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SURVEY OF THE EPIFAUNAL INVERTEBRATES OF THE SOUTHEASTERN BERING SEA

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

The objectives of this study are: 1) a qualitative and quantitative inventory of dominant epibenthic species within and near identified oil-lease sites in the Bering Sea, 2) a description of spatial distribution patterns of selected species in the designated study areas, 3) preliminary observations of biological interrelationships, specifically trophic interactions, between selected segments of the benthic biota in the designated study area.

One hundred and eighty-three stations (207 tows) were successfully sampled in 1975 with a 400-mesh Eastern otter trawl in the southeastern Bering Sea. The majority of the 1975 stations were within the 80-m contour. Total epifaunal invertebrate biomass averaged 3.34 g/m^2. Ninety-five percent (95%) of the biomass consisted of Arthropoda (58.0%), Echinodermata (22.0%), Chordata (Ascidiacea) (8.5%), and Mollusca (6.5%). Red king crabs (*Paralithodes camtschatica*) (21.1%), snow crabs (*Chionoecetes opilio* [19.9%] and *C. bairdi* [10.8%]), and the sea star (*Asterias amurensis*) (17.9%) contributed 69.7% of the total epifaunal biomass. King crabs were mainly restricted to stations in Bristol Bay. *Chionoecetes opilio* was mainly caught at depths between 40 and 80 m. Stations in Bristol Bay were essentially void of C. *opilio* while moderate concentrations were found at stations north of Unimak Pass. *Chionoecetes bairdi* was found mainly at stations in Bristol Bay and north of Unimak Pass. The distribution of C. *bairdi* was limited to stations south of 58°30'N. *Asterias amurensis* was the most ubiquitous epibenthic species, although it was absent from stations immediately north of Unimak Pass.

In 1976, 81 stations (104 tows) were successfully sampled. Most of the stations were at depths greater than 80 m. Epifaunal biomass averaged 4.88 g/m^2, and was dominated by Arthropoda (66.9%) and Echinodermata (11.1%), Porifera (sponges) (8.8%) and Cnidaria (anemones) (5.2%) were of lesser importance. *Chionoecetes opilio* (28.8%), *C. bairdi* (16.7%), *Paralithodes camtschatica* (10.8%), and *Asterias amurensis* (4.7%) were the dominant individual species. Both C. *opilio* and C. *bairdi* were found at most stations in 1976. The major concentration of *P. camtschatica* was near

A major portion of the *Paralithodes camtschatica* and *Chionoecetes bairdi* populations occurred immediately north of the Alaska Peninsula. This area is also where the major fishery for these species takes place. The area is also located in a portion of Bristol Bay under consideration for petroleum exploration.

Of the 264 stations sampled, 19 were successfully occupied from two to nine times within the same year. At stations where two or more tows were taken, the first tow of a series included species that were most abundant in number and biomass. Subsequent tows yielded those species which were less important in number and biomass.

Five 30-minute tows and four 60-minute tows were made in 1975 at Station D7. A total of 44 taxa was collected from the combined tows. No significant difference in number of species and biomass (g/m*) of the two tow durations was noted.

Stomach contents were recorded for one invertebrate species in 1975. Stomachs of six species of invertebrates and more than 13 species of fishes were examined in 1976. *Paralithodes camtschatica* fed primarily on the cockle *Clinocardium ciliatum*, the small snail *Solariella* sp., the nut shell *Nuculana fossa*, the polychaete *Cistenides* sp. and brittle stars of the family Amphiuridae. Polychaetes and ophiuroids were the dominant food items in *Chionoecetes opilio* stomachs. Clams and brittle stars were the only two food items found to be very important in both crabs. Among the sea stars, *Asterias amurensis* fed on *Pandalus goniurus* (bumpy shrimp), Ectoprocta (bryozoans) and cockles (Cardiidae, presumably *Clinocardium* sp.) while *Leptasterias polaris acervata* fed exclusively on cockles. The fishes showed a variety of food preferences. *Gadus macrocephalus* (Pacific cod) fed mainly on *Pandalus borealis* (pink shrimp) while *Hemilepidotus papilio* (Irish lord) consumed polychaetes, gammarid and caprellid amphipods, *Theragra chalcogramma* (pollock), and miscellaneous fishes with about equal frequency. *Reinhardtius hippoglossoides* (Greenland halibut) consumed mainly fishes.

It is suggested in this report that comprehension of the relationship between oil, sediment, deposit-feeding clams, king and snow crabs is essential to an understanding of the potential impact of oil on the latter two commercially important species.

In 1975, man-made debris was recorded for 12 tows; in 1976, 43 of the 104 tows contained debris. Of the total number of debris-containing tows, 90% were in the most intensively fished region of the southern Bering Sea.

Initial assessment of all data suggests that: 1) sufficient station uniqueness exists to permit development 'of monitoring programs based on species composition at selected stations utilizing trawl techniques, and 2) adequate numbers of biologically well-known,' unique, and/or large 'species are available to permit nomination' of likely monitoring candidates once industrial activity is initiated.

II. INTRODUCTION

General Nature and Scope of Study

The operations connected with oil exploration, production, and transportation in the Bering Sea will present a wide 'spectrum of potential dangers to the marine environment (see Olson and Burgess, 1967, 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 (see Baker, 1976; Nelson-Smith, 1973; Pearson, 1971, 1972; 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 communication), but such fluctuations are typically unexplainable because of absence of long-term data (Lewis, 1970).

Benthic invertebrates (primarily the infauna, and sessile and slow-moving epifauna) are particularly 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; and Rosenberg, 1973, for discussion on long-term usage of benthic organisms for monitoring pollution in fjords). The presence of large numbers of benthic epifaunal species of actual or potential commercial importance (crabs, shrimps, snails, fin fishes) in the Bering Sea 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; and Feder, 1977 and 1978, for a discussion 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 (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 should make it possible to differentiate between normal ecosystem variation and pollutant-induced alteration. Intensive investigations of the benthos of the Bering Sea are also essential in order to understand the trophic interactions there and to predict the changes that might take place once oil-related activities are initiated.

The 1975-76 trawl study considered in this report delineates the major epifaunal species on the eastern Bering Sea shelf in regions of offshore oil and gas concentrations. Data were obtained on faunal composition and abundance which now are baselines to which future changes can be compared. Long-term studies on life histories and trophic interactions should define functional aspects of communities and ecosystems that are vulnerable to environmental damage, and should help determine the rates at which damaged environments can recover.

Relevance to Problems of Petroleum Development

Lack of an adequate data base makes it difficult to predict the effects of oil-related activity on the subtidal benthos of the Bering Sea. However, the rapid expansion of research activities in the Bering Sea"should ultimately enable us to point with some confidence to certain species or areas that might bear closer scrutiny once industrial activity is initiated. It must be emphasized that a considerable time frame is needed to comprehend long-term fluctuations in density of marine benthic species; thus, it cannot be expected that short-term research programs will result in adequate predictive capabilities. Assessment of the environment must be conducted on a continuing basis.

As indicated previously, infaunal benthic organisms tend to remain in place and consequently have been useful as an indicator species for disturbed areas. Thus, close examination of stations with substantial complements of infaunal species is warranted (see Feder, 1977, and National Oceanographic Data Center (NODC) data on file for examples of such stations). 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, station with substantial numbers of epifaunal species should be assessed on a continuing basis (see Feder, 1977, for references to relevant stations). The effect of loss of species to the overall trophic structure in the Bering Sea can be conjectured on the basis of available, limited food studies (Feder, 1977; Smith, 1978; Tsalkina, 1969; Mineva, 1964; Shubnikov, 1963; Shubnikov and Lisovenko, 1964).

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, asteroids, and holothuroids) are conspicuous members of the benthos of the Bering Sea and could be affected by oil activities there. Two echinoderm groups, asteroids (sea stars) and ophiuroids (brittle stars), are often components of the diet of large crabs (Cunningham, 1969; Feder, 1977; G. Powell, ADF&G, personal communication) and a few species of demersal fishes (Smith, 1978; Wigley and Theroux, 1965). Snow crabs (*Chionoecetes bairdi* and C. *opilio)* are conspicuous members of the shallow shelf of the Bering Sea, and support commercial fisheries of considerable importance there. Laboratory experiments with C, *bairdi* have shown that postmolt individuals lose most of their legs after exposure to Prudhoe Bay crude oil (Karinen and Rice, 1974); obviously the effect of oil on postmolt snow crabs must be considered in the continuing assessment of this species. Little other direct data based on laboratory experiments are available for subtidal benthic species (Nelson-Smith, 1973). Thus, experimentation on toxic effects of oil on other common members of the subtidal benthos should be strongly encouraged for the future in Outer Continental Shelf (OCS) programs.

A direct relationship between trophic structure (feeding type) and bottom stability has been demonstrated (Rhoads, 1974). A diesel fuel spill resulted in oil becoming adsorbed on sediment particles with the resultant mortality of 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 Bering Sea infaunal species are deposit feeders; thus, oil-related mortality of these species could likewise result in a changed near-bottom sedimentary 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 Bering Sea outer continental shelf.

III. CURRENT STATE OF KNOWLEDGE

The macrofauna of the Bering Sea is relatively well known, and data on distribution, abundance, and feeding mechanisms for infaunal species are reported in the literature (Feder *et al.*, 1976; Filatova and Barsanova, 1964; Kuznetsov, 1964; Lowry et *al.*, 1977, McLaughlin, 1963; Tsalkina, 1969; Pereyra *et al.*, *1976;* Feder, 1977; Neyman, 1960, Stoker, 1973). The relationship of infaunal feeding types to the overlying winter ice cover and to primary and secondary productivity in the water column is not known. Also, data on temporal and spatial variability of the benthic fauna are sparse.

Epifauna of the eastern Bering Sea was first examined by the Harriman Alaska Expedition (Merriam, 1904). Additional, but limited, information is found in the reports of the pre-World War 11 king crab investigations (Fishery Market News, 1942) and from the report on the fishing and processing operations of the *Pacific Explorer* in 1948 (Wigutoff and Carlson, 1950). Some information on species found in the northern Bering Sea is included in the reports of the U.S. Fish and Wildlife Service (Ellson *et al.*, 1949, 1950). Neyman (1960) published a quantitative report, in Russian, on benthic communities in the eastern Bering Sea. A phase of the research program conducted by the king crab investigation of the Bureau of Commercial Fisheries for the International North Pacific Fisheries Commission during the summers of 1958 and 1959 included an ecological study of the eastern Bering Sea (McLaughlin, 1963). Sparks and Pereyra (1966) presented a partial checklist and general discussion of the benthic fauna of the southeastern Chukchi Sea for the summer of 1959. Their marine survey was carried out in the southeastern Chukchi Sea from the Bering Strait to just north of Cape Lisburne and west to 169°W. Some species described by them in the Chukchi Sea extend into the Bering Sea and are important there.

The distribution, biomass and turnover rates of sediment-dwelling microflora, diatoms, microfauna, and meiofauna have not been determined; it is essential that the roles of these organisms be clarified if the Bering Sea benthic system is to be comprehended. It is probable that some of these organisms are vital biological agents for recycling nutrients and carbon from sediment to the overlying water mass (see Fenchel, 1969; and Fenchel and Jørgensen, 1977, for reviews). Of unique interest in the Bering Sea is the potential relationship of the ice edge and under-ice primary productivity blooms to the underlying benthic-biotic-chemical system (V. Alexander, IMS., . Univ. of Alaska, personal communication).

Crabs and bottom-feeding fishes of the Bering Sea exploit a variety of food types, benthic invertebrates being most important (Feniuk, 1945; McLaughlin and Hebard, 1961; Takeuchi, 1959, 1967; Mineva, 1964; Shubnikov and Lisovenko, 1964; Cunningham, 1969). Most of these predators feed on the nutrient-enriched upper slope during the winter, but move into the shallower and warmer waters of the shelf of the southeastern Bering Sea for intensive feeding and spawning during the summer. Occasionally they exploit the colder northern portions of the Bering Sea shelf. This differential distribution is reflected by catch statistics which demonstrate that the southeastern shelf area is a major fishing area for crabs and bottom fishes. The effect of intensive predatory activity in the southern vs.

the northern part of the shelf may be partially responsible for the lower standing stock of the food benthos in the southeastern Bering Sea (Neyman, 1960, 1963). It is apparent that bottom-feeding species of fisheries importance are intensively exploiting the southeastern Bering Sea shelf, and are often cropping what appear to be slow-growing species such as polychaetous annelids, snails and clams (Feder, unpublished observations). However, nektobenthic and pelagic crustacea such as amphipods and euphausiids may grow more rapidly in the nutrient-rich water at the shelf edge, and may provide additional important food resources there.

Some marine mammals of the Bering Sea feed on benthic species (see Lowry *et al.*, 1977). Walrus feed predominantly on what appear to be slow-growing species of molluscs, but seals prefer the more rapidly growing crustaceans and fishes in their diets (Fay *et al.*, 1977; Lowry *et al.*, 1977). Although marine mammals show food preferences, they are opportunistic feeders. As a consequence of the broad spectrum of food utilized and the exploitation of secondary and tertiary consumers, marine mammals are difficult to place in a food web and to assess in terms of energy cycling. Intensive trawling, hydraulic dredging, and oil-related activities on the Bering Sea shelf may adversely affect benthic organisms used as food by marine mammals. If benthic trophic relationships are altered by the latter activities, marine mammals may have their food regimes altered.

IV. STUDY AREA

Stations were occupied in conjunction with the National Marine Fisheries Service Resource Assessment trawl survey (Pereyra *et al.*, 1976) which sampled an area encompassed by an outer boundary extending along the shelf edge from Unimak Pass to the vicinity of St. Matthew Island, from St. Matthew Island to the coast, and along the coast to Bristol Bay (Figs. 1 and 2; Table I).

V. SOURCES, METHODS AND RATIONALE OF DATA COLLECTION

Specimens were collected onboard the NOAA Ship *Miller Freeman*. One-half-hour and one-hour tows were made at predetermined stations using a

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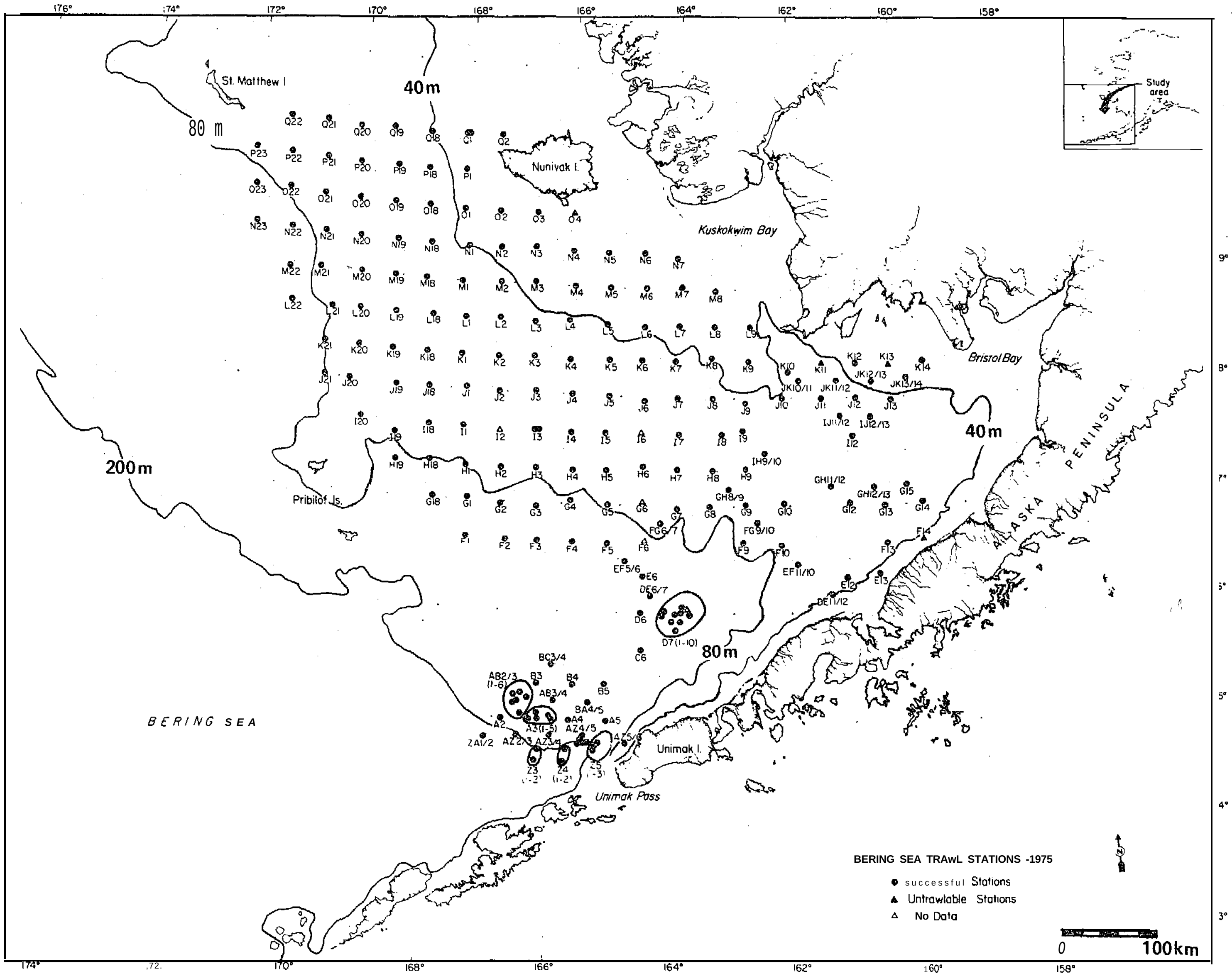

Figure 1. Benthic trawl stations occupied by NOAA Ship *Miller Freeman, 15* August-20 October, 1975 Multiple tows are typically enclosed within a circle to separate them from neighboring stations. Shaded areas represent potential petroleum lease sites.

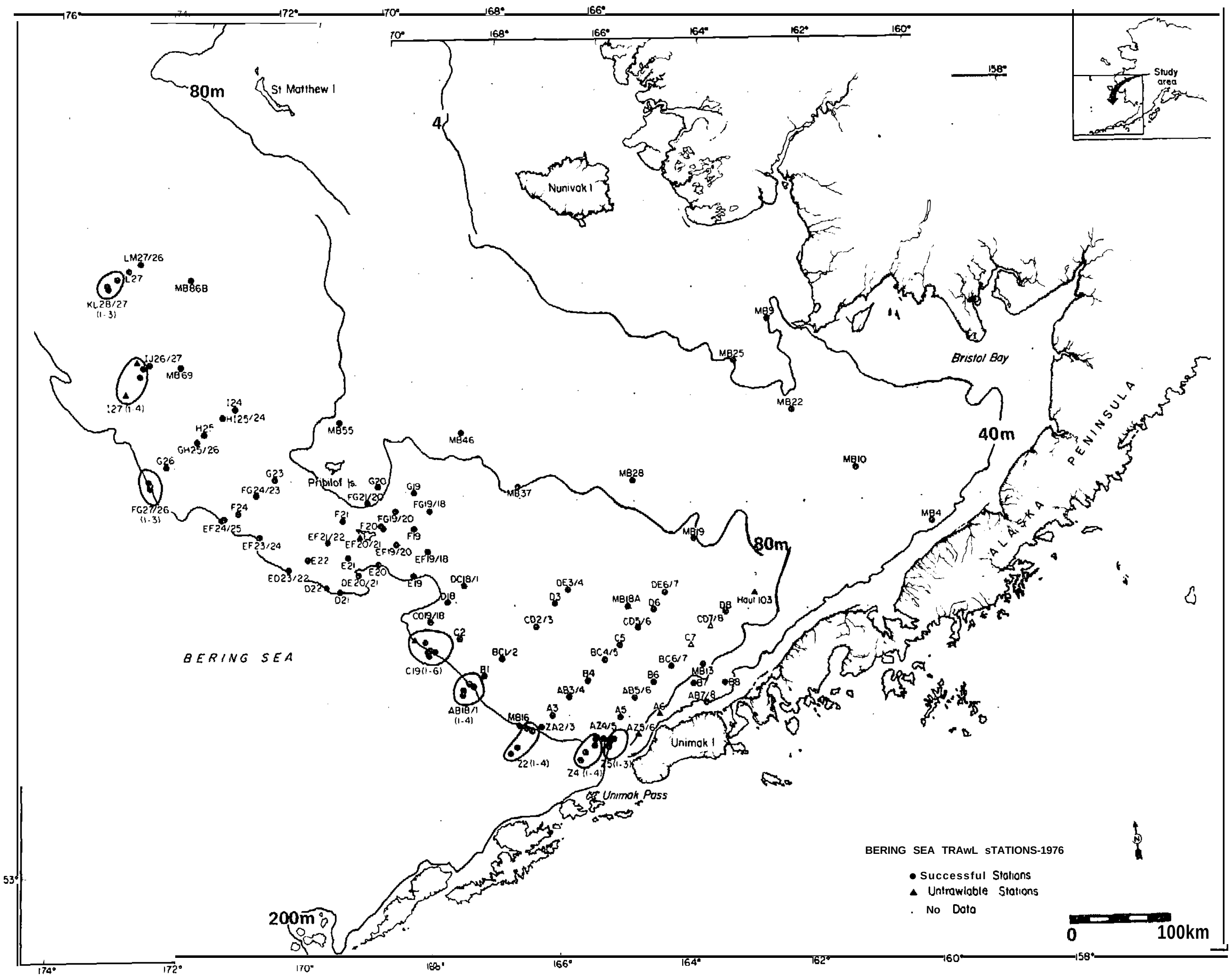

Figure 2. Benthic trawl stations occupied by NOAA Ship *Miller Freeman,* 28 March-4 June, 1976. Multiple tows are typically enclosed within a circle to separate them from neighboring stations. Shaded areas represent potential petroleum lease sites.

TABLE I

SOUTHEASTERN BERING SEA BENTHIC TRAWL STATIONS OCCUPIED BY THE NOAA SHIP *MILLER FREEMAN*, 1975 AND *1976*

1975 Stations	Latitude	Longitude	Depth m
F2	*56°37'*	166"59'	93.0
G2	*56°59'*	167°03'	72.8
G1	57°01'	167°37'	75.7
G18	*57°01'*	168°14'	80.1
H18	*57°21'*	168°18'	71.0
H19	*57°20'*	168°53'	70.0
119	*57°39'*	168°591	68.3
120	*57°41'*	169°35'	68.0
J20	*57°59'*	169°36'	69.2
J21	*58°01'*	170°16 '	72.8
K21	*58°19'*	170°20'	72.8
L21	*58°39'*	170°15'	70.0
L22	*58°40'*	170°59'	80.5
M22	*58°581*	171°05'	75.6
N22	*59°20'*	171°07'	73.1
N23	*59°20'*	171°47 '	80.1
023	*59°40'*	171°51'	75.7
P23	*60°00'*	171"56'	65.0
Q22	*60°20'*	171°21'	66.0
Q21	*60°21 '*	170°40'	66.0
Q20	*60°20'*	.170°02'	50.0
Q19	*60°21'*	169°24'	43.0
Q18	*60°20'*	168°42'	32.0.
Q1	*60°22'*	168°02'	28.2
Q2	*60°22'*	167°22'	26.2
P1	*60°01'*	168°00'	24.0
P18	*60°00'*	168°42 '	36.4
P19	*60°00'*	169°16 '	44.0
P20	*60°00'*	169°58'	52.0
P21	*60°00'*	170°36'	59.2
P22	*60°00'*	171°16 '	68.3
022.	*59°41'*	171°14'	71.0
021	*59°40'*	170°35 '	66.0
020	*59°40'*	169°56'	55.0
019	*59°40'*	169°16'	46.0
018	*59°40'*	168°38'	36.4
01	*59°40'*	167°59'	33.5
02	*59°40'*	167°20'	32.0
03	*59°40'*	166°39 '	25.0
04	*59"40'*	165°58'	21.5
N4	*59°20'*	165°56 '	20.5
N5	*59°20'*	165°19$	22.0
N6	*59°20'*	164°38'	24.0
N7	*59°17'*	164°02'	24.0

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TABLE I

CONTINUED

1975 Stations	Latitude	Longitude	Depth m
M8	59°59′	163°22′	24.0
M7	59°01′	163°59′	28.2
M6	59°00′	164°37 ′	28.2
M5	59°00′	165°16 ′	29.0
M4	59°00′	165°54′	32.0
M3	59°01′	166″37′	35.7
N3	59°21′	166°38′	30.0
N2	59°20′	167°16′	35.0
N1	59°20′	167°52′	38.2
N18	59°20′	168°32′	40.0
N19	59°20′	169°10′	52.0
N20	59°20′	169°51 ′	63.0
N21	59°20′	170°30′	71.5
M21	59°00′	170°28′	74.0
M20	59°01′	169°45 ′	65.0
M19	59°00′	169°09′	58.0
M18	59°00′	168°33 ′	48.0
Ml	59°00′	167°54′	44.0
M2	59°01′	167°13′	42.0
L1	58°40′	167°48′	48.0
L18	58°40′	168°24′	55.0
L19	58°40′	169°05′	66.0
L20	58°40′	169°42′	71.0
K20	58°20′	169°41′	73.0
K19	58°20′	169°05′	71.0
K18	58°20′	168°27 ′	72.0
K1	58°20′	167°50′	66.6
J1	58°01′	167°43′	70.0
J19	58°00′	168°58′	74.0
J18	58°00′	168023 ′	74.0
118	57°41′	168°22′	74.0
I1	57°41′	167°45′	73.0
H1	57°201	167°411	76.4
D7	56°00′	164°01′	92.8
C6	55°40′	1640341	115.0
B5	55°21′	165°10′	98.6
A4	55°00′	165″44′	134.0
BC3/4	55°30′	166°04 ′	126.7
B3	55°20′	166°18′	132.0
AB2/3	55°09′	166°39′	146.0
ZA1/2	54°49′	167°06′	355.0
A2	55°00′	166°51′	159.5
F1	56°40′	167°38′	103.5
H2	57°19′	167°04′	74.6
12	57°39′	167°09 ′	71.0
13	57°40′	166°30′	69.1

TABLE I

CONTINUED

1975 Stations	Latitude	Longitude	Depth m
14	57°40′	165°52 ′	66.0
H4	57°19′	165°50′	40.0
G5	57°00′	165°13 ′	"74.6
H5	57°20′	165°15 '	80.3
15	57°40′	165°16 '	63.7
16	57°40′	164°38′	55.0
H6	57°22′	164°371	67.3
G6	57°01′	164037 ′	73.0
FG6/7	56°51′	164018 '	74.6
A 3	55°00′	166°16′	138.0
F3	56°39′	166°24′	87.3
G3	56°58′	166°277	72.8
23	54°40 '	166°16 '	322.1
AZ2/3	54°50′	166°34′	188.3
AZ3/4	54°51′	166°01′	156.4
AZ4/5	54°50′	165°25 '	148.0
25	54°42′	165°05 ′	88.3
D6	55°59′	164°351	93.6
DE6 / 7	56°11′	164"16′	91.0
E6	56°20′	164°35′	89.1
EF5 / 6	56°29′	164055 ′	81.0
F6	56°40′	1640351	76.8
G7	56°59′	164°00′	69.1
G8	57°00′	163°26′	65.5
GH8/ 9	57°10′	163006 ′	68.2
G9	57°01′	162°48′	61.6
FG9/10	56°51′	162°36′	65.5
F10	56°38′	162°10′	75.4
EF11/10	56°28′	161°521	82.8
AZ5/6	54°51′	164°53 '	75.5
A5	55°00′	165°091	111.2
BA4/ 5	55°10′	165°26′	201.1
B4	55°20′	165°44′	123.7
AB3/4	55"09′	166°00′	132,3
Z4	54°40′	165°46 ′	319.0
H3	57"20′	166°291	71.0
G4	57°02′	165°52′	73.0
F4	56°39′	165°48′	73.0
F5	56°40'	165°12′	77.3
1 7	57°40′	163°59 ′	52.0
H7	57°20′	164°00′	63.0
H8	57°20′	163°23'	54.0
H9	57°21′	162°48′	50.0
IH9/10	57°291	162°27′	50.0
112	57°391	160°56 ′	56.4

TABLE I

CONTINUED

1975 Stations	Latitude	Longitude	Depth m
IJ12/13	57°49′	160°36′	52.5
J13	57°59′	160°15′	53.0
JK13/14	58°11′	159°57′	42.0
K14	58°20′	159°37′	27.3
K13	58°18′	160°15 ′	25.5
JK12/13	58°09′	160°34′	44.0
J12	58°00′	160°51′	46.0
IJ11/12	57°50′	161°08′	47*3
J11	58°00′	161°29′	55.6
JK11/12	58°10′	161°12′	47.3
K12	58″20′	160°51′	48.5
J10	58°00′	162°10′	38.2
JK10/11	58°10′	161°52′	40.0
K11	58°20′	161°29 ′	39.2
K10	58°15′	162°03 ′	46.6
K9	58°21′	162°45′	32.0
L9	58°40′	162°43′	24.0
L8	58°40′	163°21′	32.0
L7	58°40′	163°58′	35.0
L6	58°39′	164°37′	38.2
L5	58°40′	165″17′	39.1
L4	58″41′	165°58′	36.4
L2	58°41′	167°12′	45.0
K2	58°20′	167°11′	54.0
J2	58°00′	167°08′	66.0
L3	58°39′	166°34′	44.0
K3	58°21′	166°33′	47.3
J3	58°01′	166°30′	62.0
J4	58°00′	165°51′	55.7
K4	58°19′	165°54′	47.3
J5	58°00′	165°12′	50.0
K5	58°21′	165°13′	46.0
K6	58°21′	164°39′	45.0
K7	58°20′	164°01 ′	42.0
K8	58°22′	163°24′	37.2
J6	57°57′	164°35 ′	47.3
J7	58°00′	164°00′	47.3
J8	58°00′	163°23′	45.0
J9	57°58′	162°49 ′	45.0
19	57°42′	162°52′	46.0
18	57°40′	163°12′	49.8
DE11/12	56°11′	161018 ′	43.0
E12	56°20′	161°02′	55.0
G12	57°01′	160°58′	65.6

TABLE I

CONTINUED

1975 Stations	Latitude	Longitude	Depth m
GH12/13	57°101	160°35 '	65.6
G13	57°00'	160"22'	65.6
F13	56°39'	160020 '	54.6
E13	56°23'	160°30 '	37.5
F14	56°40'	159°45 '	38.2
G14	57°01'	159°44'	56.6
G15	.57°11'	160000-'	60.0
GH11/12	57°11'	161°18'	68.2
G10	57°01'	162°07'	59.1
F9 -	56°40'	162°50'	73.0

'TOTAL STATIONS" 191

TABLE I

CONTINUED

1976 Stations	Latitude	Longitude	Depth m
Z5	54°481	165°17 '	168.0
Z4	54°42'	163°38'	346.5
AZ5/6	54°50'	164°50'	72.4
A6	55°00'	164°35'	111.0
B7	55°1'9'	163°56'	71.0
AB7/8	55°09'	163"43'	46.0
B8	55°19'	163°24'	55.0
Z2	54°55'	166°42'	358.5
ZA2 / 3	54°54'	166"27 '	160.9
A3	55°00'	166°16'	145.6
AB3/4	55°09'	166°01'	132.8
B4	55°19'	165°43'	113 .2
BC4/5	55°31'	165°27 '	117.3
C5	55°40'	165°10'	112.4
cD5/6	55°50'	164°53 '	99.1
D6	55°56'	164°35'	96.4
DE6/7	56°08'	164°27 '	91.8
DE3/4	56°10'	166"07'	110.1
D3	56°01'	166°20'	125.4
CD2/3	55°48'	166°39'	136.0
C2	55°40'	166°56 '	138.3
BC1/2	55°30'	167°10'	140.1
B1	55°19'	167°28'	150.1
AB18/1	55°10'	167°43'	199.0
C19	55°36'	168°391	277.5
CO19/18	55°49'	168°23'	143.7
D18	56°00'	168°07'	147.0
DC18/1	56°10'	167°50'	140.5
EF19/18	56°25'	168°33'	122.8
E19	56°15'	168°45'	153.0
AZ4/5	54°49'	165°23'	161.0
A5	54°59'	165°09'	116.4
AB5/6	55°09'	164°55 '	155.0
B6	55°19'	164°34'	105.9
BC6/7	55°28'	164016 '	104.6
C7	55°42'	163°58'	100.1
D8	55°58'	163°22'	93.7
CD7 / 8	55°50'	163°42'	96.4
EF23/24	56°27'	171°24'	179.6
ED23/22	56°11'	170°51'	150.9
E22	56°19'	170°35'	127.1
EF21/22	56°29'	170°15'	115.2
F21	56°40'	170°03'	107.6
EF20/21	56°31'	169°41'	86.0
D21	56°01'	169°58'	144.4

TABLE I

CONTINUED

1976 Stations	Latitude	Longitude	Depth m
DE20/21	56°12′	169°42′	313.5
E 2 0	56°19′	169°19 ′	155.4
EF19/20	56°31′	169°02′	105.7
F19	56°41′	168°47 ′	109.7
G20	57°01′	169°29 ′	67.7
FG21/20	56°52′	169°39 ′	75.4
G19	57°00′	168°50′	85.1
FG19/18	56°50′	168°33′	103.4,
FG19/20	56°48′	169007 ′	89.6
F20	56°41′	169°21′	80.5
E21	56°21′	169°56′	112.6
D22	56°03′	170°12′	142.1
EF24/25	56°34′	172°02′	181.0
F24	56°41′	171°51 ′	127.2
FG24/23	56″51′	171°32′	120.7
G23	57°00′	171°16 ′	111.1
HI25/24	57°30′	172°20′	114.3
H25	57°20′	172°35′	116.4
GH25/26	57°13′	172°45 ′	.119.2
FG27/26	56°47′	173°22′	192.8
G26	57°00′	173°07 ′	135.1
IJ26/27	57°50′	173″38′	140.0
127	57°50′	173°47′	327.0
KL28/27	58°34′	174°24′	199.3
L27	58°40′	174°12′	155.6
LM27/26	58°44′	174°02′	139.0
124	57°36′	172°04′	113.0
MB13	55°31′	163°49 ′	48.0
MB4	56°45′	159°53′	28.0
Haul 103	56°09′	162°55 ′	84.0
MB9	57°50′	160°08′	54.0
MB25	58°19′	163°13′	37.5
MB22	57°50′	162°14′	45.7
MB10	57°18′	161°08 ′	65.9
MB19	56°40′	163058 ′	76.8
MB16	54°53′	166°48′	102,7
MB55	57°37′	170°21′	75.7
MB69	57°56′	173°02′	116.5
MB86B	58°40′	173°16 ′	117.0
MB46	57°35′	168°04′	73.2
MB37	57°06′	167°01′	76.4
MB28	57°12′	165°02′	71.3
MB18A	56°01′	165°03′	97.0

TOTAL STATIONS 87

commercial size 400-mesh Eastern otter trawl. Multiple tows were made at selected stations for comparative purposes. At Station D7, a series of tows were made for the purpose of comparing data by different trawl durations. Due to the difficulties in maintaining station position a series of tows taken at a given station were not all taken precisely on station, but rather each tow sampled an area near the coordinates of the particular station. Large catches were weighed in their entirety and subsampled. All invertebrates were sorted out on shipboard, given tentative identifications, counted, weighed when time permitted, and aliquot samples of individual species preserved and labeled for final identification at the Institute of Marine Science, University of Alaska. Counts and weights of commercially important invertebrate species were recorded by the National Marine Fisheries Service biologists in accordance with contractual agreements, and data made available to "the benthic invertebrate program.

For obvious logistic reasons all invertebrates could not be returned to the laboratory for verification. Therefore, a subsample of each field identification was returned to the University. Closer laboratory examination often revealed more than one species in a sample of what was designated in the field as one species. In such cases, the counts and weights of the species in question were expanded from the laboratory species ratio to the entire catch of the trawl.

Hermit crab weights did not include the shell.

Biomass per unit area (g/m^2) is calculated as follows: $\frac{w}{Tw(Dx1000)}$; where w = weight (grams), Tw = width of trawl opening (meters), and (i) x 1000) is distance fished (kilometers x 1000). The data bases for all calculations of biomass are included with the station data submitted to NODC .

Selected fish species were collected or their stomachs removed and preserved; this material was given to Dr. Ron Smith (University of Alaska) for stomach content analysis in 1975 and 1976 (Smith, 1978).

The stomachs of variable numbers of red king crabs (*Paralithodes camtschatica*) , snow crabs (*Chionoecetes opilio*), and selected species of fishes were examined to determine food habits. Some food items were identified onboard ship. Stomach contents were then placed in "Whirlpak" bags and fixed in 10% buffered formalin for final identifications at the

University of Alaska. Analysis of stomach contents was carried out using the frequency of occurrence method. In the latter method, prey organisms are expressed as the percent of stomachs containing various food items from the total number of stomachs analyzed.

VI. RESULTS

Distribution, Abundance and Biomass

Trawling operations during 1975 and 1976 resulted in the collection of animals from 11 phyla, 21 classes, 109 families, and 233 species (Tables II and III) of epifaunal invertebrates. In 1975, sampling was attempted at 191 stations (219 tows); 183 stations were successfully sampled (207 tows, Fig. 1). In 1976, sampling was attempted at only 87 stations (117 tows) and collections were made at 81 stations (104 tows, Fig. 2). It is probable that all dominant epifaunal species have been collected in the areas of investigation and only rare ones will be added with further trawl sampling.

The 1975 sampling period

The majority of the stations occupied in 1975 were within the 80-m contour (Fig. 1; Table I). Total epifaunal invertebrate biomass averaged 3.34 g/m^2. Four phyla dominated the epifaunal invertebrate biomass (Table IV). Ninety-five percent (95%) of the biomass was made up of these groups: Arthropoda (58.0%), Echinodermata (22.0%), Chordata (Ascidiacea) (8.5%), and Mollusca (6.5%).

A pattern of biomass dominance by a few families was found. Five families made up 87.5% of the total epifaunal invertebrate biomass (Table V). Similarly, only 11 species contributed over 1% each to the total epifaunal invertebrate biomass (Table VI).

The crabs, *Paralithodes camtschatica*, *Chionoecetes opilio*, *C. bairdi*, and the sea star, *Asterias amurensis*, contributed 69.7% of the total epifaunal biomass (Table VII).

Paralithodes camtschatica, the commercially important red king crab, was the dominant invertebrate, by weight, in the area. King crabs averaged slightly over 1 kg in weight and made up 21.1% of the total epifaunal

Text continued on Page 33

TABLE II

A LIST OF INVERTEBRATE SPECIES TAKEN BY TRAWL FROM THE S.E. BERING SEA ON THE NOAA SHIP *MILLER FREEMAN*, 1975 AND 1976

Phylum Porifera
- Unidentified species

Phylum Cnidaria
- Class Hydrozoa
  - Unidentified species
- Class Scyphozoa
  - Unidentified species
- Class Anthozoa
  - Unidentified 'species
  - Subclass Alcyonaria
    - Family Nephtheidae
      - *Eunephthya rubiformis* (Pallas)
    - Family Paragorgiidae
      - *Paragorgia arborea*
    - Family Virgulariidae
      - *Stylatula gracile* (Gabb)
    - Family Actiniidae
      - Unidentified species

Phylum Annelida
- Class Polychaeta
  - Unidentified species
  - Family Polynoidae
    - Unidentified species
  - Family Nereidae
    - Unidentified species
  - Family Flabelligeridae
    - *Brada sachalina*
  - Family Pectinariidae
    - *Cistenides hyperborea*
  - Family Serpulidae
    - *Crucigera* irregulars
  - Family Aphroditidae
    - *Aphrodita japonica* Marenzeller
- Class Hirudinea
  - *Notostomobdella* sp.
  - *Carcinobdella* sp.

Phylum Mollusca
- Class Pelecypoda
  - Unidentified species
  - Family Nuculanidae
    - *Nuculana fossa* Baird
    - *Yoldia myalis*
    - *Yoldia scissurata*
    - *Yoldia hyperborea* Torrell
    - *Yoldia seminuda* Dan
  - Family Mytilidae
    - *Mytilus edulis*
    - *Musculus niger* (Gray)

TABLE II

CONTINUED

Musculus discors (Linnaeus)
Modiolus modiolus
Family Pectinidae
Chlamys pseudoislandica
Chlamys rubida (Hinds)
Pecten caurinus
Family Anomiidae
Pododesmus macrochisma
Family Astartidae
Astarte montagui
Astarte alaskensis
Family Carditidae
Cyclocardia crebricostata Krase
Cyclocardia ventricosa
Cyclocardia crassidens
Family Kelliidae
Pseudopythina compressa
Family Cardiidae
Clinocardium ciliatum (Fabricius)
Clinocardium califoriense (Dan)
Serripes groenlandicus (Bruguiere)
Family Veneridae
Liocyma fluctuosa
Family Mactridae
Spisula polynyma (Stimpson)
Family Tellinidae
Macoma calcarea (Gmelin)
Tellina lutea Wood
Family Solenidae
Siliqua alta (Broderip and Sowerby)
Family Hiatellidae
Hiatella arctica (Linnaeus)
Family Teredinidae
Bankia setacea
Family Cuspidariidae
Cardiomya beringensis (Leche)
Class Gastropoda
Unidentified species
Family Trochidae
Margarites giganteus (Leche)
Margarites costalis (Gould)
Solariella obscura
Solariella micraulax
Family Turritellidae
Tachyrynchus erosus (Couthouyi)
Family Calyptraeidae
Crepidula grandis Middendorff
Family Trichotropididae
Trichotropis insignis

TABLE 11

CONTINUED

Family Naticidae
- *Natica clausa* (Broderip and Sowerby)
- *Polinices pallida* (Broderip and Sowerby)

Family Velutinidae
- *Velutina* sp.
- *Velutina velutina* (Müller)
- *Velutina lanigera*

Family Cymatiidae
- *Fusitriton oregonensis* Redfield

Family Muricidae
- *Boreotrophon clathratus*
- *Boreotrophon pacificus* (Dan)
- *Boreotrophon dalli* (Kobelt)

Family Buccinidae
- *Buccinum* sp.
- *Buccinum angulosum* Gray
- *Buccinum scalariforme* (Möller)
- *Buccinum glaciale* Linnaeus
- *Buccinum solenum* (Dan)
- *Buccinum polare* Gray
- *Buccinum plectrum* Stimpson

Family Neptuneidae
- Unidentified species
- *Ancistrolepis eucosmia*
- *Ancistrolepis magna* Dan
- *Ancistrolepis ochotensis*
- *Beringius kennicotti* (Dall)
- *Beringius beringi* (Middendorff)
- *Beringius stimpsoni*
- *Beringius frielei* (Middendorff)
- *Beringius crebricostatus undatus*
- *Beringius* sp.
- *Colus* Sp.
- *Colus spitzbergensis* (Reeve)
- *Colus herendeenii*
- *Colus halli* (Dall)
- *Colus hypolispus*
- *Colus aphelus* (Dall)
- *Colus dautzenbergi* (Dall)
- *Neptunea* sp.
- *Neptunea lyrata* (Gmelin)
- *Neptunea ventricosa* (Gmelin)
- *Neptunea pribiloffensis* (Dan)
- *Neptunea communis* borealis
- *Neptunea heros* (Gray)
- *Plicifusus kroyeri* (Möller)
- *Pyrulofusus* sp.
- *Pyrulofusus harpa*

TABLE II

CONTINUED

Pyrulofusus de formis
Volutopsius sp.
Volutopsius fragilis (Dan)
Volutopsius middendorfi
Volutopsius melonis (Dan)
Volutopsius trophonius
Volutopsius castanees (Dan)
Family Volutidae
Arctomelon stearnsii
Family Cancellariidae
Admete couthouyi (Jay)
Family Turridae
Aforia circinata
Family Dorididae
Unidentified species
Family Dendronotidae
Unidentified species
Family Tritoniidae
Unidentified species
Tritonia exsulans
Tochuina tetraquetra (Pallas)
Class Cephalopod
Family Sepiolidae
Rossia pacifica
Family Gonatidae
Unidentified species
Family Octopodidae
octopus Sp.
Phylum Arthropods
Class Pycnogonida
Family Phoxichilidiidae
Anaplodactylus erectus
Family Pycnogonidae
Unidentified species
Class Crustacea
Subclass Thoracica
Family Lepadidae
Lepas pectinata pacificus
Family Balanidae
Balanus balanus (Linnaeus)
Balanus evermani
Balanus rostratus
Balanus hesperius
Sub-class Malacostraca
Order Cumacea
Family Diastylidae
Diastylis bidentata (Dan)

TABLE 11

CONTINUED

Order Mysidacea
  Family Mysidae
    Neomysis rayii
Order Isopoda
    Unidentified species
  Family Idoteidae
    Synidotea bicuspida (Owen)
  Family Sphaeromatidae
    Tecticeps alascensis (Richardson)
  Family Aegidae
    Rocinela augustata Richardson
  Family Bopyridae
    Argeia pugettensis Dana
Order Amphipoda
    Unidentified species
  Family Ampeliscidae
    Ampelisca eschrichti
  Family. Gammaridae
    Melita dentata
    Jassa pulchella
  Family Lysianassidae
    Anonyx nugax pacifica (Krøyer)
  Family Hyperiidae
    Parathemisto libellula
  Family Caprellidae
    Unidentified species
Order Decapoda
  Family Pasiphaeidae
    Pasiphaea pacifica
  Family Pandalidae
    Pandalus borealis Krøyer
    Pandalus goniurus Stimpson
    Pandalus montagui tridens Rathbun
    Pandalopsis dispar
  Family Hippolytidae
    Spirontocaris lamellicornis (Dana)
    Spirontocaris ochotensis (Brandt)
    Spirontocaris sp.
    Eualus sp.
    Eualus macilenta (Krøyer)
    Eualus gaimardii belcheri
  Family Crangonidae
    Crangon dalli Rathbun
    Crangon communis Rathbun
    Sclerocrangon boreas
    Argis dentata (Rathbun)
    Argis ovifer

TABLE II

CONTINUED

Family Paguridae
- *Pagurus* sp.
- *Pagurus ochotensis* (Benedict)
- *Pagurus aleuticus* (Benedict)
- *Pagurus capillatus* (Benedict)
- *Pagurus kennerlyi*
- *Pagurus beringanus*
- *Pagurus confragosus* (Benedict)
- *Pagurus cornutus* (Benedict)
- *Pagurus trigonocheirus* (Stimpson)
- *Pagurus townsendi*
- *Pagurus rathbuni*
- *Elassochirus cavimanus* (Miers)
- *Elassochirus tenuimanus*
- *Elassochirus gilli*
- *Labidochirus splendescens* Owen

Family Lithodidae
- *Hapalogaster grebnitzkii*
- *Placetron woznessenskii*
- *Paralithodes camtschatica* (Tilesius)
- *Paralithodes platypus* Brandt
- *Lithodes aequispina*
- *Sculptolithodes derjugini*

Family Majiidae
- *Oregonia gracilis*
- *Hyas lyratus* Dana
- *Hyas coarctatus alutaceus* Brandt
- *Chionoecetes* (hybrid)
- *Chionoecetes opilio* (Fabricius)
- *Chionoecetes bairdi* Rathbun

Family Cancridae
- Cancer *oregonensis*

Family Atelecyclidae
- *Telmessus cheiragonus* (Tilesius)
- *Erimacrus isenbeckii* (Brandt)

Phylum Sipunculida
- Unidentified species

Phylum Echiurida
- Class Echiuroidea
  - Family Echiuridae
    - *Echiurus echiurus*

Phylum Ectoprocta
- Unidentified species

Phylum Brachiopoda
- Family Cancellothyrididae
  - *Terebratulina unguicula*

TABLE II

CONTINUED

Family Dallinidae
- *Laqueus californicus*
- *Terebratalia* transversal

Phylum Echinodermata
- Class Asteroidea
  - Family Astropectinidae
    - *Dipsacaster borealis* Fisher
  - Family Benthopectinidae
    - *Ludiaster dawsoni*
  - Family Goniasteridae
    - *Geophyreaster swifti*
    - *Ceramaster patagonicus* Sladen
    - *Pseudarchaster parelii*
  - Family Porcellanasteridae
    - *Ctenodiscus crispatus*
  - Family Echinasteridae
    - *Henricia aspera* Fisher
    - *Henricia beringiana*
    - *Henricia* sp.
  - Family Pterasteridae
    - *Diplopteraster multipes*
    - *Pteraster obscurus* (Perrier)
    - *Pteraster tesselatus*
  - Family Solasteridae
    - *Crossaster* borealis (Fisher)
    - *Crossaster papposus* (Linnaeus)
    - *Lophaster furcilliger*
    - *Solaster endeca*
    - *Solaster dawsoni*
  - Family Asteridae
    - *Asterias amurensis* Lutkin
    - *Evasterias echinosoma*
    - *Evasterias troschelii*
    - *Leptasterias polaris acervata* (Stimpson)
    - *Leptasterias* sp.
    - *Lethasterias nanimensis* (Verrill)
- Class Echinoidea
  - Family Echinarachniidae
    - *Echinarachnius parma*
  - Family Schizasteridae
    - *Brisaster townsendi*
  - Family Strongylocentrotidae
    - *Strongylocentrotus droebachiensis* (O. F. Müller)
- Class Ophiuroidea
  - Unidentified species
  - Family Asteronychidae
    - *Asteronyx loveni*
  - Family Gorgonocephalidae
    - *Gorgonocephalus caryi* (Lyman)

TABLE II

CONTINUED

Family Ophiactidae
Ophiopholis aculeata (Linnaeus)
Family Ophiuridae
Ophiopenia tetracantha
Ophiura sarsi Lütkin
Stegophiura nodosa (Lütkin)
Class Holothuroidea
Unidentified species
Family Synaptidae
Unidentified species
Family Molpadiidae
Molpadia sp.
Family Stichopodidae
Parastichopus sp.
Family Cucumariidae
Cucumaria sp.
Class Crinoidea
Unidentified species
Phylum Chordata
Unidentified species
Class Stolidobranchia
Family Styelidae
Unidentified species
Styela rustica macrenteron
Family Pyuridae
Boltenia ovifera (Linnaeus)
Halocynthia aurantium (Pallas)

TABLE III

NUMBER OF SPECIES OF EPIFAUNAL INVERTEBRATES BY PHYLUM AND CLASS, S.E. BERING SEA, 1975 - 1976

Phylum	Class	Number of Species	Percent of Species
Porifera		1	0.4
Cnidaria	Hydrozoa	1	0.4
	Scyphozoa	1	0.4
	Anthozoa	5	2.1
Annelida	Polychaeta	7	3.0
	Hirudinea	2	0.9
Mollusca	Pelecypoda	31	13.3
	Gastropoda	65	27.9
	Cephalopod	3	1.3
Arthropoda	Pycnogonida	2	0.9
	Crustacea	65	27.9
Sipunculida		1	0.4
Echiurida	Echiurida	1	0.4
Ectoprocta		1	0.4
Brachiopoda	Articulate	3	1.3
Echinodermata	Asteroidea	23	9.9
	Echinoidea	3	1.3
	Ophiuroidea	7	3.0
	Holothuroidea	5	2.1
	Crinoidea	1	0.4
Chordata	Urochordata	5	2.1
		Total 233	

TABLE IV

NUMBERS , WEIGHT, AND BIOMASS (g/m^2) OF MAJOR EPIFAUNAL INVERTEBRATE PHYLA OF THE S.E. BERING SEA, 1975. TRAWL SURVEY.

Phylum	Number of Organisms	Wet Weight (kg)	Percent of Total Weight	Mean Grams Per Square Meter ($\bar{x}$ g/m^2)
Porifera	159	303.65	1.1	0.035
Cnidaria	5580	1118.95	3*9	0.130
Annelida	1514	4.13	< ,1	<0.001
Mollusca	21760	1890.76	6.5	0.219
Arthropods (Crustacea)	124636	16729.99	58.0	1.937
Echinodermata	54629	6337.70	22.0	0.734
Chordata (Ascidiacea)	24700	2448.10	8.5	0.283
Total	232978	28833.28	100.0	3.338

TABLE V

NUMBERS, WEIGHT, AND BIOMASS (g/m^2) OF MAJOR EPIFAUNAL INVERTEBRATE FAMILIES OF THE S.E. BERING SEA, 1975, TRAWL SURVEY.

Family	Number of Organisms	Wet Weight (kg)	Percent of Total Weight	Mean Grams Per Square Meter ($\bar{x}$ g/m^2)
Neptuneidae	9671	1612.71	5.6	0.187
Lithodidae	6142	6209.24	21.5	0.719
Maj idae	87589	9633.86	33.4	1.115
Asteridae	46059	5640.33	19.6	0.653
Styelidae	22595	2144.28	7.4	0.248
Total	172006	25240.42	87,5	2.922

TABLE VI

NUMBERS, WEIGHT, AND BIOMASS (g/m^2) OF 11 SPECIES CONTRIBUTING MORE THAN ONE PERCENT EACH TO THE TOTAL EPIFAUNAL INVERTEBRATE BIOMASS, S.E. BERING SEA, 1975. TRAWL SURVEY.

Species	Number of Organisms	Wet Weight (kg)	Percent of Total Weight	Mean Grams Per Square Meter ($\bar{x}$ g/m^2)
Neptunea ventricosa	2101	350.82	1.2	0.041
Neptunea heros	4250	692.18	2.4	0.080
Pagurus trigonocheirus	12302	370.29	1.3	0.043
Paralithodes camtschatica	6057	6097.13	21.1	0.706
Chionoecetes (hybrid)	3591	585.87	2.0	0.068
Chionoecetes opilio	72585	5740.87	19.9	0.665
Chionoecetes bairdi	9352	3120.29	10.8	0.361
Asterias amurensis	44421	5167.50	17.9	0.598
Leptasterias polaris seer-vata	1231	335.46	1.2	0.039
Gorgonocephalus caryi	1832	446.77	1.6	0.052
Styela rustica macrenteron	22595	2144.19	7.4	0.248
Total	180315	25051.37	86.8	2.901

TABLE VII

NUMBERS, WEIGHT, AND BIOMASS (g/m^2) OF THE MAJOR EPIFAUNAL SPECIES OF MOLLUSCA, ARTHROPODA, ECHINODERMATA, AND CHORDATA (ASCIDIACEA) FROM THE S.E. BERING SEA, 1975. TRAWL SURVEY.

Phylum	Species	Number of Organisms	Wet Weight (kg)	Percent of Total Weight	Percent of Phylum Weight	Mean Grams Per Square Meter ($\bar{x}$ g/m^2)
Mollusca	*Neptunea lyrata*	730	173.23	0.6	9.16	0.02
	N. ventricosa	2101	350.82	1.2	18.55	0.04
	N. pribiloffensis	730	143.40	0.5	7.58	0.02
	N. communis borealis	1380	191.15	0.7	10.11	0.02
	N. heros	4250	692.18	2.4	36.61	0.08
	Total	9191	1550.78	5.4	82.01	0.18
Arthropoda	*Paralithodes camtschatica*	6057	6097.13	21.1	36.44	0.71
	Chionoecetes opilio	72585	5740.88	19.9	34.31	0.66
	Chionoecetes bairdi	93.52	3120.29	10.8	18.65	0.36
	Total	87994	14958.30	51.8	89.40	1.73
Echinodermata	*Asterias amurensis*	44421	5167.50	17.9	81.54	0.60
	Leptasterias polaris acervata	1231	335.46	1.2	5.29	0.04
	Gorgonocephalus caryi	1832	446.77	1.6	7.05	0.05
	Total	47484	5949.73	20.7	93.88	0.69
Chordata (Ascidiacea)	*Styela* rustics *macrenteron*	22595	2144.19	7.4	87.59	0.25
	Boltenia ovifera	1777	204.41	0.7′	8.35	0.02
	Halocynthia aurantium	328	99.40	0.3	4.06	0.01
	Total	24700	2448.00	8.4	100.00	0.28

biomass (Table VI). The 1975 catch was mainly restricted to stations in Bristol Bay (Figs. 1 and 3). The average biomass was 0.706 g/m^2; however, the highest biomass was at Station FG9/10 with 68.3 g/m^2. Thirty-five percent (2,091 individuals) of all *P. camtschatica* caught in 1975 came from Station FG9/10.

Chionoecetes opilio, a commercially important brachyuran crab, averaged less than 0.1 kg per animal, but its numerical abundance was nearly 12 times that of king crabs. The biomass of *C. opilio* was 19.9% of the total invertebrate biomass (Table VI). The majority of *C. opilio* were caught at depths between 40 and 80 m. Stations in Bristol Bay were essentially void of this species while moderate concentrations were found at stations north of Unimak Pass. Station L21 had the highest biomass with 13.7 g/m^2 (6,534 individuals; Figs. 1 and 4).

Chionoecetes bairdi, another commercial crab, made up 10.8% of the total epifaunal weight and was found mainly at stations in Bristol Bay and north of Unimak Pass (Table VI; Fig. 5). The distribution of this species was limited to stations south of 58°30'N. The highest biomass was at Station Z5 with 3.1 g/m^2 (368 individuals).

The sea star, *Asterias amurensis*, made up 17.9% of the total epifaunal biomass (Table VI) and was the most ubiquitous species (137 stations), although it was absent from stations immediately north of Unimak Pass. Many high biomass stations were found in Bristol Bay, specifically at stations J12, JK11/12, J10, JK10/11, DE11/12, and E12 where the biomass ranged between 4.3 and 9.8 g/m^2 (Figs. 1 and 6). Station DE11/12 had the highest biomass of *A. amurensis* with 9.8 g/m^2 (3,688 individuals).

Frequency of occurrence varied from the presence of a particular species in only one tow to the presence of a species in as many as 140 tows (e.g., *A. amurensis*) (Table VIII). Twenty-seven species occurred in greater than 20% of the tows (Table VIII). High frequency of occurrence did not correlate with greatest biomass. The large crab *Paralithodes camtschatica* (21.1% of the total biomass) occurred in only 37.2% of the tows while the small individuals of the polychaetous annelid family Polynoidae (less than 0.01% of total biomass) occurred at 57.5% of the tows.

A summarization of general biological information collected by trawling in 1975 is included in Appendix I.

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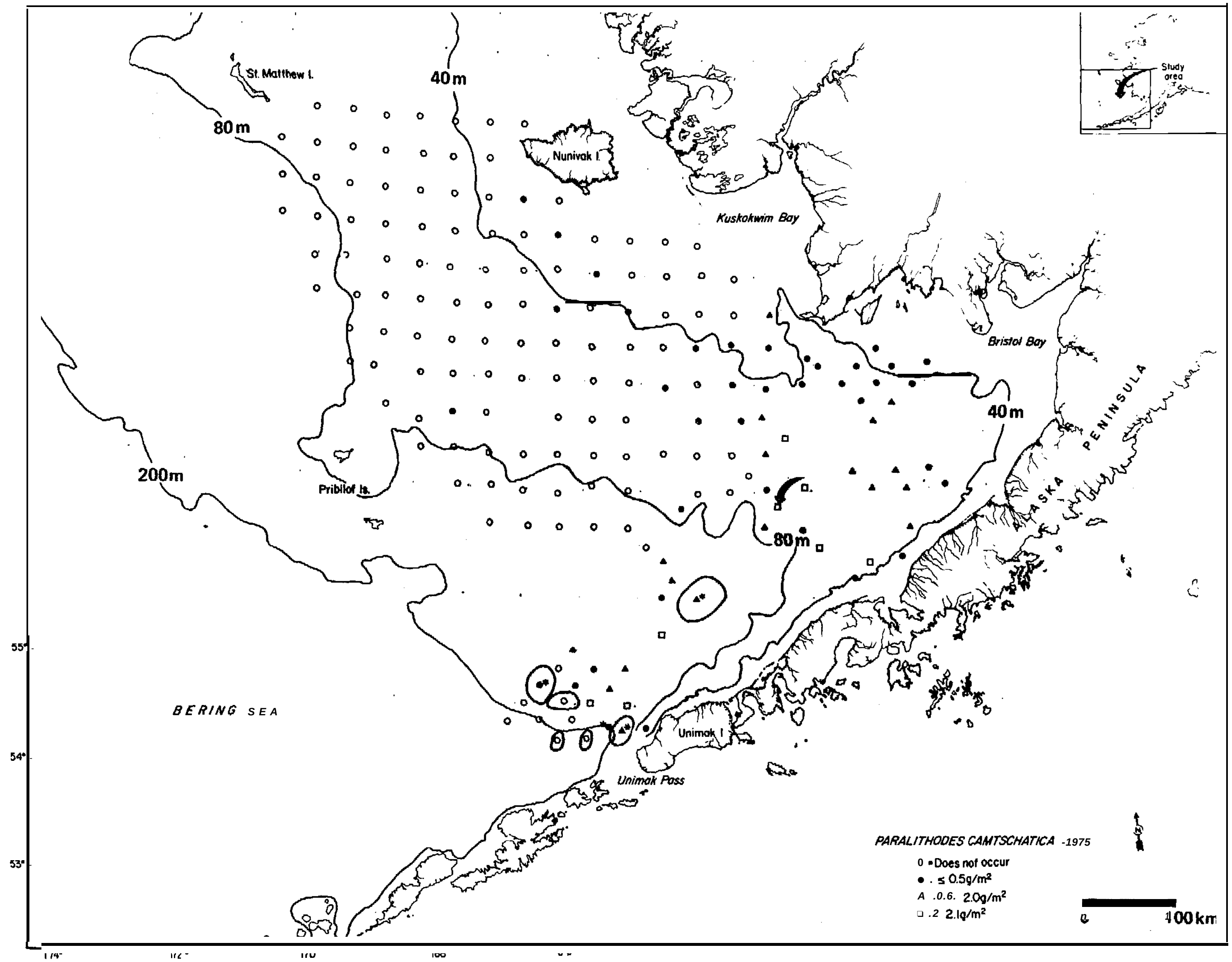

Figure 3. Distribution and biomass of the king crab, *Paralithodes camtschatica*, from the southeastern Bering Sea, 1975. Arrow indicates highest biomass station, i.e. 68.3 g/m^2 at Station FG 9/10. Asterisks indicate mean values from multiple tows.

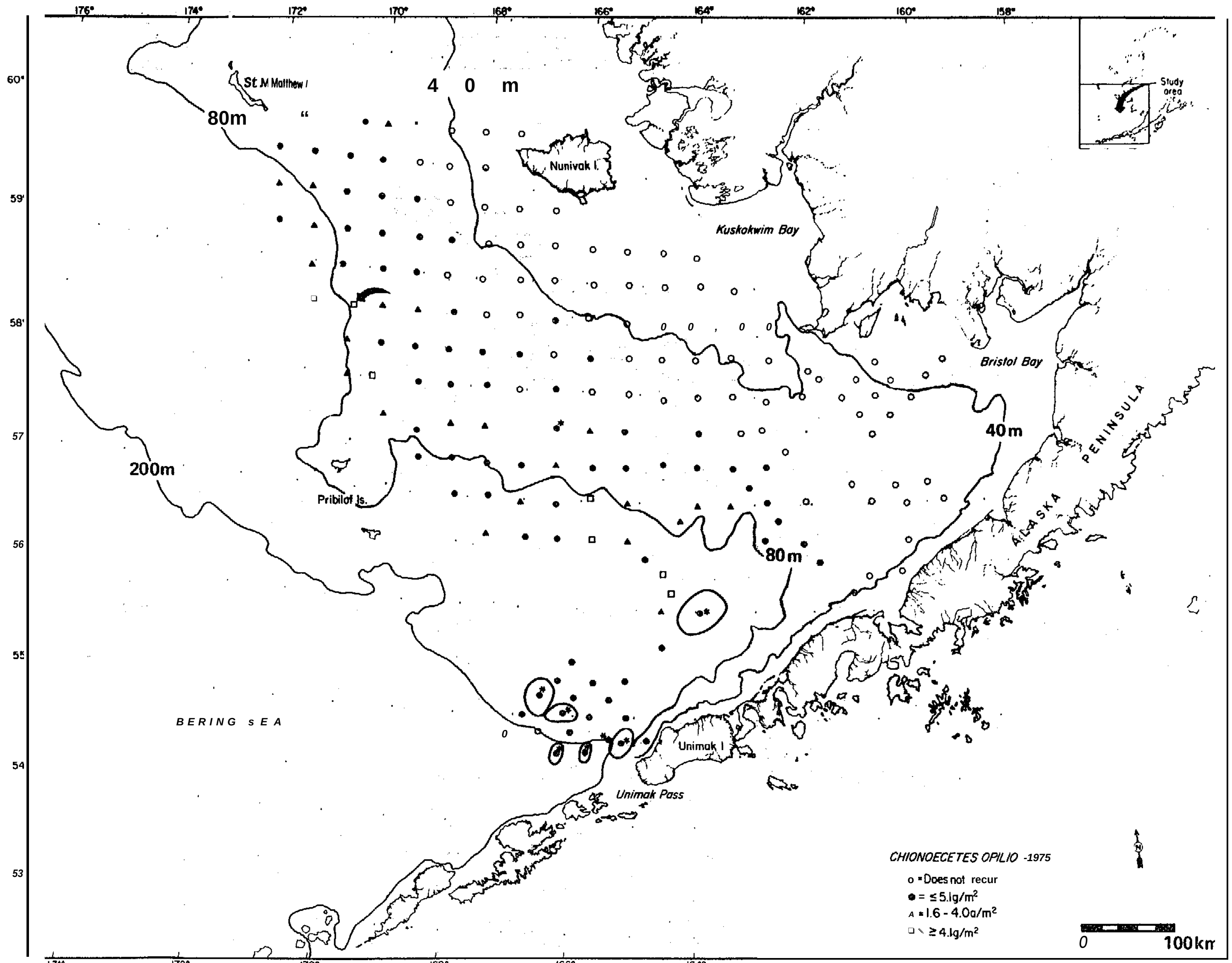

Figure 4. Distribution and biomass of the snow crab, *Chionoecetes opilio*, from the southeastern Bering Sea, 1975. Arrow indicates highest biomass station, i.e. 13.7 g/m^2 at Station L 21. Astericks indicate mean value from multiple tows.

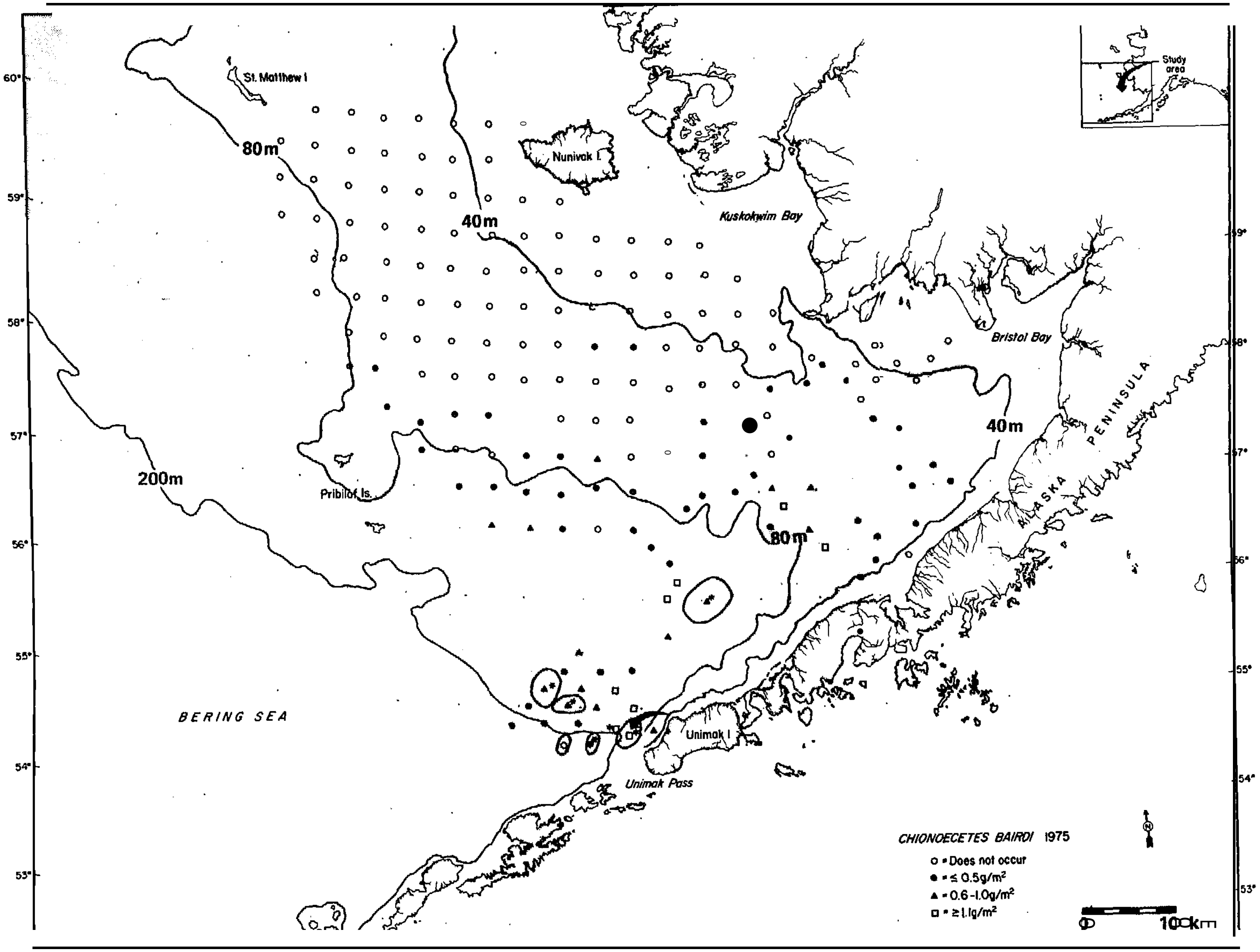

Figure 5. Distribution and biomass of the snow crab, *Chionoecetes bairdi*, from the southeastern Bering Sea, 1975. Arrow indicates highest biomass station, i.e. 3.1 g/m^2 at Station Z 5. Asterisks indicate mean values from multiple tows.

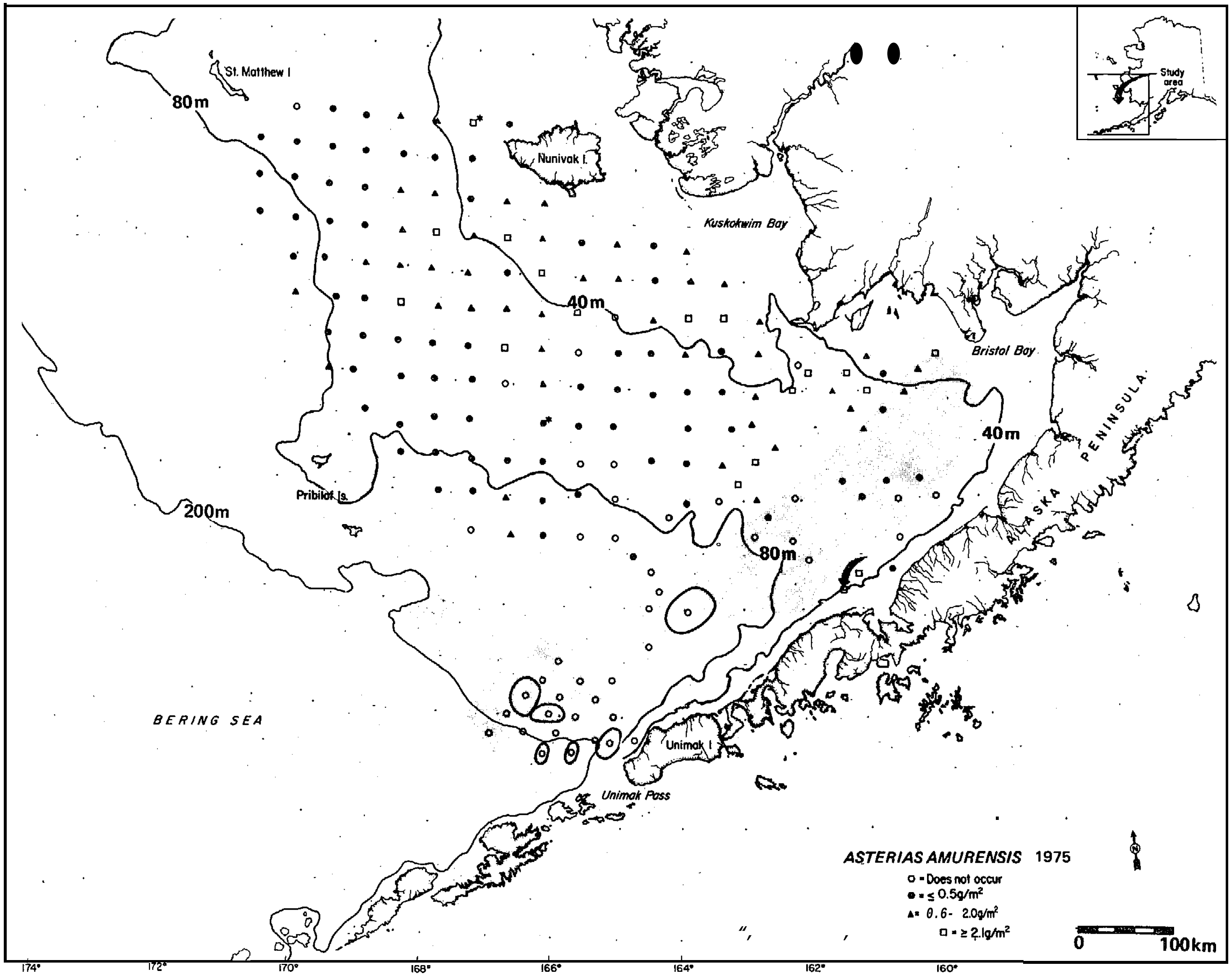

Figure 6.' Distribution and biomass of the sea star, *Aster<as amurensis*, from the southeastern Bering Sea, 1975. Arrow indicates highest biomass station, i.e. 9.8 g/m^2 at Station DE 11/12. Asterisks indicate mean values from multiple tows.

TABLE VIII

FREQUENCY OF OCCURRENCE OF EPIFAUNAL INVERTEBRATES FOUND AT GREATER THAN 20 PERCENT OF SUCCESSFUL S.E. BERING SEA TRAWL TOWS, 1975

Taxonomic Name	Number of Tows at which Organism Occurred	Percent of Tows at which Organism Occurred
Scyphozoa (unid. species)	54	26.1
Eunephthya rubiformis	48	23.2
Actiniidae (unid. species)	107	51.7
Polynoidae	119	57.5
Serripes groenlandicus	43	20.8
Neptunea ventricosa	74	35.7
N. heros	91	44.0
Tritoniidae (unid. species)	42	20.3
Pandalus borealis	46	22.2
P. goniurus	52	25.1
Crangon dalli	71	34.3
Argis dentata	65	31.4
Pagurus ochotensis	80	38.7
P. capillatus	96	46.4
P. trigonocheirus	95	45.9
Labidochirus splendescens	68	32.9
Paralithodes camtschatica	77	37.2
Hyas coarctatus alutaceus	99	47.8
Chionoecetes (hybrid)	102	49.3
C. opilio	126	60.9
C. bairdi	102	49.3
Erimacrus isenbeckii	53	25.6
Asterias amurensis	140	67.6
Leptasterias sp.	48	23.2
L. polaris acervata	52	25.1
Gorgonocephalus caryi	89	43.0
Styela rustica macrenteron	95	45.9

The 1976 sampling period

Most of the 1976 stations were at depths greater than 80 m (Fig. 2; Table 1).

Epifaunal invertebrate biomass averaged 4.87 g/m^2. The epifaunal invertebrate biomass was dominated by Arthropoda (66.9%) and Echinodermata (11.1%) with Porifera (8,.8%) and Cnidaria (5.2%) of lesser importance (Table IX). Annelida, Sipunculida (the' single "additional phylum occurring in 1976), Echiurida, Ectoprocta, and Brachiopoda contributed less than 0.02% to the total biomass.

Seven of the 81 families of invertebrates collected made up 82% of the biomass (Table X) with Majidae contribution 48.4% (over three times the biomass of the second family, Lithodidae). Ten species contributed more than 1% each to the total biomass (Table X1). *Chionoecetes opilio* (28.8%), *C. bairdi* (16.7%), *Paralithodes camtschatica* (10.8%) and *Asterias amurensis* (4.7%) were the dominant individual species by weight. The order of importance for species shifted in 1976 as compared to 1975 with *P. camtschatica* moving from first to third. *Asterias amurensis* (third in 1975) was fourth in biomass. The 1976 list of species contributing over 1% to the biomass differed from the 1975 list by the addition of *Octopus* sp., the blue king crab (*Paralithodes platypus*), the Korean horsehair crab (*Erimacrus isenbeckii*), and the tunicate (*Halocynthia aurantium*) (Table XI). Species included in the 1975 list, but deleted from the 1976 list, included *Neptunea* (2 species), *Pagurus trigonocheirus*, *Leptasterias polaris*, and the tunicate, *Styela rustica macrenteron*.

Each major phylum again contained several dominant species by weight: *Neptunea* spp. (40.6%) and *Octopus* sp. (32.8%) for Mollusca; king crabs (*Paralithodes camtschatica* and *P. platypus*, 21.8%) and snow crabs (*Chionoecetes bairdi* and C. *opilio*, 68.1%) for Arthropoda; *Asterias amurensis* (42.7%), *Gorgonocephalus caryi* (40.0%) and *Parastichopus* sp. (8.0%) for Echinodermata (Table XII).

Major concentrations o'f *Paralithodes camtschatica* were near Unimak Island. The highest biomass of this crab was noted at Station BC6/7 with 6.2 g/m^2 (240 individuals) (Figs. 2 and 7).

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TABLE IX

NUMBERS, WEIGHT, AND BIOMASS (g/m^2) OF MAJOR EPIFAUNAL INVERTEBRATE PHYLA OF THE 1976 S.E. BERING SEA TRAWL SURVEY.

Phylum	Number of Organisms	Wet Weight (kg)	Percent of Total Weight	Mean Grams Per Square Meter ($\bar{x}$ g/m^2)
Porifera	110	1754.02	8.8	0.43
Cnidaria	3709	1029.00	5.2	0.25
Annelida	1217	3.41	<.1	<0.01
Mollusca	5506	911.43	4.6	0.22
Arthropoda (Crustacea)	97360	13298.73	66.9	3.27
Echinodermata	9756	2195.38	11.1	0.54
Chordata (Ascidiacea)	110	659.65	3.3	0.16
Total	117769	19851.62	100.0	4.87

TABLE X

NUMBERS, WEIGHT, AND BIOMASS (g/m^2) OF MAJOR EPIFAUNAL INVERTEBRATE FAMILIES OF THE 1976 BERING SEA TRAWL SURVEY,

Family	Number of Organisms	Wet Weight (kg)	Percent of Total Weight	Mean Grams Per Square Meter ($\bar{x}$ g/m^2)
Actiniidae	3385	772.90	3.9	0.19
Neptuneidae	2175	412.78	2.1	0.10
Lithodidae	2227	2932.37	14.8	0.72
Maj idae	56914	9614.59	48.4	2.37
Asteridae	1047	1015.86	5.1	0.25
Gorgonocephalidae	3960	877.45	4,4	0.22
Pyuridae	not enumerated	631.65	3.2	0.16
Total		16257.60	81.9	4.01

TABLE XI

NUMBERS, WEIGHT, AND BIOMASS (g/m^2) OF 10 SPECIES CONTRIBUTING MORE THAN ONE PERCENT EACH TO THE TOTAL EPIFAUNAL INVERTEBRATE BIOMASS, 1976 S.E. BERING SEA TRAWL SURVEY.

Species	Number of Organisms	Wet Weight (kg)	Percent of Total Weight	Mean Grams Per Square Meter ($\bar{x}$ g/m^2)
Octopus Sp.	51	298.60	1.5	0.07
Paralithodes camtschatica	1739	2152.60	10.8	0.53
P. platypus	452	744.63	3.8	0.18
Chionoecetes (hybrid)	1395	520.83	2.6	0.13
C. *opilio*	45592	5724.94	28.8	1.41
C. *bairdi*	9275	3322.42	16.7	0.82
Erimacrus isenbeckii	313	412.62	2.1	0.10
Asterias amurensis	842	936.67	4.7	0.23
Gorgonocephalus caryi	3960	877.45	4.4	0.22
Halocynthia aurantium	not enumerated	568.77	2.9	0.14
Total		15559.53	78.3	3.83

TABLE XII

NUMBERS, WEIGHT, AND BIOMASS (g/m^2) OF THE MAJOR EPIFAUNAL SPECIES OF MOLLUSCA, ARTHROPODA, AND ECHINODERMATA FROM THE 1976 BERING SEA TRAWL SURVEY.

Phylum	Species	Number of Organisms	Wet Weight (kg)	Percent of Total Weight	Percent of Phylum Weight	Mean Grams Per Square Meter ($\bar{x}$ g/m^2)
Mollusca	*Fusitriton oregonensis*	778	84.20	0.4	9.2	0.02
	Neptunea lyrata	586	144.51	0.7	15.9	0.04
	N. ventricosa	448	98.82	0.5	10.8	0.02
	N. pribiloffensis	503	80.74	0.4	8.9	0.02
	N. heros	262	45.76	0.2	5.0	0.01
	Octopus sp.	51	298.60	1.5	32.8	0.07
	Total	2628	752.61	3.7	82.6	0.18
Arthropoda	*Paralithodes camtschatica*	1739	2152.60	10.8	16.2	0.53
	P. platypus	452	744.63	3.8	5.6	0.18
	Chionoecetes opilio	45592	5724.94	28.8	43.1	1.41
	C. bairdi	9275	3322.42	16.7	25.0	0.82
	Total	57058	11944.59	60.1	89.9	2.94
Echinodermata	*Asterias amurensis*	842	936.67	4.7	42.7	0.23
	Gorgonocephalus caryi	3960	877.45	4.4	40.0	0.22
	Parastichopus sp.	510	176.74	0.9	8.0	0.04
	Total	5312	1990.86	10.0	90.7	0.49

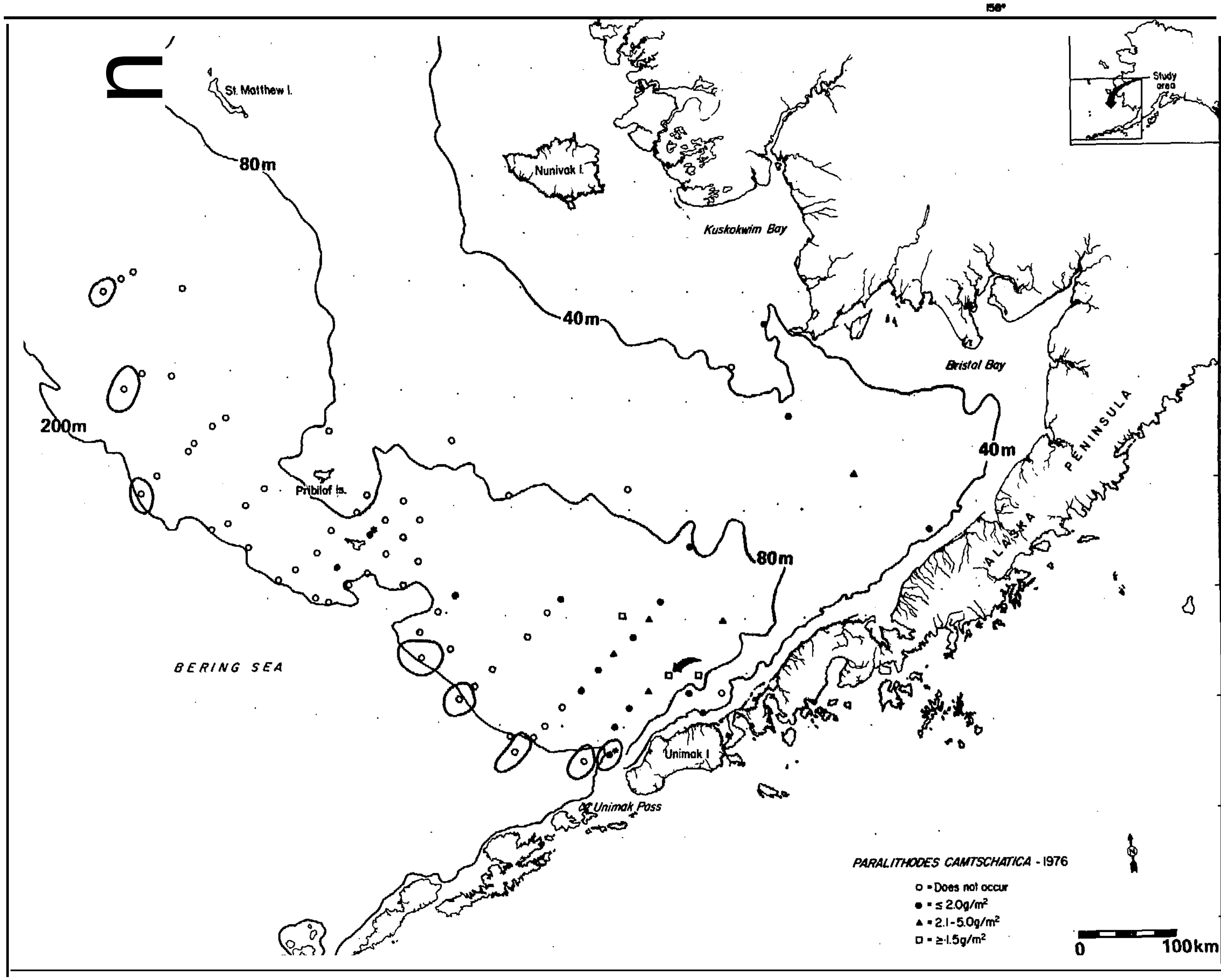

Figure 7. Distribution and biomass of king crab, *Paralithodes camtschatica*, from the southeastern Bering Sea, 1976. Arrow indicates highest biomass station, i.e. 6/2 g/m^2 at Station BC 6/7. Asterisks indicate mean values from multiple tows.

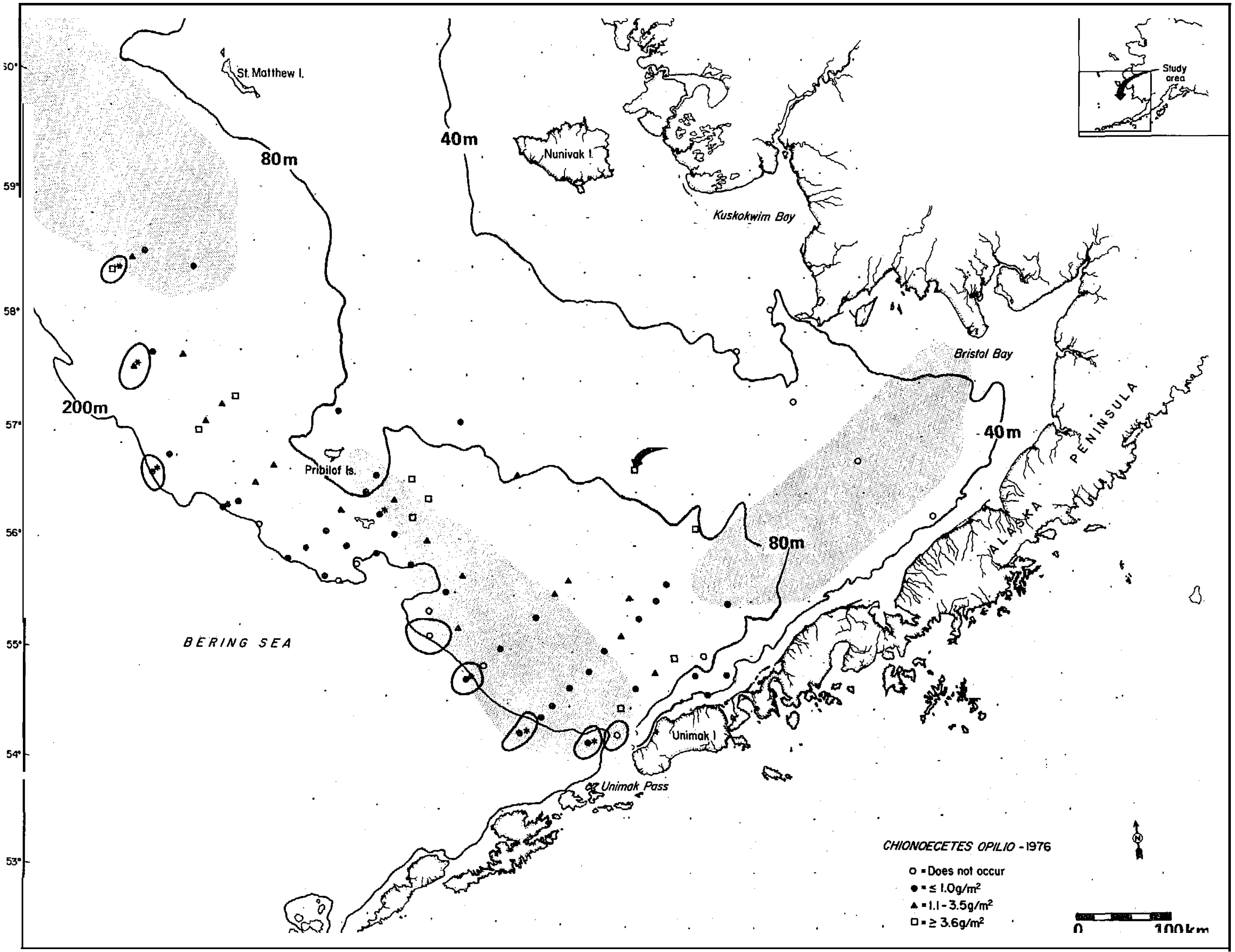

Figure 8. Distribution and biomass of the snow crab, *Chionoecetes opilio*, from the southeastern Bering Sea, 1976. Arrow indicates highest biomass station, i.e. 15.5 g/m^2 at Station MB 28. Asterisks indicate mean values from multiple tows.

The highest biomass station for *Chionoecetes opilio* in 1976 was MB28 with 15.5 g/m^2 (9,141 individuals) (Figs. 2 and 8). The distance fished at this station was 2.78 km. The highest biomass station of C. *bairdi*, BC6/7, was also 15.5 g/m^2; however, only 1,630 individuals were caught in 4.07 km (Figs. 2 and 9). Both C. *opilio* and *C. bairdi* were found at most of the 1976 stations.

Most occurrences of *Asterias amurensis* were at stations near the Pribilof Islands (Figs. 2 and 10). The highest biomass station was at MB9 with 6.9 g/m^2.

Frequency of occurrence in 1976 (Table XIII) was highest for C. *bairdi* which occurred at 87.5% of the tows. *Asterias amurensis*, the most widespread animal in 1975, occurred at only 37.5% of the 1976 tows.

A summarization of general biological information collected by trawling in 1976 is included in Appendix II.

Multiple Tows

Of the 264 stations sampled, 19 were occupied from two to nine times within the same year (Tables XIV and XV). At those stations where four or five tows were taken, 21.9 to 71.8% ($\bar{x}$ 43.0%) of the total number of species were obtained in the first tow (Table XIV), By the fourth tow of a 5-tow series, an average of 96.0% of the species were collected. At those stations where two or three tows were taken, the first tow obtained an average of 63.2% of the total number of species obtained at the particular station (Table XV). The species represented in the first tow of a series included those that were most abundant in number and in biomass. Subsequent tows in the same vicinity yielded species less important in number and in biomass.

In 1975, the area about Station D7 was sampled by ten tows, nine of which were successful. Five tows were 30 minutes in duration, while the other four were 60 minutes. A total of 44 taxa were collected by the combined tows (Table XVI). Thirty-nine taxa (88.6%) were collected by the five 30-minute tows; 36 taxa (81.8%) were collected by the four 60-minute tows. The mean count and weight of organisms collected by the 30-minute tows was 493 individuals and 128.43 kg respectively. The mean count and weight taken by the 60-minute tows was 883 individuals and 187.04 kg respectively. The mean estimate of biomass for the 30-minute tows was 3.67

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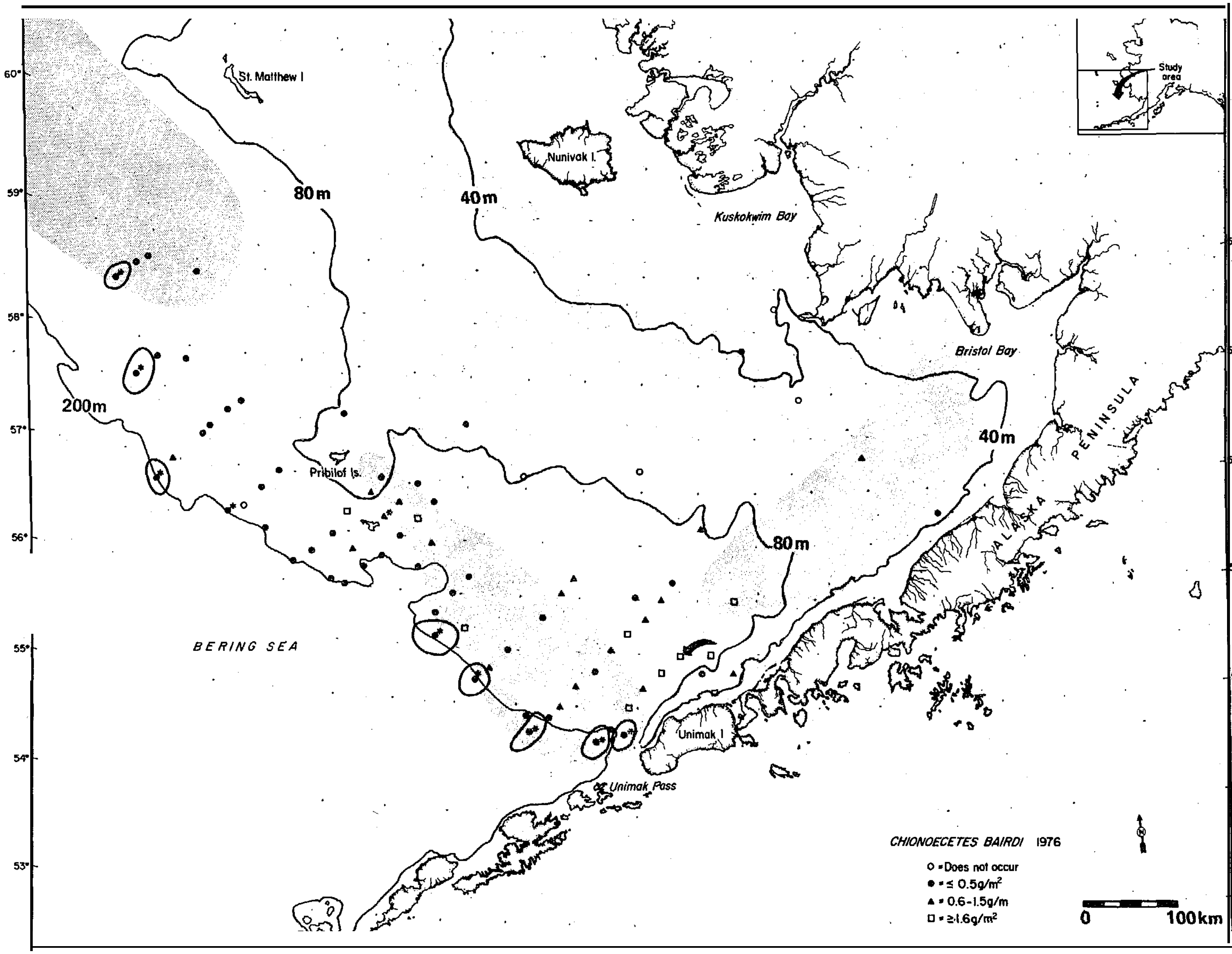

Figure 9. Distribution and biomass of the snow crab, *Chionoecetes bairdi*, from the southeastern Bering Sea, 1976. Arrow indicates highest biomass station, i.e. 15.5 g/m^2 at Station BC 6/7. Asterisks indicate mean values from multiple tows.

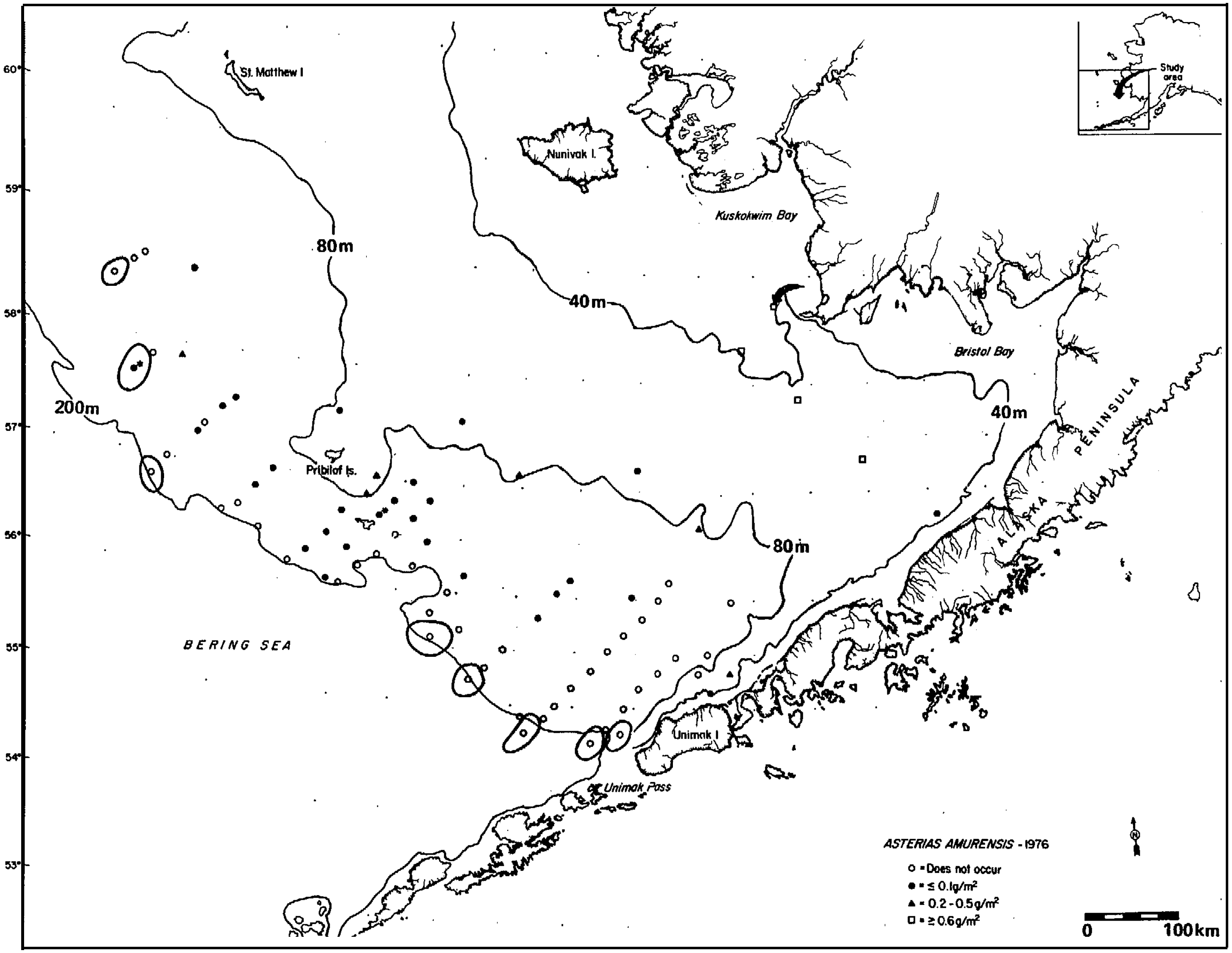

Figure 10. Distribution and biomass of the sea star, *Asterias amurensis*, from the southeastern Bering Sea, 1976. Arrows indicate highest biomass station, i.e. 6.9 g/m^2 at Station MB 9. Asterisks indicate mean values from multiple tows.

TABLE XIII

FREQUENCY OF OCCURRENCE OF EPIFAUNAL INVERTEBRATES FOUND AT GREATER THAN 20 PERCENT OF SUCCESSFUL S.E. BERING SEA TRAWL TOWS, 1976

Taxonomic Name	Number of Tows at which Organism Occurred	Percent of Tows at which organism Occurred
Porifera (Unid. species)	35	33.7
Scyphozoa (Unid. species)	22	21.2
Stylatula gracile	71	68.2
Polynoidae (Unid. species)	41	39.4
Notostomobdella sp.	29	27.9
Fusitriton oregonensis	53	50.9
Neptunea lyrata	41	39.4
N. ventricosa	26	25.0
N. pribiloffensis	44	42.3
Gonatidae (Unid. species)	25	24.0
Pandalus borealis	73	70.2
Crangon communis	25	24.0
Argis dentata	30	28.8
A. ovifer	22	21.1
Pagurus aleuticus	36	34.6
P. capillatus	28	26.9
P. confragosus	46	44.2
P. trigonocheirus	38	36.5
Elassochirus cavimanus	33	31.7
Paralithodes camtschatica	27	25.9
Hyas lyratus	23	22.1
Chionoecetes (hybrid)	58	55.8
c. *opilio*	77	74.0
C'. bairdi	91	87.5
Erimacrus isenbeckii	3 3	31.7
Ceramaster patagonicus	25	24.0
Henricia	26	25.0
Asterias amurensis	39	37.5
Lethasterias nanimensis	28	26.9
Strongylocentrotus droebachiensis	23	22.1
Gorgonocephalus caryi	37	35.6
Ophiopholis aculeata	21	20.1

TABLE XIV

CUMULATIVE PERCENTAGE OF SPECIES ADDED BY SUBSEQUENT TOWS
FOR STATIONS SAMPLED BY FOUR OR MORE TOWS

Year	Station	No. of Successful Tows	Total No. of Species Collected	Cumulative Percentage of Species Added at Subsequent Tows: Tow 1	Tow 2	Tow 3	Tow 4	Tow 5
1975	AB23	5	23	56.5%	65.2%	87.0%	95. 7%	100.0%
1975	D7	5 (30 rein)	39	35.9%	61.5%	97.4%	100.0%	100.0%
1975	D7	4 (60 rein)	36	36.1%	66. 7%	83.3%	100.0%	
1975	A3	4	30	40.0%	66.6%	96.7%	100.0%	
1975	AZ45	5	33	42.4%	60.6%	81.8%	90.9%	100.0%
1976	Z4	4	32	21.9%	50.0%	87.5%	100.0%	
1976	Z2	4	49	57.1%	79.6%	87.8%	100.0%	
1976	AB18/1	4	36	25.0%	47.2%	77.8%	100.0%	
1976	cl 9	5	39	71.8%	82.1%	84.6%	97.4%	100.0%
			X	43.0%	64.4%	87.1%	96. 0%	
			S.D.	16.2%	11.6%	6.5%	3.8%	

TABLE XV

THE CUMULATIVE PERCENTAGE OF SPECIES ADDED BY SUBSEQUENT TOWS FOR STATIONS SAMPLED BY TWO OR THREE TOWS

Year	Station	No. of Successful Tows	Total No. of Species Collected	Cumulative Percentage of Species at Subsequent Tows: Tow 1	Tow 2	Tow 3
1975	Q1	2	21	57.1%	100.0%	
1975	13	2	26	80.1%	100.0%	
1975	Z3	2	17	88.2%	100.0%	
1975	Z4	2	20	55.0%	100.0%	
1976	Z5	3	32	59.4%	68. 8%	100.0%
1976	KL28/27	3	38	57.9%	84.2%	100.0%
1976	127	2	27	55.6%	100.0%	–
1976	FG27/26	3	30	66.7%	76.7%	100.0%
1976	F20	2	44	56.8%	100. 0%	
1976	EF24/25	2	27	55.6%	100. 0%	
			x	63. 2%	76.7%	
			S.D.	11.7%	7.7%	

TABLE XVI

SPECIES LIST COMPILED FROM FOUR 60-MIN TOWS AND FIVE 30-MIN TOWS
AT STATION D7, SEPTEMBER 1975 (TOWS 78, 101-108)

	30 MIN TOWS					60 MIN TOWS			
Taxon	Tow 78	Tow 101	Tow 103	Tow 106	Tow 108	Tow 102	Tow 104	Tow 105	Tow 107
Porifera		X	X	X	X	X	X	X	X
Hydrozoa		X							
Eunephthya rubiformis		X	X	X	X		X	X	
Scyphozoa	X								
Actiniidae		X	X	X			X	X	X
Polychaeta		X	X	X	X	X	X	X	X
Polynoidae	X	X	X	X	X	X	X	X	X
Notostomobdella sp.			X	X	X	X	X	X	X
Clinocardium ciliatum									X
Serripes groenlandicus		X		X				X	X
Macoma calcarea	X								
Tellina lutes alternidentata		X					X		
Crepidula grandis			X				X		X
Natica clausa			X				-		
Fusitriton oregonensis	X	X	X	X	X		X	X	X
Colus spitzbergensis			X				X		
Beringius kennicotti				X					
Neptunea lyrata	X			X	X			X	X
Neptunea ventricosa		X			X			X	X
Neptunea pribiloffensis	X	X			X	X	X		
Neptunea heros			X	X			X		
Plicifusus kroyeri	X			X					X
Tritoniidae			X		X				
Octopus sp.							X		
Melita dentata									X
Pandalus goniurus			X	X	X		X	X	X
Crangon dalli			X		X				
Argis dentata			X				X		

TABLE XVI

CONTINUED

Taxon	Tow 78	Tow 101	Tow 103	Tow 106	Tow 108	Tow 102	Tow 104	Tow 105	Tow 107
	30 MIN TOWS					60 MIN TOWS			
Pagurus aleuticus	X	X	X	X	X	X	X	X	X
Pagurus capillatus	X	X	X	X	X	X	X	X	X
Pagurus confragosus	–	–	X	X	X	–	X	X	X
Pagurus trigonocheirus	–	–	X	–	–	–	–	–	–
Paralithodes camtschatica	X	X	X	X	X	X	X	X	X
Hyas coarctatus alutaceus	–	–	–	–	–	–	–	X	–
Hyas lyratus	–	–	X	–	–	X	–	–	–
Chionoecetes (hybrid)	X	X	X	X	X	X	X	X	X
Chionoecetes opilio	X	X	X	X	X	X	X	X	X
Chionoecetes bairdi	X	X	X	X	X	X	X	X	X
Ectoprocta	–	X	X	X	X	–	–	X	X
Leptasterias polaris acervata	X	X	–	–	–	–	–	–	X
Gorgonocephalus caryi	–	X	–	–	–	–	–	–	–
Ophiopholis aculeata	–	X	X	X	X	–	–	–	X
Cucumaria sp.	–	–	X	–	–	–	–	–	X
Styela rustica macrenteror	–	–	–	–	–	X	–	–	–

TOTAL: 44 Taxa

	Tow 78	Tow 101	Tow 103	Tow 106	Tow 108	Tow 102	Tow 104	Tow 105	Tow 107
No. of Taxa	14	20	28	22	21	13	21	21	25
CNT:	468	648	358	498	491	703	605	1279	945
Mean CNT:			493					883	
Wet Wt. (kg)	138.92	140.63	41.49	217.92	103.23	164.31	70.50	301.61	211.73
Mean Wet Wt (kg):			128.48					187.04	

Mean Estimate of Biomass: 3.67 g m^2 (30 MIN TOWS)

Mean Estimate of Biomass: 2.68 g m^2 (60 MIN TOWS)

g/m^2, while the mean for the 60-minute tows was 2.68 g/m^2. No significant difference (α=0.05) in mean number of species and mean estimate of biomass was noted between tow periods.

Food Studies

Feeding relationships of epifaunal invertebrates and fishes in the southeastern Bering Sea were determined from direct observation and literature sources. Stomach contents were recorded for *Ophiura sarsi* in 1975 (Table XVII) and for six species of invertebrates (*Paralithodes camtschatica, Chionoecetes opilio, Asterias amurensis, Evasterias echinosoma, Leptasterias polar-is acervata,* and *Pteraster* sp.) and more than 13 species of fishes (*Gadus macrocephalus, Myoxocephalus* spp., *Careproctus* sp., *Platichthys stellatus, Limanda aspera, Hemilepidotus papilio, Pleuronectes quadrituberculatus, Hippoglossus stenolepis, Glyptocephalus zachirus, Raja stellulata, Hippoglossoides elassodon, Reinhardtius hippoglossoides,* and *Lepidopsetta bilineata*) in 1976 (Table XVIII).

Paralithodes camtschatica fed primarily on the cockle *Clinocardium ciliatum,* the small snails *Solariella* spp., the nut shell *Nuculana fossa,* the polychaete *Cistenides* sp. and brittle stars of the family Amphiuridae. Polychaetes and brittle stars (ophiuroids) were the dominant food items in *Chionoecetes opilio* stomachs. Clams (pelecypods) and ophiuroids were the only two food items found to be very important to both crabs. Among the sea stars, *Asterias amurensis* concentrated on the bumpy shrimp (*Pandalus goniurus*), Bryozoans (Ectoprocta) and cockles (Cardiidae, probably *Clinocardium* sp.) while the sea star *Leptasterias polaris acervata* fed exclusively on cockles. The fishes showed a variety of food preferences. The Pacific cod (*Gadus macrocephalus*) fed mainly on pink shrimp (*Pandalus borealis*) while the irish lord (*Hemilepidotus papilio*) consumed polychaetes, gammarid and caprellid amphipods, pollock (*Theragra chalcogramma*), and miscellaneous fishes with about equal frequency. The Greenland Halibut (*Reinhardtius hippoglossoides*) consumed mainly fishes.

Data from Tables XVII and XVIII and various literature sources (Pereyra et al., 1976; Barr, 1970a,b; Skalkin, 1963, 1964; Moiseev, 1955; Takeuchi and Imai, 1959; Takahashi and Yamaguchi, 1972; Mite, 1974; Krivobok and Tarkouskaya, 1964; Shubnikov, 1963; Novikov, 1964; Wakabayashi, 1974;

Text continued on Page 61

TABLE XVII

STOMACH CONTENTS OF *OPHIURA SARSI* FROM THE BERING SEA, 1975

Predator		Percent Frequency of Occurrence
Ophiura sarsi (Brittle. star)		
Stomachs examined: 10		
Stomachs with food: 9		
Stomach contents:	Detritus (9)	100. 0%
	Sediment (6)	66.6%
	Unidentified nematode (3)	33.3%
	Unidentified crustacean (3)	33.3%
	Unidentified amphipod (1)	11. 1%
	Unidentified mollusc (1)	11.1%
	Unidentified gastropod (1)	11.1%
	Plant fragments (1)	11.1%

TABLE XVIII

STOMACH CONTENTS OF SELECTED EPIFAUNAL INVERTEBRATES AND FISHES FROM THE BERING SEA, 1976

Predator		Percent Frequency of Occurrence
Paralithodes camtschatica (King Crab)		
Stomachs examined:	124	
Stomachs with food:	115	92.7%
Stomach contents:	*Clinocardium ciliatum* (83)	66.9%
	Solariella sp. (68)	54.8%
	Nuculana fossa (62)	50.0%
	Cistenides sp. (43)	34.7%
	Amphiuridae (43)	34.7%
	Unidentified snails (30)	24.2%
	Unidentified soft parts (26)	21.0%
	Sediment (22)	17.7%
	Unidentified Ophiuroidea (19)	15.3%
	Ophiopenia disacantha (18)	14.5%
	Unidentified Pelecypod (16)	12.9%
	Lyonsia norwegica (15)	12.1%
	Amphipholis pugetana (15)	12.1%
	Unidentified debris (15)	12.1%
	Chionoecetes sp. (9)	7.3%
	Turritellidae (8)	6.5%
	Cardita sp. (5)	4.0%
	Macoma sp. (4)	3.2%
	Eggs (4)	3.2%
	Unidentified crustaceans (4)	3.2%
	Unidentified amphipods (3)	2.4%
	Lischkeia sp. (3)	2.4%
	Ophiura sp. (3)	2.4%
	Fish Remains (3)	2.4%
	Unidentified crabs (2)	1.6%
	Unidentified polychaetes (2)	1.6%
	Balanus sp. (1)	0.8%
	Cylichna sp. (1)	0.8%
	Neptunea sp. (1)	0.8%
	Astarte sp. (1)	0.8%
	Dentalium sp. (1)	0.8%
	Plant material (1)	0.8%
	Elphidium sp. (1)	0.8%

TABLE XVIII

CONTINUED

Predator		Percent Frequency of Occurrence
Chionoecetes opilio (Snow crab)		
Stomachs examined: 23		
Stomachs with food: 16		69.6%
Stomach contents:	Unidentified polychaetes (12)	52.2%
	Ophiura sp. (6)	26.1%
	Unidentified debris (6)	26.1%
	Unidentified Ophiuroidea (4)	17.4%
	Unidentified soft parts (3)	13.0%
	Unidentified pelecypod (3)	13.0%
	Unidentified fish (3)	13.0%
	Unidentified amphipods (3)	13.0%
	Unidentified Paguridae (1)	4.3%
	Unidentified decapod (1)	4.3%
	Cyclocardia sp. (1)	4.3%
	Unidentified gastropod (1)	4.3%
Asterias amurensis (Sea star)		
Stomachs examined: 41		
Only animals with food in oral area examined		
Stomach contents:	*Pandalus goniurus* (7)	17.1%
	Unidentified Ectoprocta (7)	17.1%
	Unidentified Cardidae (6)	14.6%
	Unidentified sand dollar (5)	12.2%
	Unidentified Porifera (4)	9.8%
	Unidentified Balanidae (3)	7.3%
	Unidentified fish (3)	7.3%
	Unidentified Scyphozoa (2)	4.9%
	Spisula polynyma (2)	4.9%
	Crangon dalli (2)	4.9%
	Unidentified polychaete (2)	4.9%
	Parasitic copepods (2)	4.9%
	Unidentified soft parts (2)	4.9%
	Unidentified pelecypod (1)	2.4%
	Pagurus ochotensis (1)	2.4%
	Oregonia gracilis (1)	2.4%
	Chionoecetes sp. (1)	2.4%
	Unidentified Mysidae (1)	2.4%
Evasterias echinosoma (Sea star)		
Stomachs examined: 1		
Only animals with food in oral area were recorded		
Stomach contents:	*Boltenia ovifera*	100%

TABLE XVIII

CONTINUED

Predator		Percent Frequency of Occurrence
Leptasterias polaris acervata (Sea star)		
Stomachs examined: 12		
Only animals with food in oral area were recorded		
stomach contents:	Unidentified Cardidae (12)	100%
Pteraster sp. (Sea star)		
Stomachs examined: 1		
Only animals with food in oral area were recorded		
Stomach contents:	Unidentified Sabellidae (1)	100%
Gadus macrocephalus (Pacific cod)		
Stomachs examined: 29		
Stomachs with food: 29		100%
Stomach contents:	*Pandalus borealis* (15)	51.7%
	Theragra chalcogramma (5)	17.2%
	Unidentified amphipods (5)	17.2%
	Chionoecetes sp. (3)	10.3%
	Unidentified crabs (2)	6.9%
	Unidentified Pinnotheridae (1)	3.4%
	Unidentified Euphausiids (1)	3.4%
	Unidentified gastropod (1)	3,4%
	Unidentified Cottidae (1)	3.4%
	Pagurus trigonocheirus (1)	3.4%
	Unidentified soft parts (1)	3.4%
	Unidentified arthropods (1)	3.4%
	Unidentified polychaetes (1)	3.4%
	Unidentified cephalopods (1)	3.4%
Myoxocephalus spp. (Sculpin)		
Stomachs examined: 7		
Stomachs with food: 6		85.7%
Stomach contents:	*Chionoecetes* sp. (2)	28.6%
	Unidentified crab (2)	28.6%
	Unidentified amphipod (1)	14.3%
	Unidentified fish (1)	14.3%
	Unidentified Cottidae (1)	14.3%
	Mallotus villosus (1)	14.3%
Careproctus sp. (Snail fish)		
Stomachs examined: 1		
Stomachs with food: 1		100%
Stomach contents:	*Dasycottus* sp.	
	Ophiura sp.	
	Pandalus sp.	
	Chionoecetes opilio	

TABLE XVIII

CONTINUED

Predator		Percent Frequency of Occurrence
Platichthys stellatus (Starry flounder)		
Stomachs examined: 1		
Stomachs with food: 0		
Limanda aspera (Yellowfin sole)		
Stomachs examined: 4		
Stomachs with food: 0		
Hemilepidotus papilio (Sculpin)		
Stomachs examined: 9		
Stomachs with food: 8		88.9%
Stomach contents:	*Theragra chalcogramma* (2)	22.2%
	Unidentified fish (2)	22.2%
	Unidentified Caprellidea (2)	22.2%
	Unidentified Gammaridea (2)	22.2%
	Unidentified polychaetes (2)	22.2%
	Unidentified debris (2)	22.2%
	Crangon sp. (1)	11.1%
	Unidentified isopods (1)	11.1%
	Unidentified crabs (1)	11.1%
	Unidentified squid (1)	11.1%
	Unidentified Ophiuroidea (1)	11.1%
	Unidentified decapoda (1)	11.1%
Pleuronectes quadrituberculatus (Alaska Plaice)		
Stomachs examined: 6		
Stomachs with food: 2		33.3%
Stomach contents:	Unidentified polychaetes (1)	16.7%
	Unidentified pelecypod (1)	16.7%
	Unidentified amphipod (1)	16.7%
	Nemertean (1)	16.7%
	Unidentified annelid (1)	16.7%
Hippoglossus stenolepis (Pacific halibut)		
Stomachs examined: 3		
Stomachs with food: 2		66.6%
Stomach contents:	Unidentified fish (1)	33.3%
	Theragra chalcogramma (1)	33.3%
Glyptocephalus zachirus (Rex sole)		
Stomachs examined: 3		
Stomachs with food: 3		100%
Stomach contents:	Unidentified amphipods (3)	100%
	Unidentified polychaetes (2)	66.6%
	Unidentified nemertean (1)	33.3%
	Unidentified Hirudinea (1)	33.3%

TABLE XVIII

CONTINUED

Predator		Percent Frequency of Occurrence
Raja stellulata (Starry skate)		
Stomachs examined: 1		
Stomachs with food: 1		100%
Stomach contents:	Unidentified amphipods	100%
	Crangonid shrimp	100%
Hippoglossoides elassodon (Flathead sole)		
Stomachs examined: 4		
Stomachs with food: 0		
Reinhardtius hippoglossoides (Greenland halibut)		
Stomachs examined: 128		
Stomachs with food: 59		46.1%
Stomach contents:	Unidentified fish (37)	28.9%
	Theragra chalcogramma (9)	7.0%
	Unidentified Gadidae (8)	6.3%
	Mallotus villosus (1)	1.0%
	Unidentified Cottidae (1)	1.0%
	Unidentified decapod (1)	1.0%
Lepidopsetta bilineata (Rock sole)		
Stomachs examined: 1		
Stomachs with food: 0		

Shubnikov and Lisovenki, 1964; Mikawa, 1963; Mineva, 1964; Shuntov, 1965; Hameedi *et* aZ., 1976) and marine mammal feeding (Moiseev, 1952; North Pacific Fur Seal Commission, 1962, 1971, 1975; Berzin, 1971; Tomlin, 1957; Kleinberg *et al.*, 1964, Townsend, 1942, Lowry *et al.*, 1977; Fay *et al.*, 1977) were used to complete the Bering Sea food web (Fig. 11). The food web is organized so that flow of carbon is generally from bottom to top, but always in the direction of the arrow. Bold lines indicate the most important food sources for a given animal. For example, bold lines connect *Clinocardium* Sp. and Ophiuroidea to *Paralithodes camtschatica* since they are the major components of the diet of king crabs based on frequency of occurrence. Feeding relationships of five important species - king crabs (Fig. 12), snow crabs (Fig. 13), pollock (Fig. 14), Pacific cod (Fig. 15), and Pacific halibut (Fig. 16) - are shown individually.

Polychaetous annelids, snails, clams, isopods, amphipods, mysids, krill (euphausiids), caridean shrimps, crabs, bryozoans, sand dollars, and brittle stars are the main invertebrate components of the Bering Sea food web. Deposit-feeding bivalves (clams) (Table XIX) are important food sources for king crabs, snow crabs, and sea stars - the three major invertebrate components of the Bering Sea biomass.

Among fishes, the pollock, *Theragra chalcogramma*, appears to be a major component in the Bering Sea food web. Food of the pollock includes zooplankton (e.g., euphausiids), shrimps, and small fishes (small pollock were found in up to 99.7% of larger pollock stomachs by Mite, 1974). In turn, pollock are an important source of food for fur seals (North Pacific Fur Seal Commission, 1962, 1971, 1975), Pacific cod, halibut, Greenland halibut, and arrowtooth flounder (Feder, 1977; Pereyra *et al.*, 1976).

Most of the flatfishes prey on small benthic invertebrates such as polychaetes, pelecypods, and amphipods.

Among marine mammals, fishes and crustaceans as well as clams, polychaetes, and gastropod are important food items (Stoker, in prep; Fay *et aZ.*, 1977; Lowry *et al.*, 1977).

pollutants on the Bottom

As discussed in this report, proposed oil development in the Bering Sea has led to intensive biological assessment surveys. The benthic trawl, used

Text continued on Page 73

SOUTHEAST BERING SEA-Food Web

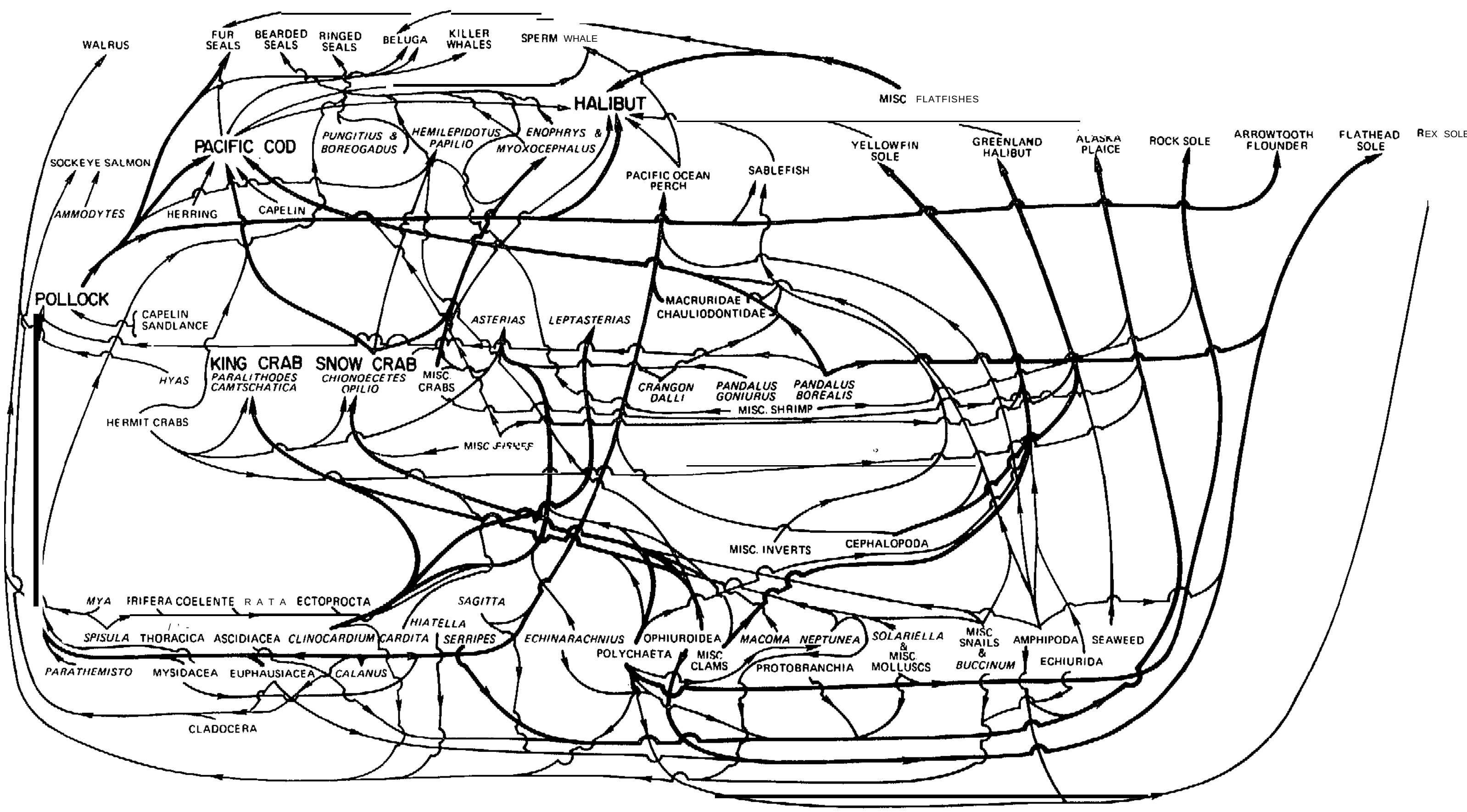

Figure 11. A food web based on the benthic invertebrates of the southeastern Bering Sea. Carbon flows generally in the direction of the arrows. Bold lines indicate major food sources based on frequency of occurrence.

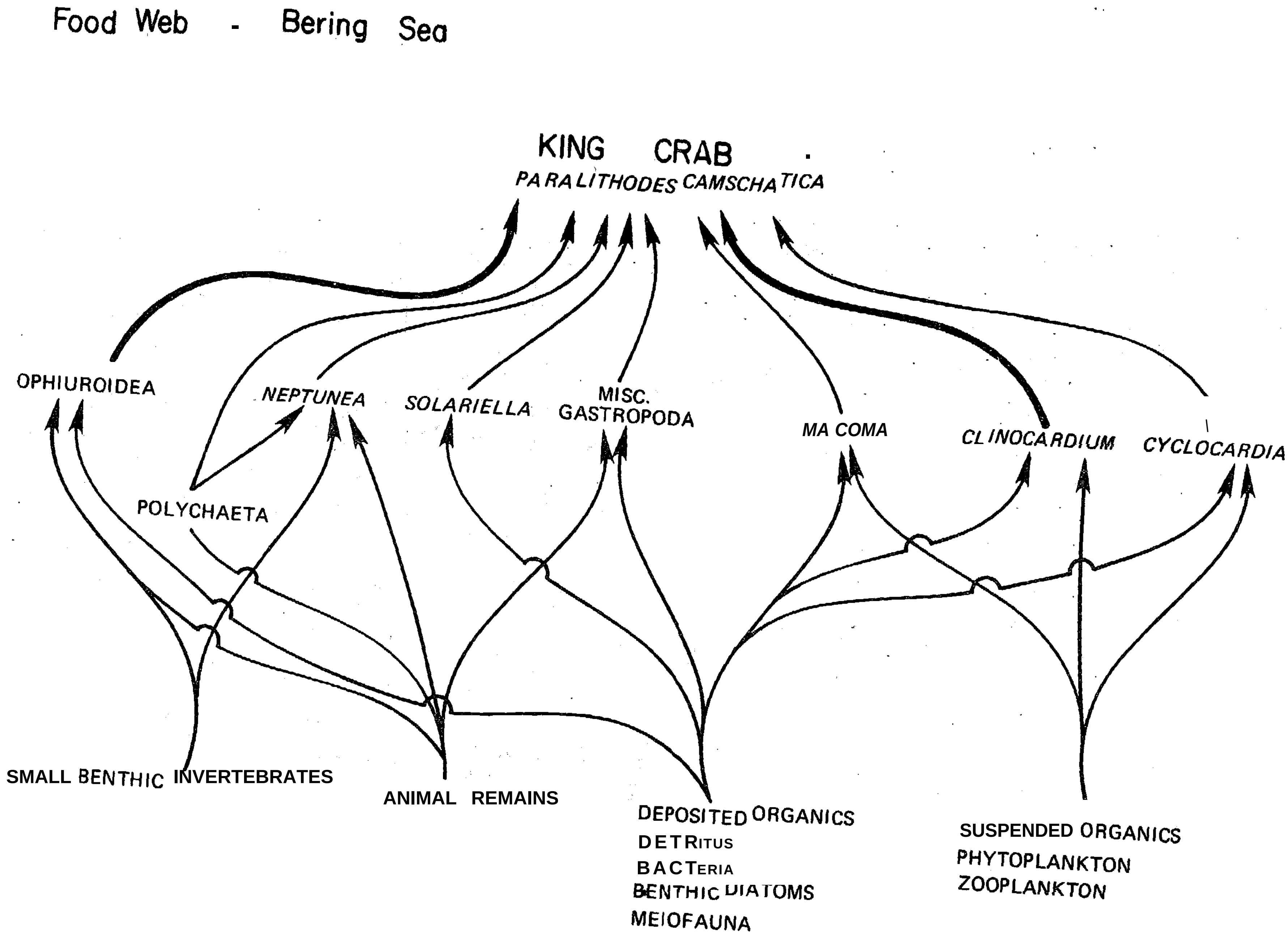

Figure 12. A food web showing carbon flow to king crab (*Paralithodes camtschatica*) in the southeastern Bering Sea. Bold lines indicate major food sources based on frequency of occurrence.

Food Web - Bering Sea

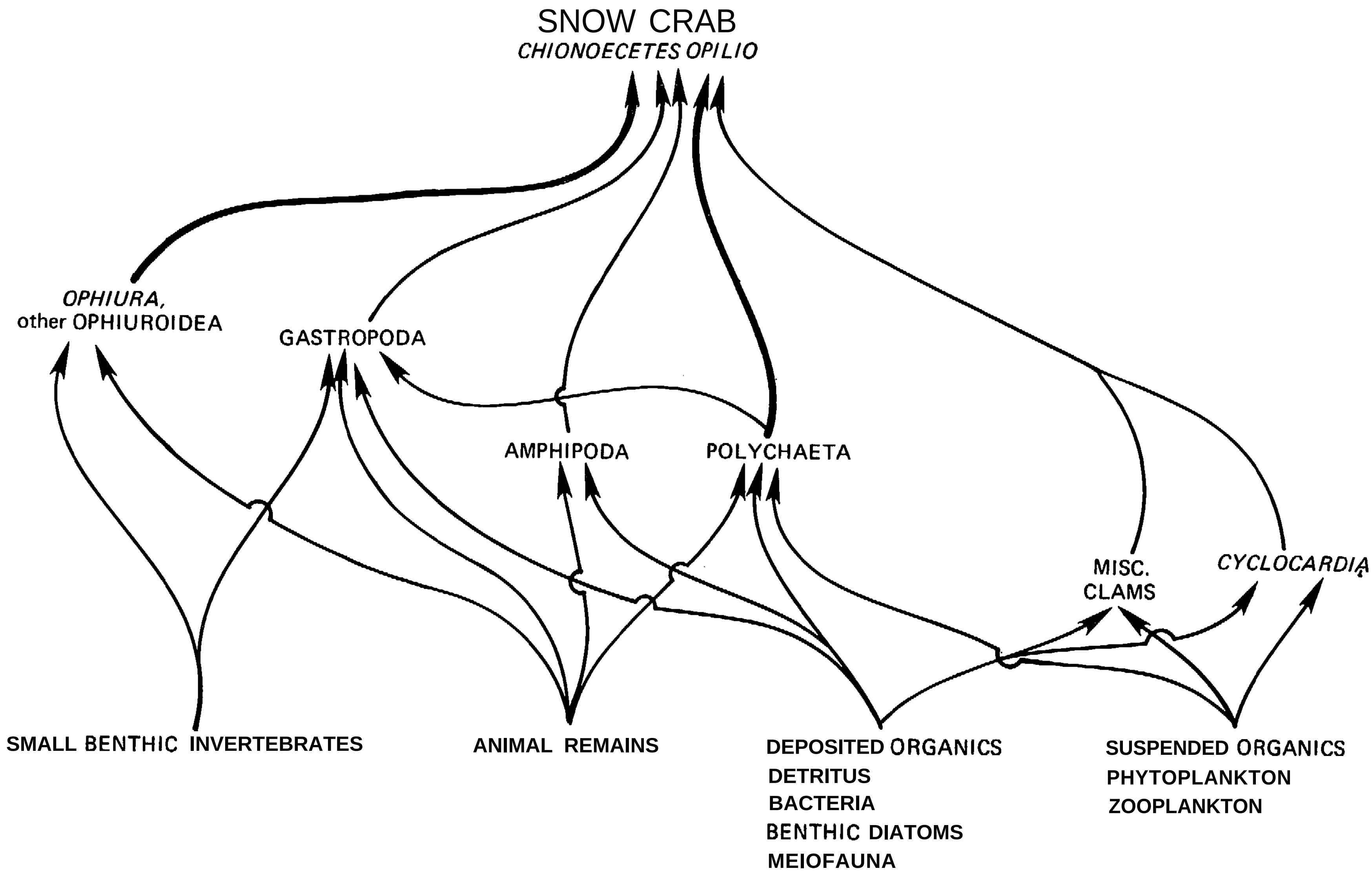

Figure 13. A food web showing carbon flow to snow crab (*Chionoecetes opilio*) in the southeastern Bering Sea. Bold lines indicate major food sources based on frequency of occurrence.

Food Web - BERING. SEA

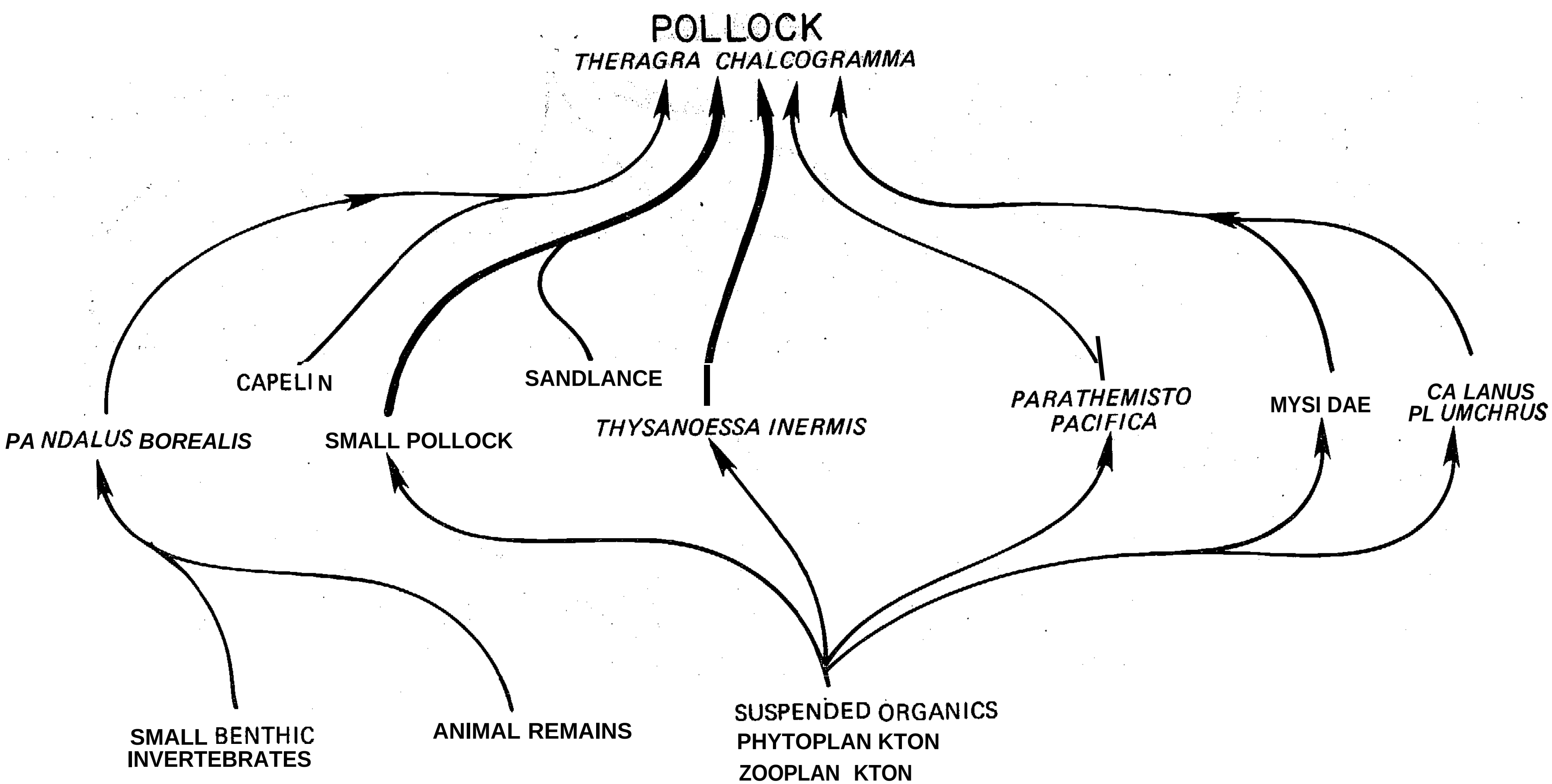

Figure 14. A food web showing carbon flow to pollock (*Theragra chalcogramma*) in the southeastern Bering Sea. Bold lines indicate major food sources based on frequency of occurrence.

Food Web – Bering Sea

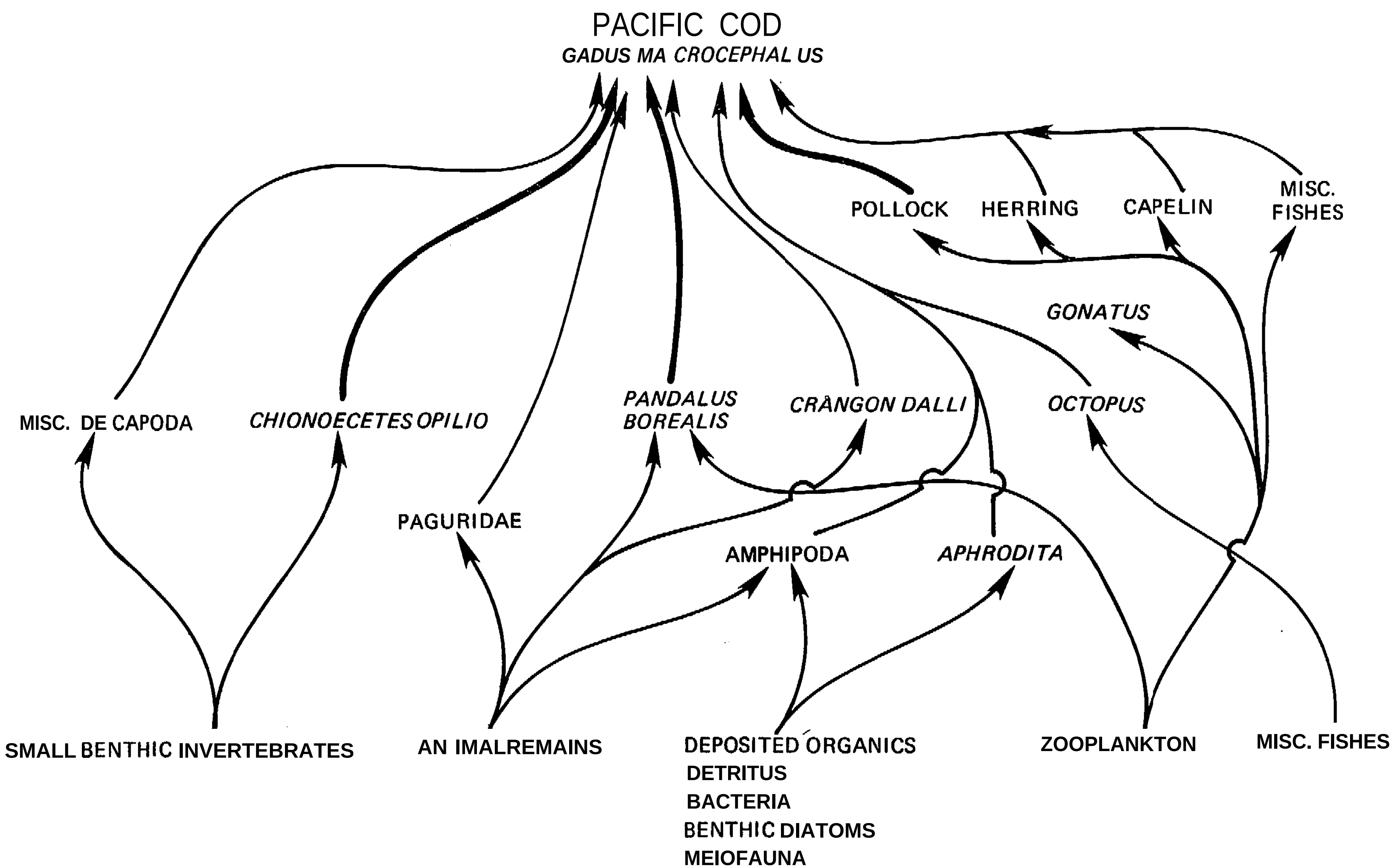

Figure 15. A food web showing carbon flow to Pacific cod (*Gadus macrocephalus*) in the southeastern Bering Sea. Bold lines indicate major food sources based on frequency of occurrence.

Food Web - Bering Sea

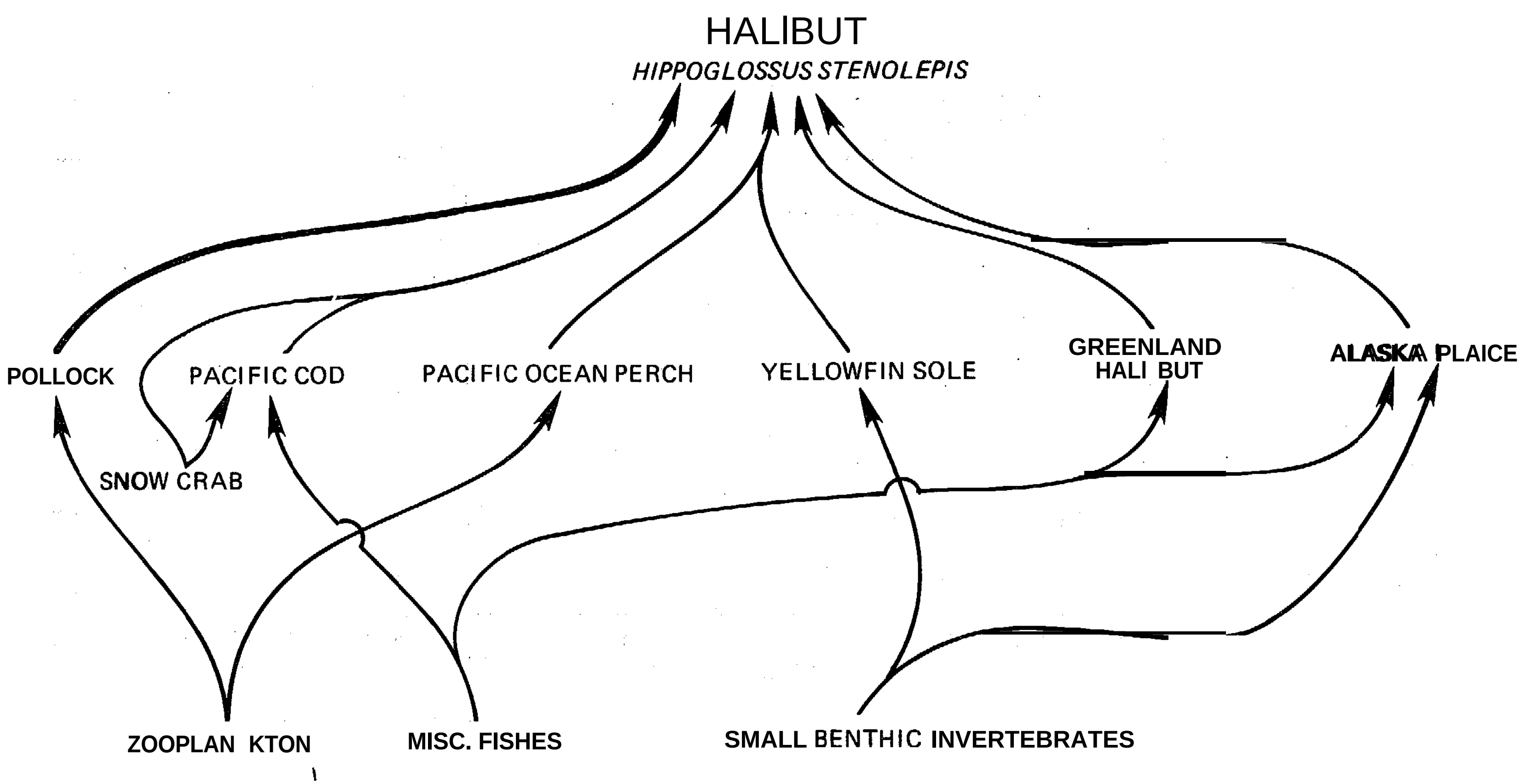

Figure 16. A food web showing carbon flow to Pacific halibut (*Hippoglossus stenolepis*) in the southeastern Bering Sea. Bold lines indicate major food sources based on frequency of occurrence.

TABLE XIX

FEEDING METHODS OF INVERTEBRATES AND FISHES INCLUDED IN THE S.E. BERING SEA FOOD WEB (SEE FIG. 11)[1]

Phyla abbreviations: P=Porifera; C=Coelenterata; A=Annelida; M=Mollusca; Art=Arthropoda; E=Echiurida; Etp=Ectoprocta; Ecd=Echinodermata; Ctn=Chaetognatha; Cho=Chordata. (X=dominant feeding method; O=other feeding method)

Organism	Phylum	Deposit Feeder	Suspension Feeder	Scavenger	Predator	Unknown
Porifera	P		X			
Coelenterata	C				X	
Polychaeta	A	X	X	X	X	
Aphrodita sp.	A	X				
Solariella sp.	M					X
Neptunea sp.	M			X	X	
Buccinum sp.	M			X	X	
Protobranchia	M	X	O			
Cyclocardia sp.	M	O	X			
Clinocardium sp.	M	O	X			
Spisula polynyma	M		X			
Serripes groenlandicus	M	O	X			
Mya sp.	M	O	X			
Hiatella arctica	M	X				

TABLE XIX ,

CONTINUED

Organism	Phylum	Deposit Feeder	Suspension Feeder	Scavenger	Predator	Unknown
Macoma sp.	M	x	o			
Cephalopoda	M				x	
Gonatus sp.	M				x	
Calanus sp.	Art		x			
Calanus plumchrus	Art		x			
Thoracica	Art		x			
Mysidacea	Art		x	x	x	
Amphipoda	Art	x		x		
Parathemisto pacifica	Art				x	
Euphausiacea	Art		x			
Thysanoessa inermis	Art		x			
Pandalus borealis	Art			x		
Pandalus goniurus	Art			x		
Crangon dalli	Art			x		
Paguridae	Art			x	x	

TABLE XIX

CONTINUED

Organism	Phylum	Deposit Feeder	Suspension Feeder	Scavenger	Predator	Unknown
Paralithodes camtschatica	Art			x	x	
Hyas sp.	Art			x		
Chionoecetes opilio	Art			x	x	
Echiurida	E	x				
Ectoprocta	Etp		x			
Echinarachnius parma	Ecd	x				
Asterias amurensis	Ecd				x	
Leptasterias sp.	Ecd				x	
Ophiuroidea	Ecd	x	x	x	x	
Ophiura sp.	Ecd			x	x	
Sagitta sp.	Ctn				x	
Ascidiacea	Cho		x		x	
Clupea harengus pallasi (herring)	Cho				x	
Mallotus villosus (capelin)	Cho				x	

TABLE XIX

CONTINUED

Organism	Phylum	Deposit Feeder	Suspension Feeder	Scavenger	Predator	Unknown
Oncorhynchus nerka (red salmon)	Cho	–	–	–	X	–
Theragra chalcogramma (pollock)	Cho	–	–	–	X	–
Gadus macrocephalus (Pacific cod)	Cho	–	–	–	X	–
Boreogadus sp. (Arctic cod)	Cho	–	–	–	X	–
Pungitius sp. (nine-spine stickleback)	Cho	–	–	–	X	–
Hemilepidotus papilio (sculpin)	Cho	–	–	–	X	–
Myoxocephalus sp. (sculpin)	Cho	–	–	–	X	–
Enophrys sp. (sculpin)	Cho	–	–	–	X	–
Sebastes alutus (Pacific Ocean perch)	Cho	–	–	–	X	–
Anaplopoma fimbria (sablefish)	Cho	–		–	X	–

TABLE XIX

CONTINUED

						wn
Atheresthes stomias (arrowtooth flounder)	Cho	–	–	–	X	–
Glyptocephalus zachirus (rexsole)	Cho	–	–	–	X	–
Hippoglossoides elassodon (flathead sole)	Cho	–	–	–	X	–
Hippoglossus stenolepis (halibut)	Cho	–	–	–	X	–
Lepidopsetta bilineata (rock sole)	Cho	–	–	–	X	–
Limanda aspera (yellowfin sole)	Cho	–	–	–	X	–
Reinhardtius hippoglossoides (Greenland halibut)	Cho	–	–	–	X	–

[1]Based on Newell, 1970; Barnes, 1969; and Thorson, 1967 Rasmussen, 1973; Skalkin, 1963 Hart, 1973; and Feder, unpublished data.

to collect bottom invertebrates and fishes in these surveys, also retrieved man-made debris in its path. A description of this debris, its distribution, and frequency of occurrence are given for the southeastern Bering Sea in 1975 and 1976 (Feder *et al.*, 1978a).

Man-made debris found in the trawl was classified as metal, rope and twine, glass, plastic, fishing gear, cloth, rubber, wood, or paper product. Most classifications contained a wide variety of objects; for example, metal included wire, cans, and metal fragments; fishing gear included derelict crab pots, glass floats, and fish net. No item was placed in more than one classification. Debris was not always recorded in 1975, but was recorded for every trawl in 1976.

In. 1975, debris was only recorded for 12 trawls; in 1976, 43 of 104 trawls (41.3%) contained debris. Occurrence of the various classes of debris "was similar in both years except for plastic which was much more prevalent in 1975 (Table XX). Of the 55 trawls containing debris, 49 (90%) were made in the shaded area shown on Figure 17, a region of intensive fishing pressure. Debris-containing trawls outside this area were widely separated and apparently. random. Debris of obvious Asian origin was found primarily in the shaded area west of 170°W longitude (Figure 17).

VII. DISCUSSION

Distribution, Abundance, and Biomass

The 1975 and 1976 trawl surveys covered only slightly overlapping areas. The 1975 area, mainly on the inner shelf, had an epifaunal standing stock of 3.3 g/m^2; the 1976 area, mainly on the outer shelf, averaged 4.9 g/m^2. The OCSEAP trawl survey made in the Northeast Gulf of Alaska resulted In an estimate of 2.6 g/m^2 (Jewett and Feder, 1976). Epifaunal studies in Norton Sound and the Chukchi Sea - Kotzebue Sound areas yielded similar biomass estimates of 3.7 and 3.3 g/m^2 respectively (Feder and Jewett, in press).

In the Bering Sea, major differences in species dominance were observed between the areas sampled in 1975 and 1976. *Chionoecetes* spp., typically deep-water crabs, increased from 32.7% of the invertebrate biomass in 1975

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TABLE XX

FREQUENCY OF OCCURRENCE OF MAN-MADE DEBRIS ON THE BERING SEA FLOOR

Type of Debris	Number of trawls in which debris was found		
	1975	1976	1975 and 1976 Combined
All types	12	43	55
Metal	2	16	18
Rope and Twine	3	11	14
Glass	2	9	11
Plastic	12	7	19
Fishing gear	1	5	6
Cloth	2	5	7
Rubber	1	3	4
Wood	0	3	3
Paper product	0	1	1

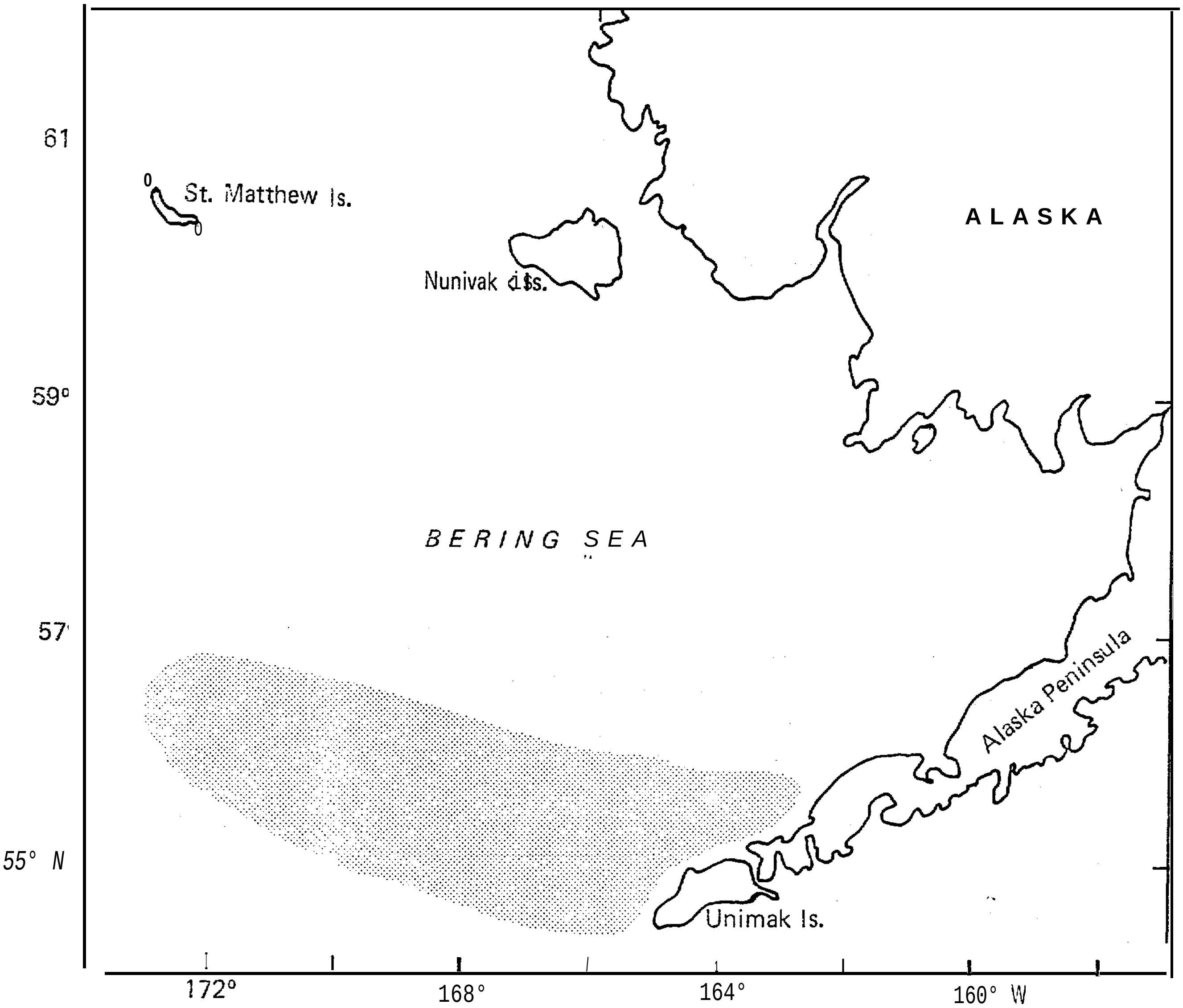

Figure 17.. Study area showing location (shaded area) where 49. debris-containing trawls were made. Debris of Asian origin was found in the shaded area west of 170°W Longitude.

to 48.1% of the biomass in 1976 when the survey area moved into deeper water. The decreasing importance of *Paralithodes camtschatica* and *Asterias amurensis* from 1975 to 1976 is probably also due to this shift in depth. Arthropoda and Echinodermata appear to be the two dominant phyla in the southeast Bering Sea regardless of area. Arthropoda were clearly the dominant group, being 2.6 times as abundant as Echinodermata in the 1975 sampling area and 6.1 times as abundant in the 1976 sampling area. This dominance is attributable to the abundance of the large commercial crabs, *Paralithodes camtschatica*, *Chionoecetes opilio*, and C. *bairdi*, each of which supports a major fishery in the Bering Sea.

In decreasing order of percent of total weight, crustaceans, echinoderms, ascidians, and molluscs were the major epifaunal invertebrate groups taken in the 1975-76 trawl surveys. In general, the most common species were similar to those found by McLaughlin (1963), i.e., *Paralithodes camtschatica*, *Chionoecetes opilio*, *C. bairdi*, and *Asterias amurensis*.

Based on the present study, the distribution of *Paralithodes camtschatica* occurs immediately north of the Alaska Peninsula extending west to Unimak Island. This area is also the commercial fishing grounds for this crab. The pattern of distribution coincides with McLaughlin (1963). The major portion of the population occurs within an area in Bristol Bay which is under consideration for petroleum exploration (also see Pereyra *et al.*, 1976).

Chionoecetes opilio, a slightly smaller crab than *C. bairdi*, was the most widely distributed and dominant crab species encountered. Hybrids (C. *bairdi* x *C. opilio*) were often found. Further information of distribution, abundance, and biological features of the principal crab species can be found in Pereyra et *al.* (1976).

Tne genus *Pagurus* was the decapod with the most species collected. *Pagurus trigonocheirus* dominated the hermit crabs; however, *P. aleuticus*, and *P. capillatus* were also commonly taken. *Labidochirus splendescens*, a small, rapidly moving hermit crab, was normally found to use the shells of small gastropod such as *Natica* spp. or *Polinices* SPP. These shelters were too small to allow the crab to fully withdraw within the shell, but *Labidochirus* is uniquely equipped with a heavily calcified exoskeleton for protection. Furthermore, *Labidochirus splendescens* was often found with its shell completely replaced by a sponge that had assumed the shape of the original shell (also, see MacGinitie and MacGinitie, 1968). An apparent advantage of this replacement is that the sponge is lighter than the original snail shell. The lighter shell may be a clue to the ability of *L. splendescens* to move rapidly so as to enable it to avoid predators. Another advantage may be that of predator avoidance since sponges are seldom preyed upon.

Sea stars of the Bering Sea were represented by 23 species; a similar number of species occurred in the northeast Gulf of Alaska (24 species) (Feder, 1977). Only 17 species were found in the Norton Sound and the Chukchi Sea-Kotzebue Sound areas (Feder and Jewett, 1977). Sea stars made up 19.6% and 5.1% of the total southeastern Bering Sea invertebrate biomass in 1975 and 1976 respectively. On the other hand, 69% and 48% of the total epifaunal invertebrate biomass in the Norton Sound and the Chukchi Sea-Kotzebue Sound areas were sea stars (Feder and Jewett, 19.77). The forcipulate *Asterias amurensis* was the most abundant Bering Sea asteroid (92% of all sea stars from both sampling years). The sea star *Ceramaster patagonicus* occurred more frequently and in greater numbers in 1976 than in 1975. The latter species is common in the deeper waters of the continental shelf sampled in 1976.

Leptasterias polaris acervata occurred at 25.1% of the stations occupied in 1975, and was the second most commonly encountered sea star. In 1976 it was collected at only seven stations, most of which were located in shallow water on the shelf. This sea star, was also an important member of the shallow water benthic community in the Norton Sound-Chukchi Sea area (Feder and Jewett, in press).

Tunicate composition also varied with depth. Ascidians accounted for 8.5% of the epifaunal biomass in 1975, while they comprised 3.3% in 1976. In 1975, where stations were mostly shallower than 80 m, *Styela rustica macrenteron* dominated. McLaughlin (1963) also found this species; however, *Boltenia ovifera* was the most widely distributed tunicate species she encountered. The station grid sampled in the 1975 study was far more extensive than that of McLaughlin (1963).

Among the molluscs, the most striking difference in distribution of a species between the 1975 and 1976 sampling periods is that of *Neptunea heros*. In 1975, the majority of the stations occupied were located on the shelf, in relatively shallow water. *Neptunea heros* occurred at 91 stations, and a total of 4250 individuals were collected. During the 1976 sampling period, when most stations were located in deeper water on the shelf slope, only nine stations yielded *N. heros*. A total of 262 individuals were collected, and the species comprised 5.0% of the total phylum weight. In 1975, N. *heros* comprised 36.6% of the phylum weight. *Neptunea heros* was also important in terms of numbers and weight in the Norton Sound and the Chukchi Sea-Kotzebue Sound area (Feder and Jewett, 1977).

Snails of the genus *Beringius* revealed an opposite trend as compared to *Neptunea heros*. *Beringius* spp. occurred in greater numbers and at more stations during the 1976 sampling period than during 1975. *Fusitriton oregonensis* also occurred more frequently in the deeper waters sampled in 1976.

Russian benthic investigations (Neyman, 1963) provide biomass estimates based on grab samples for infauna and small epifauna from the Bering Sea. The lowest value, 55 g/m^2, for the southeast Bering Sea is greater than our 3.3 g/m^2 (1975) and 4.9 g/m^2 (1976) for trawl collected epifauna from similar areas. Higher infaunal biomass values were reported (Neyman, 1963; summarized by Alton, 1974) for the northern Bering Sea - 905 g/m^2 in the Chirikov Basin and 468 g/m^2 in the Gulf of Anadyr. Use of a commercial trawl results in the loss of infaunal and small epifaunal organisms which are an important part of the benthic biomass. Therefore, the total benthic biomass value is probably best expressed by combining both grab and trawl values (infaunal data will be included in a separate OCSEAP report).

Alton (1974) points out that low biomass values in the southeast Bering Sea may be due to constant cropping by large demersal fish populations, and may not accurately reflect production rates in the area. Furthermore, Alton (1974) shows that, on a world-wide basis, large demersal fish harvests, as occur in the southeast Bering Sea, are not directly related to a large benthic standing stock.

A large proportion of the southeastern Bering Sea benthos is composed of species of direct use as food for man. King crabs, snow crabs, and snails of the genus *Neptunea* are among the most abundant epifaunal invertebrates present in the southeast Bering Sea. In addition, the area may also support clam resources of commercial magnitude (Steven Hughes, NWAFC, unpubl. ; Feder *et* al., 1978b).

The OCSEAP trawl surveys in the northeast Gulf of Alaska (NEGOA) in 1975 and in the Norton Sound and Chukchi Sea-Kotzebue Sound areas provided extensive information on epifauna that can be compared with data from the southeastern Bering Sea (Jewett and Feder, 1976; Ronholt *et al.*, 1976; Feder and Jewett, 1977). The southeastern Bering Sea exhibited greater diversity (233 species) than NEGOA (168 species) and Norton Sound, Chukchi Sea-Kotzebue Sound (187 species). NEGOA epifaunal invertebrate biomass was dominated by Arthropoda (71.4%), Echinodermata (19.0%), and Mollusca (4.6%). 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 (59.9%), Mollusca (12.8%), and Arthropoda (12.5%) (Feder and Jewett, 1977). In general, the arthropod biomass decreased toward higher latitudes and the echinoderm biomass increased. Molluscan biomass was highest in the Norton Sound, Chukchi Sea-Kotzebue Sound area; biomass was similar in the other study areas.

Multiple Tows

Since multiple tows were not taken on exact station locations, these tows cannot be subjected to statistical analysis. However, the results of the intensive sampling of relatively small areas can be used to gain a better understanding of the patchiness of the benthic environment. Also, a somewhat better understanding of the effectiveness of the otter trawl in multiple sampling and trawling duration was achieved.

The number of species collected by a series of tows was not necessarily related to the total count and weight of organisms at a particular station. The number of tows in which a species occurred was indicative of the density of that species in the 'sampling area.

The comparison of the results of the five 30-minute tows and the four 60-minute tows taken at Station D7 seem to indicate that for practical purposes the 30-minute tow is as efficient as the 60-minute tow for sampling the benthic environment. However, further studies in this aspect of sampling should be undertaken to confirm this conclusion.

Food Studies

Of the major biomass components in the Bering Sea (i.e., king crab, snow crabs, and the sea star *Asterias amurensis*), only the feeding habits of the king crab have been examined intensively by numerous investigators.

Cunningham (1969) studied the food of Bering Sea king crabs (*Paralithodes camtschatica*) and determined that echinoderms (*Ophiura sarsi*, *Gorgonocephalus* sp., *Strongylocentrotus* sp., and *Echinarachnius* sp.) were the most important food category based on percent of total food weight (49.1%). Molluscs (*Nuculana radiata*, *Clinocardium californiense*, *Chlamys* sp., *Solariella* sp., and Buccinidae) and crustaceans (*Hyas coarctatus alutaceus*, *Erimacrus isenbeckii*, *Pagurus* sp., *Pandalus* sp., and Amphipoda) were next in importance with 37.2% and 10.1% respectively. As determined by Takeuchi (1959, 1967), molluscs, crustaceans, and echinoderms were the main king crab food items in decreasing order of importance. McLaughlin and Hebard (1961) determined percent frequency of occurrence for food items of male and female Bering Sea king crabs. Primary food items were molluscs (pelecypods) (76.9%, male; 60.6%, female), echinoderms (asteroids, ophiuroids and echinoids) (48.5%, male; 35.6%, female), and decapod crustaceans (Reptantia) (26%, male; 19.4%, female). Polychaetes, algae, and other crustaceans followed in descending order of importance. Feeding was not significantly different between the sexes. Feniuk (1945) found molluscs, crustaceans, and polychaetes, in that order, to be the important food items of king crabs from the west-Kamchatka shelf. Tsalkina (1969) reported that hydroids, primarily *Lafoeina maxima*, are the most preferred food items of early postlarval king crab. Results presented in the present report match other reports, i.e. , molluscs, echinoderms, and crustaceans are important food resources for king crabs in the Bering Sea.

Inferences from the present study, as well as other snow crab food studies, suggest that food groups used by snow crabs are somewhat similar throughout their range. The deposit-feeding clam, *Nucula tenuis*, dominated the diet of *Chionoecetes opilio* from Norton Sound and the Chukchi Sea (Feder and Jewett, in press). *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.*, (in press) 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 detritial material (Feder, unpub. data). 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.

Asterias amurensis is a feeding generalist. Food items were from seven phyla with no single item being used by more than 17.1% of the sea stars examine d. In contrast, the sea star *Leptasterias polaris acervata* fed solely on cockles (Cardiidae). Cockles are apparently quite common in the southeast Bering Sea as suggested by their importance as prey for *Paralithodes camtschatica*, *A. amurensis*, and *L. polaris acervata*. The great abundance and wide distribution of the moderately sized (100 g) sea star, *Asterias amurensis*, implies a great availability of food. It was estimated by Hatanaka and Kosaka (1958) in Sendai Bay, Japan that food consumed annually by the bottom fish population approximated 10,000 metric tons and the food consumed by *A. amurensis* amounted to about 8,000 metric tons. If the food requirements are similar for both bottom fishes and this sea star in the Bering Sea, the sea star population clearly has an important bearing on the production of useful fish.

Sea stars, together with such organisms as sponges, sea anemones, jellyfishes, and sea urchins, are usually considered as terminal members in food webs in marine ecosystems. Hatanaka and Kosaka (1958) calculated that 20-30% of the weight of *Asteria amurensis* in Tokyo Bay is gonadal material which is ultimately extruded during spawning (also see Feder, 1956 and 1970 for comments on the reproductive output of the sea star *Pisaster ochraceus*). Sea stars and the other invertebrates noted above generally exhibit distinct annual reproductive cycles; thus, species that shed their gametes into the surrounding water tend to liberate their sex products over short periods of time (Feder, 1956; Boolootian, 1966 unpubl. observations). Such pulses of high energy reproductive material during the spawning of large populations of sea stars and other invertebrates probably represent important components of secondary production in the study areas (see Isaacs, 1976 for a general discussion of this concept).

Tunicates are sessile, benthic organisms that feed by filtering suspended particles of organic material and small plankters from the water. It is a relatively successful group in some parts of the Bering Sea. Reduced sedimentation may, in part, contribute to their success. Trawling activities in the northeast Gulf of Alaska typically revealed few ascidians (Feder and Jewett, unpub. data), presumably due to high sedimentation rates there. The only known predator on ascidians in the Bering Sea is the walrus (Stoker, 1973).

Crustaceans and fishes dominated as food items for the Bering Sea Pacific cod. These findings are consistent with food of cod from the Kodiak shelf (Jewett, in press).

Bering Sea flatfishes were feeding heavily on clams. Most of these clams are probably using a combination of suspension and deposit feeding methods (Rasmussen, 1973; Reid and Reid, 1969; Feder, unpub. data) with one feeding strategy dominant and the other employed occasionally. Thus, addition of pollutants to the sediments may affect pelecypods not typically considered as deposit feeders. Pelecypods are intensively fed upon by king crabs, snow crabs, and Pacific cod", as well as flatfishes, and are of unquestionable importance as a basis for much of the Bering Sea food web.

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APPENDIX TABLE I

SUMMARIZATION OF GENERAL COMMENTS, MISCELLANEOUS BIOLOGICAL INFORMATION, REPRODUCTIVE AND FEEDING DATA, AND POLLUTANTS COLLECTED ON LEGS I-III OF THE NOAA SHIP *MILLER FREEMAN* S.E. BERING SEA CRUISE - 1975

Tow Number	Station Name	Comments
1	F2	Snail eggs found here. *Chionoecetes bairdi* - 32 males. *Chionoecetes opilio* - 69 males and 2 females. *Chionoecetes* (hybrid) - 13 males.
2	G2	Sex ratio for *Chionoecetes* based on 100% of sample. *Chionoecetes bairdi* - 17 males. *Chionoecetes opilio* – 369 males and 1176 females.
3	G1	*Chionoecetes opilio* - 141 males and 607 females. *Chionoecetes bairdi* – 1 male and 4 females. Snail eggs found here.
4	G18	Snail eggs on *Neptunea* spp. All *Chionoecetes* are males.
5	H18	*Chionoecetes opilio* – 266 males and 2262 females. *Chionoecetes* (hybrid) - 9 males.
6	H19	*Chionoecetes opilio* - 564 males and 96 females. *Chionoecetes bairdi* – 52 males and 4 females. *Chionoecetes* (hybrid) - 13 males and 4 females.
	119	*Chionoecetes opilio* - 156 males and 318 females. *Chionoecetes bairdi* - 4 males and 1 female. *Chionoecetes* (hybrid) – 2 males.
8	120	*Chionoecetes opilio* - 259 males and 1508 females. *Chionoecetes bairdi* – 3 males. *Chionoecetes* (hybrid) – 4 males,
9	J20	*Chionoecetes opilio* - 1067 males and 1566 females. *Chionoecetes bairdi* - 3 males and 29 females.
10	J21	1 plastic bag found. *Chionoecetes opilio* - 508 males and 707 females. *Chionoecetes bairdi* - 3 males. *Chionoecetes* (hybrid) - 8 males.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
11	K21	*Chionoecetes opilio* - 379 males and 1082 females. *Chionoecetes* (hybrid) - 2 males.
12	L21	*Chionoecetes opilio* - 2864 males and 3670 females. *Chionoecetes* (hybrid) - 1 male.
13	L22	*Chionoecetes opilio* - 1747 males and 2784 females. *Chionoecetes* (hybrid) - 1 male.
14	M22	*Chionoecetes opilio* - 1260 males and 1348 females.
15	N22	*Chionoecetes opilio* - 1411 males and 1665 females.
16	N23	*Chionoecetes opilio* - 215 males and 281 females.
17	023	*Chionoecetes opilio* - 520 males and 794 females.
18	P23	*Chionoecetes opilio* - 300 males and 323 females.
19	Q22	*Chionoecetes opilio* - 118 males and 217 females.
20	Q21	*Chionoecetes opilio* - 205 males and 107 females. *Chionoecetes* (hybrid) - 1 male and 5 females.
21	Q20	*Chionoecetes opilio* - 363 males and 215 females.
22	Q19	*Chionoecetes opilio* - 102 males and 53 females.
29	P20	*Chionoecetes opilio* - 506 males and 578 females. *Chionoecetes* (hybrid) - 1 male and 5 females. One piece of plastic strapping found.
30	P21	*Chionoecetes opilio* - 175 males and 156 females. *Chionoecetes* (hybrid) - 1 male and 1 female.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
32	022	*Chionoecetes opilio* - 993 males and 2369 females.
33	021	*Chionoecetes opilio* - 276 males and 364 females.
34	020	*Chionoecetes opilio* - 88 males and 38 females.
35	019	*Chionoecetes opilio* - 57 males and 25 females.
40	04	Trawl ripped.
49	M04	Plastic was found in this trawl. All *Theragra chalcogramma* were juveniles.
54	N18	*Chionoecetes opilio* - 10 males and 14 females.
55	N19	40% of *Argis dentata* were ovigerous. *Chionoecetes opilio* - 9 males and 1 female.
56	N20	*Chionoecetes opilio* – 603 males and 344 females. *Chionoecetes* (hybrid) - 9 males.
57	N21	*Chionoecetes opilio* - 290 males and 300 females. *Chionoecetes* (hybrid) - 11 males and 6 females.
58	M21	*Chionoecetes opilio* - 203 males and 122 females.
60	M19	*Chionoecetes opilio* - 22 males and 10 females. *Chionoecetes* (hybrid) - 2 males.
61	M18	Juvenile *Theragra chalcogramma* - 18.144 Kg.
65	L18	*Chionoecetes opilio* - 91 males and 10 females.
66	L19	Plastic found here. *Chionoecetes opilio* - 473 males and 755 females. *Chionoecetes* (hybrid) - 13 males and 12 females.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
67	L20	*Chionoecetes opilio* - 607 males and 1025 females. *Chionoecetes* (hybrid) - 19 males.
68	K20	*Chionoecetes opilio* - 280 males and 455 females.
69	K19	*Chionoecetes opilio* - 275 males and 516 females. *Chionoecetes* (hybrid) - 6 males.
70	K18	*Chionoecetes opilio* - 291 males and 421 females. *Chionoecetes* (hybrid) – 3 males.
71	K1	*Chionoecetes opilio* - 105 males and 62 females.
72	J1	*Chionoecetes opilio* - 171 males and 195 females.
73	J19	*Chionoecetes opilio* - 94 males and 127 females.
74	J18	*Chionoecetes opilio* - 367 males and 417 females, *Chionoecetes* (hybrid) - 55 males and 18 females.
75	118	*Chionoecetes opilio* - 372 males and 220 females. *Chionoecetes* (hybrid) - 20 males and 8 females.
76	I1	*Chionoecetes opilio* - 680 males and 290 females. *Chionoecetes* (hybrid) - 25 males and 10 females.
77	H1	*Chionoecetes opilio* 168 males and 291 females.
78	D7	*Chionoecetes opilio* – 34 males and 71 females. *Chionoecetes bairdi* - 82 males and 18 females. *Chionoecetes* (hybrid) - 3 males and 1 female.
79	C6	*Chionoecetes opilio* - 11 males and 2 females. *Chionoecetes bairdi* - 37 males and 5 females. *Paralithodes camtschatica* - 32 males and 676 females.

APPENDIX TABLE I

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Tow Number	Station Name	Comments
80	B5	Plastic found here. *Chionoecetes bairdi* - 23 males and 1 female. *Paralithodes camtschatica* - 11 males and 12 females.
81	A4	*Paralithodes camtschatica* - 40 males and 3 females.
83	B3	*Chionoecetes bairdi* - 19 males and 19 females. *Chionoecetes opilio* - 8 males. *Chionoecetes* (hybrid) - 1 male and 3 females.
84	AB2/3	*Chionoecetes bairdi* - 33 males and 88 females. *Chionoecetes opilio* - 1 male and 2 females. *Chionoecetes* (hybrid) - 5 males and 17 females.
85	ZA1/2	*Chionoecetes bairdi* - 1 male and 1 female. *Chionoecetes* (hybrid) - 1 male and 3 females.
86	A2	Sex ratio for *Chionoecetes* based on 100% of sample. *Chionoecetes bairdi* - 10 males and 4 females. *Chionoecetes* (hybrid) - 2 males and 21 females. *Theragra chalcogramma* weight - 3878,3 Kg.
87	F1	*Pagurus aleuticus* - 5 gravid (eggs black). *Pandalus borealis* - 2 gravid (eggs pur- pie). Yellow snail eggs on *Neptunea* shells. *Chionoecetes bairdi*, *Chionoecetes opilio*, and *Chionoecetes* (hybrid) were all males.
88	H2	*Chionoecetes bairdi* – 4 males and 1 female. *Chionoecetes opilio* – 140 males and 131 females. *Chionoecetes* (hybrid) - 6 males and 3 females.
89		Contents not enumerated.
90	13	*Chionoecetes opilio* - 115 males and 34 females. *Chionoecetes* (hybrid) - 1 male. Snail eggs - 120 g. *Styela mac- renteron*, *Eunephthya rubiformis* and snail eggs were found on snail shells.

APPENDIX TABLE I

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Tow Number	Station Name	Comments
91	13	*Chionoecetes opilio* - 604 males and 174 females. *Chionoecetes* (hybrid) - 56 males and 29 females. Snail eggs - 430 g.
92	14	*Chionoecetes opilio* - 758 males and 189 females. *Chionoecetes* (hybrid) 37 males and 36 females. Snail eggs - 2.513 Kg.
93	H4	*Chionoecetes* (hybrid) - 9 males. *Chionoecetes bairdi* - 2 females. *Chionoecetes opi lio* - 100 females and 195 males. Yellow snail eggs - 34 g.
94	G5	*Chionoecetes bairdi* - 4 males. *Chionoecetes* (hybrid) - 36 males and 12 females. *Chionoecetes opilio* - 679 males and 431 females. Snail eggs - 27.058 Kg. Comments are based on 100% of sample.
95	H5	Snail eggs - 2.118 Kg. *Chionoecetes opilio* - 234 males and 416 females. *Chionoecetes* (hybrid) - 9 males,
96	15	Snail eggs - 1.315 Kg. *Chionoecetes opi lio* - 376 males and 10 females. *Chionoecetes* "(hybrid) - 17 males.
97	16	Catch not enumerated.
98	H6	*Chionoecetes bairdi* - 2 males and 1 female. *Chionoecetes opilio* - 131 males and 8 females. *Chionoecetes* (hybrid) - 1 male. Snail eggs - 3.835 Kg.
99	G6	Catch not enumerated.
100	FG6/7	Snail eggs - 2.104 "Kg. *Chionoecetes opilio* - 355 males and 373 females. *Chionoecetes* (hybrid) - 26 males and 8 females. *Chionoecetes bairdi* - 30 males and 28 females. *Paralithodes camtschatica* - 1 male. Juvenile *Theragra chalcogramma* - 5.171 Kg.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
101	D7	# comparative trawl 1. *Chionoecetes bairdi* - 89 males and 38 females. *Chionoecetes opilio* - 127 males and 154 females. *Chionoecetes* (hybrid) - 12 males and 12 females. *Paralithodes camtschatica* - 1 male. Snail eggs - 98 g.
102	D7	# comparative trawl 2. Comments are based on 100% of sample. Snail eggs - 497 g. *Paralithodes camtschatica* - 2 males and 1 female. *Chionoecetes bairdi* - 83 males and 27 females. *Chionoecetes opilio* - 98 males and 293 females. *Chionoecetes* (hybrid) - 9 males and 3 females.
103	D7	# comparative trawl 3(5). *Chionoecetes opilio* - 18 males and 65 females. *Chionoecetes bairdi* - 22 males and 23 females. *Chionoecetes* (hybrid) - 4 males. Yellow snail eggs - 165 g.
104	D7	# comparative trawl 4(6). 2 *Pagurus aleuticus* - gravid (black eggs). White snail eggs - 50 g. Yellow snail eggs - 43 g* *Chionoecetes opilio* - 46 males and 83 females. *Chionoecetes bairdi* - 23 males and 9 females. *Chionoecetes* (hybrid) - 9 males.
105	D7	# comparative trawl 5(8). Snail eggs - 283 g. (Based on 100% of sample.) *Chionoecetes bairdi* - 93 males and 56 females. *Chionoecetes opilio* - 88 males and 126 females. *Chionoecetes* (hybrid) - 10 males and 5 females. *Paralithodes camtschatica* - 54 males and 1 female.
106	D7	# comparative trawl 6(9). Snail eggs - 82 g. *Chionoecetes bairdi* - 53 males and 110 females. *Chionoecetes opilio* – 43 males and 25 females. *Chionoecetes* (hybrid) - 3 males and 5 females. *Paralithodes camtschatica* - 62 males and 5 females.

APPENDIX TABLE I

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Tow Number	Station Name	Comments
107	D7	# comparative trawl 7(10). Snail eggs - 33 g. *Chionoecetes bairdi* - 99 males and 34 females. *Chionoecetes opilio* - 152 males and 169 females. *Chionoecetes* (hybrid) - 6 males and 7 females. *Paralithodes camtschatica* - 13 males and 2 females.
108	D7	# comparative trawl 8(12). Snail eggs - 12 g. 2 *Pagurus capillatus* with parasitic barnacle. *Chionoecetes bairdi* - 61 males and 22 females. *Chionoecetes opilio* - 73 males and 91 females. *Chionoecetes* (hybrid) - 4 males and 12 females. *Paralithodes camtschatica* - 8 males and 1 female..
109	D7	Catch not enumerated.
110	A3	*Chionoecetes bairdi* – 30 males and 1 female. *Chionoecetes opilio* - 7 males and 1 female. *Chionoecetes* (hybrid) - 4 males and 1 female.
111	A3	Snail eggs - 102 g. *Chionoecetes bairdi* - 85 males and 78 females. *Chionoecetes opilio* - 1 male and 12 females. *Chionoecetes* (hybrid) - 14 males and 70 females.
112	A3	Trawl contents emptied on deck in the process of removing a sea lion, not sampled.
113	A3	Sex ratio based on 100% of sample. *Chionoecetes bairdi* - 56 males and 70 females. *Chionoecetes opilio* - 1 male and 2 females. *Chionoecetes* (hybrid) - 5 males and 47 females.
114	A3	*Chionoecetes bairdi* - 15 males and 62 females. *Chionoecetes opilio* - 1 male. *Chionoecetes* (hybrid) - 7 males and 6 females.

APPENDIX TABLE I

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Tow Number	Station Name	Comments
115	AB2/3	# comparative trawl 1. Pollutants - 1 piece plastic and 1 bottle. *Chionoecetes bairdi* - 142 males and 158 females. *Chionoecetes opilio* - 10 males and 3 females. *Chionoecetes* (hybrid) - 5 males and 34 females. *Paralithodes camtschatica* - 2 males. 1 crab pot caught in trawl.
116	AB2/3	# comparative trawl 2. Snail eggs - 8 g. Wood with ship worms present - 247 g. *Chionoecetes bairdi* - 32 males and 65 females. *Chionoecetes opilio* - 4 males and 3 females, *Chionoecetes* (hybrid) .- 4 males and 35 females.
117	AB2/3	# comparative trawl 3. *Chionoecetes bairdi* - 51 males and 84 females. *Chionoecetes opilio* - 3 males. *Chionoecetes* (hybrid) - 2 males and 27 females. *Paralithodes camtschatica* - 1 male.
118	AB2 /3	# comparative trawl 4. *Chionoecetes bairdi* - 35 males and 32 females. *Chionoecetes opilio* - 2 males. *Chionoecetes* (hybrid) - 4 males and 12 females. *Paralithodes camtschatica* - 2 males.
119	AB2/3	# comparative trawl 5. Sex ratio based on 100% of sample. *Chionoecetes bairdi* - 55 males and 63 females. *Chionoecetes opilio* - 6 males and 4 females. *Chionoecetes* (hybrid) - 8 males and 30 females. *Paralithodes camtschatica* - 2 males.
120	F3	*Chionoecetes bairdi* - 3 males and 2 females. *Chionoecetes opilio* - 39 males and 7 females. *Chionoecetes* (hybrid) - 12 males and 1 female.
121	G3	Snail eggs - 233 g. 3 *Leptasterias polaris ascervata* feeding on *Clinocardium* sp. *Chionoecetes bairdi* - 4 males. *Chionoecetes opilio* - 100 males and 206 females. *Chionoecetes* (hybrid) - 14 males and 27 females.

APPENDIX TABLE I

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Tow Number	Station Name	Comments
122	23	# comparative trawl 1. Snail eggs - 157 g.
123	23	# comparative trawl 2. *Argis ovifer* - 2 gravid females - eggs turquoise-green.
124	AZ2/3	Comments based on 100% of sample. *Chionoecetes bairdi* - 8 males and 5 females. *Chionoecetes* (hybrid) - 1 male and 6 females.
125	AZ3/4	*Chionoecetes bairdi* - 15 males and 34 females. *Chionoecetes opilio* - 4 males and 3 females. *Chionoecetes* (hybrid) - 2 males and 43 females.
126	AZ4/5	# comparative trawl 1. *Chionoecetes bairdi* - 337 males and 251 females. *Chionoecetes* (hybrid) - 8 males and 48 females.
127	AZ4/5	# comparative trawl 2. Snail eggs - 55 g. *Chionoecetes bairdi* - 35 males and 16 females. Comments based on 100% of sample.
128	AZ4/5	# comparative trawl 3. Pollutants - 1 plastic bag, 2" x 6' rubber belt, 1 aluminium beer can, miscellaneous plastics. Snail egg - 70 g. *Chionoecetes bairdi* - 64 males and 58 females. *Chionoecetes* (hybrid) - 2 males and 4 females. *Paralithodes camtschatica* – 1 male.
129	AZ4/5	# comparative trawl 4. Pollutants - plastic and polypropylene. *Chionoecetes bairdi* - 407 males and 118 females. *Chionoecetes opilio* - 1 male. *Chionoecetes* (hybrid) - 5 males and 1 female. *Paralithodes camtschatica* - 25 males.
130	AZ4/5	# comparative trawl 5. Snail eggs - 32 g. *Chionoecetes bairdi* - 304 males and 144 females. *Chionoecetes* (hybrid) - 1 male. *Paralithodes camtschatica* - 15 males.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
131	Z5	# comparative trawl 3. Pollutants - plastic and cloth. *Chionoecetes bairdi* - 266 males and 337 females. *Chionoecetes opilio* - 1 male. *Chionoecetes* (hybrid) - 1 female. *Paralithodes camtschatica* - 41 males and 10 females.
132	Z5	# comparative trawl 2. Catch not enumerated. Trawl ripped.
133	Z5	# comparative trawl 1. *Chionoecetes bairdi* - 114 males and 7 females. *Chionoecetes opilio* - 1 male. *Paralithodes camtschatica* - 5 males and 18 females.
134	Z5	# comparative trawl 4. Sex ratio based on 100% of sample. *Chionoecetes bairdi* - 237 males and 114 females. *Chionoecetes opilio* - 11 males. *Chionoecetes* (hybrid) - 3 males and 4 females. *Paralithodes camtschatica* - 4 males.
135	D6	*Chionoecetes bairdi* - 39 males and 169 females. *Chionoecetes opilio* - 71 males and 408 females, *Chionoecetes* (hybrid) - 33 females. *Paralithodes camtschatica* - 6 males and 5 females. 1 *Pagurus capillatus* with parasitic barnacle on abdomen.
136	DE6/7	Comments based on 100% of sample. *Chionoecetes bairdi* - 124 males and 36 females. *Chionoecetes opilio* - 410 males and 66 females. *Chionoecetes* (hybrid) - 59 males. *Paralithodes camtschatica* - 36 males. Snail eggs - 257 g.
137	E6	Snail eggs - 209 g. *Chionoecetes bairdi* - 60 males and 13 females. *Chionoecetes opilio* - 381 males and 541 females. *Chionoecetes* (hybrid) - 6 males and 6 females. *Paralithodes camtschatica* - 21 males. Juvenile *Theragra chalcogramma* - 23.042 Kg.

APPENDIX TABLE I

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Tow Number	Station Name	Comments
138	EF5/6	Snail eggs - 3.567 Kg. *Natica clausa* attached under the operculum of *Neptunea lyrata*. *Chionoecetes bairdi* - 7 males and 18 females. *Chionoecetes* (hybrid) - 23 males and 40 females. *Chionoecetes opilio* - 488 males and 1014 females. Juvenile *Theragra chalcogramma* 10.886 Kg.
139	F6	Catch not enumerated.
140	G7	*Chionoecetes bairdi* - 68 males and 94 females. *Chionoecetes opilio* - 894 males and 743 females. *Chionoecetes* (hybrid) - 8 females. Snail eggs - 714 g.
141	G8	Snail eggs - 726 g. *Chionoecetes bairdi* - 57 males and 81 females. *Chionoecetes opilio* - 570 males. and 29 females. *Chionoecetes* (hybrid) - 24 males.
142	GH8/9	Pollutants - tin cans. Snail eggs - 7.625 Kg. *Chionoecetes bairdi* - 21 males and 21 females. *Chionoecetes opilio* - 97 males and 4 females. *Chionoecetes* (hybrid) - 8 males.
143	G9	Comments based on 100% of sample. Snail eggs - 7.262 Kg. *Chionoecetes bairdi* - 105 males and 149 females. *Chionoecetes opilio* - 136 males. *Chionoecetes* (hybrid) - 12 males and 2 females. *Paralithodes camtschatica* - 5 males.
144	FG9/10	Comments based on 100% of sample. Snail eggs - 87 g. *Chionoecetes bairdi* - 270 males and 213 females. *Chionoecetes opilio* - 152 males. *Paralithodes camtschatica* - 2091 males.
145	F10	Comments based on 100% of sample. *Chionoecetes bairdi* - 75 males and 54 females. *Chionoecetes opilio* - 17 males and 6 females. *Paralithodes camtschatica* - 13 males and 4 females. Juvenile *Theragra chalcogramma* - .53.842 Kg.

APPENDIX TABLE I

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Tow Number	Station Name	Comments
146	EF11/10	Comments based on 100% of sample. *Chionoecetes bairdi* - 98 males and 177 females. *Chionoecetes opilio* - 12 males and 5 females. *Paralithodes camtschatica* - 329 males and 449 females. Juvenile *Theragra chalcogramma* - 46.8069 Kg.
147	AZ5/6	*Chionoecetes bairdi* - 35 males and 70 females. *Chionoecetes opilio* - 2 males. *Paralithodes camtschatica* – 3 males and 1 female.
148	A5	Snail eggs - 96 g. *Chionoecetes bairdi* - 151 males and 7 females. *Chionoecetes opilio* - 1 male. *Paralithodes camtschatica* - 27 males and 80 females.
149	BA4 / 5	Comments based on 100% of sample. Snail eggs - 33 g. *Chionoecetes bairdi* - 61 males and 69 females. *Chionoecetes opilio* - 3 males. *Chionoecetes* (hybrid) - 2 males. *Paralithodes camtschatica* - 14 males and 13 females.
150	B4	Snail eggs - 15 g. Pollutants - plastic, rope and gloves. *Chionoecetes bairdi* - 32 males and 5 females. *Chionoecetes opilio* - 3 males. *Chionoecetes* (hybrid) - 1 male and 1 female. *Paralithodes camtschatica* - 6 males.
151	AB3/4	*Chionoecetes bairdi* - 146 males and 194 females. *Chionoecetes opilio* - 3 males and 4 females. *Chionoecetes* (hybrid) - 8 males and 54 females. *Paralithodes camtschatica* - 1 male.
152	Z4	# comparative trawl 1. Comments based on 100% of sample. Several thousand Ophiuridae, *Ctenodiscus crispatus* and *Ceramaster patagonicus* in trawl wings-irretrievable. *Chionoecetes bairdi* - 20 males and 15 females. *Chionoecetes opilio* - 5 females. *Chionoecetes* (hybrid) - 15 females.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
1 5 3	Z4	# comparative trawl 2. *Chionoecetes bairdi* - 18 males and 14 females. *Chionoecetes* (hybrid) - 1 female. *Chionoecetes opilio* - 4 females. Pollutants - glass, rope and plastic.
154	H3	*Pandalus goniurus*, 1 gravid female with aqua colored eggs. *Chionoecetes bairdi* 1 male. *Chionoecetes opilio* - 731 males and 186 females. *Chionoecetes* (hybrid) - 30 males and 15 females. Snail eggs - 1.81 Kg. *Balanus* sp., *Styela macrenteron*, bryozoan and snail eggs attached to *Neptunea* shell.
155	G4	*Pandalus borealis*, 1 gravid with aqua colored eggs. *Chionoecetes bairdi* - 1 male. *Chionoecetes opilio* - 646 males and 1469 females. *Chionoecetes* (hybrid) - 38 males and 64 females. Snail eggs - 454 g. Empty shells - 26.300 Kg.
156	F4	Calculated for 100% of sample. *Chionoecetes opilio* - 1282 males and 1918 females. *Chionoecetes* (hybrid) - 50 males and 143 females. Empty shells - 82.6 Kg. Snail eggs - 7.6 Kg.
157	F5	*Chionoecetes bairdi* - 6 males and 14 females. *Chionoecetes opilio* - 549 males and 633 females. *Chionoecetes* (hybrid) - 25 males and 47 females. Empty shells - 22.8 Kg.
158	17	Calculated to 100% of sample. *Chionoecetes opilio* - 108 males and 80 females. *Chionoecetes bairdi* - 16 males and 20 females. *Chionoecetes* (hybrid) - 8 males and 12 females. *Hyas coarctatus alutaceus* - 40 males and 124 females. Empty shells - 34.7 Kg. *Balanus* sp., *Styela macrenteron*, *Musculus* sp., bryozoan, and *Hiatella arctica* attached to *Neptunea* shells.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
159	H7	Empty shell 103.7 Kg. *Chionoecetes opilio* - 162 males and 1 female. *Chionoecetes bairdi* - 3 males and 4 females. *Chionoecetes* (hybrid) - 28 males,
160	H8	*Chionoecetes opilio* - not sexed. *Chionoecetes bairdi* - 9 males and 9 females. *Chionoecetes* (hybrid) - 1 female. Empty shell - 26.7 Kg.
161	H9	Calculated to 100% of sample. *Chionoecetes bairdi* - 799 males and 43 females. *Chionoecetes opilio* - 6 males. *Chionoecetes* (hybrid) - 2 males.
162	IH9I10	Calculated to 100% of sample. *Chionoecetes bairdi* - 27 males. *Chionoecetes* (hybrid) - 7 males. Snail eggs, orange eyed eggs, and *Balanus* sp. attached to *Neptunea* shells.
163	I12	*Hyas coarctatus alutaceus* with *Mytilus edulis* attached to carapace. Empty shell - 1.1 Kg. *Hyas coarctatus alutaceus* - 6 males. *Chionoecetes bairdi* - 4 males. *Paralithodes camtschatica* - 29 males and 15 females.
164	IJ12/13	*Paralithodes camtschatica* - 10 males and 9 females. *Hyas coarctatus alutaceus* - 17 males and 5 females. *Chionoecetes bairdi* - 1 male. Type 16 sea anemone, *Balanus* sp., snail eggs and *Boltenia ovifera* attached to *Neptunea* shell.
165	J13	*Hyas coarctatus alutaceus* - 1 male. *Paralithodes camtschatica* - 4 males and 7 females. Juvenile *Theragra chalcogramma* weight - 3.628 Kg.
166	JK13/14	*Paralithodes camtschatica* - 6 females *Pandalus goniurus* - 80 gravid, eggs aqua colored.
168	K13	Trawl ripped, specimens were not enumerated.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
169	JK12/13	Empty shells - 5.79 Kg. Snail eggs - 454 g. *Paralithodes camtschatica* - 1 male and 4 females. *Telmessus cheiragonus* - 2 males.
170	J12	*Styela macrenteron, Boltenia ovifera* and *Mytilus edulis* attached to *Neptunea* shells. Juvenile *Theragra chalcogramma* weight - 2.812 Kg. *Paralithodes camtschatica* - 1 male and 4 females.
171	IJ11/12	Type 16 sea anemone, *Styela macrenteron, Balanus* sp., *Boltenia ovifera*, and bryozoan attached to *Neptunea* shell. *Spisula* and *Serripes* shell fragments also present. *Paralithodes camtschatica* - 2 males.
172	J11	*Balanus rostratus*, type 7 and 16 sea anemone, *Boltenia ovifera, Styela macrenteron* and sponge attached to *Neptunea* shell. Sponge was also attached to the stipe of *Boltenia*. *Hyas lyratus* - 16 males and 4 females. *Hyas coarctatus alutaceus* - 16 males and 4 females. *Pandalus goniurus* - 330 gravid, eggs aqua colored. *Argis dentata* - 4 gravid, eggs aqua colored. *Chionoecetes bairdi* - 4 males. *Paralithodes camtschatica* - 1 male and 1 female. Juvenile *Theragra chalcogramma* weight - 42.048 Kg.
173	JK11/12	*Paralithodes camtschatica* - 8 males and and 7 females, 6 gravid with eggs black colored. *Pandalus goniurus* - 20 gravid, eggs aqua colored. Snail eggs present.
174	K12	*Balanus* sp. and type 19 sea anemone attached to *Mytilus edulis*. *Telmessus cheiragonus* - 7 males and 1 female. *Paralithodes camtschatica* - 1 female.
175	J10	*Chionoecetes bairdi* - 7 males and 2 females. *Telmessus cheiragonus* - 39 males and 3 females, 1 gravid with dark brown eggs. *Paralithodes camtschatica* - 8 males and 7 females. 1 *Pagurus capillatus* parasitized by a parasitic barnacle.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
176	JK10/11	Snail eggs - .907 g. *Balanus* sp. attached to *Neptunea* shells. *Paralithodes camtschatica* - 13 females and 11 males, 12 gravid with brown eggs. *Telmessus cheiragonus* - 3 males. *Chionoecetes bairdi* – 1 female, gravid with orange eggs.
177	K11	Trawl ripped extensively, specimens were not enumerated.
178	K11	Trawl ripped extensively, a few interesting specimens collected, otherwise none were enumerated.
179	K1 0	*Telmessus cheiragonus* - 10 males and 4 females. *Paralithodes camtschatica* - 4 males and 4 females. *Hyas lyratus* - 4 males. *Balanus* sp. attached to *Neptunea* shells.
180	K9	*Balanus* sp. attached to *Neptunea* shells. *Paralithodes camtschatica* - 7 males. *Telmessus cheiragonus* - 3 males. *Hyas coarctatus alutaceus* - 2 males and 1 female.
184	L6	*Telmessus cheiragonus* - 2 males. Snail eggs - 1.31 Kg.
185	L5	*Paralithodes camtschatica* - 1 male.
187	Q11	*Balanus* sp. attached to *Neptunea* shells.
188	L2	*Erimacrus isenbeckii* - 4 males and 1 female. *Hyas lyratus* – 4 males. Juvenile *Theragra chalcogramma* weight - 33.240 Kg.
189	K2	Calculated to 100% of sample. *Chionoecetes* (hybrid) - 12 males. *Chionoecetes opilio* - 182 males. *Hyas lyratus* - 124 males and 41 females. *Styela macrenteron*, *Balanus* sp. and *Musculus discors* attached to *Neptunea* shells.
190	J2	Empty shells - 73.7 Kg.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
191	L3	*Paralithodes camtschatica* - 1 female. *Chionoecetes opilio* - 120 males and 26 females. *Balanus* sp., *Musculus discors*, *Styela macrenteron*, snail eggs bryozoan and compd. tunicate attached to *Neptunea* shells. Empty shells - 8.7 Kg. Juvenile *Theragra chalcogramma* weight - 952 g.
192	K3	Bryozoan, *Tecticeps alascensis*, *Musculus discors*, compd. tunicate, *Balanus* sp., *Crepidula grandis*, and *Velutina lanigera* attached to *Neptunea* shells. Empty shell - 25.8 Kg. Juvenile *Theragra chalcogramma* weight - 31.752 Kg. *Hyas coarctatus alutaceus* - 65 males and 7 females.
193	J3	Empty shell - 79.6 Kg. *Chionoecetes opilio* - 476 males and 34 females. *Chionoecetes* (hybrid) - 18 males and 10 females.
194	J4	Juvenile *Theragra chalcogramma* weight - 14.379 Kg.
195	K4	*Chionoecetes opilio* - 157 males. *Chionoecetes bairdi* - 1 male. *Chionoecetes* (hybrid) - 27 males and 2 females. *Erimacrus isenbeckii* - 4 males and 1 female. Juvenile *Theragra chalcogramma* weight – 7.076 Kg.
196	J5	*Argis dentata* - 10 gravid, eggs aqua colored.
197	K5	*Balanus* sp., hydrozoan, snail eggs, *Crepidula grandis*, *Styela macrenteron*, *Musculus discors* attached to *Neptunea* shell. *Leptasterias* sp. in aperture of *Neptunea*. Juvenile *Theragra chalcogramma* weight - 14.515 Kg. *Hyas coarctatus alutaceus* - 18 males and 2 females. *Chionoecetes bairdi* - 1 male.
198	K6	*Balanus* sp., snail eggs, type 10 and 16 sea anemone, *Styela macrenteron*, *Musculus discors*, *Velutina lanigera* and *Synidotea bicuspida* attached to *Neptunea* shell. Scale worms found in aperture of *Neptunea*. *Hyas coarctatus alutaceus* - 22 males and 2 females. Empty shell - 7.4 Kg. Parasitic barnacle on abdomen of *Pagurus capillatus*.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
199	K7	Empty shells - 16.7 Kg. *Balanus* sp., type 16 sea anemone, and snail attached to *Neptunea* shell. *Argis dentata* 1 gravid, eggs aqua colored. *Paralithodes camtschatica* - 1 female. *Hyas coarctatus alutaceus* - 15 females.
200	K8	Empty shells - 5.4 Kg. Snail eggs - .22 g. *Balanus* sp., snail eggs and type 16 sea anemone attached to *Neptunea* shells. *Hyas coarctatus alutaceus* - 3 males. *Paralithodes camtschatica* - 1 gravid, eggs colored purple.
201	J6	*Argis dentata* - 3 gravid, eggs aqua colored. *Hyas coarctatus alutaceus* - 25 males and 2 females. *Paralithodes camtschatica* - 1 male. *Balanus* sp., snail eggs, *Styela macrenteron*, and *Musculus discors* attached to *Neptunea* shell.
202	J7	*Hyas coarctatus alutaceus* - 20 males and 1 female. *Balanus* sp., snail eggs, and bryozoan attached to *Neptunea* shells.
203	J8	*Balanus* sp., snail eggs, and *Styela macrenteron* attached to *Neptunea* shells. Empty shells - 6.2 Kg.
204	J9	*Hyas coarctatus alutaceus* - 3 males. *Chionoecetes bairdi* - 1 male and 1 female. *Paralithodes camtschatica* - 9 males and 7 females. Empty shells - 9.4 Kg.
205	19	*Paralithodes camtschatica* - 13 males and 3 females. 277.6 Kg of peat.
206	18	*Paralithodes camtschatica* - 5 males. *Hyas coarctatus alutaceus* - 13 males and 1 female. *Chionoecetes bairdi* – 4 males and 1 female.
207	DE11/12	*Paralithodes camtschatica* - 7 females. *Chionoecetes* - 4 males and 1 female.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
208	E12	Calculated to 100% of sample. *Paralithodes camtschatica* - 6 males and 167 females. *Erimacrus isenbeckii* - 6 males and 3 females. *Chionoecetes bairdi* - 9 males and 3 females.
209	G12	*Erimacrus isenbeckii* – 4 males. *Paralithodes camtschatica* - 57 males and 34 females. *Chionoecetes bairdi* - 14 males and 8 females.
210	GH12/13	*Paralithodes camtschatica* - 14 males and 28 females. *Balanus* sp., *Styela macrenteron* and *Boltenia ovifera* attached to *Neptunea* shells. Juvenile *Theragra chalcogramma* weight - 16.057 Kg.
211	G13	*Paralithodes camtschatica* - 6 males and 63 females. *Chionoecetes bairdi* - 17 males and 2 females.
213	E13	Sponge attached to kelp holdfast, both containing Polychaeta worms, *Hiatella arctica*, assorted brittle stars, *Musculus discors*, nemerteans, *Balanus rostratus*, juvenile *Paralithodes camtschatica*, *Hyas coarctatus alutaceus*, and *Oregonia gracilis*. *Balanus rostratus* was also attached to volcanic rock (basalt). The above species were also present in vacant *Balanus rostratus* shells. *Pododesmus macrochisma* apparently settled in the upper portion of a *Neptunea* shell occupied by *Pagurus kennerlyi*.
214	F14	Trawl ripped, no specimens enumerated.
215	G14	*Chionoecetes bairdi* - 2 females. *Hyas lyratus* - 1 male. *Hyas coarctatus alutaceus* - 2 females. *Paralithodes camtschatica* - 6 females, gravid - 2 purple-brown, 4 brown colored eggs. Approx. 266.8 Kg. of *Boltenia ovifera* on trawl warps and dandy lines. Juvenile *Theragra chalcogramma* weight - 3.674 Kg.

APPENDIX TABLE I

CONTINUED

Tow Number	Station Name	Comments
216	G15	Empty shells - 8.4 Kg. *Paralithodes camtschatica* - 3 males and 54 females. *Chionoecetes bairdi* - 3 males and 6 females. Hydrozoan attached to *Boltenia ovifera*. *Balanus* sp. attached to *Neptunea ventricosa*.
217	GH11/12	Rip in trawl. *Chionoecetes bairdi* - 3 males and 2 females. *Paralithodes camtschatica* - 35 males and 18 females. *Mytilus edulis* attached to *Paralithodes camtschatica* between carapace and telson. Juvenile *Theragra chalcogramma* weight - 7.4 Kg.
218	G10	*Chionoecetes bairdi* - not sexed.
219	F9	*Chionoecetes bairdi* - 73 males and 39 females. *Chionoecetes opilio* – 8 males. *Chionoecetes* (hybrid) - 35 males and 3 females.

APPENDIX TABLE II

SUMMARIZATION OF GENERAL COMMENTS, MISCELLANEOUS BIOLOGICAL INFORMATION, REPRODUCTIVE AND FEEDING DATA, AND POLLUTANTS COLLECTED ON LEGS I-III OF THE NOAA SHIP *MILLER FREEMAN* S.E. BERING SEA CRUISE - 1976

Tow Number.	Station Name	Comments
1	Z5	Pollutants: Blue strapping material, nylon line approx. 1.0 m, and pieces of , wire. *Paralithodes camtschatica*: 85 males, 170.4 kg; 2 females, 1.40 kg. *Chionoecetes bairdi*: 18 males, 6.08 kg; 16 females, .907 kg. *Erimacrus isenbeckii*: 12 males.
2	Z5	*Paralithodes camtschatica*: 21 males, 46.3 kg. *Chionoecetes bairdi*: 1 male. *Erimacrus isenbeckii*: 3 males.
3	Z5	Pollutants: 1 Canada Dry tonic water bottle. *Paralithodes camtschatica*: 3 males, 8.35 kg; 3 females 2.36 kg. *Chionoecetes bairdi*: 1 female, 0.045 kg; 4 males, 2.95 kg.
4	Z4	Encrusting sponges weighed with rock attached. Pollock: 6244 kg. *Chionoecetes bairdi*: 7 males, 0.64 kg; 14 females, 0.74 kg.
5	Z4	Pollutants: 1-5 x 25 cm plastic bag, rope, nylon line. Pollock: 6472 kg. *Chionoecetes bairdi*: 8 males, 1.11 kg; 8 females, 0.61 kg. Z04-3 & Z04-4 haul numbers 45 and 47.
8	B7	Pollutants: 1 plastic bag. *Paralithodes camtschatica*: 9 males. *Erimacrus isenbeckii*: 14 males. *Chionoecetes bairdi*: 6 males, 2.49 kg; 3 females, 0.817 kg.
10	B8	*Laminaria* sp.: 0.907 kg. Two *Pagurus capillatus* with parasitic barnacle on abdomen, three with polynoidae and sponge in shell, 20 gravid females with black eggs.
12	Z2	Pollutants: 1-25 cm diameter metal bowl.
13	Z2	Pollutants: 1 rubber glove, 1 sock, 20 cm of line, 2 glass containers. *Chionoecetes bairdi*: 13 males and 70 females. C. *opilio*: 1 male and 14 females. *Chionoecetes* (hybrid): 3 males and 1 female.

APPENDIX TABLE II

CONTINUED

Tow Number	Station Name	Comments
14	Z2	*Chionoecetes bairdi*: 3 males and 69 females. C. *opilio*: 1 male.
15	ZA2 / 3	Pollutants: 1 glove, 1-4.2 ℓ paint can. *Chionoecetes bairdi*: *14* males and 7 females. C'. *opilio*: 1 male.
16	A3	*Chionoecetes bairdi*: *30* males and 4 females. C. *opilio*: 13 males. C. "(hybrid): 3 males.
17	AB3/4	Pollutants: 0.454 g cotton webbing.
19	BC4/5	*Carcinobdella* sp. noted on ventral side of *Myoxocephalus* sp. and *Gadus macrocephalus*.
20	C5	Pollutants: 1 glass float. Yellowfin sole: 3190 kg.
24	DE3/4	Pollutants: 50 g plastic with leech egg cases attached. Juvenile pollock: 726 g.
28	BC1/2	Pollutants: 15 cm braided rope.
29	B1	Pollock weight 2452 kg.
30	AB18/1	Pollutants: 1 tin can.
31	AB18/1	Pollutants: 1 soda can, 1-1.5 ℓ glass bottle.
32	AB18/1	Pollutants: 1-20 ℓ glass jar, green plastic fragments.
33	AB18/1	Pollutants: 1 Asahi beer can.
35	C19	Pollutants: 1 tin can, 1 graduated sea water cylinder, 1-10 ℓ glass bottom (brown).
36	C19	Pollutants: 10 tin cans and soda cans.
37	C19	Pollutants: Piece of wire, 1 soda can.
38	C19	Pollutants: 1 bundle of wood stakes.
39	C19	Pollutants: 2 glass bottles - 1 Q and 1.5 ℓ.

APPENDIX TABLE II

CONTINUEI)

Tow Number	Station Name	Comments
41	D18	Pollutant: Metal fragment
42	DC18/1	Pollutants: 1 piece of plastic. Brittle stars, leechs, worms, snails noted in empty barnacle shells, worms also attached to outer surface. Juvenile pollock: 10.033 kg.
43	EF19/18	Juvenile pollock: 62 kg.
46	Z 4	1 parasitized *Pandalus borealis.*
47	Z4	Pollock weight 8165 kg.
49	A5	Juvenile pollock: 0.050 kg.
50	AB5/6	Juvenile pollock: 2.59 kg.
51	B6	Neptunea shells covered with *Balanus* sp. 3 polynoidae in 3 *Pagurus capillatus* shells. Pollutants: 1 old crab pot. Rock sole: 3124 kg.
52	BC6/7	TWO *Pagurus capillatus* parasitized by barnacle. Rock sole: 3748 kg. Juvenile pollock: 9.23 kg.
53	BC6/7	Non-standard tow. Invertebrates not enum-erated.
54	C7	Trawl could not withstand the approximately 13,620 kg load of fish. Cod end of net broke. Station to be retrawled.
55	C7	Pollutants: 1-1800 ml glass bottle. Trawl could not withstand fish load, cod end broke. Approx. 22,700 kg.
56	D8	27 out of 66 *Pagurus capillatus* with polynoidae present within shell, 9 with parasitic barnacle attached to abdomen.
58	EF23/24	1st trawl of Leg II. Pollutants: 1 piece green twine, 46 cm.

APPENDIX TABLE II

CONTINUED

Tow Number	Station Name	Comments
60	E22	Many basket stars, sea pens from trawl wings (2 bushels). Pollutants: 33 m rope, several glass balls, 2 anchors.
61	EF21/22	Pollutants: 1 can mandarin oranges with Japanese writing on label.
65	DE20/21	Pollutants: ,13 cm string, remains of 1 tin can (12 g). Dead and decaying fish more abundant than usual (approx. 10-15 found in this tow).
67	E20	Haul 66 - net set upside down. No catch records. Second set haul 67 successful. Pollutants: 30.4 x 15.2 x 1 cm piece of wood. Juvenile pollock 6.35 kg.
68	EF19/20	Pollutants: 1 piece of wood, similar to last trawl (30.4 x 15.2 x 1 cm).
70	G2 0	Amphipods numerous on mammal carcass (decomposed to bone, vertebrae and skull held together.)
71	FG21/20	Hermit crabs weighed with shells.
72	G19	Juvenile pollock 10.4 kg.
73	FG19/18	Pollutants: 1 piece of string 15.2 cm long. Juvenile pollock: 11.8 kg.
74	FG19/20	Juvenile pollock: 16.8 kg.
75	F20	Pollutants: several large pieces of string.
77	D22	Large numbers of basket stars on lead lines to trawl (estimated 227 kg). 34 minute trawl due to winch problem delaying retrieval.
79	EF24/25	Pollutants: cardboard with Japanese writing (60 x 60 cm).
81	FG24/23	Juvenile pollock: 60.8 kg.

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APPENDIX TABLE II

CONTINUED

Tow Number	Station Name	Comments
82	G23	Juvenile pollock: 27.2 kg.
84	H25	Juvenile pollock: 15.4 kg.
85	GH25/26	Juvenile pollock: 70 kg.
86	FG27/26	Pollutants: 2 tin cans and 1 glove.
87	FG27/26	Pollutants: 1 pop bottle with Japanese labelling.
92	127	Net snagged 3 minutes before 1/2 hour.
93	I27	Net torn, bad bottom.
94	127	Net torn, bad bottom.
95	KL28/27	Pollutants: 1-10 oz. tomato juice can. Distance fished set equal to average distance fished for 11 randomly selected stations.
96	KL28/27	Pollutants: 1 Japanese coke can.
100	124	Pollutants: Cotton cloth – no markings - 33 g.
101	F20	Distance fished set equal to average distance fished for 11 randomly selected stations.
102	MB13	First station of Leg III. Times are GMT. *Chionoecetes bairdi*: 240 females; 329 males. Few *Chionoecetes* with leech egg cases on the carapace. *Paralithodes camtschatica*: 94 males; 194 females. *Pagurus capillatus*: 80 males; 36 females. Three with eggs. *P. confragosus*: 58 males; 36 females. *P. aleuticus*: 38 males; 47 females. Polynoidae from Paguridae. Feeding data: *Paralithodes camtschatica*: 7 stomachs, feeding on brittle stars and snails. *Gadus macrocephalus*: 5 stomachs, feeding on crabs and fish. *Hippoglossoides*: 4 stomachs, empty. *Lepidopsetta lineata*: 1 stomach, empty. *Myoxocephalus*: 5 stomachs, empty.

APPENDIX TABLE II

CONTINUED

Tow Number	Station Name	Comments
102 (cent'd)	MB13	*Pleuronectes quadrituberculatus*: 3 stomachs, feeding on polychaetes and amphipods. *Glyptocephalus zachirus*: 3 stomachs, feeding on amphipods and polychaetes. *Raja stellulata*: 1 stomach, feeding on amphipods and crangonids.
104	MB4	*Hyas coarctatus alutaceus*: 15 males; 2 females, one with brown-orange eggs. *Pandalus goniurus*: 3 with eggs. *Oregonia gracilis*: 10 females, one with dark orange eggs. *Crangon dalli*: 9 with light blue eggs. Polynoidae: 2 with *Pagurus ochotensis* one with *P. capillatus*. *P. ochotensis*: 2 with blue-black eggs. *Sclerocrangon boreas*: 2 with olive eggs, leech cases on the pleopods. *Paralithodes camtschatica*: 2 females; 1 male. *Chionoecetes bairdi*: 1 female; 5 males. *Boltenia ovifera*: Digestive system dark green, hundreds were caught on the outside of the cod end. *Evasterias echinosoma* (humped up, stomach out) feeding on *Boltenia ovifera*. Juvenile *Gadus macrocephalus*: 0.454 kg.
105	MB9	*Hyas coarctatus alutaceus*: 50 males; 9 females, 4 with orange eggs, 2 with brown eggs. *Pagurus ochotensis*: 16 with black eggs. *Paralithodes camtschatica*: 2 males; 2 females. Feeding data: *Asterias amurensis*: 19 stomachs, feeding on *Pandalus goniurus*, clams, and sponge.
106	MB25	*Hyas coarctatus alutaceus*: 82 males; 28 females with bright orange eggs. *Crangon dalli*: 84 with light blue eggs.
107	MB22	*Paralithodes camtschatica*: 13 males; 16 females, 8 with egg color from bright orange to deep purple. *Pagurus ochotensis* with black eggs. *Hyas coarctatus alutaceus*: 3 males; 6 females with light blue eggs. Juvenile *Theragra chalcogramma*: 0.045 g. Juvenile *Gadus macrocephalus*: 0.045 g. Juvenile *Limanda aspera*: 21.24 kg. Feeding Data: *Asterias amurensis*: 4 stomachs,

APPENDIX TABLE II

CONTINUED

Tow Number	Station Name	Comments
107 (cont'd)	MB22	feeding on sand dollars and mysids. *Paralithodes camtschatica*: 6 stomachs, feeding on snails and crustaceans.
108	MB10	*Paralithodes camtschatica*: 113 females; 181 males. *Chionoecetes bairdi*: 6.5 females; 12 males. *Hyas coarctatus alutaceus*: 1 female with orange eggs. *Pagurus trigonocheirus*: 1 female with eggs. Juvenile *Theragra chalcogramma*: 0.18 g. Feeding Data: *Paralithodes camtschatica*: 13 stomachs, feeding on *Macoma* and *Cardita (=Cyclocardia)*.
109	MB19	Polynoidae in *Pagurus trigonocheirus* shell. Pollutants: 1 piece plastic (Japanese or Korean) with growth on it. 1 piece red rubber glove (small) with Bryozoa growth. *Pagurus trigonocheirus*: 6 females with brown eggs, *Hyas coarctatus alutaceus*: 9 females with orange eggs. *Labidochirus splendescens*: 6 females with brown eggs. *Chionoecetes bairdi*: 180 females; 150 males. C'. *opilio*: 1083 females; 186 males. *Kronborgia* egg case. Juvenile *Theragra chalcogramma*: 3.17 kg. Feeding data: *Paralithodes camtschatica*: 7 stomachs, feeding on *Cyclocardia* and crustaceans.
110	MB16	*Chionoecetes bairdi*: 44 males; 43 females. C. (hybrid): 22 males; 58 females. Pollutant: 1 piece of fishing net and trash. Feeding data: *Gadus macrocephalus*: 16 stomachs, feeding on *Pandalus borealis* and fish. *Hippoglossus stenolepis*: 3 stomachs, feeding on fish.
111	MB55	*Pagurus trigonocheirus*: 3 with black eggs. Pollutant: 1 small piece of rope. No observable items in stomach of *Gorgonocephalus caryi*, orange gonads well developed. Nearly all Paguridae shells with polynoidae in apex of shell. *Paralithodes platypus*: 1 male; 1 female, male soft shell with empty stomach. *Chionoecetes bairdi*: 20 males; 17 females. C. *opilio*: 69 females; 15 males. C. (hybrid): 1 male; 9 females.

APPENDIX TABLE II

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Tow Number	Station Name	Comments
112	MB69	Two bopyroid isopods under carapace of *Pandalus borealis*, males small. *Argis den-tutu*: 2 with bright green eggs. Polynoidae in all Paguridae shells. *Chionoecetes* (hybrid): 4 meals. C. *opilio*: 1 male; 1 female. C. *bairdi*: 127 males; 20 females. Feeding data: *Chionoecetes opilio*: 23 stomachs, feeding on Ophiuroids and Polychaetes. *Gadus macrocephalus*: 3 stomachs, feeding on fish and crustaceans.
113	MB-86B	Pollutants: 1 large wine bottle, 1 piece rubber mat. *Chionoecetes opilio*: 31 males, half soft shell. C. *bairdi*: 5 males, soft shell. C. (hybrid): 60 males, 3 soft shell. *Pagurus trigonocheirus*: 3 with brown eggs. Empty *Panomya arctica* shells: 90, 42.2 lbs. Feeding data: Liparid: 1 stomach, feeding on fish and crustaceans. *Gadus macrocephalus*: 6 stomachs, feeding on pollock. *Hemilepidotus papilio*: 9 stomachs, feeding on Polychaetes and amphipods.
114	MB46	Empty *Panomya arctica* shells. *Leptasterias* sp.: 2 with orange eggs, all humped up in brooding position. *Hyas coarctatus alutaceus*: 23 males; 3 females with black eggs. *Chionoecetes opilio*: 466 females; 64 males. C. *bairdi*: 1 female. Polynoidae present in paguridae shells. *Kronborgia* egg cases. Masses of *Volutopsius* egg cases. *Polinices pallida* egg cases also present. Juvenile *Reinhardtius hippoglossoides*: 3.85 kg. Juvenile *Theragra chalcogramma*: 0.045 g. Juvenile *Gadus macrocephalus*: 0.045 g. Feeding data: *Platichthys stellatus*: 1 stomach, empty. *Limanda aspera*: 4 stomachs, empty. *Pleuronectes quadrituberculatus*: 3 stomachs, empty.
115	MB37	Most *Chionoecetes* in soft shell condition. Pollutants: Piece of netting. *Hyas coarctatus alutaceus*: 23 males; 5 females. *Erimacrus isenbeckii*: 2 males. *Pagurus trigonocheirus*: 316 males; 2 females with

APPENDIX TABLE II

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Tow Number	Station Name	Comments
115 (cent'd)	MB37	dark blue eggs. Polychaeta (tube worm) in Paguridae shells. *Chionoecetes opilio*: 72 females; 584 males. Juvenile *Gadus macrocephalus*: 0.136 g. Juvenile *Theragra chalcogramma*: 0.045 g. Feeding data: *Asterias amurensis*: 12 stomachs, feeding on Bryozoa. *Pteraster*: 1 stomach, feeding on a worm. *Myoxocephalus*: 3 stomachs, feeding on fish and crustaceans.
116	MB28	*Chionoecetes opilio*: 4326 males; 4815 females. *Pandalus goniurus*: 5 with eggs. Polychaete: Tube worm observed with Paguridae. *Hyas coarctatus alutaceus*: 5 males. *Kronborgia* egg cases. Feeding data: *Leptasterias polaris*: 13 stomachs, feeding on cockles. *Asterias amurensis*: 6 stomachs, feeding on cockles. *Myoxocephalus jaok*: 1 stomach, feeding on sculpins. *Myoxocephalus polyacanthocephalus*: 1 stomach, feeding on capelin and a snow crab. *Limanda aspera*: 10 stomachs, empty. *Pleuronectes quadrituberculatus*: 5 stomachs, empty. *Chionoecetes*: 1 stomach, miscellaneous soft parts.
117	MB-18A	*Pagurus capillatus*: 1 female, eggs brown; 1.0 males. *P. aleuticus*: 36 females, eggs brown; 40 males. *Paralithodes camtschatica*: 87 males; 2 females. *Chionoecetes opilio*: 139 males; 72 females. C. *bairdi*: 20 males; 12 females. *Hyas lyratus*: 1 female with purple-brown eggs. Juvenile Pacific cod: 0.090 kg. Juvenile pollock: 82,037 kg. Feeding data: *Paralithodes camtschatica*: 23 stomachs, feeding on cockles, brittle stars, *Solariella*, and Polychaetes. *Myoxocephalus*: 1 stomach, feeding on snow crabs.