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Habitat-Associated Diet of Some Flatfish in the Southeastern Bering Sea

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ABSTRACT

A total of 1,111 Alaska plaice (*Pleuronectes quadrituberculatus*), northern rock sole (*Lepidopsetta polyxystra*), yellowfin sole (*Limanda aspera*), and flathead sole (*Hippoglossoides elassodon)* stomachs collected from 27 stations in the eastern Bering Sea in 2009 were analyzed. Benthic grab samples collected at each of the 27 stations (by different cruise) were compared with the diet data. The habitat types for the stations were classified, from northeast inner-shelf to the southwest outer-shelf of the study area, as sandy (%sand > 80), muddy sand (50 < %sand < 80), sandy mud (50 < %mud < 80), and muddy (%mud > 80). The objective of this study is to correlate the diets of the small-mouth flatfish with their specific habitats and the benthic samples in the eastern Bering Sea area.

The main diet of Alaska plaice included clams and polychaetes. In the inner-shelf sandier stations (northeast of the study area), Alaska plaice consumed high proportions (> 49% by weight) of clams (mainly Tellinidae). Towards the southwest middle-shelf muddier stations, the diet of Alaska plaice shifted to higher proportions of deposit-feeding polychaetes (Ampharetidae, Terebellidae, and Trichobranchidae). The shift in diet from the sandier stations to the muddier stations corresponded relatively well with the shift in the benthic community.

The main food of northern rock sole included clams, polychaetes, and amphipods. Diet variations were also found among different habitats. In the middle-shelf muddier stations, polychaetes Terebellida and Sabellida comprised high proportions in their stomach contents. On the contrary, more bivalves were consumed by northern rock sole in the inner-shelf sandy stations.

The diet of yellowfin sole included: clams (mainly *Macoma* sp.), gammarid amphipods, polychaetes, ophiurids (mainly *Ophiura sarsi* and *Amphipholis* sp.), and sand dollars (Clypeasteroida). More polychaetes (Phyllodocida, Terebellida, and Sabellida) were consumed by yellowfin sole collected in the middle-shelf muddier stations whereas more Tellinidae clams were consumed in the inner-shelf sandier stations.

The main food of flathead sole included: brittle stars (mainly *Ophiura sarsi* and *Amphipholis* sp.), clams (mainly *Nuculana* sp. and *Yoldia* sp.), shrimp (mainly *Pandalus* sp. and *Crangon* sp.) and amphipods. Less important prey included polychaetes (mainly Onuphidae), cumacean, crabs, and echiuroids. Because of the distributions of the flathead sole were mainly in the muddier stations in the middle-shelf and outer-shelf, their diets were quite different from other flatfishes. They also had higher diet variations among different stations, caused by the combination of different proportions of polychaetes, clams, amphipods, shrimps, crabs, and brittle stars.

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INTRODUCTION

Food habit studies reveal the trophic relationships that influence the distribution and abundance of animal populations. The Food Habits Laboratory of the Alaska Fisheries Science Center's (AFSC) Resource Ecology Ecosystem Modeling Program (REEM) has been collecting food habits data of managed fish species since the early 1980s in order to understand and predict the ways in which predator-prey relationships influence the population dynamics of managed fish species. The sampling area covers the eastern Bering Sea, Gulf of Alaska, and the Aleutian Islands. The data have been used for ecosystem modeling, fishery management, and ecological studies.

Flatfish are dependent on the benthic habitat for food and shelter. Northern rock sole (*Lepidopsetta polyxystra*) and yellowfin sole (*Limanda aspera*) are highly abundant commercial flatfish species in the eastern Bering Sea (EBS). The total catch of these two species combined was about 200,000 metric tons (t) in 2011 (NPFMC 2011). Alaska plaice (*Pleuronectes quadrituberculatus*) and flathead sole (*Hippoglossoides elassodon*), although of lower commercial value, are also flatfish species of ecological importance in the EBS (Lee et al. 2010). All four species have similar characteristics: small body-size, small stomach, and large intestine. Because of these similarities, they are distinguished from the larger flatfish such as Pacific halibut (*Hippoglossus stenolepis*), arrowtooth flounder (*Atheresthes stomias*), and Greenland halibut (*Reinhardtius hippoglossoides*) in the eastern Bering Sea. The diets of these four species in the EBS consist mainly of three major infauna groups: polychaetes, clams, and amphipods (Pacunski 1990, Lang 1992).

The infauna assemblage in the EBS is primarily associated with surficial sediments characteristics. The availability of infauna prey in benthic habitats is important to small-sized flatfish but is largely unexamined. Recently, Yeung et al. (2010) explored the spatial associations between polychaete prey, sediment characteristics and the diet and distribution of groundfish in the southeastern Bering Sea. Groundfish diet and distribution data for that study were summarized from AFSC annual EBS bottom trawl survey collections between 1995 and 2007 (Food Habits Lab database); benthic sediment and infauna samples were collected at 26 standard bottom trawl survey stations in 2006. The analysis showed that major polychaete-feeders such as Alaska plaice and rock sole generally consume polychaete taxa that are most available. This suggests that total polychaete abundance or biomass may be used an index of prey availability and thus habitat quality for these flatfish. Here, we further examine this hypothesis using contemporaneous benthic and diet data collected in the 2009 sampling season specifically to understand the diet-habitat relationship of flatfish. The focus of this paper is on describing and comparing diets among and within small-sized flatfish species over different habitat types as characterized by surficial sediment grain size.

METHODS

Stomach Collection

Flatfish stomachs for diet analysis were collected during the EBS bottom-trawl survey in the summer of 2009 on board FV *Arcturus* and FV *Aldebaran* (Lauth 2010). Stomachs of Alaska plaice (AKP), northern rock sole (NRS), yellowfin sole (YFS), and flathead sole (FHS) were collected at the 27 stations shown in Figure 1. Sampling covered the area from the northeast station (58° 19' N, 162° 1' W) to the southwest station (54° 59' N, 166° 56' W). Fifteen stomachs per species were collected at each station-five in each of three size groups (< 20 cm, 20-39 cm, ⩾ 40 cm for AKP; < 20 cm, 20-34 cm, ≥ 35 cm for NRS; < 20 cm, 20-29 cm, ≥ 30 cm for YFS and FHS), where available. Stomachs were preserved in buffered 10% formalin solution.

Grab Sample Collection

Benthic grab samples for EBS habitat characterization were collected with a 0.1-m^2 Van Veen-type sampler in July-August 2009 on board the NOAA ship *Fairweather*. Duplicate samples were collected at each of the 27 stations where stomachs were collected - one for analyzing sediment properties and the other for infauna assemblage. Detailed methods are documented in Yeung et al. (2012).

Data Analyses

Stomach contents were identified to the lowest taxonomic level possible. Diet variations among stations/habitat types/predator size-groups were analyzed for each species. Inter-specific dietary differences were also analyzed. The percent similarity index (PSI), a modified Schoener's Index (Schoener 1970), was calculated by using the proportional weight of the main prey items in stomachs to compare the diet similarities. The PSI is calculated as

$$PSI = \sum_{i=1}^{n} \min(P_{xi}, P_{yi}),$$

where P_{xi} and P_{yi} are the proportions by weight of prey i in the diets of species x and y, respectively. In this study, prey were grouped by taxonomic order or higher taxa. For example, polychaetes were grouped into Scolecida, Aphroditoidea, Phyllodocida, Eunicida, Spionida, Terebellida, and Sabellida; snails were grouped into Gastropoda; clams were grouped into Bivalvia, etc.

Biomass (g m^{-2}) and abundance (individuals m^{-2}) per unit area of dominant infauna taxa were calculated by station. The relationship between diet, habitat characteristics, and infauna assemblage were analyzed and reported in Yeung et al. (2012).

RESULTS and DISCUSSION

Habitat Types

Habitat types were classified by surficial sediment grain size, where particles 0.0625-2 mm in diameter is defined as sand, <0.0625 mm is mud, and >2 mm is gravel. No gravel was present in any sediment samples in this study. Habitat types are either sand (≥80% sand by sample weight), muddy sand (≥50% to ≤80% sand), sandy mud (≥50% to <80% mud), or mud (≥80% mud). Based on this, our data shows that sandy stations included K12, K11, K10, J11, J10, J9, I10, I9, I8, H9, H8, and G8; muddy sand stations included G7, G6, F7, F6, E6, and D5; sandy mud stations included E5, E4, D4, B2, and A2; and the mud stations included C4, C3, C2, and B3.

Alaska Plaice

A total of 262 AKP stomachs from 19 stations were analyzed. AKP were absent at stations D5, D4, C4, C3, C2, B3, B2, and A2 (Fig. 1). All AKP were collected from no deeper than 100 m, in sediment types ranging from sandy in the northeast (e.g., K, J, I stations) to sandy mud in the southwest (e.g., E5, E4).

General diet

Table 1 lists the percentage by weight of the main prey items consumed by AKP at each station. The mean, standard deviation, the range of the fork length of fish, and the total number of stomachs collected are included. The diet of AKP mainly included polychaetes and clams. Less important prey included amphipods, cumacean, echiuroids, sipuncula, and echinoderms (Table 1).

Diet in relation to habitat type

AKP were collected in sandy, muddy, and sandy mud habitat types. Bivalves were the main prey of AKP at sandy stations on the inner shelf, especially K12, K11, K10, J11, J10, and J9 (Table 1). They comprised >49% of the (total) stomach (contents) weight of AKP at each of those stations. Polychaetes such as Terebellida (mainly Ampharetidae and Terebellidae) and Eunicida (mainly Onuphidae) replaced bivalves as the dominant prey at the muddier stations on the middle shelf, especially G6, F7, F6, E6, E%, and E4. They comprised >43% of stomach weight at each of those stations. Phyllodocida (mainly Nephtyidae) was another important polychaete prey group of Alaska plaice. In general, they comprised higher percentages (between 14% and 28%) in the stomachs collected in the sandier area (e.g., K12, K11, K10 stations) than in the muddier area (less than 6% for each of the F6, E6, E5, E4 stations); however, they were also abundant in some of the stations between these two areas (e.g., G7; muddy sand (37%)).

Less important polychaete prey include Sabellida (mainly Sabellidae), Spionida, Aphroditoidea (mainly Polynoidae), and Scolecida (including Arenticolidae, Capitellidae, Cossuridae, Maldanidae, Opheliidae, Orbiniidae, Paraonidae, and Scalibregmatidae).

Sabellida were found in AKP stomachs more often at muddy than at sandy stations. Spionida (one large chaetopterid) only occurred in an AKP stomach at station G8. Polynoidae and Sigalionidae occurred frequently in the diet at many stations, but they usually comprised <3% of the stomach contents weight. Orbiniidae occurred in the diet of AKP at almost every station, but they also comprised <3% of the stomach contents weight in each station. Maldanidae occurred more in the muddier (mud ≥50%) stations than in the sandier (sand ≥50%) stations. They comprised ≤5% of stomach content weight at every station.

Other invertebrate prey included gastropods, gammarid amphipods, echinoderms, echiuroids, and sipuncula. Gammarid amphipods (Ampeliscidae, Gammaridae, Isaeidae, and Lysianassidae) occurred in AKP stomachs at every station. They comprised between 1% and 13% of the total stomach content weight, respectively. Sand dollars (Clypeasteroida) occurred only at sandy stations and comprised ≤15% at each station. Ophiuroids and holothuroids were less important echinoderm prey in the diet of AKP. They comprised ≤4% of stomach contents weight at each station. Echiuroids and sipunculan were not dominant prey, but echiuroids comprised as high as 43% of stomach contents weight at one station (G8). Fish (unidentifiable teleost) was not important prey for AKP, occurring only in one stomach at station K12, where it comprised only 2% of stomach contents weight.

Diet overlap among stations

The upper diagonal section in Figure 2 shows PSI among stations. The lower diagonal section shows diet overlap levels. Diet overlap was high among the inner-shelf sandy stations (K12, K11, K10, J11, J10, J9, I10, and I9) (Fig. 2, upper right), as a result of the dominance of clams in the diet. The highest overlap (91%) was between J9 and J10. Diet overlap among muddier stations (E4, E5, E6, F6, F7, G6) were also high (≥50%) (Fig. 2, lower left), as a result of the dominance of polychaetes in the diet. The highest diet overlap (71%) was between stations E6 and F7. Diet overlap between the sandier stations (I, J, K stations in the northeast) and the muddier stations (E, F, G stations in the southwest) (Fig. 2, lower right) was mainly low to medium. Diet overlap between middle-shelf stations (G7, G8, H8, H9, I8, I9), which were either sandy mud or muddy sand habitats, ranged from low to high.

Diet variations among predator size-groups

Of the 262 Alaska plaice specimens, only 5 were less than 20 cm (all from station K12). At station K12, the diet overlap between <20 cm and 20-39 cm AKP was high (PSI=50), as a result of clams comprising more than 46% of the diets for both size-groups. There was only one specimen in the ≥40 cm size-group. Based on the limited sample size, the diet overlap between this size-group and the 20-39 cm size-group was medium (40%). The diet overlap between the smallest and the largest size-groups was small (13%).

At other stations, only the diet of the two larger size-groups (20-39 cm and ≥40 cm) were compared since no ≤20 cm specimens were available. Diet overlap between these two size-groups at most stations was high (≥50%). Low diet overlap occurred mainly when the sample sizes were small (e.g., <4). The diet in one station usually showed the availability of the prey in that station; hence, the diet overlap value for different size-groups in that station usually was high. However, the diet of the same size-groups in different stations can be quite different in different stations, if the habitats are different. For example, at station J-10 (sandy habitat), the diet overlap between 20-39 cm size-group and ≥40 cm size-group was high (64 PSI). At station E-4 (sandy-mud habitat), diet overlap between the 20-39 cm size-group and the ≥40 cm size-group was also high (50 PSI) due to the high overlap of Trichobranchidae, Sabellidae, and other polychaetes. However, the diet overlap of the size-group 20-39 cm between J-10 and E-4 was low (2 PSI), the diet overlap of the size-group ≥40 cm between J10 and E-4 was low (10 PSI), the diet overlap between 20-39 cm in J-10 and ≥40 cm in E-4 was low (11 PSI), and the diet overlap between 20-39 cm in E-4 and ≥40 cm in J-10 was also low (1 PSI), as a result of the abundant prey in J-10 was clams and the dominant prey in E-4 station was Terebellida polychaetes. This shows that habitat differences (and hence the prey availabilities) are very important when we compare the diet variations. The diet variations between different size-groups may not be as important compared to the differences between habitats.

Diet trends

In most sandy (K, J, I) stations, clams (mainly Tellinidae) were the most important food of AKP. In all K and J stations, they comprised approximately 50% or more of the total stomach contents weight of AKP. Polychaetes (mainly Nephtyidae) were the second most important prey. AKP diet matched well with the infauna assemblage at most of those stations - Tellinidae were the dominant infauna in terms of biomass in benthic grab samples (Yeung et al. 2012).

Towards the southwest, as habitat became muddier (e.g., H and G stations), AKP consumed less clams and more Nephtyidae, Ampharetidae and Terebellidae polychaetes. Nephtyidae were the dominant infauna in benthic grab samples at most of the H and G stations. The main prey of AKP apparently changed in correspondence to the infauna assemblage.

At the southwesternmost area, where it was muddiest (F and E stations), polychaetes were the dominant prey of AKP, comprising usually more than 50% of the total stomach contents weight at each station. Terebellida (mainly Ampharetidae, Terebellidae, and Trichobranchidae) and Onuphidae were the dominant polychaete prey. Station E4 was a unique station. It was categorized as a sandy mud habitat. It had the most diversity of prey items (25) and the most polychaete species (16) found in AKP stomachs. Scalibregmatidae comprised 20% of the total stomach contents weight of AKP; they were not important prey at any other stations.

Northern Rock Sole

A total of 284 NRS stomachs collected from 19 stations were analyzed. NRS were absent at stations D4, C4, C3, C2, B3, B2, and A2 (Fig. 1). All were collected from no deeper than 100 m, in sediment types ranging from sandy in the northeast (e.g., K12, K11) to sandy mud in the southwest (e.g., E4, D5).

General diet

Table 2 presents the percent by weight of the main prey items consumed by NRS at each station. The mean, standard deviation, the range of the fork lengths of fish specimens, and the total number of stomachs are included.

The diet of NRS mainly included polychaetes, clams, and amphipods. Less important prey included cumacean, echiuroids, and echinoderms (Table 2). Prey fish were also found in some stomachs; however, they were not common food.

Diet in relation to habitat type

NRS were collected in sandy (inner-shelf), muddy sand, and muddy (outer-shelf) habitat types. Bivalves were the main prey of NRS at sandy stations, especially K11, K10, J11, J10, and J9 (Table 2). Bivalves comprised >30% of stomach contents weight of NRS at each of those stations. Polychaetes such as Terebellida (mainly Ampharetidae and Terebellidae) and Eunicida (mainly Onuphidae) replaced bivalves as the dominant prey in the muddier stations on the middle-shelf, especially G6, E4, and D5. They comprised >30% of stomach contents weight at each of those stations.

Phyllodocida (mainly Nephtyidae) was another important polychaete prey of NRS. Phyllodocida comprised higher percentages (≥24%) of the diet in the sandier area (e.g., K12, J11, J9, I10, I8, H9 stations) than in the muddier E6, E5, D5 stations where they comprised ≤8% of the total stomach contents weight. NRS diet at station F6 (muddy sand) contained 31% of Phyllodocida; however, the sample size was small (n=3). Station E4 was the only sandy mud station where the diet of NRS contained a high percentage of Phyllodocida (30%).

Less important polychaete prey include Sabellida (mainly Sabellidae), Spionida, Aphroditoidea (mainly Polynoidae), and Scolecida. Sabellida were found in NRS stomachs more often at muddy than at sandy stations. Spionida occurred only in three NRS stomachs, and they comprised ≤% of the total stomach content weight in each occurrence. Polynoid occurred frequently in the diet at many stations, but they comprised ≤9% of the total stomach content weight at each station. Orbiniidae (in group Scolecida) occurred in the diet of NRS at many stations, but they comprised <2% of the total stomach content except at station H9 (23%). Maldanidae (Scolecida) comprised 7% of the total stomach content weight at the sandy mud station E4.

Other invertebrate prey included gastropods, gammarid amphipods, echiuroids, sand dollars, and sea cucumbers. Gammarid amphipods occurred in the diet of NRS at every station. In general, gammarid amphipods comprised ≤20% of the total stomach content weight at each station; however, they comprised 53% of the total stomach content weight at station E5 (sandy mud). Gammarid amphipods comprised 83% of the total stomach contents weight of NRS at station H8, but the sample size was only three. Echiuroids occurred in the diet of NRS at many stations. They generally comprised ≤6% of the total stomach contents weight at each station, but accounted for 69% at G8 (sandy station). A high percentage (43%) of echiuroids also appeared in AKP diet at station G8. Sand dollars (Clypeasteroida) occurred in NRS diet mainly in the sandy stations, as with AKP. As did in AKP diet, sand dollars comprised a high percentage (11%) of NRS stomach contents weight at station J10. Sea cucumbers (Holothuroidea) were found in the diet of NRS at two stations. They comprised 16% of the total stomach contents weight at station G6 (muddy sand).

There were 12 Pacific sand lance (*Ammodytes hexapterus*) in NRS stomachs at station K-12 (sandy). The mean standard length of the fish prey was 77.8 mm, with a range between 60 and 112 mm. They were eaten by all three predator size-groups. At station K-11 (sandy), Pacific sand lance and capelin (*Mallotus villosus*) were found only in the stomachs of the largest NRS size-group (≥35 cm), where they comprised 73% of the total stomach contents weight. Overall teleost prey occurred more frequently (6 out of 19 stations) in the diet of NRS than in that of AKP (1 out of 19 stations). For both predators, Pacific sand lance and capelin were only found in the stomachs collected at sandy stations.

Diet overlap among stations

PSI for NRS is shown in Figure 3. The upper diagonal section shows PSI among stations. The lower diagonal section shows diet overlap levels. Diet overlap was high among the inner-shelf sandy stations (K12, K11, K10, J11, J10, and J9) (Fig. 3, upper right), as a result of the dominance of clams in the diet. The highest overlap (80%) was between J9 and J11. The high diet overlap of NRS among these stations was generally similar to that found in AKP. High proportions of clams were consumed by both species in this area. Diet overlap among muddier stations (E4, E5, E6, F6, F7, G6, G7) was medium to low (Fig. 3, lower left). Only three PSI values were high (≥ 50%). The lower diet overlap among stations in this muddier area was caused by the consumption of amphipods and polychaetes in varied proportions. Diet overlap among stations in the lower right of Figure 3 was low to medium, reflecting comparisons between sandier stations (I, J, K series in the northeast) and the muddier stations (E, F, G stations in the southwest).

Diet variations among predator size-groups

At K-12 (sandy), the diet of NRS < 20 cm contained 38% of clams, 22% Pacific sand lance, 20% amphipods, and 18% of polychaetes (mainly Phyllodocidae). The diet of NRS 20-34 cm contained 46% Pacific sand lance, 10% clams, 14% polychaetes, 6% amphipods, and 15% shrimps (mainly Crangonidae). The diet of NRS ≥ 35 cm contained 43% polychaetes, 35% Pacific sand lance, 10% clams, and 7% amphipods. Diet overlap among the three size-groups at K-12 was high (51% for < 20 cm and 20-34 cm, 65% for 20-34 cm and ≥ 35 cm, 53% for < 20 cm and ≥ 35 cm).

At station E-5 (sandy mud), the diet of NRS <20 cm (n = 2) contained 41% ampharetids, 49% gammarid amphipods, and 1% clams. The diet of NRS 20-34 cm (n = 10) contained 76% gammarid amphipods and 9% ampharetids, but no clams. The diet of NRS ≥ 35 cm (n = 2), contained 24% gammarid amphipods, 16% sabellids, and 38% clams. Diet overlap was 61% for < 20 cm and 20-34 cm, 37% for 20-34 cm and ≥ 35 cm, and 30% for < 20 cm and ≥ 35 cm.

Diets among size-groups can be very similar, as at K-12, or different, as at in E-5. At sandy K-12, clams, Pacific sand lance, and polychaetes dominated in NRS stomachs; whereas, at muddier E%, gammarid amphipods were the dominant prey and no fish was found in the stomachs. Prey availability in different habitats is probably an important factor determining prey selection among predator size-groups.

Interspecific diet comparison

Both NRS and AKP were collected at all stations except NRS at G7 and AKP at D5. Clams (mainly Tellinidae) and Nephtyidae were the most important food of both species at most sandy (K, J, I) stations. Diet overlap between the two species at most sandy stations were high. Towards the southwest, as habitat became muddier (e.g., H and G stations), NRS consumed less clams and more Nephtyidae polychaetes, and gammarid amphipods. The trend of diet changes in NRS was similar to that in AKP. At the southwesternmost area, where it was muddiest (F and E) stations, polychaetes (Phyllodocida, Eunicida, Terebellida, and Sabellida) were the dominant prey of NRS. High proportions of gammarid amphipods were consumed by NRS in two stations (E5 and D5), where they comprised 53% and 24% of the total stomach contents weight, respectively. In general, the diet of NRS was relatively similar to that of AKP. Diet overlap between these two species was high at eight stations, medium at six stations, and low at four stations.

Yellowfin Sole

A total of 257 YFS stomachs from 19 stations were analyzed, of which 15 stomachs (6%) were empties. All were collected from no deeper than 100 m, in sandy or muddy sand habitat types, and on station (E5) of sandy mud type. YFS were absent from the deeper, muddier stations: E4, D5, D4, C4, C3, C2, B3, B2, and A2.

General diet

Table 3 lists the percentage by weight of the main prey items consumed by YFS at each station. The mean, standard deviation, and range of the fork length of the fish specimens, and the number of stomachs (non-empty, empty, and total) are included.

The diet of YFS included clams (mainly *Macoma* sp.), gammarid amphipods, polychaetes, Ophiuroids (mainly *Ophiura sarsi* and *Amphipholis* sp.), and sand dollars (Clypeasteroida). Less important prey included euphausiids, crabs, and echiuroids.

Diet in relation to habitat type

YFS were mainly found at sandy and muddy sand stations, and only at a single station (E5) characterized as sandy mud type. They were absent from muddy stations.

Clams (mainly *Macoma* sp.) were the most important prey for YFS, particularly in the sandy stations J10 and J9 where they comprised 85% and 96% of the total stomach content weight at those two stations, respectively. Nephtyids were the most important polychaete prey of YFS. They comprised high percentages (>24%) of the stomach contents weight of YFS collected at H9, H8, G8, and G7. These stations were deeper than 50 m with a sediment type of mixed sand and mud. Less important polychaete prey included Polynoidae, Sabellaridae, Ampharetidae, Terebellidae, and Sabellidae. Gammarid amphipods (mainly Isaeidae and Lysianassidae) were also important prey. At many stations, they comprised >15% of the total stomach contents weight, and as high as 61% at J11.

Euphausiids occurred in YFS more often than in the diets of AKP, NRS, or FHS. They occurred at 12 of 19 stations where YFS were collected. The euphausiids comprised more than 10% of the total stomach content weight at six stations, and as high as 31% at G7. Crabs (mainly Paguridae and *Chionoecetes* sp.) were found in YFS diet at five middle-shelf stations (e.g. F6, E6, and E5), comprising ≤20% of the total stomach content weight at each station. Echiuroids occurred in YFS at 8 of 19 stations, on the middle-shelf (G, F, and E stations). Echiuroids comprised a high percentage (54%) of the total stomach content weight in YFS diet at G8, where they also dominated AKP (43%) and NRS (69%) diets. Brittle stars were also an important diet component of YFS at muddier stations. They occurred at six stations and comprised <20% of the total stomach content weight at each station except G7, where they comprised 29%. Similar to AKP and NRS, sand dollars (Clypeasteroida) were only found in YFS diets at sandy stations (K, J, I stations). They comprised 60%, 46%, and 21% in the total stomach content weight of YFS at stations K11, I10, and I9, respectively. Sea cucumbers occurred in the diet of YFS at only two stations (G6 and F6). They comprised 24% and 13% of the total stomach contents weight, respectively.

Diet overlap among stations

Compared to AKP and NRS, high diet overlap among stations were uncommon in YFS (Fig. 4). However, the few stations that had high diet overlap were the sandy stations (K12, K11, J11, J10, I10, and I9). The highest overlap (89%) was between J9 and J10, which was also the case with AKP (91%).

Diet overlap among muddier stations (E5, E6, F6, F7, G6, G7) was medium to low (<30%), except for two that were high (Fig. 4, lower left). Diets in this area were a mix of polychaetes, amphipods, brittle stars, echiuroids, and crabs. Diet overlap between sandier (I, J, K in the northeast) and muddier (E, F, G in the southwest) stations were low to medium (Fig. 4, lower right). Diet overlap was high between I8 and E5 (53%) and between I8 and E6 (54%) because of common high proportions of amphipods, crabs, and echiuroids in YFS diet there.

Diet variations among predator size-groups

At K12, the diet of YFS <20 cm contained 13% polychaetes, 55% amphipods, 6% euphausiids, and 19% crangonid shrimp. The diet of YFS 20-29 cm contained 5% polychaetes, 22% clams, 49% amphipods, 8% euphausiids, 6% shrimp, and 11% bryozoans. The diet of YFS ≥30 cm contained 3% polychaetes, 40% clams, 26% amphipods, 24% euphausiids, and 7% sand dollars. Diet overlap between YFS <20 cm and ≥30 cm was medium (PSI=35), whereas overlap among other pairs of size-groups were all high (≥59%).

At K10 (sandy), the diet of YFS <20 cm contained 22% clams, 63% amphipods, and 13% euphausiids. The diet of YFS 20-29 cm contained 34% polychaetes, 29% mollusks, 20% clams, 13% amphipods, and 5% euphausiids. The diet of YFS ≥30 cm, contained 14% polychaetes, 59% mollusks, 10% amphipods, 9% euphausiids, and 7% sand dollars. Diet overlap was medium (38%) between <20 cm and 20-29 cm size-groups; high (58%) between 20-29 cm and ≥30 cm; and low (10%) between <20 cm and ≥30 cm.

At J9, the diet of all three size-groups contained 95% or more clams; therefore, diet overlap was all high (≥ 95%).

At I10, the diet of YFS <20 cm contained 6% polychaetes, 39% clams, 7% cumacean, and 47% amphipods. The diet of YFS 20-29 cm contained 26% polychaetes, 26% clams, 4% cumacean, and 44% amphipods. The diet of YFS ≥30 cm, contained 33% polychaetes, 2% clams, 5% amphipods, and 58% sand dollars. Diet overlap was high (80%) between <20 cm and 20-29 cm size-groups; medium (33%) between 20-29 cm and ≥30 cm size-groups; and low (13%) between <20 cm and ≥30 cm size-groups.

At station I8, the diet of YFS <20 cm contained 17% polychaetes, 32% mollusks, 1% clams, 2% cumacean, 8% amphipods, and 42% echiuroids. The diet of YFS 20-29 cm contained 36% polychaetes, 2% clams, 57% amphipods, and 5% euphausiids. The diet of YFS ≥30 cm contained 28% polychaetes, 3% mysids, 2% amphipods, 39% euphausiids, and 27% crabs. Diet overlap was low (26%) between <20 cm and 20-29 cm size-groups; medium (35%) between 20-29 cm and ≥30 cm; and low (19%)between <20 cm and ≥ 30 cm.

At H8, the diet of YFS <20 cm size-group contained 84% of clams, 2% of amphipods, and 13% of echiuroids. The diet of YFS 20-29 cm contained 96% of polychaetes, 1% of cumacean, and 1% of amphipods. The diet of YFS ≥30 cm contained 28% of polychaetes, 4% of amphipods, 1% of echiuroids, and 62% of jellyfish. Diet overlap between size-groups were all low (<30%).

At G8, the diet of YFS <20 cm contained 81% polychaetes, 3% cumacean, 7% amphipods, 6% euphausiids, and 3% brittle stars. The diet of YFS 20-29 cm contained 82% polychaetes, 1% mollusks, 3% echiuroids, and 12% of brittle stars. The diet of YFS ≥30 cm contained 1% amphipods, 3% shrimp, 86% echiuroids, 4% brittle stars, and 3% tunicates. Diet overlap between <20 cm and 20-29 cm size-groups was high (84%), whereas between all other group-pairs was low (<30%).

Overall, YFS diet varied greatly by different size-groups at most of the stations sampled.

Interspecific diet comparison

In general, YFS ate less polychaete and clams and more gammarid amphipods and euphausiids, comparing to AKP and NRS. This indicates that YFS probably fed more often in the water column. Brittle stars occurred at muddier stations. At those stations, YFS generally consumed more brittle stars than AKP and NRS, and FHS. But at G7, FHS ate more brittle stars than YFS. In general, YFS consumed more sand dollars than AKP and NRS at sandy stations, whereas sand dollars were rarely found in FHS diet. At K11, sand dollars comprised 60% of YFS stomach contents weight. Sea cucumbers were not important food of any species in this study, except at G6 and F6 where they comprised 24% and 13% of YFS diet, respectively, and 16% of NRS diet at G6. Crabs (Paguridae and *Chionoecetes* sp.), found in YFS stomachs in the muddier F6, E6, and E5 stations, and comprised 30% of YFS stomach contents weight at station D5, were rarely in the diets of AKP, NRS, and FHS.

Flathead Sole

A total of 225 FHS stomachs from 18 stations were analyzed. One hundred and twenty-seven (56%) of them were empty. FHS were collected at stations deeper than 65 m, in muddy sand, sandy mud, or mud substrates in the southwest of the study area (e.g., C and B stations). FHS were absent from sandy and shallower (K, J, I) stations on the inner-shelf area.

General diet

Table 4 lists the percentage by weight of the main prey items consumed by FHS at each station. The mean length, standard deviation, and range of the fork length of the fish specimens, and the number of stomachs (non-empty, empty, and total) are included.

The diet of FHS included brittle stars (mainly *Ophiura sarsi* and *Amphipholis* sp.), clams (mainly *Nuculana* sp. and *Yoldia* sp.), shrimp (mainly *Pandalus* sp. and *Crangon* sp.) and amphipods. Less important prey included polychaetes (mainly Onuphidae), cumacean, crabs, and echiuroids. One prey fish (zoarcid) was found in one stomach.

Diet in relation to habitat type

FHS were mainly found at muddy sand, sandy mud, and muddy stations. They were collected from only three sandy stations, I10, H9, and G8, and only one stomach each was collected at I10 and H9. Thus G8 was the lone sandy habitat with good diet data (non-empty stomach sample size 9) for FHS.

Polychaetes were not as important a prey for FHS as they were for AKP and NRS. Onuphids was the main polychaete consumed by FHS and they were found mainly at G7. Less important polychaete prey included Sabellidae, Polynoidae, Maldanidae, and Trichobranchidae. Clams were not important prey for FHS at sandy or muddy sand stations (e.g., G8, G7, and G6), but they were very important at sandy mud or muddy stations (E5, E4, D5, D4, and C4). They comprised 71% and 79% of the total stomach contents weight at station E5 and C4, respectively. Cumacean occurred more often at muddier stations. They usually comprised <2% of the total stomach contents weight, but at one station, C2, they comprised 48%. Gammarid amphipods (Ampeliscidae, Gammaridae, Isaeidae, and Lysianassidae) were the most frequently occurring prey in FHS diet; however, they were not important prey in terms of percent weight of total stomach contents. In general, they comprised <10% of the total stomach contents weight at each station except B3, where they comprised 37%. Shrimp occurred in FHS stomachs at 16 stations. They comprised more than 10% of the total stomach contents weight at each station. At stations G8, G6, and B2, they comprised >75% of the diet weight. The high percent consumption of shrimp by FHS, comparing to AKP and NRS, may indicate that FHS fed occasionally in the water column, as shrimp were not often found in benthic samples. Crabs, mainly *Chionoecetes* sp., were only found in FHS stomachs at E5, E4, and D5, where they comprised 4%, 3%, and 30% of the total stomach contents weight in each station, respectively. Brittle stars were important prey of FHS. They occurred in FHS stomachs at many stations and comprised usually >20% of the total stomach contents weight at each, and as high as 60% at muddier stations (e.g., stations E4 and B3). One zoarcid was found in one FHS stomach collected in station D4, but fish was not an important food of FHS.

Diet overlap among stations

Diet overlap trends among stations in FHS were different from the other three flatfish species. Firstly, FHS were mainly collected at muddier stations and only at three stations classified as sandy. Secondly, only in a few cases did adjacent stations (e.g. A2 and B2; G8 and G6) have a high diet overlap (Stations H9 and I10 also had high diet overlap, but the sample size was only one for each station). Diet overlap among A2, B2, G6, and G8 was high since FHS had a high percentage (≥75%) of shrimp in their diets at each of these stations. However, diet overlap was low or medium in other comparisons (Fig. 5). There was no clear trend in FHS diet in this study.

Diet variations among predator size-groups

At G8, the diet of FHS < 20 cm contained 37% polychaetes and 60% shrimp. The diet of FHS 20-29 cm contained 14% mysids and 82% shrimp. The diet of FHS ≥ 30 cm contained 100% shrimp. Diet overlap among size-groups was high (≥ 60%).

At G7, the diet of FHS < 20 cm contained 89% of euphausiids. The diet of FHs 20-29 cm (n = 1) contained 61% polychaetes and 33% brittle stars. The diet of FHS ≥ 30 cm (n=1) contained 100% of brittle stars. Diet overlap among size-groups was low (< 34%).

At D4, the diet of FHS < 20 cm (n = 1) contained 100% brittle stars. The diet of FHS 20-29 cm contained 9% polychaetes, 10% clams, 15% shrimp, 20% brittle stars, and 43% fish. The diet of FHS ≥ 30 cm (n = 2) contained 44% polychaetes, 40% clams, and 11% brittle stars. Diet overlap among size-groups was low (< 30%).

At B2, the diet of FHS < 20 cm contained 17% calanoid copepods, 7% cumacean, 40% gammarids, and 36% euphausiids. The diet of FHS 20-29 cm contained 99% shrimp. The diet of FHS ≥ 30 cm contained 100% clams. Diet overlap among size-groups was low (< 30%).

Overall, the diet of FHS varied greatly among size-groups at most of the stations sampled except G8. The results might not be representative since the sample sizes were small for some size-groups.

Interspecific diet comparison

FHS were found in 16 of the 27 stations. H9 and I10 (sandy) each had only one stomach sample available, thus were excluded from this analysis. Fifteen of the 16 stations were categorized as muddy sand, sandy mud, or muddy habitats. Only station G8 was categorized as sandy type.

FHS were distributed in different habitat types than AKP, NRS, and YFS, and had a different diet. FHS also had higher diet variation among stations, consuming varied proportions of polychaetes, clams, amphipods, shrimp, crabs, and brittle stars.

Brittle stars were important food of FHS (Table 4); but they are not important for AKP (Table 1) and NRS (Table 2), even at E5, G6, and G7 (<6% of total stomach contents weight) where brittle stars were abundant in benthic samples. Brittle stars were consumed by YFS at some stations, but they comprised ≤30% of the total stomach contents weight at those stations (Table 3).

In general, diet overlap between FHS and AKP was low (<30%) at every station. Diet overlap between FHS and NRS was low, except at F7 (PSI=62%) where both species consumed large amount of Sabellidae (>56% total stomach contents weight) and some gammarid amphipods. Diet overlap between FHS and YFS was low (<30%), except at G7 (40%), E5 (40%), and F7 (63%), where they consumed a high proportion of Sabellidae (68% total stomach contents weight).

Correspondence Between Diet And Infauna Assemblage

Polychaetes

1. Polynoidae and Sigalionidae -- In benthic samples, Polynoidae were distributed mainly on the middle shelf (Fig. 6a). Sigalionidae were ubiquitous on the inner and middle shelves (Fig. 6b). In this study, Polynoidae and Sigalionidae were not able to be identified separately from stomachs. AKP consumed these two families (combined) in similar proportion to their presence in benthic samples. They were mainly <5% of total stomach contents weight (Fig. 6c). NRS (Fig. 6d), YFS (Fig. 6e), and FHS (Fig. 6f) also consumed <5% of total stomach contents weight of these two families in general. Haflinger (1981) reported that Sigalionidae were distributed on the inner-shelf and middle-shelf areas, whereas Polynoidae were mainly in the middle shelf.

2. **Phyllodocidae --** Phyllodocidae were found mainly on the inner-shelf stations in the benthic samples (Fig. 7a). They comprised <5% of the infauna biomass at each station. Phyllodocidae were consumed by AKP (Fig. 7b), NRS (Fig. 7c), and YFS (Fig. 7d) mainly on the inner-shelf at usually <5% of the total stomach contents weight at each station. Phyllodocidae were not found in FHS stomachs.

3. **Nephtyidae --** Nephtyidae were important in the benthic samples. They were found at many stations. Especially high biomass (>25% of infauna biomass) were found around the depth of 50 m line (Fig. 8a). They were important prey for AKP, NRS, and YFS. The proportion of Nephtyidae consumed varied spatially and depending on flatfish species (Fig. 8b-d), and can be as high as 75% of the total stomach contents weight at some stations. No Nephtyidae was found in FHS stomachs.

4. **Goniadidae --** Goniadidae were mainly found on the middle-shelf in the benthos. They were also found in a few stations in inner-shelf, but not on the outer-shelf (Fig. 9a). They were <5% of the infauna biomass at each station. Goniadidae were consumed by AKP (Fig. 9b), NRS (Fig. 9c), and YFS (Fig. 9d), but comprised <5% of the total stomach contents weight at each station. No Goniadidae was found in FHS stomachs.

5. **Onuphidae --** In the benthos, Onuphidae were found on the middle-shelf, plus one station on the outer-shelf. They comprised <25% of the infauna biomass at each station (Fig. 10a). Onuphidae were consumed by AKP (Fig. 10b), NRS (Fig. 10c), YFS (Fig. 10d), and FHS (Fig. 10e). High proportions (up to 75% of the total stomach contents weight) of Onuphidae were consumed by these flatfishes at some stations on the middle shelf.

6. **Lumbrineridae --** High proportions (25-50% of infauna biomass) of Lumbrineridae were found on outer-shelf benthic samples, but none was found in the inner-shelf (Fig. 11a). Lumbrineridae were consumed by AKP (Fig. 11b), NRS (Fig. 11c), and YFS (Fig. 11d). They usually comprised <5% of the total stomach contents weight at each station. No Lumbrineridae was found in FHS stomachs.

7. **Orbiniidae --** Orbiniidae were ubiquitous in benthic samples (Fig. 12a), at ≤25% of the infauna biomass at each station. Orbiniidae were consumed by AKP, NRS, and YFS at ≤5% of the total stomach contents weight (Fig. 12b-d). Orbiniidae was not found in FHS stomachs.

8. **Opheliidae --** Opheliidae were abundant in benthic samples on the inner-shelf and middle-shelf (Fig. 13a). They comprised ≤32% of the infauna biomass at each station. Opheliidae were found in the stomachs of AKP (Fig. 13b), NRS (Fig. 13c), and YFS (Fig. 13d) at many stations on the inner-and middle-shelves, at <25% of the total stomach contents weight at each station. No Opheliidae were found in FHS stomachs.

9. **Maldanidae --** Maldanidae occurred at many stations in the benthic samples. Higher proportional biomass (25-50% of infauna biomass) was found at stations around the depth of 100 m (Fig. 14a). Maldanidae were found in the stomachs of AKP (Fig. 14b), NRS (Fig. 14c), YFS (Fig. 14d), and FHS (Fig. 14e), usually comprising <5% of the total stomach contents weight at each station.

10. **Ampharetidae --** Ampharetidae were found at many stations in benthic samples (Fig. 15a), but they comprised <5% of the infauna biomass at each station. They were found in AKP and NRS stomachs at many stations. High proportions (75-100%) of Ampharetidae were found in AKP stomachs at H8 (Fig. 15b) and in NRS stomachs at G6 on the middle-shelf (Fig. 15c). YFS consumed less Ampharetidae than those consumed by AKP and NRS. They consumed <25% of the stomach contents weight at each stations (Fig. 15d). No Ampharetidae was found in FHS stomachs.

11. Terebellidae -- Terebellidae were found in benthic samples at many stations (Fig. 16a). They comprised <25% of infauna biomass at station. Terebellidae were consumed by AKP (Fig. 16b), NRS (Fig. 16c), and YFS (Fig. 16d). High proportions (up to 50%) of Terebellidae were found in AKP stomachs on middle-shelf. Terebellidae was not found in FHS stomachs.

12. Trichobranchidae -- Trichobranchidae were found in benthic samples on the middle- and outer-shelves. They comprised <25% of infauna biomass at each station (Fig. 17a). Trichobranchidae were found in AKP (Fig. 17b), NRS (Fig. 17c), YFS (Fig. 17d), and FHS (Fig. 17e), at <25% of the total stomach contents weight at each station except for AKP at E5, where Trichobranchidae comprised about 50% of the total stomach contents weight.

13. Sabellidae -- Sabellidae had a patchy distribution in the study area (Fig. 18a). They usually comprised <5% of the infauna biomass at each station. Sabellidae were consumed by AKP (Fig. 18b), NRS (Fig. 18c), and YFS (Fig. 18d) mainly at muddier stations on the middle-shelf. The highest consumption of Sabellidae by NRS (85% of the total stomach contents weight) and by YFS (38%) was at F7 (Fig. 18c-d). Sabellidae were consumed by FHS (8%) at only one station (D4) on the outer-shelf area (Fig. 18e).

Clams

14. Nuculanidae -- In the benthos, Nuculanidae (mainly *Yoldia* sp.) were found at muddier stations on the middle- and outer-shelves. Biomass was high for Nuculanidae at E4, E5, E6, and D4 (Fig. 19a); they comprised between 28 and 45% of infauna biomass at each of those stations. Nuculanidae were consumed by AKP (Fig. 19b), NRS (Fig. 19c), YFS (Fig. 19d), and FHS (Fig. 19e). The highest proportion (50% of the total stomach contents weight) of Nuculanidae was found in the stomachs of FHS at E5.

15. Tellinidae -- In the benthos, Tellinidae were found mainly at sandy stations on the inner-shelf. They comprised high proportions (⩾75%) of infauna biomass at K10, K12, J11, J10 (Fig. 20a). AKP consumed a high percentage (≥88% of the stomach contents weight) of Tellinidae at sandy stations J9 and J10 (Fig. 20b). NRS consumed high proportions (≥54% of the total stomach contents weight) of Tellinidae at sandy stations K10 and J10 (Fig. 20c). YFS consumed high proportions (≥55% of the total stomach contents weight) of Tellinidae at sandy stations J9 and J10 (Fig. 20d). Tellinidae was found in FHS stomachs at only one station (D4) on the outer-shelf, where they comprised 9% of the total stomach contents weight (Fig. 20e).

Crustaceans

16. Mysidae -- No Mysidae were found in benthic samples but they were found in the stomachs of NRS (Fig. 21a), YFS (Fig. 21b) and FHS (Fig. 21c). In general, they comprised <5% of the total stomach contents weight at each station; however, high proportions (≥90% of the total stomach contents weight) of mysides were found in FHS stomachs collected at H9 and I10 stations on the inner-shelf (Fig. 21c).

17. Cumacea -- In the benthos, Cumacea were found at many stations over study area (Fig. 22a), but they comprised <5% of infauna biomass at each station. Cumacea were consumed by AKP (Fig. 22b), NRS (Fig. 22c), YFS (Fig. 22d), and FHS (Fig. 22e) at many stations. They usually comprised <5% of the total stomach contents weight at each station; however, high proportions of cumacean were found in FHS stomachs at C2 (48%) and F6 (33%).

18. Amphipoda -- Amphipods (mainly Ampeliscidae, Gammaridae, Isaeidae, and Lysianassidae) were found in benthic samples at all stations in this study (Fig. 23a). They usually comprised <25% of infauna biomass at each station, but was 35% of infauna biomass at J9. Amphipods were found in the stomachs of AKP, (Fig. 23b), NRS (Fig. 23c), YFS (Fig. 23d), and FHS (Fig. 23e) at many stations. Amphipoda comprised <13% of the total stomach contents weight of AKP at each station. The highest proportion (83% of the total stomach contents weight) of Amphipoda in NRS was found at H8 and at J11 for YFS (61%). FHS consumed relatively less Amphipoda than NRS and YFS, the highest proportion (44%) of Amphipoda found in FHS stomachs was at F7.

19. Euphausiidae -- Euphausiids were not found in benthic samples, but they were found in the flatfish stomachs. They comprised <7% of the total stomach contents weight in NRS at each station (Fig. 24a). Euphausiids were consumed by YFS mainly at sandy stations on the inner-shelf (Fig. 24b), and the highest (31%) proportion of euphausiids consumption was at G7. Euphausiids were found in FHS stomachs at three stations, comprising <11% of the total stomach contents weight at each (Fig. 24c).

Other

20. Caridea (shrimp) -- In the benthos, shrimps were found only at two stations on the inner-shelf. They comprised <15% of infauna biomass at each station (Fig. 25a). Shrimps (Pandalidae, Hippolytidae, and Crangonidae) were found in the stomachs of AKP (Fig. 25b), NRS (Fig. 25c), YFS (Fig. 25d), and FHS (Fig. 25e). They were not the main prey of AKP and NRS (≤5% of the total stomach contents weight), but the proportion of shrimp consumed by YFS was as high as 29% at E5 and 75-100% of the stomach contents weight at G6, G8, B2, and A2. This indicates that YFS probably fed on epibenthic and also in the water column.

21. Sipuncula (peanut worm) -- Sipuncula were found at almost all stations on the outer-shelf benthic samples plus at two stations on the middle-shelf (Fig. 26a). They were also found in AKP stomachs at two stations on the middle-shelf area (Fig. 26b). They were usually <5% of infauna biomass or stomach contents weight. No Sipuncula was found in NRS, YFS or FHS stomachs.

22. Echiura (spoon worm) -- Echiuroids were not found in the outer-shelf benthic samples. They were mainly found on the inner-shelf, plus a few stations on the middle-shelf (Fig. 27a). The highest (61%) proportion of echiuroids in benthic samples was found at H8. The highest proportion of echiuroids in AKP (43% of the total stomach contents weight) stomachs, NRS (69%), and YFS (54%) stomachs were all found at G8 (Fig. 27b-d). FHS consumed less echiuroids than other flatfish species. Echiuroids comprised <14% of FHS total stomach contents weight at each station (Fig. 27e).

23. Ophiurida (brittle star) -- Brittle stars were found at almost every station on the muddier middle-shelf benthic samples (Fig. 28a). In general, they were <5% of infauna biomass at each station. The highest (26%) biomass was found at G6. Brittle stars were consumed by AKP (Fig. 28b), and NRS (Fig. 28c) at <5% of the total stomach contents weight at each station. Brittle stars were also consumed by YFS (Fig. 28d) at as high as 25% of the total stomach contents weight at G6. Comparing to other flatfish species, FHS consumed more brittle stars (Fig. 28e). They comprised a high proportion of FHS stomach contents weight at E4 (65%), B3 (44%), C2 (30%), and D5 (26%).

24. Clypeasteroida (sand dollar) -- Sand dollars were found at six stations on the sandier inner-shelf in benthic samples (Fig. 29a). The highest (26%) proportion of sand dollars in the infauna was found at J10. The highest proportion of sand dollars in AKP was found at I10 (15% of the total stomach contents weight) (Fig. 29b), and at J10 in NRS (11%)(Fig. 29c). YFS were the main predator of sand dollars in this study. High proportions of sand dollar were found in YFS stomachs at K11 (60%) and I10 (46%)(Fig. 29d). No sand dollar was found in FHS stomachs.

25. Holothuroidea (sea cucumber) -- High biomasses (94% for station F6 and 69% for station G6) of sea cucumbers were found in the middle-shelf of the benthic samples (Fig. 30a). Sea cucumbers were consumed by AKP at six stations (Fig. 30b); they comprised <5% of the total stomach contents at each station. Sea cucumbers were found in NRS stomachs in two stations (G6 and E4) (Fig. 30c); they comprised 16% and 1%, at each station, respectively. Sea cucumbers were consumed by YFS at two stations (G6 and F6) (Fig. 30d); they comprised 24% and 13% of the total stomach contents weight, respectively. FHS did not consume sea cucumber often; they were only found in one station (G6) and they comprised <2% of the total stomach contents weight of FHS at that station (Fig. 30e).

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Table 1. -- Percent by weight of main prey items consumed by Alaska plaice (*Pleuronectes quadrituberculatus*) in the eastern Bering Sea in 2009 (Data used for diet overlap comparisons).

Prey / Station	**E4**	**E5**	**E6**	**F6**	**F7**	**G6**	**G7**	**G8**	**H8**	**H9**	**I8**	**I9**	**I10**	**J9**
Habitat type	**SM**	**SM**	**MS**	**MS**	**MS**	**MS**	**MS**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
Scolecida	25.3	3.5	5.4	1.7	3.6	0.4	8.4	0.2	2.5	10.1	2.1	1.6	8.8	0.7
Aphroditoidea	6.0	0.1	3.8	2.6	1.1	0.6	20.1	2.7	0.3	6.7	1.8	1.0	0.1	0.0
Phyllodocida	2.5	0.6	1.4	0.6	6.8	0.2	37.3	0.0	0.6	35.7	8.5	21.6	8.9	1.8
Eunicida	0.1	1.0	10.6	52.5	16.4	16.6	5.5	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Spionida	0.0	0.1	0.0	0.0	7.2	0.0	0.0	28.6	0.0	0.1	0.0	0.1	0.2	0.1
Terebellida	43.4	50.6	40.0	35.3	39.8	44.1	14.2	11.1	77.1	0.0	47.1	3.6	17.9	1.5
Sabellida	8.1	8.5	2.7	0.0	3.9	27.8	1.5	0.0	5.4	19.0	1.4	0.0	0.1	0.0
Gastropoda	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.6	0.0	24.0	5.1	0.1
Bivalvia	4.2	24.1	8.8	6.1	10.0	4.2	2.9	2.6	3.2	21.5	13.0	37.0	28.7	94.1
Cumacea	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1
Gammaridea	2.7	3.4	11.1	1.3	2.6	5.7	3.6	0.5	3.4	4.8	2.2	7.9	12.6	2.1
Sipuncula	4.3	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Echiura	3.0	8.1	15.9	0.4	0.0	0.0	0.0	42.9	6.1	0.0	21.6	0.0	0.5	0.0
Ophiurida	0.4	0.1	0.0	0.1	0.4	0.2	1.5	3.5	0.8	1.2	0.1	0.0	0.0	0.0
Ectoprocta	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clypeasteroida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	15.2	1.1
Holothuroidea	0.0	0.0	0.0	0.0	0.3	0.0	3.3	0.9	0.3	0.0	0.0	0.0	1.8	0.0
Ascidiacea	0.0	0.0	0.0	0.0	1.1	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Teleostei	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.1	100.2	99.7	100.6	93.8	99.8	99.7	95.1	99.8	99.7	97.8	99.7	100.0	101.6
Average fork length (non-empty)	37.8	36.2	37.4	34.4	39.0	29.6	34.7	39.8	37.7	39.6	38.4	32.0	37.3	35.2
Standard deviation of fork length	3.4	4.6	6.6	7.5	8.1	6.5	7.2	8.7	8.2	6.4	8.2	5.6	7.8	9.0
Minimum fork length	31	29	28	25	28	23	26	25	24	27	26	24	24	22
Maximum fork length	44	44	48	48	51	41	44	50	48	47	52	42	49	50
Non-empty stomach	12	13	8	14	15	12	11	15	15	10	14	12	15	15
Empty stomach	0	0	1	1	0	0	4	0	0	1	1	3	0	0
Total stomach	12	13	9	15	15	12	15	15	15	11	15	15	15	15

Scolecida includes Arenticolidae, Capitellidae, Cossuridae, Maldanidae, Opheliidae, Orbiniidae, Paraonidae, and Scalibregmatidae.

Aphroditoidea includes Aphroditidae and Polynoidae.

Phyllodocida includes Nereididae, Glyceridae, Goniadidae, Nephtyidae, Phyllodocidae, and Syllidae.

Eunicida includes Eunicidae, Lumbrineridae, Oenonidae, and Onuphidae.

Spionida includes Chaetopteridae, Magelonidae, and Spionidae.

Terebellida includes Cirratulidae, Flabelligeridae, Sternaspidae, Ampharetidae, Pectinariidae, Terebellidae, and Trichobranchidae.

Sabellida includes Oweniidae, Sabellaridae, Sabellidae, and Serpulidae.

Habitat type: S, sandy, % sand ≥ 80% wt; MS, muddy sand, 50% wt ≤ % sand < 80% wt; SM, sandy mud, 50% wt ≤ % mud < 80% wt; M. muddy, % mud ≥ 80%Wt.

* prey items with ≤ 0.1 percent weight and occurred only once, were not included in this table.

** prey items occurred only in one station were not included in this table.

Table 1. -- Continued.

Prey / Station	J10	J11	K10	K11	K12
Habitat type	**S**	**S**	**S**	**S**	**S**
Scolecida	0.7	0.0	8.2	0.5	1.4
Aphroditoidea	0.0	0.0	2.1	0.1	2.2
Phyllodocida	0.0	0.0	14.0	18.7	27.9
Eunicida	0.0	0.0	0.0	0.0	0.0
Spionida	0.0	0.0	0.0	0.0	0.0
Terebellida	0.0	4.5	12.0	4.6	5.0
Sabellida	0.0	0.0	0.1	4.3	0.0
Gastropoda	0.1	9.2	0.0	0.0	0.0
Bivalvia	87.3	74.4	58.1	69.3	48.8
Cumacea	0.2	0.0	0.1	0.2	0.0
Gammaridea	1.4	11.3	1.5	1.9	7.4
Sipuncula	0.0	0.0	0.0	0.0	0.0
Echiura	0.0	0.0	0.0	0.0	0.0
Ophiurida	0.0	0.0	1.9	0.0	0.0
Ectoprocta	0.0	0.0	0.0	0.0	0.3
Clypeasteroida	9.7	0.0	0.4	0.6	0.0
Holothuroidea	0.0	0.0	0.0	0.0	2.0
Ascidiacea	0.0	0.0	0.0	0.0	0.0
Teleostei	0.0	0.0	0.0	0.0	1.6
Total	99.4	99.4	98.4	100.2	96.6
Average fork length (non-empty)	34.6	29.3	33.9	27.7	26.0
Standard deviation of fork length	9.0	5.0	9.0	5.5	9.5
Minimum fork length	24	24	20	20	17
Maximum fork length	51	36	50	36	48
Non-empty stomach	13	8	14	15	11
Empty stomach	2	6	1	0	0
Total stomach	15	14	15	15	11

Table 2.-- Percent by weight of main prey items consumed by northern rock sole (*Lepidopsetta polyxystra)* in the eastern Bering Sea in 2009.
(Data used for diet overlap comparisons.)

Prey / Station	**D5**	**E4**	**E5**	**E6**	**F6**	**F7**	**G6**	**G8**	**H8**	**H9**	**I8**	**I9**	**I10**	**J9**	**J10**
Habitat type	**MS**	**SM**	**SM**	**MS**	**MS**	**MS**	**MS**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
Scolecida	0.0	9.4	0.2	0.0	0.0	0.0	0.1	1.3	0.5	26.0	4.5	20.2	2.5	8.8	6.5
Aphroditoidea	0.1	1.3	0.1	4.6	0.0	2.0	0.0	0.0	0.0	0.0	0.1	1.0	8.7	0.0	0.0
Phyllodocida	7.8	30.1	0.0	0.0	31.3	0.0	1.1	0.4	0.0	56.6	27.1	1.3	46.5	33.6	0.3
Eunicida	1.9	0.0	3.1	77.4	56.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spionida	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Terebellida	36.4	30.6	13.4	10.5	0.0	0.0	79.6	0.0	9.0	0.0	29.2	34.2	17.5	11.4	6.0
Sabellida	15.6	13.0	9.6	0.0	0.0	90.1	0.9	25.1	0.0	0.7	0.6	0.1	0.0	0.5	0.0
Gastropoda	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	2.3	0.0	0.1	0.0
Bivalvia	5.2	6.1	14.7	0.2	0.0	1.3	0.7	1.5	7.4	3.4	2.8	12.2	9.1	31.3	67.3
Crustacea	0.0	0.0	0.0	0.0	9.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Mysidae	0.0	0.0	0.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0
Cumacea	0.0	0.8	0.4	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.7	0.5	0.2	0.5	0.1
Isopoda	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Gammaridea	24.0	5.6	52.5	2.8	3.1	6.6	0.9	2.2	83.2	12.5	15.9	17.9	11.3	6.0	4.5
Euphausiidae	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.8	0.0	0.2	0.7	0.6
Echiura	2.7	1.9	5.7	0.0	0.0	0.0	0.0	69.2	0.0	0.0	15.2	1.2	0.1	4.9	2.4
Ophiurida	5.3	0.7	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Clypeasteroida (sand dollar)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	2.1	0.6	11.1
Holothuroidea	0.0	0.9	0.0	0.0	0.0	0.0	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Teleostei	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	2.0	0.0
Total	99.6	100.5	99.8	100.1	100.1	100.1	99.6	100.3	100.1	100.3	98.0	101.6	98.4	100.5	100.4
Average fork length (non-empty)	27.6	26.2	27.6	19.0	16.7	21.0	20.3	28.2	22.0	25.2	26.9	27.3	26.8	28.9	25.3
S.D. of fork length	4.4	3.8	6.5	3.4	0.6	5.7	4.2	5.8	3.5	5.6	8.1	6.3	8.8	5.1	6.4
Minimum fork length	22	21	18	15	16	15	15	17	20	18	16	16	14	15	16
Maximum fork length	35	32	36	25	17	31	29	35	26	36	36	37	36	37	35
Non-empty stomach	15	13	14	6	3	8	13	11	3	14	15	15	15	15	14
Empty stomach	0	2	1	8	12	2	2	4	12	2	0	1	0	0	1
Total stomach	15	15	15	14	15	10	15	15	15	16	15	16	15	15	15

Scolecida includes Arenticolidae, Capitellidae, Cossuridae, Maldanidae, Opheliidae, Orbiniidae, Paraonidae, and Scalibregmatidae.

Aphroditoidea includes Aphroditidae and Polynoidae.

Phyllodocida includes Nereididae, Glyceridae, Goniadidae, Nephtyidae, Phyllodocidae, and Syllidae.

Eunicida includes Eunicidae, Lumbrineridae, Oenonidae, and Onuphidae.

Spionida includes Chaetopteridae, Magelonidae, and Spionidae.

Terebellida includes Cirratulidae, Flabelligeridae, Sternaspidae, Ampharetidae, Pectinariidae, Terebellidae, and Trichobranchidae.

Sabellida includes Oweniidae, Sabellaridae, Sabellidae, and Serpulidae.

Habitat type: S, sandy, % sand $\geq$ 80% wt; MS, muddy sand, 50% wt $\leq$ % sand < 80% wt; SM, sandy mud, 50% wt $\leq$ % mud < 80% wt;
M. muddy, % mud ≥ 80%Wt.

* prey items with $\leq$ 0.1 percent weight and occurred only once, were not included in this table.

** prey items occurred only in one station were not included in this table.

Table 2. -- Continued.

Prey / Station	J11	K10	K11	K12
Habitat type	**S**	**S**	**S**	**S**
Scolecida	1.1	8.4	2.6	1.3
Aphroditoidea	1.6	0.2	0.0	2.0
Phyllodocida	27.0	13.1	1.3	23.9
Eunicida	0.0	0.0	0.0	0.0
Spionida	0.0	0.0	0.0	1.6
Terebellida	14.3	4.4	3.1	3.0
Sabellida	0.4	0.0	0.0	0.0
Gastropoda	0.0	0.0	0.0	1.1
Bivalvia	31.4	53.5	37.9	11.2
Crustacea	0.0	0.0	0.1	0.0
Mysidae	0.0	0.4	0.0	0.0
Cumacea	0.8	0.1	0.0	0.2
Isopoda	0.0	0.0	0.0	0.0
Gammaridea	12.0	4.0	1.9	7.6
Euphausiidae	0.0	6.3	0.0	0.0
Echiura	0.0	3.4	0.7	0.0
Ophiurida	0.1	0.0	0.0	0.0
Clypeasteroida (sand dollar)	4.9	3.0	3.8	4.1
Holothuroidea	0.0	0.0	0.0	0.0
Teleostei	6.0	3.6	43.8	38.4
Total	99.6	100.4	95.2	94.4
Average fork length (non-empty)	26.5	27.9	27.3	26.8
S.D. of fork length	5.9	8.7	10.0	10.5
Minimum fork length	16	16	12	13
Maximum fork length	37	39	41	39
Non-empty stomach	15	15	15	16
Empty stomach	2	0	0	0
Total stomach	17	15	15	16

Table 3.-- Percent by weight of main prey items consumed by yellowfin sole (*Pleuronectes asper*) in the eastern Bering Sea in 2009.
(Data used for diet overlap comparisons.)

Prey / Station	**E5**	**E6**	**F6**	**F7**	**G6**	**G7**	**G8**	**H8**	**H9**	**I8**	**I9**	**I10**	**J9**	**J10**	**J11**
Habitat type	**SM**	**MS**	**MS**	**MS**	**MS**	**MS**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
Scyphozoa	0.0	0.0	0.0	0.0	0	0.0	0.0	37.9	0.0	0.0	7.0	0.0	0.0	0.0	0.0
Scolecida	0.5	0.5	2.1	0.1	0.8	0.9	1.2	0.1	0.7	4.4	0.0	0.9	0.0	0.1	4.6
Aphroditoidea	0.5	17.5	1.6	4.7	0.1	0.4	0.2	0.1	0.1	0.0	0.0	0.8	0.0	0.0	2.4
Phyllodocida	2.5	8.3	10.7	0.0	17.3	33.4	30.3	24.2	60.5	6.1	0.0	0.0	0.0	0.0	0.5
Eunicida	0.0	1.5	18.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spionida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Terebellida	8.3	7.8	2.5	0.0	17.9	0.4	0.0	0.0	0.0	14.4	3.2	29.0	0.2	0.8	2.6
Sabellida	0.0	0.2	1.9	68.0	0.0	5.5	0.0	27.3	0.0	0.7	0.0	0.0	0.0	0.0	1.4
Mollusca unknown	0.1	1.3	0.0	0.0	0.0	0.0	0.4	0.0	0.0	10.1	0.0	0.1	0.0	0.0	0.0
Gastropoda	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Bivalvia	16.0	15.2	4.8	5.0	2.1	0.1	0.2	1.2	1.9	0.6	2.5	7.9	96.1	84.5	2.6
Crustacea	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.6	0.0	0.8	0.2	0.1	0.0	0.0
Mysidae	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.6
Cumacea	0.1	0.0	0.1	0.1	0.0	0.4	0.3	0.5	2.9	0.5	0.6	1.3	0.0	0.1	3.4
Amphipoda	14.2	20.3	2.9	7.0	9.5	0.1	1.5	3.0	17.3	13.2	29.3	12.9	1.4	3.8	61.4
Euphausiidae	0.0	0.0	2.3	0.0	0.0	30.5	0.5	4.1	7.4	21.1	19.5	0.0	0.0	7.0	11.8
Natantia	0.0	0.0	0.0	0.8	0.0	0.0	1.9	0.0	8.0	0.0	5.6	0.0	0.0	0.0	4.1
Reptantia	29.4	10.8	17.0	0.0	0.8	0.0	0.0	0.0	0.0	14.2	0.0	0.0	0.0	0.0	0.0
Echiura	28.8	16.0	1.6	0.9	0.0	0.0	53.6	0.9	0.0	13.1	0.0	0.0	0.0	0.0	0.0
Ectoprocta	0.0	0.0	0.2	0.0	0	0.0	0.1	0.1	0.6	0.2	11.0	0.0	0.0	0.0	0.1
Ophiurida	0.5	0.7	21.6	2.0	27.6	28.6	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clypeasteroida	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.8	46.1	2.4	3.8	4.0
Holothuroidea	0.0	0.0	13.4	0.0	24.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Teleostei	0.0	0.0	0.0	11.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total	101.0	100.1	100.9	100.2	100.4	100.3	96.6	100.2	100.0	100.1	100.3	99.3	100.2	100.1	99.7
Average fork length (non-empty)	33.7	33.9	29.5	27.6	29.9	27.5	26.4	27.3	24.6	23.6	26.2	25.1	26.9	28.1	26.0
S.D. of fork length	3.3	3.5	5.3	4.6	4.3	4.1	6.0	5.7	5.1	6.5	5.0	6.4	5.8	4.1	4.0
Minimum fork length	25	25	22	21	24	19	17	18	20	16	21	17	18	22	21
Maximum fork length	37	38	38	33	37	33	33	34	35	35	38	34	34	34	34
Non-empty stomach	13	14	15	10	14	12	14	12	13	14	12	15	14	15	14
Empty stomach	0	1	0	0	1	3	1	3	0	1	0	0	2	0	1
Total stomach	13	15	15	10	15	15	15	15	13	15	12	15	16	15	15

Scolecida includes Arenticolidae, Capitellidae, Cossuridae, Maldanidae, Opheliidae, Orbiniidae, Paraonidae, and Scalibregmatidae.

Aphroditoidea includes Aphroditidae and Polynoidae.

Phyllodocida includes Nereididae, Glyceridae, Goniadidae, Nephtyidae, Phyllodocidae, and Syllidae.

Eunicida includes Eunicidae, Lumbrineridae, Oenonidae, and Onuphidae.

Spionida includes Chaetopteridae, Magelonidae, and Spionidae.

Terebellida includes Cirratulidae, Flabelligeridae, Sternaspidae, Ampharetidae, Pectinariidae, Terebellidae, and Trichobranchidae.

Sabellida includes Oweniidae, Sabellaridae, Sabellidae, and Serpulidae.

Habitat type: S, sandy, % sand ≥ 80% wt; MS, muddy sand, 50% wt ≤ % sand < 80% wt; SM, sandy mud, 50% wt ≤ % mud < 80% wt;
M. muddy, % mud ≥ 80%Wt.

* prey items with ≤ 0.1 percent weight and occurred only once, were not included in this table.

** prey items occurred only in one station were not included in this table.

Table 3. -- Continued.

Prey / Station	**K10**	**K11**	**K12**
Habitat type	**S**	**S**	**S**
Scyphozoa	0.0	0.0	0.0
Scolecida	0.7	3.1	0.1
Aphroditoidea	15.7	0.0	0.1
Phyllodocida	0.0	0.1	5.3
Eunicida	0.0	0.0	0.0
Spionida	0.0	0.0	0.0
Terebellida	0.0	2.3	0.0
Sabellida	0.0	1.7	0.0
Mollusca unknown	38.5	0.0	0.0
Gastropoda	0.0	0.0	0.0
Bivalvia	10.9	4.1	28.3
Crustacea	0.0	0.0	0.0
Mysidae	0.0	0.0	0.0
Cumacea	0.0	0.7	0.5
Amphipoda	18.8	5.9	36.4
Euphausiidae	8.2	22.2	17.1
Natantia	0.0	0.0	5.1
Reptantia	0.0	0.0	0.0
Echiura	0.0	0.0	0.2
Ectoprocta	0.1	0.0	2.2
Ophiurida	0.0	0.0	0.0
Clypeasteroida	3.3	59.6	4.1
Holothuroidea	0.0	0.0	0.0
Teleostei	0.0	0.0	0.0
Total	96.2	99.7	99.4
Average fork length (non-empty)	25.6	30.4	25.7
S.D. of fork length	7.6	6.3	6.4
Minimum fork length	16	21	16
Maximum fork length	37	38	33
Non-empty stomach	15	14	12
Empty stomach	0	1	1
Total stomach	15	15	13

Table 4.-- Percent by weight of main prey items consumed by flathead sole (*Hippoglossoides elassodon*) in the eastern Bering Sea in 2009. (Data used for diet overlap comparisons.)

Prey / Station	**A2**	**B2**	**B3**	**C2**	**C3**	**C4**	**D4**	**D5**	**E4**	**E5**	**E6**	**F6**	**F7**	**G6**	**G7**
Habitat type	**SM**	**SM**	**M**	**M**	**M**	**M**	**SM**	**MS**	**SM**	**SM**	**MS**	**MS**	**MS**	**MS**	**MS**
Polychaeta	0.0	0.0	0.0	5.0	24.5	0.0	11.3	0.0	5.6	1.7	0.0	0.0	55.6	0.0	39.9
Gastropoda unknown	0.0	0.0	0.0	0.0	70.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0
Bivalvia	1.7	2.4	0.0	0.0	0.0	79.3	11.7	17.4	15.5	70.6	0.0	0.0	0.0	0.1	0.0
Crustacea unknown	0.0	0.6	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
Mysidae	0.0	0.4	0.0	0.0	0.0	0.0	2.3	0.8	0.0	1.9	1.2	0.0	0.0	0.0	0.7
Cumacea	0.0	0.3	6.2	48.7	0.8	0.0	0.8	0.1	0.1	0.0	0.0	33.3	0.0	0.0	0.0
Amphipoda	0.0	1.5	36.9	8.8	4.0	20.5	0.4	0.7	10.1	6.8	0.1	33.3	44.4	3.5	4.0
Euphausiidae	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	11.2
Caridea	98.3	93.7	0.0	0.0	0.0	0.0	13.7	24.1	0.0	0.0	0.0	0.0	0.0	80.2	0.0
Reptantia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.5	3.1	4.4	0.0	0.0	0.0	0.0	0.0
Echiura	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	14.4	0.0	0.0	0.0	0.0	0.0
Ectoprocta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0
Ophiurida	0.0	0.0	56.9	30.0	0.0	0.0	19.9	26.0	65.9	0.0	0.0	0.0	0.0	12.9	43.6
Pentamera lissoplaca	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0
Teleostei	0.0	0.0	0.0	0.0	0.0	0.0	39.1	0.0	0.0	0.0	98.6	0.0	0.0	0.0	0.0
Total	100.0	100.1	100.0	100.0	99.9	99.8	99.2	99.5	100.3	100.0	99.9	99.9	100.0	100.2	99.4
Average fork length (non-empty)	29.0	24.0	19.8	21.4	25.0	27.0	25.3	29.6	30.4	31.4	24.5	17.3	20.5	17.5	17.8
S.D. of fork length	2.8	9.3	5.8	7.7	3.4	1.7	5.3	3.4	2.7	6.4	14.9	8.5	12.0	8.4	8.8
Minimum fork length	27	12	13	12	20	25	14	22	26	27	14	11	12	12	10
Maximum fork length	31	36	29	33	27	28	33	34	34	46	35	27	29	30	31
Non-empty stomach	2	10	8	5	4	3	9	11	11	9	2	3	2	4	6
Empty stomach	10	5	7	10	11	12	8	4	3	6	13	12	13	1	6
Total stomach	12	15	15	15	15	15	17	15	14	15	15	15	15	5	12

Habitat type: S, Sandy; MS, Muddy sand; SM, Sandy mud; M, Muddy.

* prey items with $\leq$ 0.1 percent weight and occurred only once, were not included in this table.

Table 4. -- Continued.

Prey / Station	G8	H9	I10
Habitat type	**S**	**S**	**S**
Polychaeta	13.4	0.0	0.0
Gastropoda unknown	0.0	0.0	0.0
Bivalvia	0.0	0.0	0.0
Crustacea unknown	0.8	0.0	0.0
Mysidae	9.1	100.0	89.8
Cumacea	0.0	0.0	0.0
Amphipoda	0.5	0.0	0.1
Euphausiidae	0.0	0.0	0.0
Caridea	75.3	0.0	10.2
Reptantia	0.0	0.0	0.0
Echiura	0.0	0.0	0.0
Ectoprocta	0.0	0.0	0.0
Ophiurida	0.9	0.0	0.0
Pentamera lissoplaca	0.0	0.0	0.0
Teleostei	0.0	0.0	0.0
Total	100.0	100.0	100.1
Average fork length (non-empty)	23.7	37.0	33.0
S.D. of fork length	7.7	0.0	0.0
Minimum fork length	15	37	33
Maximum fork length	38	37	33
Non-empty stomach	9	1	1
Empty stomach	6	0	0
Total stomach	15	1	1

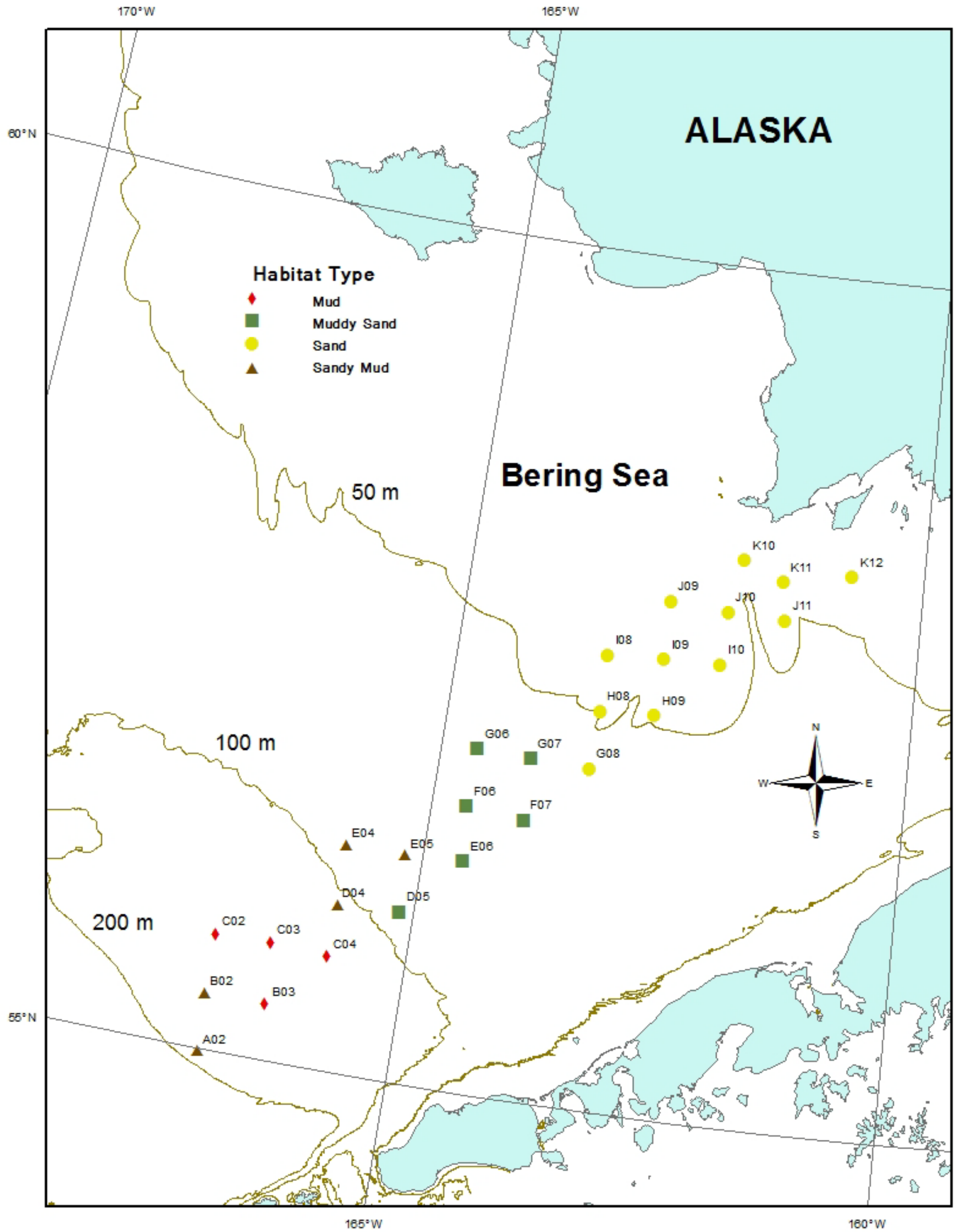

Figure 1. -- Stations of the benthic and stomach samples collected in the eastern Bering Sea in 2009.

Station	E4	E5	E6	F6	F7	G6	G7	G8	H8	H9	I8	I9	I10	J9	J10	J11	K10	K11	K12
K12	18	35	20	17	27	16	45	11	14	58	32	72	53	55	51	61	73	75	
K11	18	36	20	13	28	16	30	8	15	47	30	63	46	76	72	76	79		
K10	31	42	31	24	36	19	42	18	21	49	39	59	60	64	61	64			
J11	11	32	24	12	17	14	11	8	11	27	20	58	50	78	76				
J10	6	26	11	8	12	6	5	3	5	24	15	42	41	91					
J9	10	29	15	10	16	8	9	5	8	26	19	45	36						
I10	37	50	45	28	42	29	40	16	29	45	44	59							
I9	16	34	24	14	26	15	34	8	13	51	30								
I8	61	75	74	47	64	53	33	38	63	29									
H9	34	38	27	12	29	29	60	7	16										
H8	62	72	59	43	54	17	27	22											
G8	21	24	35	20	26	17	22												
G7	39	27	38	29	40	29													
G6	60	62	64	59	68														
F7	58	62	71	63															
F6	46	47	59																
E6	63	68																	
E5	66																		
E4																			

Diet Overlap	<30	30-49	>50
	Low	Medium	High

Figure 2. -- Percent Similarity Index (%) of dietary overlap of Alaska plaice (*Pleuronectes quadrituberculatus*) between stations in the eastern Bering Sea in 2009.

Station	D5	E4	E5	E6	F6	F7	G6	G8	H8	H9	I8	I9	I10	J9	J10	J11	K10	K11	K12
K12	24	41	22	8	27	10	6	6	16	37	39	34	49	48	25	59	40	61	
K11	12	16	21	5	3	3	6	6	12	9	12	29	20	44	50	50	54		
K10	24	38	27	8	16	6	7	9	20	30	34	38	36	68	50	61			
J11	40	57	42	15	29	10	18	5	20	44	59	50	67	80	50				
J10	20	26	28	9	3	6	8	8	18	15	21	39	25	52					
J9	34	65	38	14	34	8	15	11	22	53	59	44	64						
I10	42	64	34	18	34	10	20	6	21	64	62	45							
I9	65	56	46	15	4	9	37	7	35	38	56								
I8	59	73	39	14	30	9	33	21	23	48									
H9	25	49	17	3	34	9	4	6	25										
H8	29	21	60	3	3	8	2	5											
G8	23	21	19	3	3	29	3												
G6	40	35	16	12	2	3													
F7	24	21	18	5	3														
F6	13	33	6	59															
E6	16	15	17																
E5	57	37																	
E4	65																		
D5																			

	<30	30-49	≥50
Diet Overlap	Low	Medium	High

Figure 3.-- Percent Similaity Index (%) of dietary overlap of northern rock sole (*Lepidopsetta polyxystra)* between stations in the eastern Bering Sea in 2009.

Station	E5	E6	F6	F7	G6	G7	G8	H8	H9	I8	I9	I10	J9	J10	J11	K10	K11	K12
K12	33	41	16	13	17	23	10	15	38	37	61	26	32	43	60	42	32	
K11	13	13	16	12	11	26	4	11	17	34	52	60	8	20	32	22		
K10	26	47	12	17	12	10	4	9	29	33	33	26	15	25	36			
J11	21	29	16	15	16	16	7	11	35	35	55	25	7	18				
J10	21	20	11	9	7	8	2	9	13	12	18	17	89					
J9	21	17	6	6	4	0	2	17	3	2	7	12						
I10	30	30	12	13	30	2	4	5	17	29	40							
I9	20	26	11	10	15	21	5	17	34	37								
I8	53	54	33	9	32	30	23	16	29									
H9	19	28	19	10	30	42	36	34										
H8	8	14	20	33	22	35	28											
G8	34	28	22	6	26	39												
G7	5	11	39	8	46													
G6	24	30	55	11														
F7	14	19	14															
F6	33	35																
E6	68																	
E5																		

	<30	30-49	≥50
Diet Overlap	Low	Medium	High

Figure 4.-- Percent Similarity Index (%) of dietary overlap of yellowfin sole (*Pleuronectes asper)* between stations in the eastern Bering Sea in 2009.

Station	A2	B2	B3	C2	C3	C4	D4	D5	E4	E5	E6	F6	F7	G6	G7	G8	H9	I10
I10	10	11	0	0	0	0	13	11	0	2	1	0	0	10	1	19	90	
H9	0	0	0	0	0	0	2	1	0	2	1	0	0	0	1	9		
G8	75	77	1	7	14	1	29	26	7	4	1	1	14	77	16			
G7	0	3	48	39	29	4	32	27	53	7	1	4	44	16				
G6	80	82	16	17	5	4	27	38	17	4	0	4	4					
F7	0	2	37	14	29	21	12	1	16	9	0	33						
F6	0	2	40	42	5	21	1	1	10	7	0							
E6	0	1	0	0	0	0	40	1	0	1								
E5	2	5	7	9	6	77	16	24	27									
E4	2	4	67	44	10	26	38	45										
D5	26	28	27	27	1	18	47											
D4	15	17	21	26	13	12												
C4	2	4	21	9	4													
C3	0	2	5	10														
C2	0	2	45															
B3	0	2																
B2	95																	
A2																		

	<30	30-49	≥50
Diet Overlap	Low	Medium	High

Figure 5. -- Percent Similarity Index (%) of dietary overlap of flathead sole (*Hippoglossoides elassodon)* between stations in the eastern Bering Sea in 2009.

Figure 6a. -- Distribution of Polynoidae (polychaete) in the benthic samples.

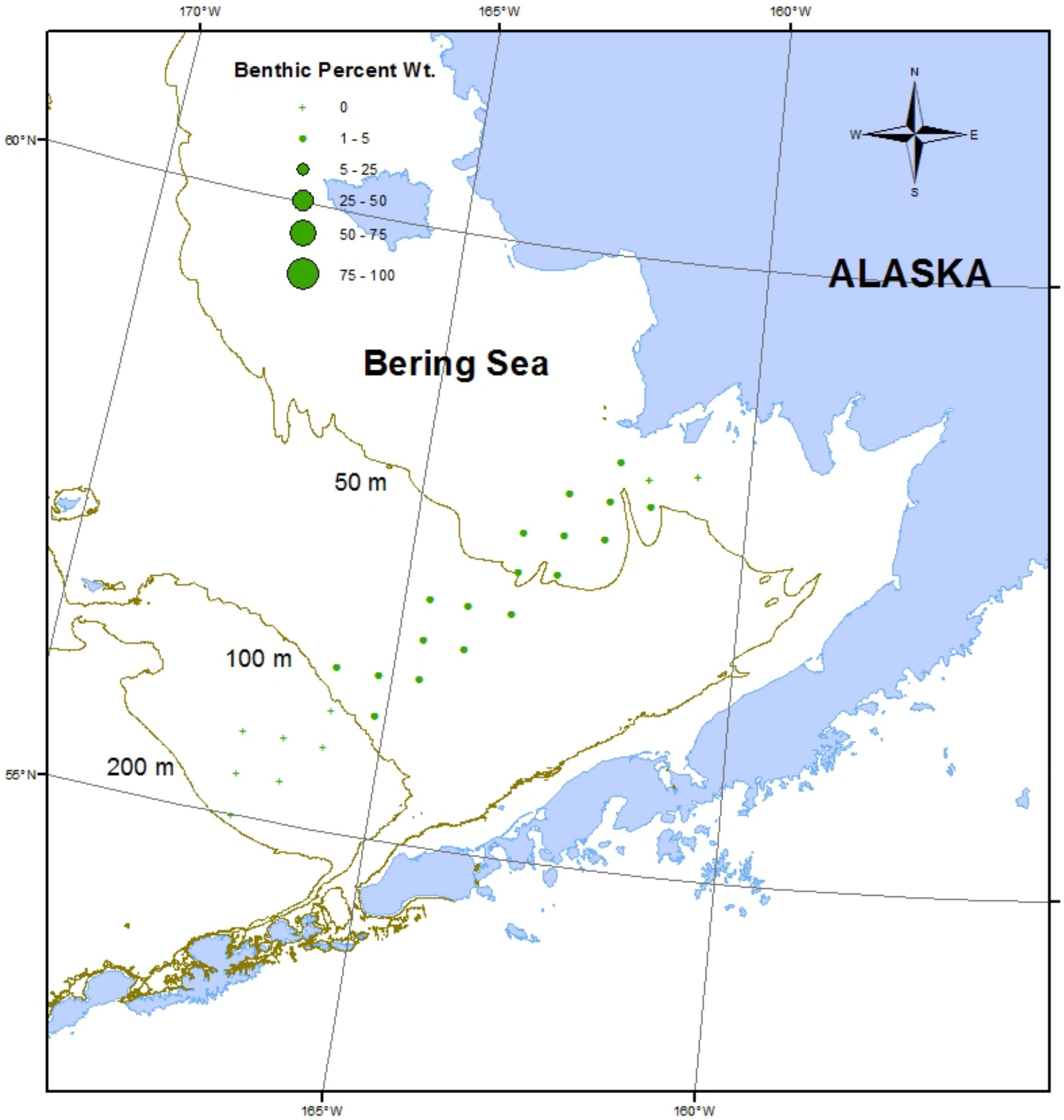

Figure 6b. -- Distribution of Sigalionidae (polychaete) in the benthic samples.

Figure 6c. -- Distribution of Polynoidae and Sigalionidae (polychaete) consumed by Alaska plaice.

Figure 6d. -- Distribution of Polynoidae and Sigalionidae (polychaete) consumed by northern rock sole.

Figure 6e. -- Distribution of Polynoidae and Sigalionidae (polychaete) consumed by yellowfin sole.

Figure 6f. -- Distribution of Polynoidae and Sigalionidae (polychaete) consumed by flathead sole.

Figure 7a. -- Distribution of Phyllodocidae (polychaete) in the benthic samples.

Figure 7b. -- Distribution of Phyllodocidae (polychaete) consumed by Alaska plaice.

Figure 7c. -- Distribution of Phyllodocidae (polychaete) consumed by northern rock sole.

Figure 7d. -- Distribution of Phyllodocidae (polychaete) consumed by yellowfin sole.

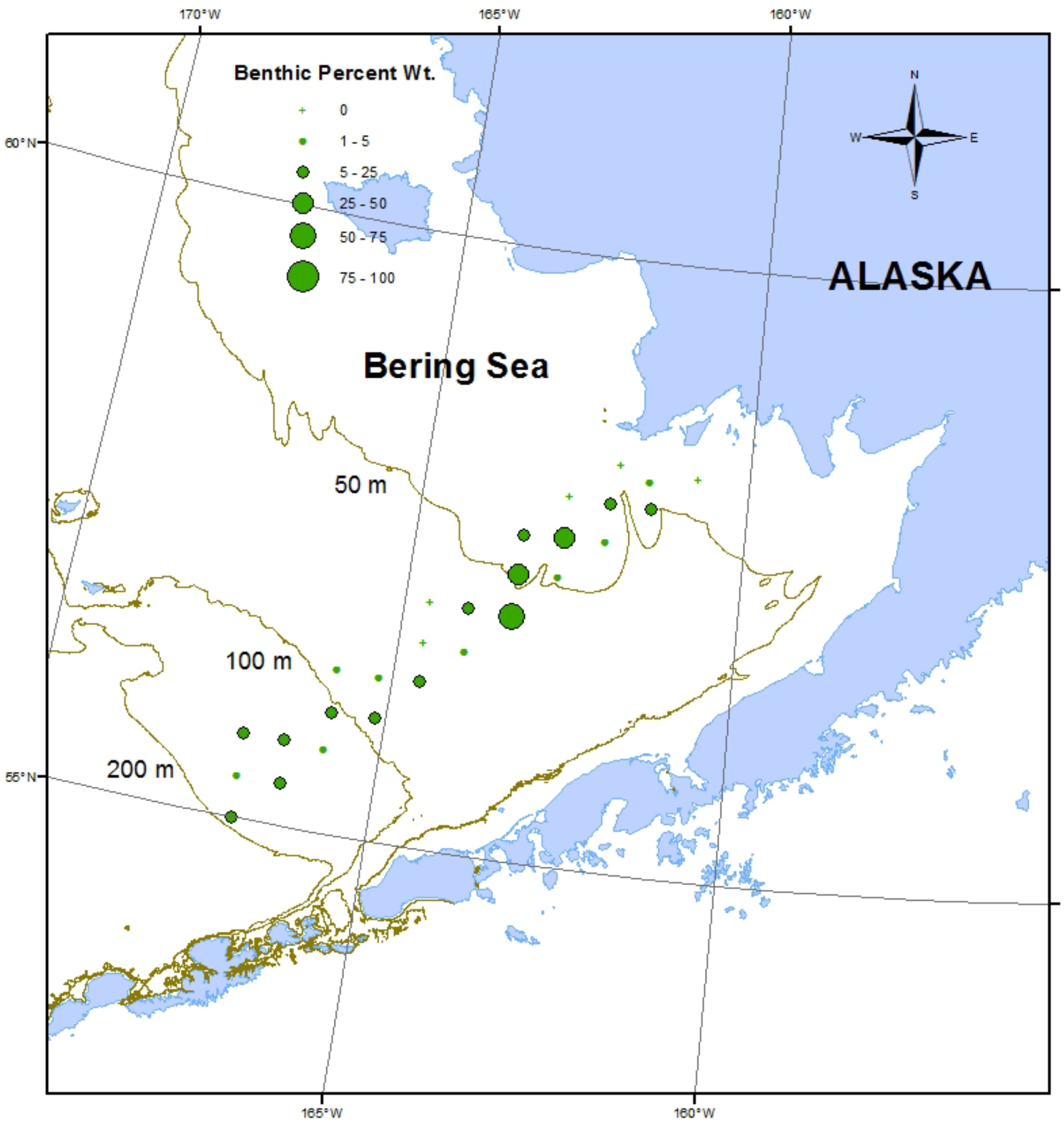

Figure 8a. -- Distribution of Nephtyidae (polychaete) in the benthic samples.

Figure 8b. -- Distribution of Nephtyidae (polychaete) consumed by Alaska plaice.

Figure 8c. -- Distribution of Nephtyidae (polychaete) consumed by northern rock sole.

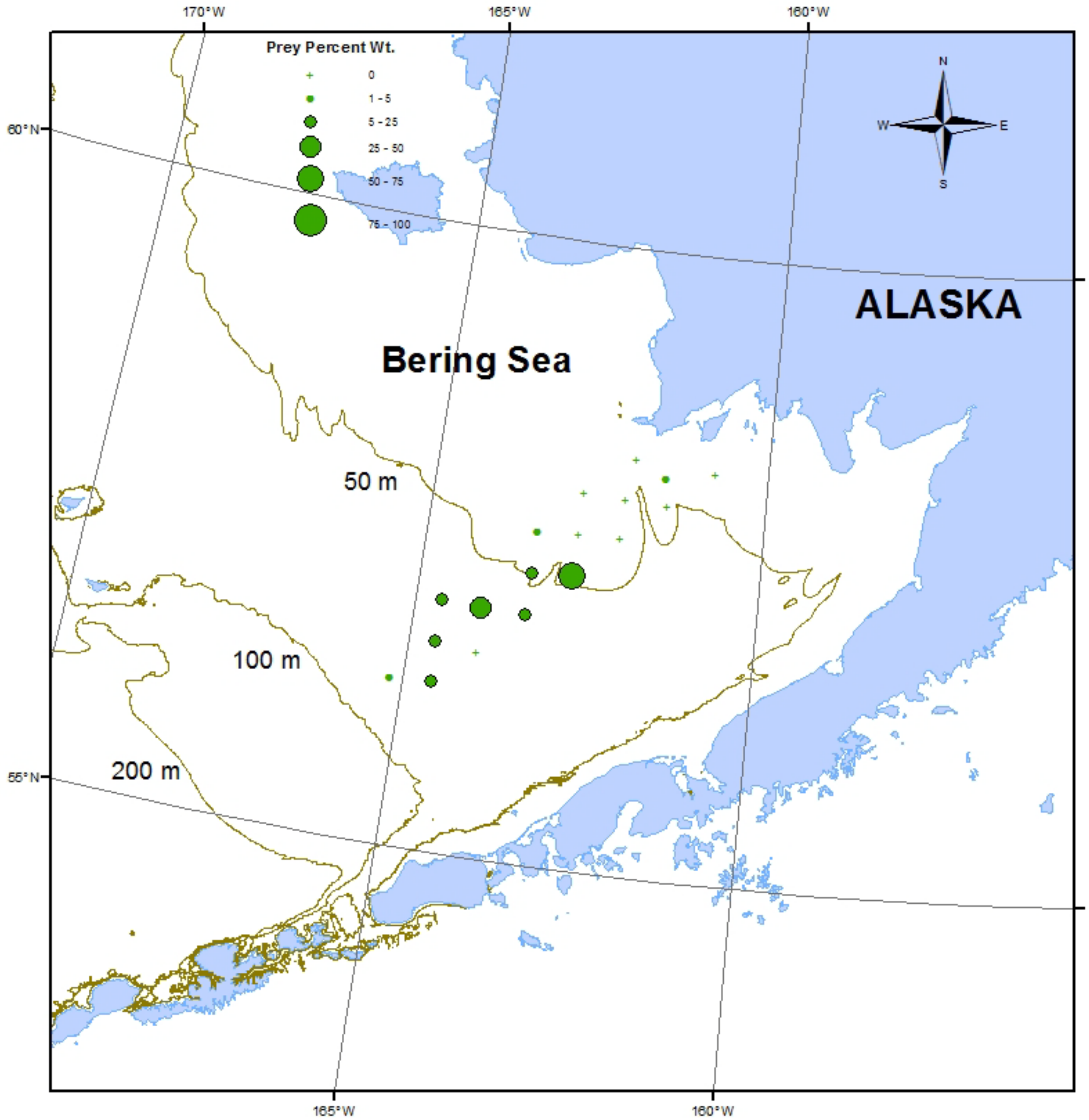

Figure 8d. -- Distribution of Nephtyidae (polychaete) consumed by yellowfin sole.

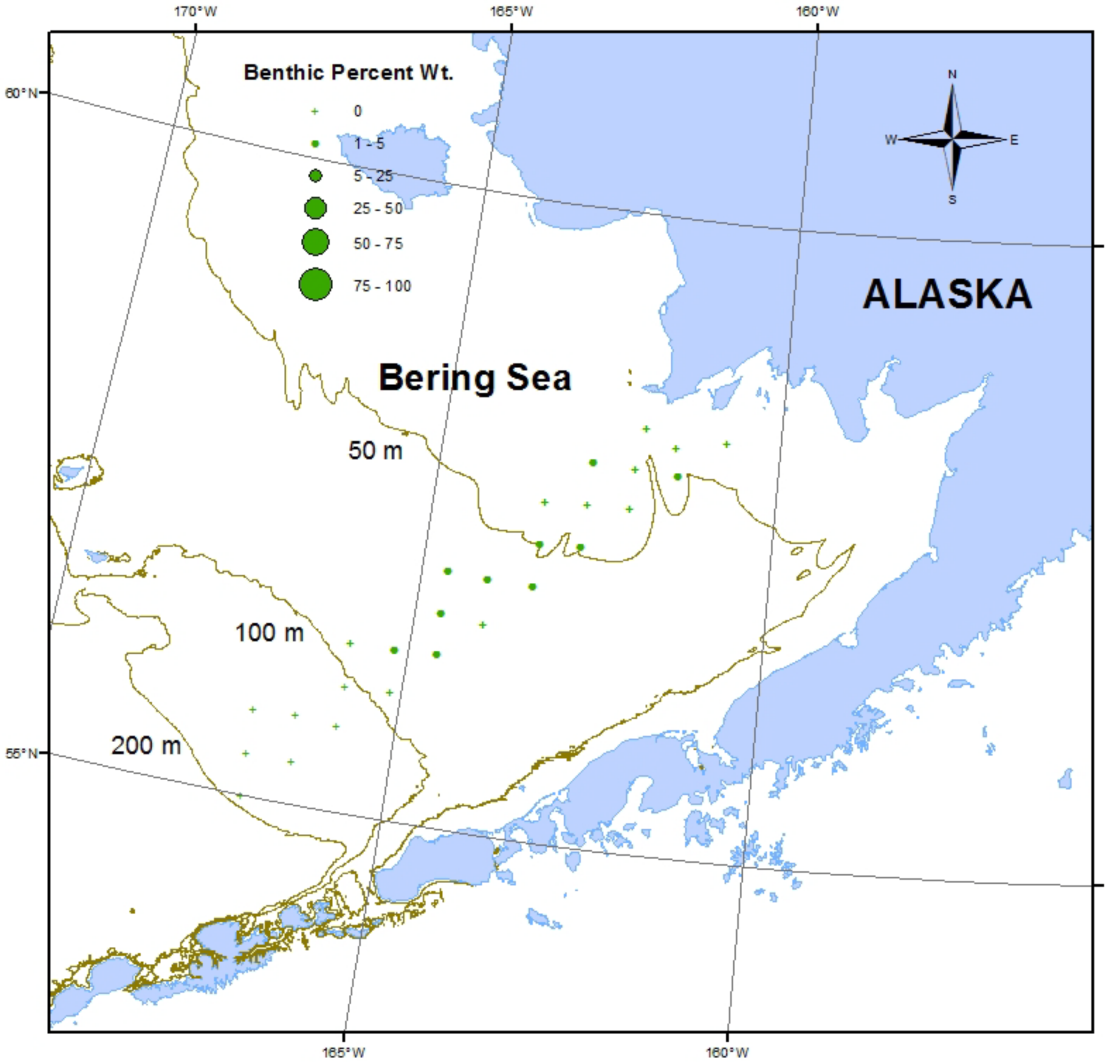

Figure 9a. -- Distribution of Goniadidae (polychaete) in the benthic samples.

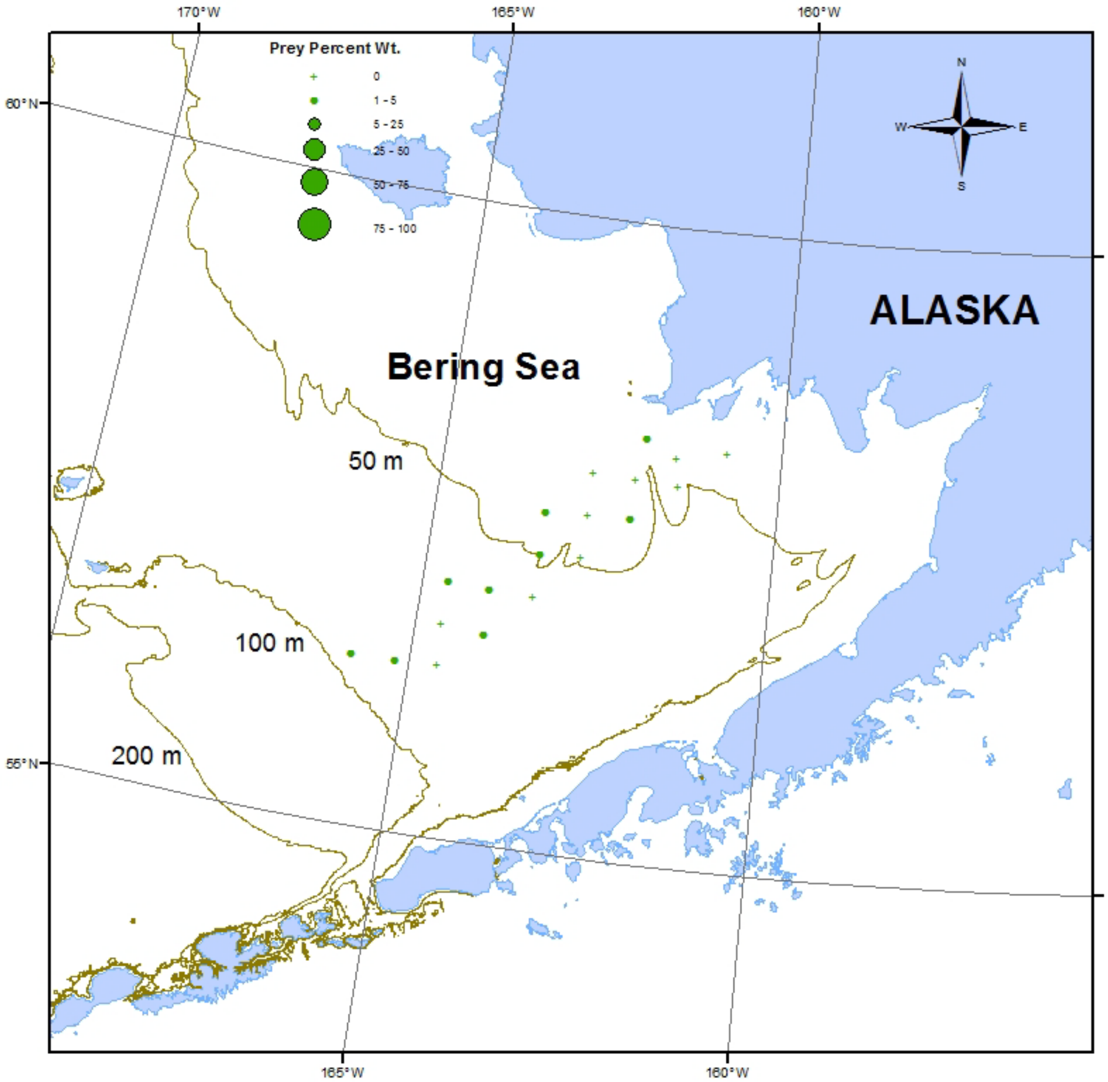

Figure 9b. -- Distribution of Goniadidae (polychaete) consumed by Alaska plaice.

Figure 9c. -- Distribution of Goniadidae (polychaete) consumed by northern rock sole.

Figure 9d. -- Distribution of Goniadidae (polychaete) consumed by yellowfin sole.

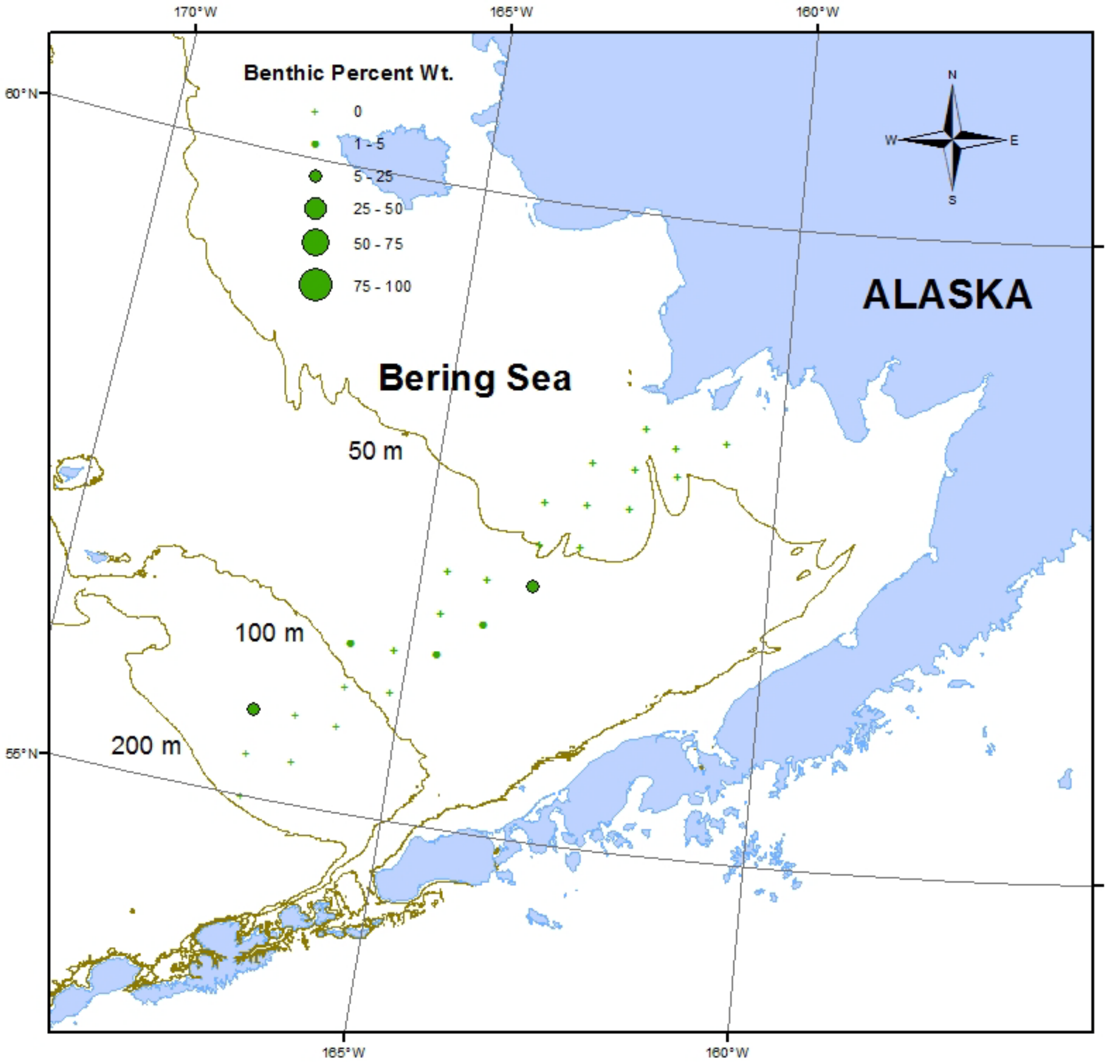

Figure 10a. -- Distribution of Onuphidae (polychaete) in the benthic samples.

Figure 10b. -- Distribution of Onuphidae (polychaete) consumed by Alaska plaice.

Figure 10c. -- Distribution of Onuphidae (polychaete) consumed by northern rock sole.

Figure 10d. -- Distribution of Onuphidae (polychaete) consumed by yellowfin sole.

Figure 10e. -- Distribution of Onuphidae (polychaete) consumed by flathead sole.

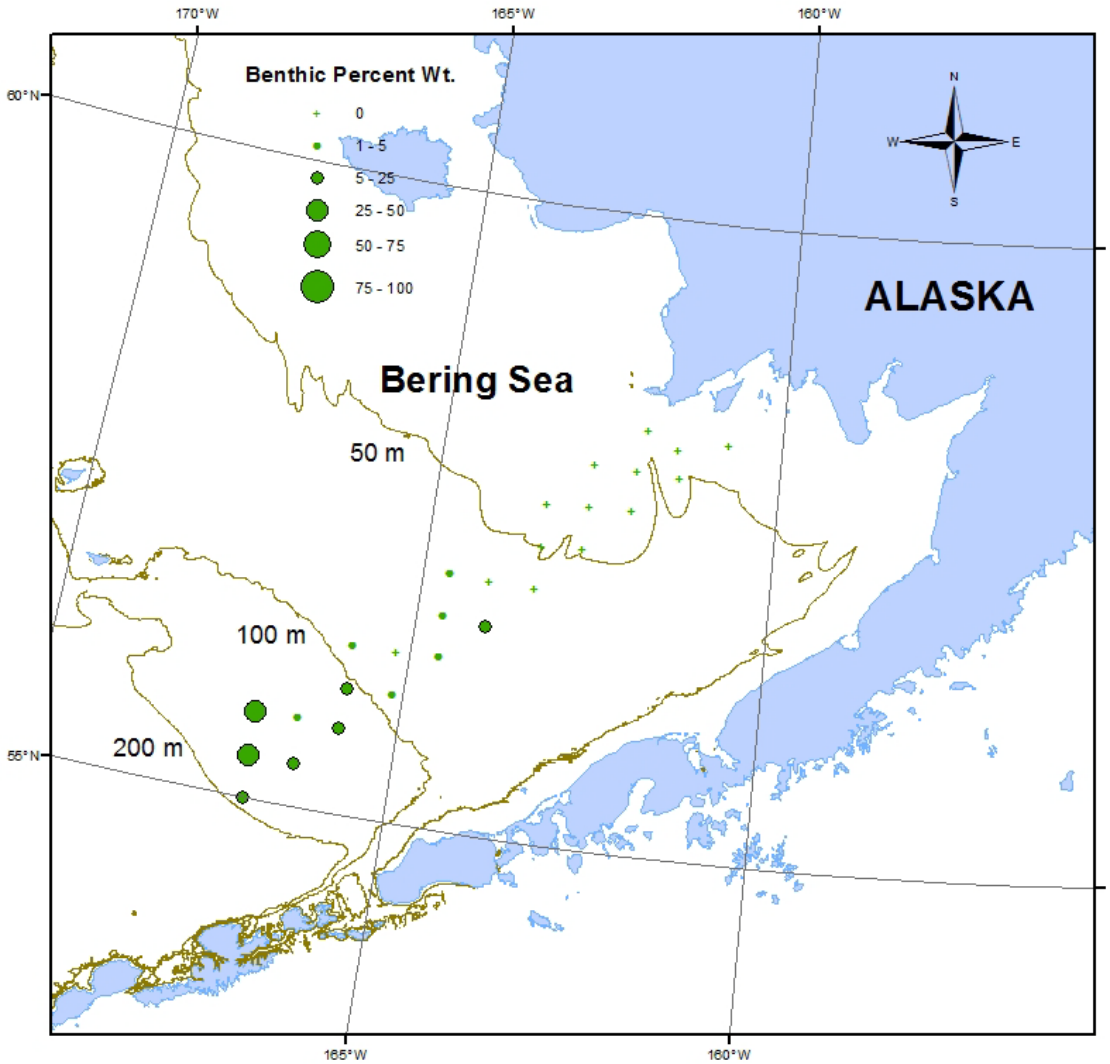

Figure 11a. -- Distribution of Lumbrineridae (polychaete) in the benthic samples.

Figure 11b. -- Distribution of Lumbrineridae (polychaete) consumed by Alaska plaice.

Figure 11c. -- Distribution of Lumbrineridae (polychaete) consumed by northern rock sole.

Figure 11d. -- Distribution of Lumbrineridae (polychaete) consumed by yellowfin sole.

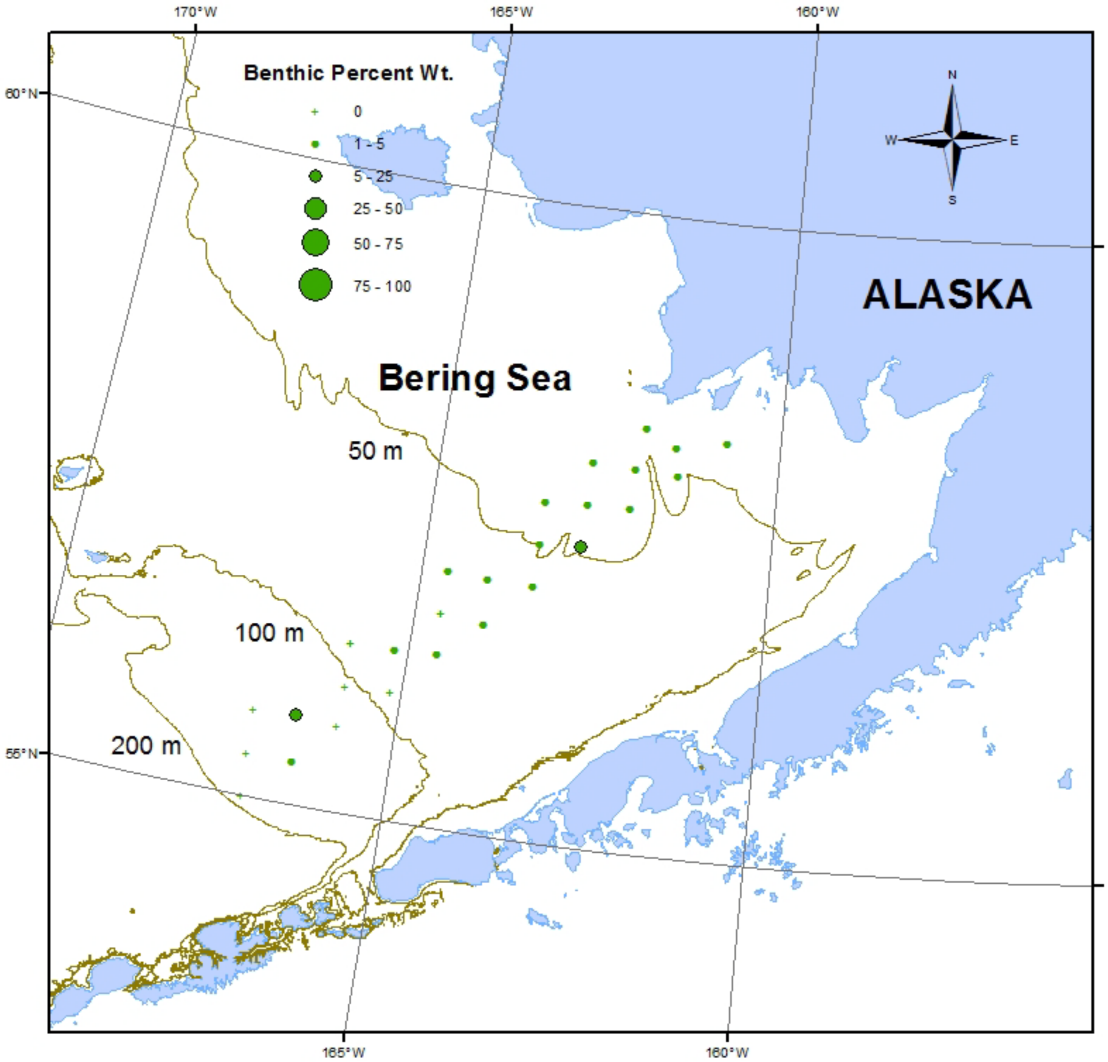

Figure 12a. -- Distribution of Orbiniidae (polychaete) in the benthic samples.

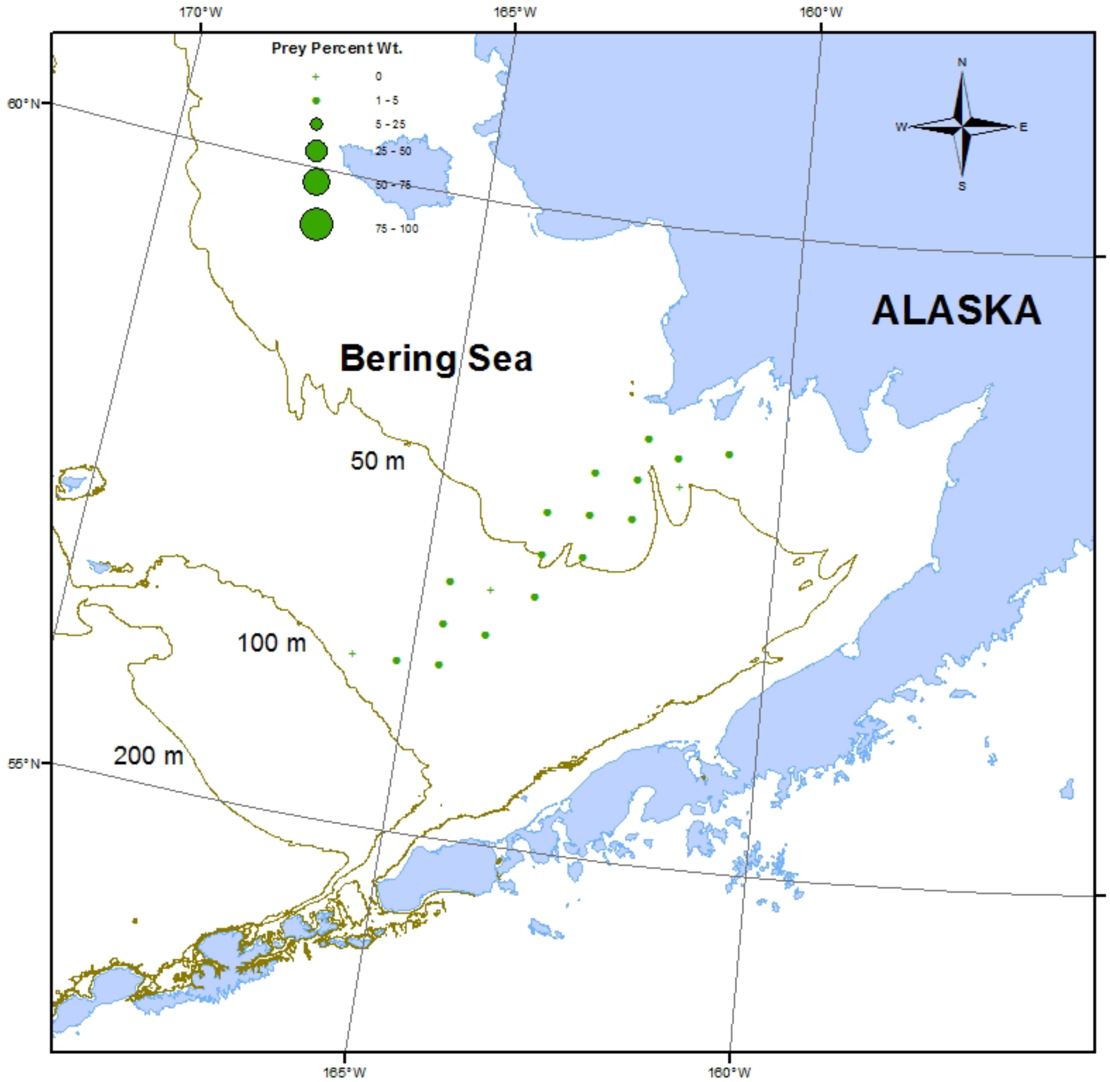

Figure 12b. -- Distribution of Orbiniidae (polychaete) consumed by Alaska plaice.

Figure 12c. -- Distribution of Orbiniidae (polychaete) consumed by northern rock sole.

Figure 12d. -- Distribution of Orbiniidae (polychaete) consumed by yellowfin sole.

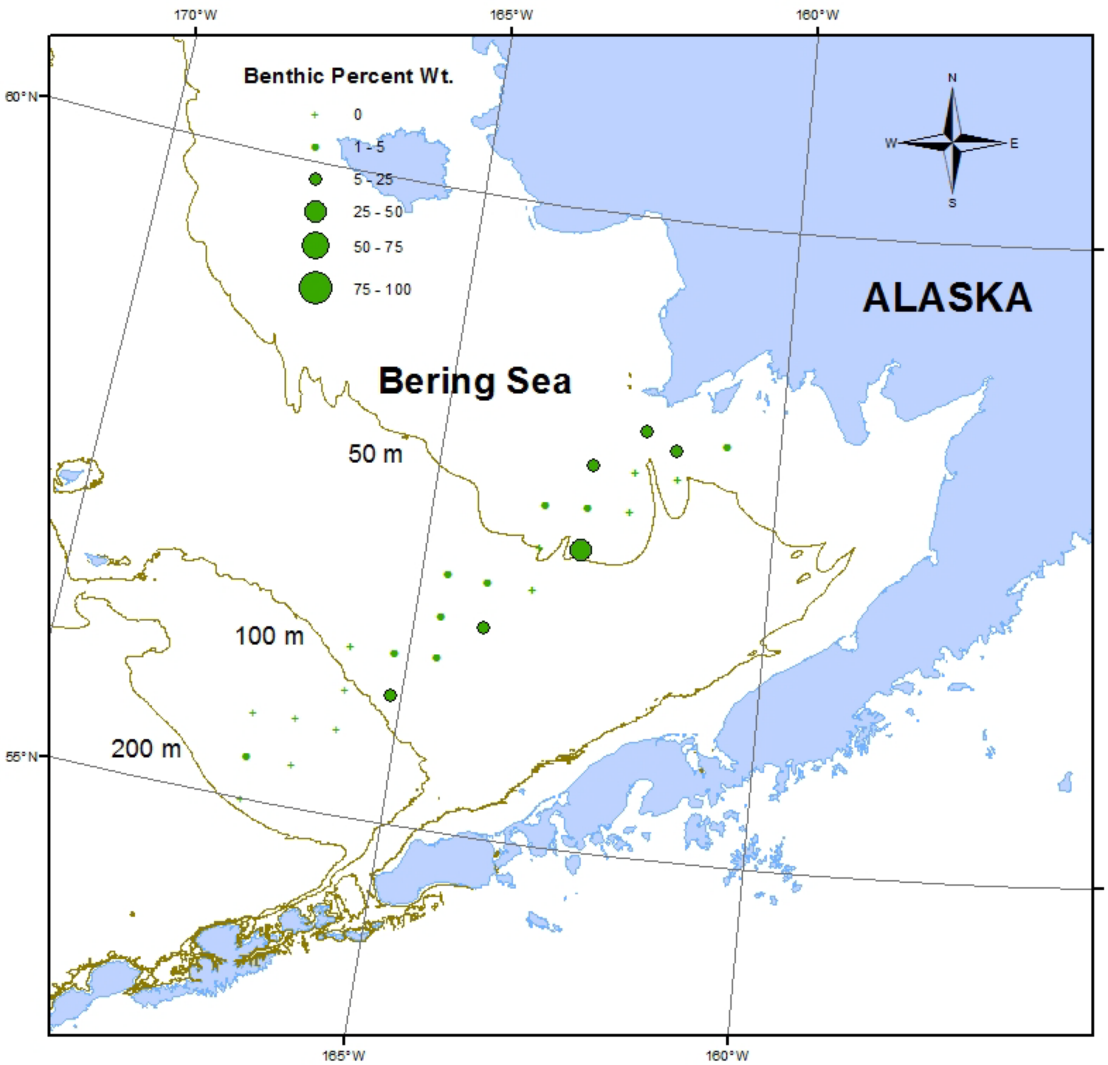

Figure 13a. -- Distribution of Opheliidae (polychaete) in the benthic samples.

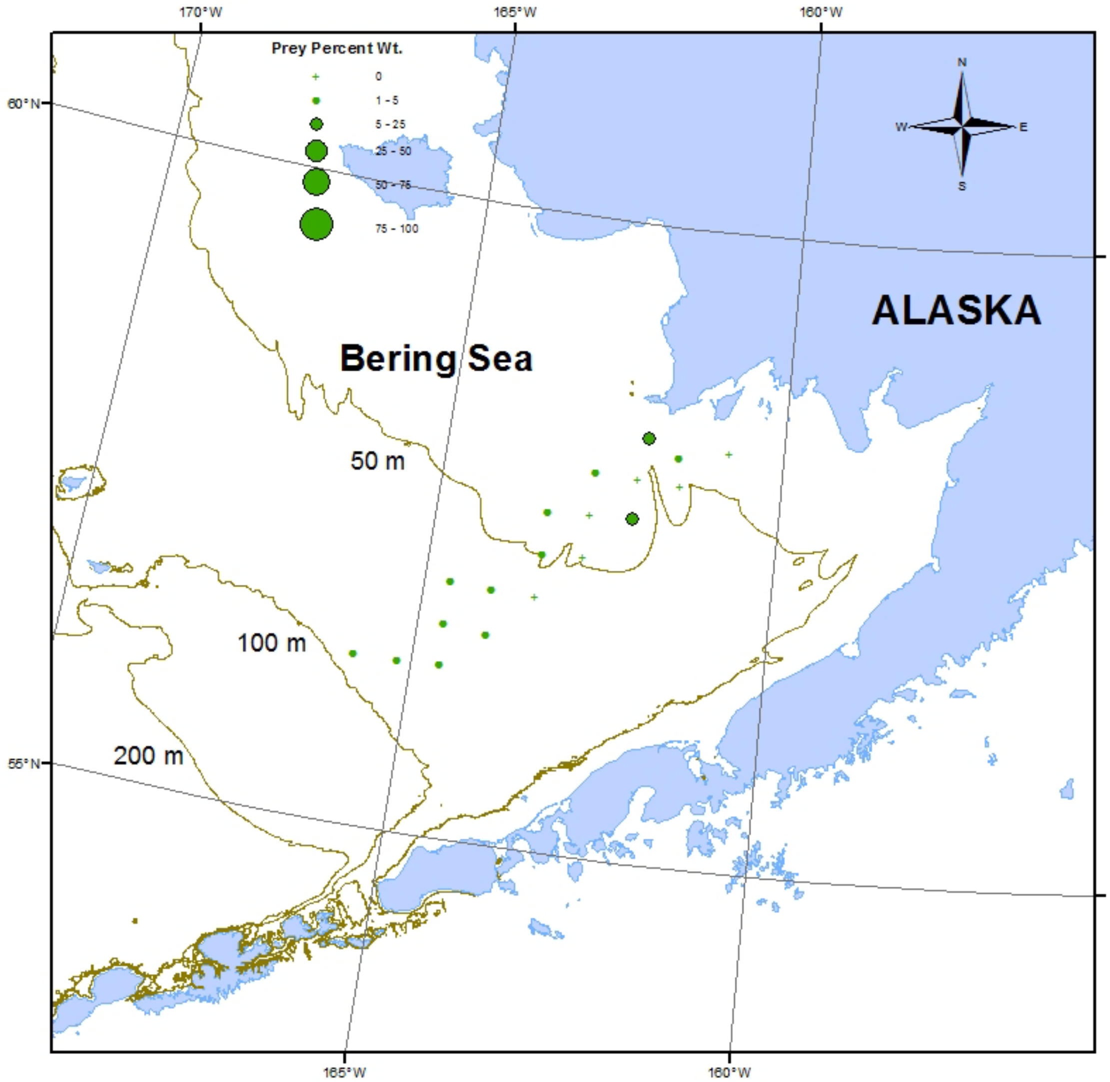

Figure 13b. -- Distribution of Opheliidae (polychaete) consumed by Alaska plaice.

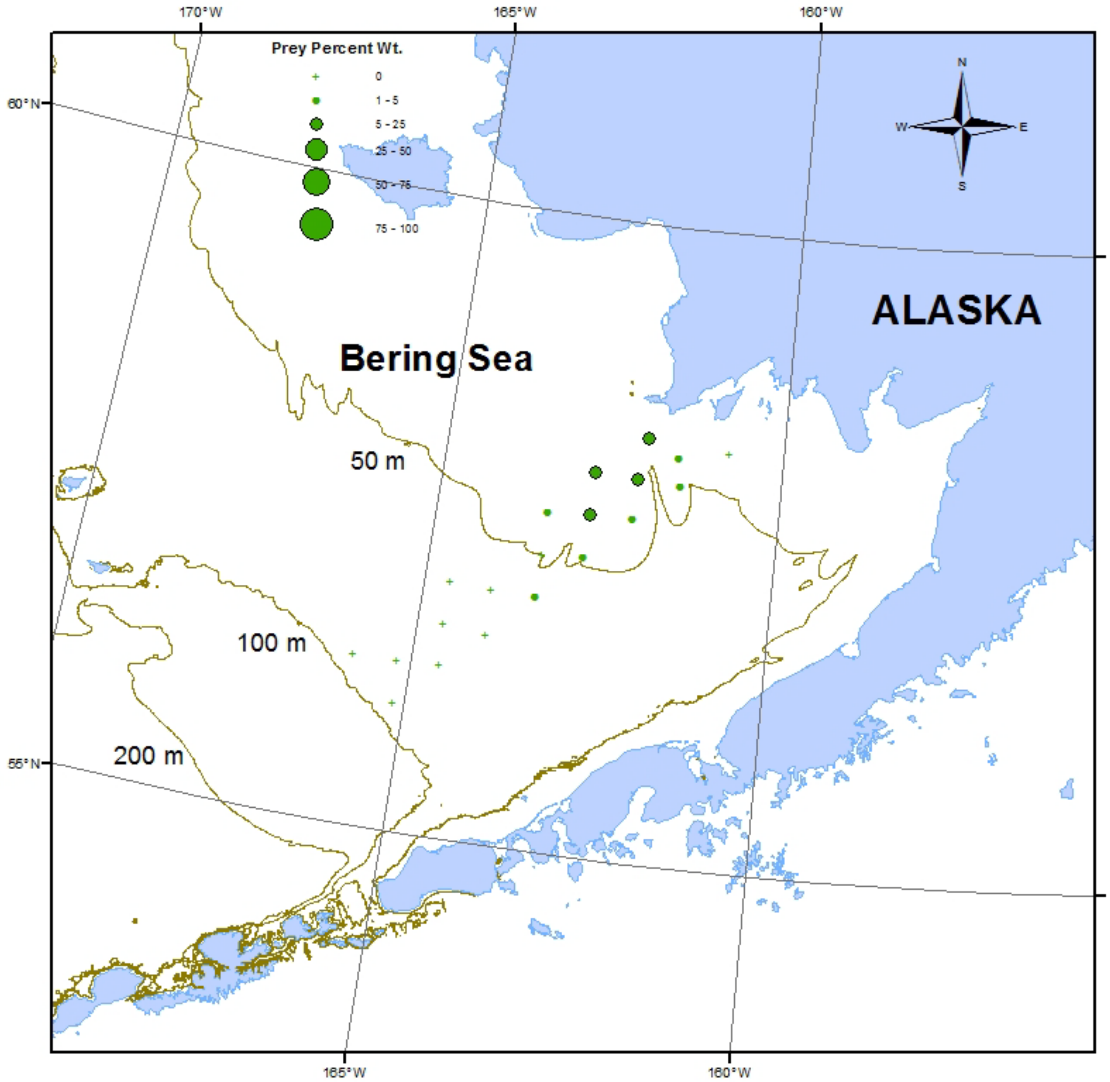

Figure 13c. -- Distribution of Opheliidae consumed (polychaete) by northern rock sole.

Figure 13d. -- Distribution of Opheliidae (polychaete) consumed by yellowfin sole.

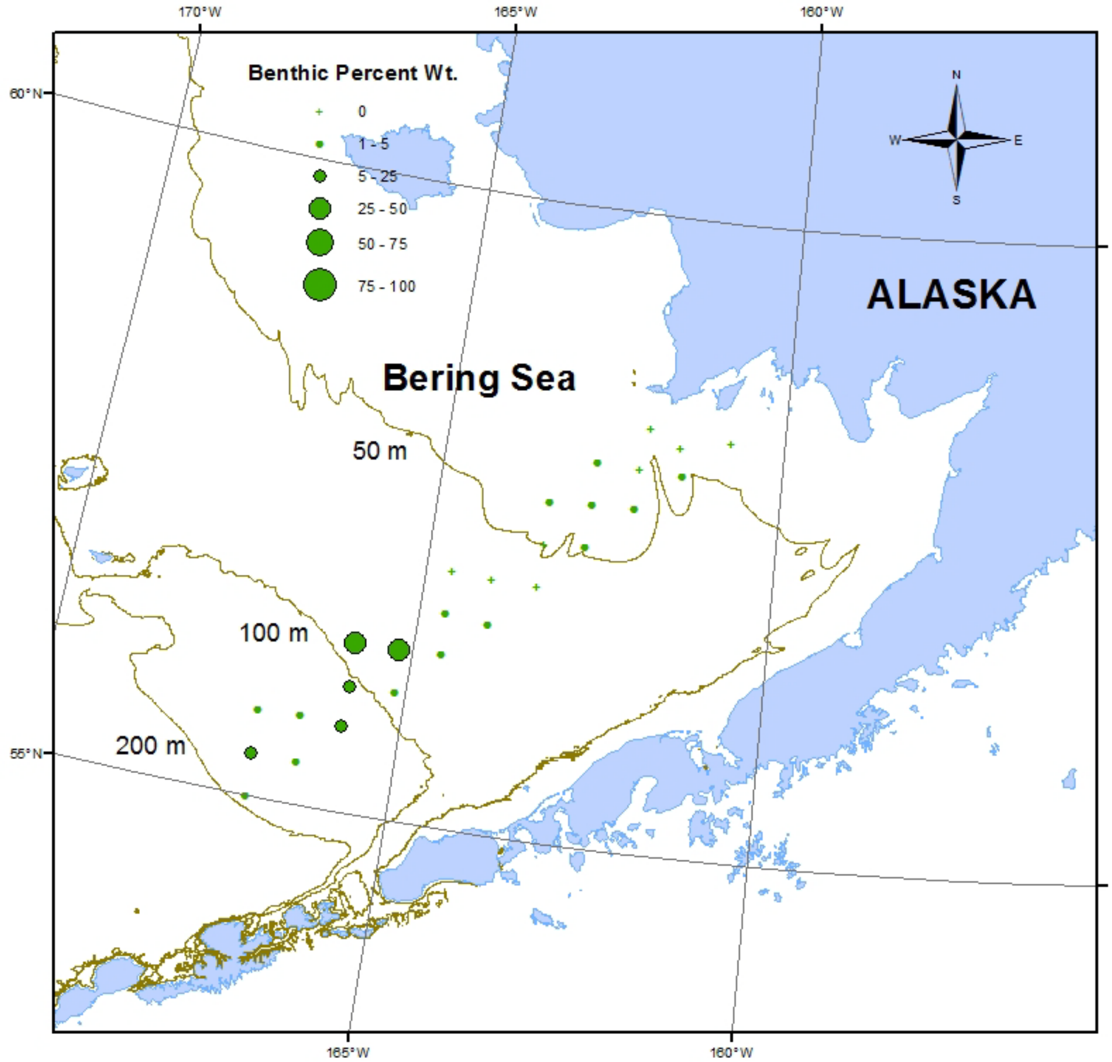

Figure 14a. -- Distribution of Maldanidae (polychaete) in the benthic samples.

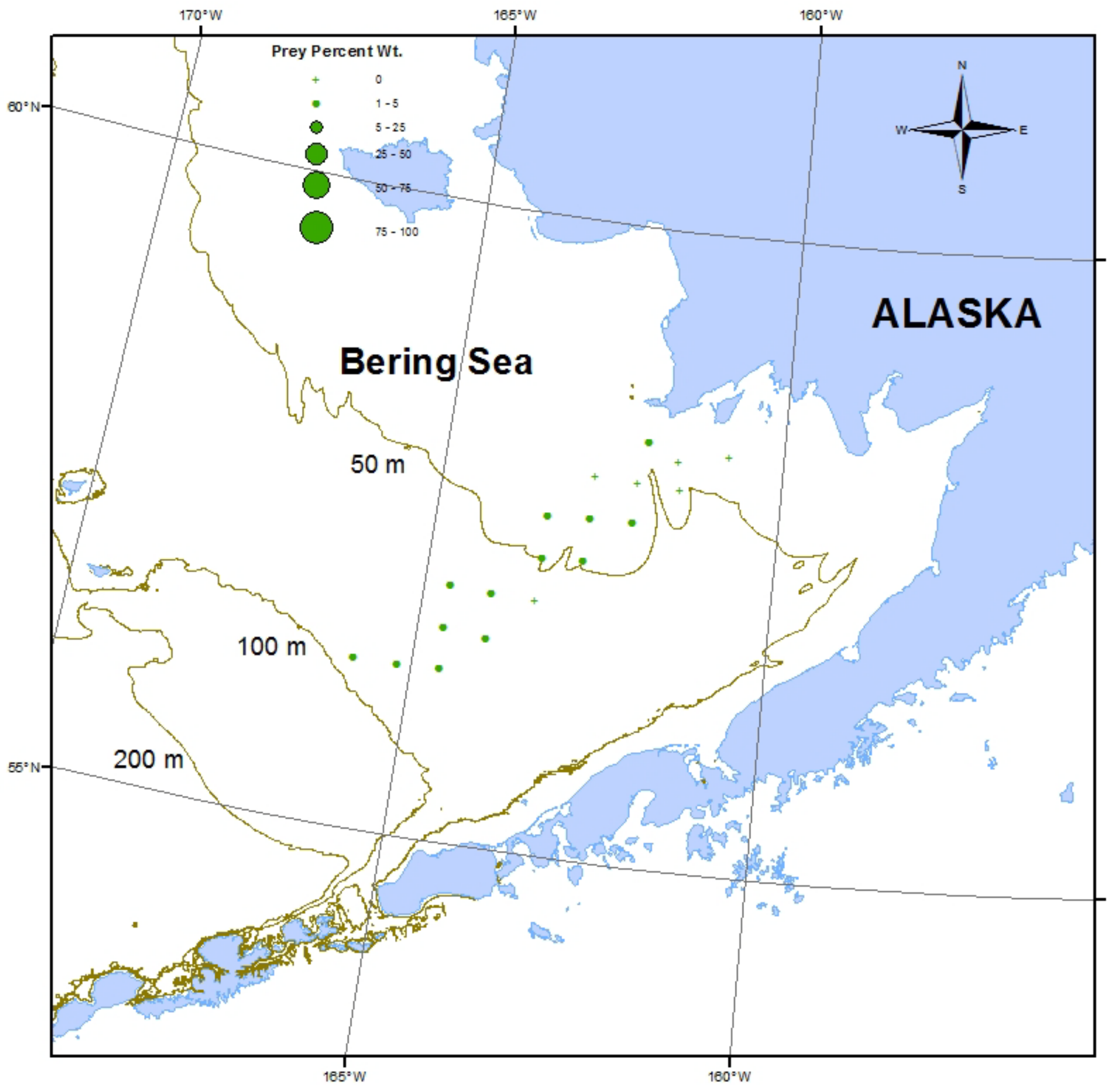

Figure 14b. -- Distribution of Maldanidae (polychaete) consumed by Alaska plaice.

Figure 14c. -- Distribution of Maldanidae (polychaete) consumed by northern rock sole.

Figure 14d. -- Distribution of Maldanidae (polychaete) consumed by yellowfin sole.

Figure 14e. -- Distribution of Maldanidae (polychaete) consumed by flathead sole.

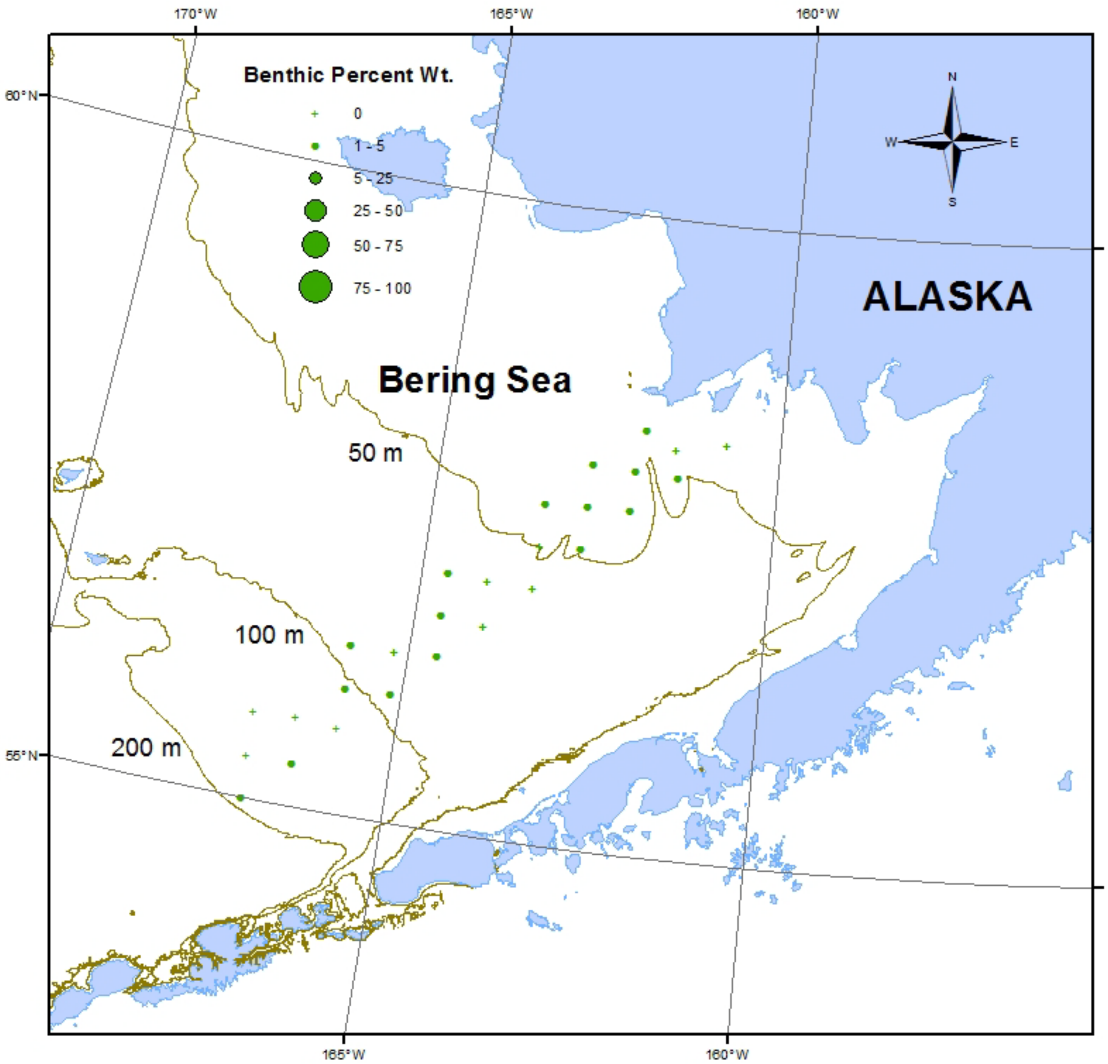

Figure 15a. -- Distribution of Ampharetidae (polychaete) in the benthic samples.

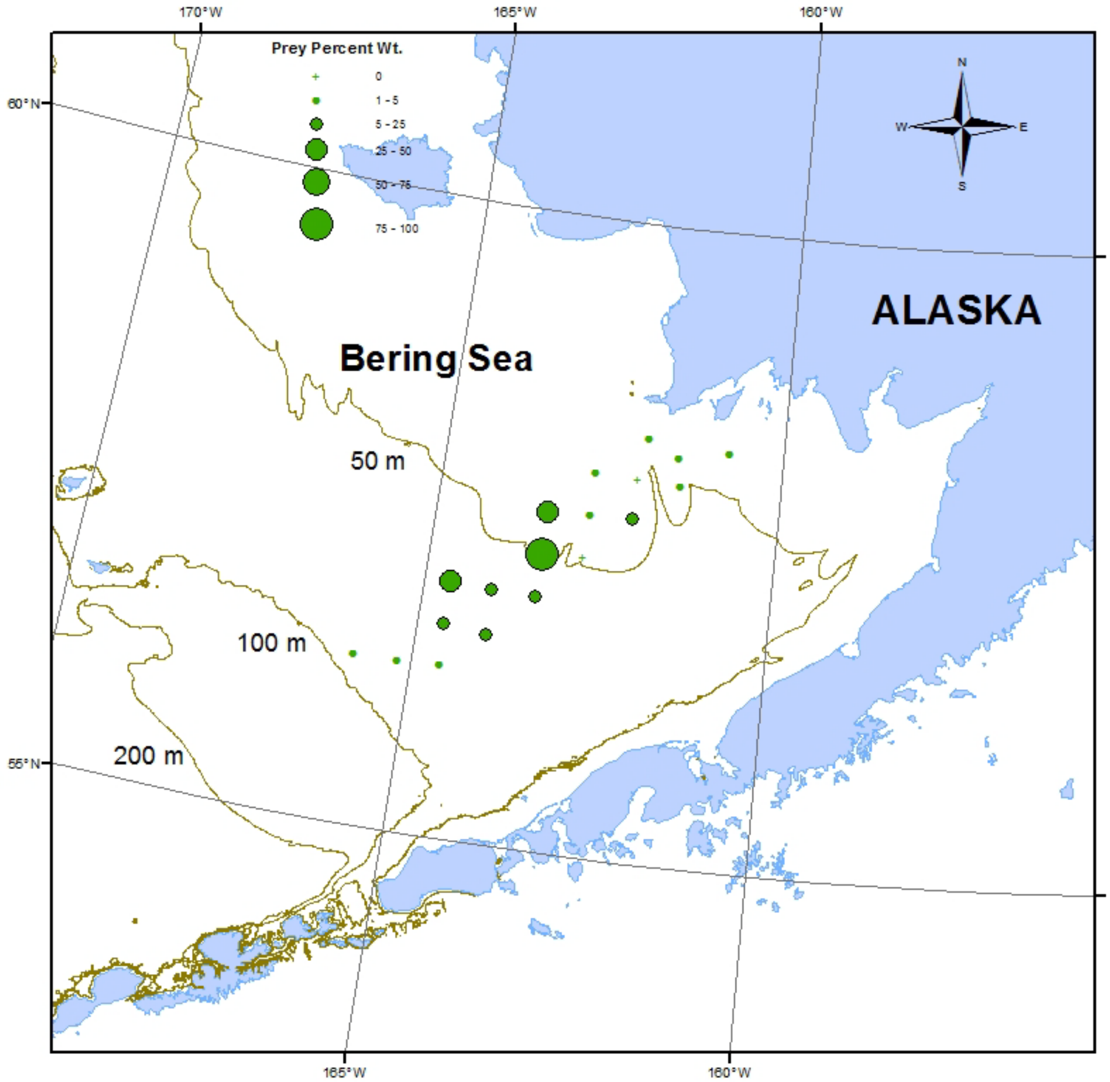

Figure 15b. -- Distribution of Ampharetidae (polychaete) consumed by Alaska plaice.

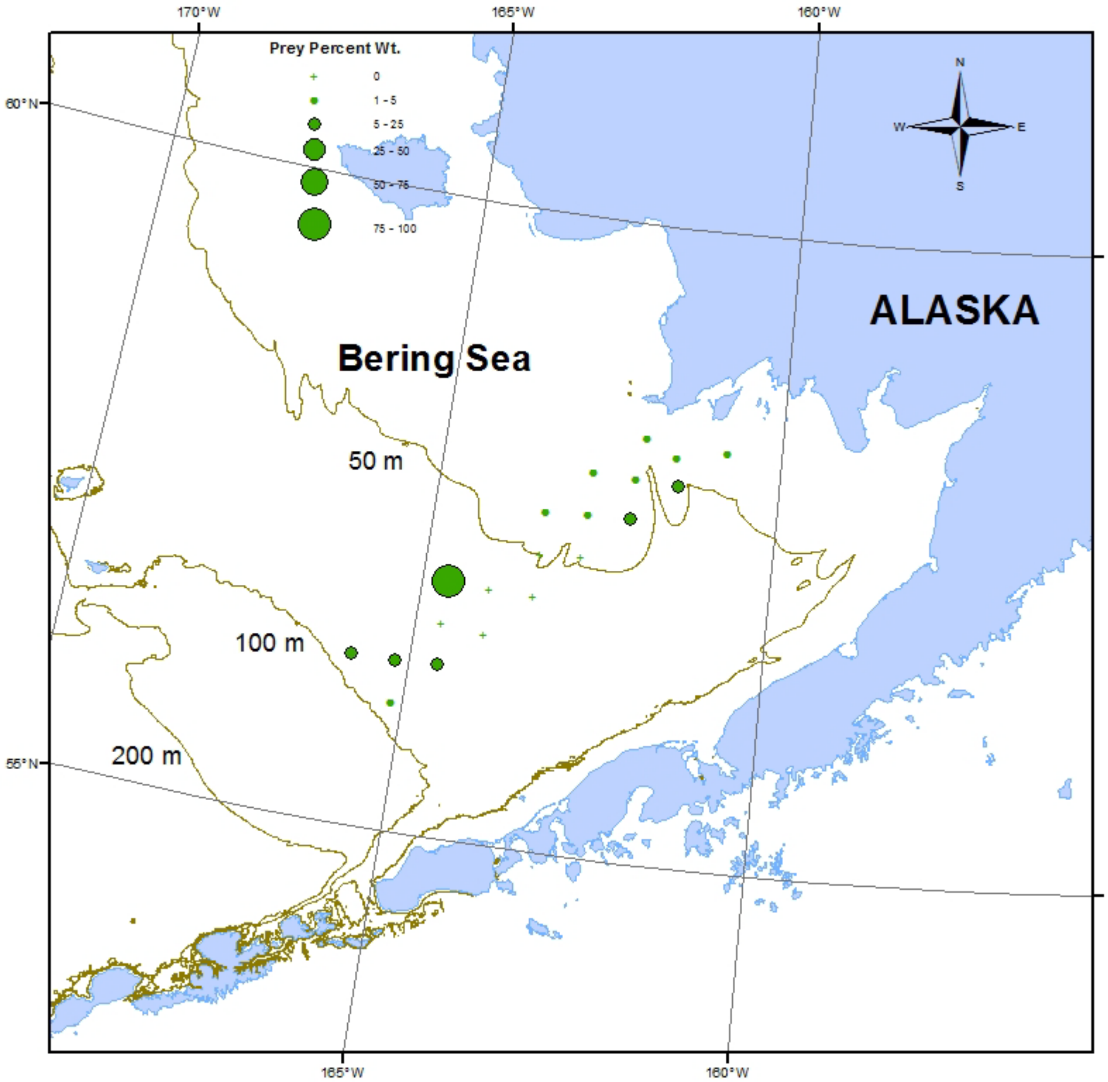

Figure 15c. -- Distribution of Ampharetidae (polychaete) consumed by northern rock sole.

Figure 15d. -- Distribution of Ampharetidae (polychaete) consumed by yellowfin sole.

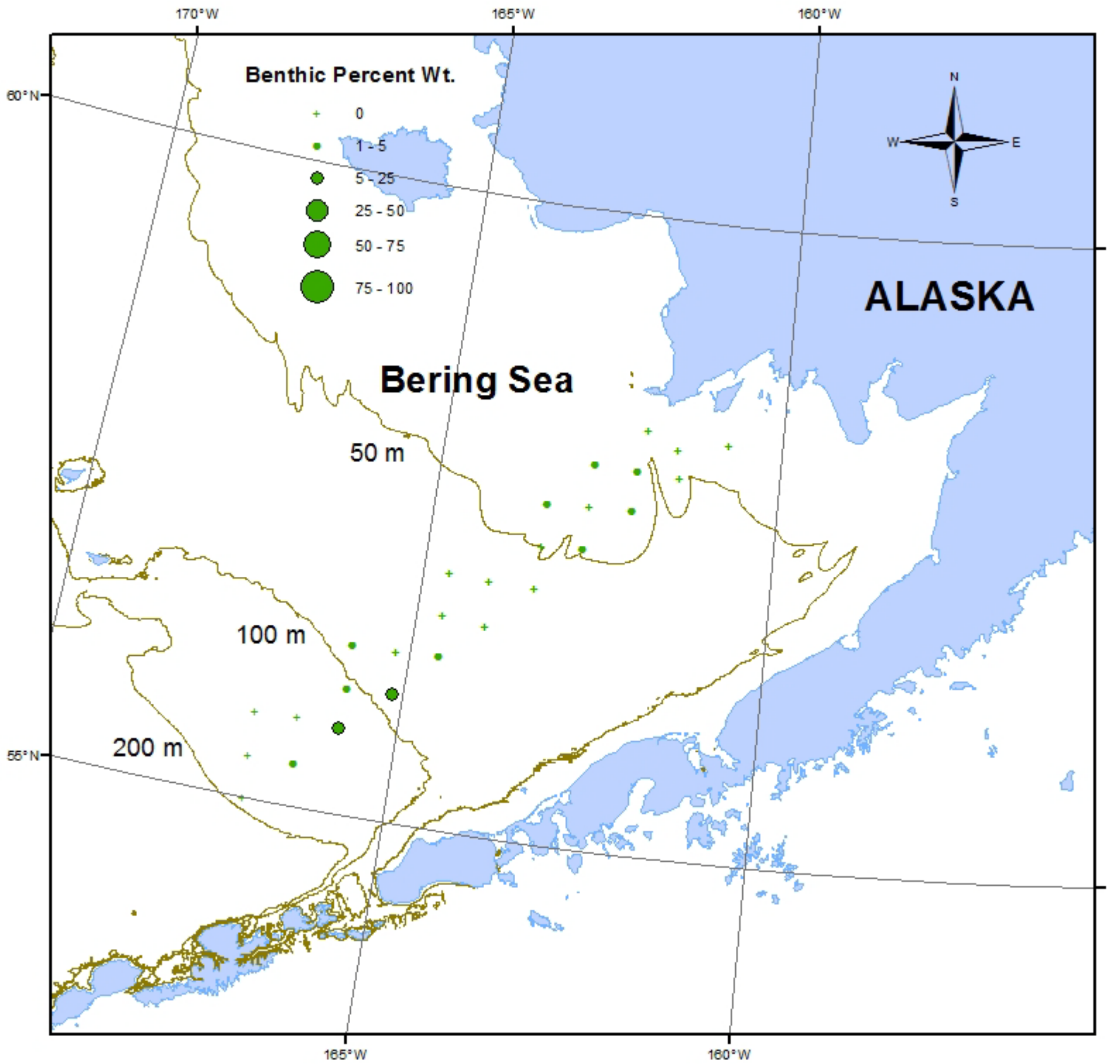

Figure 16a. -- Distribution of Terebellidae (polychaete) in the benthic samples.

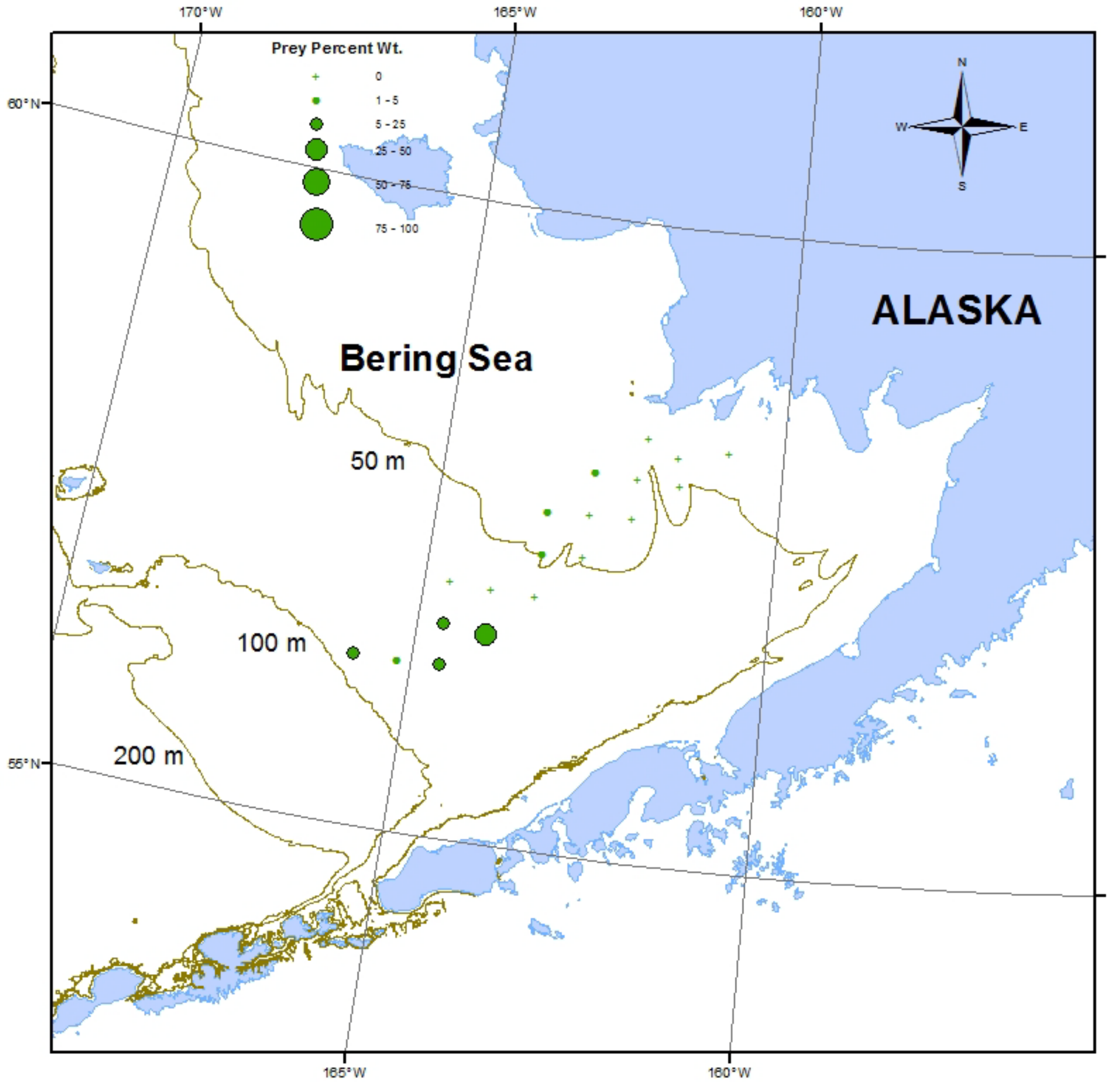

Figure 16b. -- Distribution of Terebellidae (polychaete) consumed by Alaska plaice.

Figure 16c. -- Distribution of Terebellidae (polychaete) consumed by northern rock sole.

Figure 16d. -- Distribution of Terebellidae (polychaete) consumed by yellowfin sole.

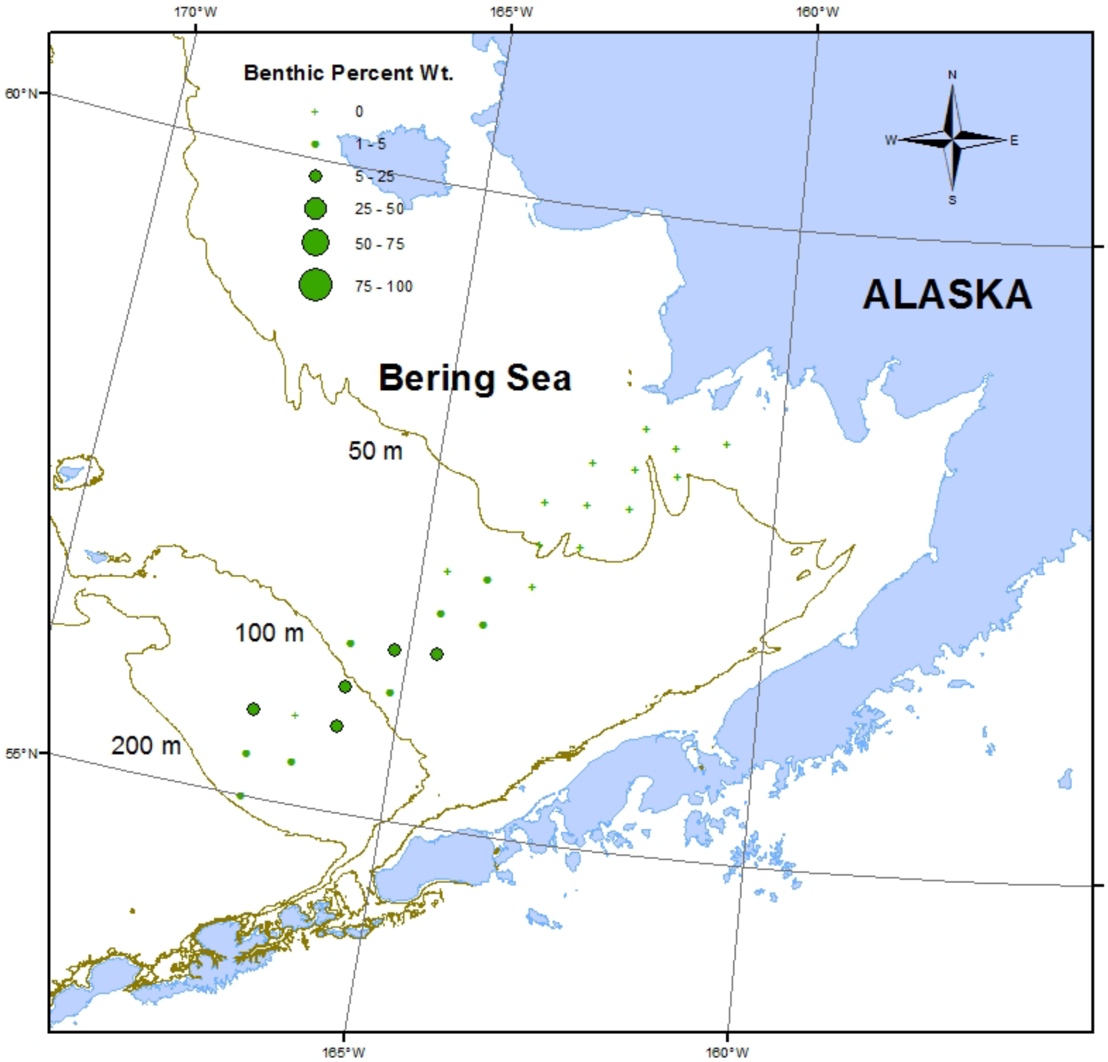

Figure 17a. -- Distribution of Trichobranchidae (polychaete) in the benthic samples.

Figure 17b. -- Distribution of Trichobranchidae (polychaete) consumed by Alaska plaice.

Figure 17c. -- Distribution of Trichobranchidae (polychaete) consumed by northern rock sole.

Figure 17d. -- Distribution of Trichobranchidae (polychaete) consumed by yellowfin sole.

Figure 17e. -- Distribution of Trichobranchidae (polychaete) consumed by flathead sole.

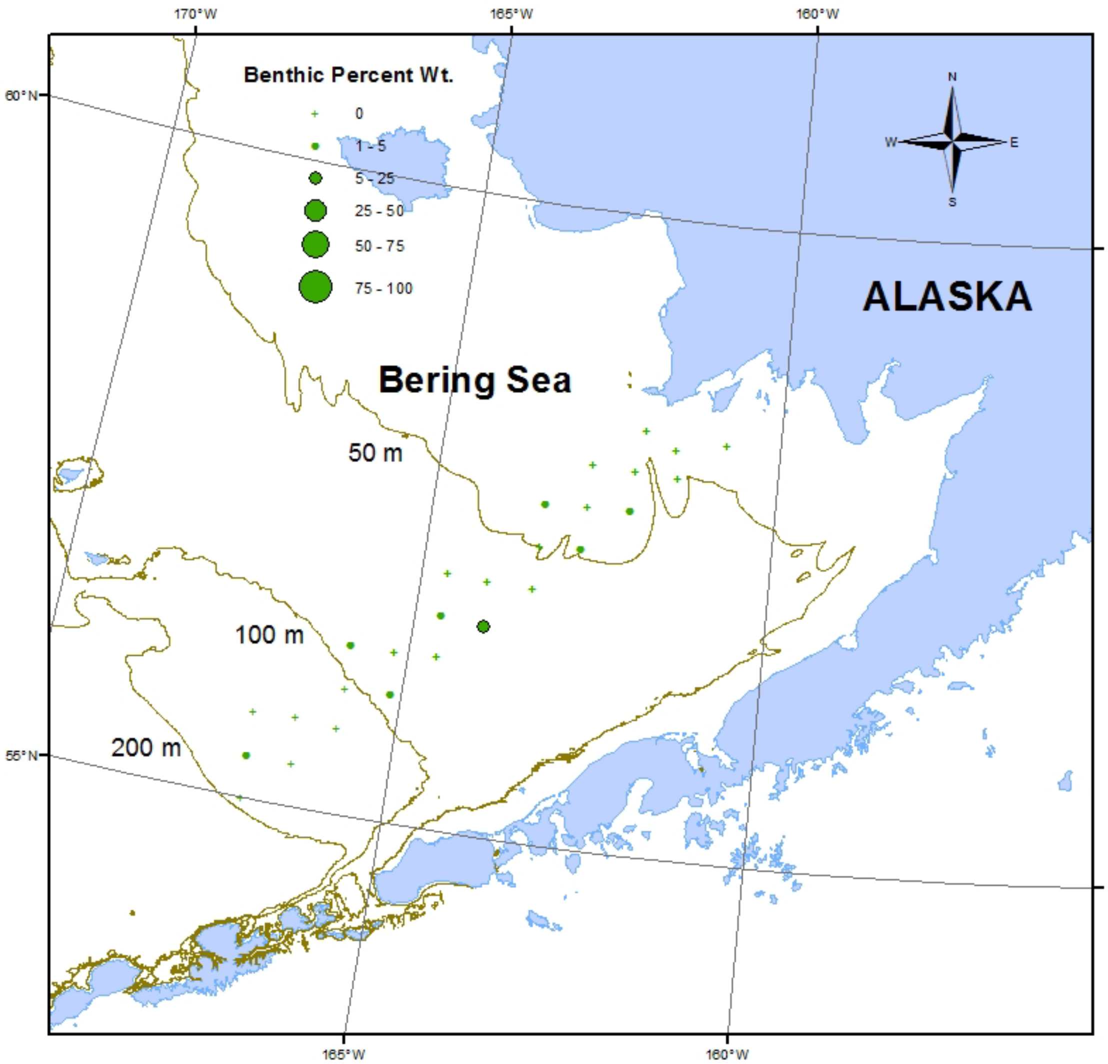

Figure 18a. -- Distribution of Sabellidae (polychaete) in the benthic samples.

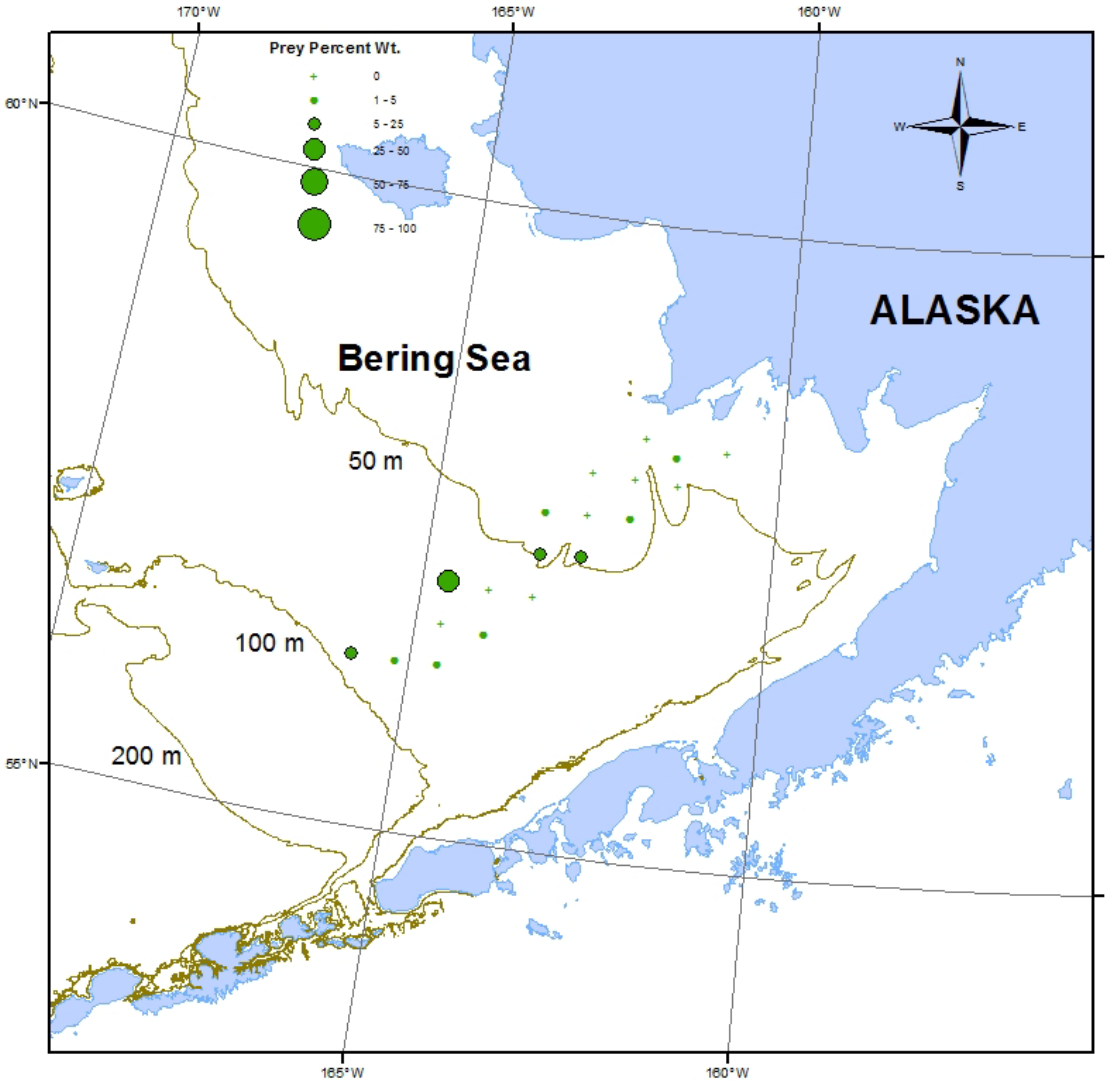

Figure 18b. -- Distribution of Sabellidae (polychaete) consumed by Alaska plaice.

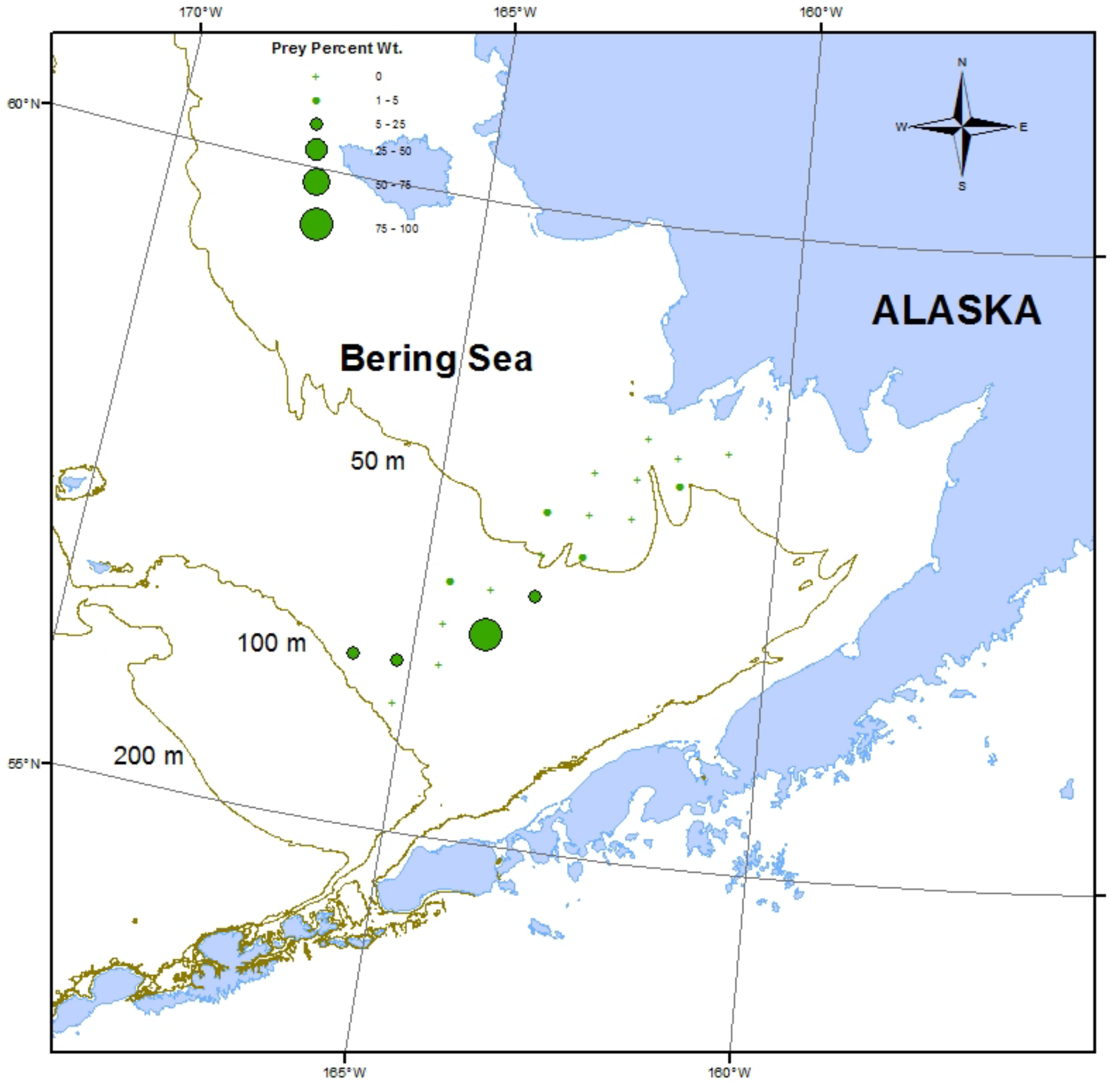

Figure 18c. -- Distribution of Sabellidae (polychaete) consumed by northern rock sole.

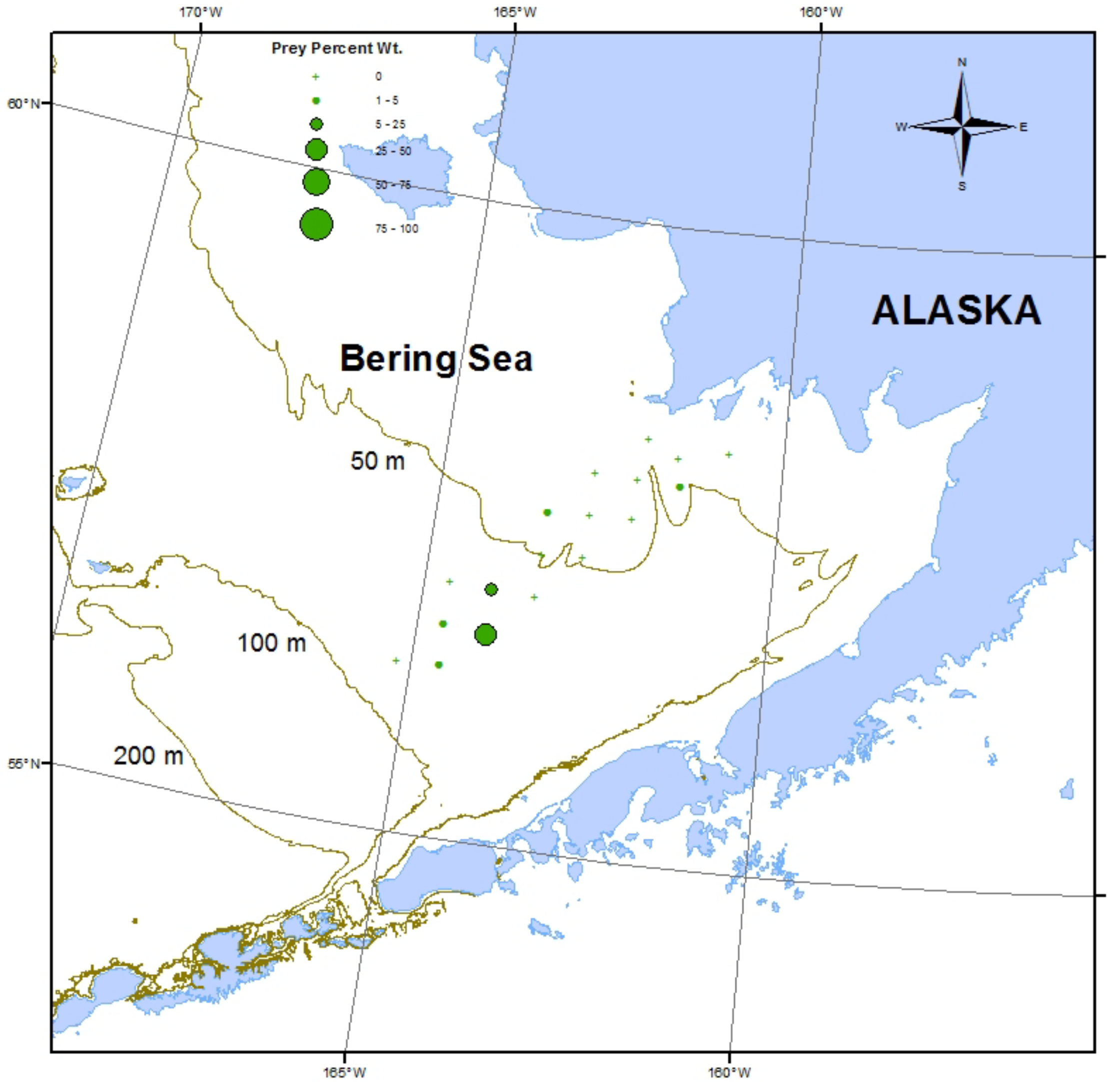

Figure 18d. -- Distribution of Sabellidae (polychaete) consumed by yellowfin sole.

Figure 18e. -- Distribution of Sabellidae (polychaete) consumed by flathead sole.

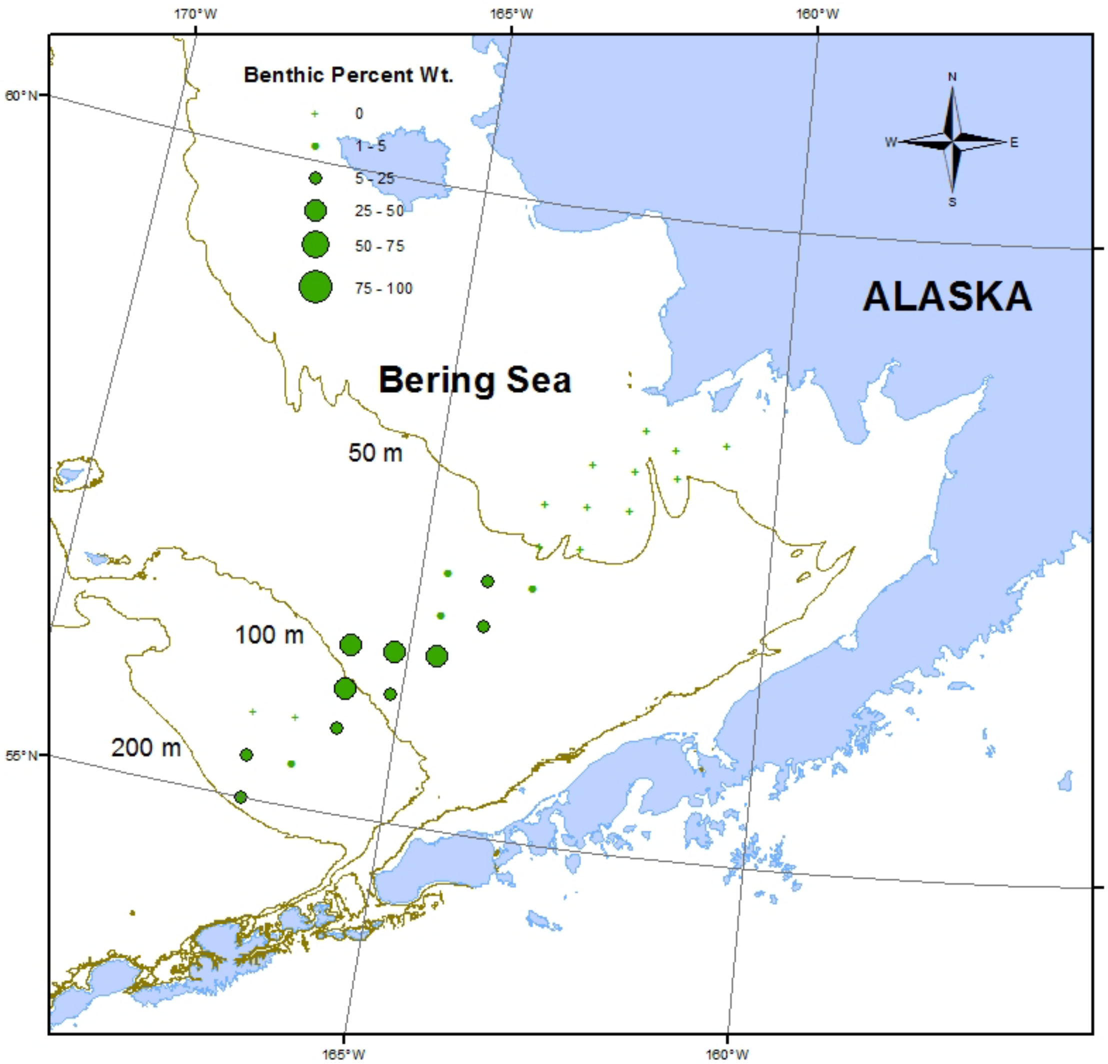

Figure 19a. -- Distribution of Nuculanidae (clam) in the benthic samples.

Figure 19b. -- Distribution of Nuculanidae (clam) consumed by Alaska plaice.

Figure 19c. -- Distribution of Nuculanidae (clam) consumed by northern rock sole.

Figure 19d. -- Distribution of Nuculanidae (clam) consumed by yellowfin sole.

Figure 19e. -- Distribution of Nuculanidae (clam) consumed by flathead sole.

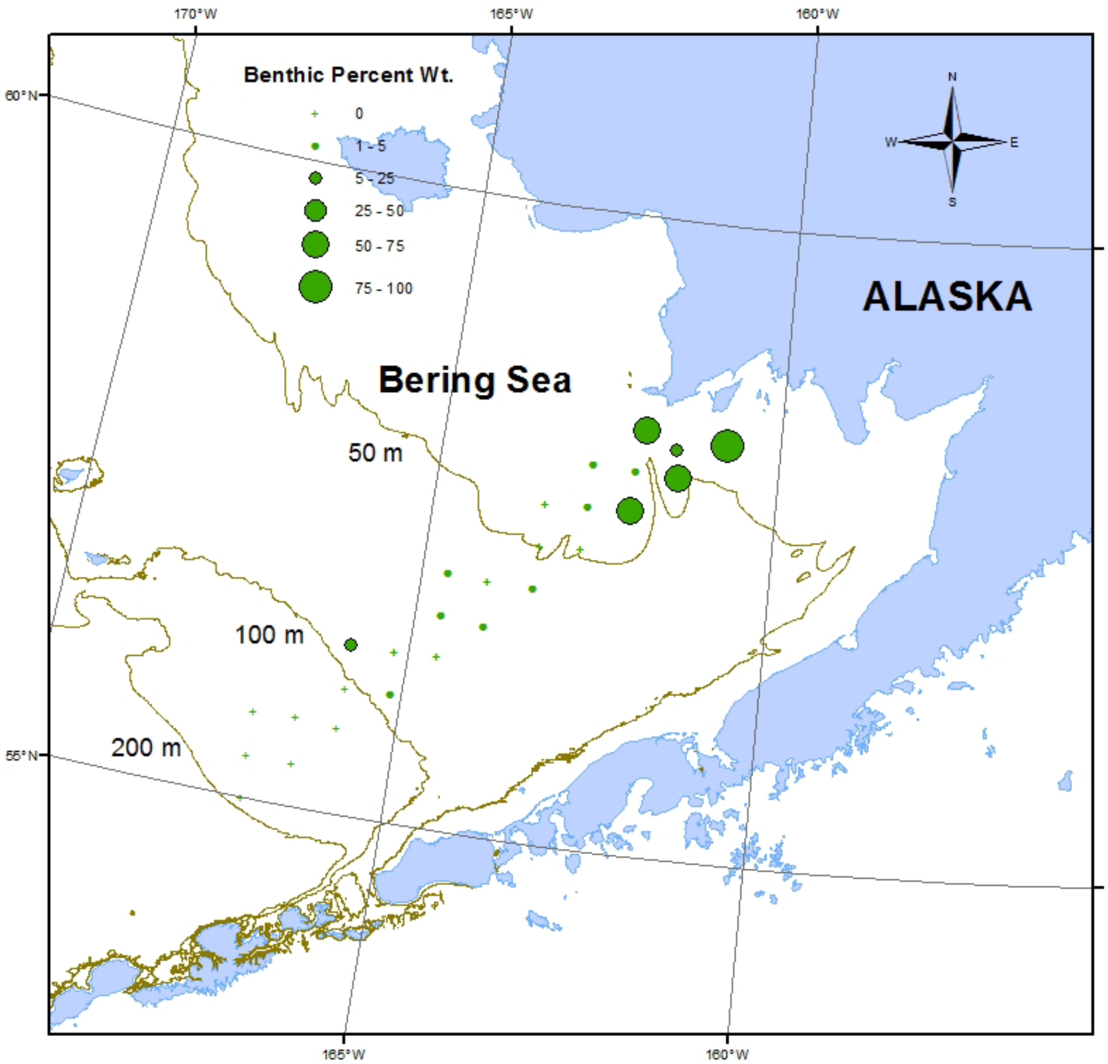

Figure 20a. -- Distribution of Tellinidae (clam) in the benthic samples.

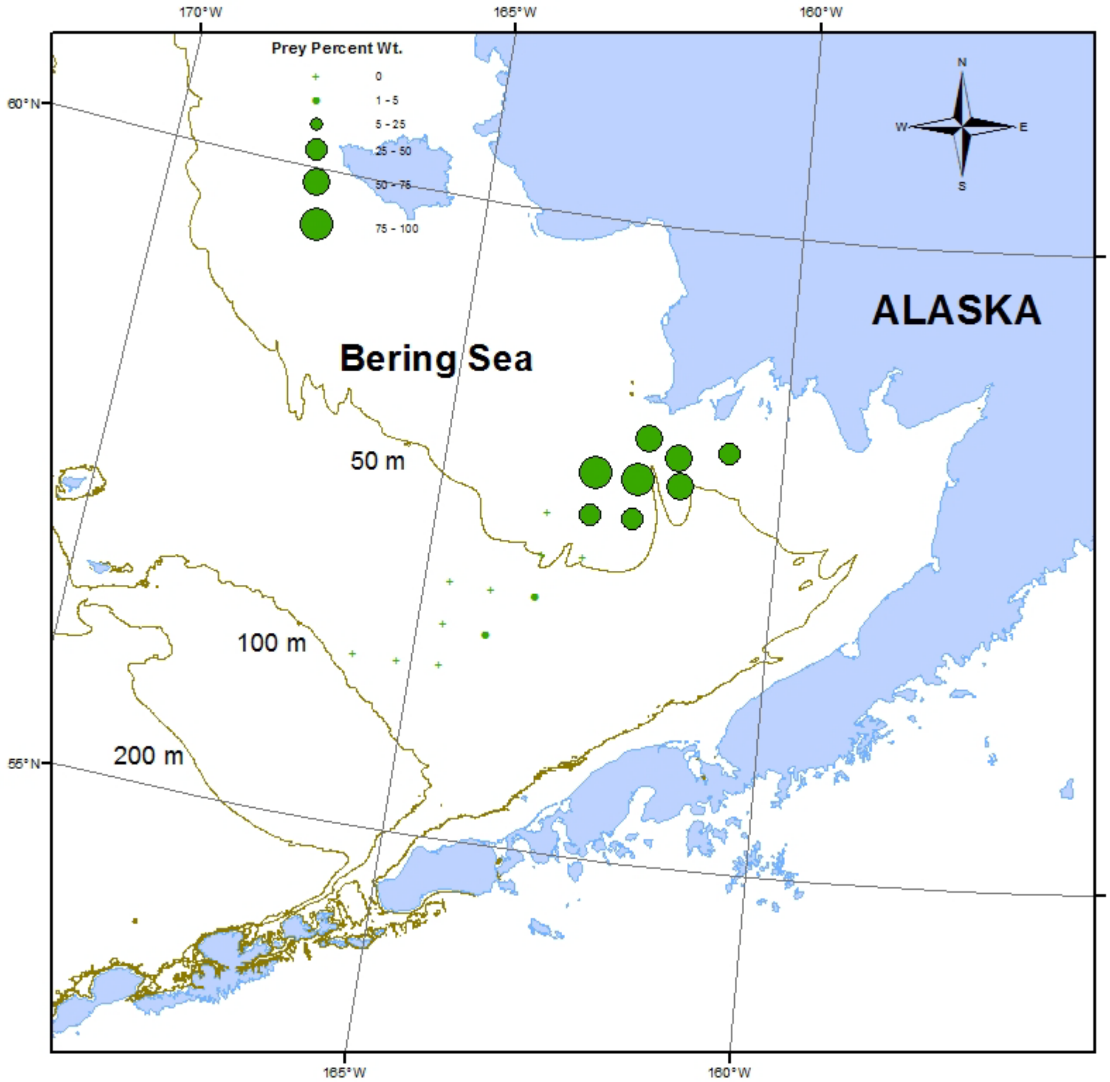

Figure 20b. -- Distribution of Tellinidae (clam) consumed by Alaska plaice.

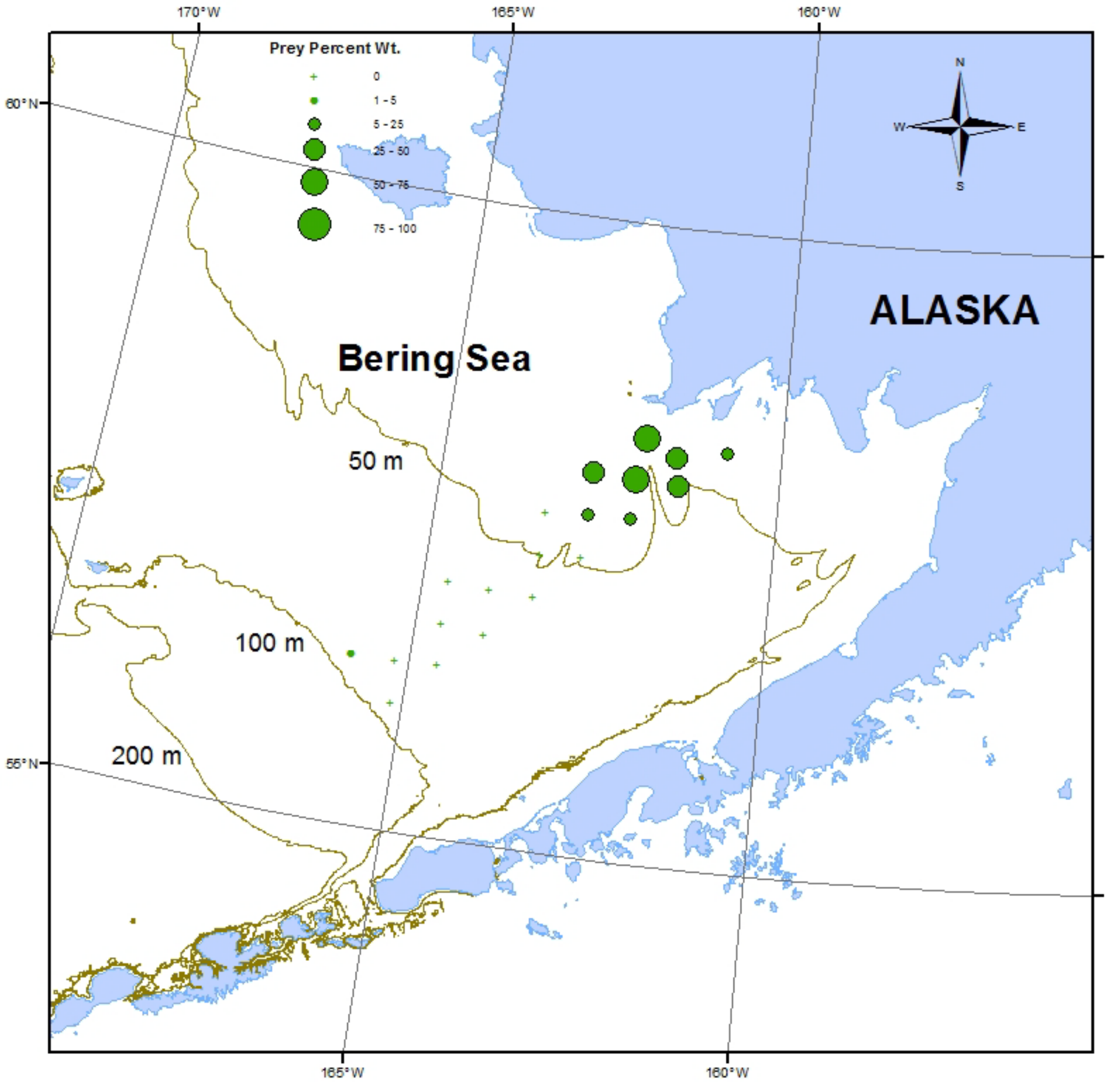

Figure 20c. -- Distribution of Tellinidae (clam) consumed by northern rock sole.

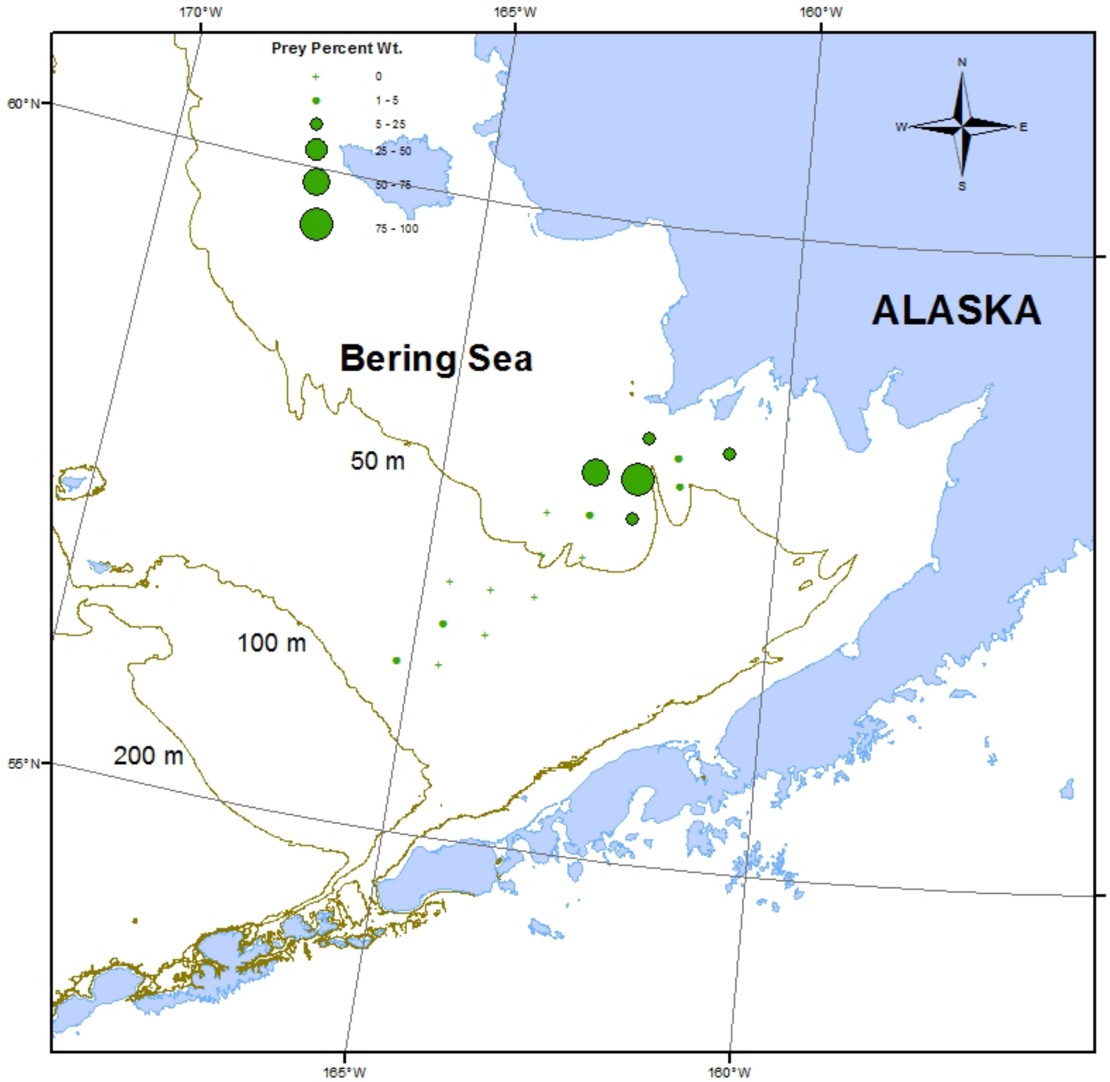

Figure 20d. -- Distribution of Tellinidae (clam) consumed by yellowfin sole.

Figure 20e. -- Distribution of Tellinidae (clam) consumed by flathead sole.

Figure 21a. -- Distribution of Mysidae (crustacean) consumed by northern rock sole.

Figure 21b. -- Distribution of Mysidae (crustacean) consumed by yellowfin sole.

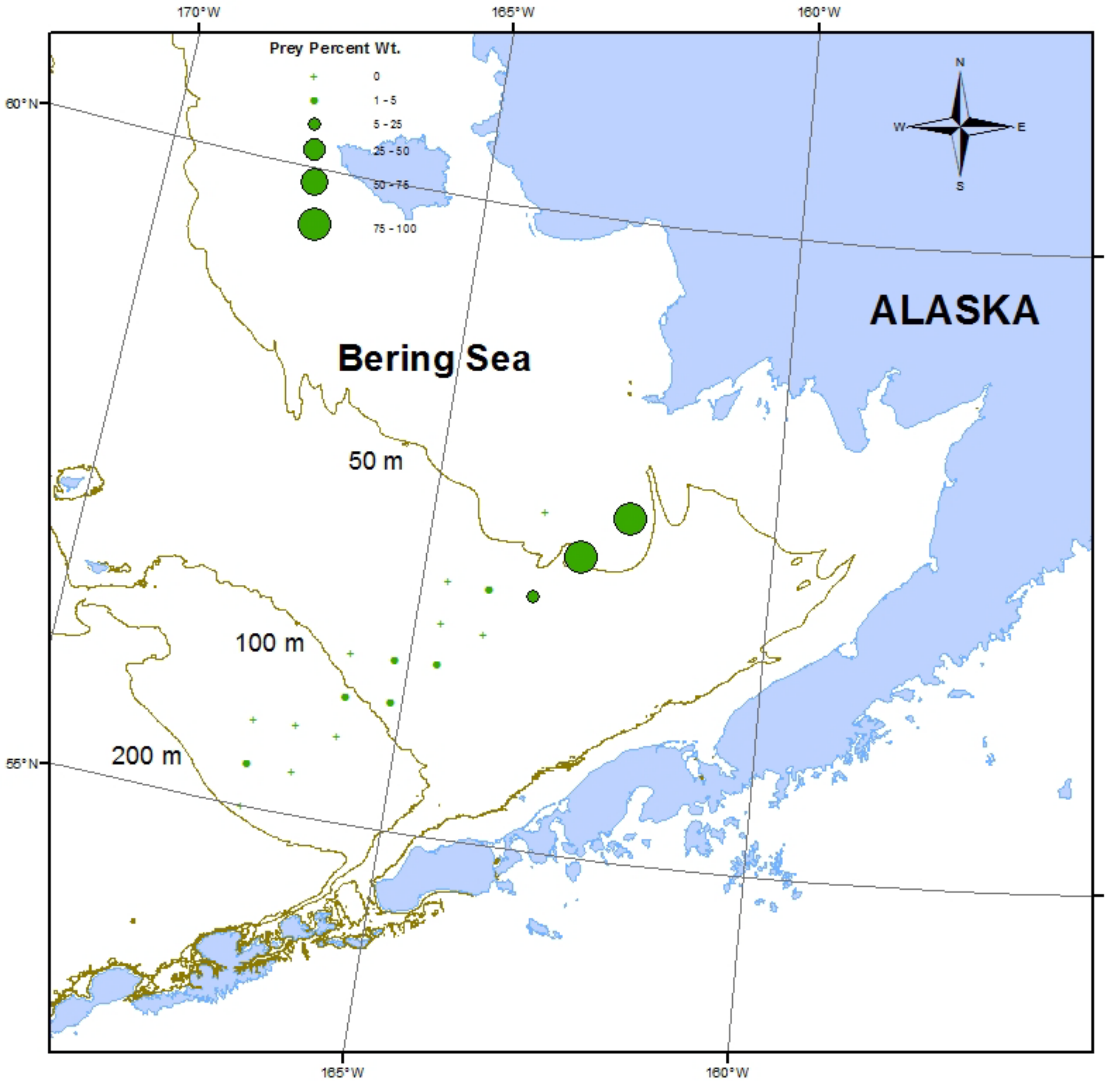

Figure 21c. -- Distribution of Mysidae (crustacean) consumed by flathead sole.

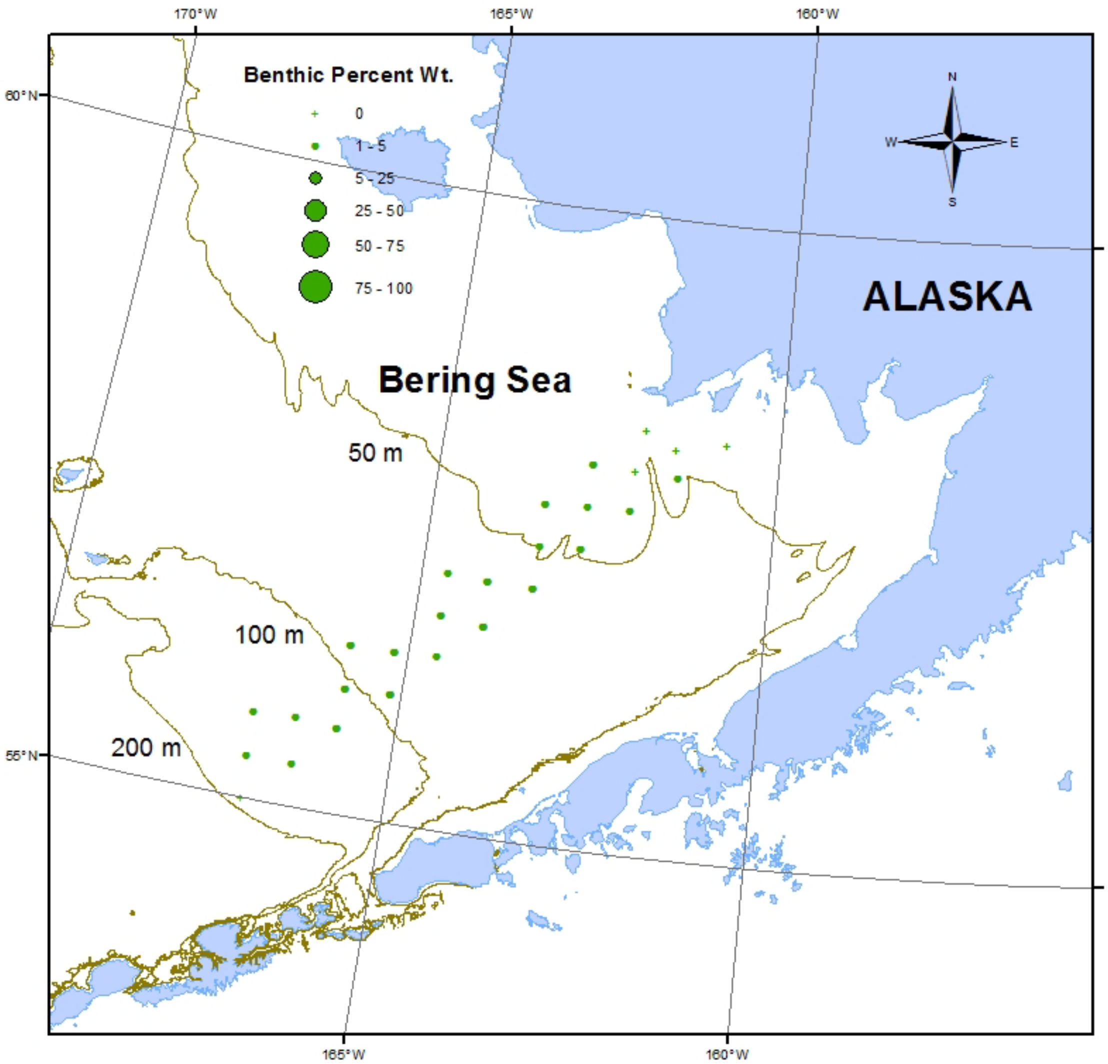

Figure 22a. -- Distribution of Cumacea (crustacean) in the benthic samples.

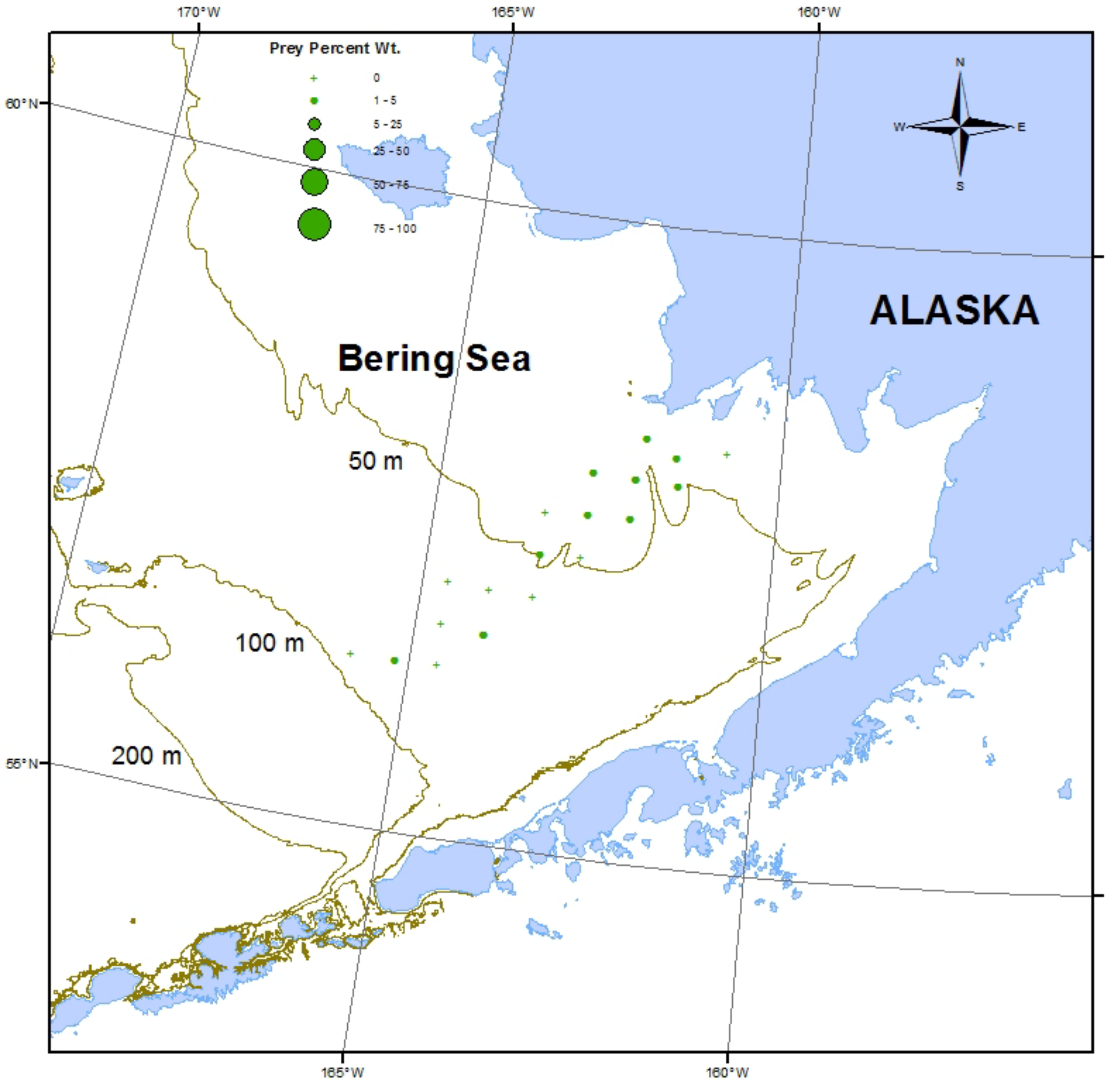

Figure 22b. -- Distribution of Cumacea (crustacean) consumed by Alaska plaice.

Figure 22c. -- Distribution of Cumacea (crustacean) consumed by northern rock sole.

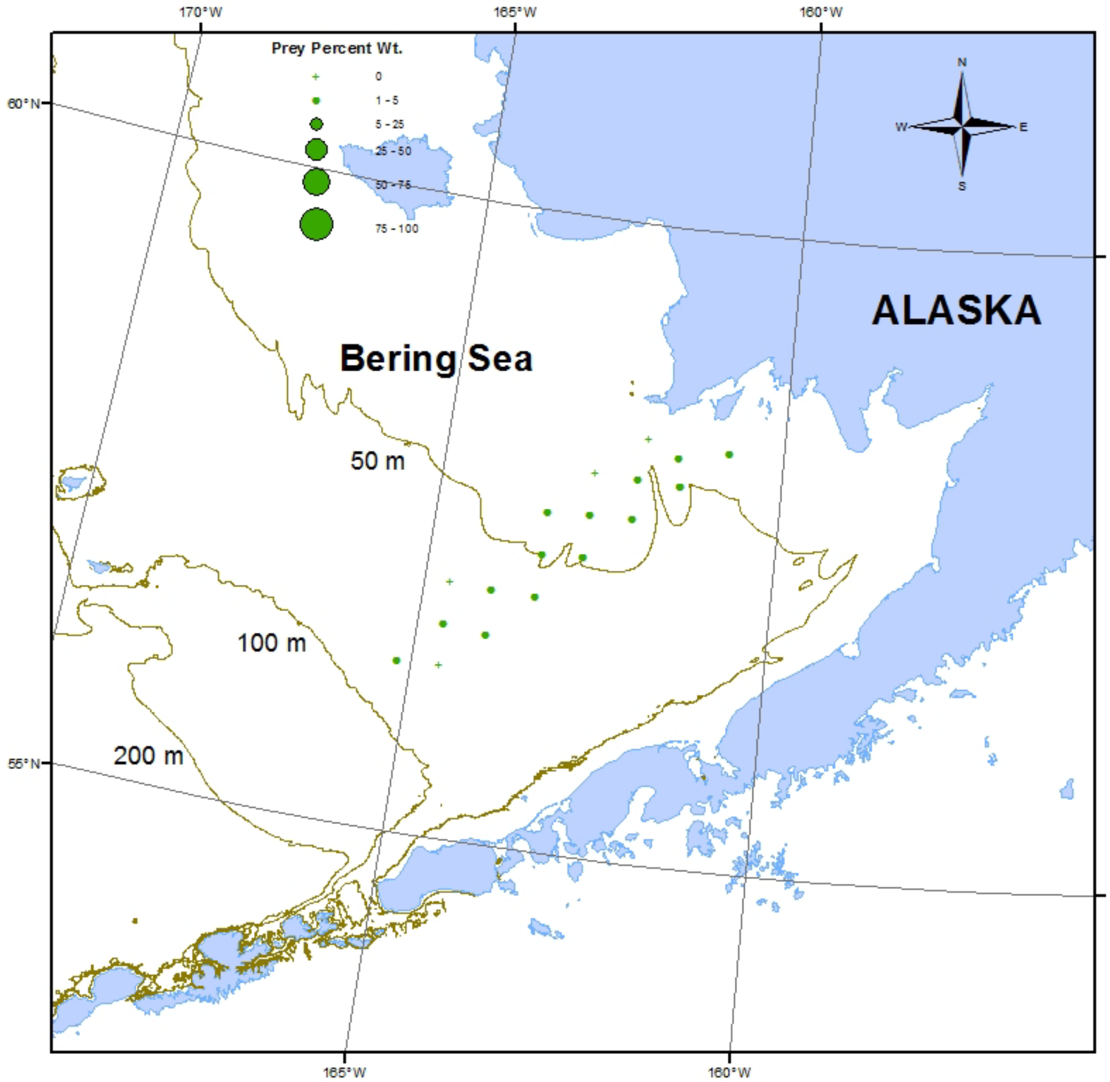

Figure 22d. -- Distribution of Cumacea (crustacean) consumed by yellowfin sole.

Figure 22e. -- Distribution of Cumacea (crustacean) consumed by flathead sole.

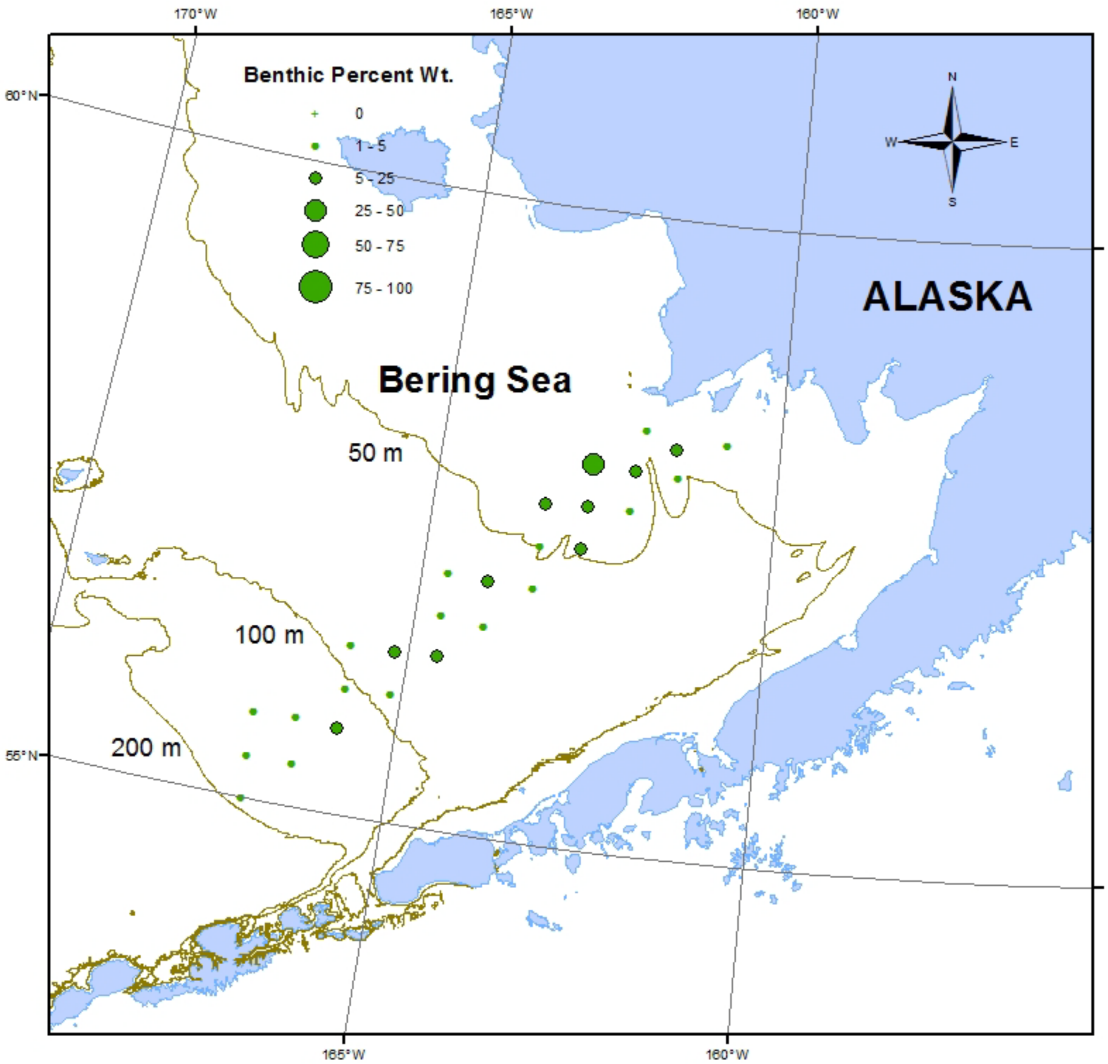

Figure 23a. -- Distribution of Amphipoda (crustacean) in the benthic samples.

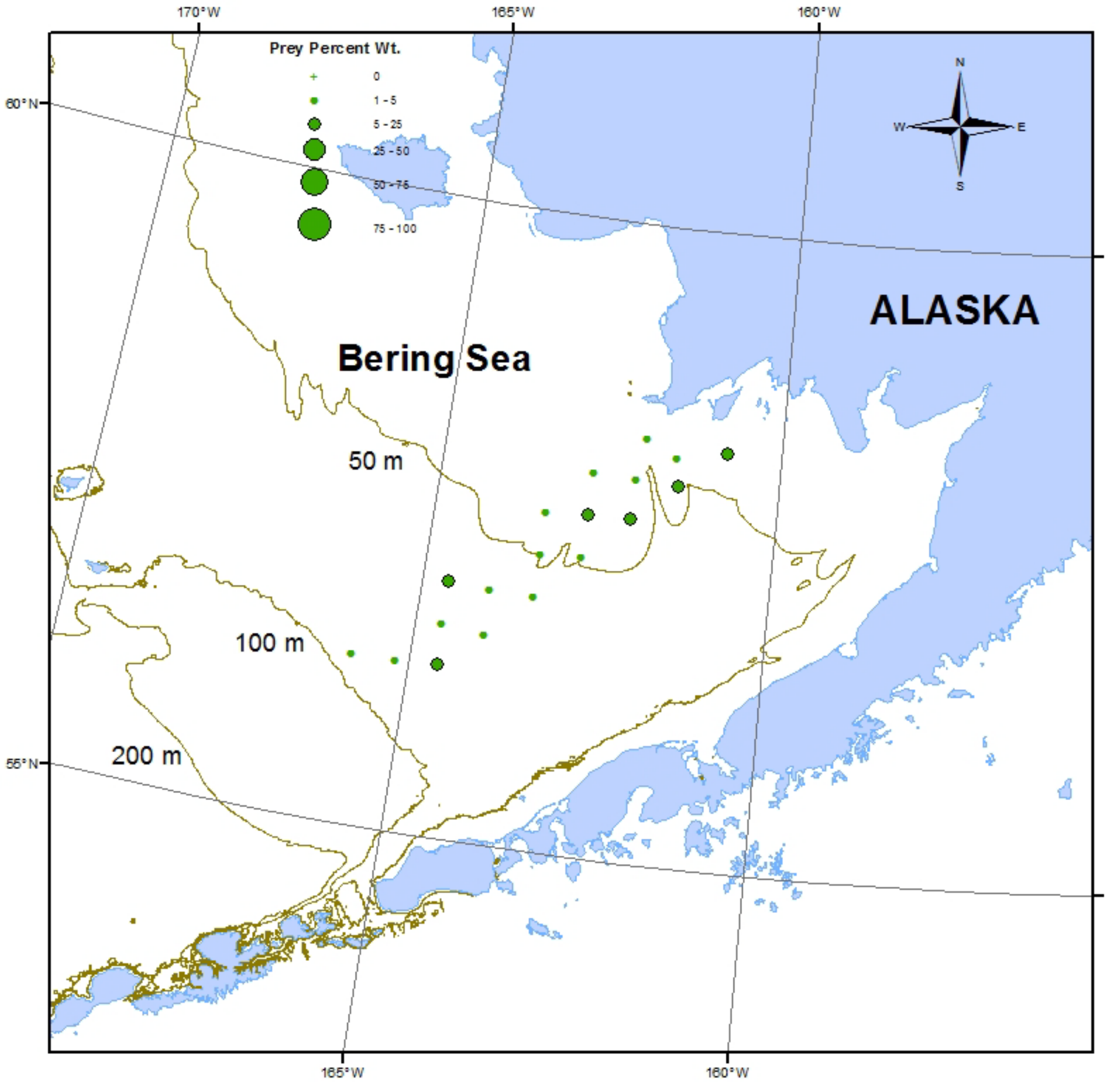

Figure 23b. -- Distribution of Amphipoda (crustacean) consumed by Alaska plaice.

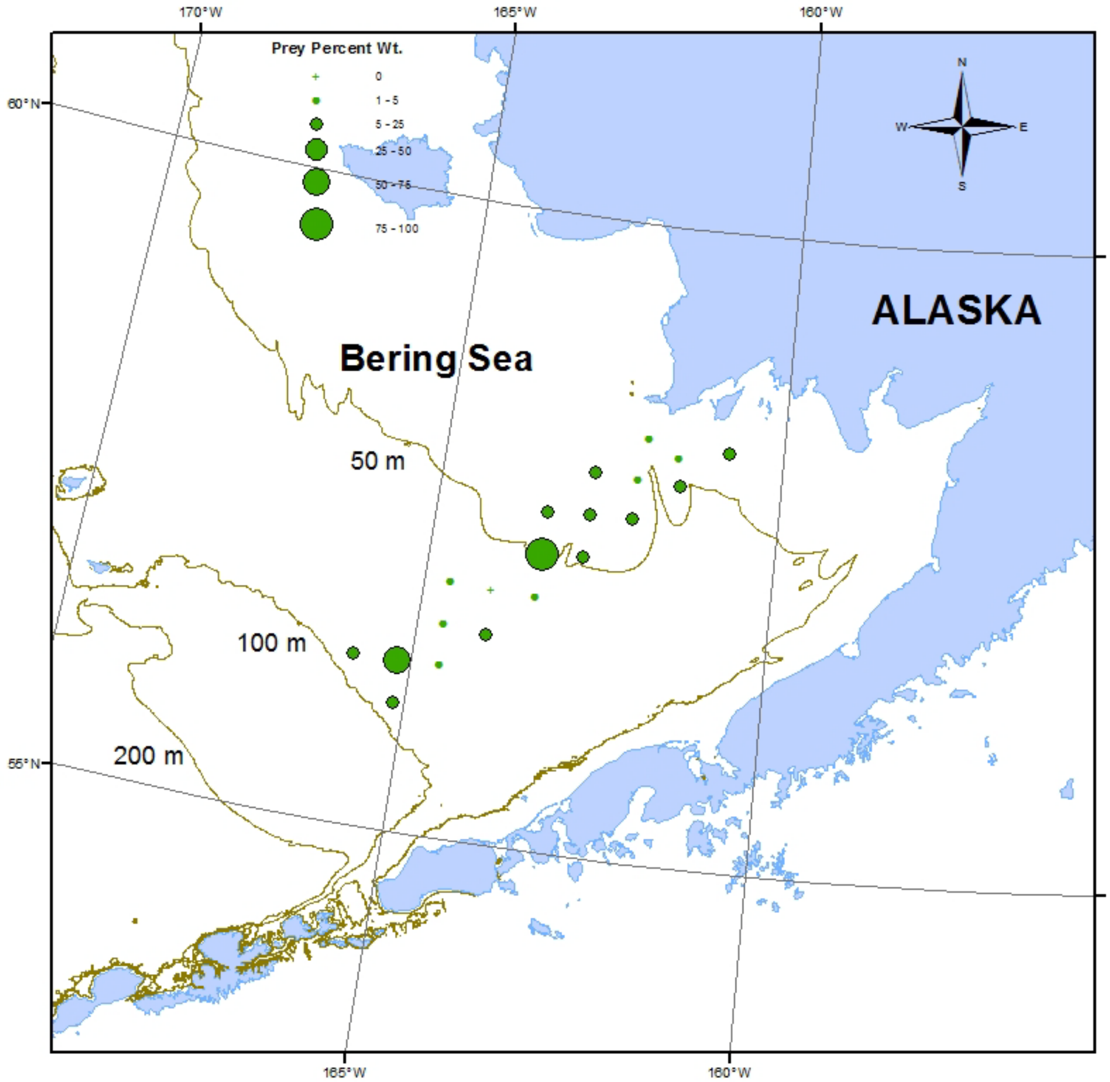

Figure 23c. -- Distribution of Amphipoda (crustacean) consumed by northern rock sole.

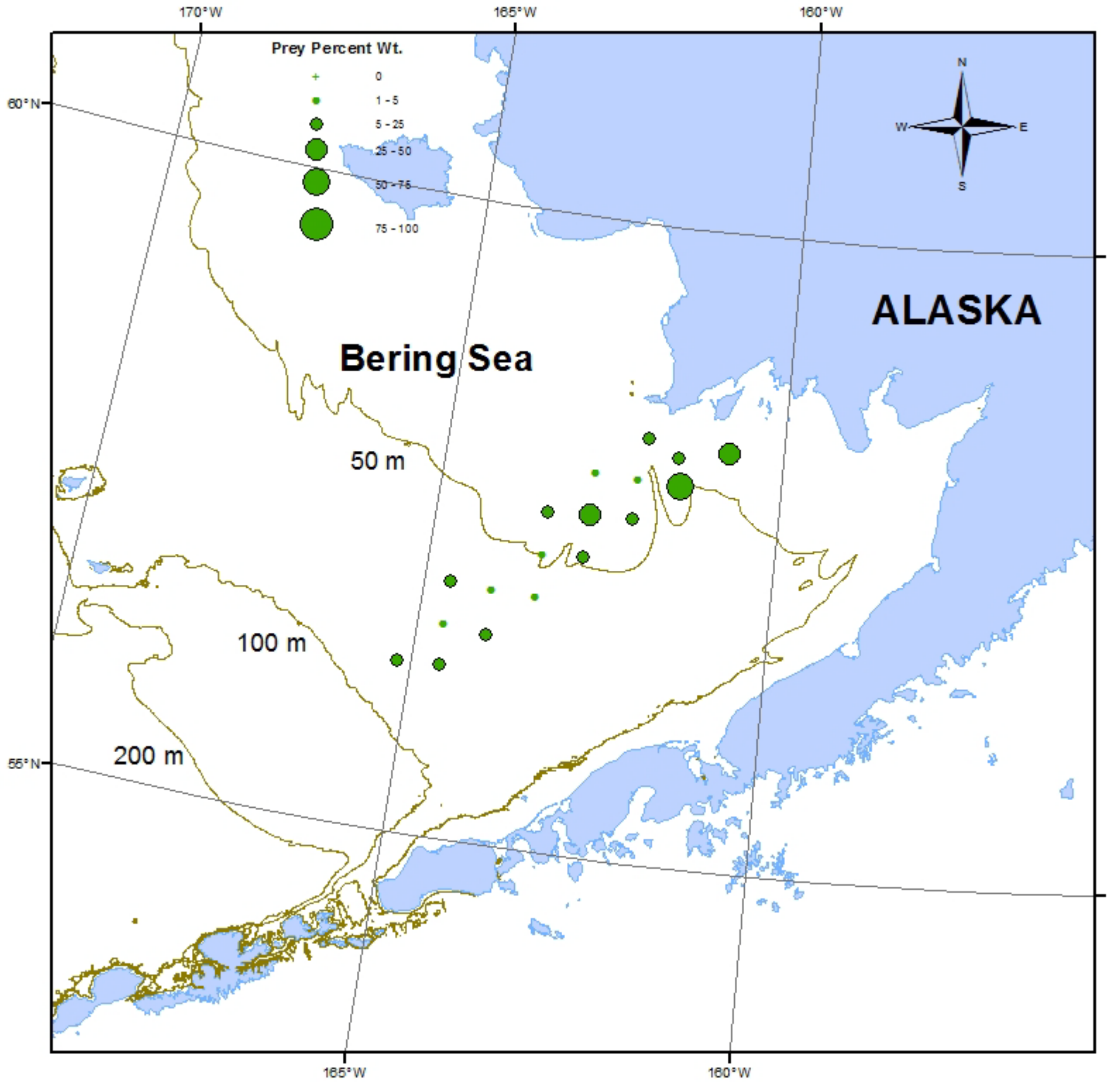

Figure 23d. -- Distribution of Amphipoda (crustacean) consumed by yellowfin sole.

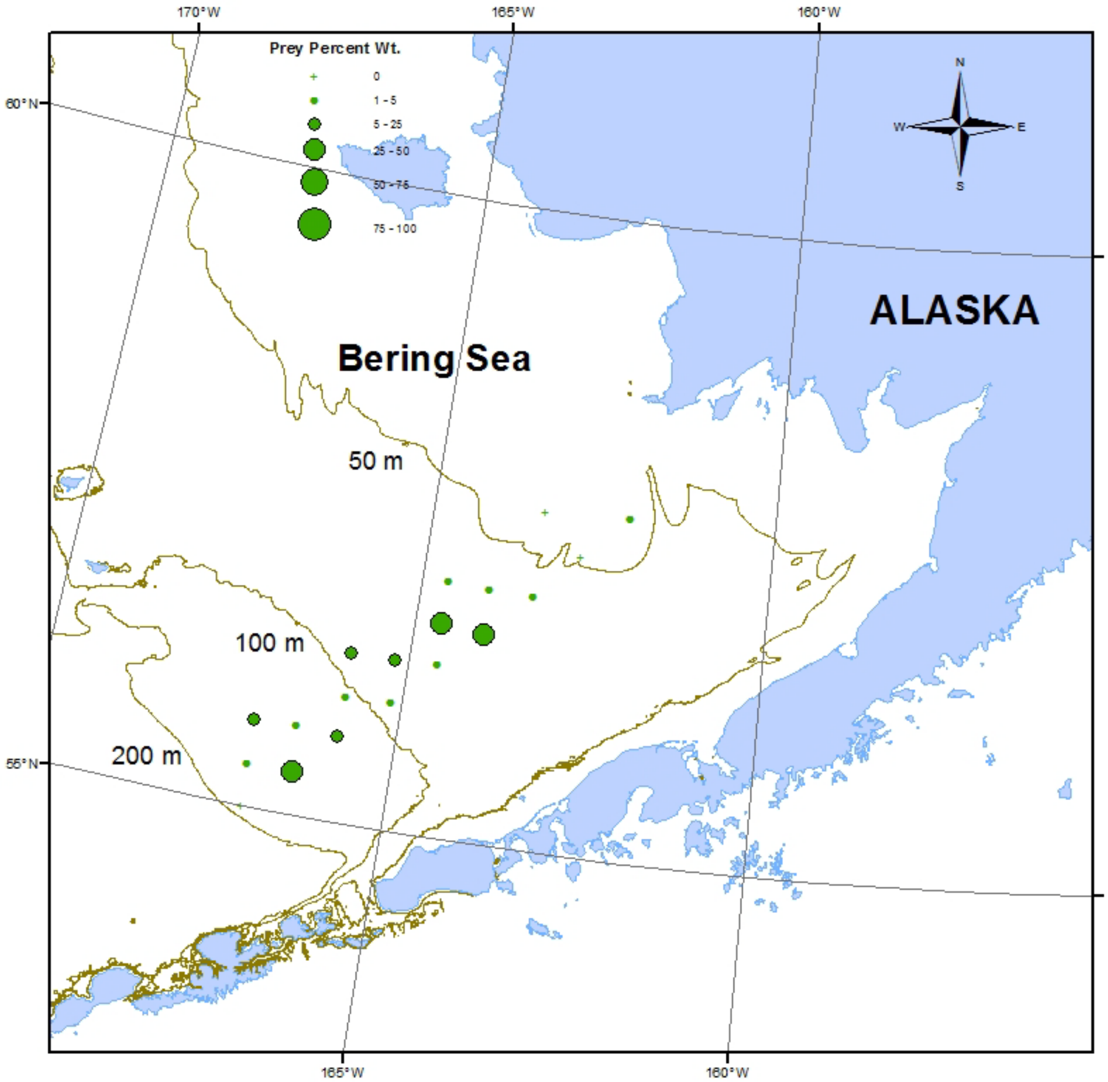

Figure 23e. -- Distribution of Amphipoda (crustacean) consumed by flathead sole.

Figure 24a. -- Distribution of Euphausiidae (crustacean) consumed by northern rock sole.

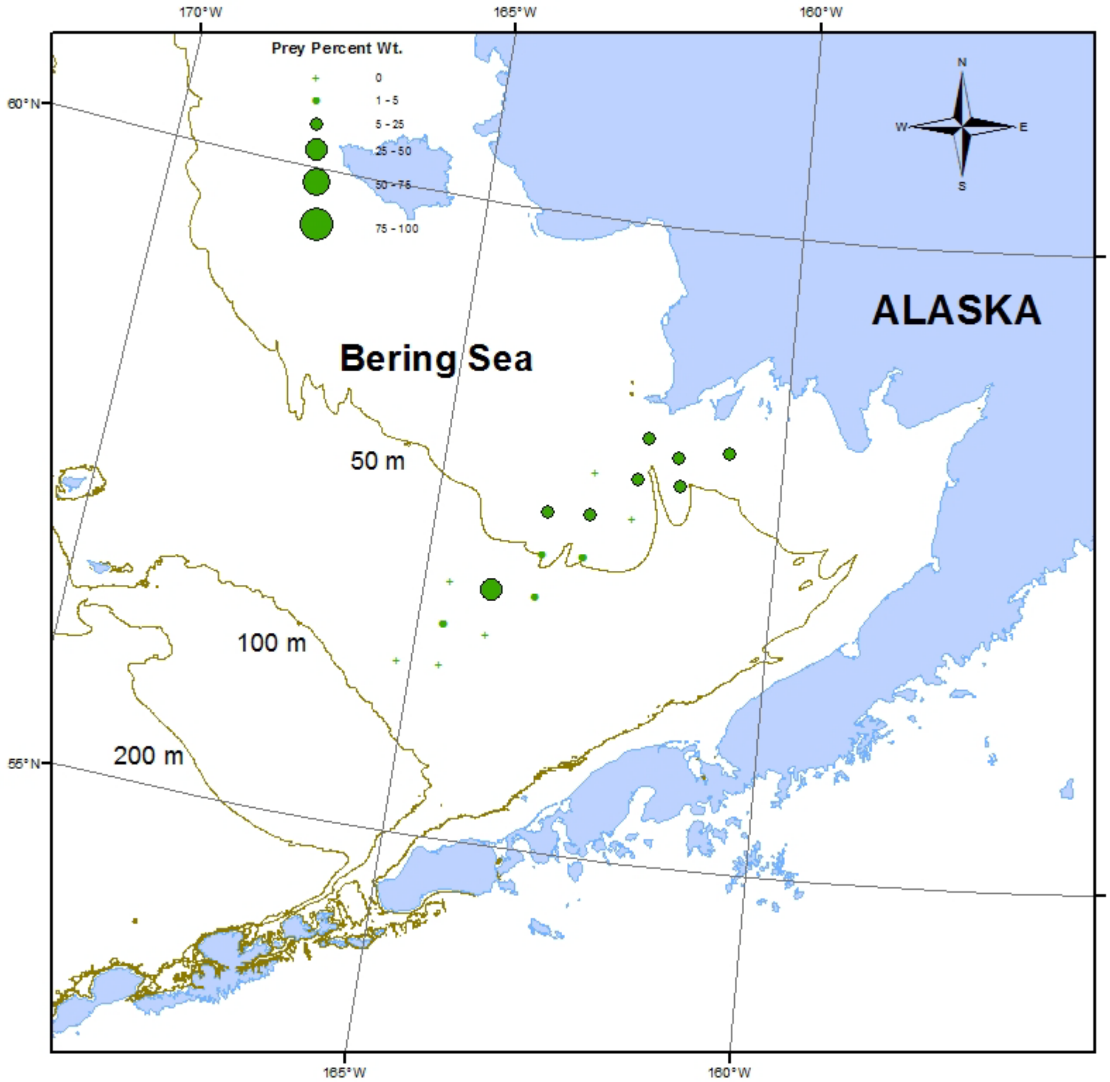

Figure 24b. -- Distribution of Euphausiidae (crustacean) consumed by yellowfin sole.

Figure 24c. -- Distribution of Euphausiidae (crustacean) consumed by flathead sole.

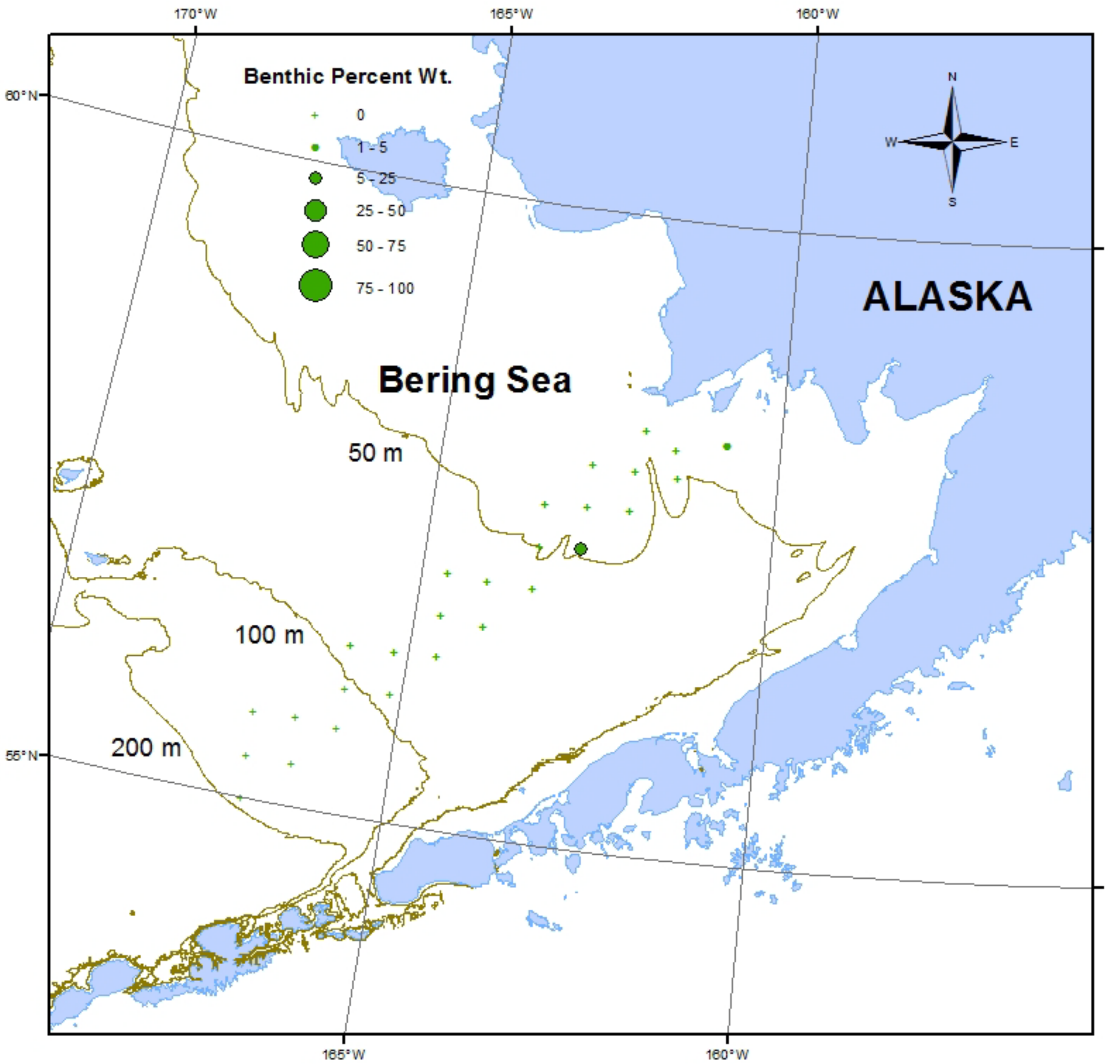

Figure 25a. -- Distribution of Caridea (shrimp) in the benthic samples.

Figure 25b. -- Distribution of Caridea (shrimp) consumed by Alaska plaice.

Figure 25c. -- Distribution of Caridea (shrimp) consumed by northern rock sole.

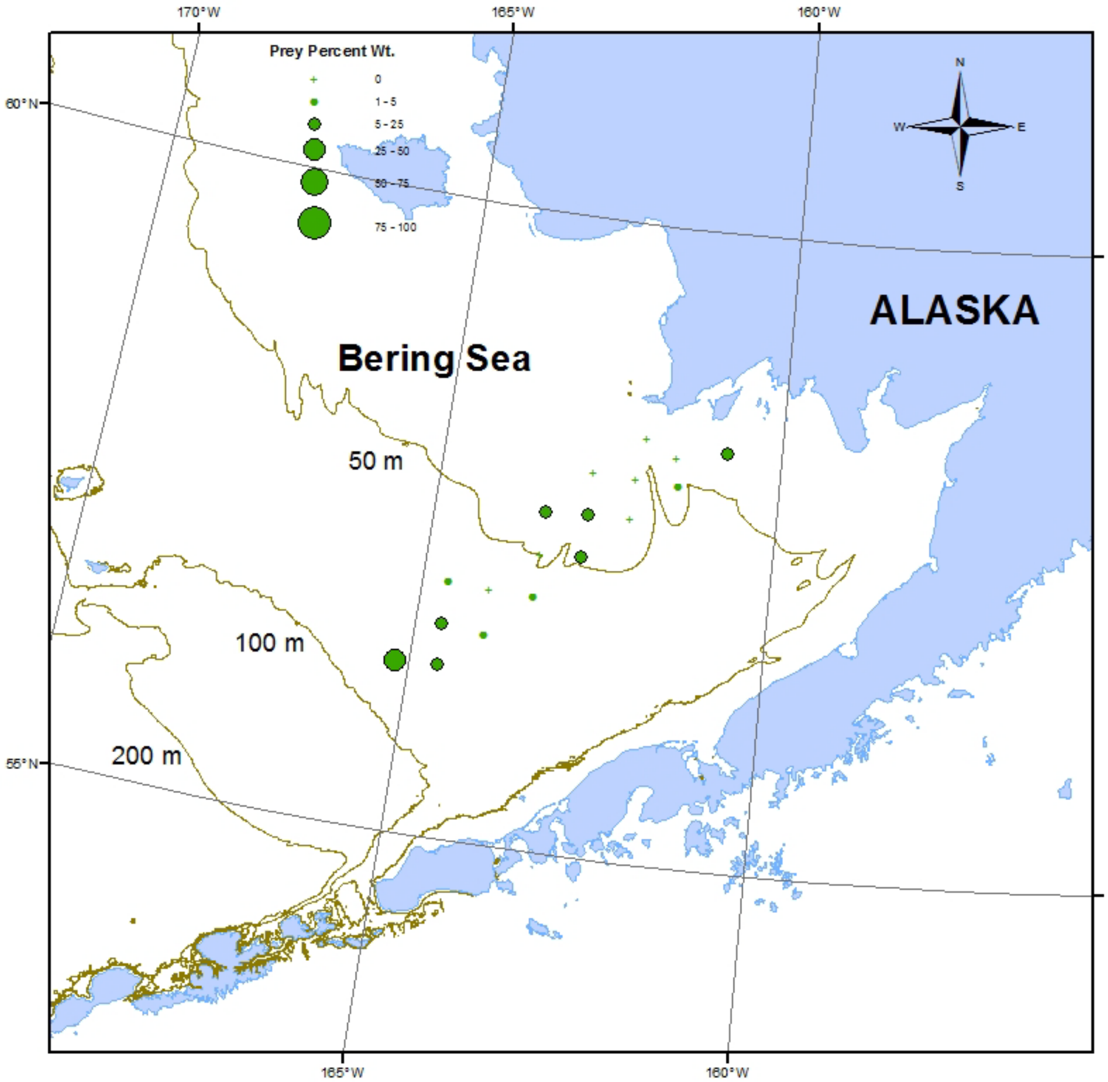

Figure 25d. -- Distribution of Caridea (shrimp) consumed by yellowfin sole.

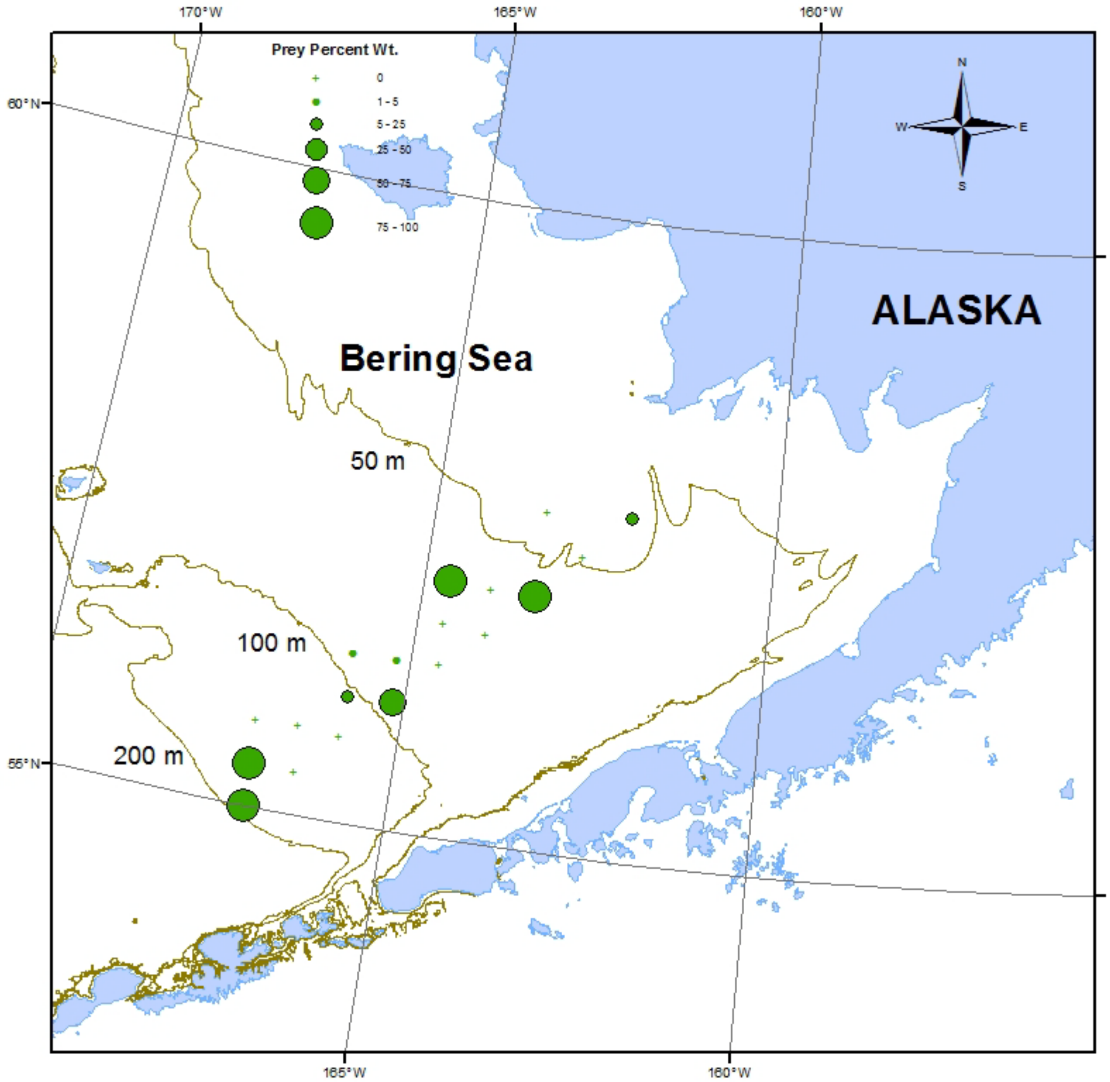

Figure 25e. -- Distribution of Caridea (shrimp) consumed by flathead sole.

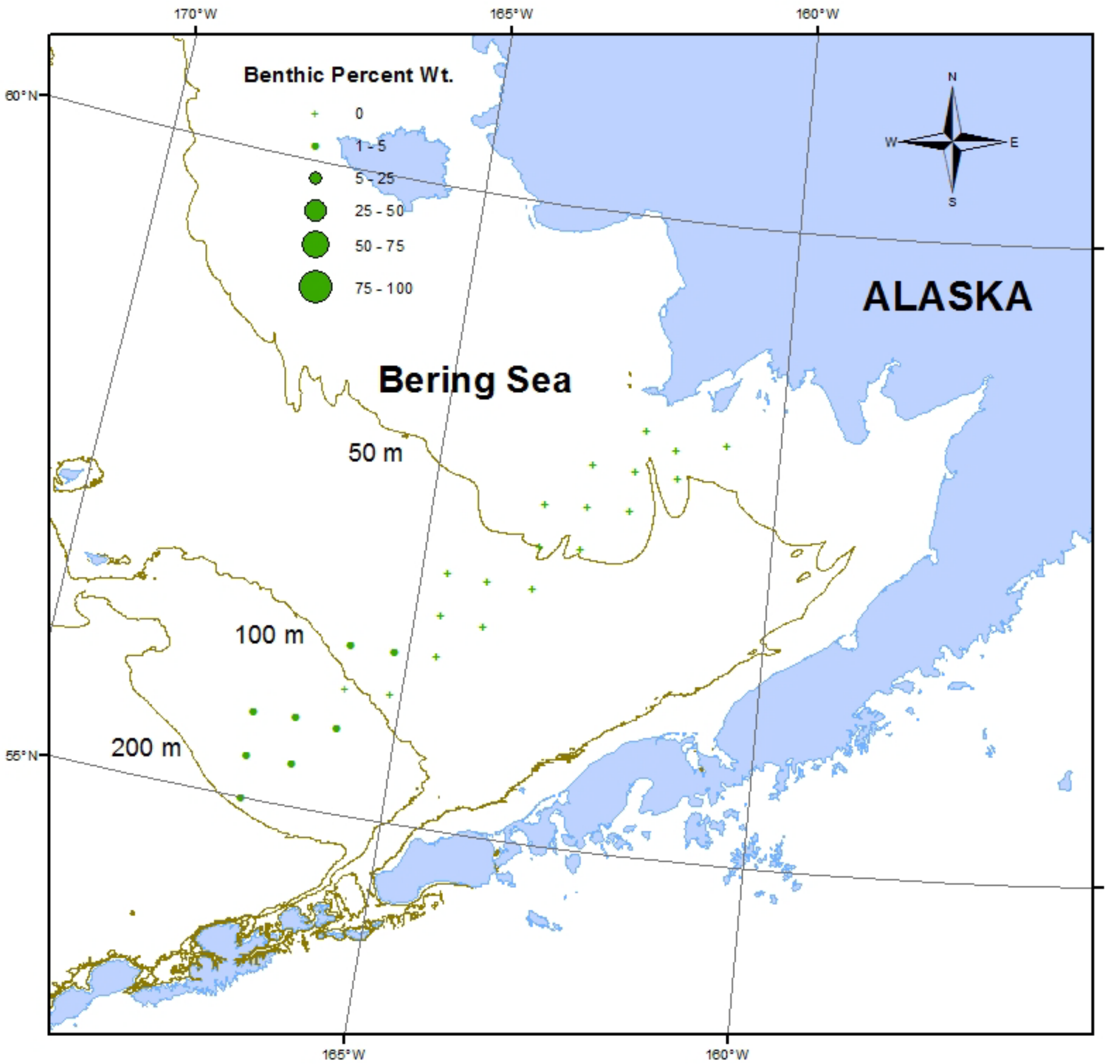

Figure 26a. -- Distribution of Sipuncula (peanut worm) in the benthic samples.

Figure 26b. -- Distribution of Sipuncula (peanut worm) consumed by Alaska plaice.

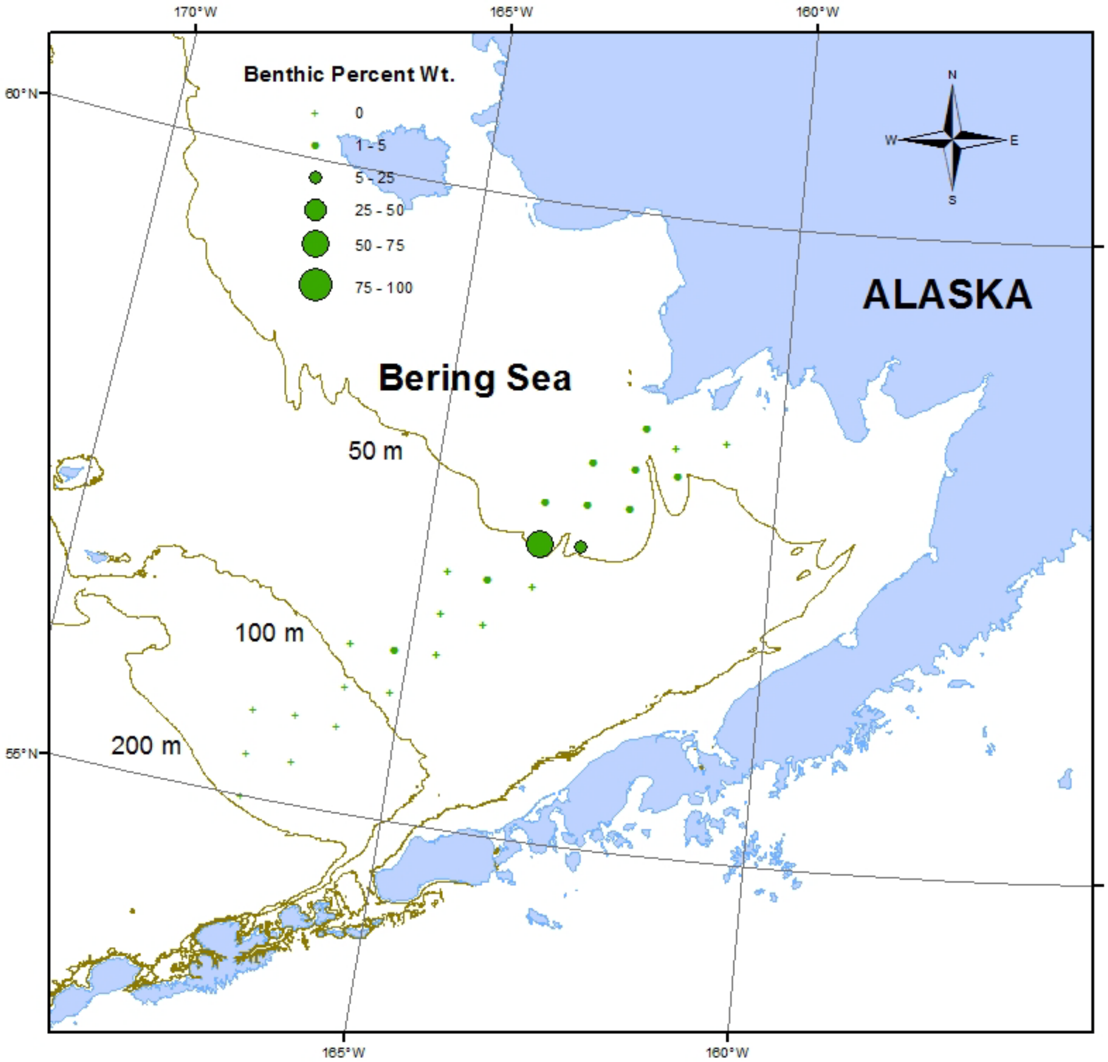

Figure 27a. -- Distribution of Echiura (spoon worm) in the benthic samples.

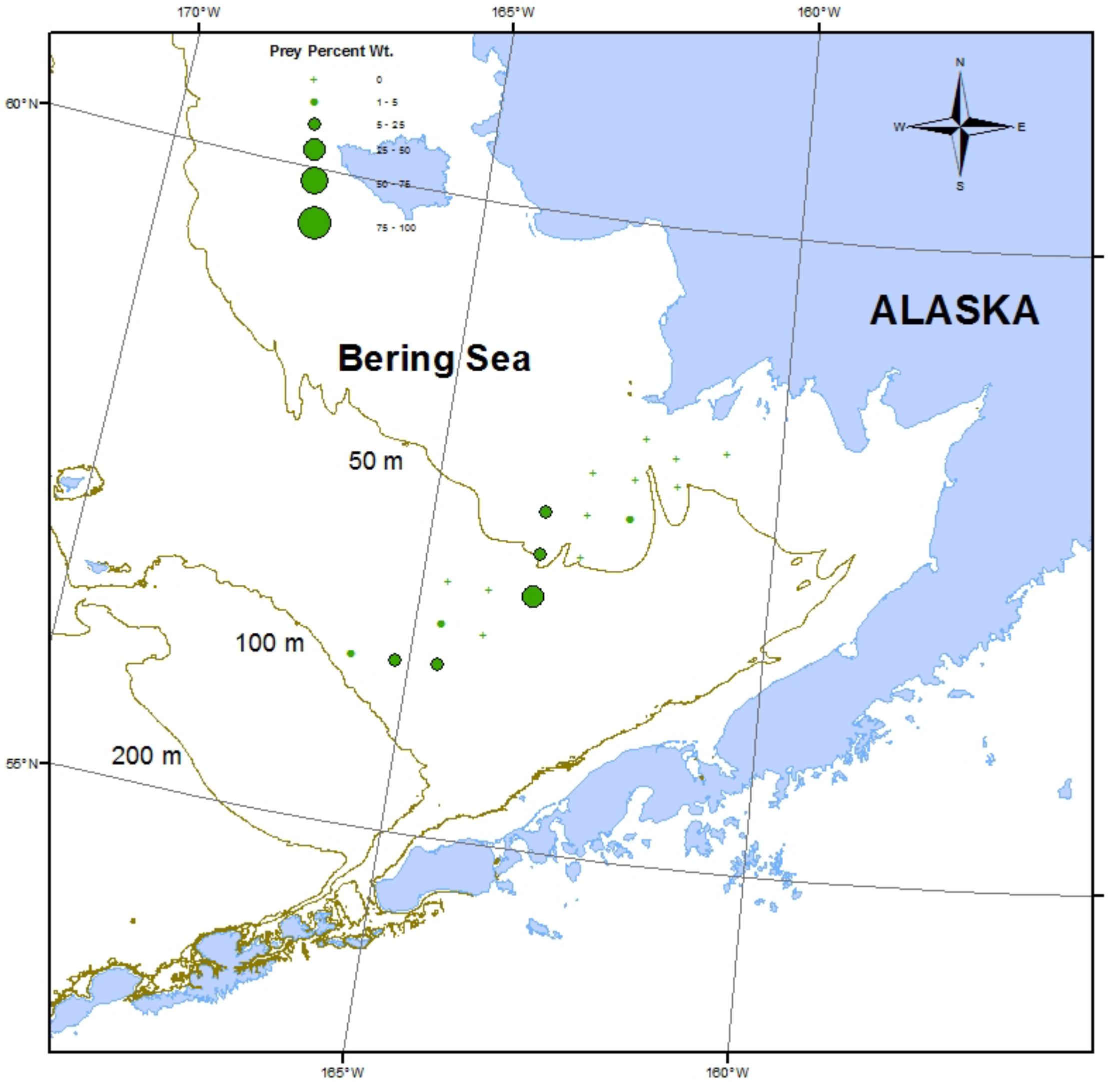

Figure 27b. -- Distribution of Echiura (spoon worm) consumed by Alaska plaice.

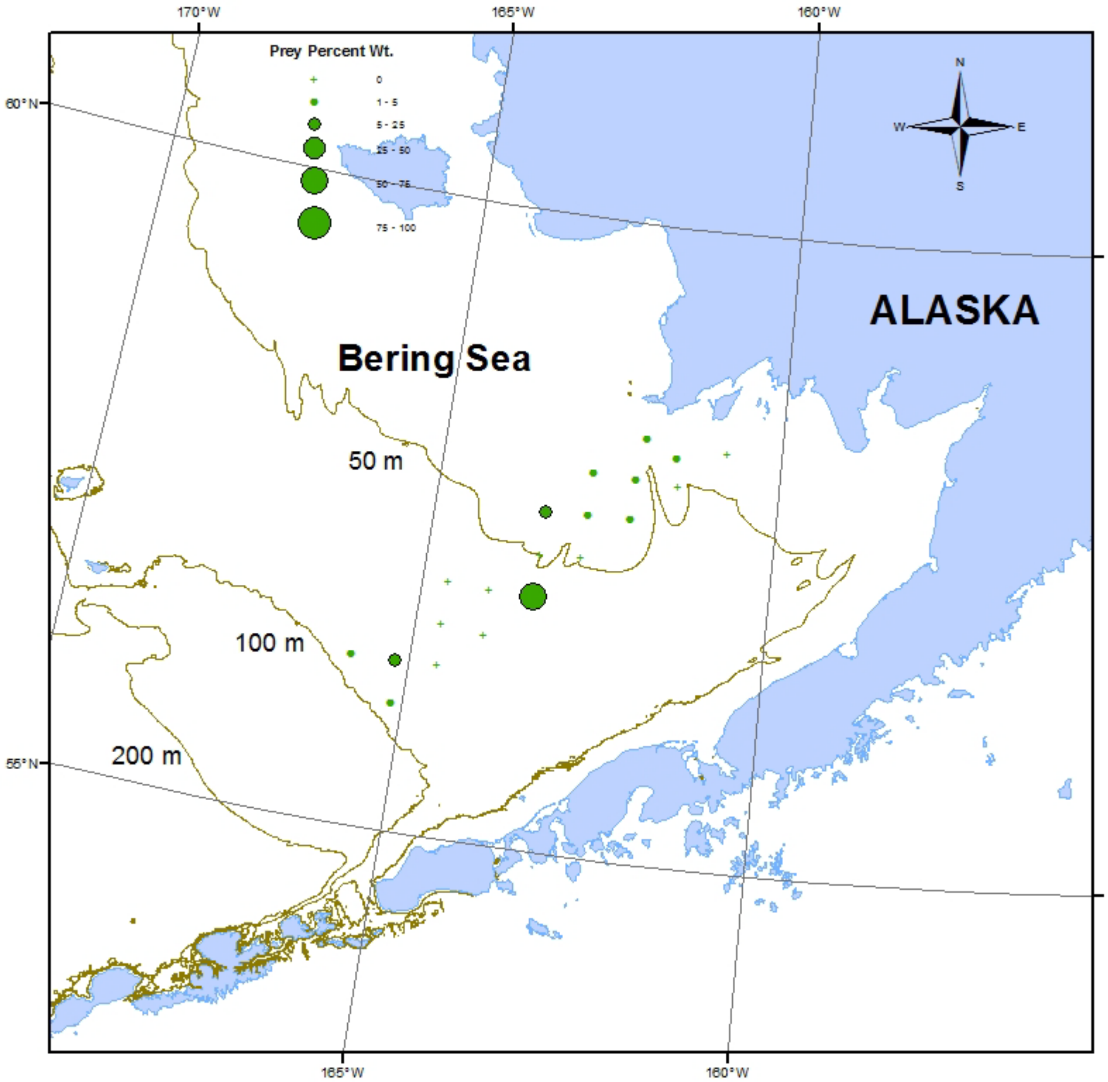

Figure 27c. -- Distribution of Echiura (spoon worm) consumed by northern rock sole.

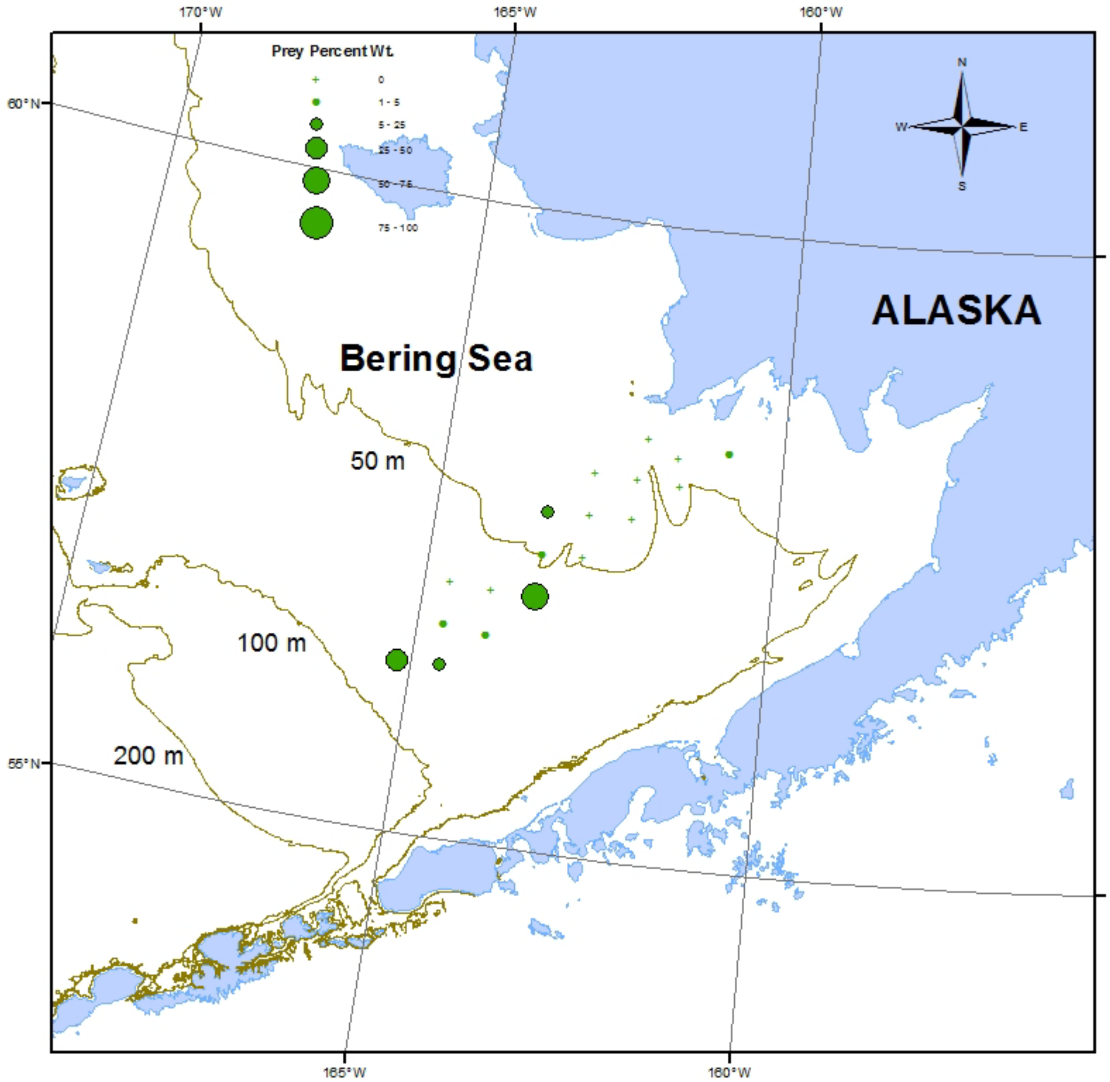

Figure 27d. -- Distribution of Echiura (spoon worm) consumed by yellowfin sole.

Figure 27e. -- Distribution of Echiura (spoon worm) consumed by flathead sole.

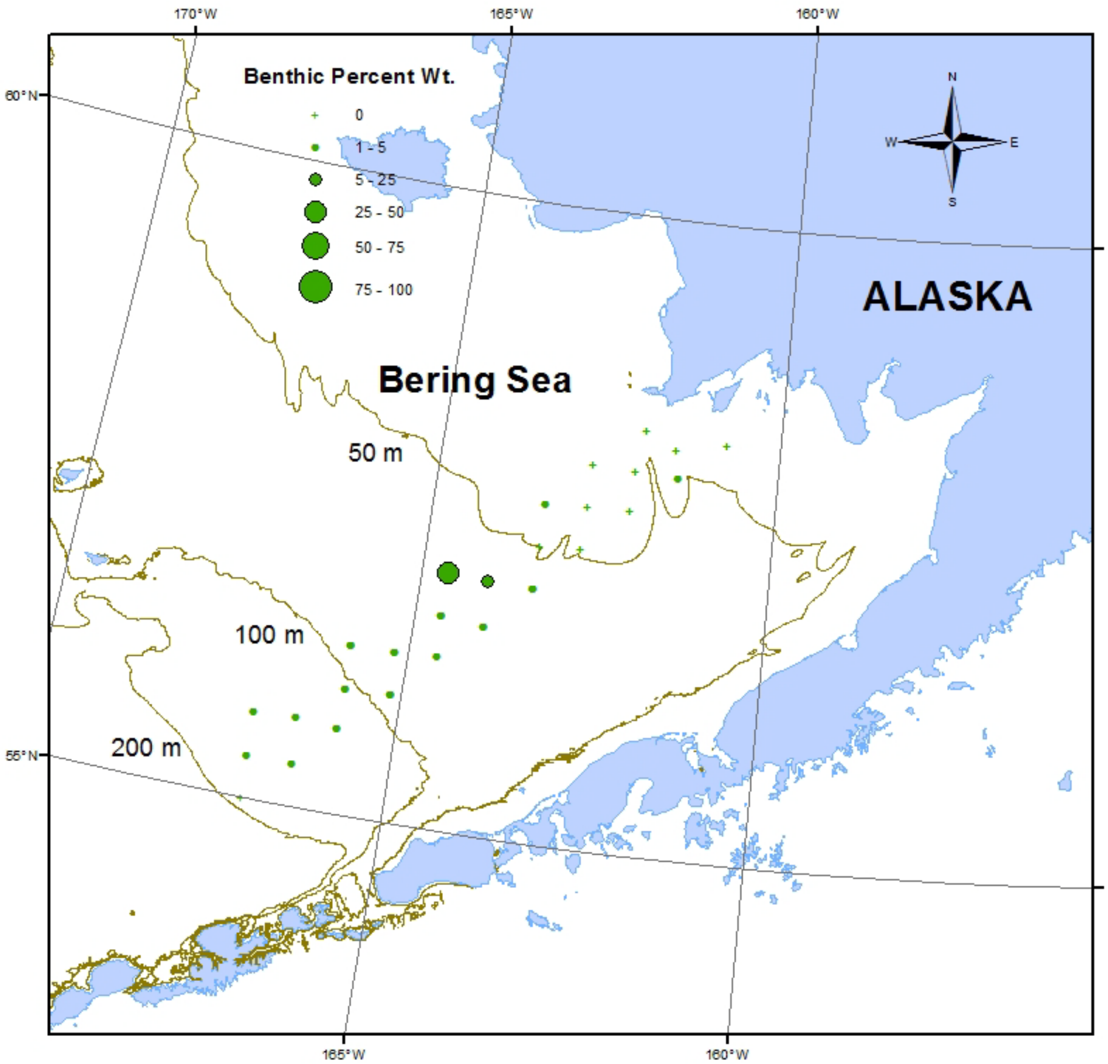

Figure 28a. -- Distribution of Ophiuroidea (brittle star) in the benthic samples.

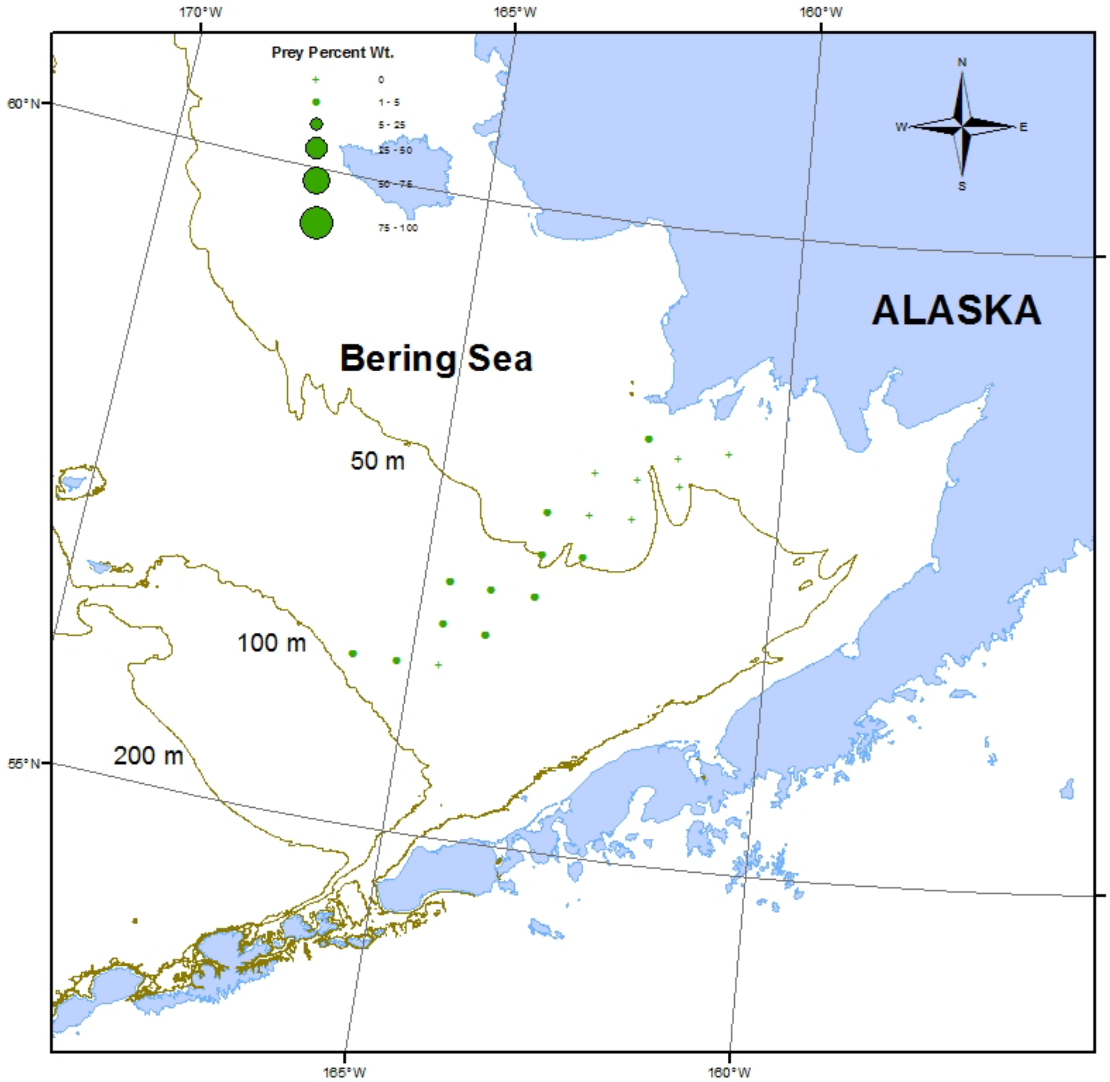

Figure 28b. -- Distribution of Ophiuroidea (brittle star) consumed by Alaska plaice.

Figure 28c. -- Distribution of Ophiuroidea (brittle star) consumed by northern rock sole.

Figure 28d. -- Distribution of Ophiuroidea (brittle star) consumed by yellowfin sole.

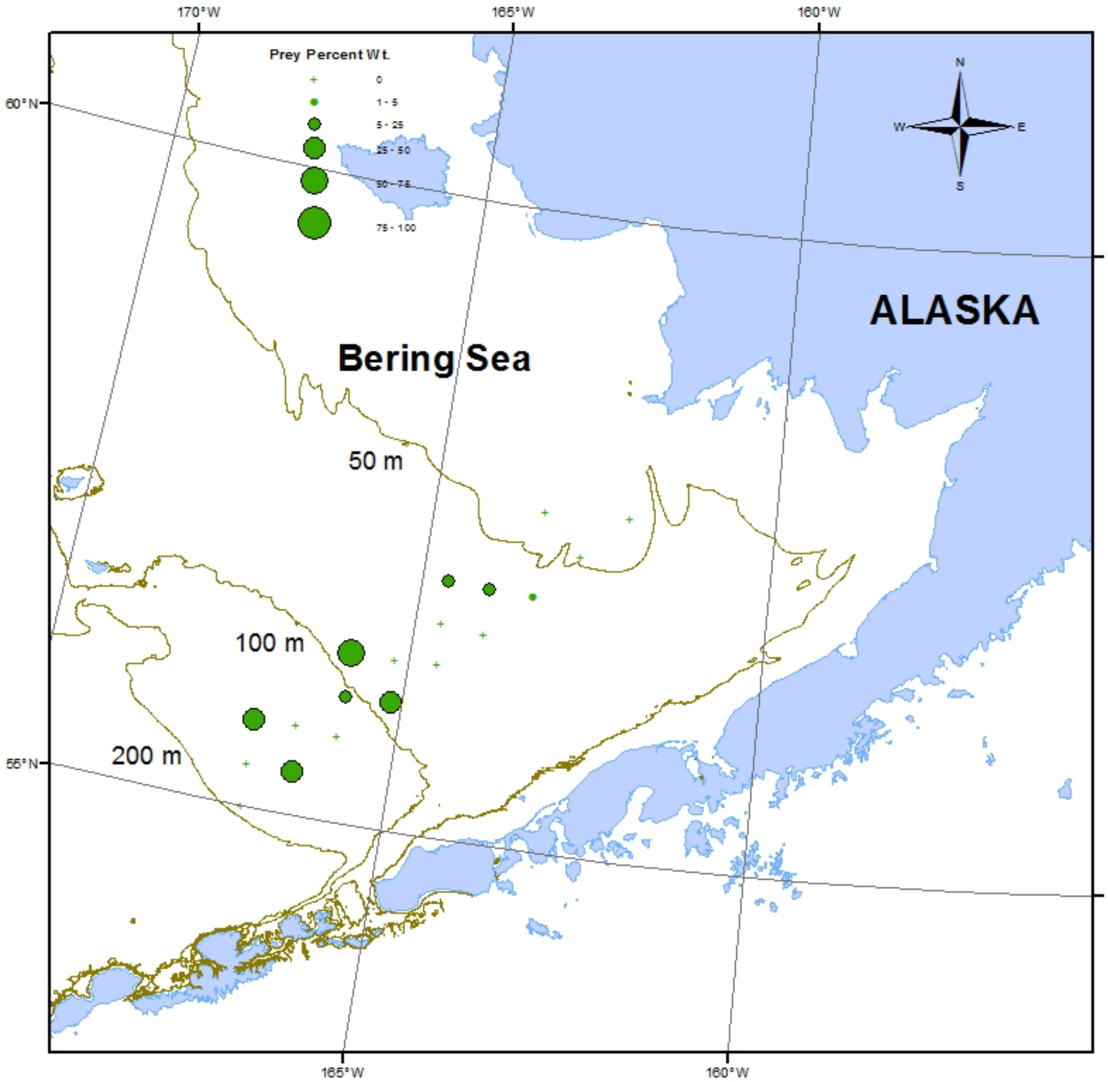

Figure 28e. -- Distribution of Ophiuroidea (brittle star) consumed by flathead sole.

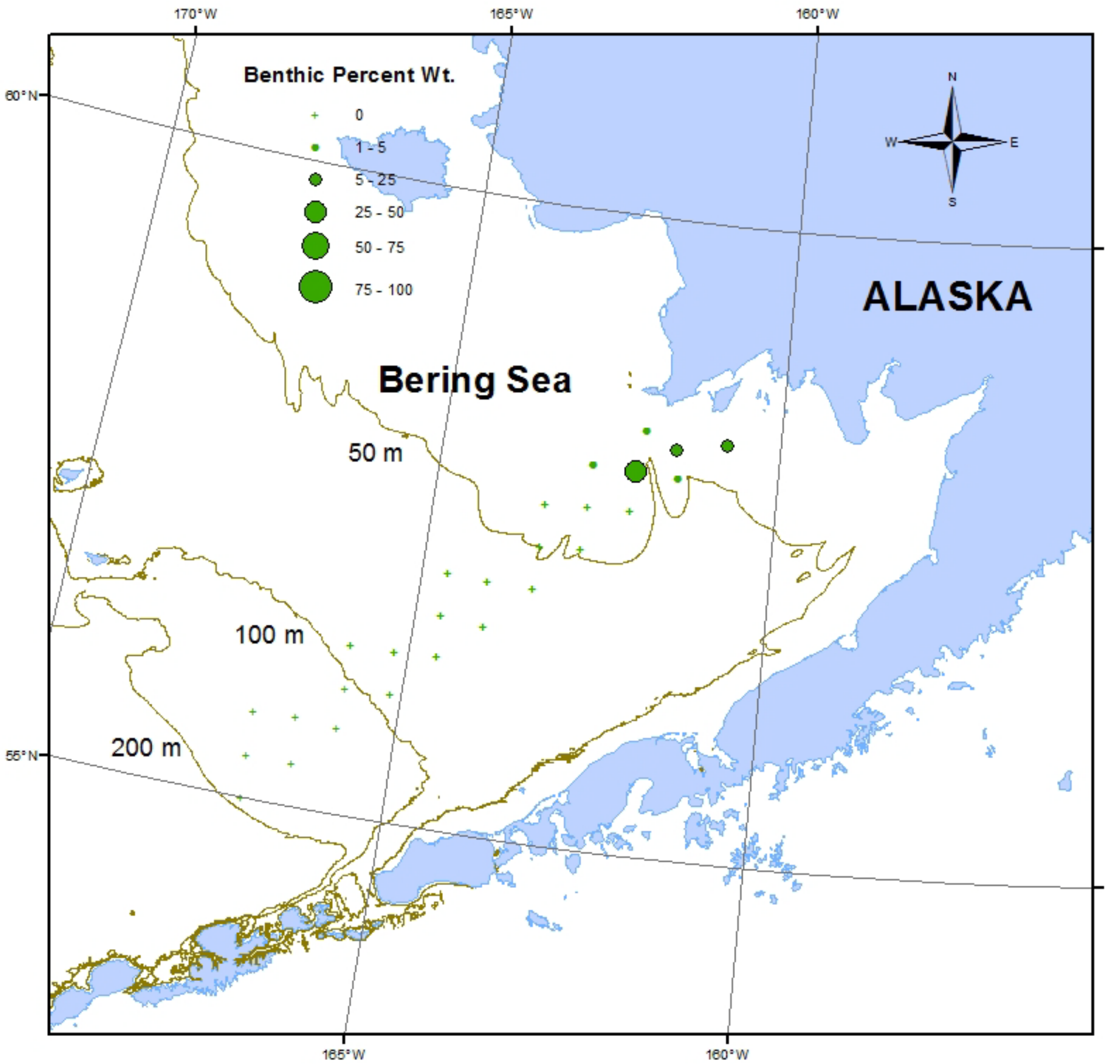

Figure 29a. -- Distribution of Clypeasteroida (sand dollar) in the benthic samples.

Figure 29b. -- Distribution of Clypeasteroida (sand dollar) consumed by Alaska plaice.

Figure 29c. -- Distribution of Clypeasteroida (sand dollar) consumed by northern rock sole.

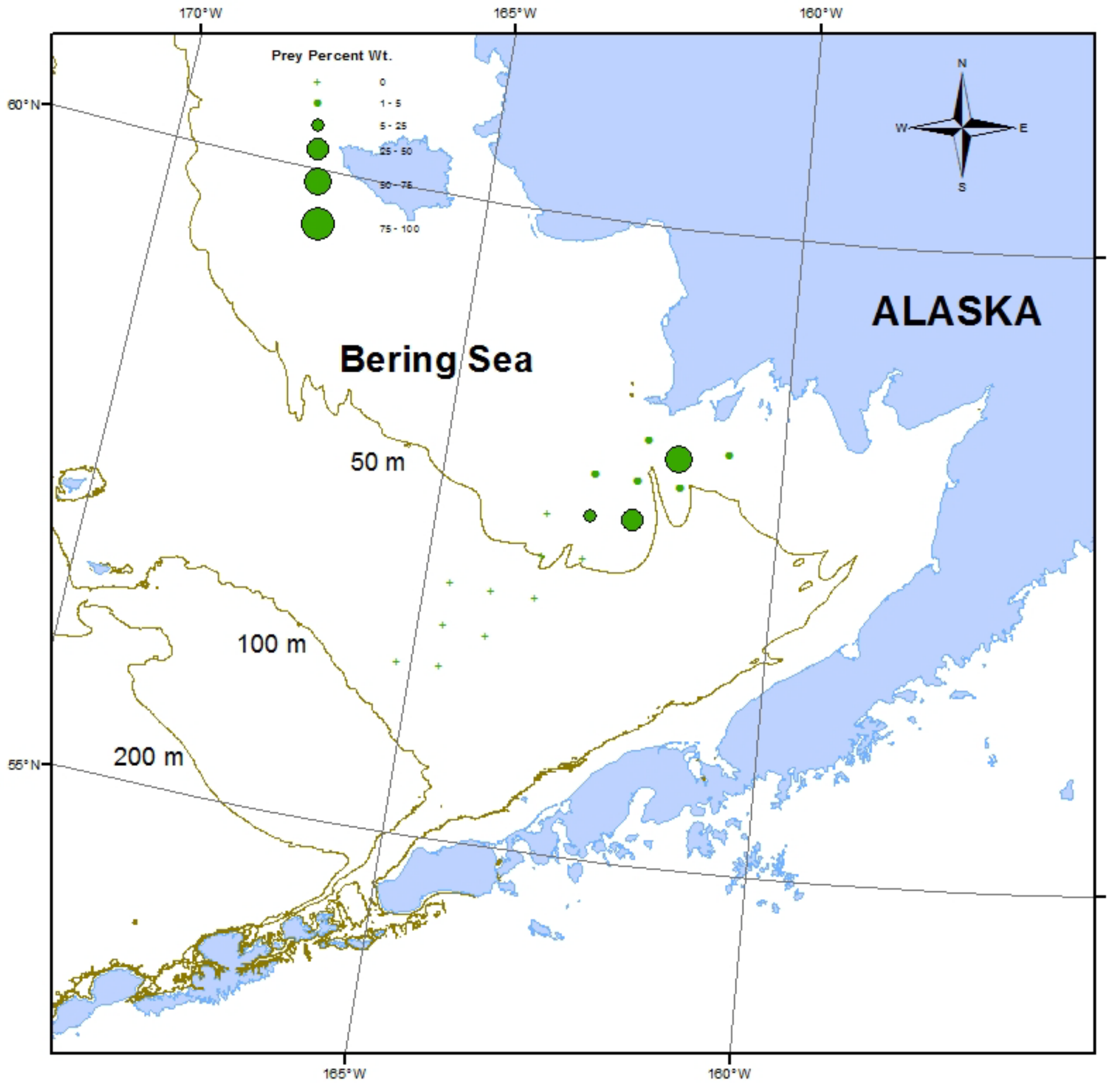

Figure 29d. -- Distribution of Clypeasteroida (sand dollar) consumed by yellowfin sole.

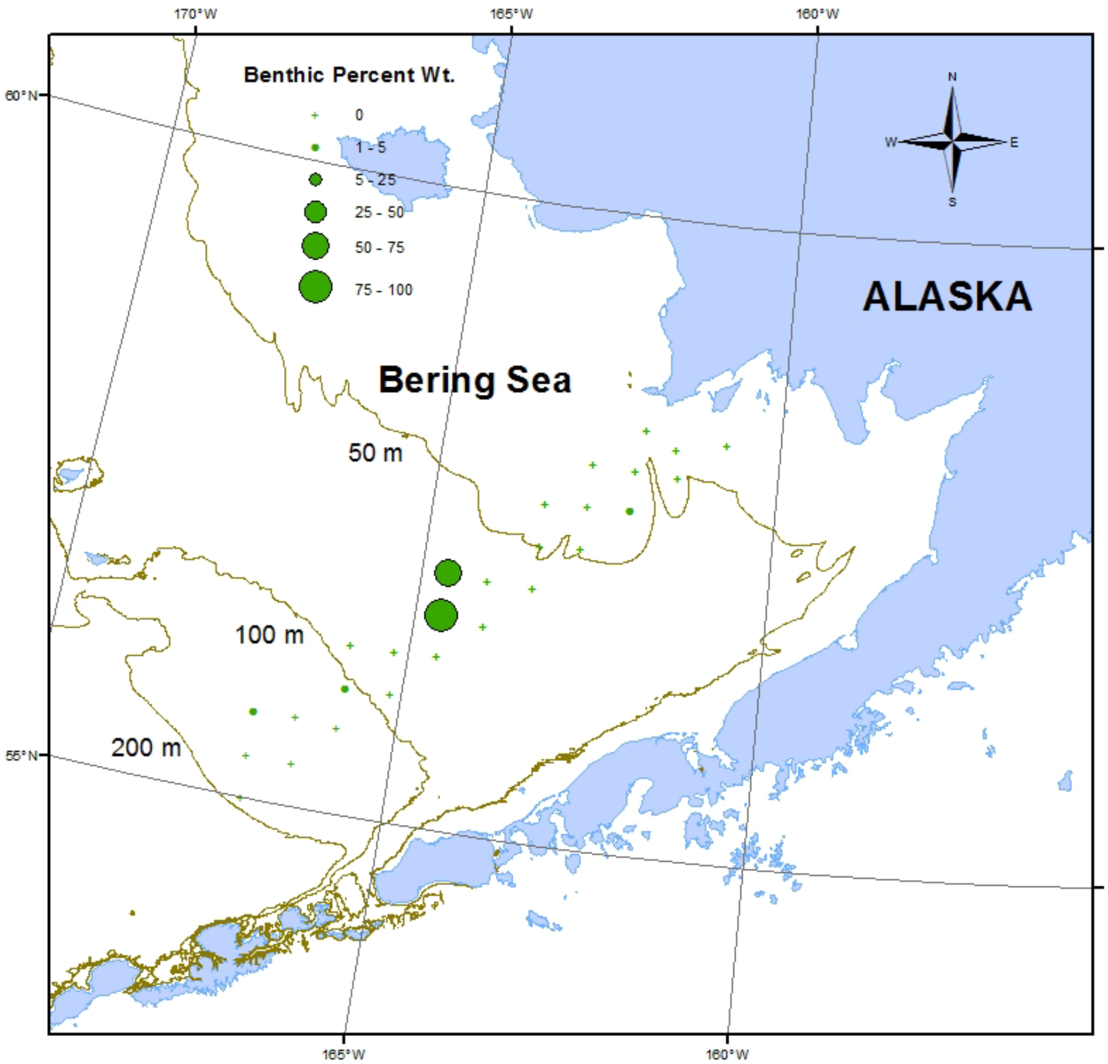

Figure 30a. -- Distribution of Holothuroidea (sea cucumber) in the benthic samples.

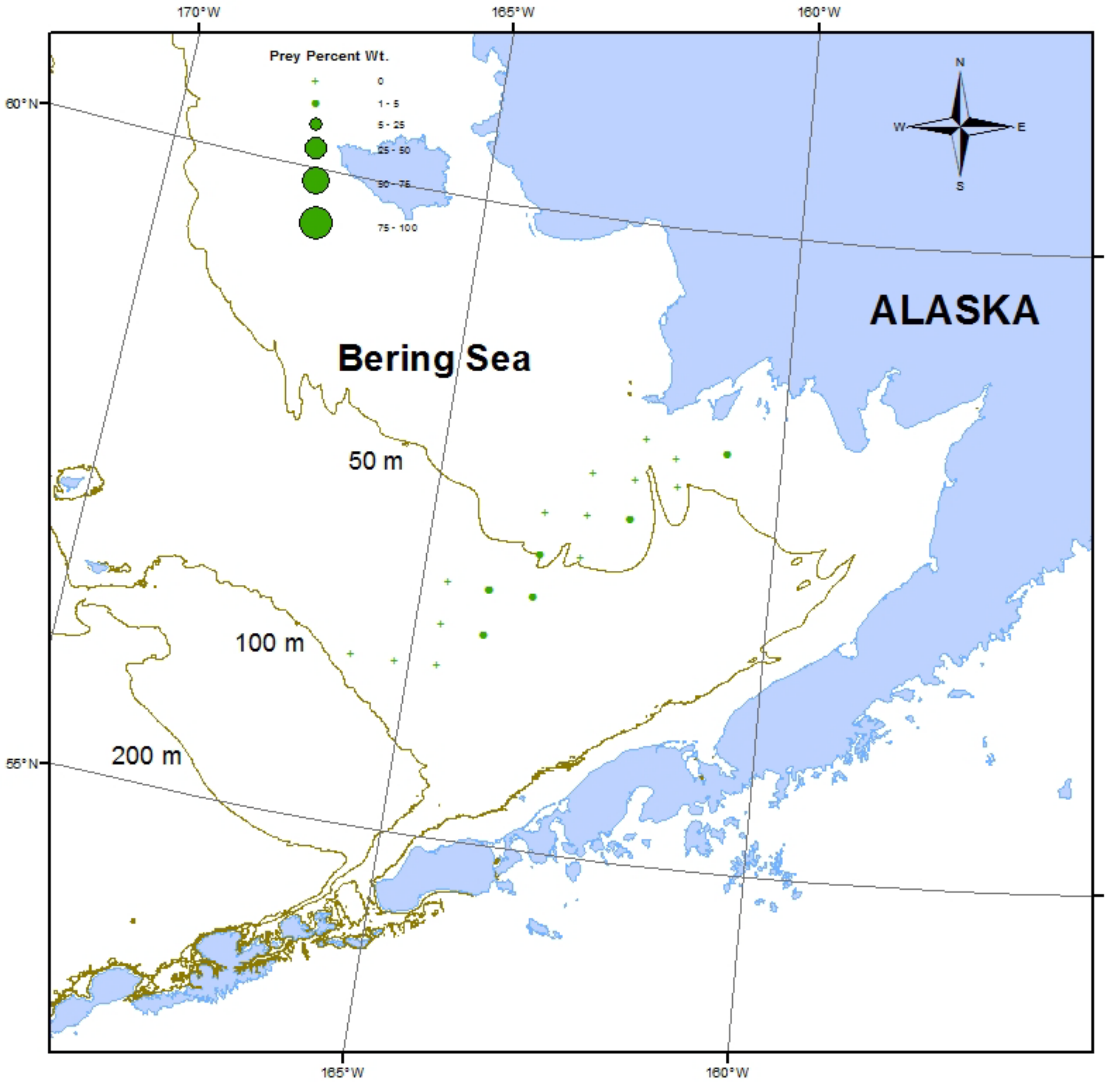

Figure 30b. -- Distribution of Holothuroidea (sea cucumber) consumed by Alaska plaice.

Figure 30c. -- Distribution of Holothuroidea (sea cucumber) consumed by northern rock sole.

Figure 30d. -- Distribution of Holothuroidea (sea cucumber) consumed by yellowfin sole.

Figure 30e. -- Distribution of Holothuroidea (sea cucumber) consumed by flathead sole.

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