/hr (8.6 lb/hr).

Although sea cucumbers (family Cucumariidae) were found at only seven stations, they ranked high in echinoderm weight composition. For example, the tow at Station 99-D contained approximately 2,600 sea cucumbers weighing 650 kg (1,433 lb), equivalent to 9.6 g/m^2 (Fig. 9). The average CPUE was 5.3 kg/hr (11.6 lb/hr).

Of the 47 species of molluscs collected, the scallop *Pecten (=Patinopecten) caurinus was* dominant. This large bivalve accounted for 2% of the total epifaunal invertebrate biomass and 43% of the molluscan biomass (Table 3). Station 83-E provided the largest catch of scallops, with 1.7 g/m^2 or 116 kg (370 lb) per standard tow (Fig. 10). The average CPUE was 3.7 kg/hr (8 lb/hr).

Snails of the family Buccinidae were the dominant gastropod. *Neptunea lyrata was* the most abundant. The greatest biomass of *N. lyrata was* taken at Station 89-A (Fig. 11), where 32.4 kg/hr (71 lb/hr) or 0.4 g/m^2 were taken. The average CPUE for this snail was 1.0 kg/hr (2 lb/hr). Other common buccinid snails were *Pyrulofusus harpa* and *Colus halli.*

The Oregon triton (*Fusitriton oregonensis*), family Cymatiidae, was another widespread and important gastropod (Fig. 12). It was most abundant at Station 74-C, where the density was 0.4 g/m^2 or 4.5 kg (10 lb) taken in a 35-minute (nonstandard) tow. The average CPUE for this snail was 1.0 kg/hr (2 lb/hr).

Two areas of biological interest in terms of species composition and diversity encompassed Stations 74-C and D, and Stations 94-A and B (Fig. 1). Stations 74-C and D contained seven species of fishes (*Hippoglossus stenolepis, Bathymaster signatus,*

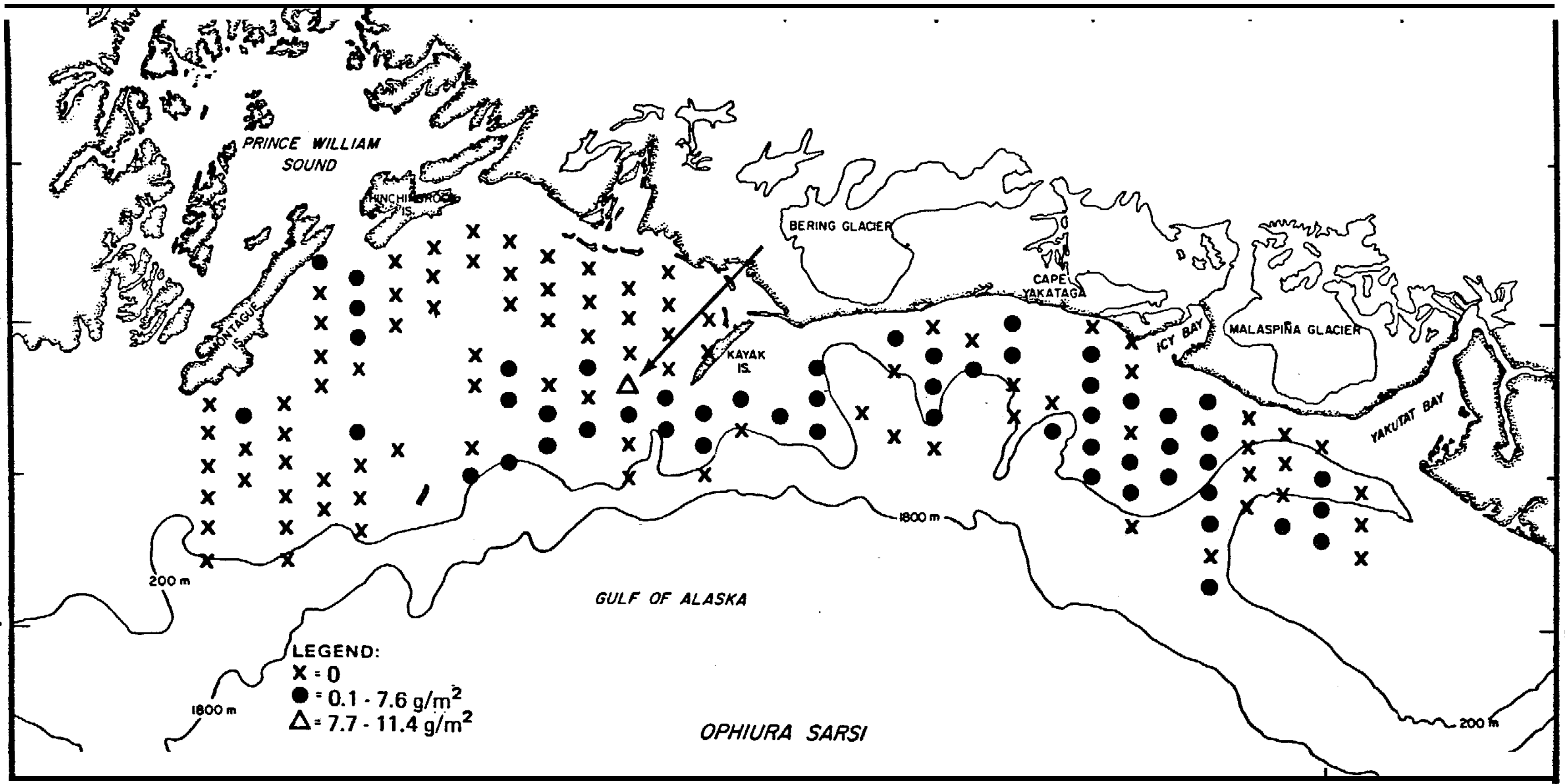

Figure 5.—Brittle star (*Ophiura sarsi*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *O. sarsi*.

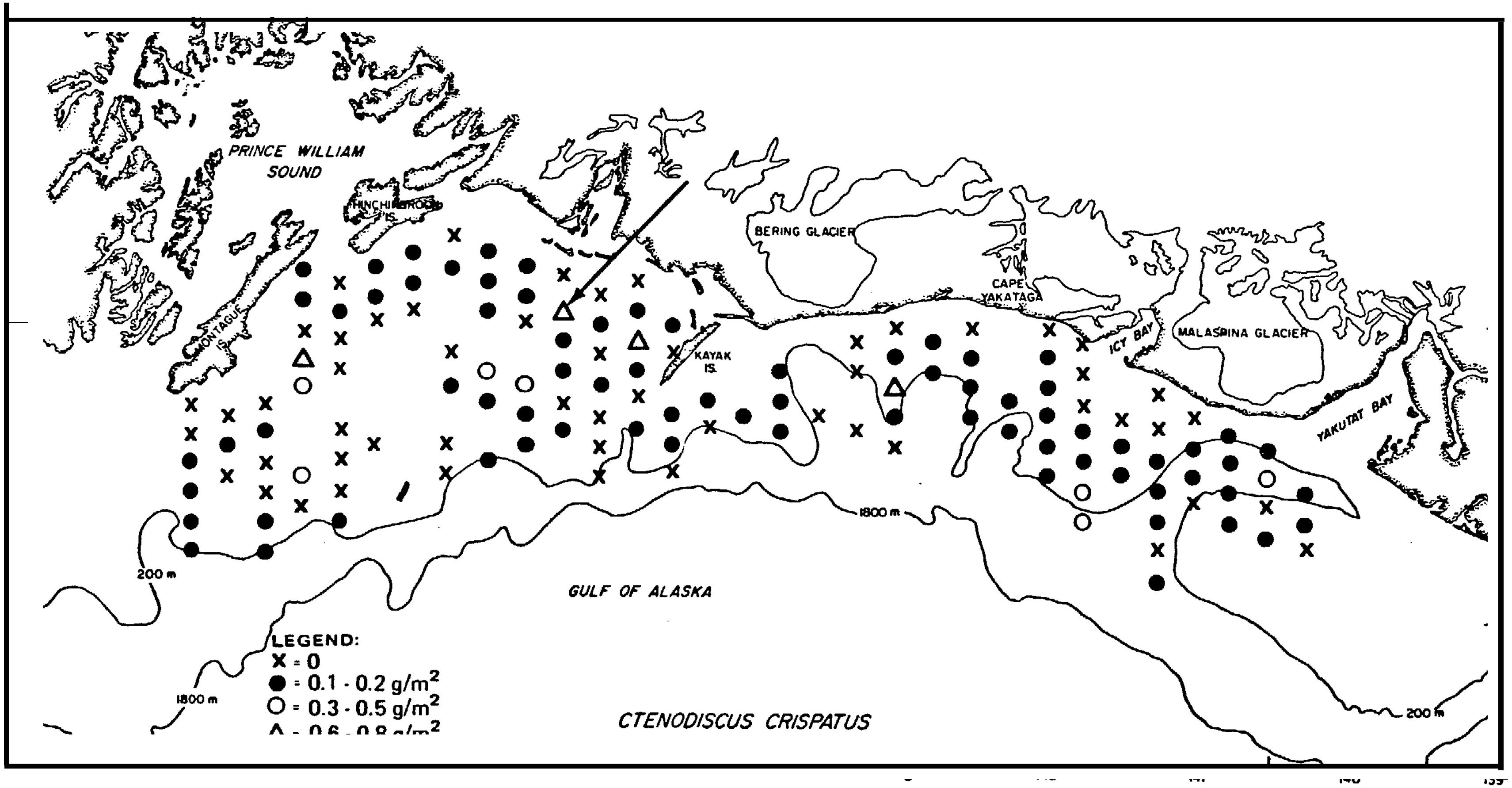

Figure 6.—Sea star (*Ctenodiscus crispatus*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *C. crispatus*.

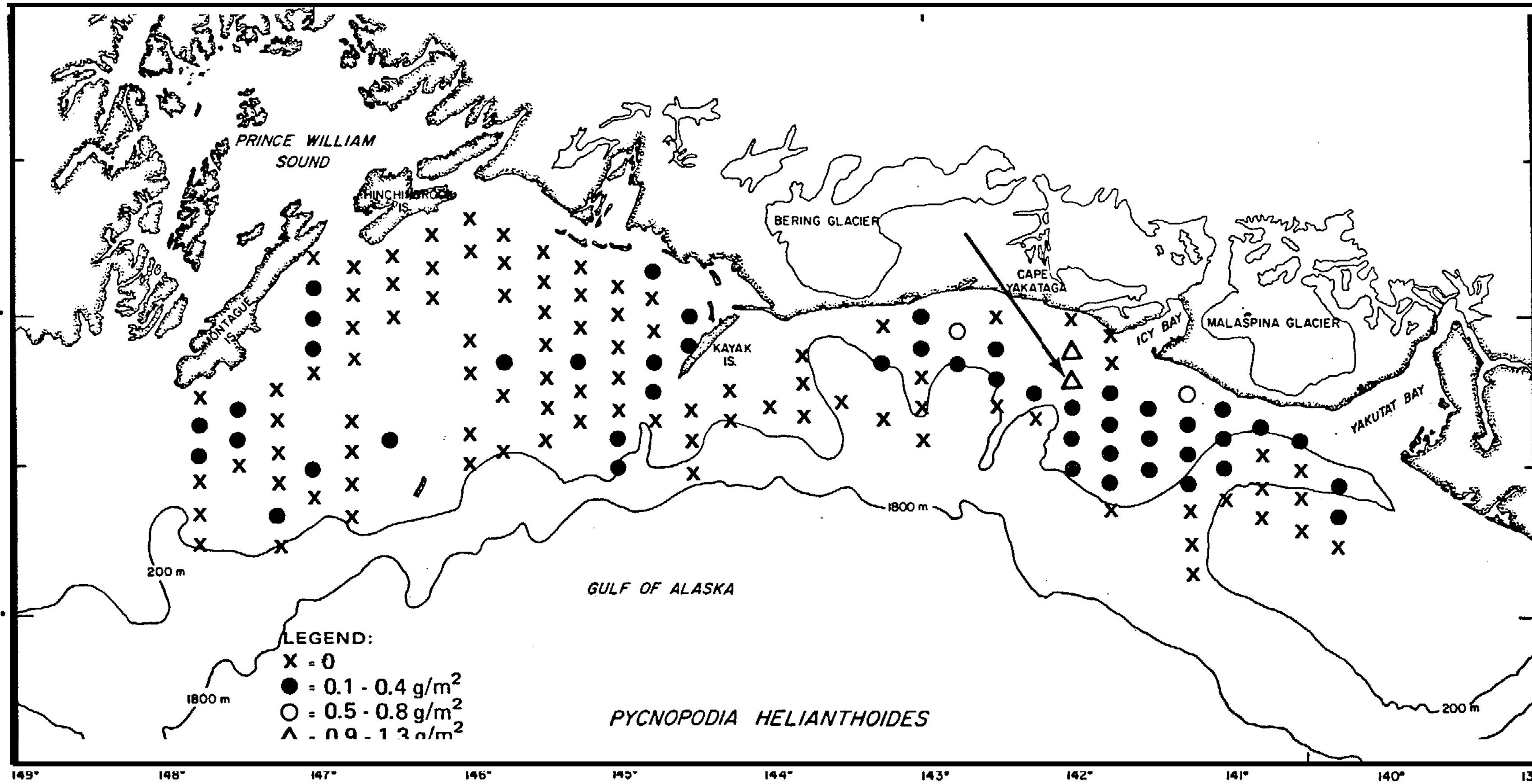

Figure 7.—Sea star (*Pycnopodia helianthoides*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *P. helianthoides*.

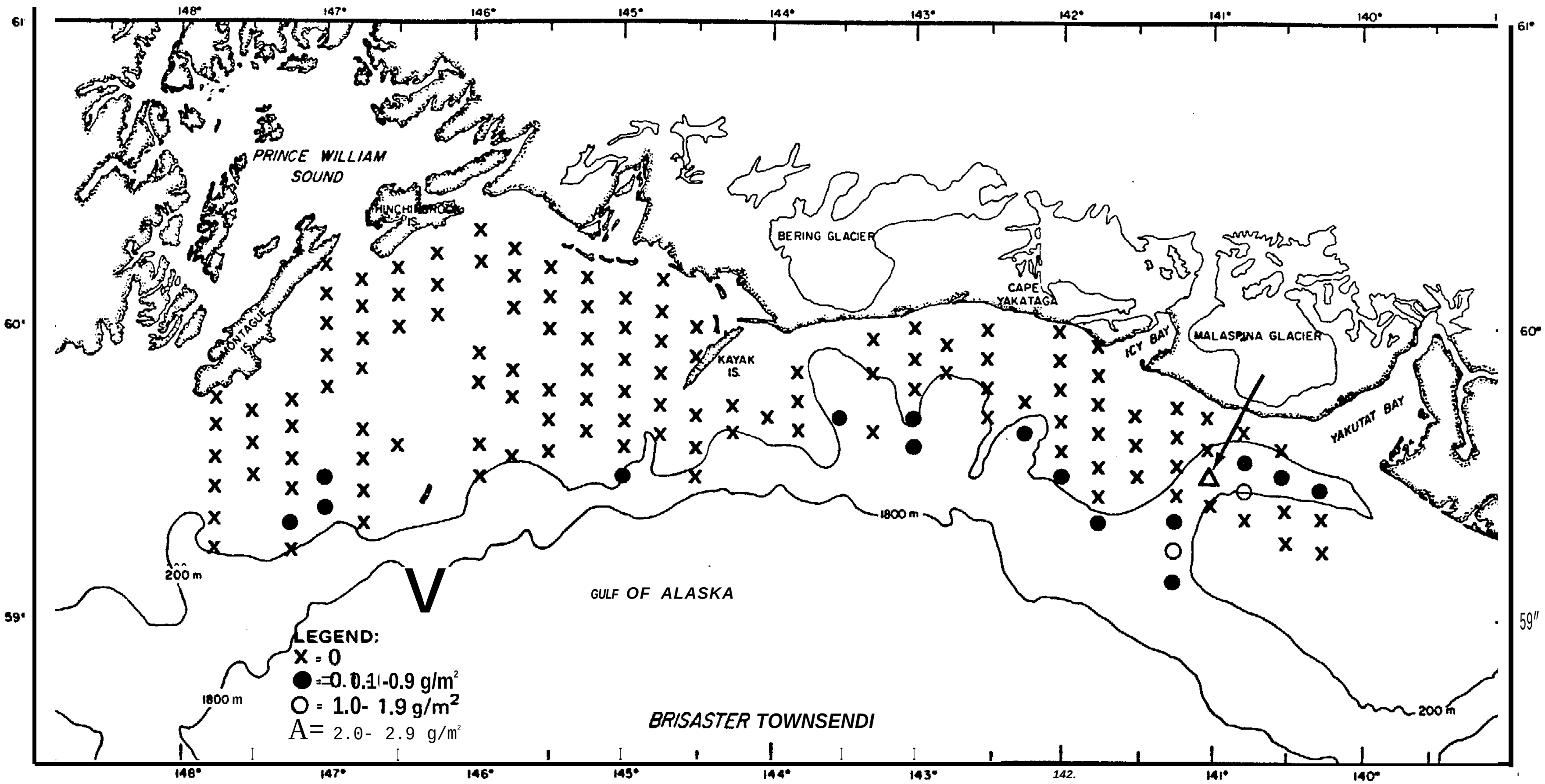

Figure 8.—Heart urchin (*Brisaster townsendi*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *B. townsendi.*

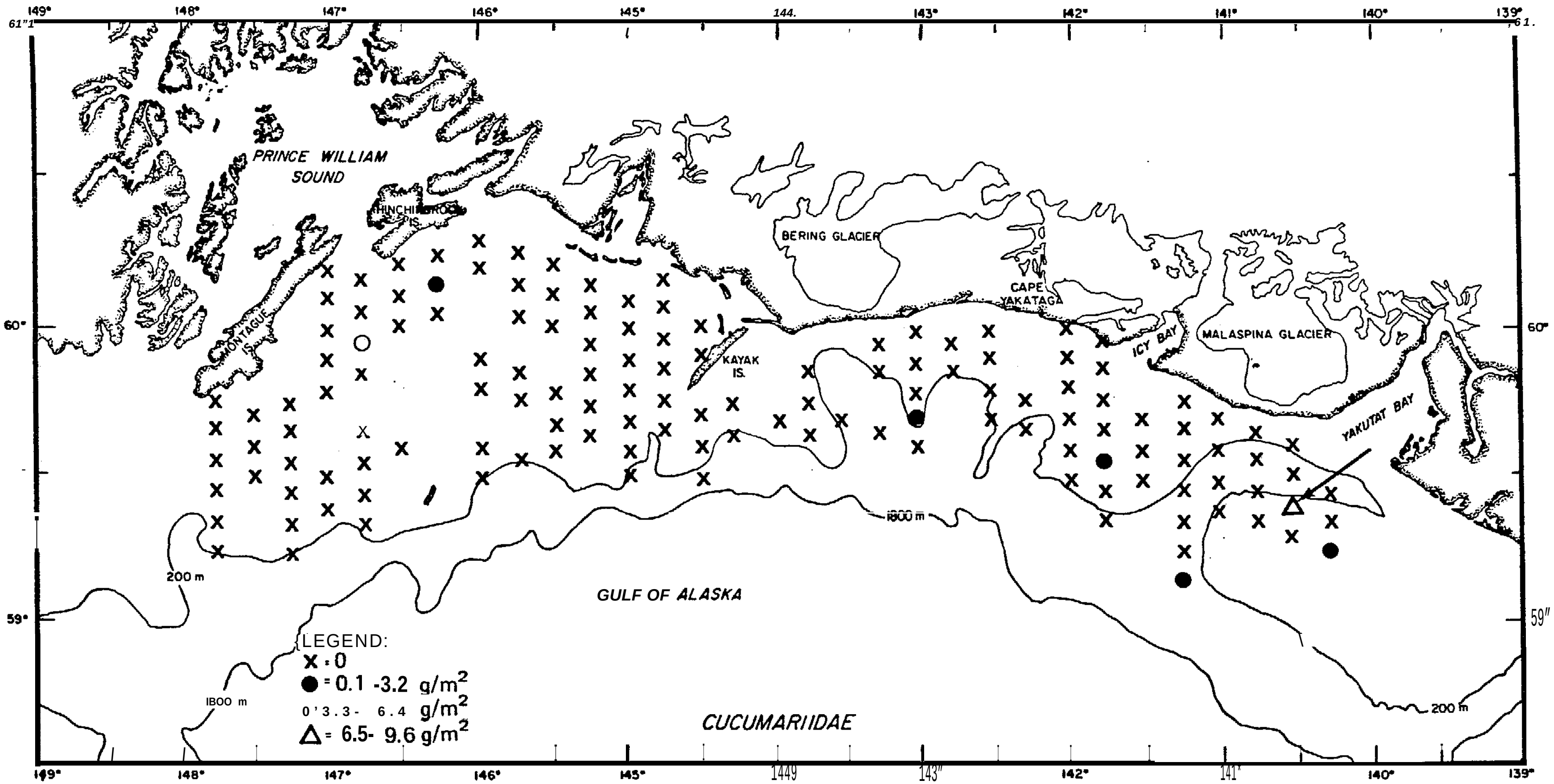

Figure 9.—Sea cucumber (Family Cucumariidae) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of Cucumariidae.

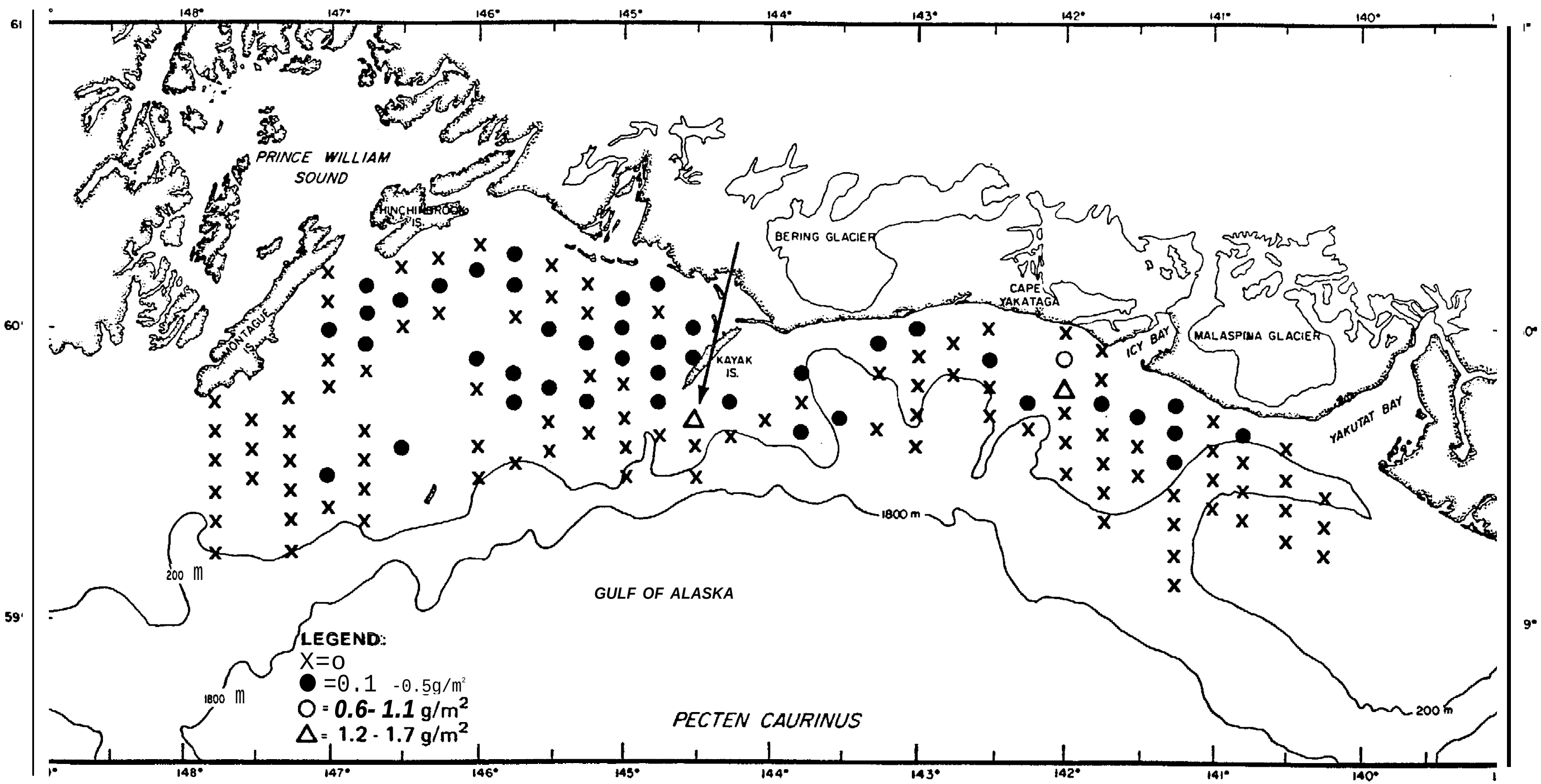

Figure 10.—Scallop (*Pecten caurinus*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *P. caurinus*.

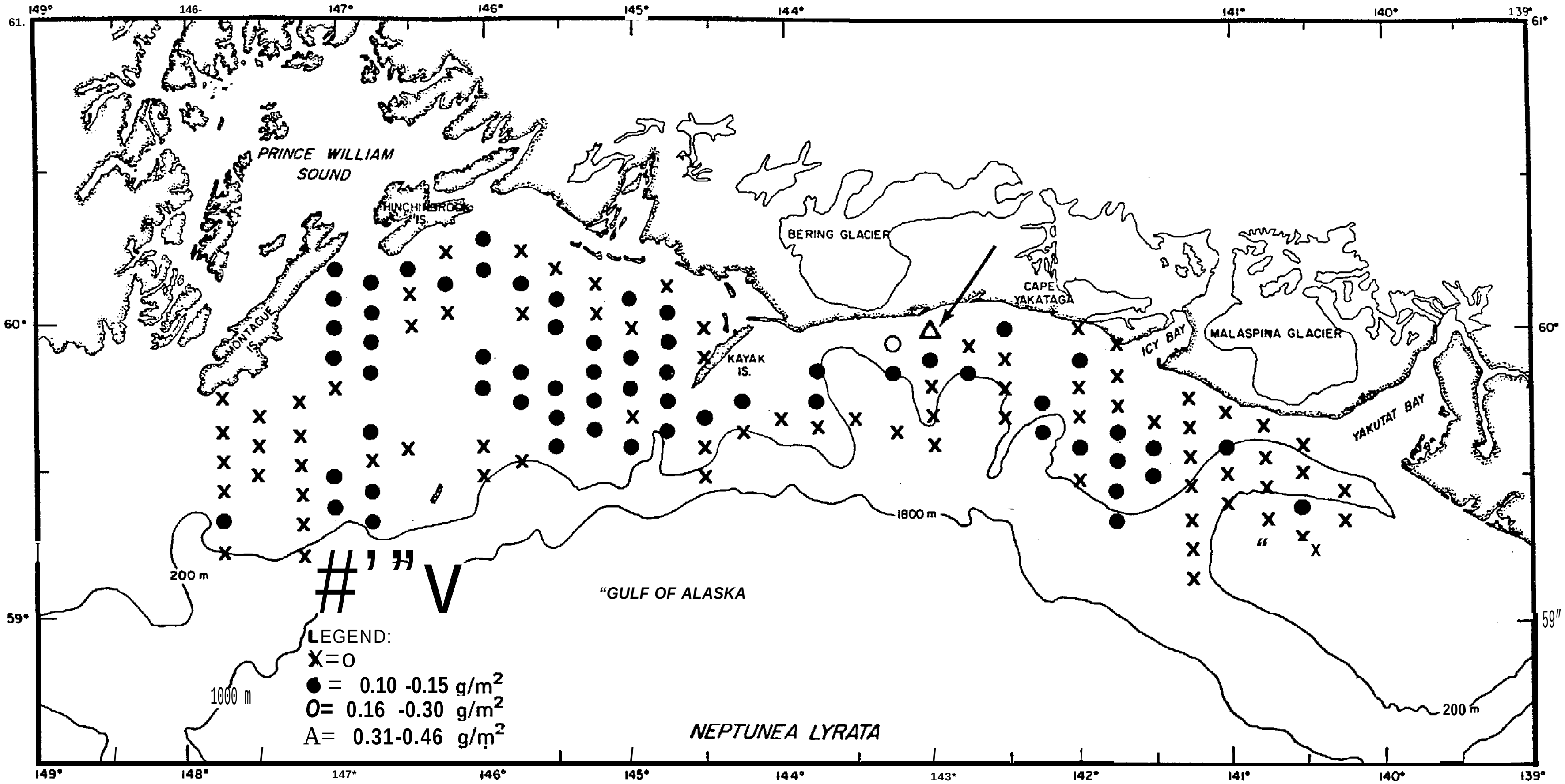

Figure Il.-Snail (*Neptunea lyrata*) distribution and abundance, northeastern Gulf of Alaska trawl survey, summer 1975. Arrow indicates highest density of *N. lyrata.*

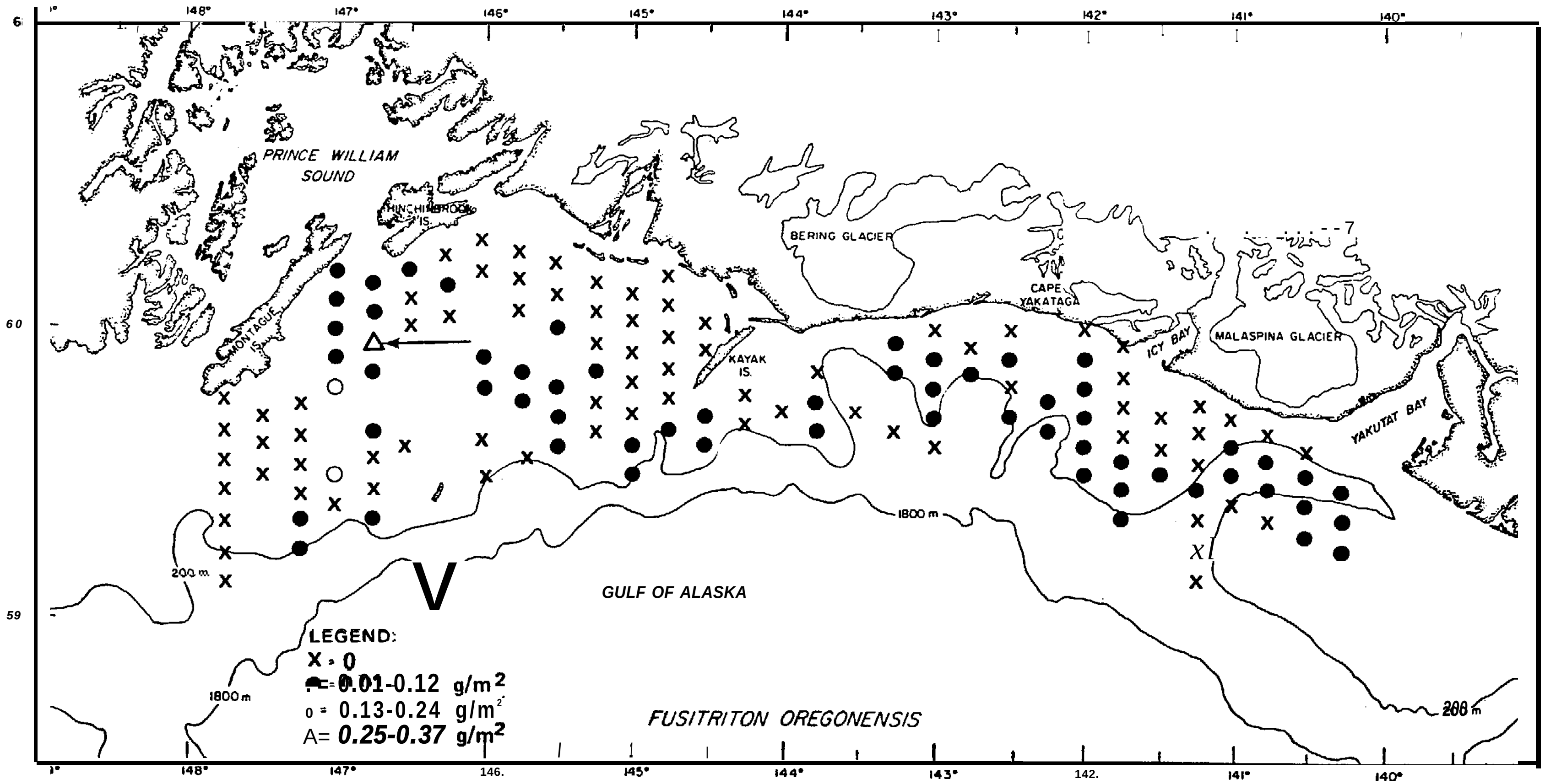

Figure 12.—Oregon triton (*Fusitriton oregonensis*) distribution and abundance, northeastern Gulf of Alaska, summer 1975. Arrow indicates highest density of F. *oregonensis.*

Lepidopsetta bilineata, Gadus macrocephalus, Hemilepidotus jordani, Atheresthes stomias, and *Glyptocephalus zachirus*), and had the highest diversity of invertebrates of all of the stations sampled. Crustaceans (14 species), echinoderms (13 species), and molluscs (13 species) made up 85% of the 47 species found there. The biomass of the ascidian *Halocynthia helgendorfi igaboja* at Station 74-C was 4.5 g/m^2 or 419.8 kg (925 lb) taken per hour. The Pacific halibut, *Hippoglossus stenolepis,* dominated the fish catch at Station 74-C; 1,299 kg (3,084 lb) were taken per hour, and each fish averaged 18.5 kg (41 lb). Stations 94-A and B, off Icy Bay, were characterized by an abundance of three species of fishes (*Platichthys stellatus, Theragra chalcogramma,* and *Isopsetta isolepis*), and the near-absence of epifaunal invertebrates. Although the number of fish species was low, biomass was high. At Station 94-B, 4,309 kg (9,499 lb) of fish were taken in the l-hour tow.

Feeding Observations

Limited observations on the food habits of three species of sea stars and two species of flatfishes were made in the study area (Table 4).

The forcipulate sea star *Pycnopodia helianthoides, a* predatory echinoderm, was the most commonly encountered member of the family Asteridae. We examined 86 specimens for feeding habits; 69 (80.2%) had been feeding. By frequency of occurrence, the brittle star *Ophiura sarsi was* the dominant prey species found in 39.l% of the *Pycnopodia* stomachs examined (Table 4). The sea star *Ctenodiscus crispatus* occurred in 18.8% of the stomachs examined, and was second in importance as a prey species. Seventy-eight percent of the stations at which *Pycnopodia was* found also contained C. *crispatus* and/or O. *sarsi.* Other prey consumed by *Pycnopodia,* in order of dimishing frequency of occurrence, were the gastropod *Colus halli, Mitrella gouldi, Solariella obscura, Oenopota* sp., and *Natica clausa,* and the pelecypods *Serripes groenlandicus* and *Clinocardium ciliatum.*

Ctenodiscus crispatus, a non-selective deposit feeder, was typically found with its stomach full of sediment.

Three specimens of *Luidia foliolata,* a moderately sized (to 12 inches in diameter) sea star, were examined. The brittle star *Ophiura sarsi* and an unidentified polychaetous annelid were found in the stomachs of *Luidia. Ophiura sarsi was* also found in the stomach of the rose star (*Crossaster papposus*).

Starry flounders (*Platichthys stellatus*) dominated the catch off Icy Bay (Stations 94-A and B) (Fig. 1). The stomachs of 30 of them were examined, All of the starry flounders had been feeding heavily on three species of clams: *Yoldia seminuda, Siliqua alta,* and *Macoma dexiosttera.* All stomachs were full.

Table 4. —Stomach contents of selected epifaunal invertebrates and fishes from the northeast Gulf of Alaska, 25 April-7 August 1975.

Predator		Percent frequency of occurrence: % of feeding fishes	% of total fishes
Pycnopodia helianthoides (twenty-rayed star)			
Stomachs examined: 86			
Stomachs with food: 69		.	80.2
Stomach contents:	*Ophiura sarsi* (27)	39.1	31.4
	Ctenodiscus crispatus (13)	18.8	15.1
	Natica clausa (5)	7.2	5.8
	Colus halli (3)	4.3	3.5
	Cardiidae (3)	4.3	3.5
	Mitrella gouldi (3)	4,3	3.5
	Sediment (3)	4.3	3.5
	Buccinum plectrum (1)	1.4	1.2
	Solariella obscura (1)	1.4	1.2
	Oenopota sp. (1)	1.4	1.2
	Serripes groenlandicus (1)	1.4	1.2
	Clinocardium ciliatum (1)	1.4	1.2
	Lyonsiidae (1)	1.4	1.2
	Mediaster aequalis (1)	1.4	1.2
	Gorgonocephalus caryi (1)	1.4	1.2
	Unidentified gastropoda (1)	1.4	1.2
	Unidentified pelecypoda (1)	1.4	1.2
	Unidentified ophiuroidea (1)	1.4	1.2
Luidia foliolata (sea star)			
Stomachs examined: 3			
Only stomachs with food recorded			
Stomach contents:	*Ophiura sarsi* (2)	66.6	66.6
	Unidentified polychaeta (1)	33.3	33.3
Crossaster papposus (rose star)			
Stomachs examined: 1			
Only stomachs with food recorded			
Stomach contents:	*Ophiura sarsi*	100	100
Platichthys stellatus (starry flounder)			
Stomachs examined: 30			
Stomachs with food: 30			100
Stomach contents:	*Yoldia seminuda* (30)	100	100
	Siliqua sloati (30)	100	100
	Macoma dexiosttera (30)	100	100
Hippoglossoides elassodon (flathead sole)			
Stomachs examined: 2			
Stomachs with food: 2			100
Stomach contents:	*Ophiura sarsi*	100	100

Another common flatfish in NEGOA, the flathead sole (*Hippoglossoides elassodon*), was feeding on *Ophiura sarsi*.

Pollutants Taken by Trawl

Pollutants were recorded on the first two legs of the MV *North Pacific* cruise, which covered an area from Montague Island to Yakutat Bay. Of 58 stations, 33 (57%) contained debris which consisted primarily of plastic materials such as brown and green trash bags, pieces of clear plastic (bait wrappers), and plastic binding straps. Numerous plastics of Japanese or Korean origin were found. Other debris included tarred paper, bottles, a steel cable, rubber gloves, a rubber tire, and two derelict snow crab pots. The high frequency of occurrence of debris within the surveyed area may give some indication of the amount of pollution throughout the North Pacific (Jewett 1976).

DISCUSSION

This investigation represents the first intensive qualitative and quantitative study of the epifaunal invertebrates of the northeast Gulf of Alaska. Hitz and Rathjen (1965) surveyed bottomfishes and invertebrates of the continental shelf in the NEGOA; however, invertebrates were a secondary interest. Only major invertebrate species and/or groups were recorded. Additional data on commercially important shellfish species can be found in Ronholt et al. (1976).

The mean estimate of biomass, 2.6 g/m^2, for the northeast Gulf of Alaska is similar to estimates of 3.3 g/m^2 for the inner portion (<80 m) and 4.9 g/m^2 for the outer portion (mainly 80-400 m) of the continental shelf of the southeastern Bering Sea (Feder et al. 1978). Benthic trawl studies of Norton Sound and the Chukchi Sea–Kotzebue Sound area yielded biomass estimates of 3.7 g/m^2 and 3.3 g/m^2, respectively (Feder and Jewett 1978). Benthic investigations in NEGOA by Feder and Matheke (1979) provide biomass estimates from grab samples for infauna and small epifauna. The lowest value, 7 g/m^2, and the highest value, 638 g/m^2, differ from our estimates for NEGOA epifauna. The reason for the difference is the type of gear used. Use of a commercial bottom trawl results in the loss of many small epibenthic species, and does not usually collect infauna, both of which are important components of benthic biomass. Therefore, a more accurate estimate of benthic standing stock will always be gained by combining both grab and trawl values.

The OCSEAP trawl surveys in the southeastern Bering Sea and Norton Sound–southeastern Chukchi Sea-Kotzebue Sound areas provided extensive information on epifauna that can be compared with data from NEGOA (Jewett and Feder 1976; Ronholt et al. 1976; Feder and Jewett 1978). The southeastern Bering Sea exhibited greater epifaunal diversity (233 species) than NEGOA (168 species) and Norton Sound–Chukchi Sea–Kotzebue Sound (187 species). The northeast Gulf of Alaska epifaunal invertebrate biomass was dominated by Arthropoda (71.4 %), Echinodermata (19.0%), and Mollusca (4.6%). The biomass in the southeastern Bering Sea stations that were less than 80 m in depth was likewise dominated by Arthropoda (58.0%), Echinodermata (22. 0%), amd Mollusca (6.5%) (Feder et al. 1978). At southeastern Bering Sea stations between 80 and 400 m, the biomass was also dominated by Arthropoda (66.9%), Echinodermata (Ill%), and Mollusca (4.6%) (Feder et al 1978). In contrast, the Norton Sound region was dominated by Echinodermata (80.3%), Arthropoda (9.6%), and Mollusca (4.4%), and the Chukchi Sea-Kotzebue Sound region was dominated by Echinodermata (59.9910), Mollusca (12.8910), and Arthropoda (12.5%) (Feder and Jewett 1978). In general, arthropod biomass decreased toward higher latitudes and echinoderm biomass increased.

The highest biomass values for snow crab (*Chionoecetes bairdi*), pink shrimp (*Pandalus borealis*), common brittle star (*Ophiura sarsi*), and mud star (*Ctenodiscus crispatus*) were recorded southeast of Kayak Island, in the vicinity of the Copper River delta (Fig. 1). Large concentrations of fishes were also present in this area (see Ronholt et al. [1976] for distribution and density data for fishes there). Little is known about the productivity of this area, but primary and secondary production may be higher there as a result of nutrients supplied by the Copper River. Enhanced productivity may be related to the presence of gyres that extend vertically from the ocean surface to the bottom (Gait 1976).

The two dominant arthropods—snow crab (*Chionoecetes bairdi*) and pink shrimp (*Pandalus borealis*)—are widespread and commercially important in the northeast Gulf of Alaska. Snow crabs are a major food of the Pacific cod (*Gadus macrocephalus*) (Feder 1977a; Jewett 1978) and sculpins (*Myoxocephalus* spp.) (Jewett and Powell, unpubl. data). Pink shrimp are also a major food of the Pacific cod (Feder 1977a; Jewett 1978) as well as of the turbot (*Atheresthes stomias*) and the rex sole (*Glyptocephalus zachirus*) (Smith et al. 1978).

Although determination of the food of snow crabs was not a part of the NEGOA study, inferences from other investigations suggest that food groups used by snow crabs (*Chionoecetes* spp.) are somewhat similar throughout their range. *Chionoecetes opilio* examined in the Bering Sea fed mainly on unidentified polychaetes and brittle stars, mainly *Ophiura* sp. (Feder et al, 1978). The deposit-feeding clam *Nucula tenuis* dominated the diet of C. *opilio* from Norton Sound and the Chukchi Sea (Feder and Jewett 1978). *Chionoecetes opilio* from the Gulf of St. Lawrence fed mainly on clams (*Yoldia* sp.) and polychaetes (Powles 1968). *Chionoecetes opilio elongatus* from Japanese waters fed primarily on brittle stars (*Ophiura* SP.), young C. *opilio elongatus*, and protobranch clams (Yasuda 1967). Most of the items consumed by C. *bairdi* from two bays of Kodiak Island were polychaetes, clams (Nuculanidae), shrimps, plants, and sediment (Feder and Jewett 1977). Paul et al. (1979) examined stomachs of C. *bairdi* from lower Cook Inlet and found the main items to be clams (*Macoma* spp.), hermit crabs (*Pagurus* spp.), barnacles (*Balanus* spp.), and sediment. *Chionoecetes bairdi* in Port Valdez (Prince William Sound) contained polychaetes, clams, C. *bairdi*, other crustaceans, and some detrital material (Feder, unpubl. data). Further data on the distribution and abundance of potential prey species are necessary in order to better identify food species for better comparison of food from different areas.

The large sea star *Pycnopodia helianthoides* preyed almost entirely upon gastropod molluscs and echinoderms, *Pycnopodia* examined in Kodiak shallow waters preyed mainly on gastropod and pelecypods (Feder and Jewett, unpubl. data). Intertidal and shallow subtidal *P. helianthoides* from Prince William Sound were found to feed primarily on small bivalve molluscs (Paul and Feder 1975). This sea star is also capable of excavating for large clams (Mauzey et al. 1968; Paul and Feder 1975). Scuba divers have observed king crabs feeding on *Pycnopodia* near Kodiak Island (S. Jewett and G. Powell, pers. observ.).

The mud star (*Ctenodiscus crispatus*) and the heart urchin (*Brisaster townsendi*) were encountered in large numbers within the study area. Both of these echinoderms use carbon associated with bottom sediments as their major source of nutrition (Feder, unpubl. data). As deposit feeders, *Ctenodiscus* and *Brisaster* continuously rework and ingest sediments, and probably have an important role in recycling nutrients. A large proportion of the NEGOA infaunal species is composed of deposit feeders (Matheke et al. 1978).

The feeding habits of the common brittle star (*Ophiura sarsi*) probably include browsing, detritus feeding, and prey-capture techniques (Gentleman 1964; Kyte 1969). A few O. *sarsi* examined in NEGOA, the southeastern Bering Sea, and Port Valdez (Prince William Sound) mainly contained detrital material and sediment but also fragments of various small benthic invertebrates (Feder, unpubl. data). In turn, this brittle star is important food for the clover sole (*Microstomus pacificus*) and the flathead sole (*Hippoglossoides elassodon*) (Smith et al. 1978).

All of the specimens of the starry flounder (*Platichthys stellatus*) examined in this study had been feeding intensively and exclusively on three species of clams (*Yoldia seminuda*, *Siliqua sloati*, and *Macoma dexiosttera*). Clams, especially thin-shelled species, have been found to be important components in the diet of starry flounders by other investigators (Villadolid 1927; Orcutt 1950; Moiseev 1953; Miller 1965). Starry flounders from the northern Bering Sea and the southeastern Chukchi Sea were found to feed heavily on *Yoldia hyperborea* and the brittle star *Diamphiodia craterodmeta* (Feder and Jewett 1978). A definite seasonality in feeding intensity has been found to exist for this flounder: feeding stops during January through late May and resumes in late May or early June (Miller 1965; Feder and Jewett, unpubl. data). The degree of fullness of the starry flounders examined in this study may be evidence of a recently terminated fasting period. All of the specimens were taken at Stations 94-A and B on 3 June 1975. Clam populations in the Icy Bay area obviously play a vital role in the trophic dynamics of 1? *stellatus*.

CONCLUSIONS

The major limitations of the survey were those imposed by the selectivity of the otter trawl used and the seasonal movements of certain species taken. In addition, rocky-bottom areas were not sampled since otter trawls of the type used can only be fished on a relatively smooth bottom. However, the study reported here was effective for determining the epibenthic invertebrates present on sediment bottom and for achieving maximum spatial coverage of the area. This report, in conjunction with the NEGOA infaunal investigation (Feder and Matheke 1979), will enhance our understanding of the shelf ecosystem.

Availability of many readily identifiable, biologically well-understood organisms is a preliminary to the development of monitoring programs. Sizeable biomasses of taxonomically well-known mol.lusts, crustaceans, and echinoderms were typical of most of our stations, and many species of these phyla were sufficiently abundant to represent organisms potentially useful as monitoring tools. The present investigation should clarify some aspects of the biology of many of these organisms and increase the reliability of future monitoring programs for the Gulf of Alaska.

NEEDS FOR FURTHER STUDY

The extensive trawl program permitted complete coverage of the benthos for epifaunal invertebrates. However, considerable effort is still needed to understand the NEGOA benthic system. It is especially important to collect chemical, physical, and geological data in conjunction with all future biological investigations.

Selected epifaunal species should be chosen for intensive study as soon as possible so that basic information will be available to a monitoring program. Biological parameters that should be examined are reproduction, recruitment, growth, age, feeding biology, and trophic interactions with other invertebrates and vertebrates.

Grouping techniques, such as cluster or recurrent group analysis, provide methods for delineating station and species groups. The outcome of such analyses can be used to delimit areas of monitoring programs. Future application of grouping techniques to epifaunal species should be strongly encouraged.

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APPENDIX

SELECTED GULF OF ALASKA BENTHIC TRAWL STATION DATA

MAY-AUGUST 19?S

CRUISE NUMBER N0817

Appendix Table 1

TOW NUMBER 14; STATION NUMBER 74-C; PERCENT SAMPLED = 50.

(All counts and weights are projected to 100% of the sample).

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
7 5 5 8	1400	58 57.0	146 45.0	59 59.0	146 43.0	35	9	4.44	63.7-67.3

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Porifera	6.0	0.1	1.4	2700.0	0.6	608.1
Ptilosarcus gurneyi	46.0	0.7	10.4	2760.0	0.7	621.6
Actiniidae	12.0	0.2	2.7	2400.0	0.6	540.5
Modiolus modiolus	20.0	0.3	4.5	2200.0	0.5	495.5
Chlamys hastata hericia	400.0	6.3	90.1	3200.0	0.8	720.7
Pecten caurinus	12.0	0.2	2.7	1320.0	0.3	297.3
Astarte polaris	8.0	0.1	1.8	80.0	0.0	18.0
Clinocardium fucanum	2.0	0.0	0.5	8.0	0.0	1.8
Serripes groenlandicus	4.0	0.1	0.9	800.0	0.2	180.2
Lischkeia cidaris	150.0	2.4	33.8	1800.0	0.4	405.4
Fusitriton oregonensis	260.0	4.1	58.6	19940.0	4.7	4491.0
Buccinum plectrum	40.0	0.6	9.0	800.0	0.2	180.2
Neptunea lyrata	30.0	0.5	6.8	5440.0	1.3	90.1
Pyrulofusus harpa	4.0	0.1	0.9	400.0	0.1	90.1
Tritoniidae	4.0	0.1	0.9	600.0	0.1	135.1
Tochuina tetraquetra	4.0	0.1	0.9	600.0	0.1	135.1
Balanus sp.	302.0	4.7	68.0	9060.0	2.1	2040.5

Appendix Table 1 (continued)

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gm) Total	WET WEIGHT (gm) %	WET WEIGHT (gm) Per km
Pandalus montagui tridens	12. (I	0.2	2.7	96.0	0.0	21.6
Paracrangon echinata	24.0	0.4	5.4	168.0	0.0	37.8
Pagurus ochotensis	1.50.0	2.4	33.8	13600.0	3.2	3063.1
Pagurus aleuticus	12.0	0.2	2.7	1320.0	0.3	297.3
Pagurus kennerlyi	‘40.0	0.6	9.0	4520.0	1.1	1018.0
Elassochirus tenuimanus	40.0	0.6	9.0	4520.0	1.1	1018.0
Elassochirus cavimanus	38.0	0.6	8.6	4520.0	1.1	1018.0
Labidochirus sp lendescens	24.0	0.4	5.4	1200.0	0.3	270.3
Lopho lithodes foraminatus	2.0	0.0	0.5	840.0	0.2	189.2
Rhino lithodes wosnessenskii	16.0	0.3	3.6	2880.0	0.7	648.6
Oregonia gracilis	14.0	0.2	3.2	2520.0	0.6	567.6
Hyas lyratus	20.0	0.3	4.5	3620.0	0.9	815.3
Cancer oregonensis	24.0	0.4	5.4	140.0	0.0	31.5
Terebratulina unguicula	864.0	13.5	194.6	6040.0	1.4	1360.4
Laqueus californianus	864.0	13.5	194.6	6040.0	1.4	1360.4
Terebratalia transversa	864.0	13.5	194.6	6040.0	1.4	1360.4
Ceramaster paragonicus	14.0	0.2	3.2	980.0	0.2	220.7
Henricia sp.	50.0	0.8	11.3	3500.0	0.8	788.3
Henricia aspera	12.0	0.2	2.7	1200.0	0.3	270.3
Poraniopsis inflata	6.0	0.1	1.4	1320.0	0.3	297.3
Pteraster tesselatus	90.0	1.4	20.3	19800.0	4.7	4459.5
Crossaster papposus	44.0	0.7	9.9	3520.0	0.8	792.8
Solaster dawsoni	24.0	0.4	5.4	4800.0	1.1	108111
Lethasterias nanimensis	20.0	0.3	4.5	4000.0	0.9	900.9
Stylasterias forreri	16.0	0.3	3.6	640.0	0.2	144.1
Strongylocentrotus droebachiensis	496.0	7.8’	111.7	14880.0	3.5	3351.4
Gorgonocephalus caryi	12.0	0.2	2.7	480.0	0.1	108.1
Ophiura sarsi	24.0	0.4	5.4	140.0	0.0	31.5
Cucumariidae	36.0	0.6	8.1	12240.0	2.9	2756.8
Halocynthia hilgendorfi igaboja	1224.0	19.2	275.7	244940.0	57.7	55166.7

Appendix Table 1 (continued)

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
VERTEBRATES						
Bathymaster signatus				64860.0	7.1	14608.1
Hippoglossus steno lepis				816480.0	88.9	183891.9
Lepidopsetta bilineata				37180.0	4.0	8373.9

COMMENTS

Weights of hermit crabs include their shells. This tow contains many small round rocks (4 cm in diameter), weights of some asidians include several small rocks which the asidians are attached.

Appendix Table 2

TOW NUMBER 146; STATION NUMBER 74-D; PERCENT SAMPLED = 100.

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
7 5 8 6	1305	59 53.0	146 51.0	59 51.0	146 53.0	30	9	3.52	67.3 -71.0

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Ptilosarcus gurneyi	50.0	1.0	14.2	3000.0	2.0	852.3
Artonoe vittata	1.0	0.0	0.3	1.0	0.0	0.3
Nereis pelagica	2.0	0.0	0.6	20.0	0.0	5.7
Eunice valens	2.0	0.0	0.6	2.0	0.0	0.6
Modiolus modiolus	6.0	0.1	1.7	660.0	0.4	187.5
Hiatella arctica	1.0	0.0	0.3	3.0	0.0	0.9
Lischkeia cidaris	1.0	0.0	0.3	12.0	0.0	3.4
Fusitriton oregonensis	20.0	0.4	5.7	2000.0	1.4	568.2
Trophonopsis stuarti	2.0	0.0	0.6	20.0	0.0	5.7
Neptunea lyrata	20.0	0.4	5.7	3600.0	2.4	1022.7
Dorididae	40.0	0.8	11.4	6000.0	4.1	1704.5
Tritonia exsulans	2.0	0.0	0.6	300.0	0.2	85.2
Balanus hesperius	11.0	0.2	3.1	330.0	0.2	93.8
Pandalus hypsinotus	200.0	4.0	56.8	1600.0	1.1	454.5
Paracrangon echinata	1.0	0.0	0.3	7.0	0.0	2.0
Pagurus kennerlyi	20.0	0.4	5.7	2200.0	1.5	625.0
Elassochirus cavimanus	4.0	0.1	1.1	480.0	0.3	136.4
Lopholithodes foraminatus	3.0	0.1	0.9	1260.0	0.9	358.0
Hyas lyratus	9.0	0.2	2.6	1620.0	1.1	460.2
Terebratulina unguicula	1000.0	20.1	284.1	7000.0	4.8	1988.6
Laqueus californianus	1000.0	20.1	284.1	7000.0	4.8	1988.6

Appendix Table 3

TOW NUMBER 35; STATION NUMBER 80-B; PERCENT SAMPLED = 65.

(All counts and weights are projected to 100% of the sample).

Date Yr Mo Da	Time Hr/Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
75 5 24	1055	60 6.0 .	145 20.0	60 5.0	145 13.0	60	9	5.55	91.0-112.8

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Ptilosarcus gurneyi	173.8	2.7	31.3	10446.2	3.0	1882.2
Buccinum plectrum	4.6	0.1	0.8	92.3	0.0	16.6
octopus sp.	6..2	0.1	1.1	200.0	0.1	36.0
Pagurus ochotensis	6.2	0.1	1.1	553.8	0.2	99.8
Chionoecetes bairdi	615.4	9.6	110.8	279138.5	80.6	50295.2
Ctenodiscus crispatus	5581.5	87.4	1005.7	55815.4	16.1	10056.8
VERTEBRATES						
Gadus macrocephalus				55123.1	16.1	9932.1
Theragra chalcogramma				170261.5	49.7	30677.8
Atheresthes stomias				68384.6	20.0	12321.6
Hippoglossoides elassodon				48846.2	14.3	8801.1

COMMENTS

Weight of hermit crab includes their shells. Plastic found.

Appendix Table 4

TOW NUMBER 110; STATION NUMBER 81-D; PERCENT SAMPLED = 40.

(All counts and weights are projected to 100% of the sample).

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
75 7 15	1305	59 49.0	145 0	59 46.0	145 2.0	60	9	5.37	182.0-193.0

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Actiniidae	2.5	0.0	0.5	500.0	0.0	93.1
Neptunea lyrata	2.5	0.0	0.5	450.0	0.0	83.8
Neptunea pribiloffensis	117.5	0.1	21.9	21150.0	1.5	3938.5
Tritonia exsulans	50.0	0.0	9.3	7500.0	0.5	1396.6
Gonatidae	2.5	0.0	0.5	50.0	0.0	9.3
octopus Sp.	2.5	0.0	0.5	225.0	0.0	41.9
Pandalus borealis	125.0	0.1	23.3	1000.0	0.1	186.2
Pandalopsis dispar	50.0	0.0	9.3	500.0	0.0	93.1
Pagurus aleuticus	25.0	0.0	4.7	275.0	0.0	51.2
Chionoecetes bairdi	1300.0	1.0	242.1	585000.0	42.3	108939.5
Pseudarchaster parelii	2.5	0.0	0.5	225.0	0.0	41.9
Ctenodiscus crispatus	1562.5	1.2	291.0	15625.0	1.1	2909.7
Ophiura sarsi	125000.0	97.5	23277.5	750000.0	54.2	139664.8
VERTEBRATES						
Raja rhina				32875.0	8.4	6122.0
Gadus macrocephalas				79375.0	20.3	14781.2
Sebastolobus alascanus				17575.0	4.5	3272.8

Appendix Table 4 (continued)

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
Anoplopoma fimbria				19275.0	4.9	3589.4
Atheresthes stomias				46475.0	11.9	8654.6
Glyptocephalus zachirus				92975.0	23.8	17313.8
Hippoglossoides elassodon				2825.0	0.7	526.1
Microstomus pacificus				99775.0	25.5	18580.1

COMMENTS

Hermit crabs weighed with shell. Pollutants were not recorded.

Appendix Table 5

TOW NUMBER 106; STATION NUMBER 82-A; PERCENT SAMPLED = 50.

(All counts and weights are projected to 100% of the sample).

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
75 7 14	1300	60 7.0	144 46.0	60 6.0	144 41.0	55	9	3.70	49.1-51.0

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gm) Total	WET WEIGHT (gm) %	WET WEIGHT (gm) Per km
INVERTEBRATES						
Ptilosarcus gurneyi	324.0	10.7	87.6	19440.0	2.1	5254.1
Actiniidae	2.0	0.1	0.5	400.0	0.0	108.1
Nuculana fossa	8.0	0.3	2.2	8.0	0.0	2.2
Pecten caurinus	4.0	0.1	1.1	1400.0	0.1	378.4
Tritonia exsulans	2.0	0.1	0.5	300.0	0.0	81.1
Pandalus borealis	600.0	19.9	162.2	4800.0	0.5	1297.3
Pandalus hypsinotus	36.0	1.2	9*7	280.0	0.0	75.7
Eualis barbata	2.0	0.1	0.5	14.0	0.0	3.8
Eualis suckleyi	2.0	0.1	0.5	14.0	0.0	3.8
Crangon communis	4.0	0.1	1.1	28.0	0.0	7.6
Pagurus ochotensis	6.0	0.2	1.6	540.0	0.1	145.9
Chionoecetes bairdi	1984.0	65.8	536.3	892800.0	95.2	241297.3
Cancer magister	34.0	1.1	9.2	15300.0	1.6	4135.1
Pycnopodia helianthoides	6.0	0.2	1.6	2700.0	0.3	729.7
VERTEBRATES						
Theragra chalcogramma				32200.0	17.2	8702.7
Anoplopoma fimbria				4080.0	2.2	1102.7

Appendix Table 5 (continued)

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
Agonus acipenserinus				15860.0	8.5	4286.5
Lumpenus sagitta				6160.0	3.3	1664.9
Atheresthes stomias				70760.0	37.9	19124.3
Hippoglossoides elassodon				57700.0	30.9	15594.6

COMMENTS

Hermit crabs weighed with shell. *Pycnopodia helianthoides* feeding on *Mitrella gouldi*. pollutants were not recorded.

Appendix Table 6

TOW NUMBER 104; STATION NUMBER 83-c; PERCENT SAMPLED = 10.

(All counts and weights are projected to 100% of the sample).

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
75 7 14	0745	59 52.0	144 38.0	59 56.0	144 34.0	60	9	5.55	54.6-54.6

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Ptilosarcus gurneyi	222.0	1.0	39.6	13200.0	3.0	2378.4
Nuculana fossa	30.0	0.1	5.4	30.0	0.0	5.4
Pecten caurinus	30.0	0.1	5.4	10500.0	2.4	1891.9
Balanus herperius	10.0	0.0	1.8	300.0	0.1	54.1
Pandalus borealis	20970.0	95.8	3778.4	167700.0	38.5	30216.2
Pandalus hyspinotus	“30.0	0.1	5.4	240.0	0.1	43.2
Eualis suckleyi	30.0	0.1	5.4	210.0	0.0	37.8
Lopholithodes foraminatus	10.0	0.0	1.8	4200.0	1.0	756.8
Chionoecetes bairdi	500.0	2.3	90.1	225000.0	51.6	40540.5
Cancer magister	10.0	0.0	1.8	4500.0	1.0	810.8
Pycnopodia helianthoides	20.0	0.1	3.6	9000.0	2.1	1621.6
Strongylocentrotus droebachiensis	30.0	0.1	5.4	900.0	0.2	162.2
Molpadia sp.	10.0	0.0	1.8	200.0	0.0	36.0
VERTEBRATES						
Raja binoculata				226800.0	52.1	40864.9
Theragra chalcogramma				54430.0	12.5	9807.2

Appendix Table 6 (continued)

TAXON	COUNT			WET WEIGHT (gm)		
	No.	%	Per km	Total	%	Per km
Anoplopoma fimbria				22600.0	5.2	4072.1
Atheresthes stomias				104320.0	24.0	18796.4
Hippoglossus stenolepis			,-	27210.0	6.3	4902.7

Appendix Table 7

TOW NUMBER 142; STATION NUMBER 83-E; PERCENT SAMPLED = 100.

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
7 5 8 4	0800	59 43.0	144 37.0	59 41.0	144 33.0	60	9	5.55	129.2 -131.0

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Porifera	0.0	0.0	0.0	7900.0	4.7	1423.4
Nereis pelagica	1.0	0.0	0.2	10.0	0.0	1.8
Nereis vexillosa	1.0	0.0	0.2	10.0	0.0	1.8
Hirudinae	1.0	0.0	0.2	2.0	0.0	0.4
Mytilus edulis	100.0	2.4	18.0	2000.0	1.2	360.4
Pecten caurinus	330.0	7.8	59.5	115500.0	68.9	20810.8
Hiatella arctica	‘1.0	0.0	0.2	3.0	0.0	0.5
Fusitriton oregonensis	6.0	0.1	1.1	600.0	0.4	108.1
Buccinum plectrum	1.0	0.0	0.2	20.0	0.0	3.6
Neptunea *lyrata*	4.0	0.1	0.7	720.0	0.4	129.7
Pyrulofusus harpa	1.0	0.0	0.2	100.0	0.1	18.0
octopus sp.	1.0	0.0	0.2	90.0	0.1	16.2
Lepas *pectinata pacifica*	1.0	0.0	0.2	30.0	0.0	5.4
Pandalus borealis	1100.0	26.1	198.2	8800.0	5.2	1585.6
Crangon communis	3.0	0.1	0.5	21.0	0.0	3.8
Argis dentata	1.0	0.0	0.2	7.0	0.0	1.3
Pagurus aleuticus	29.0	0.7	5.2	3190.0	1.9	574.8
Pagurus confragosus	12.0	0.3	2.2	1320.0	0.8	237.8
Elassochirus cavimanus	1.0	0.0	0.2	120.0	0.1	21.6
Hyas lyratus	6.0	0.1	1.1	1080.0	0.6	194.6

Appendix Table 7 (continued)

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gm) Total	WET WEIGHT (gm) %	WET WEIGHT (gm) Per km
Chionoecetes bairdi	17.0	0.4	3.1	7650.0	4.6	1378.4
Pseudarchaster pare lii	1.0	0.0	0.2	90.0	0.1	16.2
Ctenodiscus crispatus	600.0	14.2	108.1	6000.0	3.6	1081.1
Henricia aspera	1.0	0.0	0.2	100.0	0.1	18.0
Gorgonocephalus caryi	1.0	0.0	0.2	380.0	0.2	68.5
Ophiura sarsi	2000.0	27.4	360.4	12000.0	7.2	2162.2
VERTEBRATES						
Raja kincaidi				2270.0	1.2	409.0
Raja rhina				3860.0	2.1	695.5
Thaleichthys pacificus				1360.0	0.7	245.0
Theragra chalcogramma				47170.0	25.9	8499.1
Ulca bolini				4540.0	2.5	818.0
Atheresthes stomias				82560.0	45.3	14875.7
Glyptocephalus zachirus				19500.0	10.7	3513.5
Hippoglossoides elassodon				5900.0	3.2	1063.1
Microstomus pacificus				14970.0	8.2	2697.3

COMMENTS

C. bairdi sexed, 12 males, 2 nongravid females, 3 gravid females. *Mytilus edulis* attached to Kelp holfast. Hermit crabs weighed with shell. Pollutants were not recorded.

Appendix Table 8

TOW NUMBER 42; STATION NUMBER 86-D; PERCENT SAMPLED = 100.

Date			Time	Start				Finish				Time Fished	Time	Distance Fished	Depth Fished
				Latitude		Longitude		Latitude		Longitude					
Yr	Mo	Da	Hr /Min	Deg	Min	Deg	Min	Deg	Min	Deg	Min	Min	Zone	(h)	(m)
75	5	30	1240	59	40.0	143	44.0	59	41.0	143	47.0	65	9	7.22	127.4 -140.1

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Notostomobdella sp.	1.0	2.7	0.1	2.0	0.0	0.3
Pecten caurinus	1.0	0.2	0.1	350.0	1.0	48.5
Astarte polaris	90.0	17.6	12.5	900.0	2.5	124.7
Fusitriton oregonensis	4.0	0.8	0.6	400.0	1.1	55.4
Pyrulofusus harpa	1.0	0.2	0.1	100.0	0.3	13.9
Arctomelon stearnsii	1.0	0.2	0.1	180.0	0.5	24.9
octopus sp.	1.0	0.2	0.1	90.0	0.2	12.5
Eualis barbata	8.0	1.6	1.1	56.0	0.2	7.8
Lopholithodes foraminatus	55.0	10.7	7.6	25400.0	70.2	3518.0
Chionoecetes bairdi	45.0	8.8	6.2	5890.0	16.3	818.8
Laqueus californianus	5.0	1.0	0.7	15.0	0.0	2.1
Ctenodiscus crispatus	136.0	26.6	18.8	1360.0	3.8	188.4
Allocentrotus fragilis	13.0	2.5	1.8	520.0	1.4	72.0
Strongylocentrotus droebachiensis	1.0	0.2	0.1	30.0	0.1	4.2
Ophiura sarsi	150.0	29.3	20.8	900.0	2.5	124.7
VERTEBRATES						
Atheresthes stomias				249480.0	57.2	34554.0

Appendix Table 8 (continued)

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
VERTEBRATES (cent inued)						
Hippoglossoides elassodon				186880.0	42.8	25883.7

COMMENTS

Lopholithodes foraminatus - 48 males and 7 females

Appendix Table 9

TOW NUMBER 100; STATION NUMBER 89-A; PERCENT SAMPLED = 100.

Date	Time	Start Latitude	Start Longitude	Finish Latitude	Finish Longitude	Time Fished	Time	Distance Fished	Depth Fished
Yr Mo Da	Hr /Min	Deg Min	Deg Min	Deg Min	Deg Min	Min	Zone	(km)	(m)
75 7 12	1455	60 1.0	143 1.0	60 0.	142 55.0	60	9	5.74	67.3 -71.0

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
Eunoe depressa	1.0	0.2	0.2	1.0	0.0	0.2
Aphrodita sp.	2.0	0.3	0.3	12.0	0.0	2.1
Aphrodita japonica	1.0	0.2	0.2	10.0	0.0	1.7
Nuculana fossa	13.0	2.1	2,.3	13.0	0.0	2.3
Pecten caurinus	3.0	0.5	0.5	1050.0	0.9	182.9
Astarte polaris	12.0	2,0	2.1	120.0	0.1	20.9
Natica clausa	3.0	0.5	0.5	36.0	0.0	6.3
Polinices monteronis	2.0	0.3	0.3	80.0	0.1	13.9
Buccinum plectrum -	2.0	0.3	0.3	40.0	0.0	7.0
Beringius kennicotti	45.0	7.3	7.8	4950.0	4*3	862.4
Colus halli	2.0	0.3	0.3	36.0	0.0	6.3
Neptunea lyrata	180.0	29.3	31.4	32400.0	28.1	5644.6
Neptunea pribiloffensis	2.0	0.3	0.3	360.0	0.3	62.7
Pagurus ochotensis	39.0	6.3	6.8	3510.0	3.0	611.5
Pagurus aleuticus	24.0	3.9	4.2	2640.0	2.3	459.9
Pagurus kennerly	12.0	2.0	2.1	1320.0	1.1	230.0
Pagurus confragosus	130.0	21.1	22.6	14300.0	12.4	2491.3
Elassochirus tenuimanus	11.0	1.8	1.9	1320.0	1.1	230.0
Elassochirus cavimanus	4.0	0.7	0.7	440.0	0.4	76.7
Labidochirus splendescens	1.0	0.2	0.2	50.0	0.0	8.7
Oregonia gracilis	1.0	0.2	0.2	180.0	0.2	31.4
Hyas lyratus	13.0	2.1	2.3	2340.0	2.0	407.7
Chionoecetes bairdi	103.0	16.7	17.9	46350.0	40.2	8074.9

Appendix Table 9 (continued)

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
Pseudarchaster pare lii	1.0	0.2	0.2	90.0	0.1	15.7
Luidia foliolata	3.0	0.5	0.5	1350.0	1.2	235.2
Pycnopodia helianthoides	5.0	0.8	0.9	2250.0	2.0	392.0
VERTEBRATES						
Raja binoculata			-	51250.0	18.3	8928.6
Raja rhina			-	10430.0	3.7	1817.1
Raja stellulata			-	24490.0	8.7	4266.6
Gadus macrocephalas			-	91170.0	32.5	15883.3
Theragra chalcogramma			-	37190.0	13.3	6479.1
Atheresthes stomias			-	12700.0	4.5	2212.5
Glyptocephalus zachirus			-	48080.0	17.2	8376.3
Hippoglossoides elassodon			-	4980.0	1.8	867.6

COMMENTS

Hermit crabs weighed with shell. Pollutants were not recorded.

Appendix Table 10

TOW NUMBER 89; STATION NUMBER 93-C; PERCENT SAMPLED = 100.

Date	Time	Start		Finish		Time Fished	Time	Distance Fished	Depth Fished
		Latitude	Longitude	Latitude	Longitude				
Yr Mo Da	Hr /Min	Deg Min	Deg Min	Deg Min	Deg Min	Min	Zone	(km)	(m)
7 5 7 9	1550	59 51.0	142 3.0	59 50.0	141 57.0	60	9	5.55	81.9-85.5

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Actiniidae	**2.0**	0.3	0.4	180.0	0.1	32.4
Pecten caurinus	**290.0**	44.6	52.3	101500.0	52.5	18288.3
Cyclocardia ventricosa	1.0	0.2	0.2	4.0	0.0	0.7
Compsomya subdiaphana	1.0	0.2	0.2	4.0	0.0	0.7
Fusitriton oregonensis	1.0	O*2	0.2	70.0	0.0	12.6
Rocinela augustata	1.0	0.2	0.2	1.0	0.0	0.2
Pandalus borealis	1.0	0.2	0.2	4.0	0.0	0.7
Pandalus montagui tridens	6.0	0.9	1.1	50.0	0.0	9.0
Pandalus platyceros	1.0	0.2	0.2	45.0	0.0	8.1
Crangon communis	2.0	0.3	0.4	14.0	0.0	2.5
Argis ovifer	1.0	0.2	0.2	4.0	0.0	0.7
Pagurus ochotensis	1.0	0.2	0.2	90.0	0.0	16.2
Pagurus confragosus	2.0	0.3	0.4	180.0	0.1	32.4
Lopholithodes foraminatus	1.0	0.2	0.2	420.0	0.2	75.7
Chionoecetes bairdi	9.0	1.4	1.6	4050.0	2.1	729.7
Ctenodiscus crispatus	100.0	15.4	18.0	1000.0	0.5	180.2
Pycnopodia helianthoides	190.0	29.2	34.2	85500.0	44.2	15405.4
Ophiura sarsi	40.0	6.2	7.2	240.0	0.1	43.2

Appendix Table 10 (continued)

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
VERTEBRATES						
Ra ja ste l lu lata				4980.0	1.9	897.3
Gadus macrocephalas				20380.0	7.8	3672.1
Theragra cha lcogramma				138160.0	52.8	24893.7
Atheresthes stomias				59110.0	22.6	10650.5
Hippog lossoides e lassodon				17660.0	6.8	3182.0
Hippoglossus steno lepis				21290.0	8.1	3836.0

COMMENTS

Hermit crabs weighed with shells. *Pycnopodia helianthoides* feeding on *Ophiura sarsi* and *Ctenodiscus crispatus.* **Pollutants were not recorded.**

Appendix Table 11

TOW NUMBER 54; STATION NUMBER 94-A; PERCENT SAMPLED = 60.

(All counts and weights are projected to 100% of the sample).

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
7 5 6 3	0950	59 54.0	141 47.0	59 55.0	141 48.0	30	9	2.96	27'.3-29.1

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Pagurus aleuticus	6.7	50.0	2.3	750.0	20.0	253.4
Chionoecetes bairdi	3.3	25.0	1.1	1500.0	40.0	506.8
Cancer magister	3.3	25.0	1.1	1500.0	40.0	506.8
VERTEBRATES						
Theragra chalcogramma				127000.0	14.4	42905.4
Isopsetta isolepis				27200.0	3.1	9189.2
Platichthys stellatus				725750.0	82.5	245185.8

COMMENTS

All female Cancer *magister* had purple eggs with orange eyes. Weights of *Pagurus aleuticus* include their shells.

Appendix Table 12

TOW NUMBER 53; STATION NUMBER 94-B; PERCENT SAMPLED = 12.

(All counts and weights are projected to 100% of the sample).

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
7 5 6 3	0730	59 50.0	141 42.0	59 52.0	141 46.0	60	9	5.55	58.2-61.8

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Eunephthya rubiformis	0.	0.	0.	3750.0	71.4	675.7
Chionoecetes bairdi	100.0	100.0	18.0	1500.0	28.6	270.3
VERTEBRATES						
Theragra chalcogramma					12.6	98063.1
Isopsetta isolepis					5.0	38813.8
Platichthys stellatus					92.4	639534.5

COMMENTS

All *Theragra chalcogramma* was approximately 10 cm long. *Platichthys stellatus* stomachs examined - all stomachs were full of three clams, *Yoldia seminuda, siliqua sloati*, and *Macoma dexiosttera.*

Appendix Table 13

TOW NUMBER 78; STATION NUMBER 97-C; PERCENT SAMPLED = 100.

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
7 5 7 5	1410	59 30.0	141 3.0	59 32.0	140 58.0	60	8	5.93	252.9-254.8

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
Actiniidae	104.0	0.5	17.5	2630.0	1.1	443.5
Hirudinae	1.0	0.0	0.2	1.0	0.0	0.2
Fusitriton oregonensis	70.0	0.3	11.8	850.0	0.4	143.3
Neptunea pribiloffensis	7.0-	0.0	1.2	1040.0	0.4	175.4
Tritonia exsulans	91.0	0.4	15.3	1365.0	5.7	2301.9
Gonatidae	12.0	0.1	2.0	270.0	0.1	45.5
octopus Sp.	1.0	0.0	0.2	90.0	0.0	15.2
Pandalopsis dispar	10.0	0*0	1.7	450.0	0.2	75.9
Eualis barbata	1.0	0.0	0.2	4.0	0.0	0.7
Eualis macrophthalma	21.0	0.1	3.5	180.0	0.1	30.4
Crangon communis	21.0	0.1	3.5	140.0	0.1	23.6
Pagurus confragosus	4.0	0.0	0.7	440.0	0.2	74.2
Chionoecetes bairdi	2.0	0.0	0.3	450.0	0.2	75.9
Hippasterias spinosa	1.0	0.0	0.2	220.0	0.1	37.1
Pseudarchaster parelii	16.0	0.1	2.7	1450.0	0.6	244.5
Ctenodiscus crispatus	80.0	0.4	13.5	1350.0	0.5	227.7
Pycnopodia helianthoides	3.0	0.0	0.5	1350.0	0.6	227.7
Brisaster townsendi	21273.0	97.9	3587.4	212730.0	89.6	35873.5
Holothuroidea	2.0	0.0	0.3	90.0	0.0	15.2
Molpadia sp.	2.0	0.0	0.3	90.0	0.0	15.2

Appendix Table 13 (continued)

TAXON	COUNT			WET WEIGHT (gin)		
	No.	%	Per km	Total	%	Per km
VERTEBRATES						
Squalus scan.thias	-			49370.0	9.2	8325.5
Raja binocu lata	-			41670.0	7.8	7027.0
Sebastes alutus	-			4070.0	0.8	686.3
Sebasto Zebus a lascanus	-			81080.0	15.2	13672.8
Atheresthes stomias	-			138390.0	25.9.	23337.3
Glyptocepha lus zachirus	-			101920.0	19..1	17187.2
Microstomus pacificus	-			82670.0	15”.5	13941.0
Platichthys ste llatus	-			35560.0	6.7	5996.6

COMMENTS

Hermit crabs weighed with shell. Pollutants were not recorded.

Appendix Table 14

TOW NUMBER 70; STATION NUMBER 99-D; PERCENT SAMPLED = 100.

Date Yr Mo Da	Time Hr /Min	Start Latitude Deg Min	Start Longitude Deg Min	Finish Latitude Deg Min	Finish Longitude Deg Min	Time Fished Min	Time Zone	Distance Fished (km)	Depth Fished (m)
7 5 7 2	1635	59 25.0	140 29.0	59 25.0	140 32.0	60	8	5.55	141.9 -154.7

TAXON	COUNT No.	COUNT %	COUNT Per km	WET WEIGHT (gin) Total	WET WEIGHT (gin) %	WET WEIGHT (gin) Per km
INVERTEBRATES						
Actiniidae	8.0	0.1	1.4	1810.0	0.2	326.1
Euphrosine hortensis	1.0	0.0	0.2	1.0	0,0	0.2
Crucigera irregularis	1.0	0.0	0.2	1.0	0.0	0.2
Aphrodita japonica	14.0	0.3	2.5	630.0	0.1	113.5
Fusitriton oregonensis	26.0	0.5	4.7	1990.0	0.2	358.6
Neptunea lyrata	20.0	0.4	3.6	2260.0	0.3	407.2
Pyrulofusus harpa	14.0	0.3	2.5	3170.0	0.4	571.2
Arctomelon stearnsii	14.0	0.3	2.5	1580.0	0.2	284.7
Dorididae	80.0	1.5	14.4	14490.0	1.7	2610.8
octopus sp.	26.0	0.5	4.7	2340.0	0.3	421.6
Pandalus montagui tridens	429.0	8.0	77.3	3400.0	0.4	612.6
Spirontocaris arcuata	14.0	0.3	2.5	90.0	0.0	16.2
Argis ovifer	102.0	1.9	18.4	510.0	0.1	91.9
Elassochirus cavimanus	13.0	0.2	2.3	580.0	0.1	104.5
Acantholithodes hispidus	1.0	0.0	0.2	10.0	0.0	1.8
Lopholithodes foraminatus	40.0	0.7	7.2	16800.0	2.0	3027.0
Munida quadrispina	45.0	0.8	8.1	240.0	0.0	43.2
Oregonia gracilis	10.0	0.2	1.8	1800.0	0.2	324.3
Hyas lyratus	140.0	2.6	25.2	12680.0	1.5	2284.7
Chionoecetes bairdi	20.0	0.4	3.6	2260.0	0.3	407.2

Appendix Table 14 (continued)

TAXON	COUNT			WET WEIGHT (gin)		
	No.	%	Per km	Total	%	Per km
Chori lia longipes	10.0	0.2	1.8	600.0	0.1	108.1
Dipsacaster bores lis	14.0	0.3	2.5	630.0	0.1	113.5
Ceramaster patagonicus	30.0	0.6	5.4	2710.0	0.3	488.3
Pseudarchaster parelii	200.0	3.7	36.0	18120.0	2.1	3264.9
Henricia aspera	653.0	12.2	117.7	59160.0	6.9	10659.5
Diplopteraster multipes	78.0	1.5	14.1	11770.0	1.4	2120.7
Crossaster papposus	40.0	0.7	7.2	3620.0	0.4	652.3
Lophaster furcilliger	4.0	0.1	0.7	450.0	0.1	81.1
Solaster dawsoni	40.0	0.7	7.2	9060.0	1.1	1632.4
Allocentrotus fragilis	41.0	0.8	7.4	1640.0	0.2	295.5
Strongylocentrotus droebachiensis	92.0	1.7	16.6	2760.0	0.3	497.3
Gorgonocephalus caryi	20.0	0.4	3.6	4530.0	0.5	816.2
Ophiura sarsi	400.0	7.4	72.1	900.0	0.1	162.2
Cucumariidae	2600.0	48.4	468.5	650000.0	76.2	117117.1
Halocynthia aurantium	130.0	2.4	23.4	20300.0	2.4	3657.7
VERTEBRATES						
Raja binoculata				15400.0	3.2	2774.8
Raja stellulata				10870.0	2.3	1958.6
Gadus macrocephalas				78140.0	16.4	14079.3
Sebastolobus alascanus				94220.0	19.8	16976.6
Sebastes alutus				27180.0	5.7	4897.3
Atheresthes stomias				219700.0	46.2	39585.6
Glyptocephalus zachirus				30500.0	6.4	5495.5

COMMENTS

Hermit crabs weighed with shell. *Crucigera* irregulars present on snail shell. pollutants were not recorded.