Alaska
Fisheries Science
Center

National Marine
Fisheries Service

U.S DEPARTMENT OF COMMERCE

AFSC PROCESSED REPORT 2003-07

Food Habits of the Important Groundfishes in the Aleutian Islands in 1994 and 1997

June 2003

Notice to Users of this Document

In the process of scanning the original printed document into Adobe Acrobat .PDF format, slight differences in formatting can occur; page numbers in the .PDF may not match the original printed document, and some characters or symbols may not translate.

This document is being made available in .PDF format for the convenience of users; however, the accuracy and correctness of the document can only be certified as was presented in the original hard copy format.

Food Habits of the Important Groundfishes in the Aleutian Islands in 1994 and 1997

by

Mei-Sun Yang

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Fisheries Science Center
7600 Sand Point Way NE
Seattle WA 98115

June 2003

ABSTRACT

A total of 6,558 stomachs from 31 species were analyzed to describe the food habits of the major groundfish species in the Aleutian Islands area in 1994 and 1997. The analysis emphasized groundfish predation on commercially important fish, crab, and shrimp. The percent similarity index (PSI) was calculated to show the diet overlap between groundfish species in the Aleutian Islands area in 1994 and 1997. The sizes of prey fish and crab consumed by each predator species were studied.

Pacific cod, arrowtooth flounder, Pacific halibut, Greenland turbot, Alaska skate, white blotched skate, great sculpin, bigmouth sculpin, giant grenadier, and rougheye rockfish were the main piscivores. Walleye pollock, Atka mackerel, and myctophids were the dominant prey fish. The main predators that fed on Tanner crabs were Pacific halibut, Pacific cod, and great sculpin. Pacific cod, arrowtooth flounder, shortraker rockfish, rougheye rockfish, short spine thornyhead, Aleutian skate, Bering skate, and darkfin sculpin were the main consumers of pandalid shrimp. Atka mackerel, Pacific ocean perch, northern rockfish, walleye pollock, spectacled sculpin, and northern lampfish fed mainly on zooplankton (mainly euphausiids and calanoid copepods). Rock soles, mud skate, roughtail skate, Bering skate, and darkfin sculpin were benthic and epi-benthic feeders; they fed mainly on polychaetes and gammarid amphipods. Flathead sole was the brittle star feeder, though they also fed on miscellaneous shrimp and polychaetes. Prowfish fed on gelatinous prey such as jellyfish, ctenophores, and pelagic salps. Sablefish also fed on large amount of salps; however, they also fed on euphausiids and cephalopods.

CONTENTS

INTRODUCTION

In order to better understand the predator-prey relationships between the marine fishes in the Aleutian Islands area, and hence to understand the whole ecosystem and improve the fishery management in that area, the Resource Ecology and Ecosystem Modeling (REEM) task of the Resource Ecology and Fisheries Management (REFM) Division at the Alaska Fisheries Science Center (AFSC) started the first large-scale stomach sampling in 1991. The report of that study was published in 1996 (Yang).

During the 1994 and 1997 Aleutian Islands groundfish assessment survey, conducted by the Resource Assessment And Conservation Engineering (RACE) Division, we made the second and third large-scale stomach collections in the Aleutian Islands area. This report is the results of those two collections and is the extension of the earlier report (Yang 1996). This provides the updated food habits information of the marine fishes in the Aleutian Islands area and the data can be used for diet comparison, temporally.

This report contains not only the 13 commercially important species (as contained in 1996's report) like Pacific cod (*Gadus macrocephalus*); walleye pollock (*Theragra chalcogramma*); Pacific halibut (*Hippoglossus stenolepis*); arrowtooth flounder (*Atheresthes stomias*); Greenland turbot (*Reinhardtius hippoglossoides*); sablefish (*Anoplopoma fimbria*); Atka mackerel (*Pleurogrammus monopterygius);* Pacific ocean perch (*Sebastes alutus*); northern rockfish (*Sebastes polyspinis*); rougheye rockfish (*Sebastes aleutianus*); shortraker rockfish (*Sebastes borealis*); short spine thornyhead (*Sebastolobus alascanus*); rock sole (*Lepidopsetta* sp.); Flathead sole (*Hippoglossoides elassodon*); but also includes 18 non-commercially important species: Alaska skate (*Bathyraja parmifera*); Aleutian skate (*B. aleutica*); mud skate (*B. taranetzi*); white blotched skate (*B. maculata*); Bering skate (*B. interrupta*); roughtail skate (*B. trachura*); giant grenadier (*Coryphaenoides pectoralis*); spinyhead sculpin (*Dasycottus setiger*); great sculpin (*Myoxocephalus polyacanthocephalus*); big mouth sculpin (*Hemitripterus bolini*); spectacled sculpin (*Triglops scepticus*); darkfin sculpin (*Malacocottus zonurus*); northern lampfish (*Stenobrachius leucopsarus*); broken line myctophid (*Lampanyctus jordani*); sawback poacher (*Sarritor frenatus*);

searcher (*Bathymaster signatus*); and prowfish (*Zaprora silenus*).

METHODS

Study Area

In summer 1994 and 1997, scientists of the Resource Assessment and Conservation Engineering (RACE) Division at the Alaska Fisheries Science Center, Seattle, Washington, conducted groundfish resource surveys in the Aleutian Islands region. Those survey areas (Fig. 1) covered the southeastern Bering Sea from long. 165° W to 170° W and the Aleutian Islands waters from long. 170° W to 170° 30' E. Scientists from the Resource Ecology and Fishery Management (REFM) Division's Resource Ecology and Ecosystem Modeling Program collected fish stomach samples during this survey.

Sample Collection

REFM scientists aboard the charter vessels *Pacific Knight* in 1994 and *Dominator* in 1997 collected fish stomach samples. Both vessels used standard RACE Division poly-Nor'easter high opening bottom trawls rigged with rubber bobbin roller gear. Stomach samples were collected in the months between May and September and mainly during the time between 6 am and 6 pm Alaska Daylight Time.

Before excising a stomach, fish were examined for evidence of regurgitation or net feeding. If a fish had food in its mouth, around the gills, or if its stomach was inverted or flaccid, the fish was categorized as having regurgitated food, and the specimen was discarded. If a predator had fresh food (usually fish) sticking out of its mouth or throat, it was categorized as a net-feeding fish and was also discarded. When a sampled stomach was retained, it was put in a cloth stomach bag. A field tag with the species name, fork length (FL) of the fish, and haul data (vessel, cruise, haul number, specimen number) was also put in the bag. All of the samples collected were then preserved in buckets containing a 10% buffered formalin solution. When the samples arrived at the laboratory, the formalin was neutralized and they were transferred into a 70% ethanol solution before the stomach contents were analyzed.

Stomach Contents Analysis

In the laboratory, the stomach contents were first blotted with a paper towel and the wet weight was then recorded to the nearest one-tenth of a gram. After obtaining the total weight for a stomach's contents, the contents were placed in a Petri dish and examined under the microscope. Each prey item was classified to the lowest practical taxonomic level. The numbers of non-commercially important prey were not counted; instead the percent volume of these prey items was visually estimated. Prey weights and numbers of commercially important crabs and fish were recorded. If pollock otoliths were found, otolith lengths were measured and the Pollock's standard length (SL) was derived through an otolith length-fish length regression table (from REFM Age and Growth Task). Standard lengths of prey fish, carapace widths (CW) of Tanner crabs (*Chionoecetes bairdi*), snow *crabs (Chionoecetes opilio*) and Korean horse-hair crabs (*Erimacrus isenbeckii*) were also recorded.

Data Analysis

The general diet of each species was summarized by showing the overall mean percent frequency of occurrence, and the mean percent of the total weight of each prey item found in the stomach. Change in diet by predator size in terms of percent by weight of main prey items was identified by dividing predator size into 10-cm FL groups. The prey size frequency data of the commercially important fish and crabs were also summarized by different predator size groups.

The geographic distribution of the important prey consumed (expressed as percent by weight of the total stomach contents weight in each haul) by the predators were also shown. The important prey found in this study includes walleye pollock, Atka mackerel, capelin (*Mallotus villosus*), myctophids, Tanner crabs, Korean horse-hair crabs, and pandalid shrimp.

To compare the diet similarities between different sets of data, the percent similarity index (PSI) was calculated by using the proportions of the prey items found in the stomachs. The PSI is calculated as

$$PSI = \sum \text{(the smallest of } P_{xi} \text{ and } P_{yi)},$$

where P_{xi} and P_{yi} are the proportions by weight of prey i in the diets of species x and y, respectively.

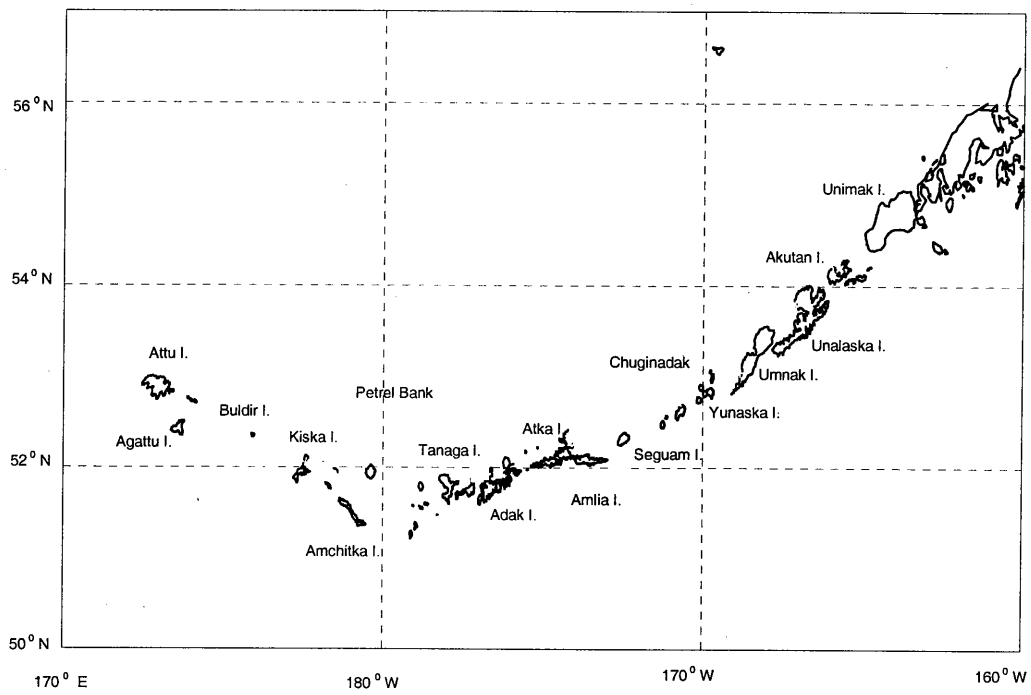

Figure 1-Study area for the stomach sampling in the Aleutian Islands area in 1994 and 1997.

RESULTS and DISCUSSION

Overview

The following species chapters summarize the consumption of commercially important prey by each major predator. Each species chapter is subdivided into subsections that provide information on general diet, effect of predator size, geographic distributions of prey, and commercially important prey size.

WALLEYE POLLOCK

Walleye pollock (*Theragra chalcogramma*) is the most abundant groundfish species in the Bering Sea and Aleutian Islands area. Based on the 2000 AFSC bottom trawl survey of the Aleutian Islands region, the projected 2002 exploitable biomass of walleye pollock was 106,000 metric tons (t) (NPFMC 2001). Food habits of pollock in the Aleutian Islands area has been studied by Yang (1996) and Simenstad et al. (1977). In those studies, euphausiids and myctophids were the most important prey of pollock. Other prey items included calanoid copepods, mysids, amphipods, shrimp, and miscellaneous fish.

RESULTS

General Diet

Walleye pollock fed mainly on zooplankton. Euphausiids and calanoid copepods were the most important food. In addition, amphipods, planktonic tunicates (larvaceans), shrimp, and chaetognaths were also frequently found. Tables 1 and 2 (for the years 1994, 1997, respectively) list the food items found in pollock stomachs, mean percentage of the prey weight to the total food weight, and the mean percentage of the frequency of occurrence of the prey. Total number of stomachs with food, the number of total empty stomachs, and the number of the hauls were also listed in Tables 1 and 2. Fish made up no more than 20% of the total stomach contents (by weight) in each of the two years sampled (Tables 1 and 2). Myctophids were the predominant prey fish consumed by pollock in this study. Other important prey fish of pollock included Atka mackerel, Pacific sand lance, bathylagids, zoarcids, and cottids. Calanoid copepods and

euphausiids were the most important invertebrate prey of walleye pollock.

The diets of walleye pollock for 1994 and 1997 were similar. In 1994, the diet included about 35% (by weight) calanoid copepods, 27% euphausiids, 5% shrimp, and 19% miscellaneous fish. Compared to 1994, the 1997 data showed a higher percentage of euphausiids (47% by weight) and smaller percentages of calanoid copepods (12%), miscellaneous fish (15%), and shrimp (only 2%) in walleye pollock stomach contents.

Variation of Diet Based on Predator Size

Figure 2 illustrates the main prey items of walleye pollock by predator fork length. In 1994, calanoid copepods comprised the largest portion of walleye pollock food and were consumed mainly by smaller (< 40 cm FL) pollock. Euphausiids comprised 17%-31% of pollock food through all size groups. Myctophids were important food item for pollock larger than 40 cm FL. They comprised 10%, 19%, and 29% of the pollock diet for the size groups of 40-49 cm, 50-59 cm, and $\geq$ 60 cm FL, respectively. Atka mackerel were consumed by pollock $\geq$ 30 cm. In 1997, euphausiids made up the largest portion of the diet in all but the smaller (< 30 cm FL) pollock size groups. High percentages of calanoid copepods (33%) were consumed by pollock less than 30 cm FL. In comparison to 1994, less myctophids were consumed and they were only consumed by larger pollock ($\geq$ 50 cm FL).

Geographic Distribution of the Prey Consumed

Figures 3 and 4 show the percentage by weight of myctophids consumed by walleye pollock in different locations in 1994 and 1997. Figure 3 illustrates that high percentages of myctophids were consumed around Yunaska Island and Tanaga Island in 1994. Figure 4 shows that large amounts of myctophids were also consumed in the Yunaska Island area in 1997.

Sizes of the Commercially Important Prey Consumed

Prey size data of walleye pollock were divided into two predator size groups (< 40 cm FL and $\geq$ 40 cm FL) for analysis. The size frequencies of myctophids consumed by walleye pollock is shown in Figure 5. It shows that, in

1994, walleye pollock less than 40 cm FL consumed smaller sized (< 50 mm SL) myctophids whereas larger pollock ($\geq$ 40 cm FL) consumed many larger (> 50 mm SL) myctophids. In 1997, only a few myctophids were consumed by pollock $\geq$ 40 cm FL. Walleye pollock also consumed Pacific cod, arrowtooth flounder, Greenland turbot, flathead sole, Dover sole, snailfish, stichaeids, eulachon, myctophids, zoarcids, and cottids. The number, mean standard length, the minimum and maximum sizes, and the standard deviation of these prey fish are listed in Tables 3 and 4.

Table 1.--Mean percent of frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of walleye pollock collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	1.43	0.25
Phyllodocidae (polychaete)	0.91	0.03
Tomopteridae (polychaete)	1.27	0.08
Nereidae (polychaete)	0.85	0.12
Flabelligeridae (polychaete)	0.16	<0.01
Gastropoda (snail)	0.15	0.01
Pteropoda (Thecosomata and Gymnosomata)	7.33	0.29
Gymnosomata (pteropod)	1.44	0.05
Cephalopoda (squid and octopus)	1.83	0.09
Teuthoidea (squid)	7.48	1.33
Octopoda (octopus)	0.20	<0.01
Ostracoda	0.15	<0.01
Calanoida (copepod)	72.99	34.82
Candacia columbiae (copepod)	0.15	0.01
Lophogastridae (mysid)	0.50	0.03
Gnathophausia sp.	0.49	0.01
Gnathophausia gigas (mysid)	1.48	0.08
Eucopiidae	4.80	0.38
Mysidacea Mysida (mysid)	6.33	1.24
Mysidae (mysid)	1.55	0.41
Cumacea (cumacean)	0.38	0.02
Isopoda (isopod)	0.28	0.04
Amphipoda (amphipod)	0.15	0.01
Gammaridea (amphipod)	12.79	2.17
Amphipoda Hyperiidea (amphipod)	0.15	0.01
Themisto sp. (amphipod)	27.26	1.31
Caprellidea (amphipod)	0.08	<0.01
Euphausiacea (euphausiid)	54.90	26.70
Euphausiidae (euphausiid)	0.16	0.02
Thysanoessa spinifera (euphausiid)	0.15	<0.01
Sergestidae (sergestid shrimp)	0.74	1.40
Caridea (shrimp)	9.78	1.09
Oplophoridae (shrimp)	1.41	0.14
Hymenodora frontalis (Pacific amber eye)	1.67	0.08
Pasiphaeidae (shrimp)	0.33	0.04
Hippolytidae (shrimp)	0.38	0.08
Pandalidae (shrimp)	2.24	1.91
Crangonidae (shrimp)	0.32	0.04
Natantia (shrimp)	0.61	0.03

Table 1.--Continued.

Name	%FO	%WT
Chaetognatha (arrow worm)	23.67	3.71
Larvacea Copelata	12.01	1.65
Gnathostomata	0.17	0.03
Osteichthyes Teleostei (fish)	4.44	1.53
Non-gadoid fish remains	0.44	0.05
Bathylagidae (deepsea smelts)	3.27	1.82
Cyclothone sp. (light fish)	0.31	0.01
Tactostoma macropus (longfin dragonfish)	0.19	0.47
Chauliodontidae (viperfishes)	0.52	0.99
Benthalbella dentata (northern pearl eye)	0.15	0.03
Myctophidae (lanternfish)	14.53	12.39
Lampanyctus jordani (broken line myctophid)	0.30	0.13
Stenobranchius nannochir (garnet myctophid)	0.30	0.07
Lycodapus fierasfer (black mouth eelpout)	0.17	0.02
Pleurogrammus monopterygius (Atka mackerel)	1.12	1.62
Cottoidei (Sculpin)	2.24	0.18
Cottidae (sculpin)	0.16	0.04
Fishery offal	0.67	0.91
Unidentified algae	0.23	0.02

Total nonempty stomachs = 571
Total prey weight = 3,304 g
Total empty stomachs = 94
Number of hauls = 45

Full stomach summary statistics
Average length = 42.3 cm
Standard deviation of length = 15.6
Minimum length = 14
Maximum length = 72

Empty stomach summary statistics
Average length = 40.0
Standard deviation of length = 17.4
Minimum length = 15
Maximum length = 68

Table 2.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of walleye pollock collected in the Aleutian Islands in 1997.

Prey name	%FO	%WT
Polychaeta (worm)	8.85	4.33
Polynoidae (polychaete)	1.01	0.44
Phyllodocidae (polychaete)	0.20	0.05
Opheliidae (polychaete)	0.15	0.00
Teuthoidea (squid)	3.17	2.21
Octopoda (octopus)	0.28	0.02
Crustacea	0.60	0.11
Ostracoda	0.13	0.00
Copepoda	13.29	4.56
Calanoida (copepod)	21.71	7.44
Candacia sp. (copepod)	0.28	0.00
Harpacticoida (copepod)	0.13	0.02
Gnathophausia sp.	2.32	0.05
Gnathophausia gigas (mysid)	0.13	0.00
Mysidacea Mysida (mysid)	0.26	0.12
Mysidae (mysid)	3.14	0.50
Cumacea (cumacean)	0.13	0.01
Gammaridea (amphipod)	11.05	3.61
Lysianassidae (amphipod)	0.31	0.06
Anonyx sp. (amphipod)	0.13	0.03
Amphipoda Hyperiidea (amphipod)	18.60	4.95
Euphausiacea (euphausiid)	0.32	0.26
Euphausiidae (euphausiid)	65.04	45.60
Euphausia pacifica (euphausiid)	0.98	0.66
Thysanoessa sp. (euphausiid)	0.13	0.00
Reptantia (crab)	0.27	0.00
Caridea (shrimp)	0.94	0.39
Pasiphaea sp. (glass shrimp)	0.13	0.02
Hippolytidae (shrimp)	0.13	0.21
Pandalidae (shrimp)	0.38	0.54
Pandalus sp. (shrimp)	0.33	0.07
Pandalus goniurus (shrimp)	0.13	0.10
Crangonidae (shrimp)	0.30	0.13
Crangon alaskensis (shrimp)	0.17	0.01
Chaetognatha (arrow worm)	5.30	1.46
Larvacea Copelata	15.16	5.97
Osteichthyes Teleostei (fish)	2.86	1.94
Non-gadoid fish remains	3.38	3.92
Osmeridae (smelts)	0.26	0.05

Table 2.--Continued.

Prey name	%FO	%WT
Leuroglossus sp.	0.13	0.10
Chauliodus macouni (Pacific viperfish)	0.50	1.29
Myctophidae (lanternfish)	6.11	5.83
Ammodytes sp. (sand lance)	1.30	2.41
Unidentified organic material	0.40	0.53

Total non-empty stomachs = 526
Total prey number = 33,795
Total prey weight = 1,933 g
Total empty stomachs = 62
Number of hauls = 50

Full stomach summary statistics
Average fork length = 45.0 cm
Standard deviation of length = 14.7
Minimum length = 14
Maximum length = 70

Empty stomach summary statistics
Average fork length = 145.4 cm
Standard deviation of length = 14.4
Minimum length = 13
Maximum length = 63

Table. 3--Mean standard length (SL), minimum size (Min), maximum size (Max), standard deviation (SD) of the standard length, and the number (N) of the measurable prey fish consumed by walleye pollock in the Aleutian Islands in 1994.

Prey name	Mean SL(mm)	Min (mm)	Max (mm)	SD(mm)	N
Bathylagidae	79.5	46.0	115.0	18.6	29
Lightfish	42.7	40.0	47.0	3.8	3
Longfin dragonfish	232.0				1
Chauliodontidae	143.5	102.0	185.0	58.7	2
Northern pearl eye	105.0				1
Myctophidae	62.8	14.0	133.0	24.0	201
Blackmouth eelpout	54.0				1
Atka mackerel	140.0	115.0	165.0	35.4	2
Cottid	19.3	11.0	47.0	7.3	18

Table. 4--Mean standard length (SL), minimum size (Min), Maximum size (Max), standard deviation (SD) of the standard length, and the number (N) of measurable prey fish consumed by walleye pollock in the Aleutian Islands in 1997.

Prey name	Mean SL(mm)	Min (mm)	Max (mm)	SD (mm)	N
Osmerid	46.5	42.3	50.6	5.9	2
Pacific viperfish	148.0				1
Myctophid	51.2	25.0	110.0	37.4	13
Pacific sand lance	87.1	56.1	120.6	25.5	12

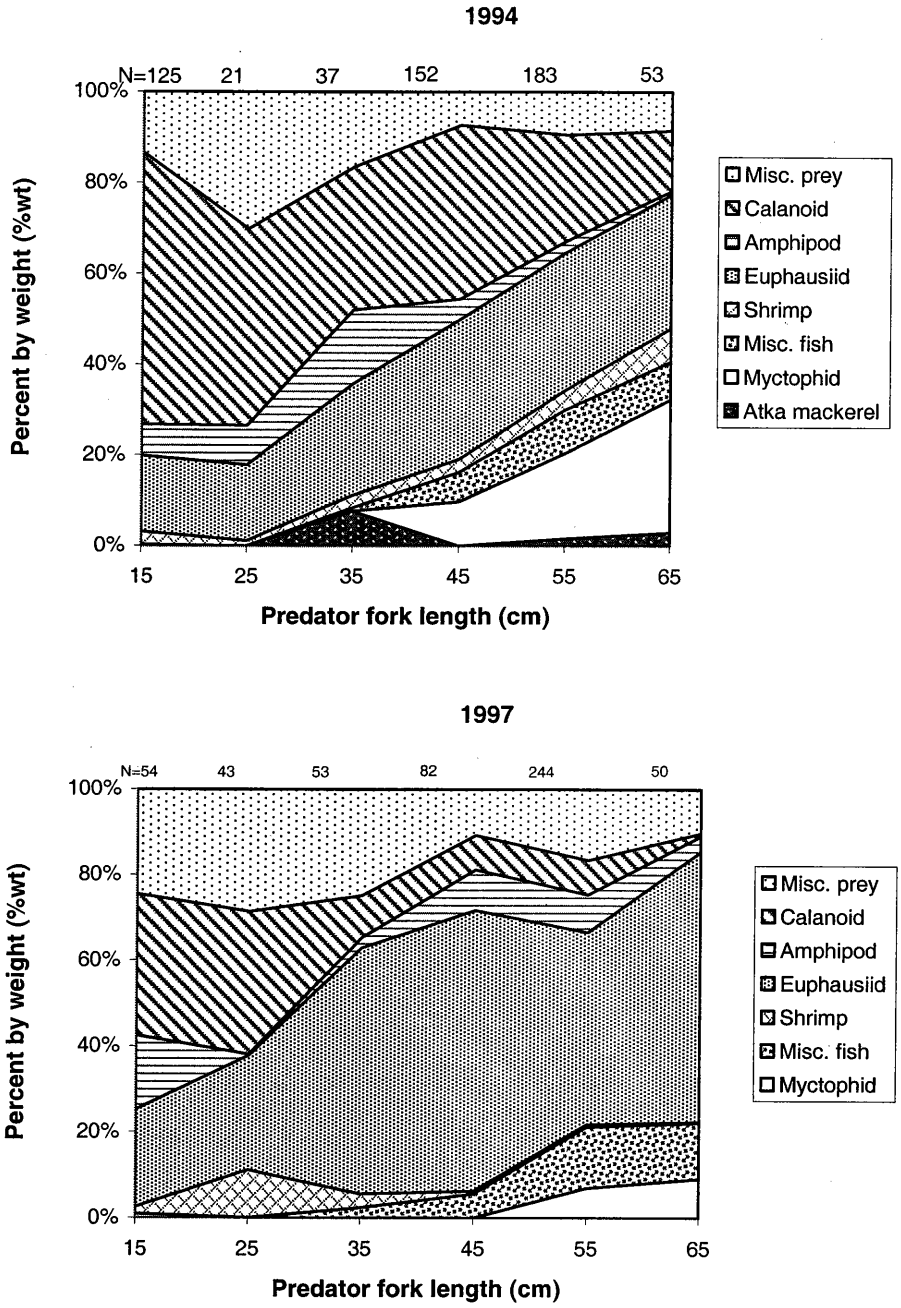

Figure 2.--Variations in the main prey of walleye pollock, by predator size, in the Aleutian Islands in 1994 and 1997.
N = number of stomachs containing food.

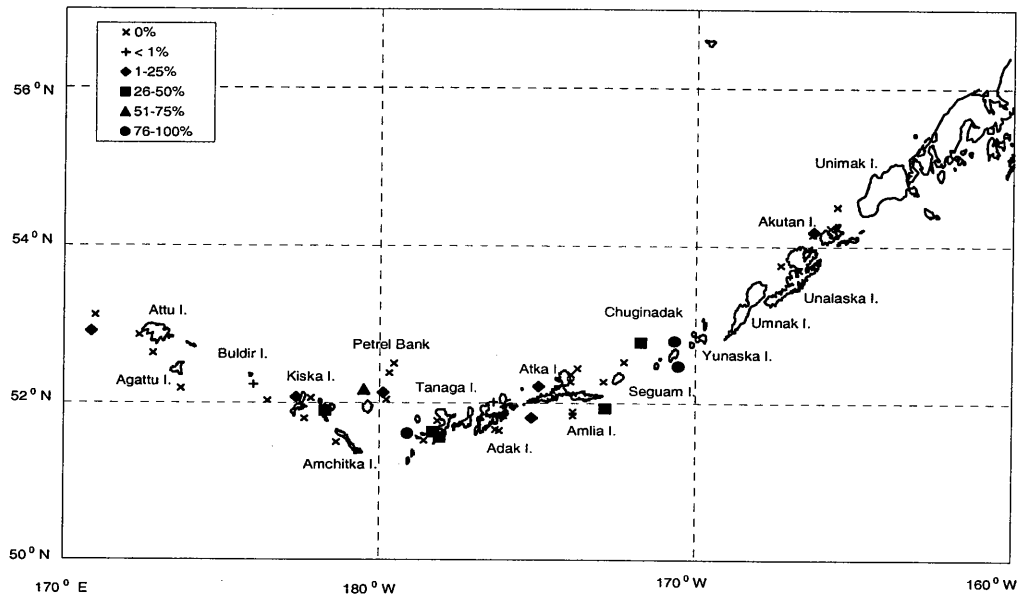

Figure 3.--Geographic distribution of myctophids consumed by walleye pollock in the Aleutian Islands area in 1994.

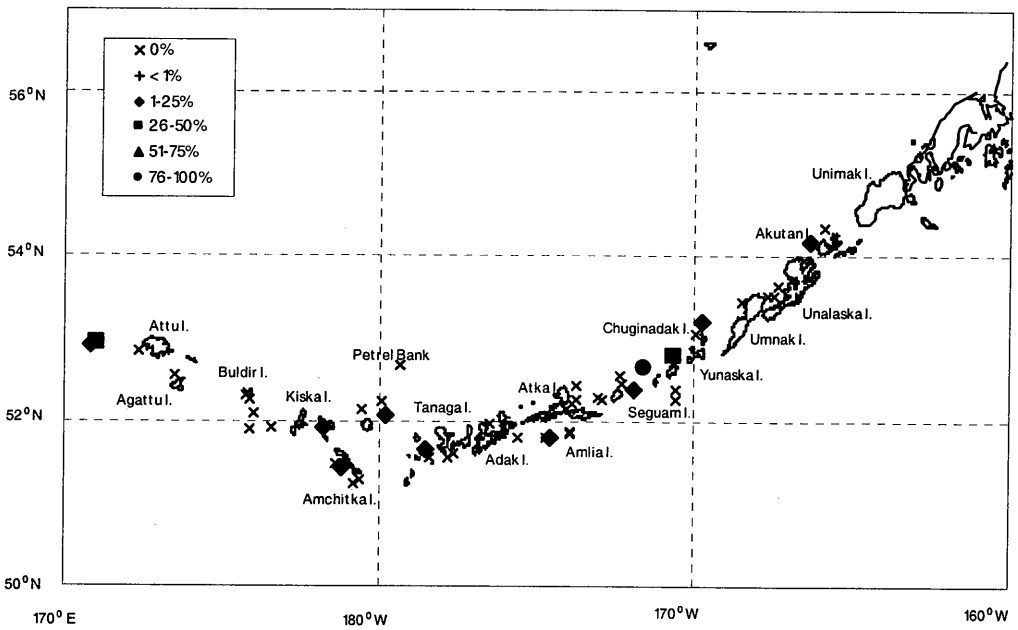

Figure 4.--Geographic distribution of myctophids consumption by w alleye pollock in the Aleutian Islands area in 1997.

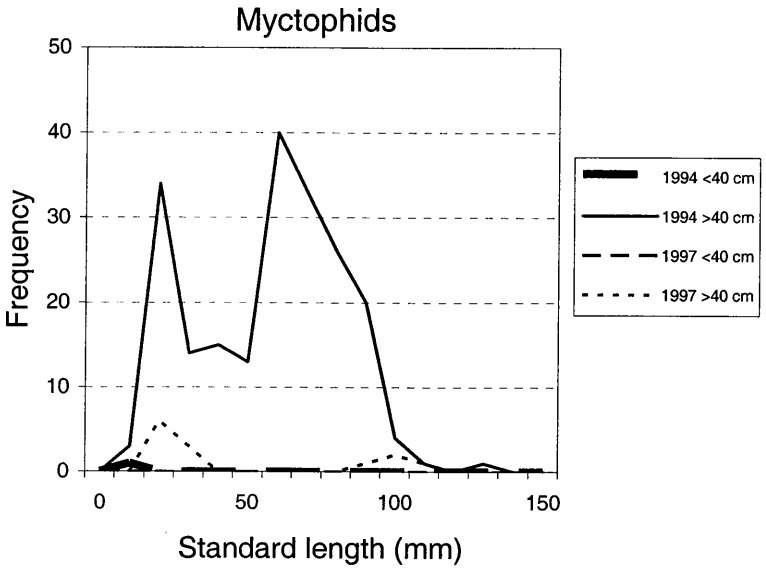

Figure 5.--Size frequency distribution of myctophids consumed by walleye pollock in the Aleutian Islands in 1994 and 1997.

DISCUSSION

The PSI value for diet of walleye pollock from 1997 compared to data on pollock diet from 1991 (Yang 1996) was 78%. Table 5 also shows the diet similarity for 1991, 1994, and 1997. The 1991 to 1997 PSI was higher than the other between year comparisons (Table 5). The higher consumption (35% by weight) of calanoid copepods in 1994 and higher consumption (47% by weight) of euphausiids in 1997 mainly caused the relatively low (57%) PSI between 1994 and 1997. Myctophids were the most important prey fish consumed by pollock in all years sampled (Table 5).

Table 5.--Percent weight of the major prey categories of walleye pollock in the Aleutian Islands area in 1991, 1994, and 1997.

Prey name	1991	1994	1997
Polychaete	1	1	5
Calanoid copepod	9	35	12
Amphipod	10	4	9
Euphausiids	44	27	47
Shrimp	7	5	2
Chaetognath	1	4	2
Larvacean	4	2	6
Myctophid	10	13	6
Pacific viperfish	1	1	1
Atka mackerel	0	2	0
Sculpins	1	1	0
Pacific sand lance	1	0	2

Percent similarity between 1991 and 1994 :61
Percent similarity between 1991 and 1997 :78
Percent similarity between 1994 and 1997 :57

PACIFIC COD

Pacific cod, *Gadus macrocephalus*, ranked seventh in the catch per unit effort (3,127 kg/km^2) for the total Aleutian Islands areas during the NMFS 1997 Aleutian Islands bottom trawl survey (Stark 1998). The exploitable biomass of Pacific cod in 2000 was 136,075 t (Thompson and Dorn, 2001). In general, Pacific cod feed both on the bottom and in the water column. Hence, their diets include many different fishes, crabs, shrimps, and other invertebrates (Yang 1996, Simenstad et al. 1977).

RESULTS

General Diet

Pacific cod is an opportunistic feeder. During this study, they fed both on the bottom and in the water column. Tables 6 and 7 (for the years 1994 and 1997, respectively) list the food items found in Pacific cod stomachs, mean percentage of the prey weight to the total food weight, and the mean percentage of the frequency of occurrence of the prey. Total number of stomachs with food, the number of total empty stomachs, and the number of the hauls were also listed in Tables 6 and 7. The percent by weight of fish consumed was 49% in 1994 and 51% in 1997 of the total stomach contents. Atka mackerel, walleye pollock, and sculpins were the most important prey fish consumed by Pacific cod. Pandalid shrimp, Tanner crab (*Chionoecetes bairdi*), and squid were the most important invertebrate prey.

The diet of Pacific cod in 1994 and 1997 was similar. In 1994, the diet consisted of 49% (by weight) of fish, 18% of shrimp, and 12% of crabs whereas the 1997 data was made up of 51% fish, 23% shrimp, and 6.3% crabs.

Variation of Diet Based on Predator Size

Figure 6 shows that Pacific cod consumed more fish with increasing cod size, especially for larger cod ($\geq$ 70 cm FL). The fish consumed comprised about 70% of the total stomach contents in this larger size group of Pacific cod for the two years. This group of large Pacific cod also consumed a large amount of walleye pollock (28% in 1994 and 16% in 1997). These large Pacific cod also consumed high percentages of Atka mackerel (25% in 1994 and 10% in 1997). Smaller size groups of Pacific cod (< 60 cm FL) consumed very small amounts of pollock

(< 3%) and Atka mackerel (< 4%). All but the largest size group in 1994 consumed a fair amount of shrimp (> 10%). Tanner crabs were mainly consumed by Pacific cod larger than 30 cm long. The smallest size group (< 20 cm FL) of cod ate primarily amphipods, cephalopod, and polychaetes which made up approximately 47% of their diet.

Geographic Distributions of the Prey Consumed

Figures 7 - 18 illustrate the geographic distributions of the important prey (percent by weight) consumed by Pacific cod in 1994 and 1997. Figures 7 and 8 show that consumption of walleye pollock by Pacific cod was mainly in the area around Akutan Island, Unalaska Island, and Unimak Island. The amounts of Atka mackerel consumed by Pacific cod were similar in 1994 and 1997. They were consumed mainly around Kiska Island, Attu Island, and Amchitka Island (Figs. 9 and 10). Figures 11 and 12 show that myctophids were mainly consumed in the area around Seguam Island, Atka Island, Adak Island, and Tanaga Island. Pandalid shrimp consumption was widespread in all the areas sampled although the highest percentages (> 75%) by weight of pandalid shrimp in stomach contents seemed to be focused west of Tanaga Island in 1997 (Figs. 13 and 14). Tanner crab consumption was mainly around Atka Island and Amlia Island area and around Unalaska and Akutan area in 1994, whereas Tanner crabs consumption by Pacific cod in 1997 was mainly around Unalaska Island and Umnak Island. Figures 17 and 18 show that Korean horse-hair crabs were consumed by Pacific cod mainly in the area around Kiska Island, Agattu Island, and Attu Island.

Sizes of the Commercially Important Prey Consumed

The commercially important prey consumed by Pacific cod were analyzed by two predator size groups: small (< 60 cm) and large ($\geq$ 60 cm FL) (Figs. 19 - 24). In 1994 and 1997, walleye pollock were only found in the stomachs of large Pacific cod. Examination of Figure 19 suggests that the walleye pollock consumed by large Pacific cod were age-0 (< 140 mm SL), age-1 (140 - 222 mm SL), age-2 (223 - 296 mm SL), and age-3+ ($\geq$ 297 mm SL) walleye pollock. The mean standard length ($\pm$SD) of pollock consumed by Pacific cod was 370.4 $\pm$ 52.3 mm with a range from 262 to 468 mm SL in 1994, and 256.3 $\pm$ 179.9 mm with a range from 61 to 523 mm SL in 1997. The length distributions of Atka mackerel consumed by Pacific cod is shown in Figure 20. The mean standard length ($\pm$SD) of Atka mackerel consumed by Pacific cod was 221.7 $\pm$ 55.5 mm, with a range from 145 to 350 mm SL in 1994, and 181.3 $\pm$ 41.8 mm, with a range from 137 to 235 mm SL in 1997.

The mean standard length (±SD) of myctophids consumed by Pacific cod in 1994 was 58.2 ± 18.8 mm with a range between 37 to 128 mm, and 54.4 ± 24.4 mm with a range from 25 to 105 mm in 1997 (Fig. 21). The mean standard length (±SD) of Pacific sand lance consumed by Pacific cod was 143.8 ± 26.3 mm with a range between 100 and 170 mm in 1994, and was 154.7 ± 36.8 mm with a range between 115 and 240 mm in 1997. The mean carapace width (±SD) of Tanner crab consumed in 1994 was 19.5 ± 9.7 mm with a range from 7 to 57 mm SL, and the mean for that in 1997 was 20.2 ± 7.0 mm with a range from 8 to 40 mm (Fig. 23). Large numbers of Tanner crabs were consumed by Pacific cod less than 60 cm FL in 1994. Most of the Tanner crabs measured from Pacific cod stomach contents were age-0 and age-1 crab (< 36 mm CW). The mean carapace width (±SD) of Korean horse-hair crabs consumed by Pacific cod in 1994 was 40.4 ± 12.0 mm with a range from 24 to 54 mm, and was 30.7 ± 13.0 mm with a range from 11 to 49 mm in 1997. Pacific cod also consumed Pacific halibut, northern rock sole, pricklebacks, poachers, and sculpins. The number, mean standard length, standard deviation and range of these fish are listed in Table 8 (for year 1994) and Table 9 (for year 1997).

Table 6.--Mean percent frequency of occurrence (%FO), and mean percent weight (%WT) of the prey items in the diet of Pacific cod collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	34.97	3.42
Gastropoda (snail)	3.33	0.22
Bivalvia (clam)	0.19	0.02
Pectinidae (scallops)	0.21	0.00
Cephalopoda (squid and octopus)	8.31	0.63
Teuthoidea (squid)	13.61	9.85
Octopoda (octopus)	4.42	0.53
Calanoida (copepod)	5.63	0.83
Mysidacea Mysida (mysid)	0.64	0.01
Mysidae (mysid)	3.60	1.00
Cumacea (cumacean)	0.18	0.00
Isopoda (isopod)	4.77	0.12
Arcturidae	0.83	0.08
Amphipoda (amphipod)	1.25	0.80
Gammaridea (amphipod)	45.21	3.85
Caprellidea (amphipod)	0.25	0.00
Euphausiacea (euphausiid)	4.96	0.45
Sergestidae (sergestid shrimp)	0.17	0.00
Reptantia (crab)	0.57	0.09
Caridea (shrimp)	11.68	2.65
Hippolytidae (shrimp)	21.59	2.27
Lebbeus groenlandicus (shrimp)	0.35	0.09
Pandalidae (shrimp)	33.48	10.64
Crangonidae (shrimp)	15.58	1.78
Argis sp. (shrimp)	0.18	0.13
Paguridae (hermit crab)	5.88	1.55
Majidae (spider crab)	0.21	0.01
Oregonia sp. (decorator crab)	0.73	0.19
Hyas sp. (lyre crab)	4.31	0.95
Hyas lyratus (lyre crab)	0.25	0.05
Chionoecetes sp. (snow and Tanner crab)	0.44	0.16
Chionoecetes bairdi (Tanner crab)	17.91	7.66
Erimacrus isenbeckii (Korean horse-hair crab)	1.69	0.94
Pinnotheridae (pea crab)	0.37	0.01
Pinnixa sp. (pea crab)	0.35	0.03
Sipuncula (marine worm)	0.19	0.01
Echiura (marine worm)	0.18	0.00
Ectoprocta (bryozoan)	0.25	0.00
Ophiuroidae Ophiurida (brittle star)	0.38	0.03

Table 6.--Continued.

Name	%FO	%WT
Chaetognatha (arrow worm)	0.25	0.00
Larvacea Copelata	0.21	0.03
Lamptera sp. (lamprey)	0.19	0.08
Osteichthyes Teleostei (fish)	5.08	0.24
Non-gadoid Fish Remains	1.65	0.13
Clupea pallasi (Pacific herring)	0.25	0.05
Mallotus villosus (capelin)	0.25	0.04
Chauliodus macouni (Pacific viperfish)	0.17	0.04
Myctophidae (lanternfish)	7.13	2.59
Gadus macrocephalus (Pacific cod)	0.21	0.03
Theragra chalcogramma (walleye pollock)	8.30	12.86
Zoarcidae (eelpout)	1.41	0.15
Gymnelis rotordorsalis (Aurora eelpout)	2.25	1.10
Sebastes sp. (rockfish)	0.17	0.47
Sebastes alutus (Pacific ocean perch)	0.17	0.32
Pleurogrammus monopterygius (Atka mackerel)	11.76	17.80
Anoplopoma fimbria (sablefish)	0.17	0.02
Cottoidei (Sculpin)	9.94	3.87
Icelus spiniger (thorny sculpin)	0.25	0.05
Cottidae (sculpin)	14.85	3.42
Artediellus sp. (sculpin)	0.18	0.02
Triglops sp. (sculpin)	0.72	0.61
Triglops scepticus (spectacled sculpin)	0.60	1.34
Agonidae (poacher)	0.43	0.03
Anoplagonus inermis (Smooth alligatorfish)	0.25	0.04
Cyclopteridae (snailfish)	1.65	0.24
Bathymaster signatus (searcher)	0.82	0.98
Stichaeidae (prickleback)	1.34	0.63
Cryptacanthodes aleutensis (dwarf wrymouth)	0.89	0.26
Ammodytes hexapterus (Pacific sand lance)	1.31	0.20
Pleuronectidae (flatfish)	0.52	0.20
Atheresthes stomias (arrowtooth flounder)	0.25	0.09
Lepidopsetta sp. (rock sole type)	0.69	0.20
Hippoglossus stenolepis (Pacific halibut)	0.17	0.02
Unidentified worm-like organism	0.69	0.33
Fishery offal	1.41	0.46
Unidentified material	0.28	0.02

Table 6.--Continued.

Total non-empty stomachs = 500
Total prey weight = 24,960 g
Total empty stomachs = 19
Number of hauls = 40

Full stomach summary statistics
Average fork length = 53.9 cm
Standard deviation of length = 19.4 cm
Minimum length = 13 cm
Maximum length = 108 cm

Empty stomach summary statistics
Average fork length = 49.5 cm
Standard deviation of length = 21.5 cm
Minimum length = 18 cm
Maximum length = 81 cm

Table 7.--Mean percent frequency of occurrence (%FO), and mean percent weight (%WT) of the prey items in the diet of Pacific cod collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Porifera (sponge)	1.81	0.52
Scyphozoa (jellyfish)	0.12	0.01
Polychaeta (worm)	18.05	2.03
Phyllodocidae (polychaete)	0.54	0.01
Nephtyidae (polychaete)	1.91	1.70
Opheliidae (polychaete)	0.11	0.00
Hirudinea (leech)	0.45	0.05
Mollusca	0.11	0.00
Gastropoda (snail)	2.63	1.46
Bivalvia (clam)	0.64	0.04
Cephalopoda (squid and octopus)	0.70	0.03
Teuthoidea (squid)	17.28	3.20
Octopoda (octopus)	1.97	0.74
Calanoida (copepod)	0.11	0.00
Candacia sp. (copepod)	0.21	0.00
Peracarida Mysidacea (mysid)	0.59	0.00
Mysidae (mysid)	0.15	0.00
Cumacea (cumacean)	0.22	0.00
Isopoda (isopod)	2.77	0.05
Gammaridea (amphipod)	18.39	1.96
Ampeliscidae (amphipod)	0.22	0.01
Anonyx sp. (amphipod)	9.66	0.49
Themisto sp. (amphipod)	0.26	0.00
Euphausiacea (euphausiid)	0.37	0.02
Euphausiidae (euphausiid)	5.07	1.31
Thysanoessa sp. (euphausiid)	0.85	0.17
Reptantia (crab)	5.04	1.83
Caridea (shrimp)	41.54	12.45
Hippolytidae (shrimp)	11.38	1.91
Spirontocaris ochotensis (shrimp)	3.29	0.41
Lebbeus groenlandicus (shrimp)	1.77	0.68
Pandalidae (shrimp)	11.62	3.86
Pandalus sp. (shrimp)	6.46	3.16
Pandalus goniurus (shrimp)	0.23	0.17
Crangonidae (shrimp)	2.92	0.31
Crangon sp. (shrimp)	1.23	0.21
Crangon communis (shrimp)	0.19	0.00
Argis sp. (shrimp)	0.23	0.02
Paguridae (hermit crab)	1.98	0.71

Table 7.--Continued.

Name	%FO	%WT
Placetron wosnessenskii (scale crab)	0.14	0.19
Munida quadrispina (pinch bug)	0.59	0.03
Majidae (spider crab)	0.11	0.00
Oregonia sp. (decorator crab)	0.15	0.01
Hyas sp. (lyre crab)	0.24	0.05
Hyas lyratus (lyre crab)	2.78	1.32
Chionoecetes sp. (snow and Tanner crab)	1.40	0.33
Chionoecetes opilio (snow crab)	0.15	0.10
Chionoecetes bairdi (Tanner crab)	3.31	1.29
Erimacrus isenbeckii (Korean horse-hair crab)	1.97	2.27
Sipuncula (marine worm)	0.15	0.02
Echiura (marine worm)	0.28	0.66
Ectoprocta (bryozoan)	0.40	0.02
Ophiuridae (brittle star)	0.40	0.01
Echinacea sp. (sea urchin)	0.41	0.04
Urochordata (tunicate)	0.82	0.26
Boltenia sp. (sea onion)	0.80	0.03
Thaliacea (pelagic salp)	0.26	0.01
Rajidae (skate)	0.15	0.10
Osteichthyes Teleostei (fish)	19.04	5.90
Non-gadoid fish remains	16.04	6.36
Fish eggs	0.14	0.00
Clupeidae	0.14	1.07
Clupea pallasi (Pacific herring)	0.25	1.05
Bathylagus stilbius (California smoothtongue)	0.12	0.30
Leuroglossus schmidti (northern smoothtongue)	0.85	0.92
Chauliodus macouni (Pacific viperfish)	0.34	0.06
Paralepididae (barracudina)	0.42	0.18
Myctophidae (lanternfish)	4.39	1.11
Gadidae (gadid fish)	1.17	0.85
Theragra chalcogramma (walleye pollock)	3.09	6.45
Zoarcidae (eelpout)	1.07	1.13
Cololabis saira (Pacific saury)	0.42	0.10
Scorpaeniformes (rockfish and cottid)	0.21	0.12
Scorpaenidae	0.15	0.01
Sebastes sp. (rockfish)	1.67	4.05
Pleurogrammus monopterygius (Atka mackerel)	3.29	7.50
Anoplopoma fimbria (sablefish)	0.11	0.24
Cottoidei (sculpin)	19.57	9.36
Icelus sp. (sculpin)	0.34	0.09

Table 7.--Continued.

Name	%FO	%WT
Icelus spiniger (thorny sculpin)	0.52	0.32
Artediellus sp. (sculpin)	2.09	1.03
Artediellus pacificus (Pacific hookear)	0.12	0.10
Hemilepidotus sp. (sculpin)	0.56	1.17
Malacocottus zonurus (darkfin sculpin)	0.23	0.32
Triglops sp. (sculpin)	0.12	0.00
Agonidae (poacher)	0.14	0.04
Stichaeidae (prickleback)	1.83	0.63
Lumpenella longirostris	0.11	0.01
Poroclinus rothrocki (whitebarred prickleback)	0.15	0.03
Ammodytes sp. (sand lance)	0.15	0.06
Ammodytes hexapterus (Pacific sand lance)	1.95	2.04
Pleuronectidae (flatfish)	0.86	0.19
Unidentified organic material	1.68	0.41
Unidentified eggs	1.00	0.40
Fishery offal	0.25	0.15
Unidentified tube	0.36	0.00
Overboard material (non-fishery)	0.11	0.01

Total non-empty stomachs = 542
Total prey number = 2,575
Total prey weight = 17,802g
Total empty stomachs = 21
Number of hauls = 59

Full stomach summary statistics
Average fork length =60.7 cm
Standard deviation of length = 19.8 cm
Minimum length = 18 cm
Maximum length = 361 cm

Empty stomach summary statistics
Average fork length = 66.3 cm
Standard deviation of length = 14.1 cm
Minimum length = 43 cm
Maximum length = 99 cm

Table 8.--Mean standard length (SL), standard deviation (SD), and range of standard length of the miscellaneous prey fish consumed by Pacific cod in the Aleutian Island in 1994. N = number of measurable prey.

Prey name	N	Mean SL (mm)	SD (mm)	Range(mm)
Lamprey	1	370.0	0.0	370-370
Capelin	1	68.0	0.0	68-68
Pacific viperfish	1	200.0	0.0	200-200
Pacific cod	1	46.0	0.0	46-46
Eelpout	23	63.3	19.0	27-100
Sculpin	65	67.4	41.3	28-210
Poacher	3	122.7	30.4	90-150
Snailfish	8	45.3	18.6	16-70
Searcher	3	153.0	46.8	99-180
Prickleback	21	93.6	56.7	34-195
Arrowtooth flounder	1	68.0	0.0	68-68
Northern rock sole	3	49.7	6.4	45-57
Pacific halibut	1	65.0	0.0	65-65

Table 9.--Mean standard length (SL), standard deviation (SD), and range of standard length of the miscellaneous prey fish consumed by Pacific cod in the Aleutian Island in 1997. N = number of measurable prey.

Prey name	N	Mean SL (mm)	SD (mm)	Range(mm)
Clupeidae	1	340.0	0.0	340-340
Bathylagidae	53	108.7	13.3	89-150
Paralepididae	1	240.0	0.0	240-240
Zoarcidae	1	170.0	0.0	170-170
Pacific saury	1	145.0	0.0	145-145
Sculpin	63	86.0	41.2	12-220
Sebastes sp.	6	250.0	137.8	98-450
Agonidae	1	140.0	0.0	140-140
Stichaeidae	12	89.1	35.7	51-160

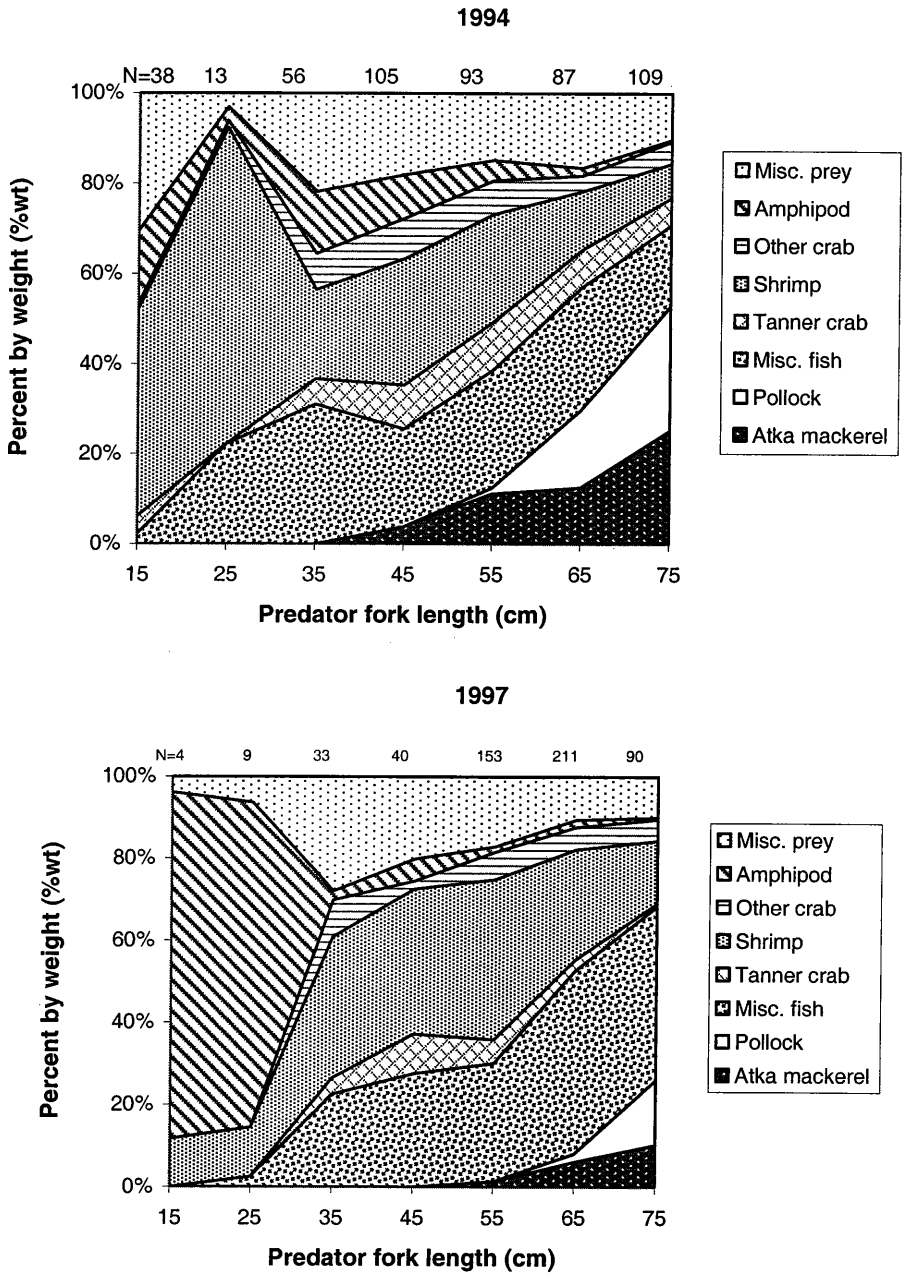

Figure 6.--Variations in the main prey of Pacific cod, by predator size, in the Aleutian Islands in 1994 and 1997.
N = number of stomachs containing food.

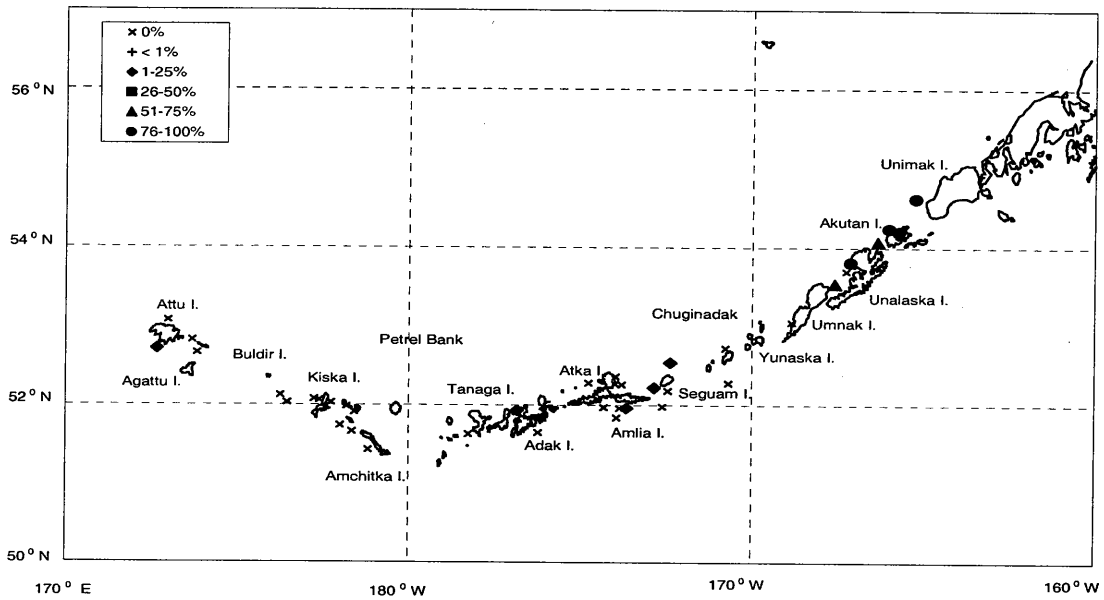

Figure 7.--Geographic distribution of walleye pollock consumed by Pacific cod in the Aleutian Islands area in 1994.

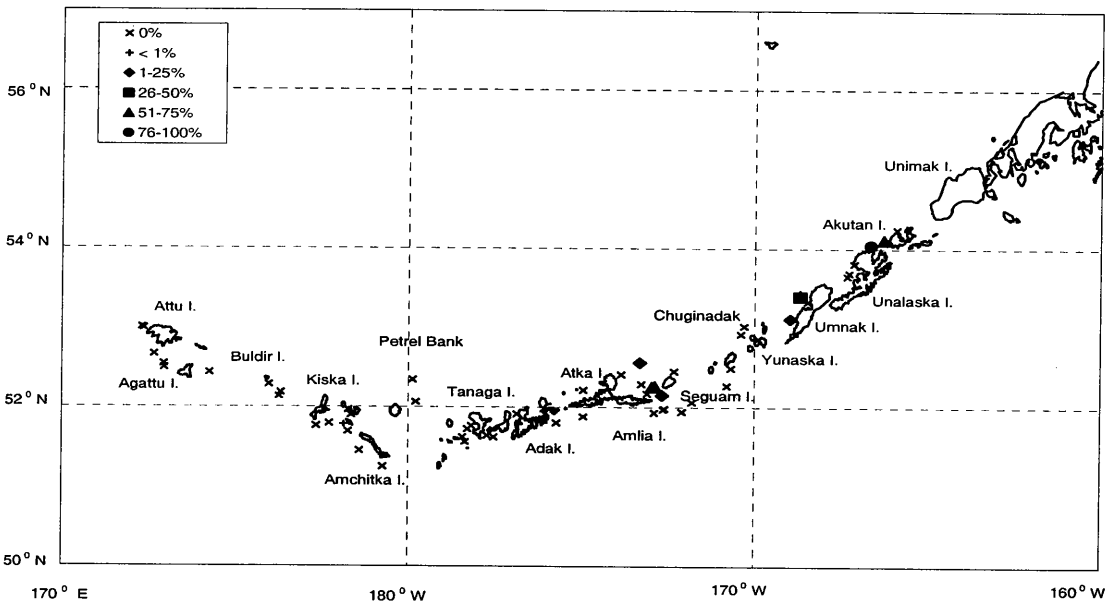

Figure 8.--Geographic distribution of walleye pollock consumed by Pacific cod in the Aleutian Islands area in 1997.

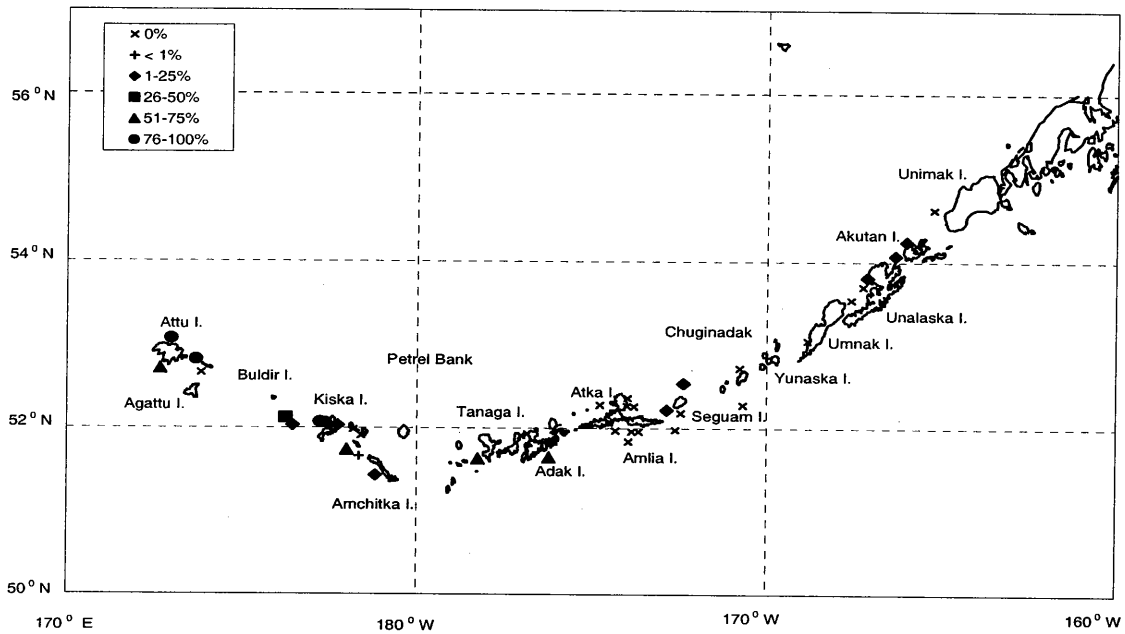

Figure 9.--Geographic distribution of Atka mackerel consumed by Pacific cod in the Aleutian Islands area in 1994.

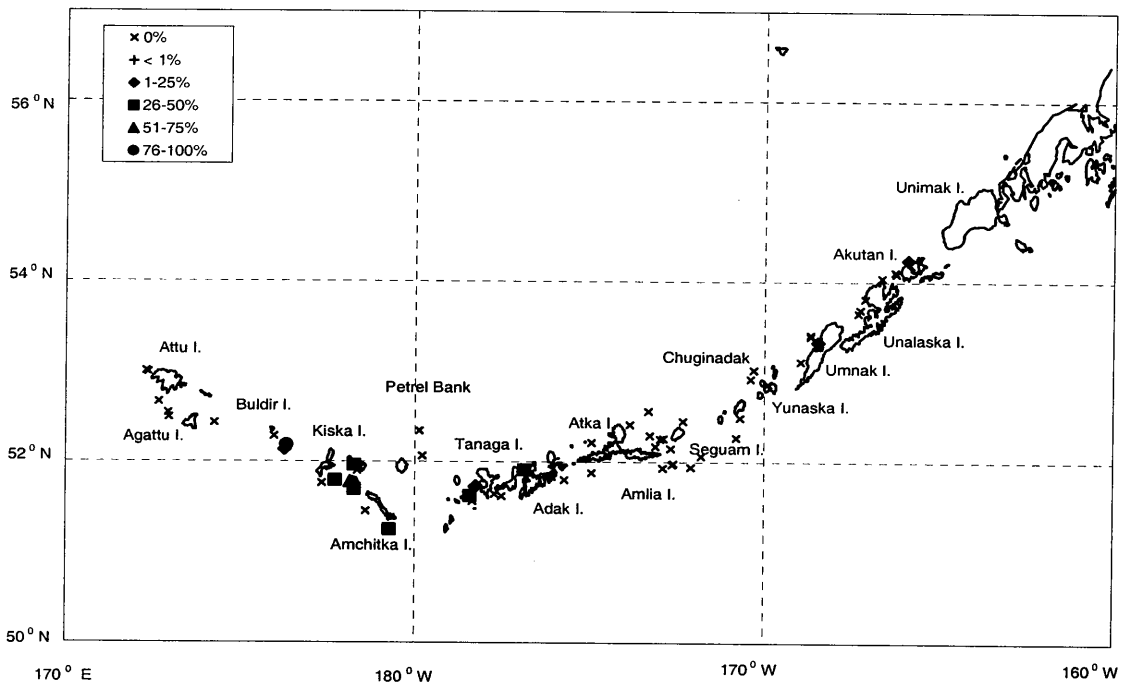

Figure 10.--Geographic distribution of Atka mackerel consumed by Pacific cod in the Aleutian Islands area in 1997.

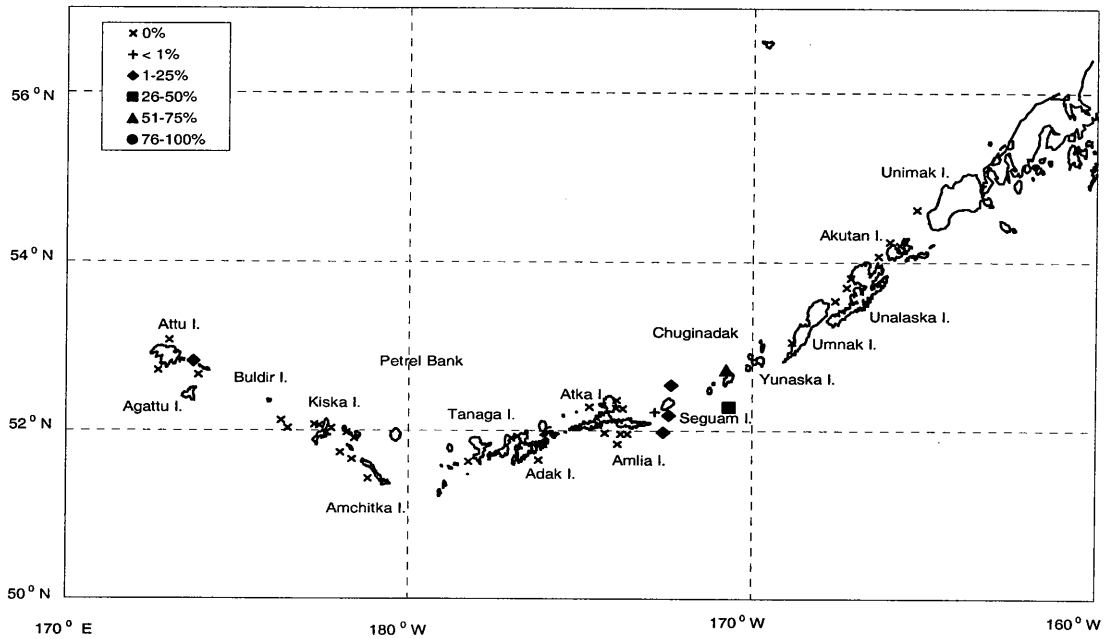

Figure 11.--Geographic distribution of myctophids consumed by Pacific cod in the Aleutian Islands area in 1994.

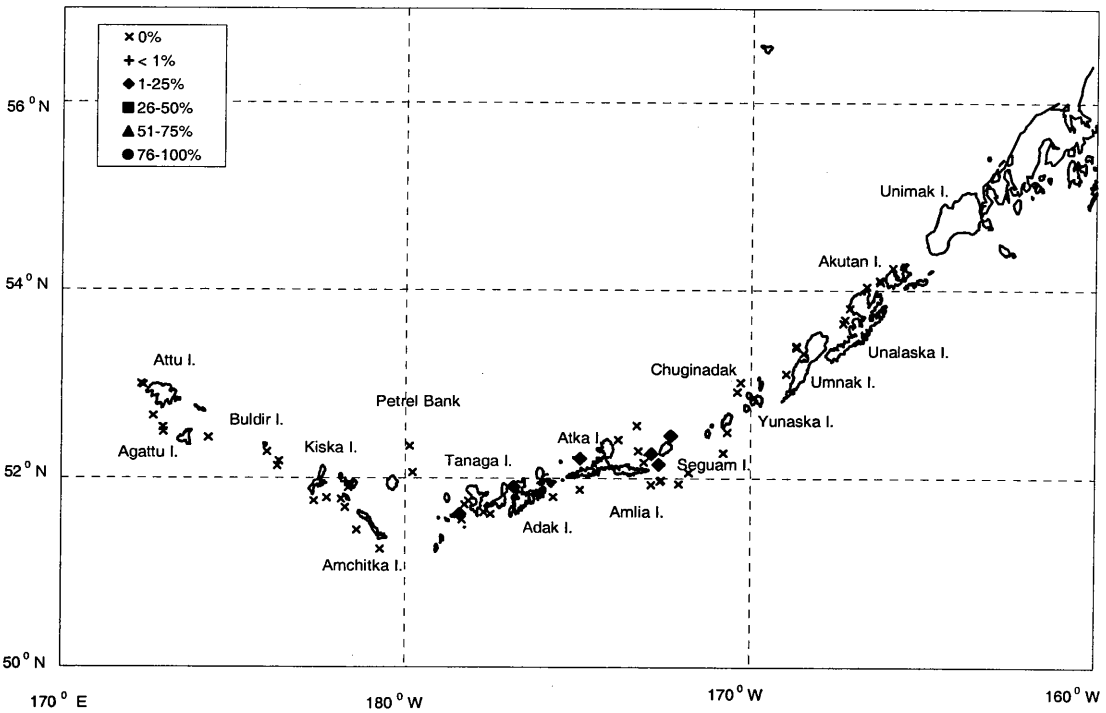

Figure 12.--Geographic distribution of myctophids consumed by Pacific cod in the Aleutian Islands area in 1997.

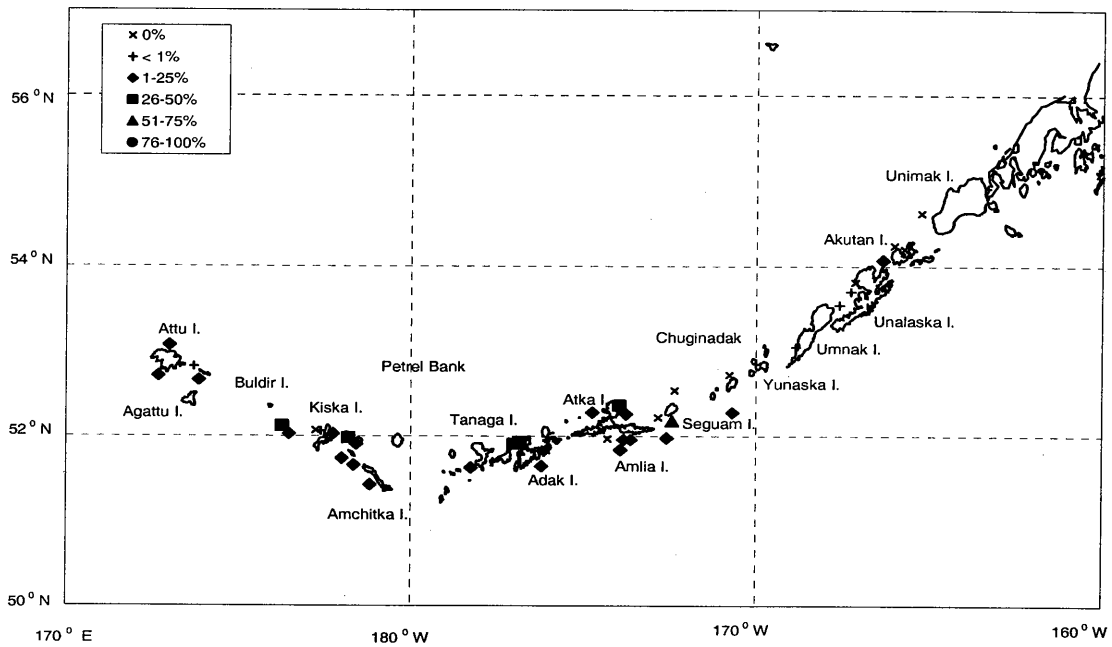

Figure 13.--Geographic distribution of pandalid shrimp consumed by Pacific cod in the Aleutian Islands area in 1994.

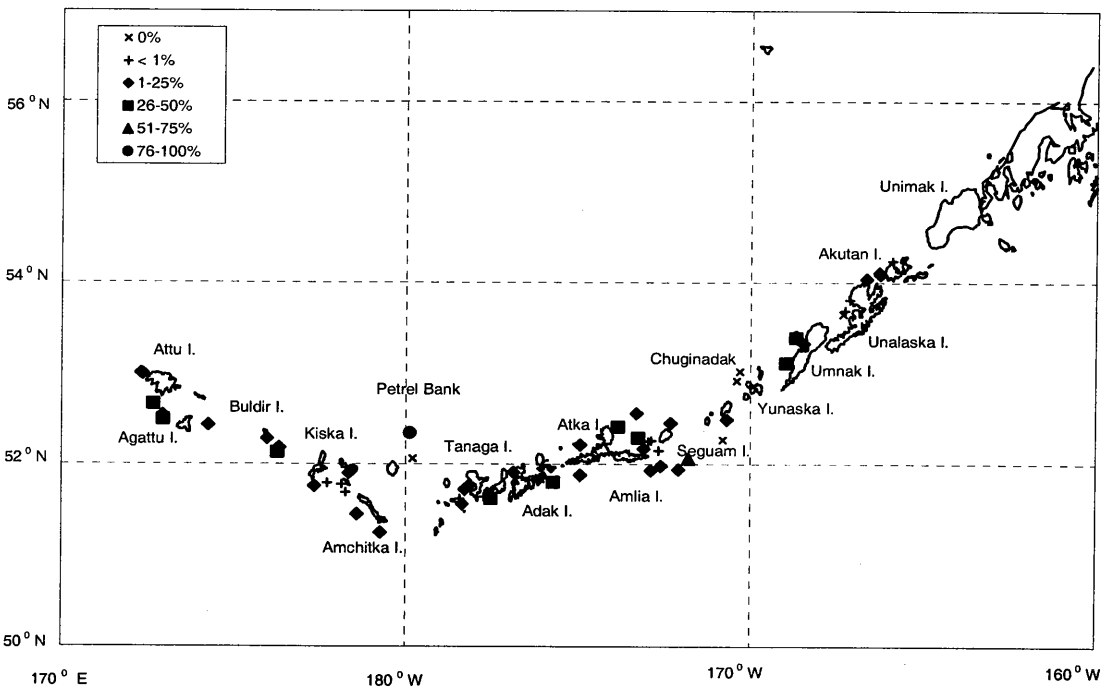

Figure 14.--Geographic distribution of pandalid shrimp consumed by Pacific cod in the Aleutian Islands area in 1997.

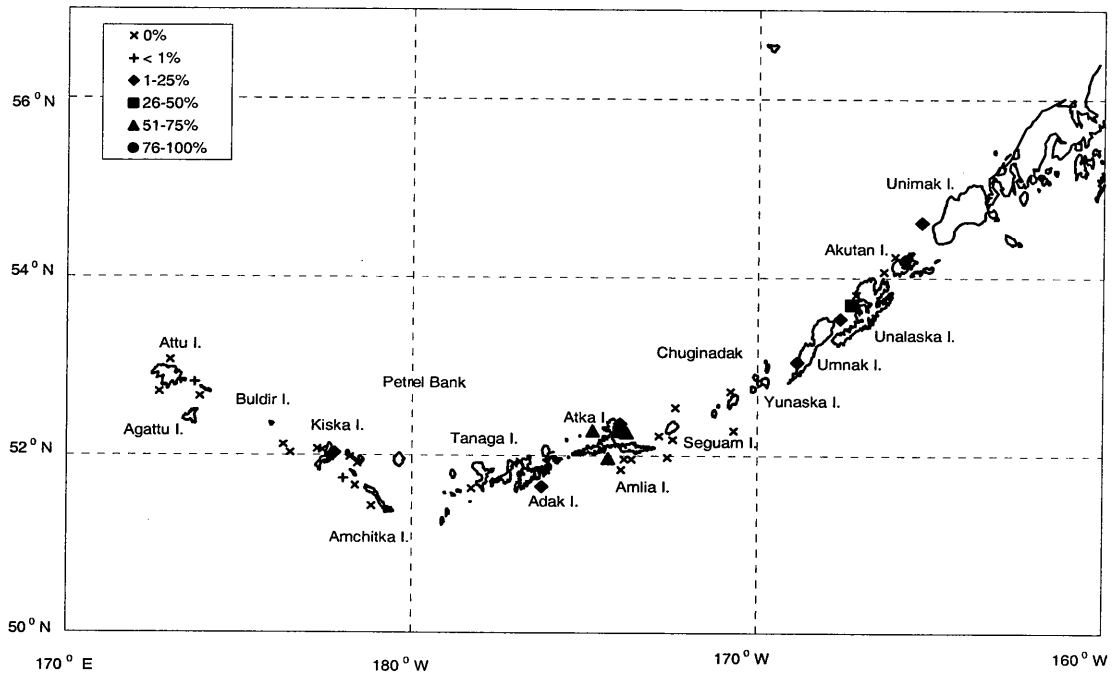

Figure 15.--Geographic distribution of Tanner crabs consumed by Pacific cod in the Aleutian Islands area in 1994.

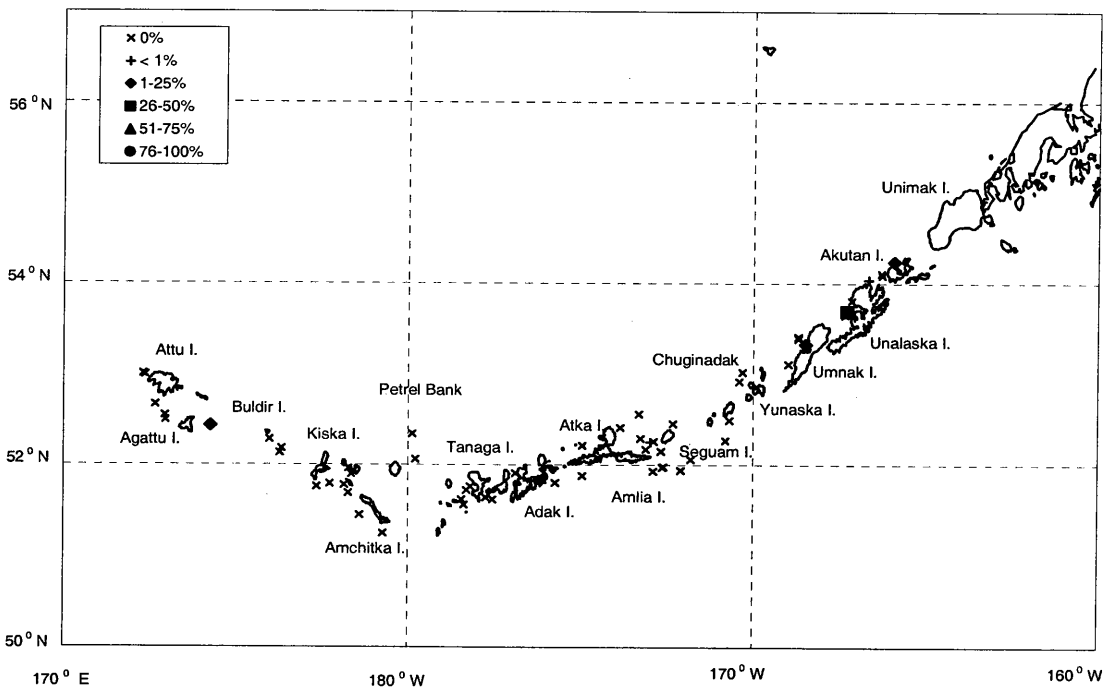

Figure16.--Geographic distribution of Tanner crabs consumed by Pacific cod in the Aleutian Islands area in 1997.

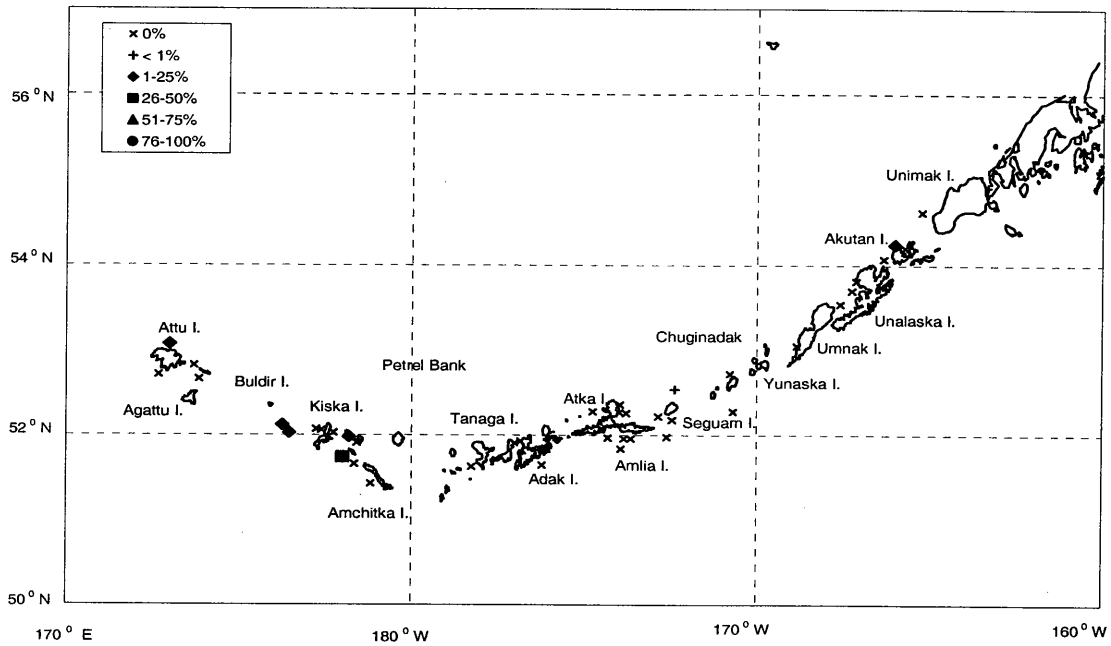

Figure 17.--Geographic distribution of Korean horse-hair crabs consumed by Pacific cod in the Aleutian Islands area in 1994.

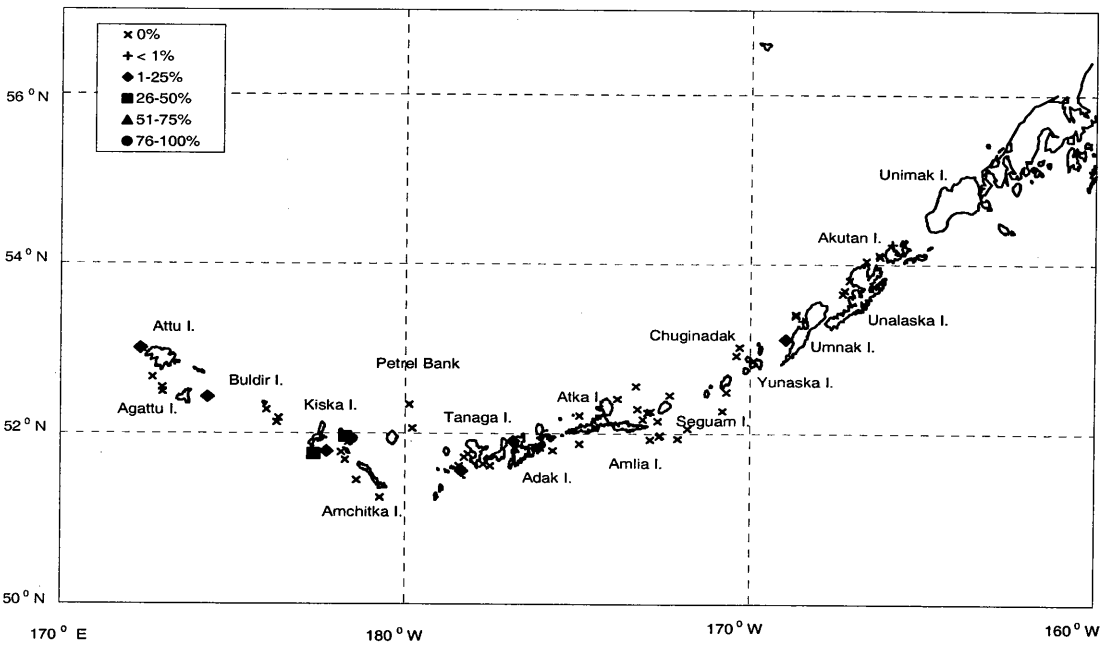

Figure 18.--Geographic distribution of Korean horse-hair crabs consumed by Pacific cod in the Aleutian Islands area in 1997.

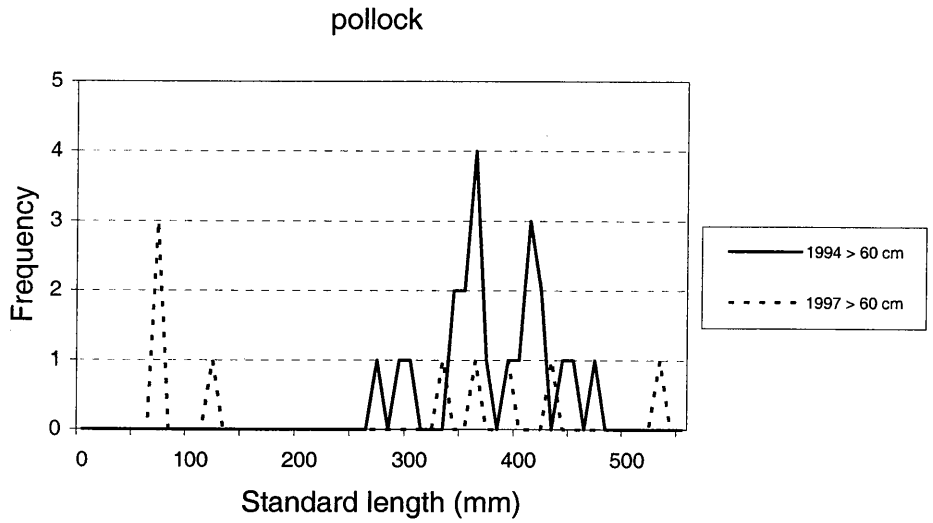

Figure 19.--Size frequency distribution of pollock consumed by Pacific cod in the Aleutian Islands in 1994 and 1997.

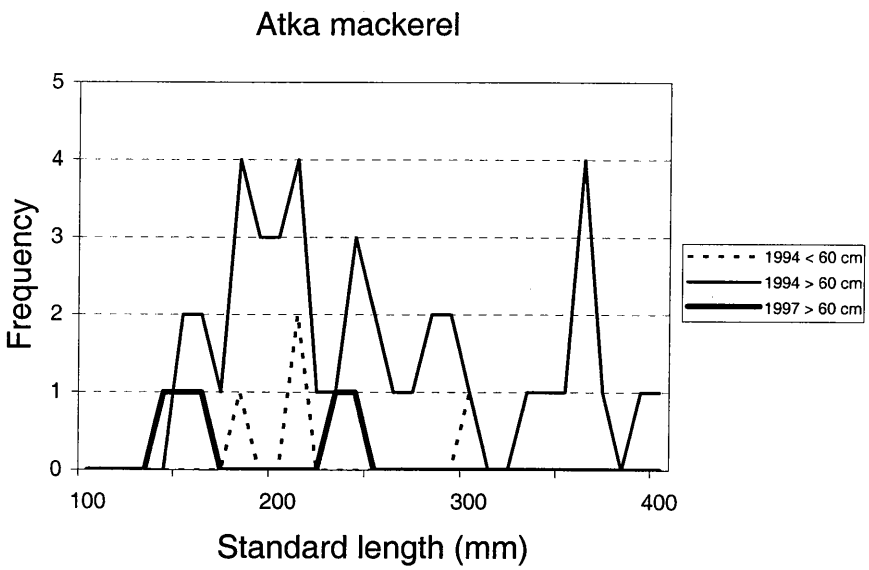

Figure 20.--Size frequency distribution of Atka mackerel consumed by Pacific cod in the Aleutian Islands in 1994 and 1997.

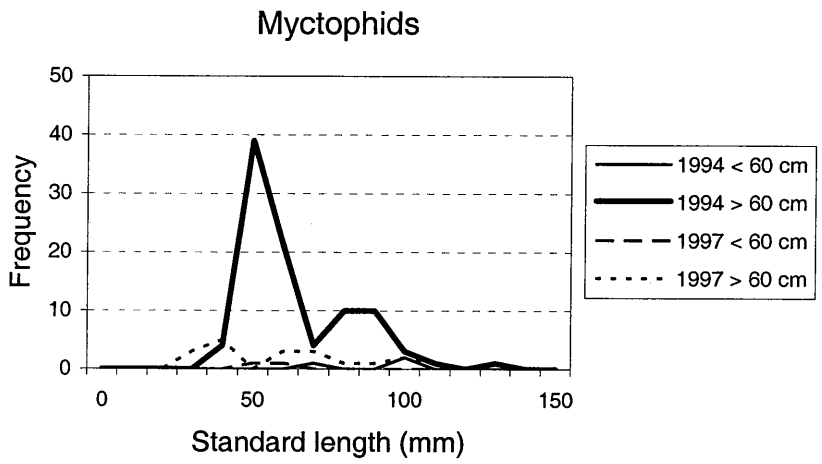

Figure 21.--Size frequency distribution of myctophids consumed by Pacific cod in the Aleutian Islands in 1994 and 1997.

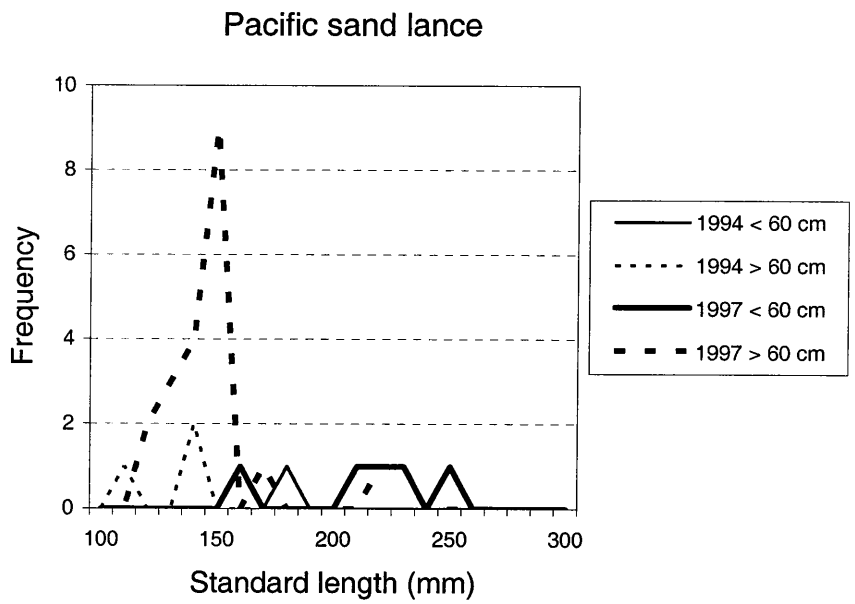

Figure 22.--Size frequency distribution of Pacific sand lance consumed by Pacific cod in the Aleutian Islands in 1994 and 1997.

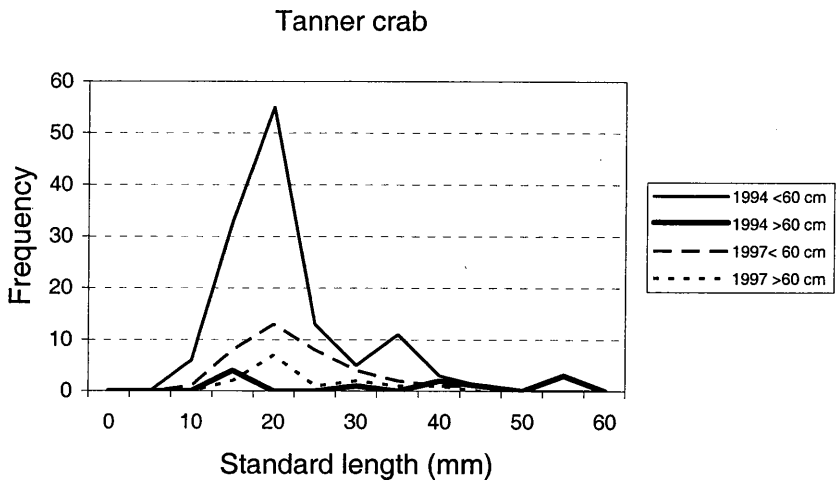

Figure 23.--Size frequency distribution of Tanner crabs consumed by Pacific cod in the Aleutian Islands in 1994 and 1997.

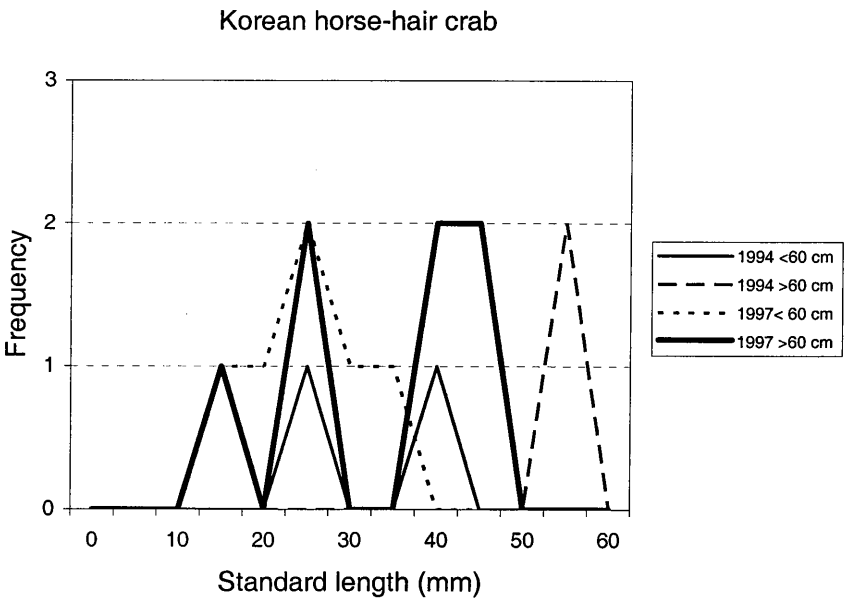

Figure 24.--Size frequency distribution of Korean horse-hair crab consumed by Pacific cod in the Aleutian Islands in 1994 and 1997.

DISCUSSION

The diet of Pacific cod from this study was compared to the diet data from an earlier study by Yang (1996). Table 10 summarizes the percentage by weight of the major prey categories of Pacific cod collected from the Aleutian Islands area in 1991, 1994, and 1997. Shrimp were the most important prey of Pacific cod in the Aleutian Islands area in all three years. Walleye pollock and Atka mackerel were the most important commercial prey fish of Pacific cod in all years. However, the consumption of these two fish decreased in 1997. Sculpins were also important prey fish of Pacific cod with a slightly increased amount in the diet of Pacific cod in 1997. The percent similarities of the diet between these years range from 63% to 75% (Table 10).

Table 10.--Percent weight of the major prey categories of Pacific cod in the Aleutian Islands area in 1991, 1994, and 1997.

Prey name	1991	1994	1997
Polychaete	4	3	4
Cephalopod	6	11	4
Amphipod	4	5	3
Shrimp	21	18	23
Chionoecetes sp.	3	8	2
Korean horse-hair crab	5	1	2
Other crab	4	3	4
Myctophid	1	3	1
Walleye pollock	10	13	7
Eelpout	1	1	1
Sebastes sp.	1	1	4
Atka mackerel	11	18	8
Sculpin	9	9	12
Pacific sand lance	1	1	2
Flatfish	3	1	1

Percent similarity between 1991 and 1994 :75
Percent similarity between 1991 and 1997 :69
Percent similarity between 1994 and 1997 :63

ARROWTOOTH FLOUNDER

Arrowtooth flounder (*Atheresthes stomias*) is a large flatfish with a symmetrical mouth and sharp teeth. They mainly feed in the water column, and their diet includes euphausiids, shrimp, pollock, myctophids, Atka mackerel, and miscellaneous fish (Yang 1996, Simenstad et al. 1977). The projected exploitable biomass (age 1+) of arrowtooth flounder in Bering Sea/Aleutian Islands area for 2002 was 671,200 t. The estimated biomass in the Aleutian Islands alone (from the 2000 Aleutian Islands trawl survey) was 93,500 t (Wilderbuer and Sample 2001).

RESULTS

General Diet

Tables 11 and 12 display the total number of stomachs with food, total empty stomachs, the mean percent frequency of occurrence and the mean percent by weight of the prey items found in arrowtooth flounder stomachs in 1994 and 1997, respectively. Euphausiids and pandalid shrimp were the most important invertebrate food of arrowtooth flounder. However, fish comprised the largest amounts of the total stomach contents of arrowtooth flounder (71%, and 64% by weight in 1994 and 1997, respectively). Atka mackerel (24% by weight) was the most important prey fish of arrowtooth flounder in 1994, followed by myctophids (16%) and walleye pollock (13%). However, myctophids (17%) were the most important prey fish of arrowtooth flounder in 1997, followed by walleye pollock and Atka mackerel. Arrowtooth flounder also consumed some capelin, Pacific herring, sculpins, poachers, pricklebacks, and fishery offal.

Variations of Diet Based on Predator Size

Figure 25 shows the percentage by weight of the main prey items for different arrowtooth flounder size groups in 1994 and 1997. In general, larger arrowtooth flounder ($\geq$ 40 cm FL) fed mainly on fish. Atka mackerel, walleye pollock, and myctophids were the predominant prey fish for this size group of arrowtooth flounder in 1994. In 1997, miscellaneous fish (sculpins, snailfish, sablefish, greenlings, etc.) and myctophids made up about 60% of the total stomach contents of the larger arrowtooth flounder ($\geq$ 40 cm FL). Smaller arrowtooth flounder (< 40 cm FL) fed mainly on euphausiids and shrimp (pandalids), but also fed on some miscellaneous fish.

Geographic Distributions of the Prey Consumed

Figures 26 to 36 illustrate the geographic distributions of the important prey consumed by arrowtooth flounder in 1994 and 1997. Atka mackerel were mainly consumed by arrowtooth flounder in the areas around Seguam Pass, Adak Island, Petrel Bank, Kiska Island, Buldir Island, and Agattu Island in 1994 (Fig. 26), whereas in 1997, Atka mackerel were only consumed by arrowtooth flounder in the Kiska Island area (Fig. 27). Walleye pollock were consumed by arrowtooth flounder northeast of Akutan Island, and in the areas around Seguam Pass, Amlia Island, Adak Island, Kiska Island, and Agattu Island in 1994 (Fig. 28), whereas in 1997, walleye pollock were consumed by arrowtooth flounder only in the areas around Akutan Island, Atka Island, and Agattu Island (Fig. 29). Figure 30 shows that capelin were consumed by arrowtooth flounder only in the areas around Unalaska Island and Agattu Island in 1994. Myctophids were consumed by arrowtooth flounder in 1994 mainly in the areas around Chuginadak Island and Tanaga Island (Fig. 31), whereas in 1997, they were consumed mainly in the areas around Atka Island, Kiska Island and east of Attu Island (Fig. 32). Sablefish and pandalid shrimp were also consumed by arrowtooth flounder. Their geographic distributions in the stomach contents are shown in Figures 33 to 36, respectively.

Sizes of the Commercially Important Prey Consumed

The commercially important prey consumed by arrowtooth flounder were analyzed by two predator size groups: small (< 40 cm FL) and large (≥ 40 cm FL) (Figs. 37 to 39). Figure 37 suggests that Atka mackerel were mainly consumed by large arrowtooth flounder (≥ 40 cm). The mean standard length ($\pm$SD) of the Atka mackerel consumed by arrowtooth flounder in 1994 was 198.4 ± 47.9 mm with a range of 128 to 340 mm SL. The mean standard length ($\pm$SD) of the walleye pollock consumed by arrowtooth flounder in 1994 was 138.4 ± 107.4 with a range of 22 to 320 mm SL (Fig. 38). The mean standard length ($\pm$SD) of myctophids consumed by arrowtooth flounder in 1994 was 63.1 ± 17.1 mm with a range from 27 to 95 mm SL, whereas that in 1997 was 44.8 ± 18.8 mm with a range from 10 to 99 mm SL (Fig. 39). Arrowtooth flounder also consumed capelin, Pacific halibut, pricklebacks, searcher, rockfish, viperfish, sablefish, sculpins, poacher, snailfish, and some flatfish. The number, mean standard length, and the standard deviation of these prey fish are listed in Tables 13 and 14.

Table 11.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of arrowtooth flounder collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	1.53	0.92
Pteropoda (Thecosomata and Gymnosomata)	0.27	0.00
Cephalopoda (squid and octopus)	0.33	0.06
Teuthoidea (squid)	3.27	2.93
Calanoida (copepod)	1.23	0.06
Gnathophausia sp.	0.59	0.06
Mysidae (mysid)	0.93	0.13
Isopoda (isopod)	0.27	0.01
Gammaridea (amphipod)	1.00	0.24
Themisto sp. (amphipod)	0.27	0.03
Euphausiacea (euphausiid)	23.75	15.37
Caridea (shrimp)	1.15	0.25
Parapasiphae sp. (grooved-back shrimp)	0.59	0.01
Hippolytidae (shrimp)	0.53	0.19
Pandalidae (shrimp)	8.31	7.63
Crangonidae (shrimp)	2.50	0.84
Chaetognatha (arrow worm)	3.92	0.44
Osteichthyes Teleostei (fish)	1.72	0.96
Non-gadoid Fish Remains	1.91	0.99
Mallotus villosus (capelin)	3.36	3.86
Chauliodus macouni (Pacific viperfish)	0.42	0.33
Myctophidae (lanternfish)	16.58	16.37
Theragra chalcogramma (walleye pollock)	11.18	12.67
Scorpaenidae	0.49	0.49
Pleurogrammus monopterygius (Atka mackerel)	16.26	23.65
Anoplopoma fimbria (sablefish)	0.49	0.43
Cottoidei (Sculpin)	1.73	0.65
Cottidae (sculpin)	2.22	2.86
Malacocottus kincaidi (blackfin sculpin)	0.37	0.04
Triglops scepticus (spectacled sculpin)	0.37	0.03
Agonidae (poacher)	3.53	2.97
Cyclopteridae (snailfish)	0.75	0.10
Bathymaster signatus (searcher)	0.76	1.17
Stichaeidae (prickleback)	0.23	0.08
Pleuronectidae (flatfish)	1.00	0.85
Lepidopsetta sp. (rock sole type)	0.42	0.98
Hippoglossus stenolepis (Pacific halibut)	0.21	0.21
Fishery offal	0.27	1.15

Table 11.--Continued.

Total prey number = 326
Total prey weight = 5,895 g
Total empty stomachs = 212
Number of hauls = 34

Full stomach summary statistics
Average length = 40.2 cm
Standard deviation of length = 14.2
Minimum length = 13
Maximum length = 76

Empty stomach summary statistics
Average length = 42.5 cm
Standard deviation of length = 13.9
Minimum length = 17
Maximum length = 76

Table 12.--Mean percent frequency of occurrence (%FO), mean percent weight (%WT) of the prey items in the diet of arrowtooth flounder collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Porifera (sponge)	0.33	0.05
Cephalopoda (squid and octopus)	1.29	1.80
Octopoda (octopus)	0.85	1.26
Crustacea	0.47	0.50
Calanoida (copepod)	0.33	1.11
Gnathophausia gigas (mysid)	0.42	0.03
Mysidae (mysid)	6.84	3.34
Amphipoda (amphipod)	0.47	0.13
Gammaridea (amphipod)	1.41	0.11
Ampeliscidae (amphipod)	2.33	1.27
Euphausiidae (euphausiid)	16.57	10.81
Euphausia pacifica (euphausiid)	0.29	0.01
Thysanoessa inermis (euphausiid)	0.29	0.05
Thysanoessa longipes (euphausiid)	0.47	0.12
Spirontocaris sp. (shrimp)	1.16	0.11
Pandalidae (shrimp)	3.79	3.98
Pandalus sp. (shrimp)	3.16	4.11
Pandalus borealis (shrimp)	2.00	1.47
Pandalus goniurus (shrimp)	0.33	0.26
Crangon sp. (shrimp)	0.93	0.81
Crangon communis (shrimp)	0.56	0.06
Natantia (shrimp)	8.76	4.55
Osteichthyes Teleostei (fish)	9.16	5.73
Non-gadoid Fish Remains	18.64	18.14
Clupeidae	0.81	0.82
Clupea pallasi (Pacific herring)	0.70	1.33
Osmeridae (smelts)	0.47	0.73
Chauliodontidae (viperfishes)	0.23	0.28
Myctophidae (lanternfish)	18.59	17.12
Gadidae (gadid fish)	3.92	3.39
Theragra chalcogramma (walleye pollock)	2.98	3.38
Hexagrammidae (greenling)	0.26	1.98
Pleurogrammus monopterygius (Atka mackerel)	1.86	2.26
Anoplopoma fimbria (sablefish)	0.78	2.05
Cottoidei (Sculpin)	0.78	2.24
Icelus sp. (sculpin)	0.23	0.21
Triglops sp. (sculpin)	0.78	0.85
Triglops scepticus (spectacled sculpin)	0.58	0.96
Cyclopteridae (snailfish)	1.16	0.13
Eumicrotremus spp. (lumpsuckers)	0.16	0.09
Eumicrotremus orbis (Pacific spiny lumpsucker)	1.16	2.22
Poroclinus rothrocki (whitebarred prickleback)	0.39	0.03

Table 12.--Continued

Total non-empty stomachs = 234
Total prey number = 1,107
Total prey weight = 3,560.6g
Total empty stomachs = 257
Number of hauls = 43

Full stomach summary statistics
Average length = 39.7 cm
Standard deviation of length = 15.0
Minimum length = 14
Maximum length = 82

Empty stomach summary statistics
Average length = 44.5 cm
Standard deviation of length = 14.4
Minimum length = 15
Maximum length = 77

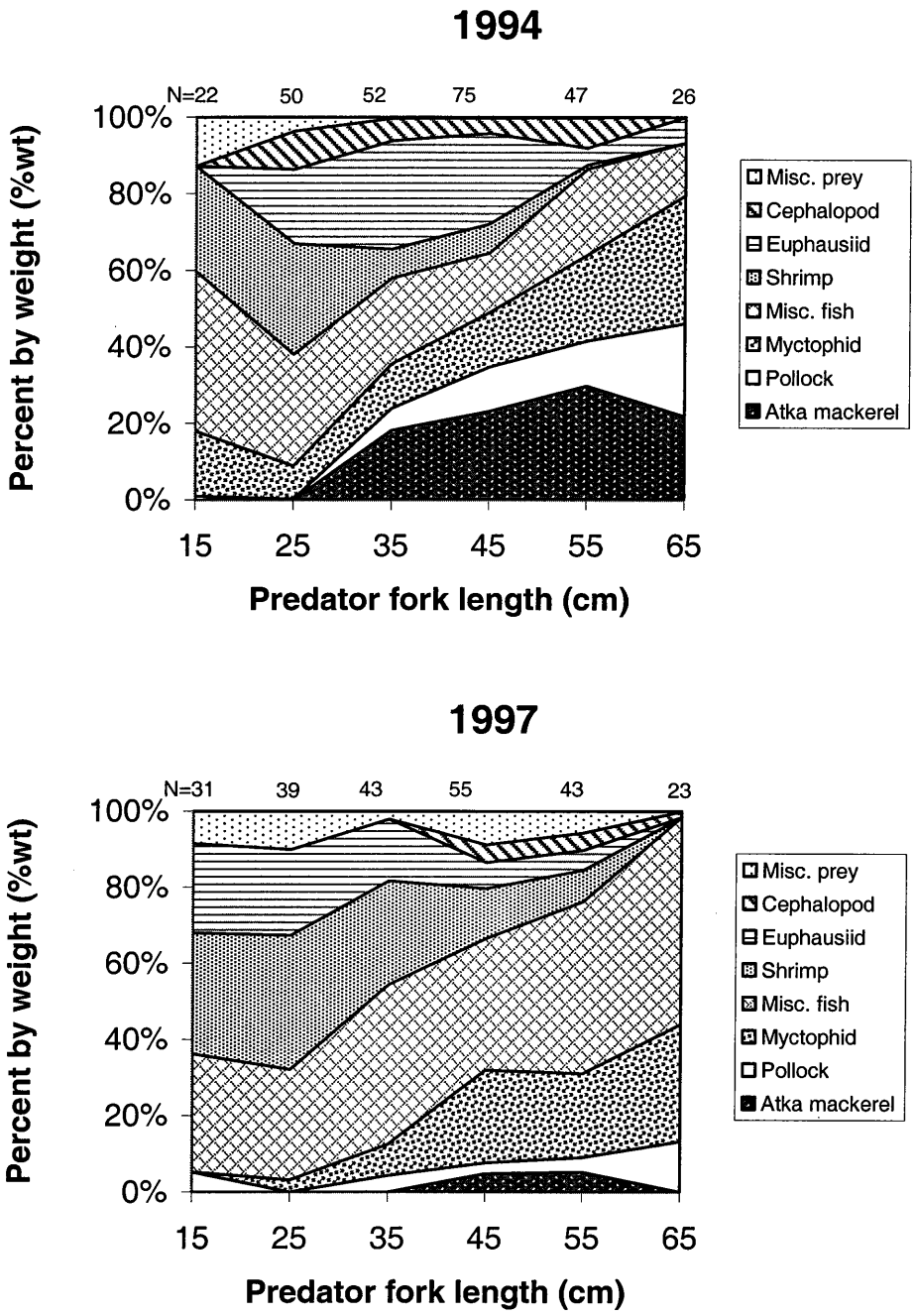

Figure 25.--Variations in the main prey of arrowtooth flounder, by predator size, in the Aleutian Islands in 1994 and 1997.
N = number of stomachs containing food.

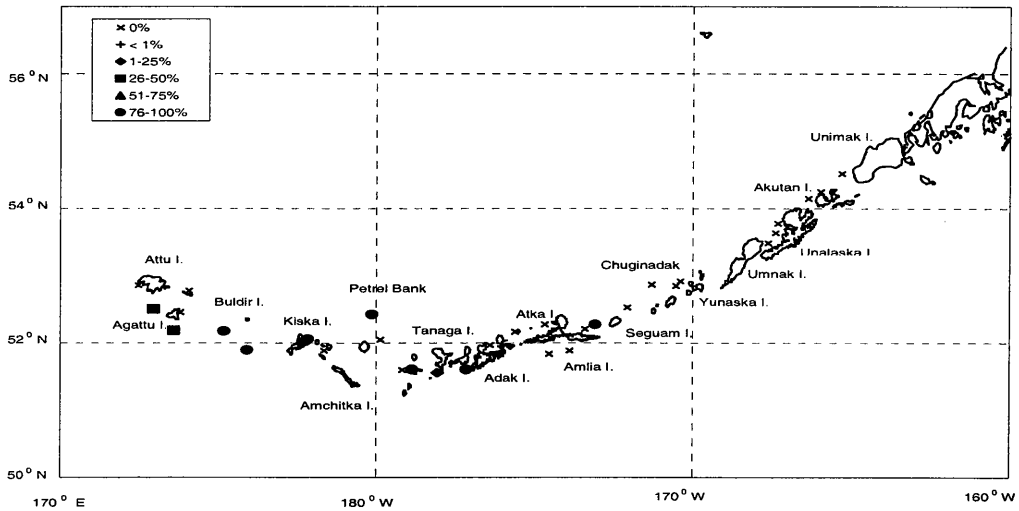

Figure 26.--Geographic distribution of Atka mackerel consumed by arrowtooth flounder in the Aleutian Islands area in 1994.

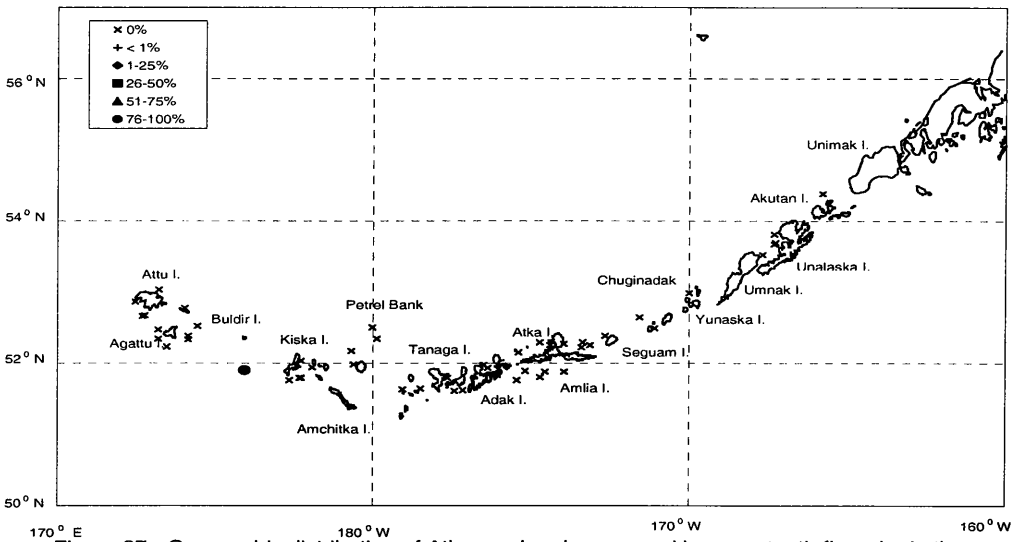

Figure 27.--Geographic distribution of Atka mackerel consumed by arrowtooth flounder in the Aleutian Islands area in 1997.

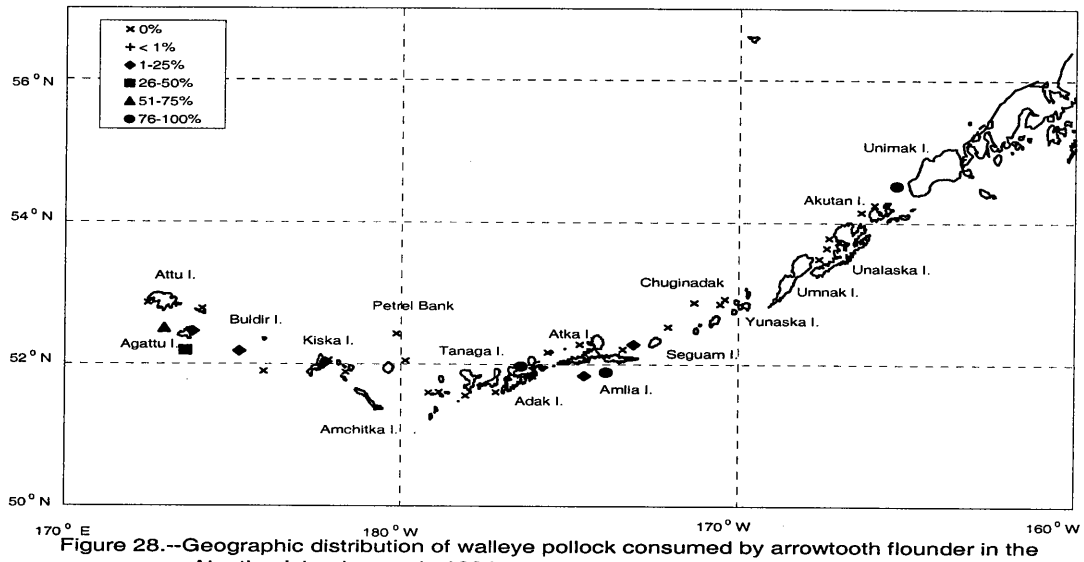

Figure 28.--Geographic distribution of walleye pollock consumed by arrowtooth flounder in the Aleutian Islands area in 1994.

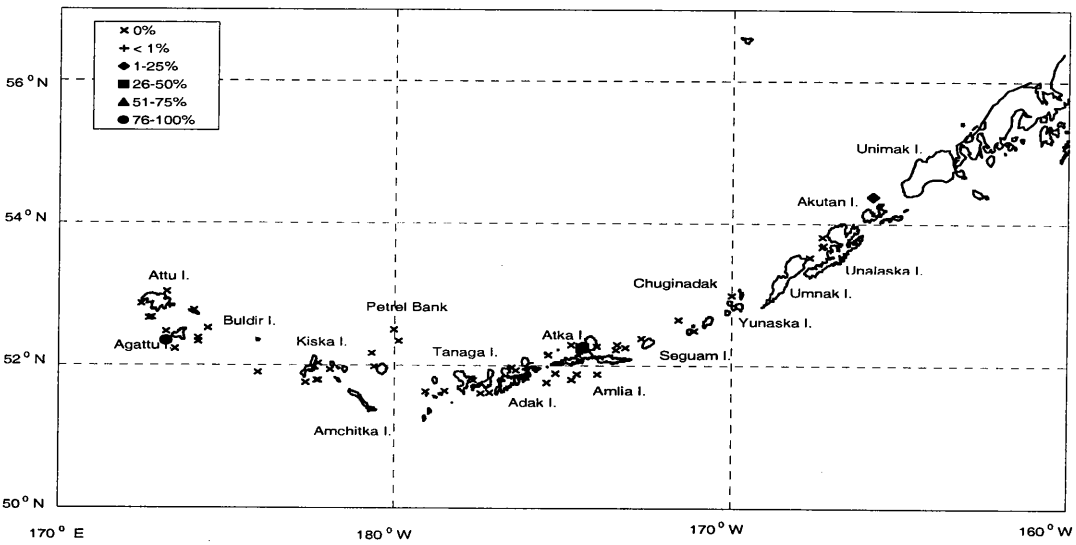

Figure 29.--Geographic distribution of walleye pollock consumed by arrowtooth flounder in the Aleutian Islands area in 1997.

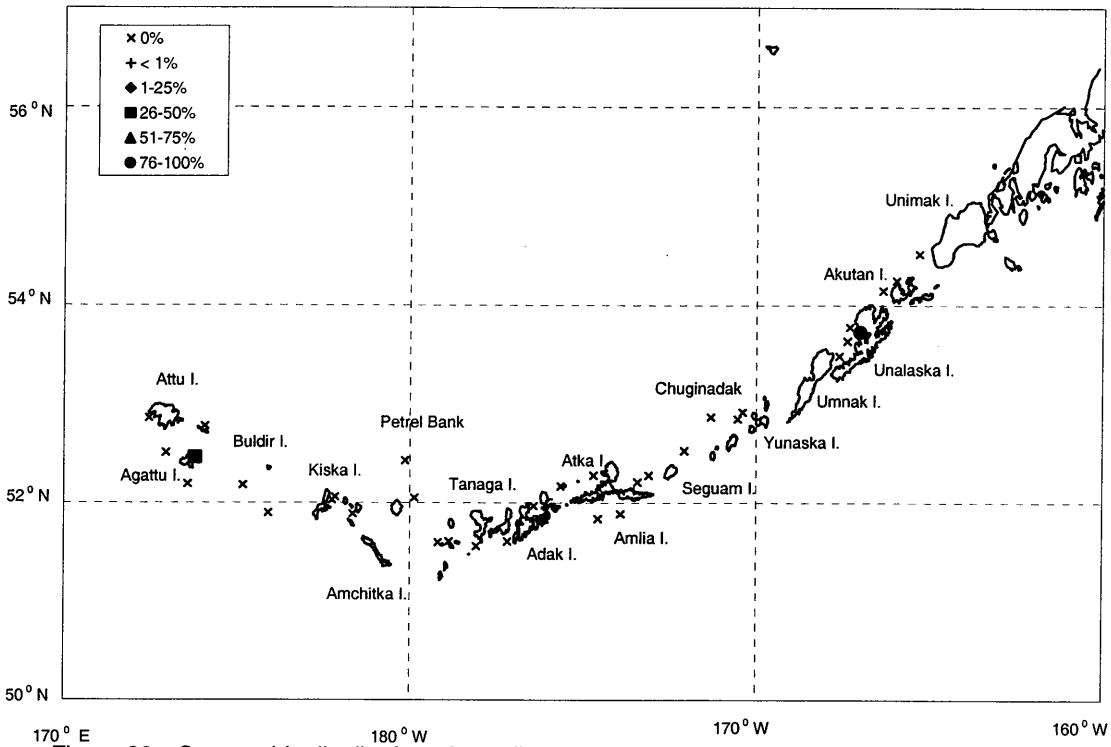

Figure 30.--Geographic distribution of capelin consumed by arrowtooth flounder in the Aleutian Islands area in 1994.

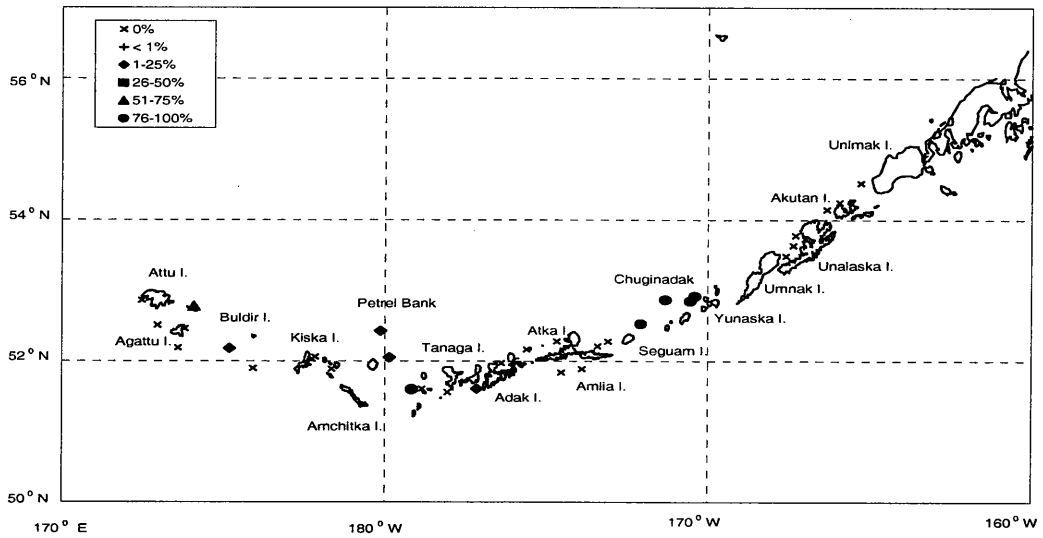

Figure 31.--Geographic distribution of myctophids consumed by arrowtooth flounder in the Aleutian Islands area in 1994.

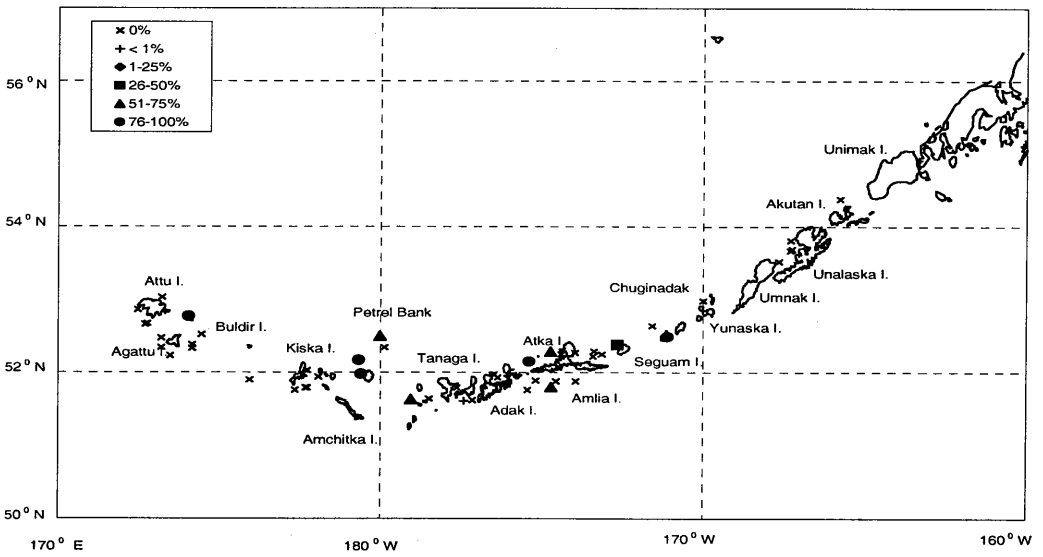

Figure 32.--Geographic distribution of myctophids consumed by arrowtooth flounder in the Aleutian Islands area in 1997.

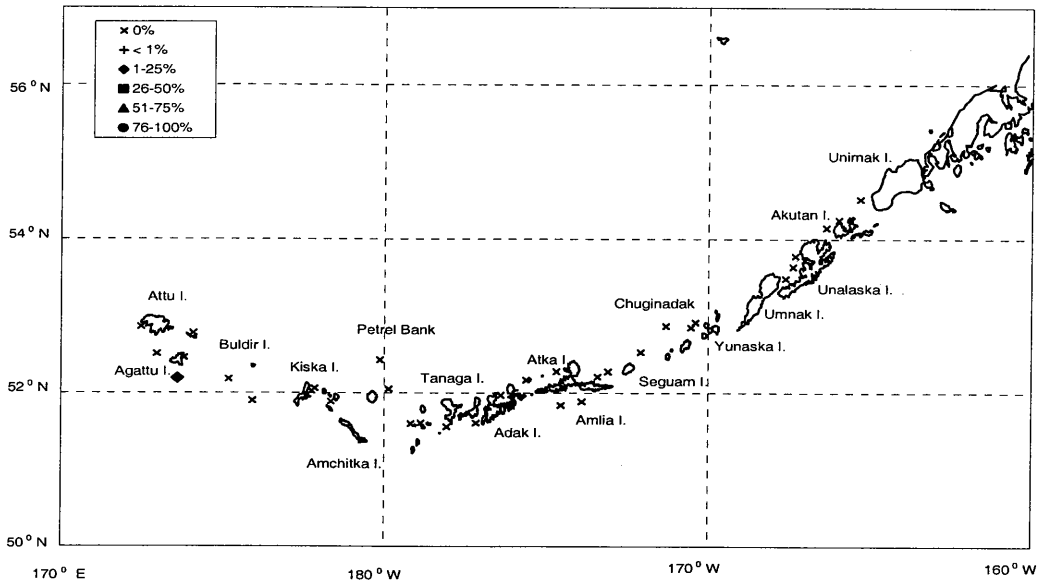

Figure 33.--Geographic distribution of sablefish consumed by arrowtooth flounder in the Aleutian Islands area in 1994.

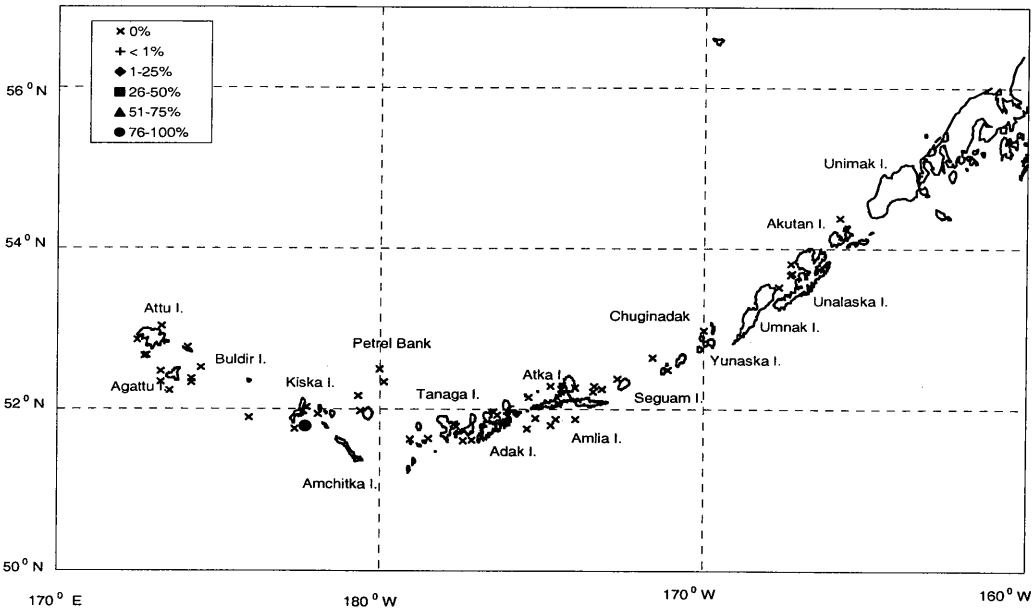

Figure 34.--Geographic distribution of sablefish consumed by arrowtooth flounder in the Aleutian Islands area in 1997.

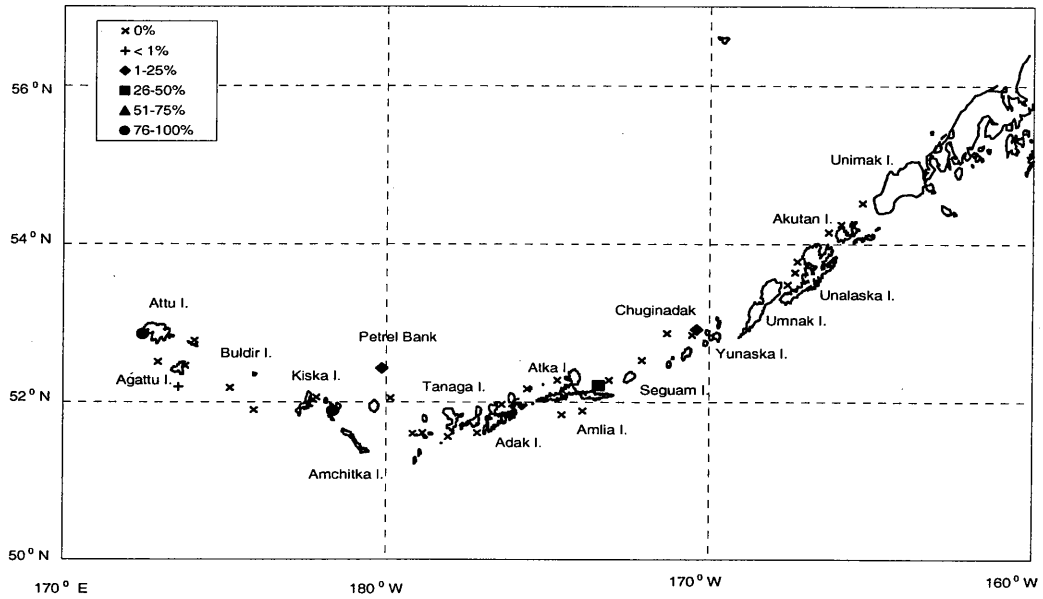

Figure 35.--Geographic distribution of pandalid shrimp consumed by arrowtooth flounder in the Aleutian Islands area in 1994.

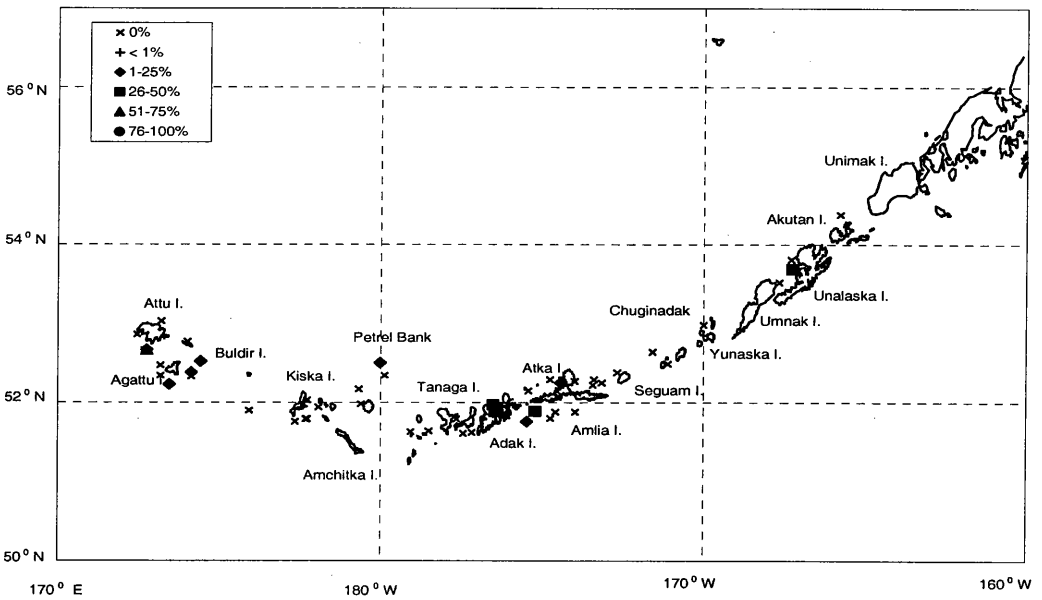

Figure 36.--Geographic distribution of pandalid shrimp consumed by arrowtooth flounder in the Aleutian Islands area in 1997.

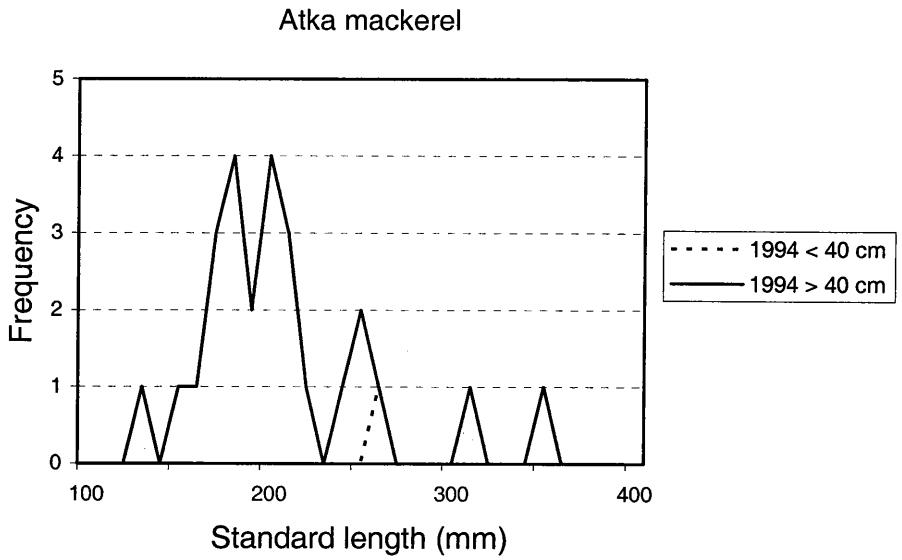

Figure 37.--Size frequency distribution of Atka mackerel consumed by arrowtooth flounder in the Aleutian Islands in 1994.

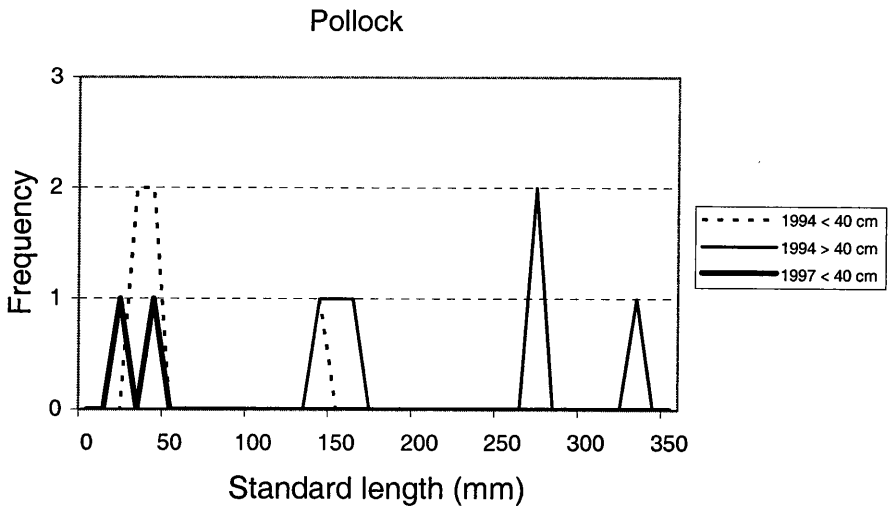

Figure 38.--Size frequency distribution of walleye pollock consumed by arrowtooth flounder in the Aleutian Islands in 1994 and 1997.

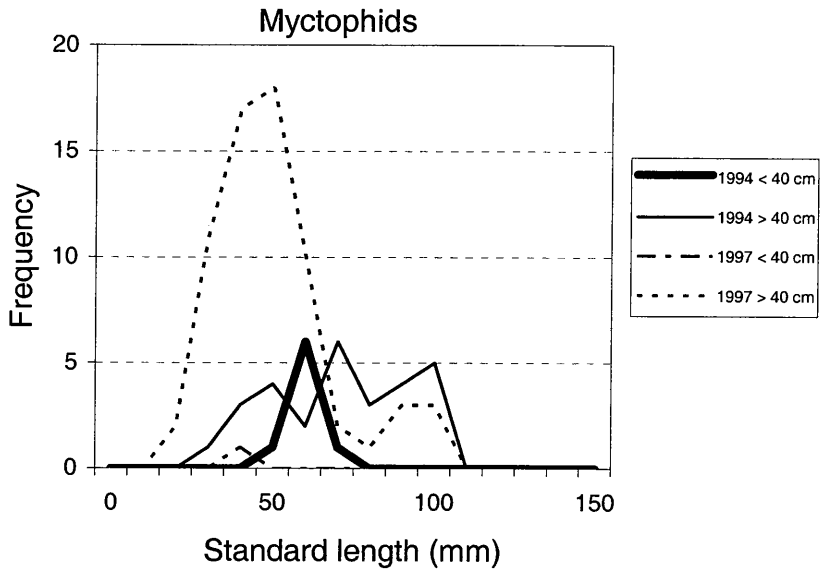

Figure 39.--Size frequency distribution of myctophids consumed by arrowtooth flounder in the Aleutian Islands in 1994 and 1997.

Table 13.--Mean standard length (SL), standard deviation (SD), and range of standard length of the miscellaneous prey fish consumed by arrowtooth flounder in the Aleutian Islands in 1994. N = number of measurable prey.

Prey name	N	Mean SL (mm)	SD (mm)	Range(mm)
Capelin	5	62.0	15.1	51-88
Pacific viperfish	1	120.0	0.0	120-120
Scorpaenidae	1	200.0	0.0	200-200
Sablefish	1	230.0	0.0	230-230
Sculpin	9	96.0	19.3	27-81
Poacher	1	60.0	0.0	60-60
Snailfish	2	67.5	47.4	34-101
Searcher	2	99.0	22.6	83-115
Prickleback	1	83.0	0.0	83-83
Lepidopsetta sp.	1	32.0	0.0	32-32
Pacific halibut	3	28.0	1.0	27-29

Table 14.--Mean standard length (SL), standard deviation (SD), and range of standard length of the miscellaneous prey fish consumed by arrowtooth flounder in the Aleutian Islands in 1997. N = number of measurable prey.

Prey name	N	Mean SL (mm)	SD (mm)	Range(mm)
Pacific herring	3	274.3	17.9	263-295
Osmeridae	3	112.2	66.4	79-132
Chauliodontidae	1	120.0	0.0	120-120
Sablefish	1	210.0	0.0	210-210
Pacific saury	1	145.0	0.0	145-145
Sculpin	3	99.3	118.4	17-235
Snailfish	3	28.5	10.8	16-37
Prickleback	1	65.0	0.0	65-65

DISCUSSION

Table 15 lists the percent weight of the main prey categories of arrowtooth flounder in the Aleutian Islands in 1991, 1994, and 1997. Euphausiids were the most important invertebrate prey of arrowtooth flounder in all years. Myctophids, pollock, and Atka mackerel were the most important prey fish. A higher percentage (24%) of euphausiids was found in the stomachs of arrowtooth flounder collected in 1991 when compared to the other two years. This difference is probably related to the fact that smaller arrowtooth flounder (average 36.7 cm FL) were collected in 1991 than in 1994 (average 40.2 cm FL) and in 1997 (average 39.7 cm FL). In 1997, a higher amount (24%) of unidentifiable fish was recorded (Table 12). Most of them were probably highly digested Atka mackerel, which may account for why Atka mackerel consumed in 1997 (4%) was lower than in 1994 (24%) and in 1991 (9%).

Table 15.--Percent weight of the major prey categories of arrowtooth flounder in the Aleutian Islands area in 1991, 1994, and 1997.

Prey name	1991	1994	1997
Cephalopod	5	3	3
Euphausiid	24	15	11
Pandalid	5	8	10
Pacific herring	2	0	2
Capelin	1	4	1
Myctophid	7	16	17
Pollock	4	13	7
Sebastes sp.	1	1	0
Atka mackerel	9	24	4
Sablefish	4	1	2
Sculpin	5	4	4

Percent similarity between 1991 and 1994 :50
Percent similarity between 1991 and 1997 :43
Percent similarity between 1994 and 1997 :55

PACIFIC HALIBUT

Pacific halibut are important predators feeding on pollock, Atka mackerel, Tanner crabs, hermit crabs, cephalopods, and miscellaneous fish (Yang 1996, Simenstad 1977). In 2001, the estimate of total exploitable biomass of Pacific halibut in the eastern Bering Sea and Aleutian Islands was 249,527 t (IPHC 2001). Catches in these areas totaled 31,000 t.

RESULTS

General Diet

Tables 16 to 17 summarize data on the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in Pacific halibut stomachs collected in 1994 and 1997. Atka mackerel and walleye pollock were the most important prey fish. In terms of weight, Atka mackerel comprised 21% and 15% of the total stomach contents in 1994 and 1997, respectively; whereas pollock comprised 20% and 11% of the total stomach contents in 1994 and 1997, respectively. Pacific herring comprised 4% of the total stomach contents weight in 1997, whereas capelin made up only 1% of the total stomach contents weight in 1997. Pacific halibut also consumed some Pacific sand lance (1% in 1994 and 5% in 1997).

Table 16.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Pacific halibut collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Anthozoa (anemome)	1.03	0.42
Lumbrineridae	0.55	0.00
Gastropoda (snail)	1.39	0.05
Bivalvia (clam)	2.83	0.25
Cephalopoda (squid and octopus)	1.10	0.06
Teuthoidea (squid)	24.96	10.63
Octopoda (octopus)	1.44	0.02
Isopoda (isopod)	2.01	0.05
Gammaridea (amphipod)	3.42	0.04
Reptantia (crab)	1.62	0.11
Pasiphaeidae (shrimp)	0.38	0.01
Hippolytidae (shrimp)	1.51	0.04
Pandalidae (shrimp)	4.38	0.30
Crangonidae (shrimp)	2.61	0.21
Argis sp. (shrimp)	0.55	0.01
Paguridae (hermit crab)	13.82	2.65
Acantholithodes hispidus (Fussy crab)	0.55	0.25
Placetron wosnessenskii (scale crab)	0.48	0.07
Majidae (spider crab)	1.03	0.12
Oregonia sp. (decorator crab)	1.94	1.40
Oregonia gracilis (decorator crab)	0.55	0.13
Hyas sp. (lyre crab)	14.09	8.63
Chionoecetes bairdi (Tanner crab)	20.68	2.63
Pugettia gracilis (kelp crab)	0.55	0.29
Erimacrus isenbeckii (Korean horse-hair crab)	2.78	0.56
Pinnixa sp. (pea crab)	0.96	0.14
Holothuroidea (sea cucumber)	2.00	0.37
Bathyraja interrupta (Bering skate)	0.43	0.07
Osteichthyes Teleostei (fish)	3.10	0.22
Non-gadoid Fish Remains	0.64	0.13
Bathylagidae (deepsea smelts)	0.48	0.21
Myctophidae (lanternfish)	2.86	0.81
Gadus macrocephalus (Pacific cod)	0.91	0.17
Theragra chalcogramma (walleye pollock)	17.67	19.91
Zoarcidae (eelpout)	1.65	0.12
Gymnelis rotordorsalis (Aurora eelpout)	0.96	0.03
Pleurogrammus monopterygius (Atka mackerel)	20.51	21.16
Cottoidei (sculpin)	5.98	3.13
Icelus sp. (sculpin)	0.43	0.15
Cottidae (sculpin)	7.51	1.60
Triglops sp. (sculpin)	0.43	0.47

Table 16.--Continued.

Name	%FO	%WT
Triglops scepticus (spectacled sculpin)	0.43	0.13
Triglops pingeli (ribbed sculpin)	0.43	0.56
Agonidae (poacher)	2.17	0.63
Cyclopteridae (snailfish)	1.83	0.15
Stichaeidae (prickleback)	2.56	0.47
Ammodytes hexapterus (Pacific sand lance)	3.02	1.18
Pleuronectidae (flatfish)	1.99	0.04
Atheresthes stomias (arrowtooth flounder)	0.55	1.20
Hippoglossoides elassodon (flathead sole)	1.71	2.42
Lepidopsetta sp. (rock sole type)	1.67	1.77
Unidentified worm-like organism	0.55	0.04
Fishery offal	14.28	13.77

Total non-empty Stomachs = 162
Total prey number = 574
Total prey weight = 14,531g
Total empty stomachs = 54
Number of hauls = 26

Full stomach summary statistics
Average length = 68.3 cm
Standard deviation of length = 16.8
Minimum length = 16
Maximum length = 149

Empty stomach summary statistics
Average length = 65.6cm
Standard deviation of length = 12.5
Minimum length = 43
Maximum length = 101

Table 17.-- Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Pacific halibut collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Porifera (sponge)	0.51	0.01
Anthozoa (anemome)	1.39	0.45
Polychaeta (worm)	2.66	0.04
Mollusca	0.34	0.22
Gastropoda (snail)	0.94	0.01
Nudibranchia dendronotoidea (nudibranch)	0.38	0.27
Bivalvia (clam)	1.66	0.27
Pectinidae (scallops)	1.73	0.34
Cephalopoda (squid and octopus)	0.98	0.31
Teuthoidea (squid)	11.71	6.07
Gonatidae (squid)	0.51	0.61
Gonatopsis sp. (squid)	3.28	4.58
Octopoda (octopus)	8.90	6.20
Isopoda (isopod)	2.15	0.01
Gammaridea (amphipod)	2.12	0.00
Lysianassidae (amphipod)	0.51	0.06
Euphausiacea (euphausiid)	0.51	0.01
Reptantia (crab)	0.67	0.10
Caridea (shrimp)	1.52	0.04
Hippolytidae (shrimp)	0.61	0.02
Pandalidae (shrimp)	1.28	0.04
Argis sp. (shrimp)	0.94	0.12
Paguridae (hermit crab)	19.94	4.12
Pagurus aleuticus	1.60	0.35
Pagurus rathbuni (hermit crab)	0.38	0.02
Elassochirus cavimanus (purple hermit crab)	0.38	0.03
Lithodidae (king crab)	3.03	0.84
Majidae (spider crab)	0.81	0.06
Oregonia sp. (decorator crab)	4.30	0.24
Oregonia gracilis (decorator crab)	1.18	0.21
Hyas sp. (lyre crab)	7.26	1.71
Hyas lyratus (lyre crab)	13.75	5.99
Chionoecetes bairdi (Tanner crab)	9.38	2.75
Telmessus cheiragonus (hair crab)	1.68	0.79
Erimacrus isenbeckii (Korean horse-hair crab)	3.66	0.63
Cancer gracilis (graceful Cancer crab)	0.61	0.01
Cancer oregonensis (pygmy Cancer crab)	0.51	0.04
Sipuncula (marine worm)	1.01	0.55
Echiura (marine worm)	1.01	0.18
Ophiuroidae Ophiurida (brittle star)	0.51	0.02
Echinacea sp. (sea urchin)	0.61	0.00

Table 17.--Continued.

Name	%FO	%WT
Rajidae (skate)	1.01	0.42
Osteichthyes Teleostei (fish)	2.03	0.04
Non-gadoid Fish Remains	7.20	0.70
Clupea pallasi (Pacific herring)	1.52	3.57
Mallotus villosus (capelin)	4.55	1.29
Bathylagidae (deepsea smelts)	0.51	0.03
Chauliodus macouni (Pacific viperfish)	0.87	0.19
Myctophidae (lanternfish)	4.31	2.47
Stenobrachius leucopsarus (northern	0.51	0.09
Theragra chalcogramma (walleye pollock)	13.53	11.00
Zoarcidae (eelpout)	0.72	0.07
Gymnelis rotordorsalis (Aurora eelpout)	1.35	0.22
Sebastes sp. (rockfish)	2.22	0.48
Pleurogrammus monopterygius (Atka mackerel)	11.63	14.93
Cottoidei (sculpin)	4.35	2.98
Icelus uncinalis (uncinate sculpin)	0.38	0.06
Cottidae (sculpin)	2.02	0.86
Gymnocanthus sp.(sculpin)	0.38	0.50
Triglops sp. (sculpin)	3.16	1.35
Triglops scepticus (spectacled sculpin)	6.97	5.79
Agonidae (poacher)	2.79	0.63
Aspidophoroides bartoni (Aleutian alligatorfish)	0.98	0.10
Cyclopteridae (snailfish)	0.88	0.31
Eumicrotremus orbis (Pacific spiny lumpsucker)	0.34	0.04
Bathymasteridae (ronquils)	0.61	0.10
Bathymaster signatus (searcher)	0.38	0.06
Ptilichthys goodei (quillfish)	0.34	0.00
Ammodytes hexapterus (Pacific sand lance)	5.18	5.28
Pleuronectidae (flatfish)	2.07	0.42
Atheresthes evermanni (Kamchatka flounder)	0.76	0.53
Hippoglossoides elassodon (flathead sole)	0.34	0.69
Lepidopsetta sp. (rock sole type)	2.53	2.77
Hippoglossus stenolepis (Pacific halibut)	1.52	0.36
Unidentified organic material	1.02	0.07
Unidentified worm-like organism	0.51	0.05
Fishery offal	4.18	3.17

Table 17.--Continued.

Total non-empty stomachs = 196
Total prey number = 1,086
Total prey weight = 13,740 g
Total empty stomachs = 13
Number of hauls = 33

Full stomach summary statistics
Average length = 68.9 cm
Standard deviation of length = 12.3 cm
Minimum length = 25 cm
Maximum length = 111 cm

Average fullness = 4.9
Standard deviation of fullness = 1.1
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 62.1 cm
Standard deviation of length = 21.3 cm
Minimum length = 19 cm
Maximum length = 95 cm

Variation of Diet Based on Predator Size

The diet of Pacific halibut varied by predator size (Fig. 40). Miscellaneous prey fish (mainly cottids, Pacific sand lance, myctophids, zoarcids, stichaeids, and flatfish) were important food for all sizes but the largest (≥ 90 cm FL) Pacific halibut, whereas high percentages (≥ 40%) of walleye pollock were mainly consumed by the largest Pacific halibut (≥ 90 cm FL). Atka mackerel were mainly consumed by Pacific halibut larger than 70 cm long. Tanner crabs were mainly consumed by Pacific halibut between 50 and 70 cm in 1994. High percentages (62% in 1994 and 74% in 1997) of other crabs (decorator crabs, lyre crabs, and hermit crabs) were consumed by the smallest size group (40-50 cm) of Pacific halibut. Cephalopods (between 18 to 38%) were mainly consumed by Pacific halibut larger than 70 cm long in 1997, whereas in 1994, only the 80 to 90 cm size group consumed a relatively high percentage (24%) of cephalopods.

Geographic Distributions of the Prey Consumed

The geographic distributions of the important prey consumed by Pacific halibut are shown in Figures 41 to 59. Figures 41 and 42 illustrate that walleye pollock were consumed by Pacific halibut in the areas from Akutan Island westward to Adak Island. Atka mackerel were consumed by Pacific halibut primarily in the areas west of Umnak Island westward to Kiska Island and Attu Island in 1994 (Fig. 43); however, in 1997, they were found in samples between the Chuginadak Island and Tanaga Island areas (Fig. 44). The amount of Atka mackerel consumed at most of these stations was high (> 25%). Pacific sand lance were consumed by Pacific halibut in the areas around Umnak Island, Amlia Island, Tanaga Island, and Attu Island in 1994 and 1997 (Figs. 45 and 46). Myctophids consumed by Pacific halibut were found mainly around Chuginadak Island. Figures 49 and 50 illustrate the locations where fishery offal was consumed by Pacific halibut. It shows that high percentages (> 75%) of fishery offal were consumed by Pacific halibut around Akutan Island area in 1994. Tanner crabs were found in Pacific halibut stomachs collected in the areas around Unalaska Island, Atka Island, and Adak Island (Figs. 51 and 52). The locations where Pacific halibut consumed Korean horse-hair crabs, Lithodidae, lyre crabs, and hermit crabs are shown in Figures 53 - 59, respectively.

Sizes of the Commercially Important Prey Consumed

The prey length data for Pacific halibut were divided into two predator size groups, small (< 80 cm FL) and large (≥80 cm FL) for analysis (Figs. 60 to 66). Small Pacific halibut consumed mainly age-0 walleye pollock (< 140 mm SL) plus a few age-1 to age-3 fish (Fig. 60). Large Pacific halibut consumed many different sizes of walleye pollock including both pre-recruits (< 300 mm SL) and recruits (≥ 300 mm SL) (Fig. 60). Most pre-recruit walleye pollock consumed were age-1 and age-2 fish, whereas most recruited pollock consumed were age-3 and age-4 fish. A few large pollock (≥ 40 cm SL) were consumed by some Pacific halibut larger than 90 cm FL. The mean standard length (±SD) of pollock consumed by Pacific halibut in 1994 was 334.8 ± 89.7 mm with a range from 145 to 424 mm SL, whereas the value of that in 1997 was 195.3 ± 80.4 mm with a range from 147 to 445 mm SL.

Atka mackerel consumed by Pacific halibut had a mean standard length (±SD) of 192.8 ± 51.9 mm with a range from 123 to 350 mm SL in 1994 and the value was 186.4 ± 47.9 mm with a range from 105 to 260 mm SL in 1997 (Fig. 61). Consumption of capelin occurred only in small Pacific halibut in 1997 (Fig. 62). The mean standard length (±SD) of the capelin consumed was 68.3 ± 14.0 mm with a range from 49 to 129 mm SL. The mean standard length (±SD) of the myctophids consumed by Pacific halibut in 1997 was 67.4 ± 18.8 mm with a range from 32 to 95 mm SL (Fig. 63). Only four myctophids were consumed by Pacific halibut in 1994. They had a mean standard length (±SD) of 80.8 ± 12.0 mm with a range from 68 to 97 mm SL. Pacific sand lance consumed by Pacific halibut had a mean standard length (±SD) of 143.2 ± 8.8 mm with a range from 132 to 155 mm SL in 1994, and 166.1 ± 43.7 mm with a range from 98 to 237 mm SL in 1997 (Fig. 64).

Chionoecetes bairdi consumed by small Pacific halibut were mainly age-0 and age-1 (< 36 mm CW) crabs, whereas large Pacific halibut consumed mainly age-1 *C. bairdi* and some age-2 and older crabs (Fig. 65). The mean carapace width (±SD) of *C. bairdi* consumed in 1994 was 25.2 ± 10.8 mm with a range from 10 to 64 mm CW, and was 22.3 ± 14.8 mm with a range from 9 to 78 mm CW in 1997.

Only one Korean horse-hair crab (33 mm CW) was consumed by a Pacific halibut (83 cm FL). All the remaining Korean horse-hair crab were consumed by small fish less than 80 cm FL. Korean horse-hair crab consumed by Pacific halibut had a mean carapace width (+SD) 29.5 ± 9.2 mm with a range from 19 to 45 mm CW in 1994, and 23.2 ± 8.8 mm with a range from 11 to 46 mm CW in 1997 (Fig. 66).

Pacific halibut also consumed arrowtooth flounder, Kamchatka flounder, flathead sole, rock sole (*Lepidopsetta* sp.), Pacific herring, searcher, quillfish, Pacific viperfish, Bering skate, Bathylagids, poachers, sculpins, snailfish, juvenile Pacific halibut, pricklebacks, rockfish, and eelpouts. The number, mean standard length, and the standard deviation of these prey fish are listed in Tables 18 and 19.

Table 18.--Mean standard length (SL), standard deviation (SD), and range of standard length of the miscellaneous prey fish consumed by Pacific halibut in the Aleutian Islands in 1994. n = number of measurable prey.

Prey name	n	Mean SL (mm)	SD (mm)	Range (mm)
Walleye pollock	15	334.8	89.7	145-424
Arrowtooth flounder	2	192.0	5.7	188-196
Bering skate	1	90.0	0.0	90-90
Bathylagidae	1	160.0	0.0	160-160
Eelpout	5	78.6	6.5	68-85
Atka mackerel	19	192.8	51.9	123-350
Myctophid	4	80.8	12.0	68-97
Pacific sand lance	5	143.2	8.8	132-155
Chionoecetes bairdi	87	25.2	10.8	10-64
Erimacrus isenbeckii	6	29.5	9.2	19-45
Sculpins	24	99.2	40.5	35-216
Prickleback	6	134.8	107.8	64-340
Poacher	7	97.9	26.8	64-125
Snailfish	5	35.4	8.5	29-50
Flathead sole	7	155.9	47.2	60-190
Lepidopsetta sp.	2	92.5	70.0	43-142

Table 19.--Mean standard length (SL), standard deviation (SD), and range of standard length of the miscellaneous prey fish consumed by Pacific halibut in the Aleutian Islands in 1997. n = number of measurable prey.

Prey name	n	Mean SL (mm)	SD (mm)	Range(mm)
Walleye pollock	22	195.3	80.4	147-445
Atka mackerel	15	186.4	47.9	105-260
Capelin	33	68.3	14.0	49-129
Myctophid	25	67.4	18.8	32-95
Pacific sand lance	14	166.1	43.7	98-237
Chionoecetes bairdi	78	22.3	14.8	9-78
Erimacrus isenbeckii	18	23.2	8.8	11-46
Sculpins	181	72.1	24.5	29-229
Poacher	14	97.3	33.6	56-183
Snailfish	4	45.7	11.5	29-55
Searcher	2	123.0	56.6	83-163
Quillfish	1	189.0	0.0	189-189
Kamchatka flounder	1	110.0	0.0	110-110
Flathead sole	5	115.6	5.6	107-122
Lepidopsetta sp.	2	125.4	30.4	107-147
Pacific halibut	8	34.8	5.2	28-42
Eelpout	16	80.7	12.0	59-104
Pacific herring	2	245.5	62.9	201-290
Bathylagid	1	112.0	0.0	112-112
Pacific viperfish	3	112.3	46.4	72-163
Sebastes sp.	4	77.0	15.6	64-99
Cancer gracilis	1	14.0	0.0	14-14
Cancer oregonensis	1	26.0	0.0	26-26

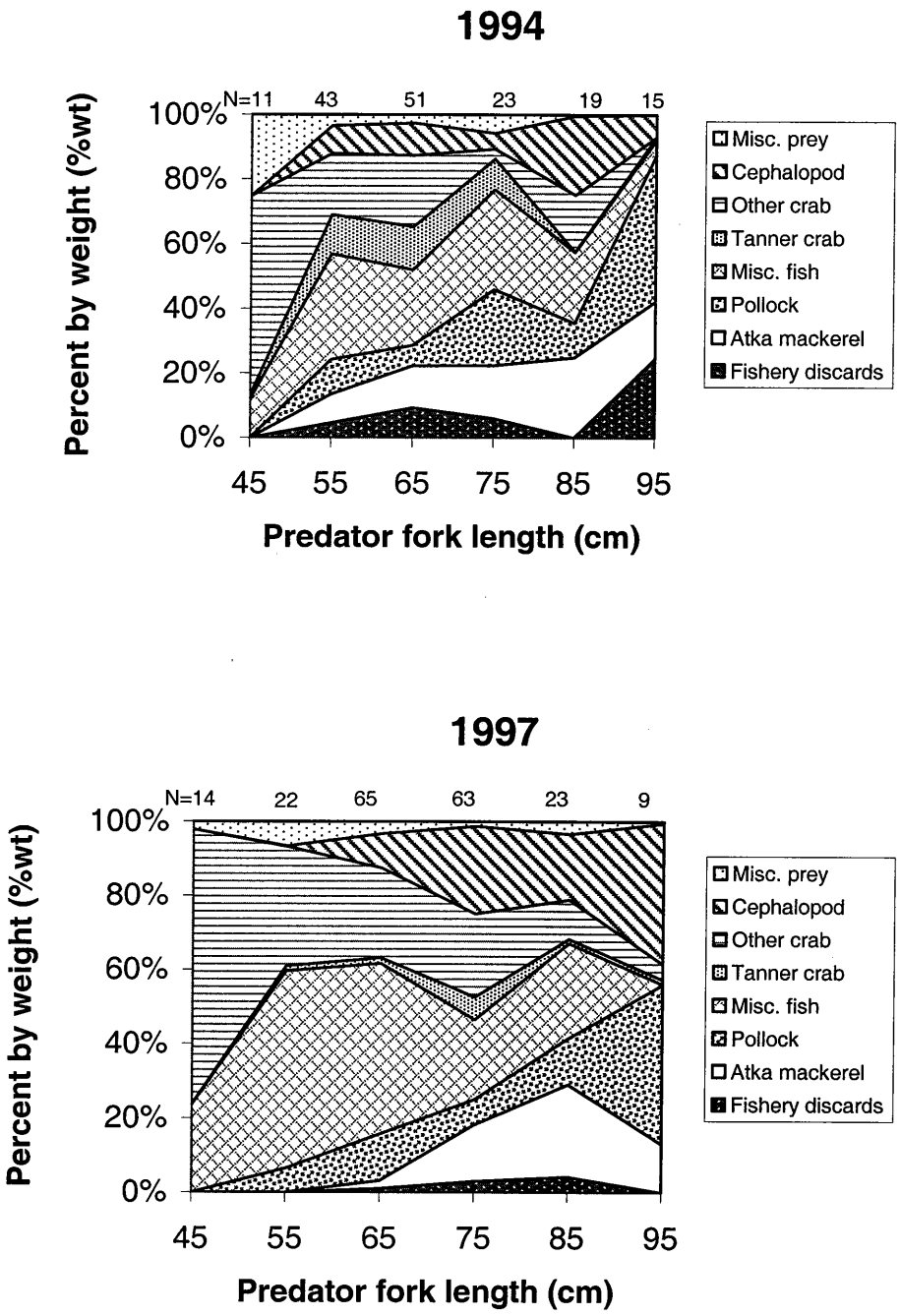

Figure 40.--Variations in the main prey of Pacific halibut, by predator size, in the Aleutian Islands in 1994 and 1997.
N = number of stomachs containing food.

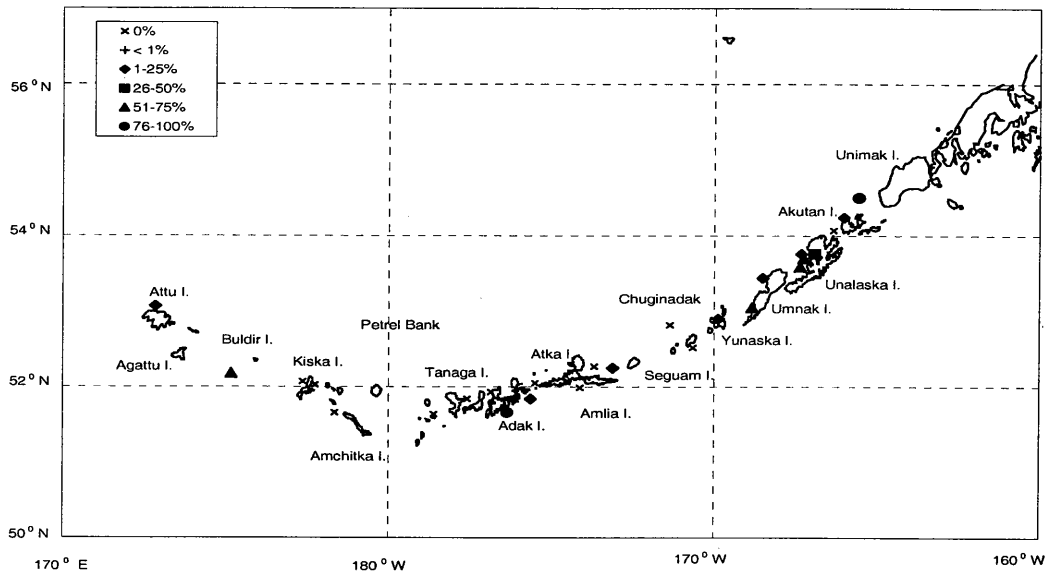

Figure 41.--Geographic distribution of walleye pollock consumed by Pacific halibut in the Aleutian Islands area in 1994.

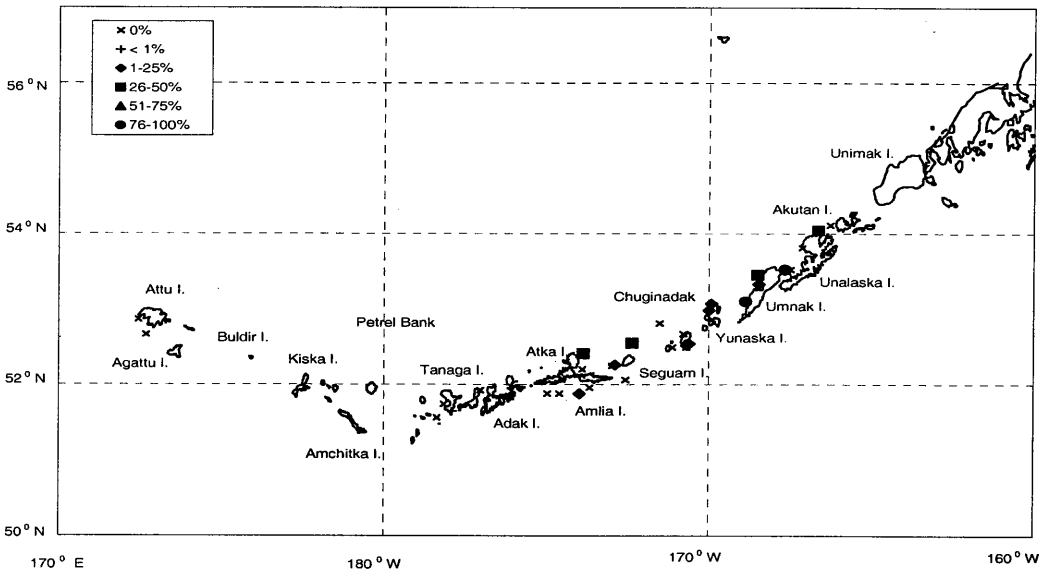

Figure 42.--Geographic distribution of walleye pollock consumed by Pacific halibut in the Aleutian Islands area in 1997.

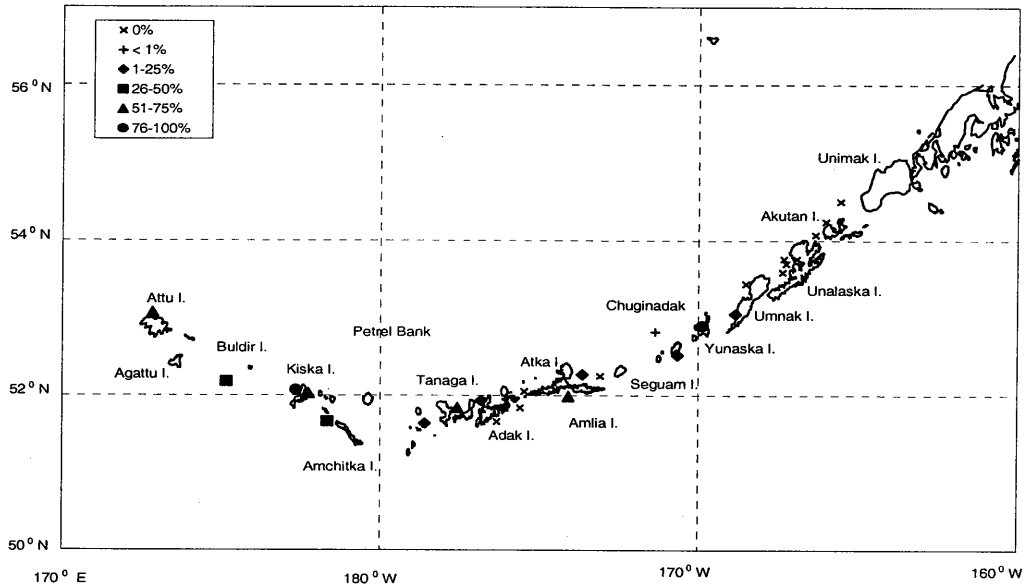

Figure 43.--Geographic distribution of Atka mackerel consumed by Pacific halibut in the Aleutian Islands area in 1994.

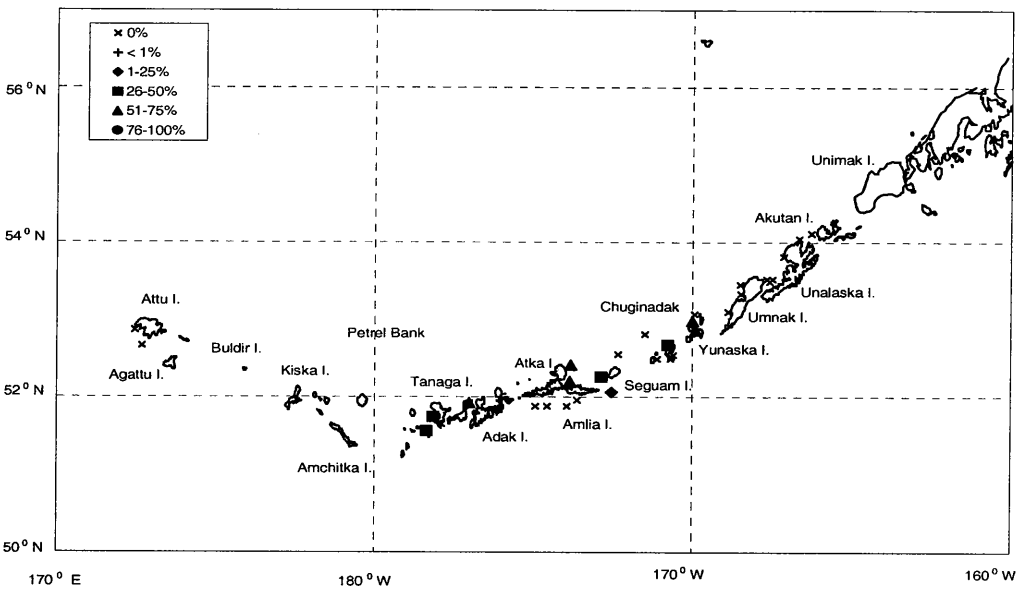

Figure 44.--Geographic distribution of Atka mackerel consumed by Pacific halibut in the Aleutian Islands area in 1997.

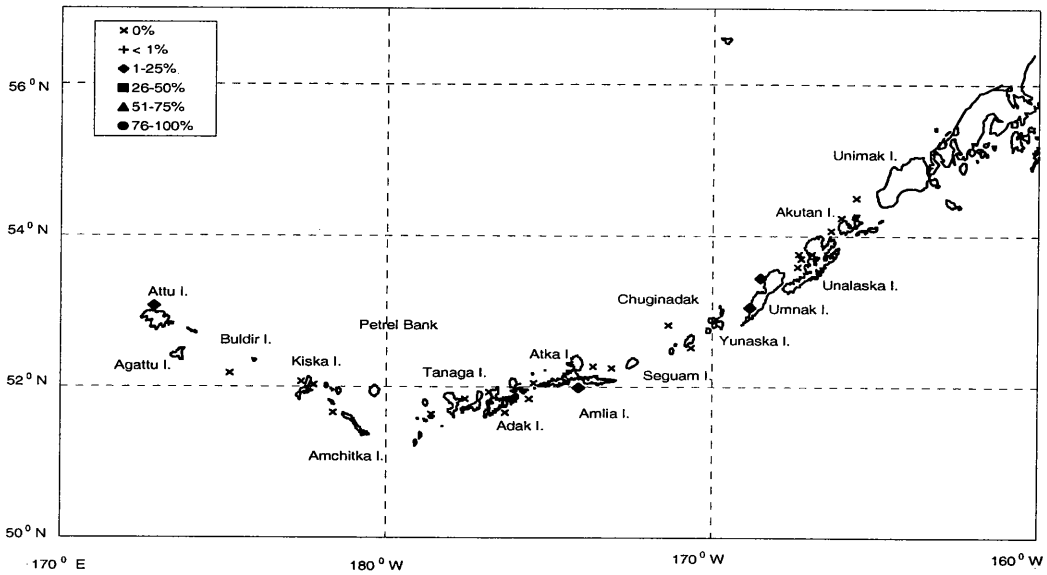

Figure 45.--Geographic distribution of Pacific sand lance consumed by Pacific halibut in the Aleutian Islands area in 1994.

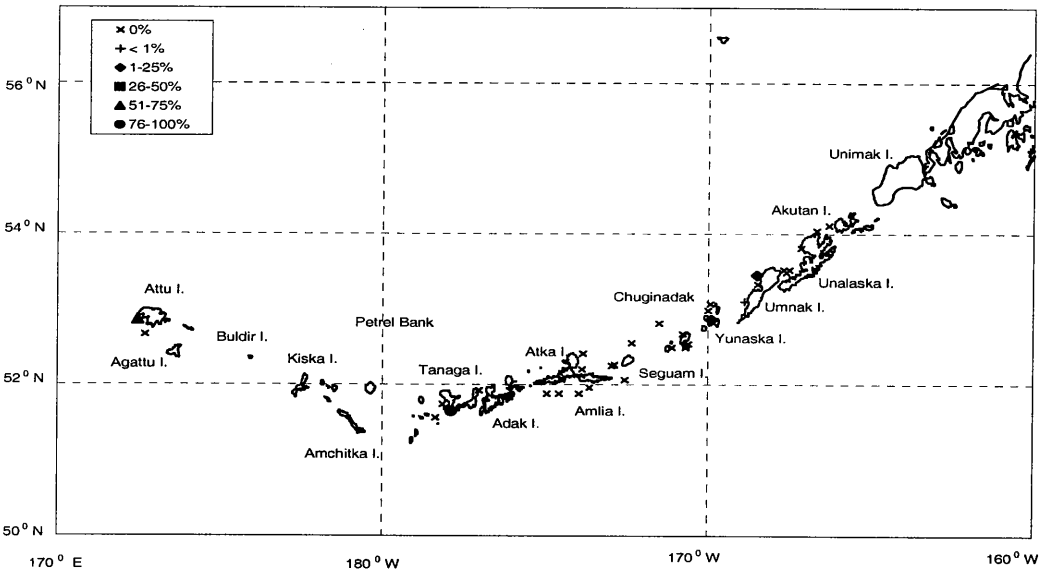

Figure 46.--Geographic distribution of Pacific sand lance consumed by Pacific halibut in the Aleutian Islands area in 1997.

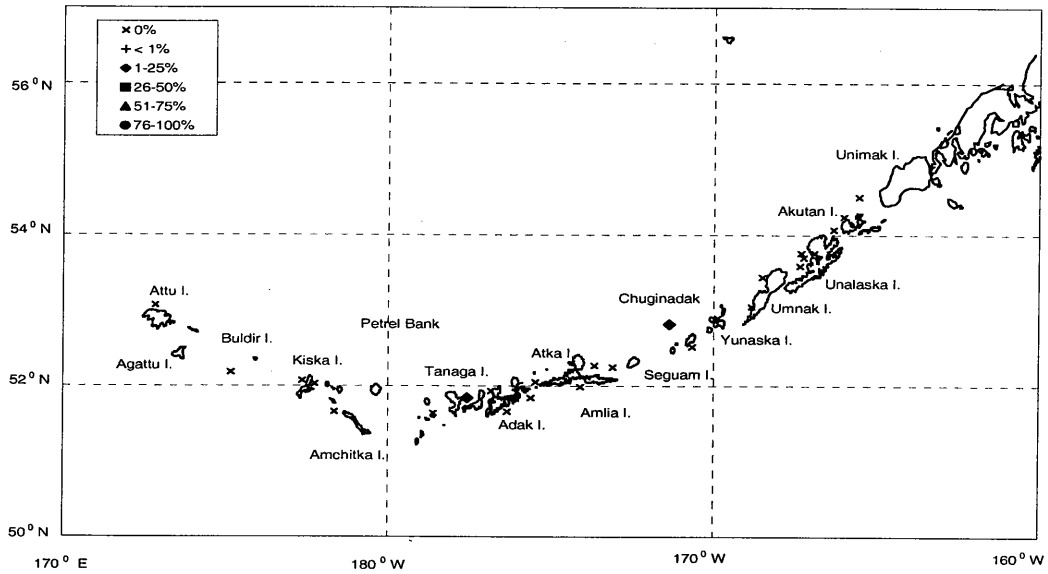

Figure 47.--Geographic distribution of myctophids consumed by Pacific halibut in the Aleutian Islands area in 1994.

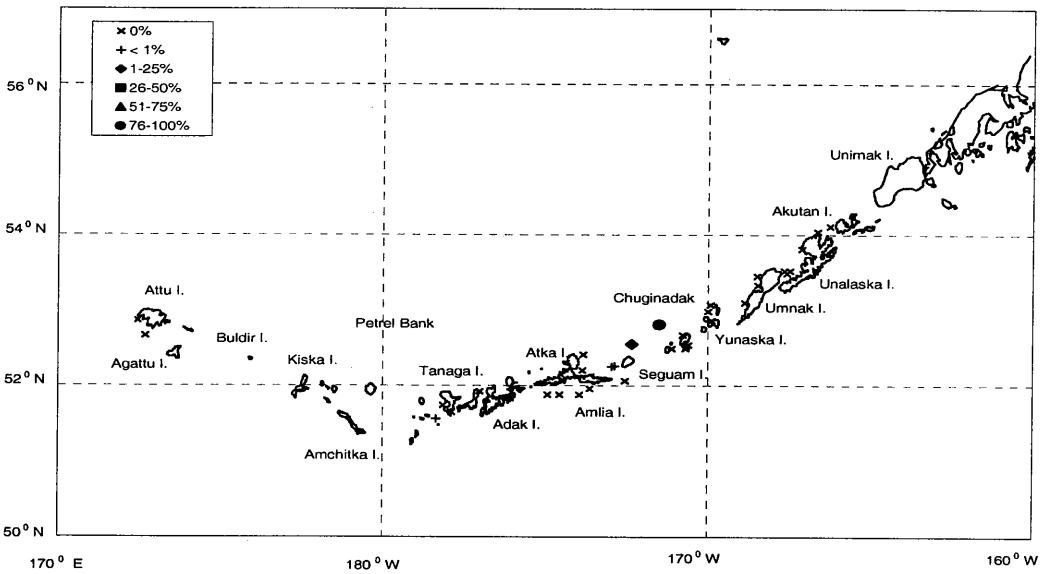

Figure 48.--Geographic distribution of myctophids consumed by Pacific halibut in the Aleutian Islands area in 1997.

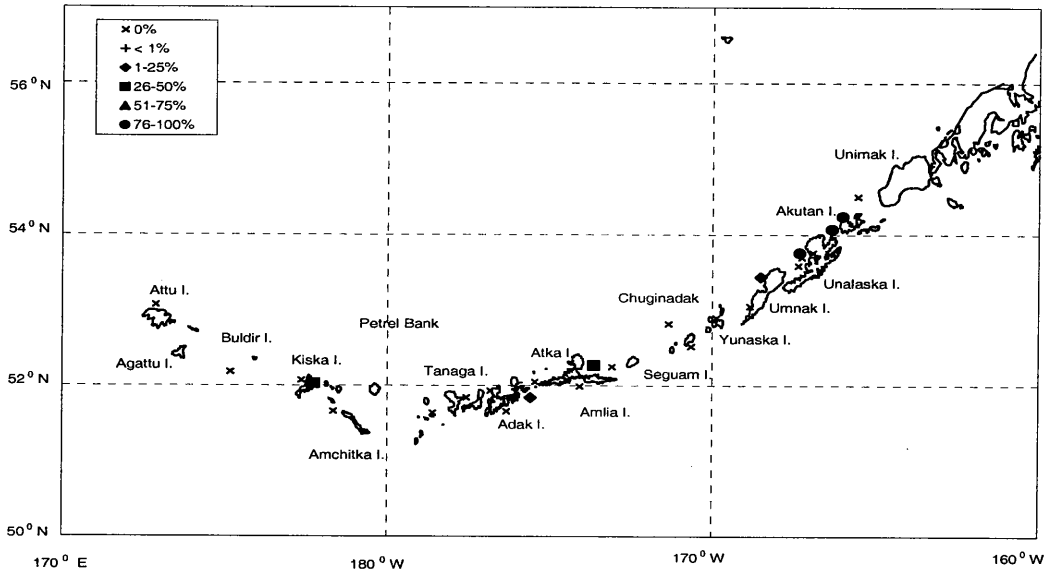

Figure 49.--Geographic distribution of fishery offal consumed by Pacific halibut in the Aleutian Islands area in 1994.

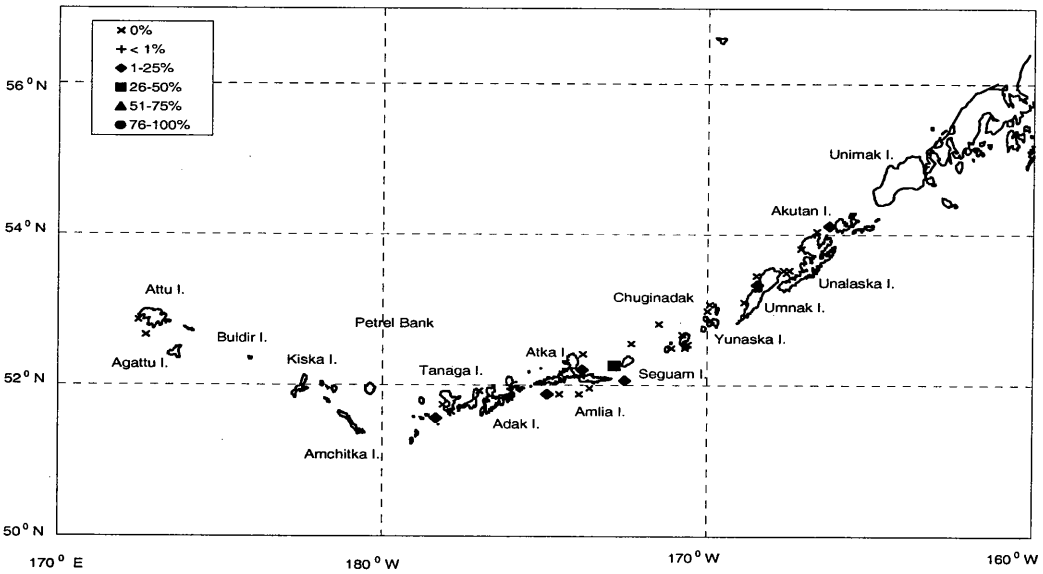

Figure 50--Geographic distribution of fishery offal consumed by Pacific halibut in the Aleutian Islands area in 1997.

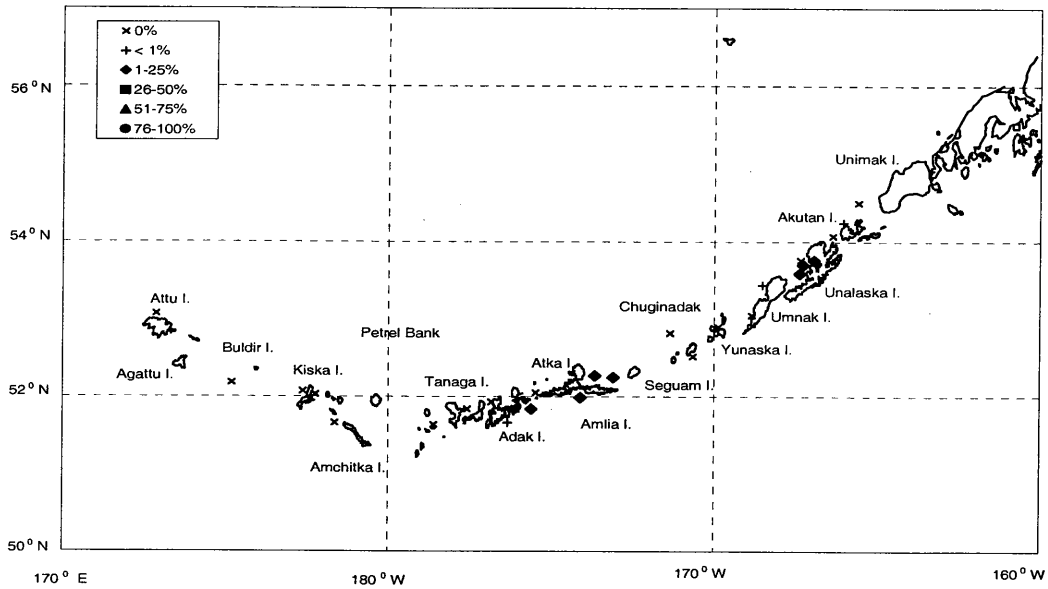

Figure 51.--Geographic distribution of Tanner crabs consumed by Pacific halibut in the Aleutian Islands area in 1994.

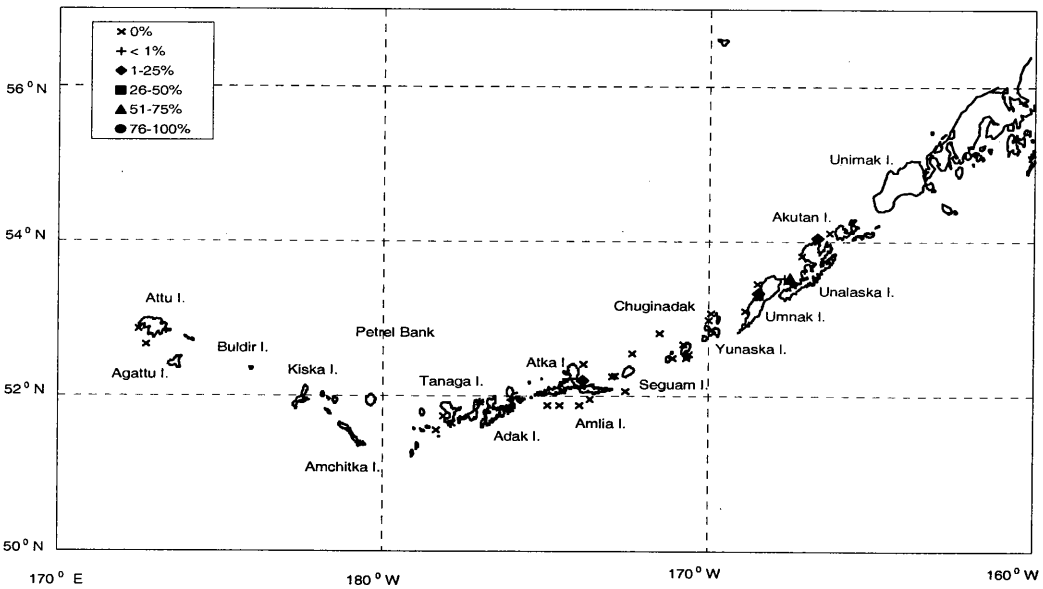

Figure 52.--Geographic distribution of Tanner crabs consumed by Pacific halibut in the Aleutian Islands area in 1997.

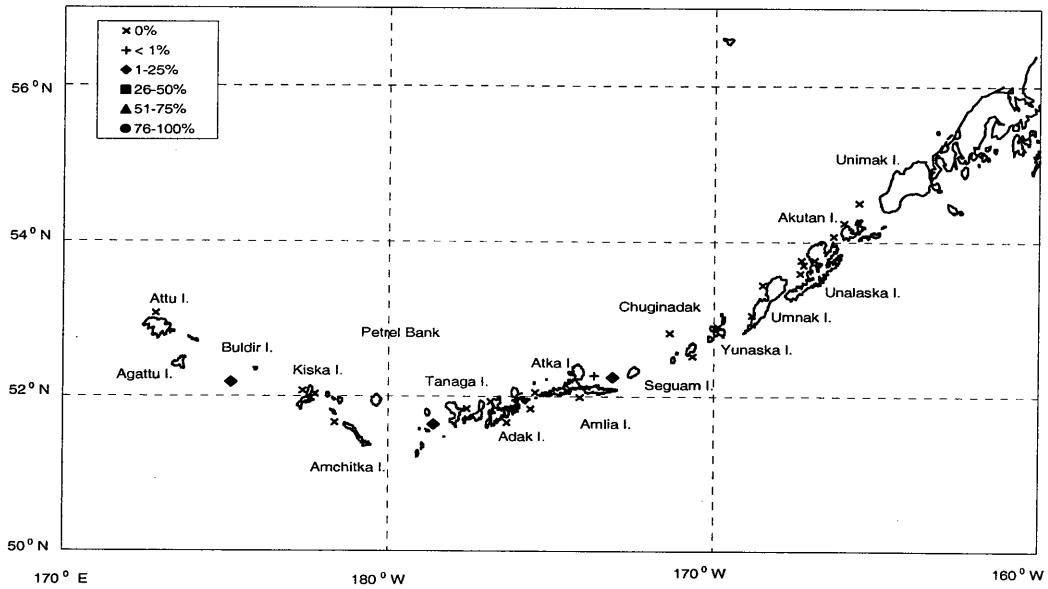

Figure 53.--Geographic distribution of Korean horse-hair crabs consumed by Pacific halibut in the Aleutian Islands area in 1994.

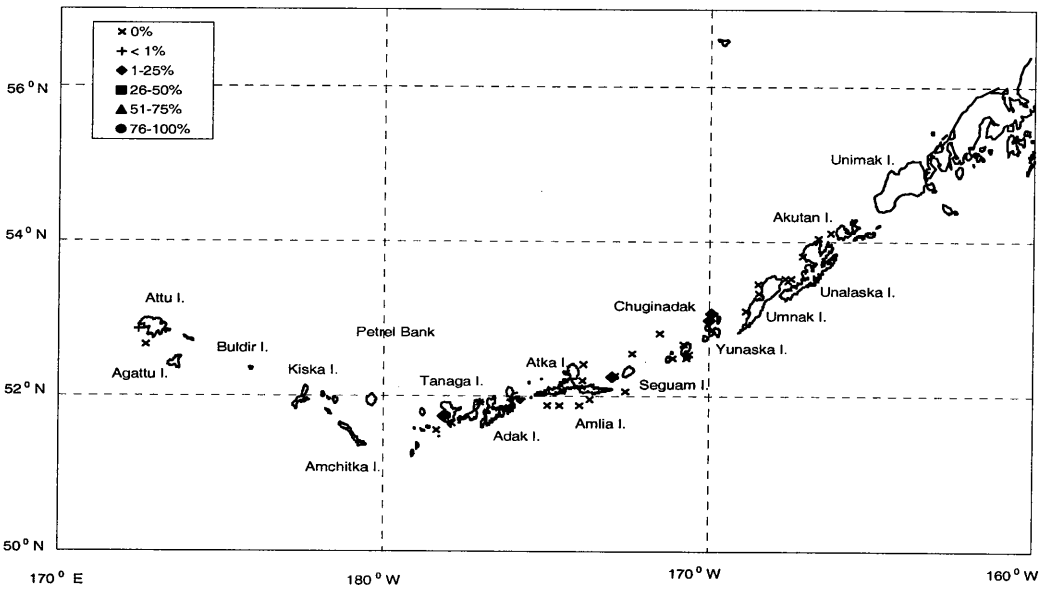

Figure 54.--Geographic distribution of Korean horse-hair crabs consumed by Pacific halibut in the Aleutian Islands area in 1997.

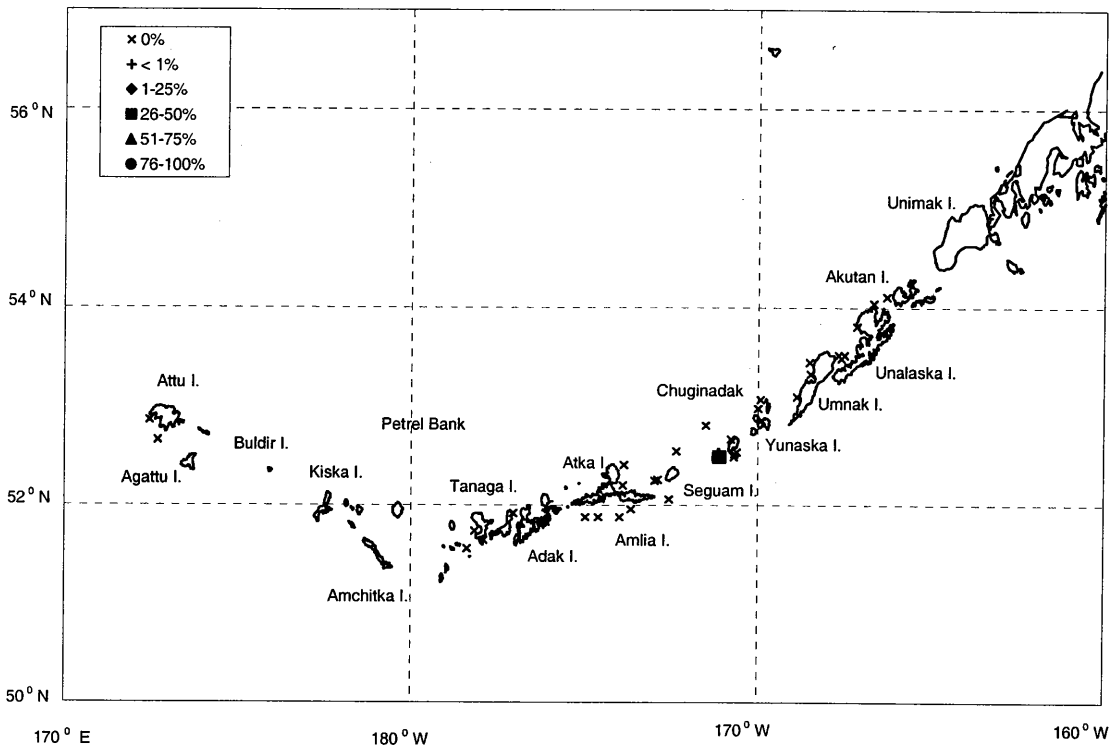

Figure 55.--Geographic distribution of Lithodidae consumed by Pacific halibut in the Aleutian Islands area in 1997.

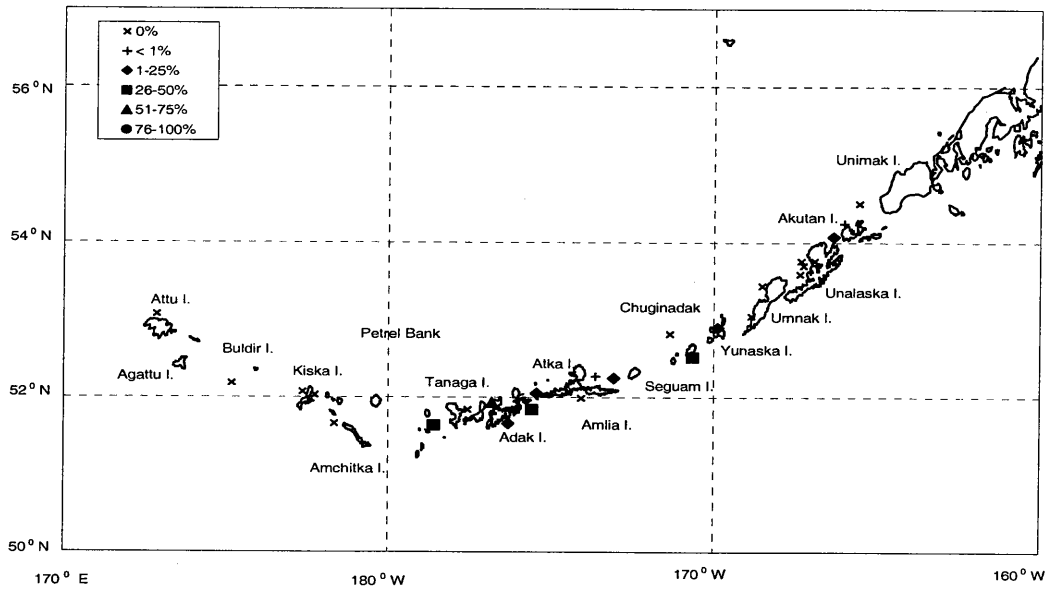

Figure 56.--Geographic distribution of lyre crabs consumed by Pacific halibut in the Aleutian Islands area in 1994.

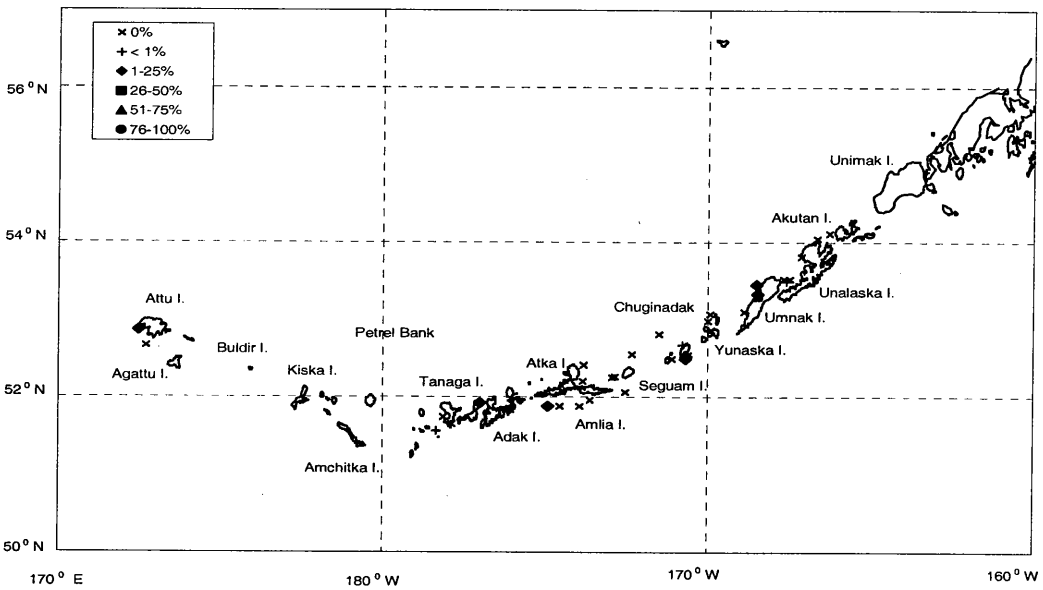

Figure 57.--Geographic distribution of lyre crabs consumed by Pacific halibut in the Aleutian Islands area in 1997.

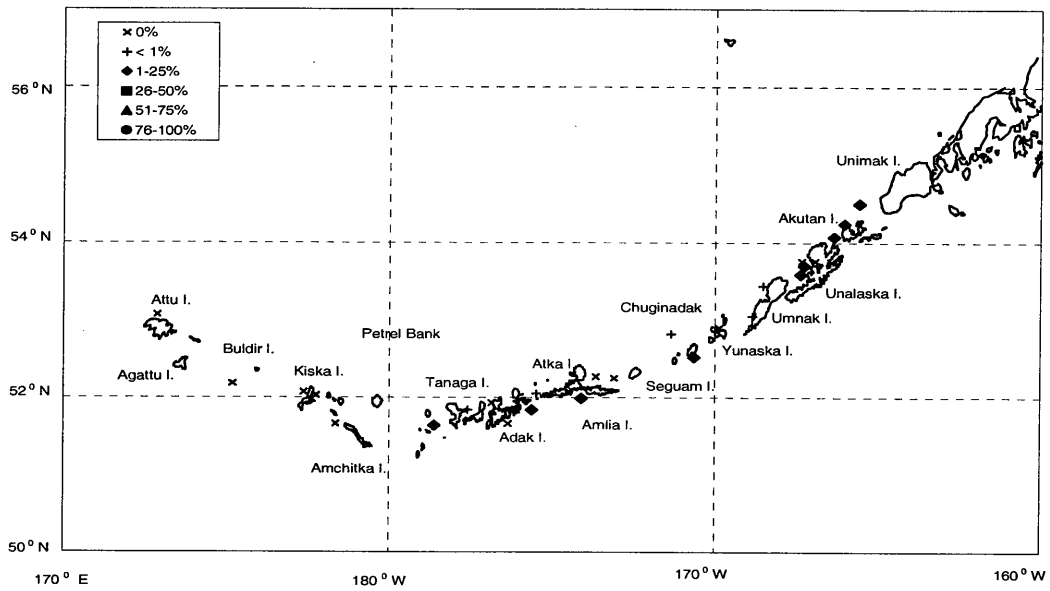

Figure 58.--Geographic distribution of hermit crabs consumed by Pacific halibut in the Aleutian Islands area in 1994.

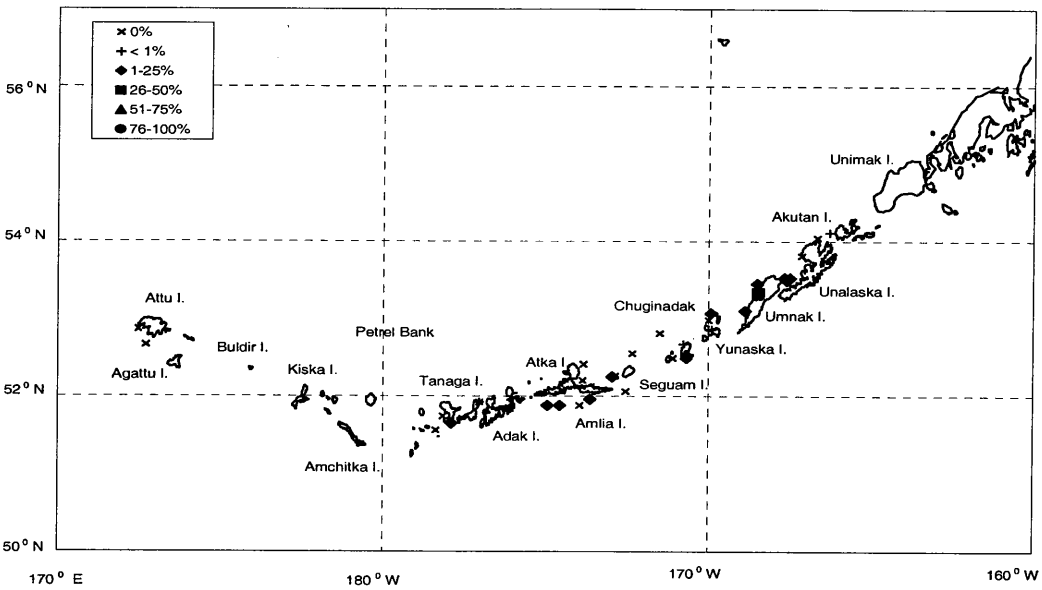

Figure 59.--Geographic distribution of hermit crabs consumed by Pacific halibut in the Aleutian Islands area in 1997.

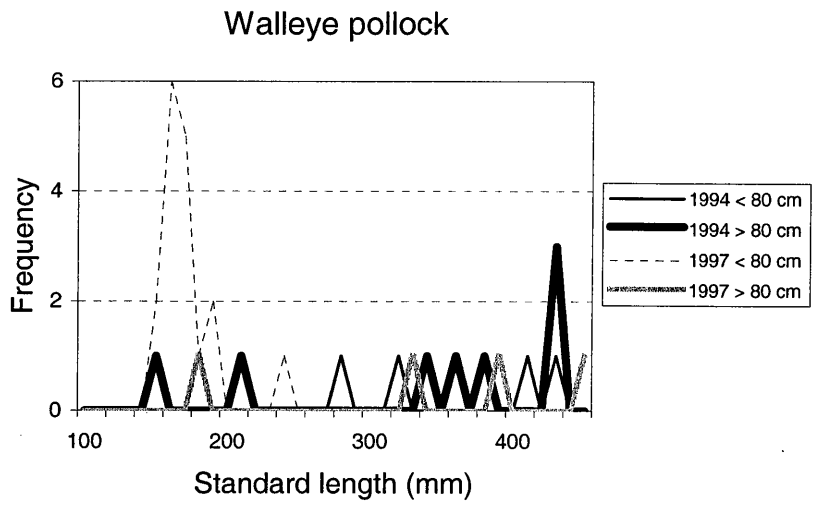

Figure 60.--Size frequency distribution of pollock consumed by Pacific halibut in the Aleutian Islands in 1994 and 1997.

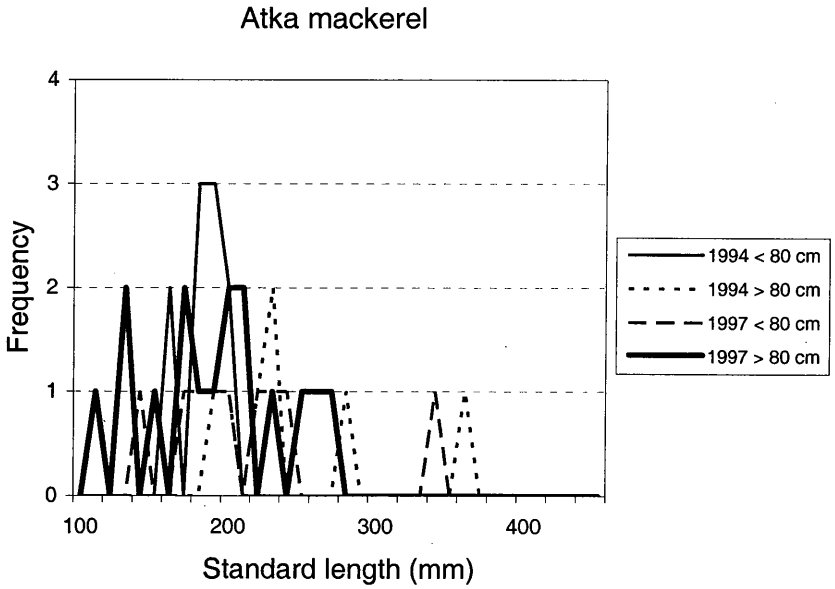

Figure 61.--Size frequency distribution of Atka mackerel consumed by Pacific halibut in the Aleutian Islands in 1994 and 1997.

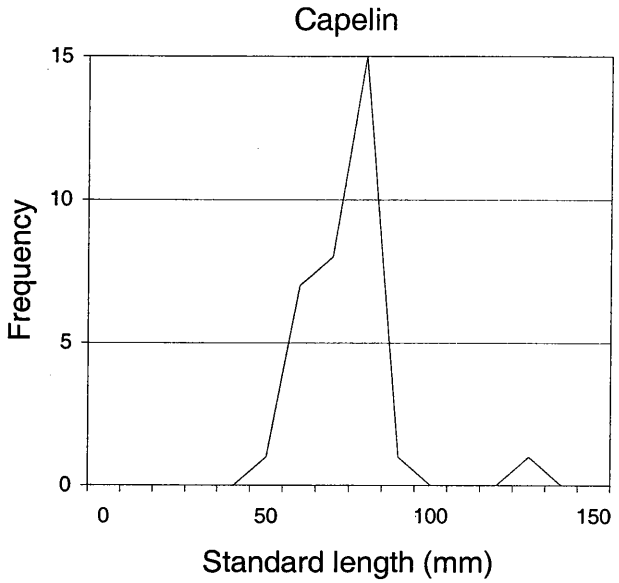

Figure 62.--Size frequency distribution of capelin consumed by Pacific halibut (< 80 cm) in the Aleutian Islands in 1997.

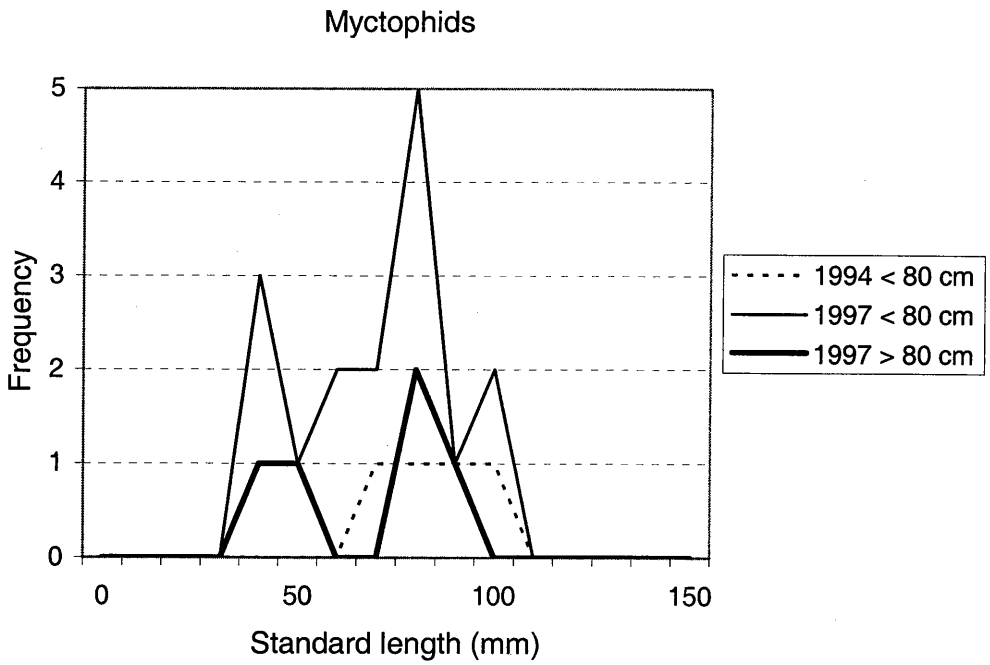

Figure 63.--Size frequency distribution of myctophids consumed by Pacific halibut in the Aleutian Islands in 1994 and 1997.

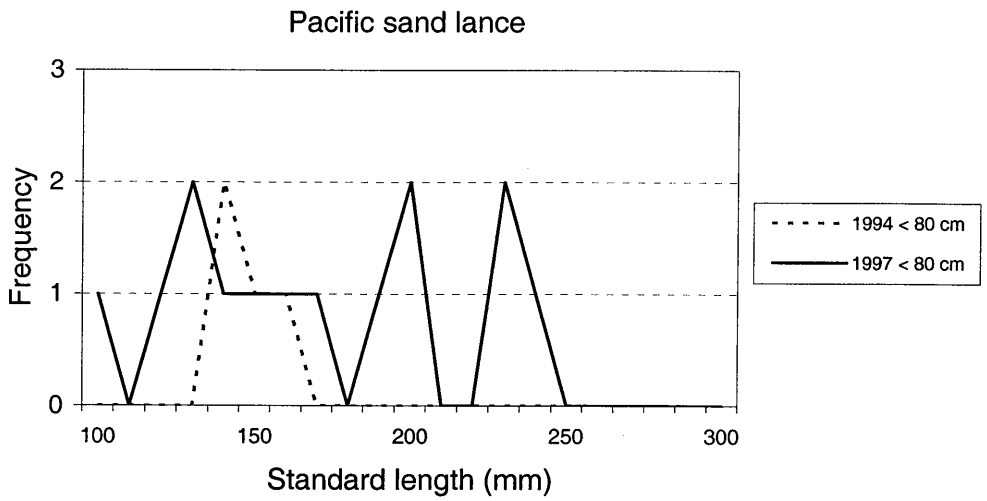

Fig. 64.--Size frequency distribution of Pacific sand lance consumed by Pacific halibut in the Aleutian Islands in 1994 and 1997.

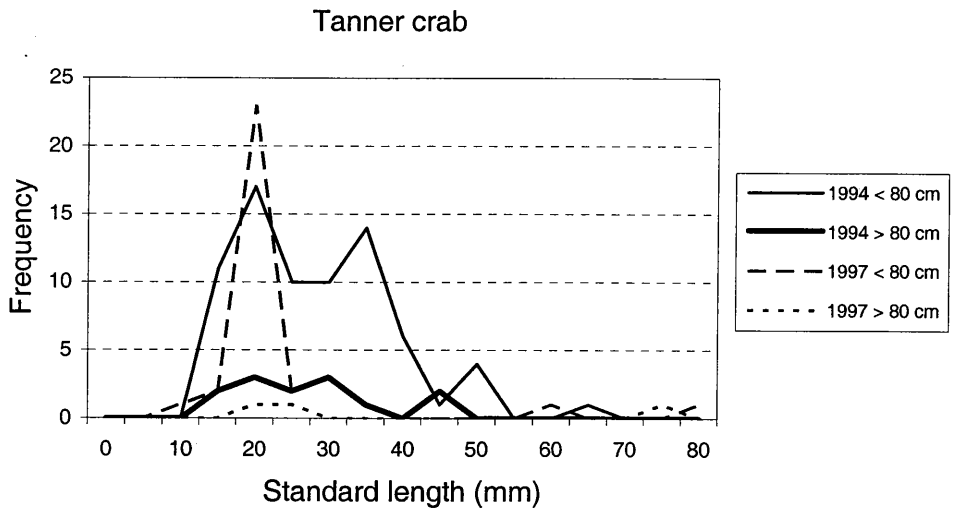

Figure 65.--Size frequency distribution of Tanner crabs consumed by Pacific halibut in the Aleutian Islands in 1994 and 1997.

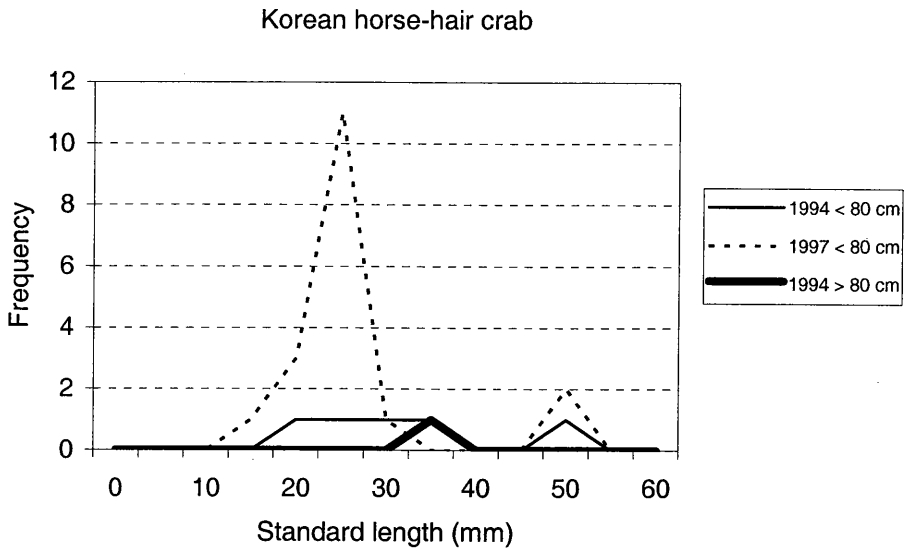

Figure 66.--Size frequency distribution of Korean horse-hair crab consumed by Pacific halibut in the Aleutian Islands in 1994 and 1997.

DISCUSSION

Table 20 lists the percent weight of the major prey categories of Pacific halibut in the Aleutian Islands area in 1991, 1994, and 1997. It shows that Pacific halibut consumed a higher percentage of cephalopods (24%), Tanner crabs (7%), and other crabs (17%) in 1991 than in 1994, and 1997. The other crabs includes hermit crabs, decorator crabs (*Oregonia* sp.), and lyre crabs (*Hyas* sp.). However, pollock and Atka mackerel comprised higher percentages of the diets on Pacific halibut in 1994 and 1997. The consumption of sculpin increased from 1991 to 1997.

Table 20.--Percent weight of the major prey categories of Pacific halibut in the Aleutian Islands area in 1991, 1994, and 1997.

Prey name	1991	1994	1997
Cephalopod	24	11	18
Tanner crab	7	3	3
Korean horse-hair crab	1	1	1
Other crabs	17	14	14
Capelin	3	0	1
Myctophid	2	1	3
Pacific cod	3	1	0
Pollock	9	20	11
Atka mackerel	10	21	15
Sablefish	2	0	0
Sculpins	1	6	12
Pacific sand lance	1	1	5
Flatfish	2	5	5

Percent similarity between 1991 and 1994 :54
Percent similarity between 1991 and 1997 :62
Percent similarity between 1994 and 1997 :68

ATKA MACKEREL

Atka mackerel (*Pleurogrammus monopterygius*) is a schooling, semi-demersal species. It is the most abundant species in the Aleutian Islands area. The projected age 3+ biomass for 2002 was estimated at 439,700 t (Lowe et al. 2001). Atka mackerel mainly feed on zooplankton. Their diet includes calanoid copepods, euphausiids, larvaceans, amphipods, and miscellaneous fish (Yang 1996).

RESULTS

General Diet

Tables 21 and 22 list the total number of stomachs containing food, number of empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in Atka mackerel. Calanoid copepods (51% and 31% by weight in 1994 and 1997, respectively) and euphausiids (35% and 32% by weight in 1994 and 1997, respectively) were the most important food of Atka mackerel. Atka mackerel also consumed some squid (5% in 1994 and 3% in 1997), polychaetes (9% in 1997), and larvaceans (1% in 1994 and 9% in 1997). Jellyfish (4%) was only consumed by Atka mackerel in 1997. Atka mackerel also consumed a small amount of miscellaneous fish (4% in 1994 and 1% in 1997).

Variation of Diet Based on Predator Size

Figure 67 illustrates the percentage by weight of the main prey items for three Atka mackerel size groups (< 25 cm, 26-35 cm, > 35 cm). Calanoid copepods were the most important food ($\geq$ 51% by weight) of all three size groups of Atka mackerel in 1994. Euphausiids were the second most important food for Atka mackerel > 25 cm in 1994. However, in 1997, the importance of calanoid copepods and euphausiids as prey of Atka mackerel were about the same. The combination of copepods and euphausiids were more than 50% by weight of the total stomach contents of each size group. Chaetognaths comprised 8% of the total stomach contents weight of the smallest size (< 25 cm) group in 1994; whereas larvaceans comprised 12% of the total stomach contents weight of this group in 1997.

Sizes of the Commercially Important Prey Consumed

In 1994, the size of Kamchatka flounder consumed by Atka mackerel ranged from 19 to 21 mm SL with a mean and SD of 20 $\pm$ 1.4 mm. Only two osmerids (19 and 40.5 mm SL) were consumed by Atka mackerel in 1994. Atka mackerel also consumed 11 cottids (standard length ranged from 13.6 to 18.0 mm SL with a mean and SD of 15.4 $\pm$ 1.5 mm). In addition, one Pacific halibut (18 mm SL) in 1994. In 1997, however, only one capelin (54 mm) and one gadid fish (19 mm) were consumed by Atka mackerel.

Table 21.-- Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Atka mackerel collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	2.52	0.01
Gastropoda (snail)	18.39	0.43
Thecosomata (pteropod)	16.90	0.14
Bivalvia (clam)	1.69	0.01
Cephalopoda (squid and octopus)	3.21	0.04
Teuthoidea (squid)	17.83	5.29
Ostracoda	1.94	0.01
Calanoida (copepod)	87.77	49.21
Calanus sp.	0.28	0.00
Neocalanus cristatus	4.01	1.15
Eucalanus bungii (copepod)	2.84	0.04
Paracalanus sp. (copepod)	0.56	0.01
Pseudocalanus sp. (copepod)	0.28	0.00
Candacia columbiae (copepod)	13.83	0.17
Cumacea (cumacean)	0.28	0.00
Amphipoda (amphipod)	0.56	0.01
Gammaridea (amphipod)	7.11	0.14
Amphipoda Hyperiidea (amphipod)	15.97	0.24
Themisto sp. (amphipod)	42.19	0.68
Themisto pacifica (amphipod)	7.80	0.17
Caprellidea (amphipod)	2.24	0.05
Euphausiacea (euphausiid)	77.43	35.16
Stylocheiron maximum	0.62	0.12
Thysanoessa inermis (euphausiid)	0.56	0.02
Thysanoessa raschii (euphausiid)	1.35	0.09
Thysanoessa spinifera (euphausiid)	0.56	0.02
Caridea (shrimp)	28.60	0.41
Ophiuroidae Ophiurida (brittle star)	0.79	0.00
Chaetognatha (arrow worm)	31.56	1.44
Sagitta sp. (arrow worm)	0.62	0.01
Larvacea Copelata	27.00	1.19
Osteichthyes Teleostei (fish)	8.54	2.88
Non-gadoid fish remains	3.09	0.70
Osmeridae (smelts)	0.56	0.04
Cottidae (sculpin)	2.41	0.08
Atheresthes evermanni (Kamchatka flounder)	0.56	0.00
Hippoglossus stenolepis (Pacific halibut)	0.56	0.00
Unidentified organic material	0.99	0.02
Unidentified worm-like organism	0.79	0.01

Table 21.--Continued

Total non-empty stomachs = 192
Total prey number = 33
Total prey weight = 1,467.6 g
Total empty stomachs = 7
Number of hauls = 18

Full stomach summary statistics
Average length = 38.3 cm
Standard deviation of length = 5.1
Minimum length = 20
Maximum length = 49

Average fullness = 4.7
Standard deviation of fullness = 1.4
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 38.9 cm
Standard deviation of length = 4.7
Minimum length = 30
Maximum length = 45

Table 22.-- Mean percent frequency of occurrence(%FO) and mean percent weight (%WT) of the prey items in the diet of Atka mackerel collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Scyphozoa (jellyfish)	9.52	3.98
Polychaeta (worm)	20.20	8.73
Aphroditidae (sea mouse)	1.39	1.49
Gastropoda (snail)	15.64	0.47
Teuthoidea (squid)	17.03	2.81
Ostracoda	0.28	0.00
Copepoda	44.46	25.05
Calanoida (copepod)	23.19	5.98
Candacia sp. (copepod)	12.80	0.18
Mysidae (mysid)	3.30	0.32
Cumacea (cumacean)	0.32	0.00
Isopoda (isopod)	0.28	0.01
Gammaridea (amphipod)	17.58	0.83
Amphipoda Hyperiidea (amphipod)	39.04	4.44
Caprellidea (amphipod)	0.88	0.01
Euphausiacea (euphausiid)	0.60	0.39
Euphausiidae (euphausiid)	54.60	29.16
Euphausia pacifica (euphausiid)	0.56	0.64
Thysanoessa sp. (euphausiid)	1.41	1.34
Reptantia (crab)	4.17	0.04
Lebbeus groenlandicus (shrimp)	0.32	1.19
Ectoprocta (bryozoan)	0.28	0.01
Chaetognatha (arrow worm)	9.49	1.01
Thaliacea (Pelagic salp)	5.85	2.32
Larvacea Copelata	31.38	8.83
Osteichthyes Teleostei (fish)	1.11	0.08
Non-gadoid fish remains	0.28	0.08
Fish eggs	0.28	0.02
Thaleichthys pacificus (eulachon)	0.28	0.01
Gadidae (gadid fish)	1.11	0.39
Aves (bird part)	0.58	0.00
Unidentified eggs	1.17	0.18
Unidentified tube	0.60	0.02

Table 22.--Continued.

Total non-empty stomachs = 243
Total prey number = 39,161
Total prey weight = 1,898.9g
Total empty stomachs = 9
Number of hauls = 24

Full stomach summary statistics
Average length = 36.7 cm
Standard deviation of length = 5.2
Minimum length = 21
Maximum length = 48

Average fullness = 4.5
Standard deviation of fullness = 1.3
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 31.9 cm
Standard deviation of length = 7.4
Minimum length = 21
Maximum length = 40

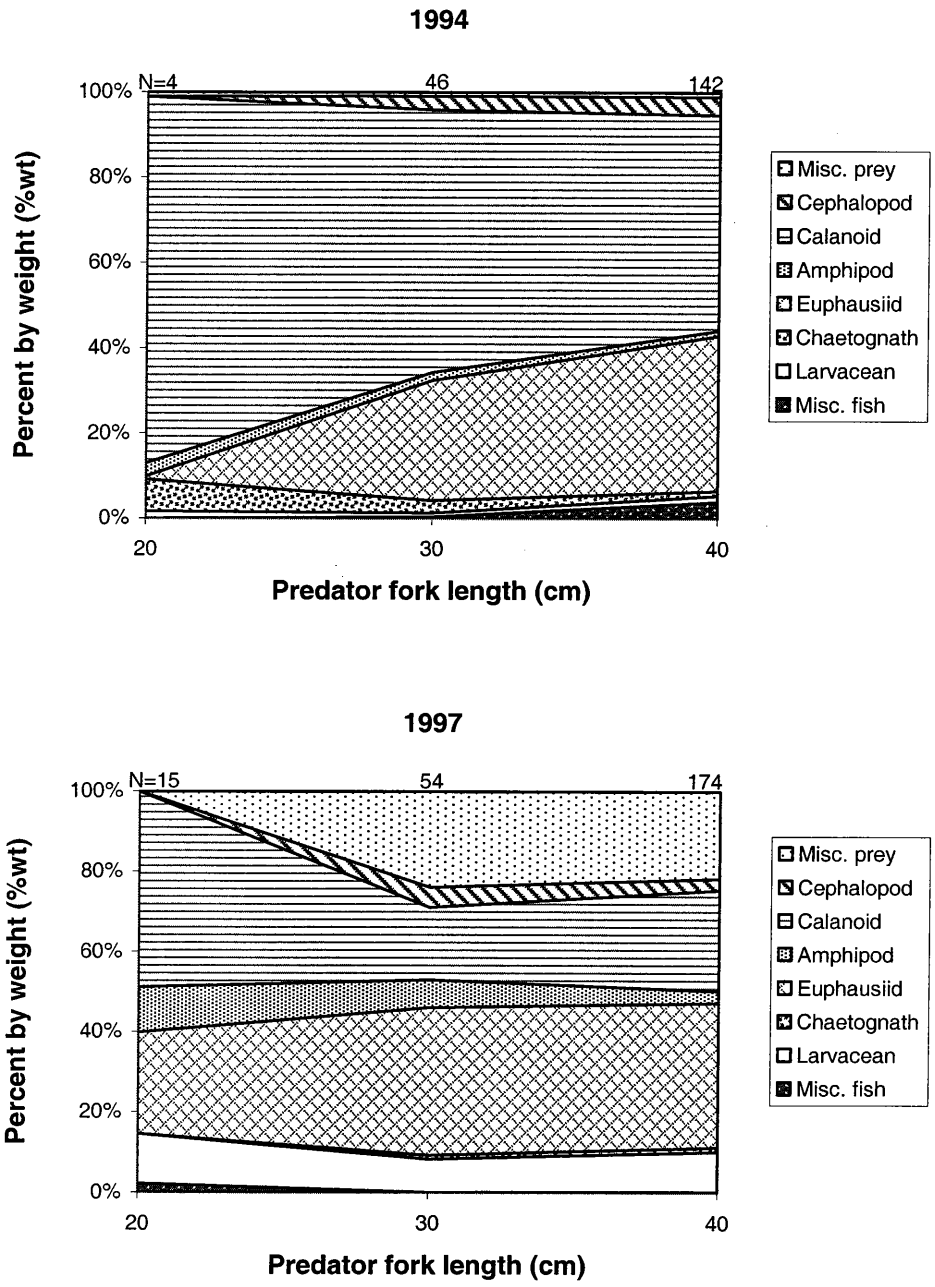

Figure 67.--Variations in the main prey of Atka mackerel, by predator size, in the Aleutian Islands in 1994 and 1997.
N = number of stomachs containing food.

DISCUSSION

The percent weight of the main prey categories of Atka mackerel in the Aleutian Islands area in 1991, 1994, and 1997 are listed in Table 23. Calanoid copepods and euphausiids were the most important prey of Atka mackerel in all three years. In 1994, calanoid copepods comprised more than half (51%) of the total stomach contents weight of Atka mackerel collected. More fish species (myctophid, pollock, eelpout, and prickleback) were found in 1991 than in 1994 and 1997. Yang (1996) found egg cannibalism by Atka mackerel in the samples collected in 1991. However, no Atka mackerel eggs were found from the 1994 or 1997 samples (though unidentified fish eggs made up a small amount (< 1%) in the 1997 sample).

Table 23. Percent weight of the major prey categories of Atka mackerel in the Aleutian Islands area in 1991, 1994, and 1997.

Prey name	1991	1994	1997
Jellyfish	0	0	4
Polychaete	1	0	10
Gastropoda	1	1	1
Unidentified crustacean	5	0	0
Calanoid copepod	23	51	31
Euphausiids	29	35	32
Shrimp	1	1	1
Crab	1	0	0
Chaetognath	1	1	1
Salp	0	0	2
Larvacean	10	1	9
Unidentified fish	0	4	0
Myctophid	1	0	0
Pollock	2	0	0
Eelpout	1	0	0
Atka mackerel eggs	6	0	0
Prickleback	1	0	0
Unidentified organic materials	10	0	0

Percent similarity between 1991 and 1994 :61
Percent similarity between 1991 and 1997 :65
Percent similarity between 1994 and 1997 :67

GREENLAND TURBOT

Greenland turbot (*Reinhardtius hippoglossoides*) is a large flatfish with symmetrical mouth. They feed mainly on squids, myctophids, and some miscellaneous fish (Yang 1996). The total biomass of the Greenland turbot in the eastern Bering Sea and Aleutian Islands area in 2002 was projected as 132,000 tons (Ianelli et al. 2001). The survey estimates of Greenland turbot in the Aleutian Islands in 2000 was 9,452 tons. Because of the piscivorous feeding habits, it is important to study the diet of the Greenland turbot in the Aleutian Islands area.

RESULTS

General Diet

Data on the total number of stomachs containing food, the number of empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in Greenland turbot are summarized in Tables 24 and 25. Myctophids (31% and 22% by weight in 1994 and 1997, respectively) were the most important prey fish consumed by Greenland turbot. Greenland turbot also consumed Atka mackerel (9%), walleye pollock (6%), deepsea smelts (7%), and viperfish (8%) in 1994. However, in 1997, viperfish (12%) was the only prey fish other than myctophids consumed by Greenland turbot. Squids (28% and 45% by weight in 1994 and 1997, respectively) were the most important invertebrate consumed by Greenland turbot.

Variation of Diet Based on Predator Size

Figure 68 illustrates the percentage by weight of the main prey items for different Greenland turbot size groups (< 70 cm, 70-79 cm, and ≥ 80 cm) in 1994. No Greenland turbot smaller than 60 cm were collected in this study. Also, the diet data for 1997 was not analyzed for different size groups due to small sample sizes. There is no specific diet trend in different size groups of Greenland turbot. They mainly consumed fish (myctophids, Atka mackerel, pollocks and miscellaneous fish) and squid.

Geographic Distributions of the Prey Consumed

Figures 69 and 70 show that myctophids were consumed by Greenland turbot primarily in the areas around Seguam

Island, Yunaska Island, and west of Tanaga Island in 1994; however, in 1997, high percentages of myctophids in the diet were mainly found in samples collected around Attu Island.

Sizes of the Important Prey Consumed

Greenland turbot consumed one Atka mackerel (205 mm SL) and two walleye pollock (470 and 480 mm SL) in 1994. They also consumed deepsea smelts (Bathylagidae), veiled angel mouth (*Cyclothone microdon*), Pacific viperfish (*Chauliodus macouni*), sculpins (cottids). The number, mean standard length, and the Standard deviation of these prey are listed in Table 26. In 1997, Greenland turbot consumed one Pacific viperfish (130 mm SL) and two myctophids (95 and 96 mm SL).

Table 24.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Greenland turbot collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Teuthoidea (squid)	22.99	28.34
Octopoda (octopus)	2.78	0.27
Gnathophausia sp.	5.21	0.42
Euphausiacea (euphausiid)	2.08	0.06
Non-gadoid fish remains	8.68	0.63
Bathylagidae (deepsea smelts)	9.72	6.64
Leuroglossus schmidti (Northern smooth tongue)	2.78	1.68
Cyclothone microdon (veiled angelmouth)	4.17	0.25
Chauliodus macouni (Pacific viperfish)	5.90	7.55
Myctophidae (lanternfish)	36.18	30.59
Theragra chalcogramma (walleye pollock)	3.33	5.86
Pleurogrammus monopterygius (Atka mackerel)	3.82	9.25
Cottidae (sculpin)	1.04	0.12
Fishery offal	8.33	8.33

Total non-empty stomachs = 46
Total prey number = 74
Total prey weight = 3,237.5g
Total empty stomachs = 59
Number of hauls = 12

Full stomach summary statistics
Average length = 70.1 cm
Standard deviation of length = 8.4 cm
Minimum length = 61 cm
Maximum length = 98 cm

Average fullness = 4.0
Standard deviation of fullness = 1.4
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 70.6 cm
Standard deviation of length = 7.9 cm
Minimum length = 61 cm
Maximum length = 101 cm

Table 25.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Greenland turbot collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Teuthoidea (squid)	36.67	44.71
Gnathophausia sp.	16.67	20.61
Osteichthyes Teleostei (fish)	13.33	0.31
Chauliodontidae (viperfishes)	11.11	11.95
Myctophidae (lanternfish)	35.56	22.43

Total non-empty stomachs = 10
Total prey number = 12
Total prey weight = 671.2g
Total empty stomachs = 29
Number of hauls = 3

Full stomach summary statistics
Average length = 69.7 cm
Standard deviation of length = 7.8 cm
Minimum length = 62 cm
Maximum length = 90 cm

Average fullness = 4.2
Standard deviation of fullness = 1.9
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 75.7 cm
Standard deviation of length = 10.4 cm
Minimum length = 61 cm
Maximum length = 99 cm

Table 26.--Mean standard length (SL), standard deviation (SD), and range of standard length of the miscellaneous prey fish consumed by Greenland turbot in the Aleutian Islands in 1994. N = number of measurable prey.

Prey name	N	Mean SL (mm)	SD (mm)	Range(mm)
Walleye pollock	2	475.0	7.0	470-480
Atka mackerel	1	205.0	0.0	205-205
Myctophid	21	64.7	19.2	32-102
Sculpins	1	40.0	0.0	40-40
Deepsea smelts	4	88.3	25.9	68-76
Veiled angel mouth	6	47.0	3.3	43-52
Pacific viperfish	3	138.0	61.0	96-208

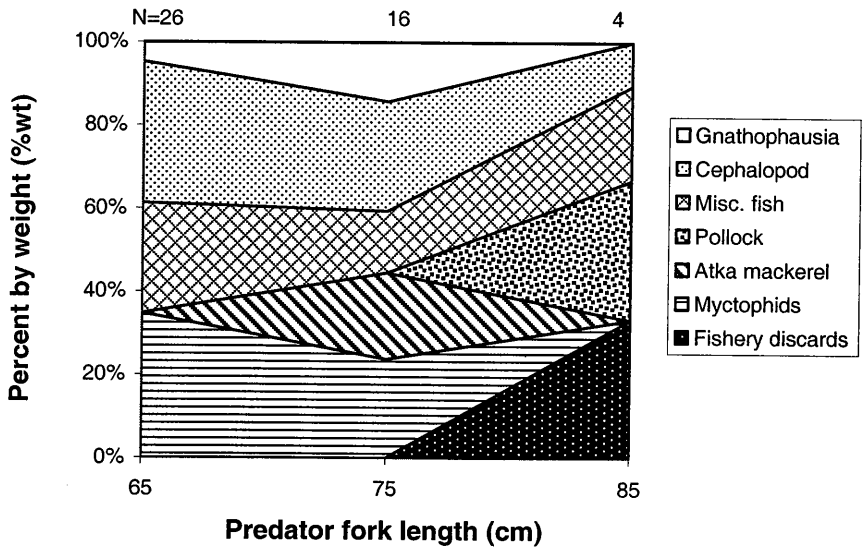

Figure 68.--Variations in the main prey of Greenland turbot, by predator size, in the Aleutian Islands in 1994.
N = number of stomachs containing food.

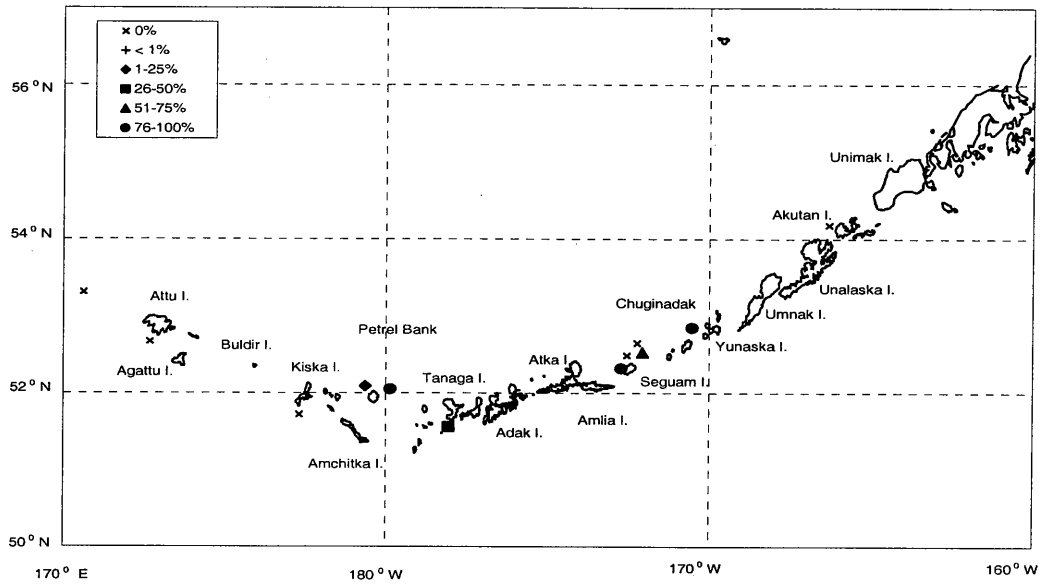

Figure 69.--Geographic distribution of myctophids consumed by Greenland turbot in the Aleutian Islands area in 1994.

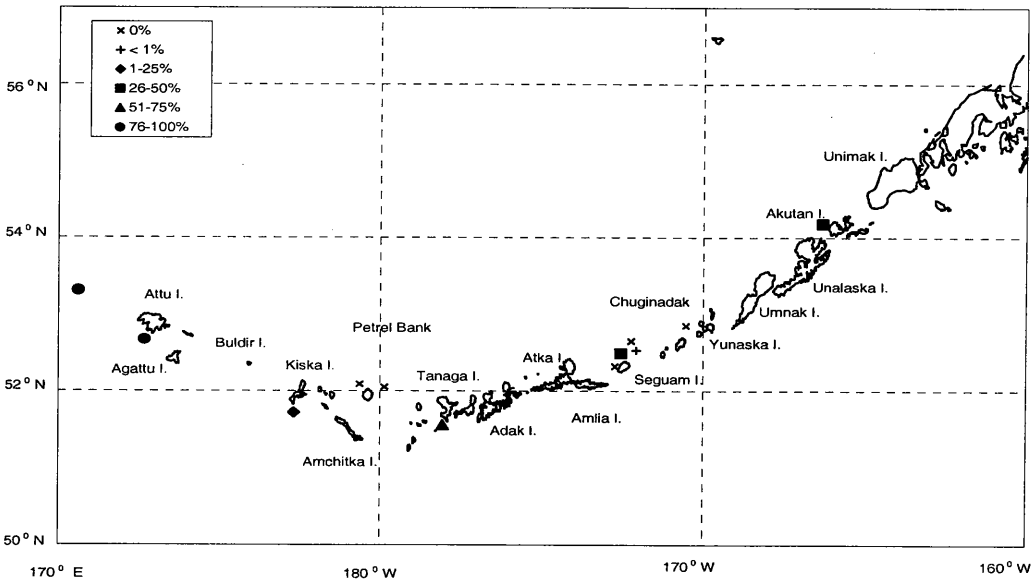

Figure 70.--Geographic distribution of squids consumed by Greenland turbot in the Aleutian Islands area in 1994.

DISCUSSION

Table 27 lists the percent weight of the major prey categories of Greenland turbot in the Aleutian Islands area in 1991, 1994, and 1997. Squid was the most important prey of Greenland turbot for all three years. Squid made up from 28% to 45% of the total stomach content weights of Greenland turbot. Myctophids were also important food for Greenland turbot in all years. Pollock (19%) was more important in 1991 (19%) than in 1994 (6%). *Gnathophausia* sp. comprised a high (21%) percent of total stomach content weight in 1997. It is probably due to small sample size (n=10).

Table 27. Percent weight of the major prey categories of Greenland turbot in the Aleutian Islands area in 1991, 1994, and 1997.

Prey name	1991	1994	1997
Squid	37	28	45
Gnathophausia sp.	0	1	21
Bathylagid	9	8	0
Pacific viperfish	1	8	12
Myctophid	10	31	22
Pollock	19	6	0
Atka mackerel	0	9	0

Percent similarity between 1991 and 1994 :53
Percent similarity between 1991 and 1997 :48
Percent similarity between 1994 and 1997 :59

PACIFIC OCEAN PERCH

Pacific ocean perch (*Sebastes alutus*) is the most important species of rockfish harvested in the eastern Bering Sea and Aleutian Islands region (Spencer and Ianelli 2001). The estimated exploitable biomass (ages 3+) of Pacific ocean perch in the eastern Bering Sea and Aleutian Islands in 2000 was 285,887 tons (Spencer and Ianelli, 2001). Pacific ocean perch is mainly a zooplankton feeder. Their food includes calanoid copepod, euphausiids, myctophids, and miscellaneous prey (Yang 1996).

RESULTS

Tables 28 and 29 summarize the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in Pacific ocean perch. Calanoid copepods (46% and 28% by weight in 1994 and 1997, respectively) and euphausiids (26% and 30% in 1994 and 1997, respectively) were the most important prey of Pacific ocean perch. Chaetognath, mysids, amphipods, and polychaetes were also found frequently; however, they comprised low percentages by weight of the total diet of Pacific ocean perch. Myctophids were the most important prey fish consumed by Pacific ocean perch; they comprised 11% and 12% of the total stomach contents weight in 1994 and 1997, respectively.

Figure 71 shows the variation in Pacific ocean perch diet as a function of fish fork length. Small ($\leq$ 25 cm FL) Pacific ocean perch fed mainly on calanoid copepods (89%) in 1997, whereas all size groups of Pacific ocean perch in 1994 and medium-sized (26-35 cm FL) and large (> 35 cm FL) Pacific ocean perch in 1997 consumed high percentages of euphausiids ($\geq$ 18%) and calanoid copepods ($\geq$ 15%). This figure also shows that myctophids (about 10%) were consumed by medium-sized and large fish in both 1994 and 1997.

The distribution of myctophids consumption by Pacific ocean perch are shown in Figures 72 and 73. High percentages of myctophids consumed by Pacific ocean perch were around Seguam Island and Yunaska Island areas in 1994 (Fig. 72); however, in 1997, myctophids were found in samples mainly in the Kiska Island, Buldir Island, and Attu Island areas.

Figure 74 illustrates the size frequency distribution of myctophids consumed by Pacific ocean perch. They had a mean standard length (±SD) of 45.6 ± 25.6 mm with a range from 19 to 96 mm SL in 1994, whereas the value of that in 1997 was 39.7 ± 21.7 mm with a range from 17 to 109 mm SL. Pacific ocean perch also consumed four northern smooth tongue (*Leuroglossus schmidti*) in 1994. They had a mean standard length (±SD) of 59 ± 31.1 mm with a range from 38 to 105 mm. In 1994, Pacific Ocean perch also consumed four viperfish. They had a mean standard length (±SD) of 81.5 ± 15.8 mm with a range from 19 to 96 mm SL. In 1997, Pacific Ocean perch also consumed one viperfish with 68 mm standard length.

DISCUSSION

Based on the percent weight of the major prey categories of Pacific ocean perch in the Aleutian Islands area in 1991, 1994, and 1997, calanoid copepods, euphausiids, and myctophids were the most important prey of Pacific ocean perch. The combination of these three prey groups comprised more than 70% of the total stomach content weight of each year. However, for each prey group, the variations between different years can be big. For example, calanoid copepod comprised 18% of the total stomach contents weight in 1991, but it comprised 46% of the total stomach contents weight in 1994. Myctophids were the most important prey fish for Pacific ocean perch in all years. The variations between these years were not large. They ranged from 11% to 17% of the total stomach contents weight.

Table 28.--Mean percent frequency of occurrence (%FO), mean percent weight (%WT) of the prey items in the diet of Pacific ocean Perch collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Foraminiferida (protozoan)	0.29	0.02
Tomopteridae (polychaete)	0.59	0.01
Gymnosomata (pteropod)	2.56	0.07
Teuthoidea (squid)	5.80	3.61
Crustacea	0.33	0.03
Calanoida (copepod)	75.66	44.93
Eucalanus sp. (copepod)	0.33	0.56
Candacia sp. (copepod)	1.57	0.09
Gnathophausia sp.	0.91	0.19
Eucopiidae	2.02	0.17
Eucopia sp.	0.33	0.18
Mysidacea Mysida (mysid)	0.85	0.03
Mysidae (mysid)	1.53	0.17
Isopoda (isopod)	0.29	0.00
Gammaridea (amphipod)	3.94	0.28
Amphipoda Hyperiidea (amphipod)	4.20	0.12
Themisto sp. (amphipod)	15.33	1.06
Caprellidea (amphipod)	0.21	0.01
Euphausiacea (euphausiid)	29.29	13.68
Euphausiidae (euphausiid)	15.92	6.40
Thysanoessa sp. (euphausiid)	3.92	4.24
Thysanoessa longipes (euphausiid)	0.29	0.10
Thysanoessa spinifera (euphausiid)	1.80	1.33
Caridea (shrimp)	4.99	0.31
Oplophoridae (shrimp)	0.29	0.02
Chaetognatha (arrow worm)	30.79	6.54
Sagitta sp. (arrow worm)	0.42	0.76
Larvacea Copelata	1.08	0.09
Osteichthyes Teleostei (fish)	1.30	0.30
Non-gadoid fish remains	2.93	1.16
Bathylagidae (deepsea smelts)	0.59	0.15
Leuroglossus schmidti (northern smooth tongue)	0.15	0.19
Chauliodontidae (viperfishes)	1.07	2.12
Chauliodus macouni (Pacific viperfish)	0.51	0.56
Myctophidae (lanternfish)	10.58	10.55

Total non-empty stomachs = 273
Total prey number = 282
Total prey weight = 430.8g
Total empty stomachs = 78
Number of hauls = 34

Table 28.—Continued.

Full stomach summary statistics
Average length = 33.5 cm
Standard deviation of length = 5.6
Minimum length = 20
Maximum length = 46

Average fullness = 3.9
Standard deviation of fullness = 1.3
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 35.3 cm
Standard deviation of length = 4.9
Minimum length = 21
Maximum length = 44

Table 29.--Mean percent frequency of occurrence(%FO) and mean percent weight (%WT)of the prey items in the diet of Pacific ocean perch collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Polychaeta (worm)	2.43	0.77
Gastropoda (snail)	0.11	0.01
Teuthoidea (squid)	4.45	1.32
Crustacea	2.95	2.88
Copepoda	23.74	12.92
Calanoida (copepod)	34.65	15.17
Candacia sp. (copepod)	1.99	0.04
Gnathophausia sp. (mysid)	0.97	0.27
Mysidae (mysid)	4.40	0.61
Gammaridea (amphipod)	4.57	1.11
Amphipoda Hyperiidea (amphipod)	16.82	3.90
Euphausiacea (euphausiid)	0.71	0.05
Euphausiidae (euphausiid)	46.58	26.95
Thysanoessa sp. (euphausiid)	3.33	1.66
Thysanoessa longipes (euphausiid)	1.99	1.60
Reptantia (crab)	0.46	0.01
Pasiphaeidae (shrimp)	0.43	0.41
Crangonidae (shrimp)	0.30	0.04
Natantia (shrimp)	0.21	0.07
Chaetognatha (arrow worm)	16.59	7.29
Thaliacea (Pelagic salp)	0.62	0.65
Larvacea Copelata	2.36	0.98
Osteichthyes Teleostei (fish)	5.33	6.53
Non-gadoid Fish Remains	2.05	2.30
Chauliodontidae (viperfishes)	0.21	0.00
Myctophidae (lanternfish)	13.98	12.33
Macrouridae (rattail)	0.30	0.09
Unidentified organic material	0.43	0.05

Table 29--Continued.

Total non-empty stomachs = 292
Total prey number = 4,822
Total prey weight = 602.3g
Total empty stomachs = 173
Number of hauls = 47

Full stomach summary statistics
Average length = 28.8 cm
Standard deviation of length = 11.5
Minimum length = 6 cm
Maximum length = 46 cm

Average fullness = 3.9
Standard deviation of fullness = 1.4
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 35.0 cm
Standard deviation of length = 6.3
Minimum length = 8 cm
Maximum length = 58 cm

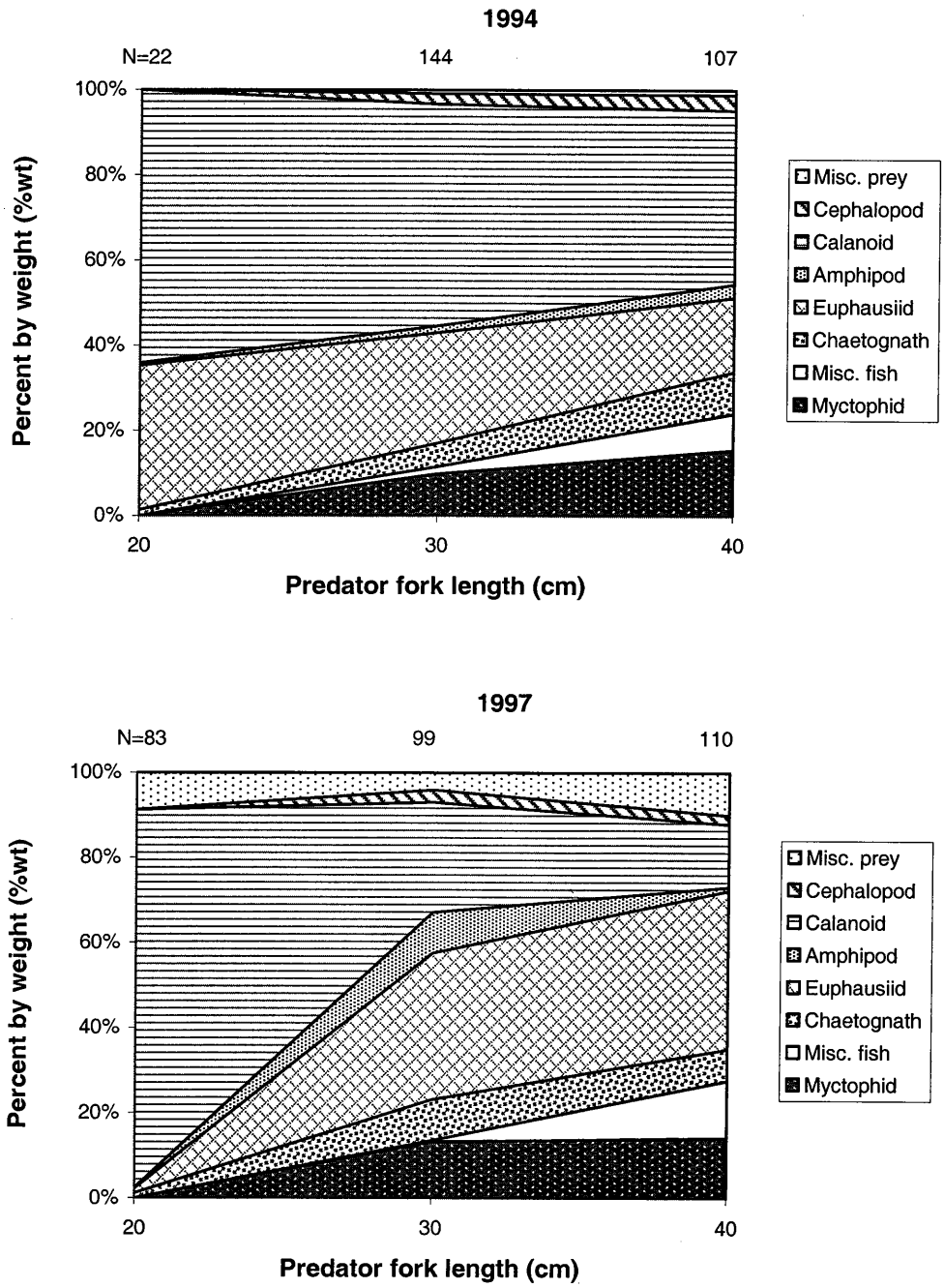

Figure 71.--Variations in the main prey of Pacific ocean perch, by predator size, in the Aleutian Islands in 1994 and 1997.
N = sample size.

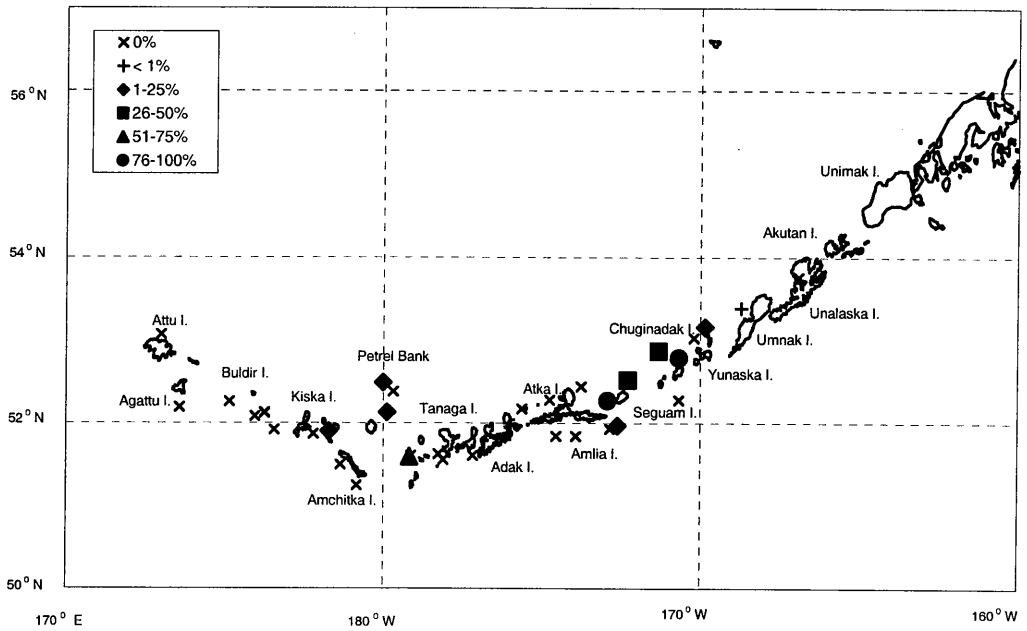

Figure 72.--Geographic distribution of myctophids consumed by Pacific ocean perch in the Aleutian Islands area in 1994.

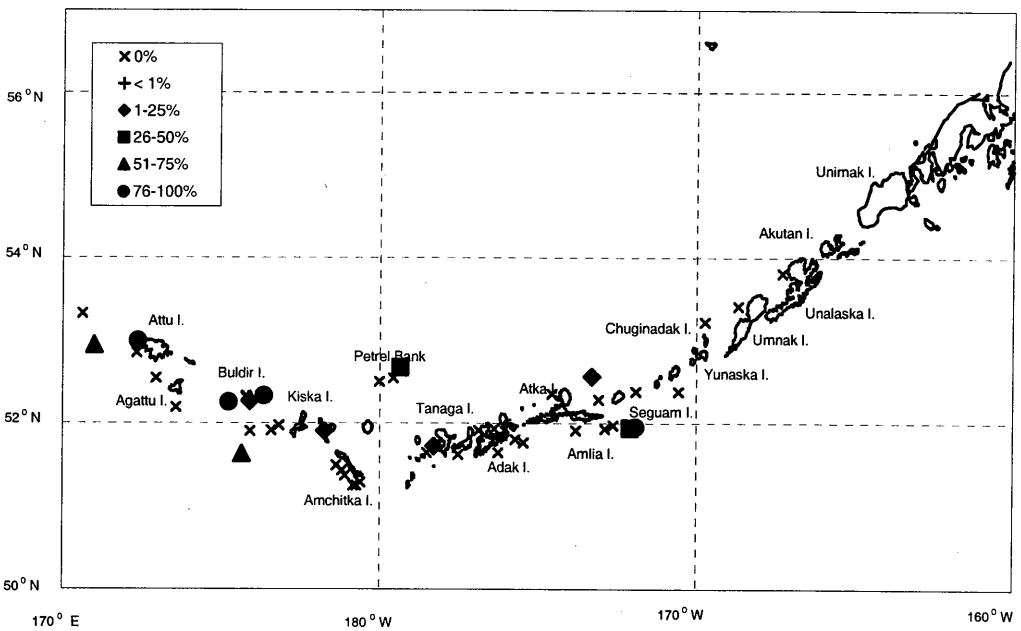

Figure 73.--Geographic distribution of myctophids consumed by Pacific ocean perch in the Aleutian Islands area in 1997.

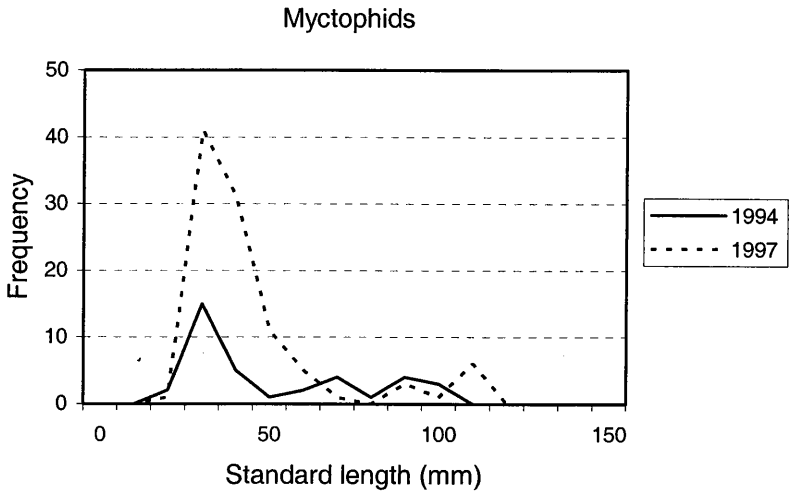

Figure 74.--Size frequency distribution of myctophids consumed by Pacific ocean perch in the Aleutian Islands in 1994 and 1997.

Table 30. Percent weight of the major prey categories of Pacific ocean perch in the Aleutian Islands area in 1991, 1994, and 1997.

Prey name	1991	1994	1997
Polychaete	4	1	1
Cephalopod	1	4	1
Calanoid copepod	18	46	28
Mysid	1	1	1
Amphipod	3	1	5
Euphausiid	52	26	30
Chaetognath	0	7	7
Salp	0	0	1
Pacific viperfish	0	3	0
Myctophid	17	11	12
Flatfish	3	0	0

Percent similarity between 1991 and 1994 :59
Percent similarity between 1991 and 1997 :66
Percent similarity between 1994 and 1997 :76

SHORTRAKER ROCKFISH

Shortraker rockfish (*Sebastes borealis*) have large mouth, short gill rakers, and low gill raker numbers. These special morphological characteristics make them a potential predator of fish, cephalopods, and other commercially important species. Earlier study showed that shortraker rockfish fed on cephalopods, isopods, hippolytid shrimp, pandalid shrimp, myctophids, and cottids (Yang 1996). The estimated biomass of shortraker rockfish from the Aleutian Islands survey in 2000 was 37,136 t. The catches of shortraker rockfish in the Aleutian Islands area was 187 t (Spencer and Reuter 2001).

RESULTS

General Diets

Tables 31 and 32 list the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in shortraker rockfish. Myctophids were the most important prey fish of shortraker rockfish. In terms of weight, they comprised 22% and 27% of the total stomach contents in 1994 and 1997, respectively. Miscellaneous fish (sculpin, deepsea smelts, and smelts) comprised 15% and 31% of the total stomach contents in 1994 and 1997, respectively. Squid (23%) was the most important invertebrate prey in 1994, whereas it comprised only 4% of the total stomach contents in 1997. Less important invertebrate prey included gammarid amphipods (15% and 14% in 1994 and 1997, respectively), shrimp (10% and 6% in 1994 and 1997, respectively) and mysids (9% and 10% in 1994 and 1997, respectively). In 1997, shortraker rockfish also consumed some (6%) pelagic salps.

Variation of Diet Based on Predator Size

Figure 75 shows the variations of the diet of shortraker rockfish by predator size. Large ($\geq$ 40 cm FL) shortraker rockfish consumed more myctophids and miscellaneous fish (smelts and deepsea smelts) than the small (< 40 cm FL) shortraker rockfish. On the other hand, the smaller sized fish consumed high percentages (61% in 1994 and 44% in 1997) of shrimp (Pandalidae and Hippolytidae). Small shortraker rockfish also consumed a

higher percentage ($\geq$ 16%) of gammarid amphipods than the larger-sized fish. Squids (26% in 1994 and 5% in 1997) were only found in the stomach contents of large shortraker rockfish.

Geographic Distributions of the Prey Consumed

The distributions of the important prey consumed by shortraker rockfish are shown in Figures 76 to 81. Figures 76 and 77 illustrate that a high percentage (> 50%) of myctophids were consumed by shortraker rockfish in the areas around Seguam Island (in 1994) and Amchitka Island (in 1994 and 1997). Pandalid shrimp were consumed by shortraker rockfish primarily in the areas around Kiska Island (1994), Adak Island (1994 and 1997), Amlia Island (1997) and Chuginadak Island (1994) (Figs. 78 and 79). Figures 80 and 81 illustrate the locations where squids were consumed by shortraker rockfish. It shows that high percentages (> 75%) of squids were consumed by shortraker rockfish around Kiska Island and Adak Island in 1994.

Sizes of the Important Prey Consumed

Shortraker rockfish consumed one deepsea smelt (105 mm SL), one sculpin (130 mm SL) in 1994. They also consumed 12 myctophids. The mean standard length ($\pm$SD) of the myctophids consumed was 85.8 $\pm$ 31.1 mm with a range from 43 to 146 mm SL. In 1997, shortraker rockfish consumed two sculpin (62 mm and 142 mm, respectively), and seven myctophids. The mean standard length ($\pm$SD) of the myctophids consumed in 1997 was 92.4 $\pm$ 9.3 mm with a range from 77 to 100 mm SL.

DISCUSSION

Table 33 lists the percent weight of the major prey categories of shortraker rockfish in the Aleutian Islands area in 1991, 1994, and 1997. The percentages of the main prey categories in different years vary greatly. For example, shrimp (mainly pandalids and hippolytids) comprised a high (47%) proportion of the total stomach contents weight in 1991 but comprised only 10% and 6% in 1994 and 1997, respectively. Because of the high variations between different years, the diet similarities between years were low (Table 33, bottom). Shortraker rockfish regurgitates easily when brought up from the

bottom trawl. So, the sample size for stomach collection is usually small. There were only 17 stomachs in the 1991 shortraker rockfish sample (58 and 54 in 1994 and 1997 samples, respectively).

Table 31.-- Mean percentage frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of shortraker rockfish collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Teuthoidea (squid)	21.33	22.55
Gnathophausia sp.	14.95	1.81
Gnathophausia gigas (mysid)	3.33	1.81
Eucopiidae	5.71	1.21
Mysidacea Mysida (mysid)	12.50	2.10
Mysidae (mysid)	2.08	2.10
Isopoda (isopod)	8.33	3.75
Gammaridea (amphipod)	29.24	14.79
Euphausiacea (euphausiid)	11.01	2.46
Caridea (shrimp)	8.68	1.34
Hippolytidae (shrimp)	2.71	1.01
Pandalidae (shrimp)	9.52	7.95
Osteichthyes Teleostei (fish)	7.99	2.11
Non-gadoid Fish Remains	2.59	6.77
Osmeridae (smelts)	1.04	0.51
Bathylagidae (deepsea smelts)	2.08	2.38
Myctophidae (lanternfish)	17.56	22.08
Cottoidei (sculpin)	1.19	3.27

Total non-empty stomachs = 58
Total prey number = 153
Total prey weight = 483.9g
Total empty stomachs = 47
Number of hauls = 12

Full stomach summary statistics
Average length = 46.8 cm
Standard deviation of length = 6.1 cm
Minimum length = 29 cm
Maximum length = 63 cm

Average fullness = 3.8
Standard deviation of fullness = 1.2
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average length = 48.3 cm
Standard deviation of length = 9.5 cm
Minimum length = 24 cm
Maximum length = 69 cm

Table 32.-- Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of shortraker rockfish collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Polynoidae (polychaete)	1.79	0.13
Teuthoidea (squid)	13.75	4.30
Peracarida Mysidacea (mysid)	1.43	0.01
Gnathophausia sp.	12.68	5.01
Gnathophausia gigas (mysid)	3.75	2.21
Mysidae (mysid)	9.76	2.98
Gammaridea (amphipod)	8.93	4.11
Ampeliscidae (amphipod)	12.80	5.18
Anonyx sp. (amphipod)	8.04	5.10
Euphausiidae (euphausiid)	7.08	0.31
Caridea (shrimp)	4.40	1.67
Hippolytidae (shrimp)	5.00	0.62
Pandalidae (shrimp)	3.21	3.11
Pandalus sp. (shrimp)	0.89	0.16
Natantia (shrimp)	1.43	0.17
Thaliacea (Pelagic salp)	3.57	6.22
Osteichthyes Teleostei (fish)	32.68	17.95
Non-gadoid Fish Remains	2.38	3.04
Myctophidae (lanternfish)	13.75	26.94
Cottoidei (sculpin)	2.62	10.34
Unidentified organic material	1.79	0.45

Total non-empty stomachs = 54
Total prey number = 104
Total prey weight = 188.1g
Total empty stomachs = 60
Number of hauls = 14

Full stomach summary statistics
Average length = 46 cm
Standard deviation of length = 6.8 cm
Minimum length = 29 cm
Maximum length = 68 cm

Average fullness = 2.8
Standard deviation of fullness = 0.9
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average length = 49.1 cm
Standard deviation of length = 7.7 cm
Minimum length = 35 cm
Maximum length = 70 cm

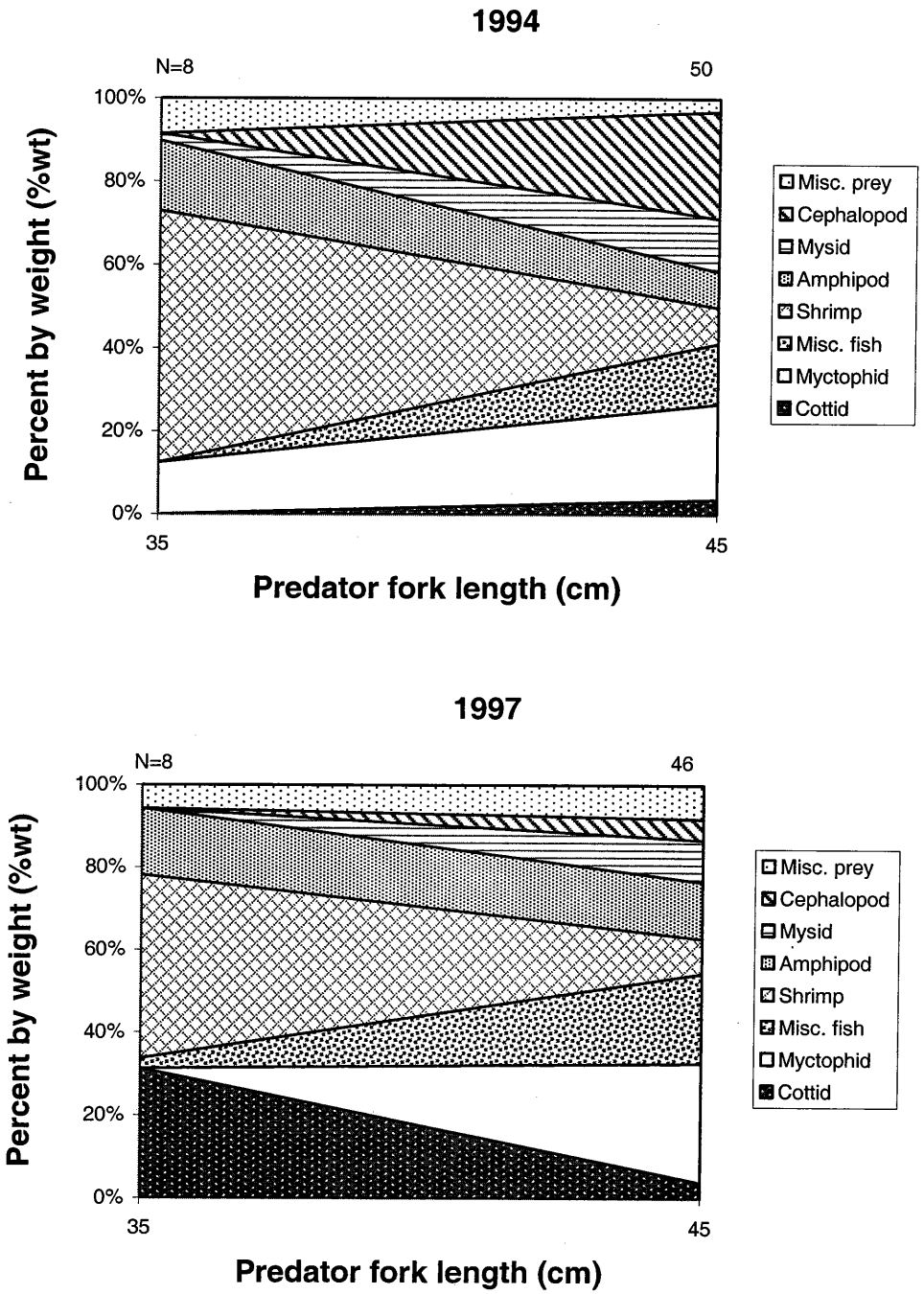

Figure 75.--Variations in the main prey of short raker rockfish, by predator size, in the Aleutian Islands in 1994 and 1997.
N = sample size.

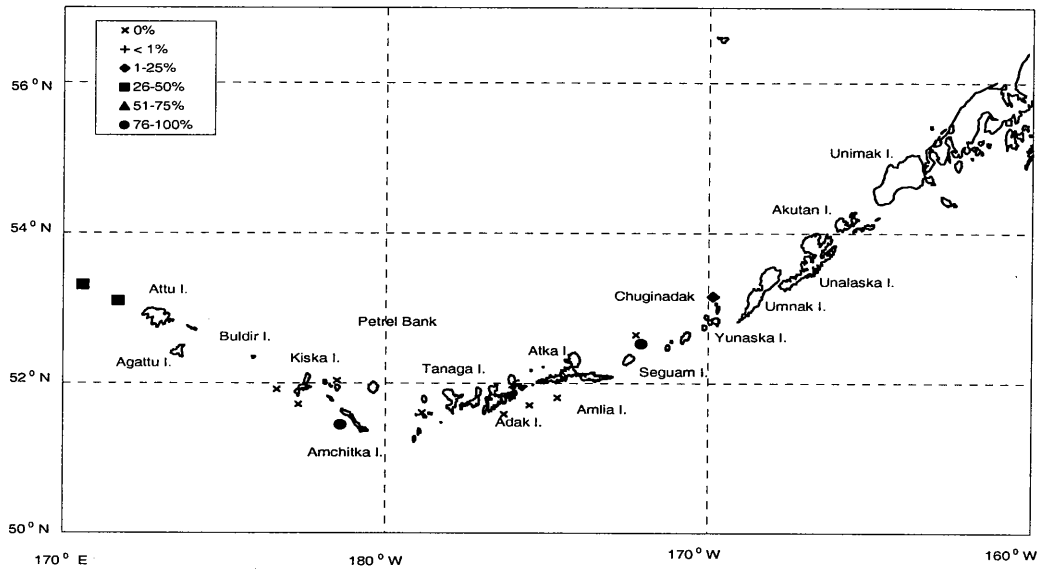

Figure 76.--Geographic distribution of myctophids consumed by shortraker rockfish in the Aleutian Islands area in 1994.

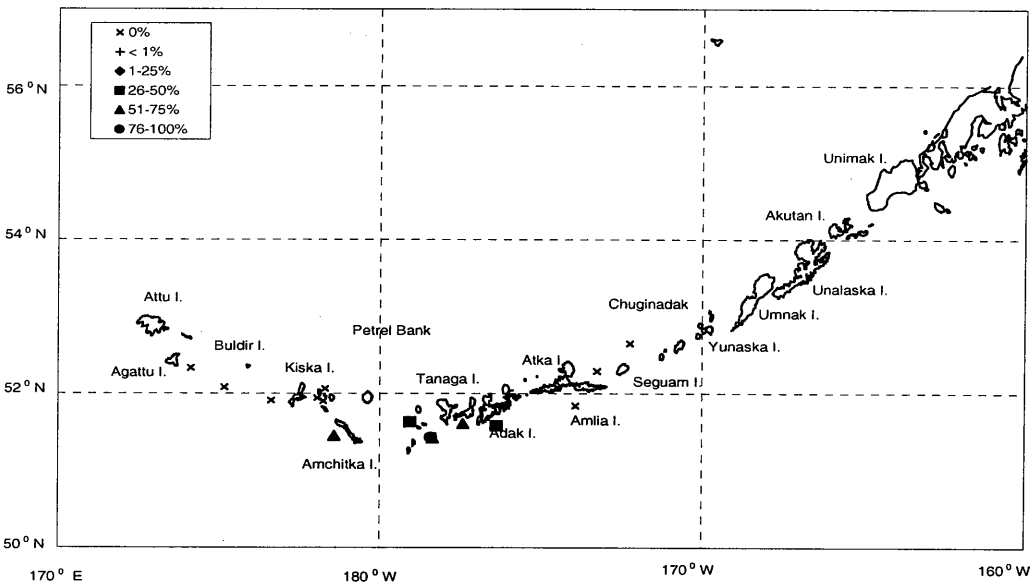

Figure 77.--Geographic distribution of myctophids consumed by shortraker rockfish in the Aleutian Islands area in 1997.

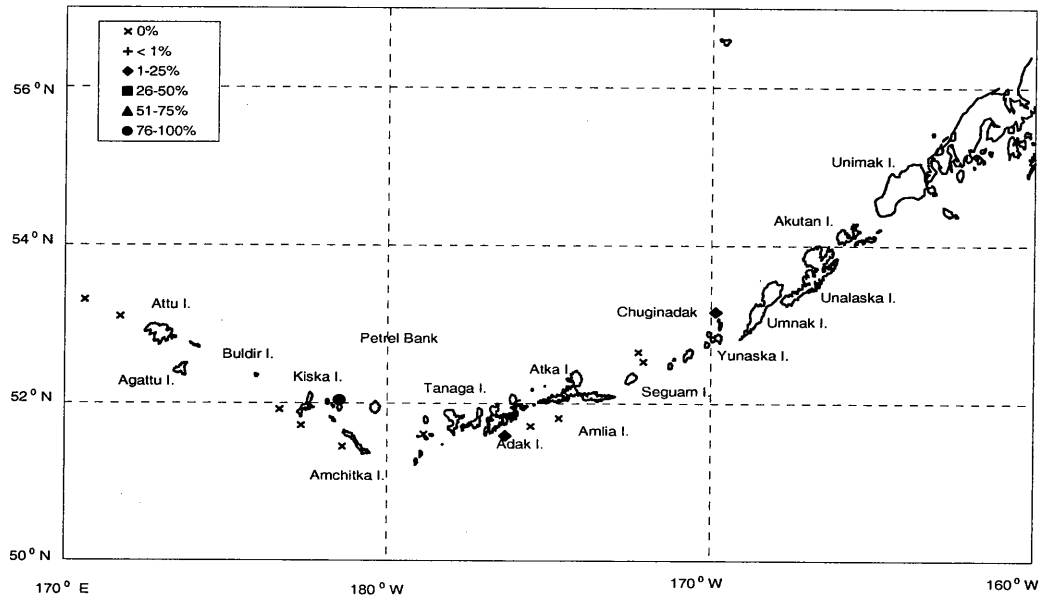

Figure 78.--Geographic distribution of pandalid shrimp consumed by shortraker rockfish in the Aleutian Islands area in 1994.

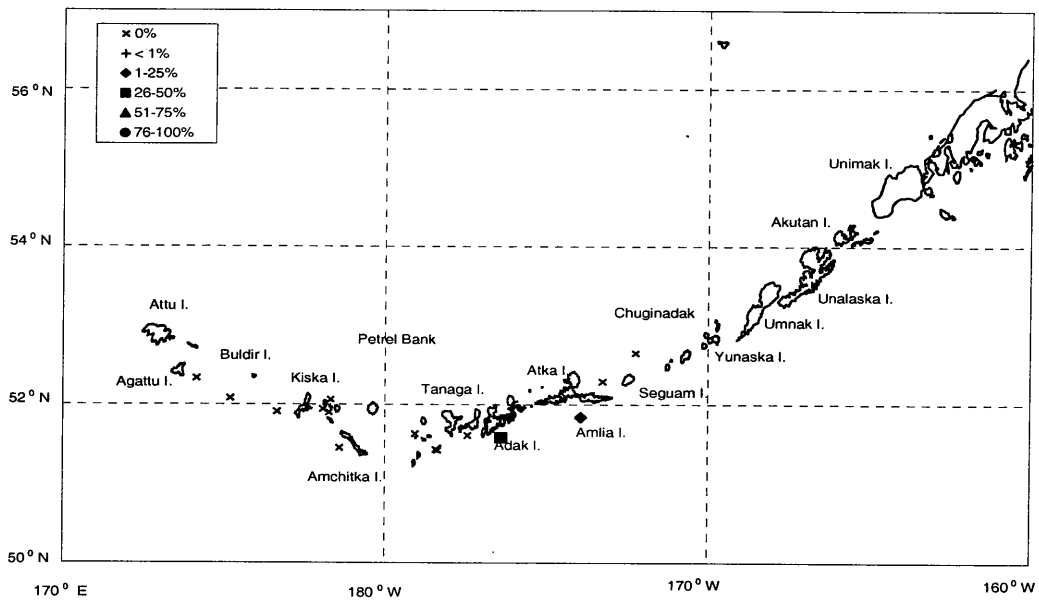

Figure 79.--Geographic distribution of pandalid shrimp consumed by shortraker rockfish in the Aleutian Islands area in 1997.

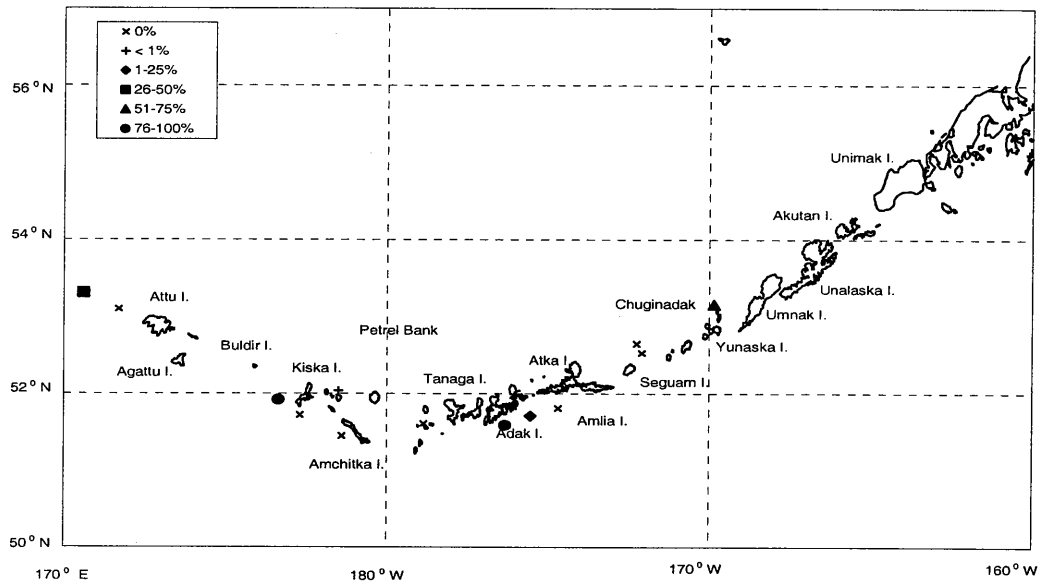

Figure 80.--Geographic distribution of squids consumed by shortraker rockfish in the Aleutian Islands area in 1994.

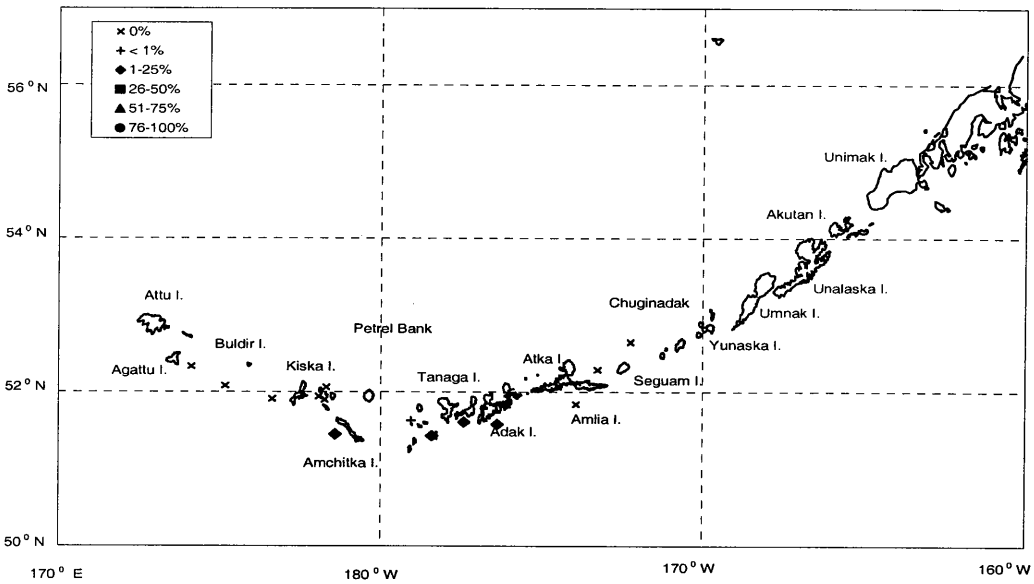

Figure 81.--Geographic distribution of squids consumed by shortraker rockfish in the Aleutian Islands area in 1997.

Table 33. Percent weight of the major prey categories of shortraker rockfish in the Aleutian Islands area in 1991, 1994, and 1997.

Prey name	1991	1994	1997
Polychaetes	3	0	1
Cephalopods	3	23	4
Mysids	1	9	10
Isopod	14	4	0
Amphipods	1	15	14
Euphausiids	1	2	1
Shrimp	47	10	6
Korean horse-hair crab	3	0	0
Myctophids	14	22	27
Sculpins	11	3	10

Percent similarity between 1991 and 1994 :37
Percent similarity between 1991 and 1997 :37
Percent similarity between 1994 and 1997 :59

ROUGHEYE ROCKFISH

Rougheye rockfish (*Sebastes aleutianus*), along with Pacific ocean perch and shortraker rockfish, are the three most valuable commercial species in the Aleutian Islands region. The estimated biomass of rougheye rockfish from the Aleutian Islands survey in 2000 was 14,205 t. The catch of rougheye rockfish in the Aleutian Islands area was 256 t (Spencer and Reuter 2001). An earlier study showed that rougheye rockfish fed on hippolytid and pandalid shrimps, myctophids, snailfish, and some miscellaneous invertebrates (Yang 1996).

RESULTS

General Diets

Table 34 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in rougheye rockfish collected in 1994 (no samples were collected in 1997). Atka mackerel and myctophids were the most important prey fish of rougheye rockfish. In terms of weight, they comprised 7% and 3% of the total stomach contents, respectively. A large amount (51%) of unidentified fish was consumed by rougheye rockfish; they were probably myctophids. Shrimp, mainly pandalids, was the most important invertebrate prey. They comprised 20% of the total stomach contents. Less important invertebrate prey included gammarid amphipods (4%) and mysids (4%).

Variation of Diet Based on Predator Size

Figure 82 shows the variations of the diet of rougheye rockfish by predator size. Large ($\geq$ 40 cm FL) rougheye rockfish consumed more fish (Atka mackerel, myctophids, and unidentified fish) than the smaller-sized (< 40 cm FL) rougheye rockfish. On the other hand, the smaller-sized fish consumed high percentages (43%) of shrimp (Pandalidae and Hippolytidae), euphausiids (9%), gammarid amphipods (10%), and mysids (9%).

Geographic Distributions of the Prey Consumed

Distributions of the important prey consumed by rougheye rockfish are shown in Figures 83-85. Figure 83

illustrates that myctophids consumed by rougheye rockfish in 1994 were mainly around Atka Island, Chuginadak Island, and Petrel Bank. The high percentage (> 75%) of Atka mackerel consumed by rougheye rockfish in 1994 was primarily in the area around Kiska Island (Fig. 84). Figure 85 illustrates that high percentages (> 50%) of pandalid shrimps were consumed by rougheye rockfish around Kiska Island and Atka Island in 1994.

Sizes of the Important Prey Consumed

Rougheye rockfish consumed one Atka mackerel (255 mm SL) and four myctophids in 1994. The mean standard length ($\pm$SD) of the myctophids consumed was 52.0 $\pm$ 28.7 mm with a range from 25 to 92 mm SL.

DISCUSSION

Yang (1996) studied the food habits of rougheye rockfish in the Aleutian Islands during 1991. The table below (Table 35) compares the main prey categories of rougheye rockfish in that study and the present one (1994). There are big variations between the diets of rougheye rockfish collected in these two years. The main reason of this difference is probably caused by the small sample size (n=11) of the stomachs collected in 1991 compared to that (n=56) in 1994. However, the high percentage (51%) of the unidentified fish in 1994 also contributed to the big variations between 1991 and 1994. The unidentified fish for both years were probably myctophids and thus would increase the diet similarity between these two years.

Table 34.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of rougheye rockfish collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	0.95	0.10
Teuthoidea (squid)	2.78	1.13
Crustacea	1.33	0.02
Calanoida (copepod)	4.44	2.73
Gnathophausia sp.	4.70	0.57
Mysidae (mysid)	4.26	3.67
Gammaridea (amphipod)	11.89	2.33
Anonyx sp. (amphipod)	3.33	1.86
Euphausiidae (euphausiid)	7.07	1.11
Thysanoessa longipes (euphausiid)	0.74	0.58
Thysanoessa spinifera (euphausiid)	0.37	0.04
Caridea (shrimp)	10.03	4.66
Pasiphaea pacifica (shrimp)	0.74	0.19
Hippolytidae (shrimp)	1.32	1.93
Pandalidae (shrimp)	4.13	6.09
Pandalus sp. (shrimp)	3.33	4.81
Pandalus montagui tridens (shrimp)	1.67	2.17
Chondrichthyes (fish)	0.37	0.92
Osteichthyes Teleostei (fish)	27.30	51.32
Myctophidae (lanternfish)	4.29	2.66
Stenobrachius leucopsarus (northern lampfish)	0.37	0.58
Pleurogrammus monopterygius (Atka mackerel)	6.67	6.67
Unidentified organic material	2.04	3.89

Total non-empty stomachs = 56
Total prey number = 237
Total prey weight = 224.1g
Total empty stomachs = 70
Number of hauls = 15

Full stomach summary statistics
Average length = 40 cm
Standard deviation of length = 5.2 cm
Minimum length = 23 cm
Maximum length = 47 cm

Average fullness = 3.5
Standard deviation of fullness = 1.3
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 39 cm
Standard deviation of length = 6.7 cm
Minimum length = 24 cm
Maximum length = 50 cm

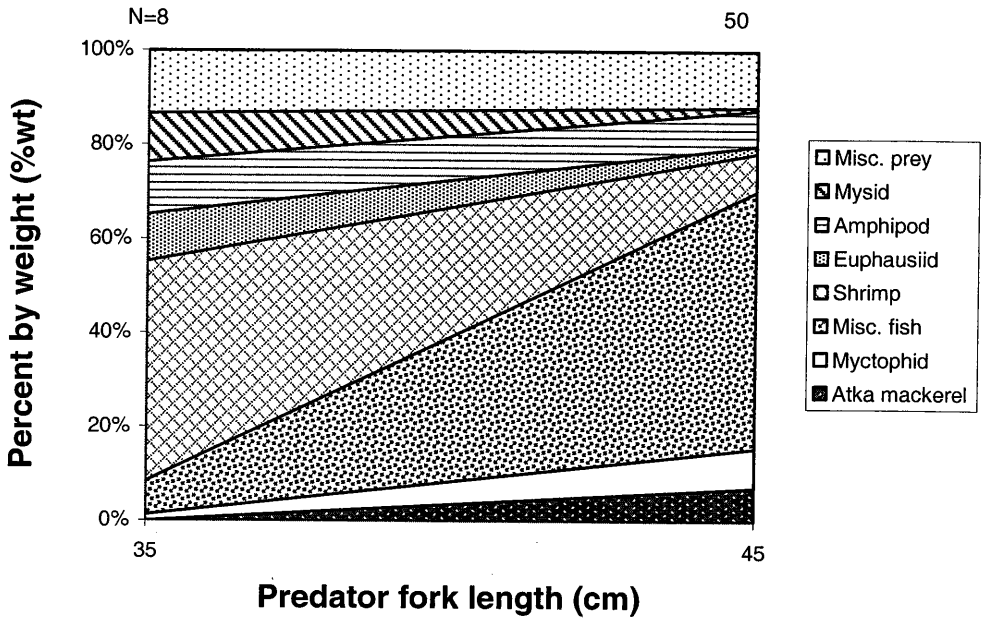

Figure 82.--Variations in the main prey of rougheye rockfish, by predator size, in the Aleutian Islands in 1994. N = sample size.

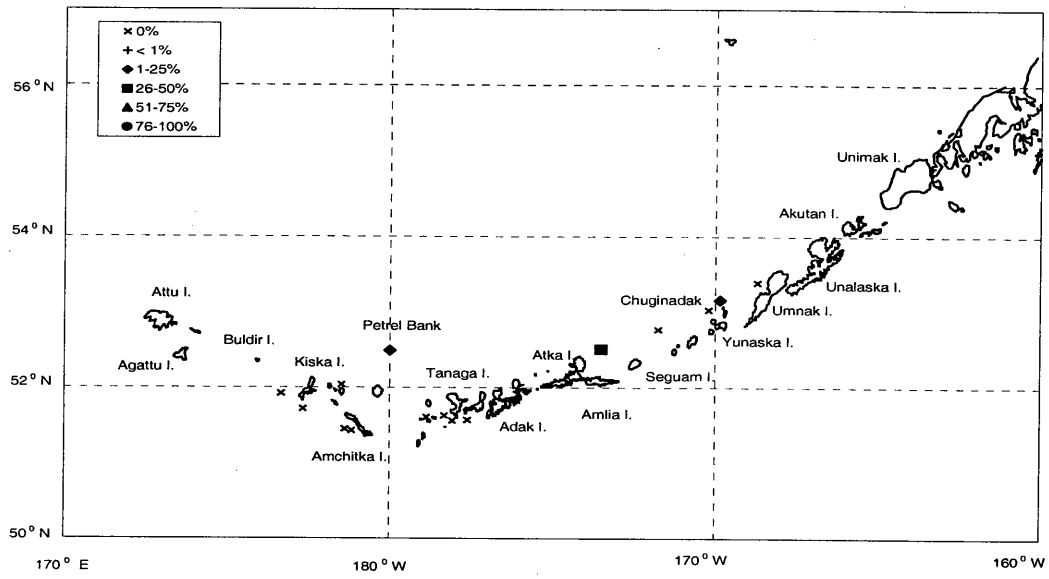

Figure 83.--Geographic distribution of myctophids consumed by rougheye rockfish in the Aleutian Islands area in 1994.

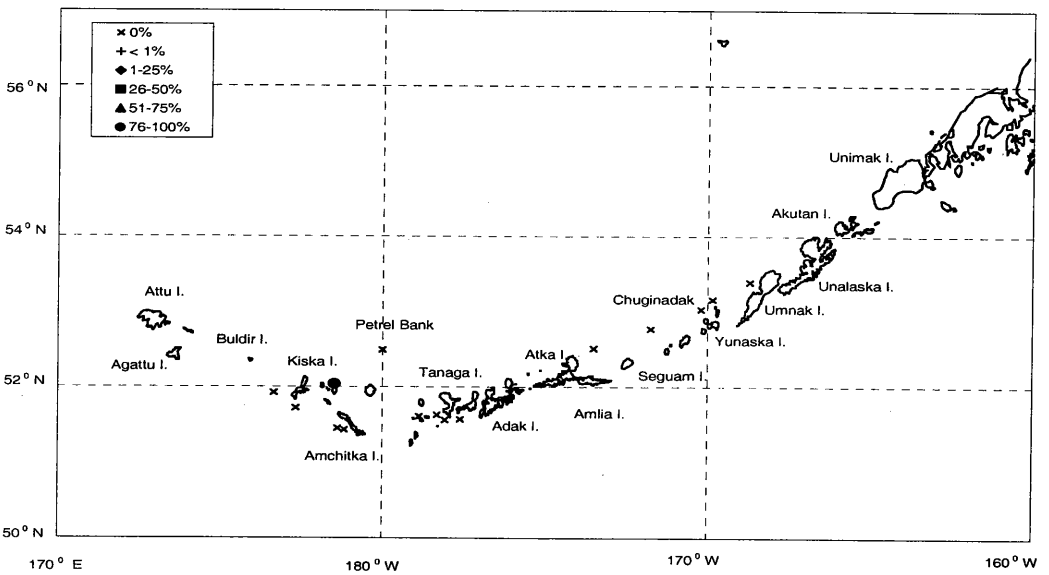

Figure 84.--Geographic distribution of Atka mackerel consumed by rougheye rockfish in the Aleutian Islands area in 1994.

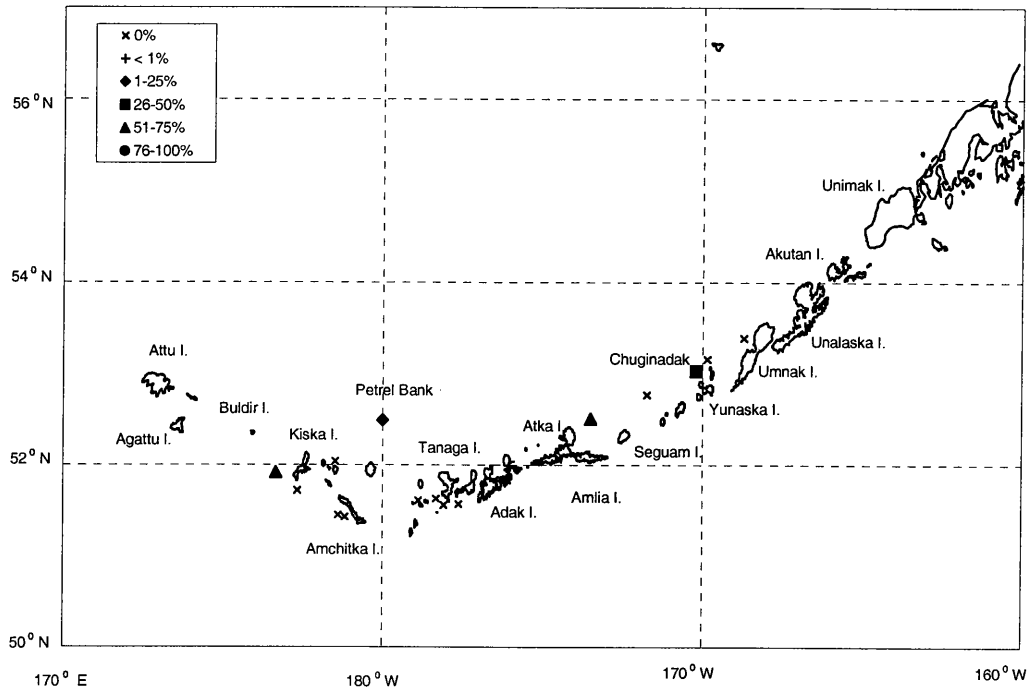

Figure 85.--Geographic distribution of pandalid shrimps consumed by rougheye rockfish in the Aleutian Islands area in 1994.

Table 35.--Percent weight of the major prey categories of rougheye rockfish in the Aleutian Islands area in 1991 and 1994.

Prey name	1991	1994
Polychaetes	1	1
Squid	0	1
Calanoid copepods	0	3
Mysids	1	4
Isopod	2	0
Amphipods	1	4
Euphausiids	2	2
Hippolytid	30	2
Pandalid	18	13
Unidentified fish	10	51
Myctophids	14	3
Snailfish	20	10
Atka mackerel	0	7

Percent similarity between 1991 and 1994:33

SHORTSPINE THORNYHEAD

Shortspine thornyhead (*Sebastolobus alascanus*) is the predominant species of the "other rockfish" in the Aleutian Islands survey and fishery catches (Reuter and Spencer 2001). The "other rockfish" category includes all species of *Sebastes* and *Sebastolobus* other than the Pacific ocean perch complex. Shortspine thornyhead had an exploitable biomass of 9,813 tons in the Aleutian Islands area in 2000. The catch of the shortspine thornyhead in 2000 year was 263 tons (Reuter and Spencer 2001). They fed mainly on amphipods, shrimp, crabs, sculpins, and some miscellaneous fish (Yang 1996).

RESULTS

General Diets

Tables 36 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in shortspine thornyhead collected in 1994 (no samples were collected in 1997). Atka mackerel was the most important commercial prey fish of shortspine thornyhead. In terms of weight, it comprised 6% of the total stomach contents. A large amount (38%) of miscellaneous fish: skate, eelpout, sculpin, poacher, and snailfish was consumed by shortspine thornyhead. Shrimp, mainly pandalids, was the most important invertebrate prey. They comprised 24% of the total stomach contents. Shortspine thornyhead diet also included 12% octopus, 11% amphipod, and 5% of golden king crab (*Lithodes aequispina*).

Variation of Diet Based on Predator Size

Figure 86 shows the diet variation of shortspine thornyhead by predator size. Larger-sized ($\geq$ 35 cm FL) shortspine thornyhead consumed more fish (Atka mackerel, sculpin, and miscellaneous fish) than the smaller-sized (< 35 cm FL) shortspine thornyhead. On the other hand, the smaller-sized fish consumed high percentages (33%) of shrimp (Pandalidae and Hippolytidae), crabs (10%), and gammarid amphipod (20%).

Geographic Distributions of the Prey Consumed

The distributions of the important prey consumed by shortspine thornyhead are shown in Figures 87-90. Figure 87 illustrates that most Atka mackerel consumption by shortspine thornyhead occurred near Buldir Island in 1994. The high percentage (> 75%) of skate consumed by shortspine thornyhead in 1994 was primarily in the area around Kiska Island (Fig. 88). Figure 89 illustrates that high percentages (> 75%) of pandalid shrimps were consumed by shortspine thornyhead west of Attu Island in 1994. Octopus were found in stomach samples from shortspine thornyhead collected south of Attu Island and west of Kiska Island (Fig. 90).

Sizes of Important Prey Consumed

Shortspine thornyhead consumed one measurable Atka mackerel (157 mm SL) and one measurable poacher (130 mm SL) in 1994. The mean standard length (±SD) of the sculpins consumed was 54.0 ± 21.2 mm with a range from 38 to 102 mm SL. The mean standard length (±SD) of the measurable snailfish consumed was 46.8 ± 18.5 mm with a range from 23 to 82 mm SL. The mean carapace length (CL) of the golden king crabs consumed was 18.6 ± 7.7 mm with a range from 9 to 30 mm CL. Shortspine thornyhead also consumed two measurable eelpout (64 and 74 mm SL, respectively) and two skates (55 and 105 mm, respectively).

DISCUSSION

The stomach contents of shortspine thornyhead collected from 1994 was compared to the data of 1991 (Table 37). It shows that the big difference between these two years was the percentages of the sculpins consumed by shortspine thornyhead. Sculpins comprised 31% of the total stomach contents weight of shortspine thornyhead in 1991, whereas the value of that in 1994 was only 9%. The other difference between the diets of these two years was that there were more miscellaneous fish (including skates, eelpout, Atka mackerel, etc.) in the diet of shortspine thornyhead collected in 1994.

Table 36.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of shortspine thornyhead collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	2.22	0.21
Octopoda (octopus)	2.41	11.50
Eucopiidae (mysid)	2.62	0.01
Mysidae (mysid)	16.41	2.59
Isopoda (isopod)	6.83	0.56
Gammaridea (amphipod)	35.25	8.19
Hyperiidae (amphipod)	2.22	2.33
Caprellidea (amphipod)	2.41	0.10
Euphausiacea (euphausiid)	0.74	0.02
Reptantia (crab)	0.74	1.06
Caridea (shrimp)	13.64	5.81
Hippolytidae (shrimp)	15.71	7.37
Pandalidae (shrimp)	11.50	10.60
Crangonidae (shrimp)	1.82	0.15
Lithodidae (king crab)	0.74	0.35
Lithodes aequispina (golden king crab)	6.56	5.47
Gnathostomata (fish)	0.83	4.55
Rajidae (skate)	5.24	11.25
Osteichthyes Teleostei (fish)	6.34	1.50
Non-gadoid fish remains (fish)	11.08	3.98
Zoarcidae (eelpout)	2.67	1.86
Pleurogrammus monopterygius (Atka mackerel)	2.29	5.59
Cottoidei (sculpin)	3.21	1.52
Cottidae (sculpin)	7.18	7.36
Agonidae (poacher)	0.95	0.47
Cyclopteridae (snailfish)	9.61	5.39
Nectoliparis pelagicus (tadpole snailfish)	0.51	0.20
Unidentified eggs	0.95	0.01

Table 36.--Continued.

Total non-empty stomachs = 109
Total prey number = 231
Total prey weight = 491.7g
Total empty stomachs = 51
Number of hauls = 15

Full stomach summary statistics
Average length = 37.9 cm
Standard deviation of length = 6.9 cm
Minimum length = 121 cm
Maximum length = 56 cm

Average fullness = 4.1
Standard deviation of fullness = 1.2
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average length = 38.2 cm
Standard deviation of length = 7.2 cm
Minimum length = 22 cm
Maximum length = 62 cm

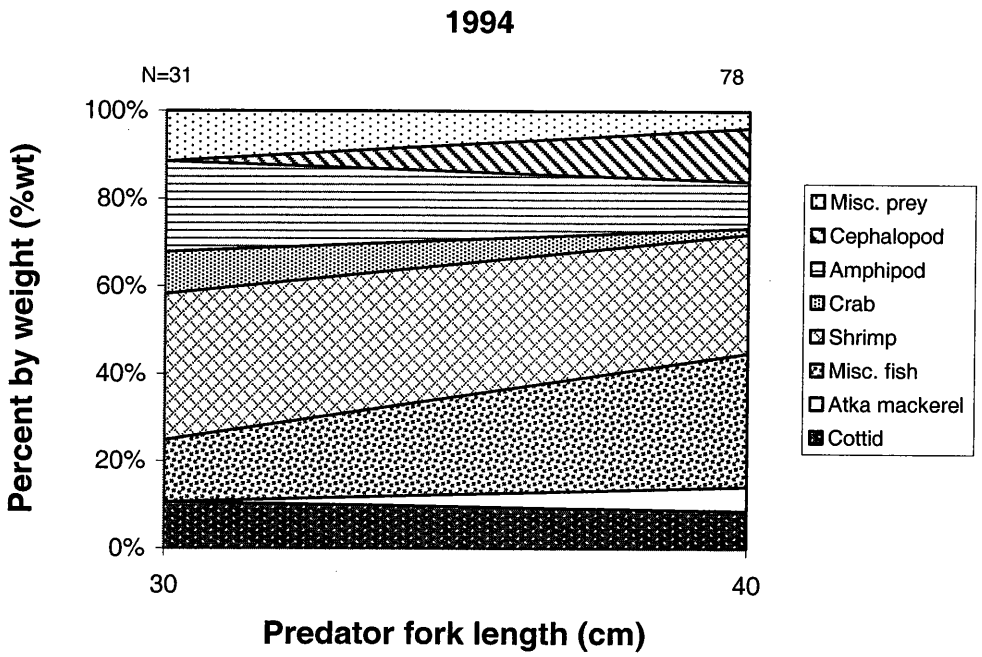

Figure 86.--Variations in the main prey of shortspine thornyhead, by predator size, in the Aleutian Islands in 1994.
N = sample size.

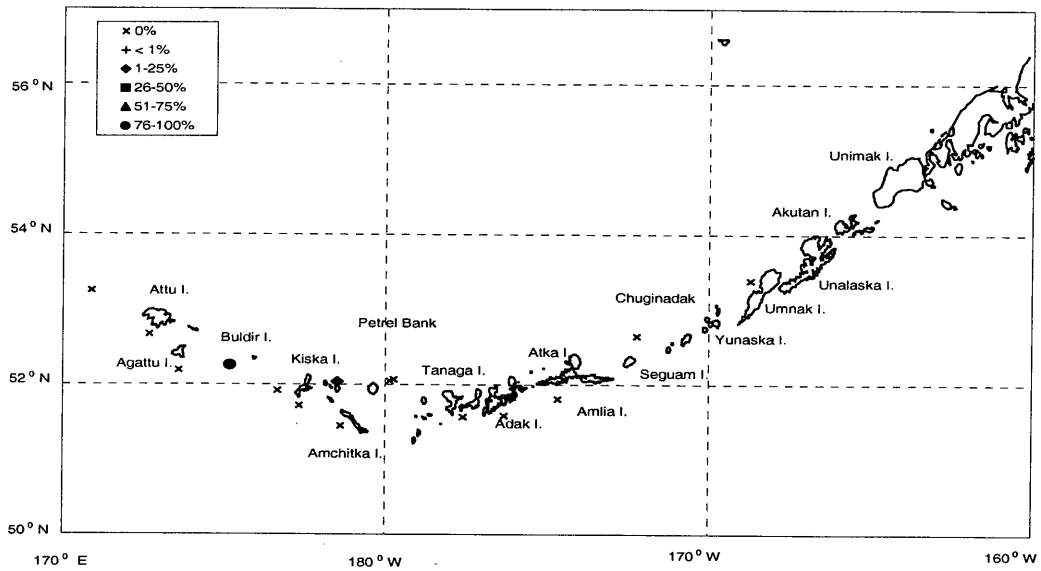

Figure 87.--Geographic distribution of Atka mackerel consumed by shortspine thornyhead in the Aleutian Islands area in 1994.

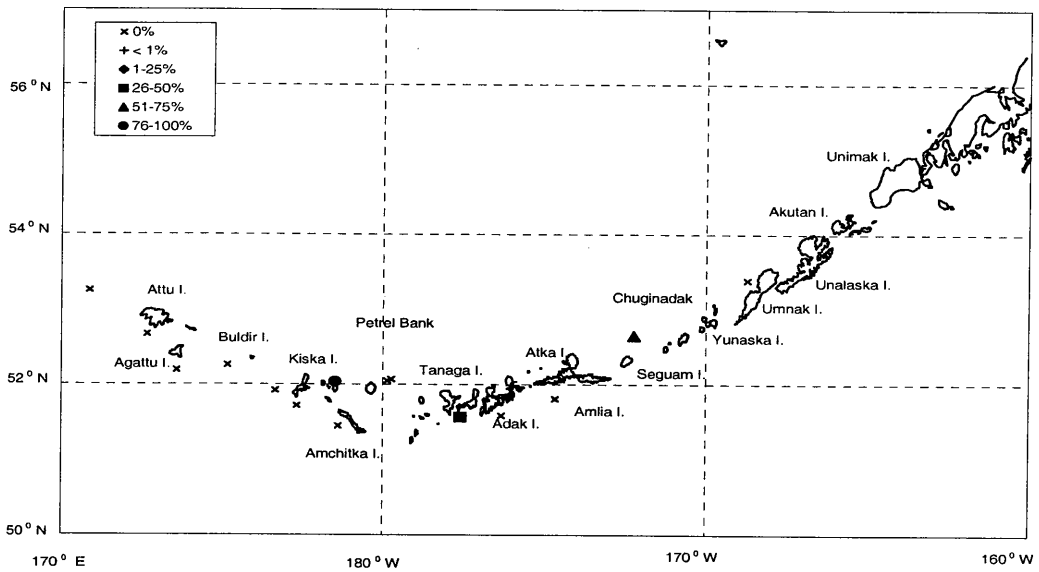

Figure 88.--Geographic distribution of skates consumed by shortspine thornyhead in the Aleutian Islands area in 1994.

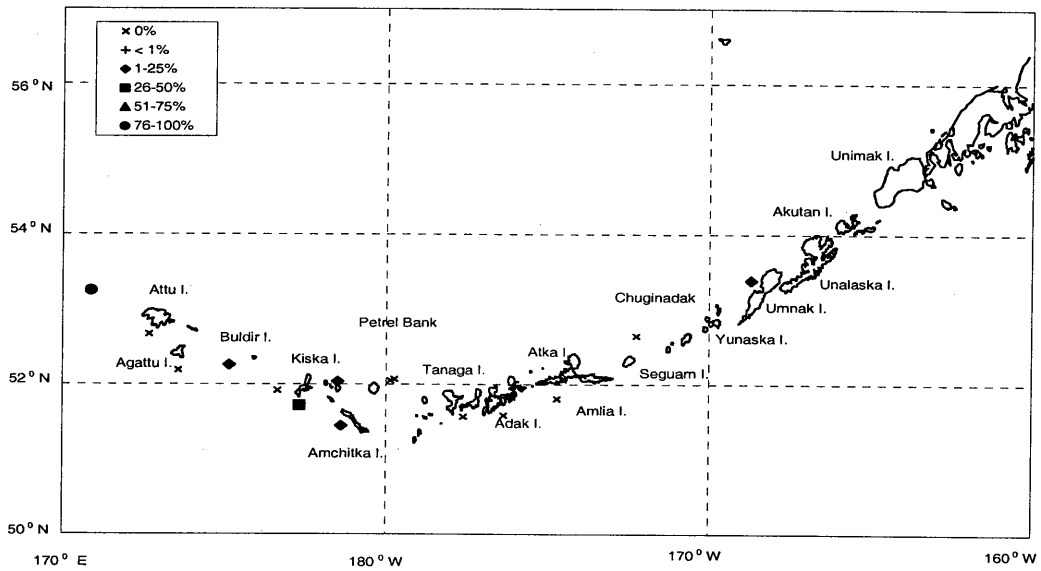

Figure 89.--Geographic distribution of pandalid shrimps consumed by shortspine thornyhead in the Aleutian Islands area in 1994.

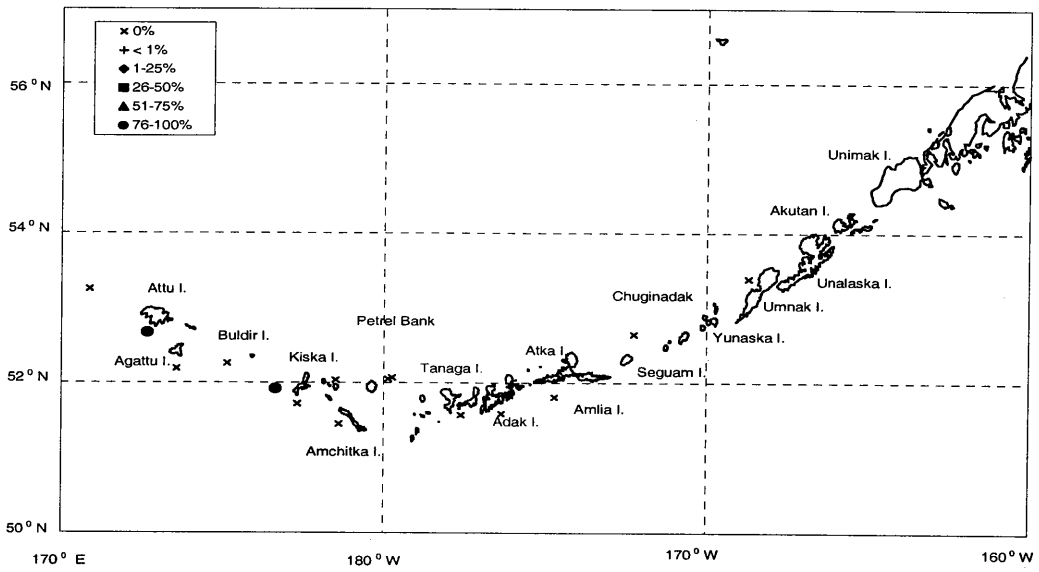

Figure 90.--Geographic distribution of octopus consumed by shortspine thornyhead in the Aleutian Islands area in 1994.

Table 37.--Percent weight of the major prey categories of shortspine thornyhead in the Aleutian Islands area in 1991 and 1994.

Prey name	1991	1994
Octopoda	1	12
Mysid	3	3
Isopod	1	1
Amphipod	11	11
Euphausiid	4	1
Hippolytid	9	7
Pandalid	10	11
Crangonid	4	1
King crab	1	6
Korean horse-hair crab	6	3
Sebastes sp.	8	0
Gnathostomata	0	5
Skate	0	11
Eelpout	0	2
Atka mackerel	0	6
Sculpins	31	9
Snailfish	1	6

Percent similarity between 1991 and 1994 :49

NORTHERN ROCKFISH

Northern rockfish (*Sebastes polyspinis*) were distributed mainly in the western Aleutian Islands area and on the Petrel Bank (Harrison 1993). They had an estimated biomass of 205,300 tons from the Aleutian Islands survey in 2000. The catch of northern rockfish in the Aleutian Islands area in 2000 was 4,737 t (Spencer and Reuter 2001). Northern rockfish are mainly a zooplankton feeder. They feed on calanoid copepods, euphausiids, chaetognaths, myctophids, and other invertebrates (Yang 1996).

RESULTS

Table 38 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in northern rockfish collected in 1994 (no samples were collected in 1997). Calanoid copepods were the most important prey of northern rockfish. In terms of weight, calanoid copepods comprised 45% of the total stomach contents. Euphausiids, which comprised 32% of the total stomach contents weight, was the second most important prey of northern rockfish. Northern rockfish also consumed some chaetognaths (7%), myctophids (4%), and squids (4%).

Figure 91 shows the variations of the diet of northern rockfish by predator size. Smaller-sized ($\leq$ 35 cm FL) northern rockfish consumed high percentages (> 40%) of calanoid copepods. Euphausiids were mainly consumed by northern rockfish larger than 25 cm long. Myctophids and cephalopods were mainly consumed by the largest size group (> 35 cm) and they comprised 11% and 16% of the total stomach contents weight in this size group, respectively.

Most myctophids were consumed by northern rockfish in 1994 near Chuginadak Island (Fig. 92).

Table 38.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of northern rockfish collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Scyphozoa (jellyfish)	1.39	0.75
Gastropoda (snail)	0.69	0.01
Thecosomata (pteropod)	2.81	0.10
Gymnosomata (pteropod)	13.16	1.34
Cephalopoda (squid and octopus)	2.19	0.14
Teuthoidea (squid)	9.31	4.05
Crustacea	0.63	0.03
Calanoida (copepod)	75.55	43.72
Calanoidae (copepod)	0.69	0.31
Candacia sp. (copepod)	9.72	1.20
Mysidae (mysid)	2.60	0.15
Gammaridea (amphipod)	3.92	0.37
Amphipoda Hyperiidea (amphipod)	14.33	1.45
Themisto sp. (amphipod)	0.63	0.04
Euphausiacea (euphausiid)	21.30	14.37
Euphausiidae (euphausiid)	27.85	17.41
Caridea (shrimp)	9.54	1.79
Ophiuridae (brittle star)	0.69	0.25
Chaetognatha (arrow worm)	47.53	6.44
Sagitta sp. (arrow worm)	0.63	0.36
Osteichthyes Teleostei (fish)	2.01	0.09
Non-gadoid fish remains	3.82	2.10
Myctophidae (lanternfish)	2.34	3.56
Sebastes polyspinis (northern rockfish)	0.69	0.01

Table 38.--Continued.

Total non-empty stomachs = 118
Total prey number = 1,291
Total prey weight = 176.0g
Total empty stomachs = 24
Number of hauls = 16

Full stomach summary statistics
Average length = 30.9 cm
Standard deviation of length = 4.5 cm
Minimum length = 14 cm
Maximum length = 39 cm

Average fullness = 3.9
Standard deviation of fullness = 1.3
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 31.0 cm
Standard deviation of length = 4.4 cm
Minimum length = 19 cm
Maximum length = 37 cm

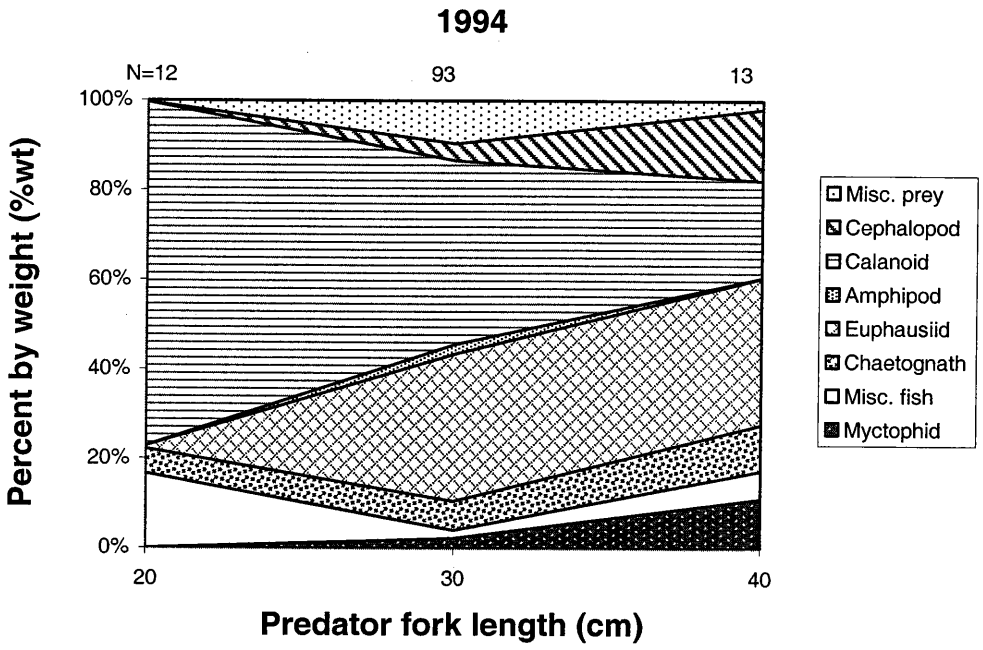

Figure 91.--Variations in the main prey of northern rockfish, by predator size, in the Aleutian Islands in 1994.
N = sample size.

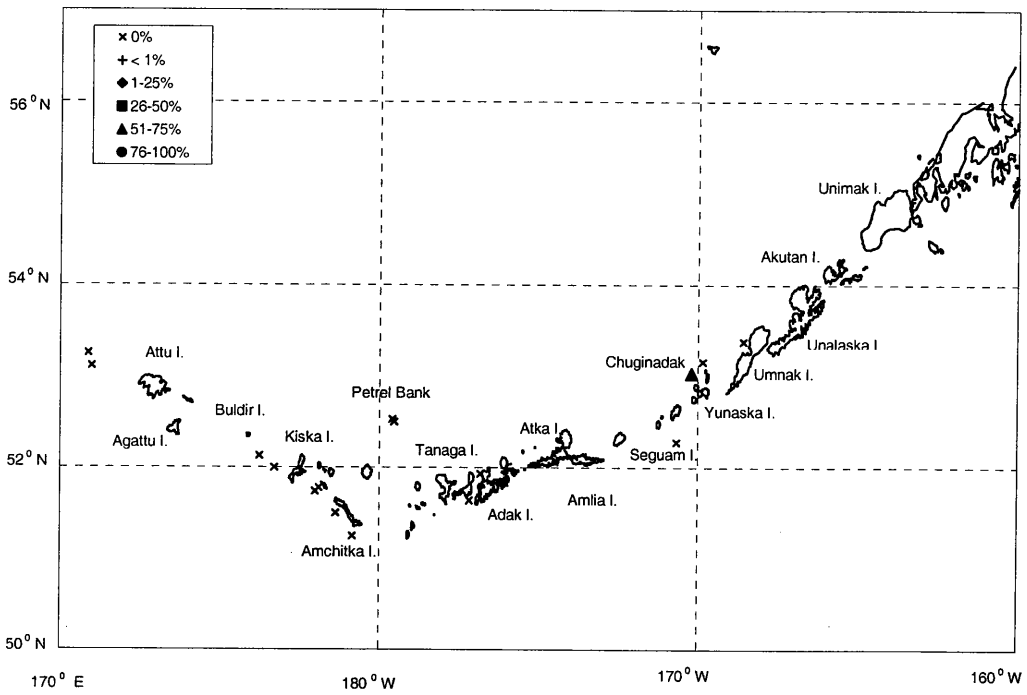

Figure 92.--Geographic distribution of myctophids consumed by northern rockfish in the Aleutian Islands area in 1994.

DISCUSSION

Yang (1996) found that northern rockfish fed mainly on calanoid copepods (26% by weight) and euphausiids (29%) in the Aleutian Islands area in 1991. In the current study, copepods and euphausiids also comprised high percentages (45% and 32%, respectively) of the total stomach content weight of northern rockfish collected in 1994. The diet similarity between these two years is 70% (Table 39). The diets of these two studies indicate that northern rockfish are planktivorous.

Table 39.--Percent weight of the major prey categories of northern rockfish in the Aleutian Islands area in 1991 and 1994.

Prey name	1991	1994
Polychaete	2	0
Cephalopod	1	4
Calanoid copepod	26	45
Mysid	1	1
Amphipod	13	2
Euphausiid	29	32
Shrimp	4	2
crabs	1	0
Chaetognath	9	7
Myctophid	1	4

Percent similarity between 1991 and 1994 :70

FLATHEAD SOLE

Flathead sole (*Hippoglossoides elassodon*) occupy an important role in the benthic ecosystem of the Bering Sea and Aleutian Islands areas. The estimated biomass of flathead sole from the Aleutian Islands survey in 2000 was 8,970 t (Spencer et al. 2001). Earlier studies show that flathead sole feed on shrimp, crabs, walleye pollock, brittle stars, and miscellaneous fish species (Pacunski 1990, Yang and Nelson 2000).

RESULTS

Table 40 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in the stomachs of flathead sole collected in 1994 (no samples were collected in 1997). Shrimp (mainly Hippolytidae) was the most important prey of flathead sole. In terms of weight, shrimp comprised 28% of the total stomach contents. Brittle stars comprised 17% of the total stomach contents weight. Flathead sole also consumed some hermit crabs (14%), lyre crabs (12%), polychaetes (11%), Sipuncula (6%), amphipods (5%), and euphausiids (5%). *Chionoecetes* sp. was also found in flathead sole stomachs; however, they comprised less than 1% of the total stomach contents weight.

Figure 93 shows the variations of the diet of flathead sole by predator size. Smaller-sized (< 30 cm FL) flathead sole consumed high percentages of shrimp (40%), polychaetes (18%), amphipods (11%), and mollusks (10%), whereas the medium-sized (30-39 cm FL) fish consumed more brittle stars and crabs than those of the smaller-sized fish. The largest size group ($\geq$ 40 cm FL) consumed high percentages of brittle stars (50%) and crabs (49%).

Table 40.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of flathead sole collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	19.91	7.07
Onuphidae (polychaete)	2.08	0.35
Pectinidae (scallops)	4.63	3.06
Copepoda	2.78	0.28
Mysidae (mysid)	2.08	0.14
Isopoda (isopod)	7.41	0.57
Arcturidae (isopod)	5.56	0.39
Gammaridea (amphipod)	11.81	4.94
Amphipoda Hyperiidea (amphipod)	2.08	0.49
Caprellidea (amphipod)	2.78	0.04
Euphausiacea (euphausiid)	2.78	0.28
Euphausiidae (euphausiid)	11.11	5.01
Caridea (shrimp)	9.26	9.50
Hippolytidae (shrimp)	5.56	10.29
Spirontocaris ochotensis (shrimp)	9.26	5.18
Eualus sp. (shrimp)	1.85	0.20
Pandalidae (shrimp)	1.85	0.32
Crangonidae (shrimp)	3.70	0.41
Crangon dalli (shrimp)	2.08	1.75
Paguridae (hermit crab)	4.63	14.34
Hyas lyratus (lyre crab)	2.08	11.69
Chionoecetes sp. (snow and Tanner crab)	2.78	0.47
Sipuncula (marine worm)	1.85	6.11
Ectoprocta (bryozoan)	1.85	0.07
Ophiuridae (brittle star)	21.30	4.67
Ophiura sarsi (brittle star)	5.56	12.36

Table 40.--Continued.

Total non-empty stomachs = 35
Total prey number = 164
Total prey weight = 23.9 g
Total empty stomachs = 28
Number of hauls = 6

Full stomach summary statistics
Average length = 31.7 cm
Standard deviation of length = 8.1 cm
Minimum length = 16 cm
Maximum length = 50 cm

Average fullness = 3.1
Standard deviation of fullness = 1.1
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average length = 33.0 cm
Standard deviation of length = 9.2 cm
Minimum length = 19 cm
Maximum length = 51 cm

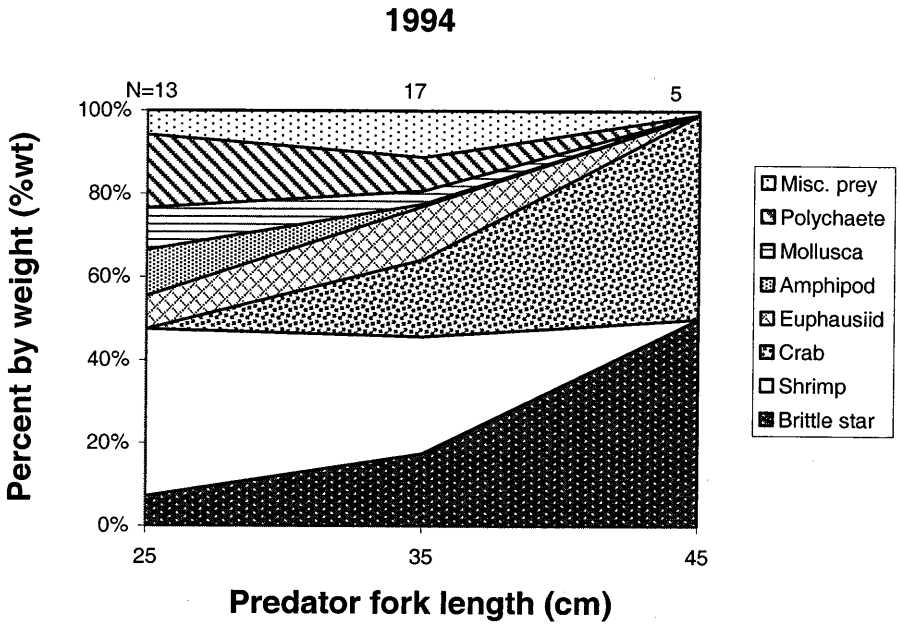

Figure 93.--Variations in the main prey of flathead sole, by predator size, in the Aleutian Islands in 1994.
N = sample size.

DISCUSSION

In this study, I compared the diets of flathead sole from the Aleutian Islands area to those from the Gulf of Alaska (Yang and Nelson 2000) and the eastern Bering Sea (Pacunski 1990). Table 41 lists the percentage by weight of the major prey categories of flathead sole from these three study areas. Table 41 indicates that walleye pollock was important prey (20% by weight) of flathead sole in the eastern Bering Sea; however, no pollock was found in the flathead sole stomachs collected in the Aleutian Islands area, and pollock comprised only 1% of the total stomach contents weight in the Gulf of Alaska area. Shrimp and hermit crabs were important food for flathead sole in the Aleutian Islands and Gulf of Alaska areas, whereas none of these were important food in the eastern Bering Sea area. Therefore, the diet similarity between the Aleutian Islands and Gulf of Alaska (66%) is the highest in all the comparisons. The diet similarities between the eastern Bering Sea and other two areas were mainly attributed to the high consumption of brittle stars (Table 41).

Table 41.-- Percent weight of the major prey categories of flathead sole in the Aleutian Islands area (AI) compared to the eastern Bering Sea (EBS) (from Pacunski 1990), and Gulf of Alaska(GOA)(from Yang and Nelson 2000).

Prey name	AI[1]	GOA[2]	EBS[3]
Polychaete	10	2	2
Clam	0	9	3
Mysid	1	2	2
Isopod	1	2	1
Amphipod	5	1	1
Euphausiid	5	4	3
Shrimp	28	39	8
Hermit crab	27	10	2
Chionoecetes sp.	1	3	2
Sipunculid and echiuroid	6	1	2
Brittle star	17	25	42
Pollock	0	1	20

Percent similarity between AI and EBS: 38
Percent similarity between GOA and EBS: 49
Percent similarity between AI and GOA: 66
1: 1994 Aleutian Islands data
2: 1993 Gulf of Alaska data
3: data from 1984 to 1988 eastern Bering Sea

ROCK SOLE

There are two species of rock sole in the North Pacific Ocean: a northern rock sole (*Lepidopsetta polyxystra*) and a southern rock sole (*L. bilineata*) (Orr and Matarese 2000). When the specimens were collected in 1994 and 1997, the status of these two rock sole species were not classified. Therefore, the two species are treated as one species in this study, and the scientific name, *Lepidopsetta* sp. is used in this study. Rock sole had an estimated biomass of 45,949 t in the Aleutian Islands area in 2000 (North Pacific Fishery Management Council also managed these two species as a single stock) (Wilderbuer and Walters 2001). Rock sole supports an important roe fishery in the Bering Sea and Aleutian Islands area. Polychaetes, gammarid amphipods and clams were the main food of rock sole in the eastern Bering Sea area (Lang 1992).

RESULTS

Table 42 summarizes the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in rock sole (*Lepidopsetta* sp.) collected in 1994 (no samples were collected in 1997). Polychaetes were the most important prey of rock sole. In terms of weight, polychaetes made up 64% of the total stomach contents. Gammarid amphipods were the second important prey. They comprised 19% of the total stomach contents weight. Rock sole also consumed some brittle stars (6%) and mollusks (6%). Miscellaneous fish (eelpouts and unidentified flatfish) were also found in the rock sole stomachs, however, they comprised only 1% of the total stomach contents weight.

Figure 94 shows the variations of the diet of rock sole by predator size. Small (<30 cm FL) rock sole consumed a higher percentage (40%) of gammarid amphipods than the larger-sized ($\geq$30 cm FL) rock sole. On the other hand, the large fish consumed high percentages ($\geq$63%) of polychaetes. Cephalopods were only found in the stomachs of rock sole that exceeded 40 cm FL.

Table 42.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of rock sole collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	76.70	57.02
Aphroditidae (polychaete)	0.77	0.85
Polynoidae (polychaete)	4.62	0.49
Phyllodocidae (polychaete)	3.08	1.05
Nereidae (polychaete)	0.77	0.01
Nephtyidae (polychaete)	0.85	0.10
Glyceridae (polychaete)	2.31	0.17
Onuphidae (polychaete)	3.25	0.31
Chaetopteridae (polychaete)	6.15	3.17
Maldanidae (polychaete)	0.85	0.05
Terebellidae (polychaete)	0.77	0.31
Trichobranchidae (polychaete)	0.85	0.10
Sabellidae (polychaete)	1.62	0.11
Mollusca	1.10	0.49
Gastropoda (snail)	0.96	0.05
Bivalvia (clam)	11.07	2.15
Pectinidae (scallops)	1.62	2.02
Octopoda (octopus)	1.10	1.33
Cumacea (cumacean)	16.74	1.98
Isopoda (isopod)	10.82	0.90
Gammaridea (amphipod)	62.24	17.35
Caprellidea (amphipod)	11.92	1.69
Caridea (shrimp)	1.10	0.10
Hippolytidae (shrimp)	1.10	0.13
Crangonidae (shrimp)	2.72	0.48
Majidae (spider crab)	2.56	0.14
Hyas sp. (lyre crab)	0.85	0.02
Echiura (marine worm)	4.76	0.60
Ophiuroidae Ophiurida (brittle star)	15.90	5.54
Echinoidea (echinoderm)	0.96	0.06
Echinoidea Clypeasteroida (sand dollar)	0.85	0.10
Ascidiacea (tunicate)	0.77	0.03
Zoarcidae (eelpout)	1.10	0.76
Pleuronectidae (flatfish)	0.85	0.33
Unidentified organic material	0.96	0.03

Table 42.--Continued.

Total non-empty stomachs = 84
Total prey number = 122
Total prey weight = 192.1 g
Total empty stomachs = 36
Number of hauls = 13

Full stomach summary statistics
Average length = 31.7 cm
Standard deviation of length = 5.6 cm
Minimum length = 19 cm
Maximum length = 45 cm

Average fullness = 3.5
Standard deviation of fullness = 1.2
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average length = 31.3 cm
Standard deviation of length = 8.5 cm
Minimum length = 17 cm
Maximum length = 59 cm

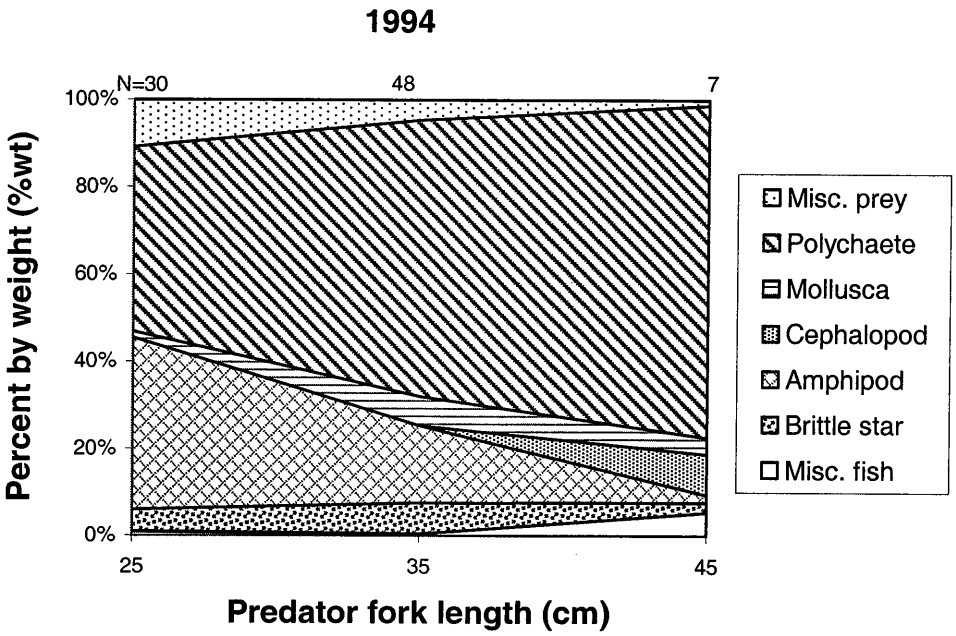

Figure 94.--Variations in the main prey of rock sole, by predator size, in the Aleutian Islands in 1994.
N = sample size.

DISCUSSION

The main prey categories (percent by weight) of rock sole from this study can be compared to the diet of rock sole from 1984 to 1988 in the eastern Bering Sea by Lang (1992) (Table 43). It shows that in both the eastern Bering Sea and Aleutian Islands, rock sole had a high percentage ($\geq$54%) of polychaetes in their diets. More amphipods were consumed in the Aleutian Islands area than in the eastern Bering Sea. On the other hand, more echiuroid were consumed in the eastern Bering Sea than in the Aleutian Islands area. Pacific sand lance was not found in the diet of rock sole in the Aleutian Islands. However, it comprised 12% of the total stomach contents weight in the eastern Bering Sea area during the period from 1984 to 1988 (Table 43).

Table 43.-- Percent weight of the major prey categories of rock sole in the Aleutian Islands area (AI) compared to the eastern Bering Sea (EBS) (from Lang 1992).

Prey name	AI[1]	EBS[2]
Polychaete	64	54
Gastropod	1	1
Clam	4	4
Amphipod	19	8
Shrimp	1	2
Sipunculid and echiuroid	1	13
Brittle star	6	1
Pacific sand lance	0	12

Percent similarity between AI and EBS: 70%

AI[1]:1994 Aleutian Islands data

ESB[2]: 1984 to 1988 eastern Bering Sea data

SABLEFISH

Sablefish, *Anoplopoma fimbria*, has an exploitable biomass of 39,000 t in the Aleutian Islands area (NPFMC 2001). The commercial catch of sablefish in 2001 was 1,033 t. Sablefish has been found to feed on walleye pollock, capelin, pandalid shrimp, Tanner crabs, and fish offal in the Gulf of Alaska area (Yang and Nelson 2000).

RESULTS

Twenty-one sablefish stomachs were collected in the Aleutian Islands in 1997. Table 44 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in sablefish. Pelagic salps were the most important prey; they comprised 46% of the total stomach contents weight of sablefish. Sablefish also consumed euphausiids (27%), squid (16%), and some amphipods (3%).

DISCUSSION

Yang and Nelson (2000) showed that sablefish fed mainly on pollock in the Gulf of Alaska area during 1996. Other fish, like eulachon, capelin, Pacific herring, Pacific cod, Pacific sand lance, and some flatfish, were also consumed by sablefish in the Gulf of Alaska. The important invertebrate prey consumed by sablefish included jellyfish, euphausiids, amphipods, squid, and pandalid shrimps.

The present study shows that salps (pelagic tunicate) comprised a high percentage (46%) of the total stomach contents weight of sablefish in the Aleutian Islands area, whereas no salps were found in sablefish stomachs in the Gulf of Alaska area (Table 45). Squid and euphausiids also comprised a higher percentage of the total stomach contents weight in the Aleutian Islands area than in the Gulf of Alaska area (Table 45). On the other hand, more fish offal was consumed by sablefish in the Gulf of Alaska area than in the Aleutian Islands area (Table 45).

The big difference (and low similarity) of the diets between the Aleutian Islands and the Gulf of Alaska areas is probably caused mainly by the different environment in these two areas. The low (n=21) sample size of sablefish collected in the Aleutian Islands area in 1997 probably

also contributed the variations of the diets in these two areas.

Table 44.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of sablefish collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Scyphozoa (jellyfish)	8.33	2.78
Teuthoidea (squid)	11.90	16.34
Gammaridea (amphipod)	18.21	0.37
Anonyx sp. (amphipod)	8.33	3.06
Themisto sp. (amphipod)	3.57	0.01
Euphausiacea (euphausiid)	50.00	23.69
Euphausiidae (euphausiid)	8.33	0.25
Thysanoessa longipes (euphausiid)	8.33	2.64
Thaliacea (Pelagic salp)	68.93	45.65
Overboard material (non-fishery)	2.50	5.21
Total non-empty stomachs = 21		
Total prey number = 83		
Total prey weight = 549.7 g		
Total empty stomachs = 0		
Number of hauls = 4		
Full stomach summary statistics		
Average length = 61.6 cm		
Standard deviation of Length = 5.6 cm		
Minimum length = 51 cm		
Maximum length = 69 cm		
Average fullness = 4.3		
Standard deviation of fullness = 1.3		
Minimum fullness = 2		
Maximum fullness = 6		

Table 45.--Percent weight of the major prey categories of sablefish in the Aleutian Islands area (AI) in 1997 compared to the Gulf of Alaska in 1996 (GOA)(from Yang and Nelson 2000).

Prey name	AI	GOA
Jellyfish	3	14
Squid	13	3
Amphipod	3	11
Euphausiid	27	10
Shrimp	0	5
Sipuncula	0	3
Salps	46	0
Pollock	0	10
Fish offal	5	32

Percent similarity between AI and GOA: 24

ALASKA SKATE

The estimated biomass of all skates in the Aleutian Islands area in 2000 was 29,206 t. Alaska skate (*Bathyraja parmifera*) comprised about 30% of the estimated biomass (Gaichas 2001). Alaska skate has been found to feed on *Chionoecetes* sp., walleye pollock, miscellaneous crustaceans, and some flatfish (Brodeur and Livingston 1988). It is important to study the food habits of Alaska skate in the Aleutian Islands area because little is known of its food habits in that region.

RESULTS

Tables 46 and 47 list the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in Alaska skate in 1994 and 1997, respectively. Atka mackerel was the most important prey fish of Alaska skate. In terms of weight, they comprised 42% and 94% of the total stomach contents in 1994 and 1997, respectively. Walleye pollock comprised 18% of the total stomach contents in 1994. Miscellaneous fish (rockfish, sculpins, stichaeids, sand lance, etc.) comprised 28% of the total stomach contents weight. Tanner crabs and gammarid amphipods were the most important invertebrate prey of Alaska skate in 1994. They comprised 3% and 4% of the total stomach contents weight, respectively.

Because of the small sample size of Alaska skate stomachs, an analysis of diet variation between different size groups could not be done.

Geographic Distributions of the Prey Consumption

The distributions of prey consumption by Alaska skate are shown in Figures 95 to 101. Figures 95 illustrates that high percentage (> 50%) of walleye pollock were consumed by Alaska skate in the areas around Kiska Island, Unalaska Island and Unimak Island. *Sebastes* sp. was consumed by Alaska skate primarily in the area west of Kiska Island in 1994 (Fig. 96). Figures 97 and 98 illustrate the locations where Atka mackerel were consumed by Alaska skates. They show that high percentages (> 75%) of Atka mackerel were consumed by Alaska skates around Tanaga Island, Kiska Island, and Attu Island in 1994, and

in Seguam Island, Atka Island, and Attu Island in 1997. A high percentage (> 75%) of Pacific sand lance consumed by Alaska skates was found near Akutan Island area in 1994 (Fig. 99). Alaska skates also consumed some fishery offal (Fig. 100) primarily around Kiska Island area in 1994. Tanner crabs were consumed by Alaska skates primarily in the Atka Island area.

Sizes of the Important Prey Consumed

Table 48 lists the mean standard length, the standard deviation, the range, and the number of the miscellaneous prey consumed by Alaska skates in 1994. The Atka mackerel consumed by Alaska skates had a mean standard length (±SD) of 220.7 ± 64.0 mm with a range between 96 and 360 mm. The average size of Atka mackerel consumed by Alaska skates in 1997 was 256.4 ± 26.4 mm SL with a range between 228 and 296 mm SL.

DISCUSSION

Alaska skate is mainly a fish eater. This study shows that fish comprised more than 80% of the total stomach contents weight of Alaska skates in the Aleutian Islands area (Tables 46 and 47). Atka mackerel and walleye pollock were the most important prey of Alaska skate. Brodeur and Livingston (1988) found that, in the eastern Bering Sea, Alaska skate feed mainly on pollock, snow crabs (*Chionoecetes opilio*), and flatfishes. Orlov (1998) found that, in the northern Kurils and southeastern Kamchatka, Alaska skate feed on Atka mackerel, pollock, sculpins, squid, snow crabs, shrimps, and amphipods.

Table 46.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Alaska skate collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	2.78	0.11
Isopoda (isopod)	8.33	0.81
Gammaridea (amphipod)	11.11	3.92
Euphausiacea (euphausiid)	2.78	0.01
Reptantia (crab)	6.02	1.26
Hippolytidae (shrimp)	2.78	0.04
Pandalus montagui tridens (shrimp)	1.39	0.20
Crangonidae (shrimp)	8.33	1.28
Paguridae (hermit crab)	2.78	0.17
Acantholithodes hispidus (Fussy crab)	1.39	0.24
Placetron wosnessenskii (scale crab)	6.25	0.51
Chionoecetes bairdi (Tanner crab)	2.78	3.33
Osteichthyes Teleostei (fish)	4.63	0.19
Non-gadoid fish remains	1.39	0.06
Theragra chalcogramma (walleye pollock)	18.52	18.21
Sebastes sp. (rockfish)	11.11	10.91
Hexagrammos decagrammus (kelp greenling)	2.78	2.14
Pleurogrammus monopterygius (Atka mackerel)	45.60	41.56
Cottoidei (sculpin)	6.94	2.84
Cyclopteridae (snailfish)	4.63	0.75
Bathymaster signatus (searcher)	1.39	1.11
Stichaeidae (prickleback)	1.39	0.46
Ammodytes sp. (sandlance)	5.56	4.28
Hippoglossus stenolepis (Pacific halibut)	2.78	0.16
Fishery offal	3.47	5.45

Table 46.--Continued.

Total non-empty stomachs = 42
Total prey number = 86
Total prey weight = 4,880.4 g
Total empty stomachs = 7
Number of hauls = 18

Full stomach summary statistics
Average wing-to-wing length = 74.5 cm
Standard deviation of length = 8.1 cm
Minimum length = 50 cm
Maximum length = 86 cm

Average fullness = 4.5
Standard deviation of fullness = 1.2
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average wing-to-wing length = 73.4 cm
Standard deviation of length = 4.1 cm
Minimum length = 68 cm
Maximum length = 81 cm

Table 47.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Alaska skate collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Pleurogrammus monopterygius (Atka mackerel)	83.33	94.05
Bathymaster signatus (searcher)	16.67	5.95

Total non-empty stomachs = 6
Total prey number = 6
Total prey weight = 549.2 g
Total empty stomachs = 1
Number of hauls = 4

Full stomach summary statistics
Average length = 75.2 cm
Standard deviation of length = 6.6 cm
Minimum length = 62 cm
Maximum length = 80 cm

Average fullness = 5.7
Standard deviation of fullness = 0.5
Minimum fullness = 5
Maximum fullness = 6

Empty stomach summary statistics
Average length = 79 cm
Standard deviation of length = 0 cm
Minimum length = 79 cm
Maximum length = 79 cm

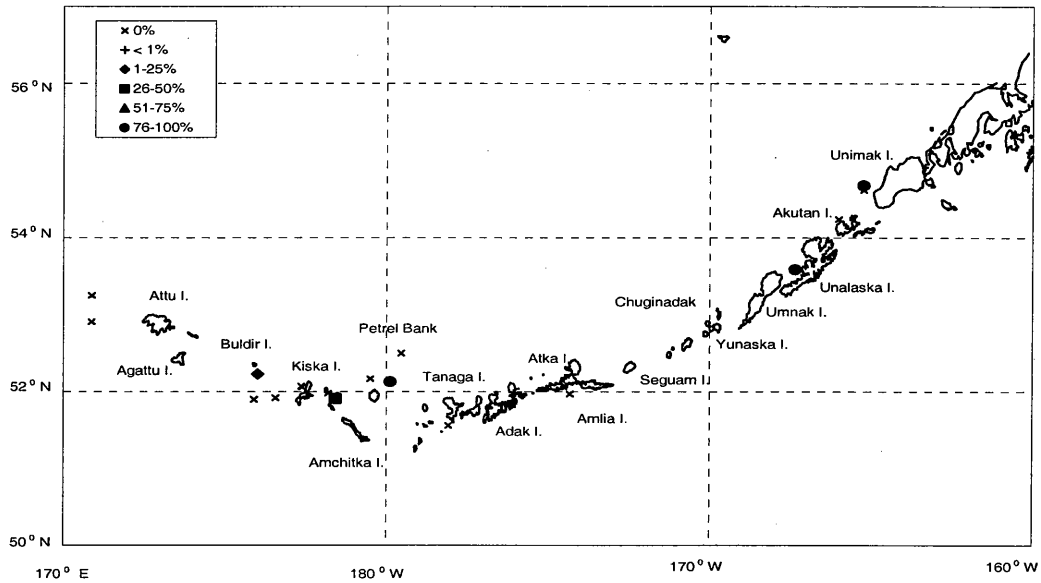

Figure 95.--Geographic distribution of walleye pollock consumed by Alaska skate in the Aleutian Islands area in 1994.

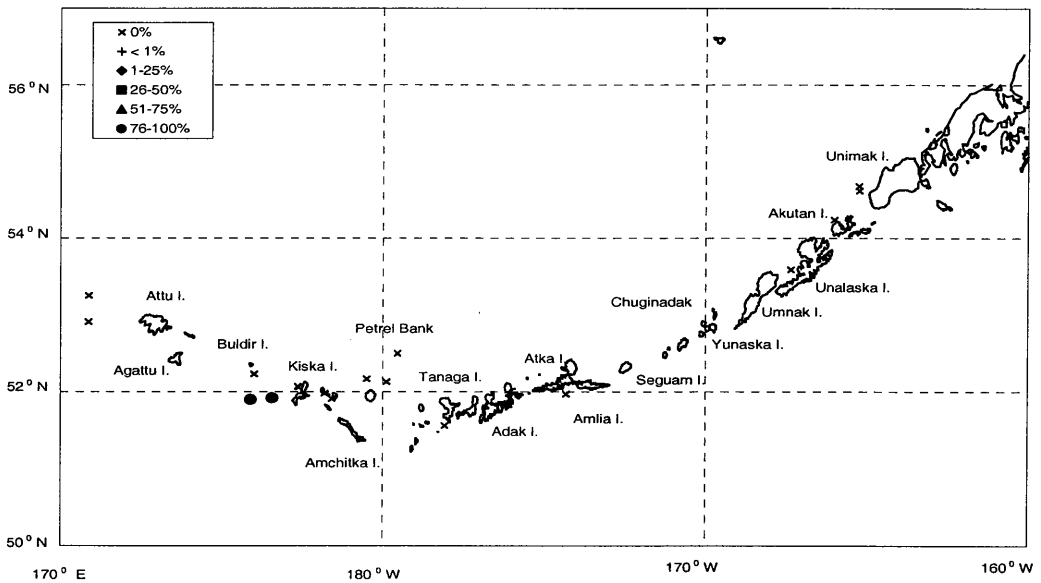

Figure 96.--Geographic distribution of Sebastes sp. consumed by Alaska skate in the Aleutian Islands area in 1994.

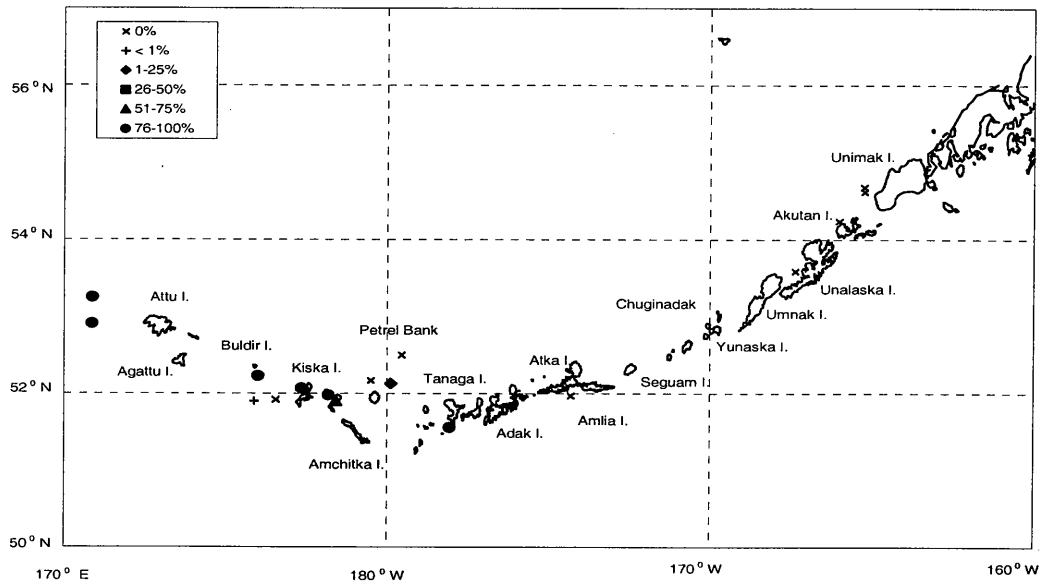

Figure 97.--Geographic distribution of Atka mackerel consumed by Alaska skate in the Aleutian Islands area in 1994.

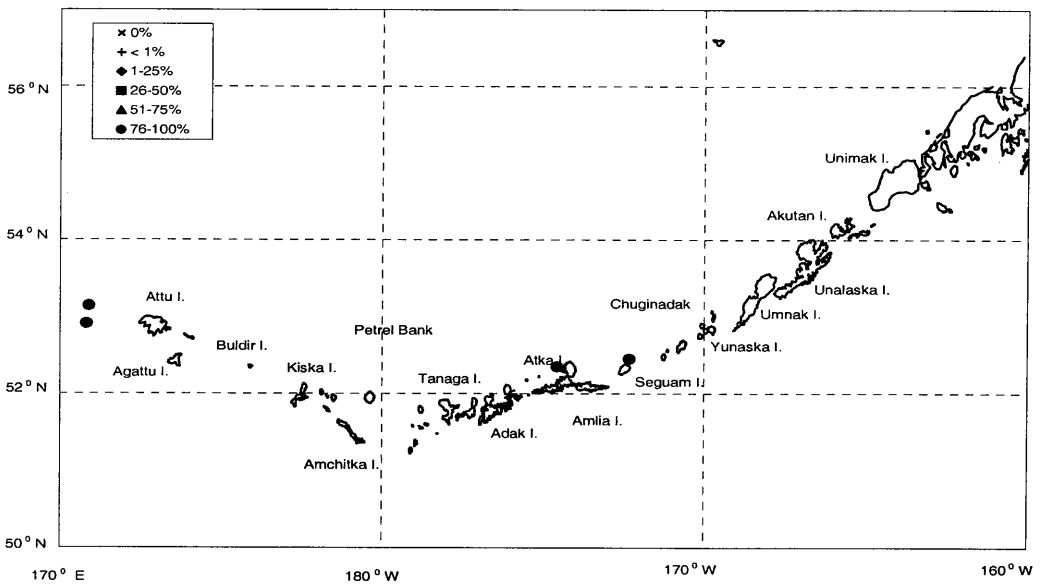

Figure 98.--Geographic distribution of Atka mackerel consumed by Alaska skate in the Aleutian Islands area in 1997.

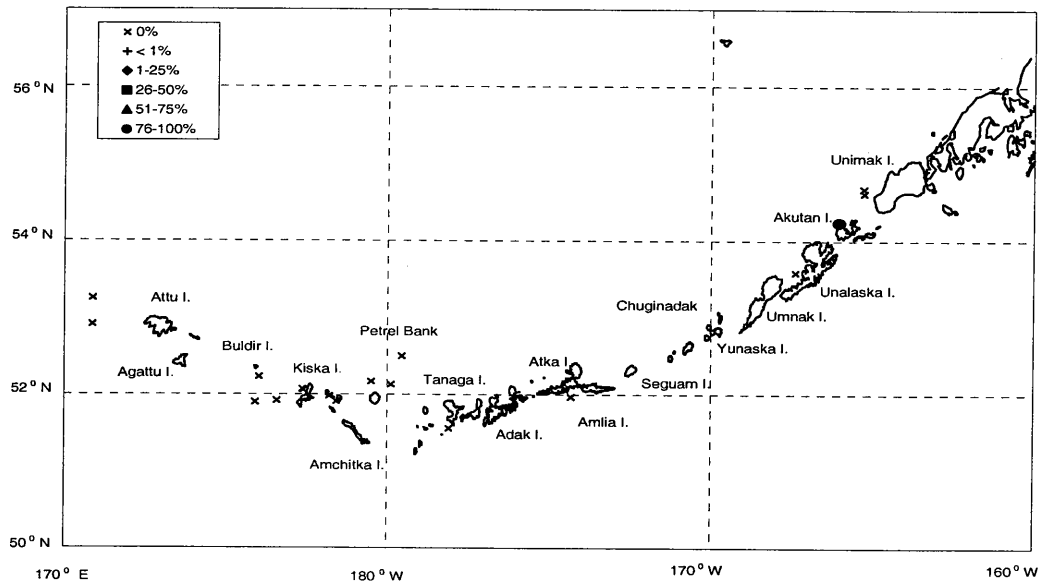

Figure 99.--Geographic distribution of Pacific sand lance consumed by Alaska skate in the Aleutian Islands area in 1994.

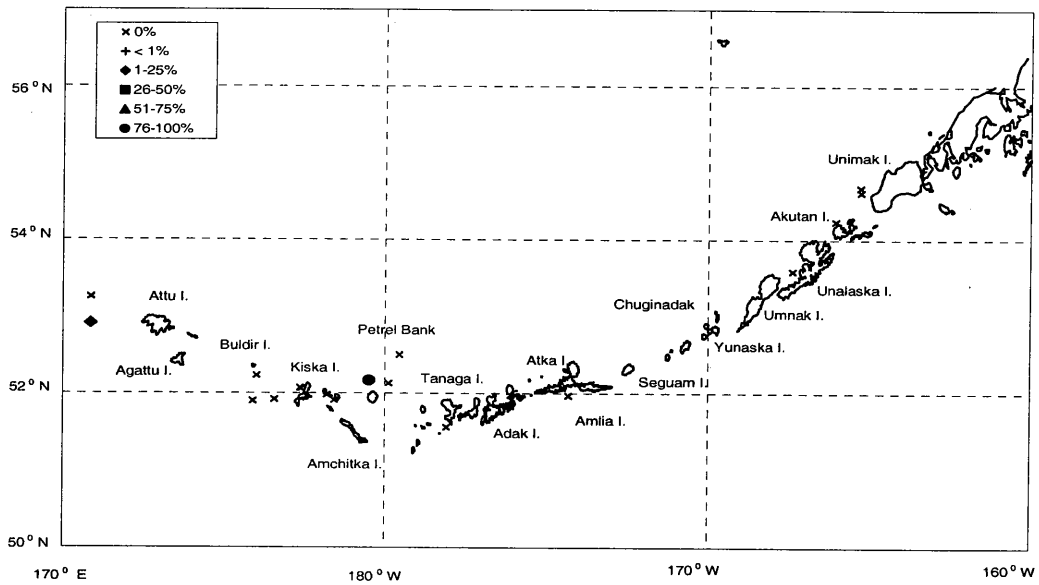

Figure 100.--Geographic distribution of fishery offal consumed by Alaska skate in the Aleutian Islands area in 1994.

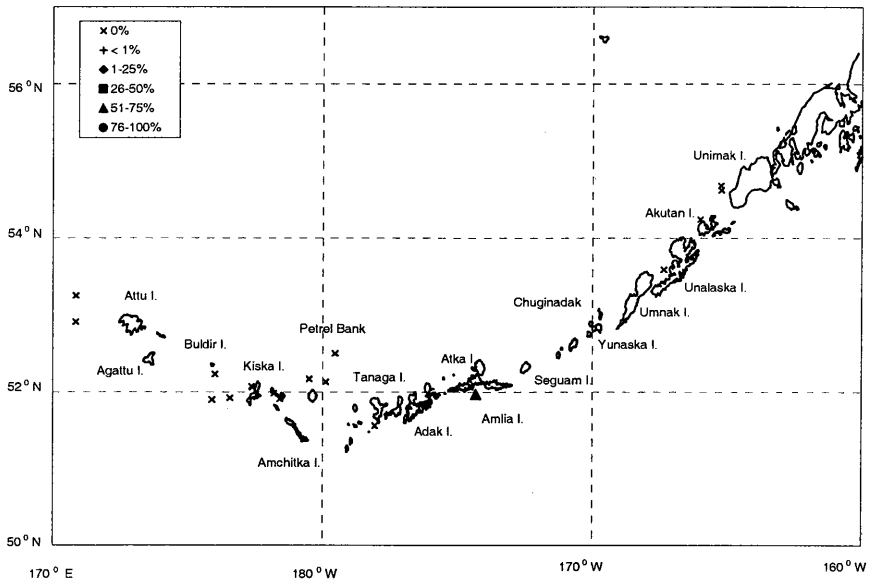

Figure 101.--Geographic distribution of Tanner crabs consumed by Alaska skate in the Aleutian Islands area in 1994.

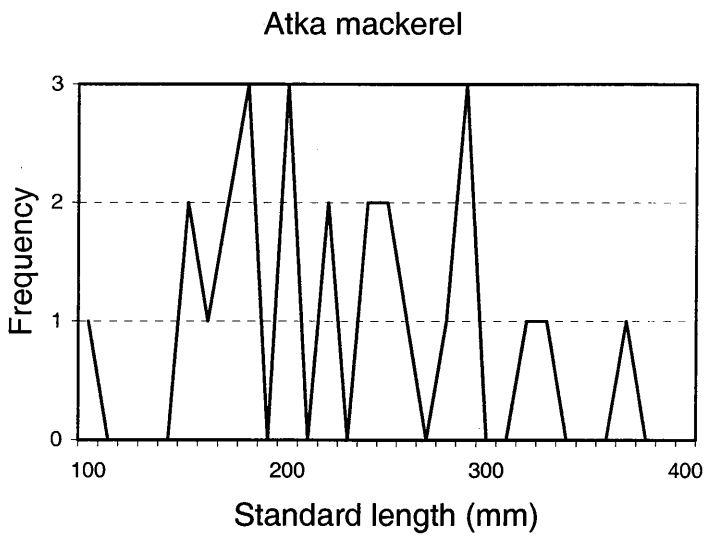

Figure 102.--Size frequency distribution of Atka mackerel consumed by Alaska skate in the Aleutian Islands in 1994.

Table 48.--Mean standard length (or carapace width), standard deviation (SD), and range of standard length of the miscellaneous prey consumed by Alaska skates in the Aleutian Island in 1994. N = sample size.

Prey name	N	Mean SL (mm)	SD (mm)	Range(mm)
Walleye pollock	3	422.0	111.9	296-510
Atka mackerel	26	220.7	64.0	96-360
Sebastes sp.	2	267.5	3.5	265-270
Sculpins	7	46.9	24.7	30-97
Kelp greenling	2	185.0	26.8	166-204
Snailfish	5	62.2	13.5	42-80
Searcher	1	143.0	0.0	143-143
Prickleback	1	113.0	0.0	113-113
Pacific sand lance	2	38.5	3.5	36-41
Pacific halibut	2	28.0	8.5	22-34
Tanner crab	3	15.3	2.1	13-17

MUD SKATE

The estimated biomass of all skates in the Aleutian Islands area in 2000 was 29,206 t. The mud skate, *Bathyraja taranetzi*, is a relatively small skate. It comprised about 3% of the total biomass of skates in the Aleutian Islands area in 2000 (Gaichas 2001). Little is known about the food habits of mud skate.

RESULTS

Tables 49 and 50 list the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in mud skate in 1994 and 1997, respectively. Gammarid amphipods were the most important prey of mud skate. In terms of weight, they comprised 62% and 60% of the total stomach contents in 1994 and 1997, respectively. Polychaetes were the second most important prey of mud skates; they comprised 21% and 12% of the total stomach contents weight in 1994 and 1997, respectively. Shrimp (mainly pandalids) comprised 6% and 7% of the total stomach contents weight in 1994 and 1997, respectively. Fish were not important prey of mud skates; they comprised only 4% and 8% of the total stomach contents weight in 1994 and 1997, respectively. Mud skates also consumed some mysids (7% by weight) in 1994 and some squid (5% by weight) in 1997.

Because of the small sample size of mud skate stomachs, an analysis of diet variation between different size groups could not be done.

One myctophid (33 mm SL) was consumed by mud skate in 1994 and one myctophid (26 mm SL) was consumed by mud skate in 1997.

DISCUSSION

Compared to other skates, mud skate is a small-sized skate. Because of this, mud skate mainly feeds on small prey such as amphipods, polychaetes, shrimps, and mysids. Little is known about the food habits of mud skate in other areas.

Table 49.--Mean percent frequency of occurrence (%FO) and mean percent weight (%wt) of the prey items in the diet of mud skate collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	83.33	20.68
Calanoida (copepod)	41.67	0.95
Mysidae (mysid)	33.33	6.94
Gammaridea (amphipod)	100.00	61.64
Hippolytidae (shrimp)	16.67	2.17
Pandalidae (shrimp)	16.67	3.90
Osteichthyes Teleostei (fish)	25.00	0.46
Myctophidae (lanternfish)	16.67	3.25

Total non-empty stomachs = 5
Total prey number = 27
Total prey weight = 8.9 g
Total empty stomachs = 1
Number of hauls = 2

Full stomach summary statistics
Average wing-to-wing length = 31.8 cm
Standard deviation of length = 10.6 cm
Minimum length = 19 cm
Maximum length = 48 cm

Average fullness = 4.4
Standard deviation of fullness = 0.9
Minimum fullness = 3
Maximum fullness = 5

Empty stomach summary statistics
Average length = 20 cm
Standard deviation of length = 0.0 cm
Minimum length = 20 cm
Maximum length = 20 cm

Table 50.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of mud skate collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Polychaeta (worm)	81.96	11.66
Cephalopoda (squid and octopus)	1.25	0.05
Teuthoidea (squid)	12.32	4.54
Calanoida (copepod)	1.25	0.01
Gnathophausia gigas (mysid)	1.25	0.02
Eucopiidae (mysid)	6.25	0.08
Mysidae (mysid)	15.36	0.19
Holmesiella anomala (mysid)	1.79	0.16
Pseudomma truncatum (mysid)	7.86	0.24
Cumacea (cumacean)	15.36	0.18
Isopoda (isopod)	36.79	2.05
Gammaridea (amphipod)	85.00	59.63
Themisto sp. (amphipod)	1.25	0.02
Caprellidea (amphipod)	32.50	1.23
Euphausiacea (euphausiid)	26.07	0.95
Thysanoessa sp. (euphausiid)	8.75	1.30
Caridea (shrimp)	18.04	3.84
Hippolytidae (shrimp)	3.57	0.31
Pandalidae (shrimp)	3.75	0.81
Pandalus borealis (shrimp)	1.79	1.65
Crangonidae (shrimp)	3.75	0.39
Paguridae (hermit crab)	1.25	0.01
Munida quadrispina (Pinch bug)	1.25	2.15
Larvacea Copelata	1.25	0.10
Osteichthyes Teleostei (fish)	15.00	2.28
Non-gadoid fish remains	1.25	0.03
Bathylagidae (deepsea smelts)	1.25	0.40
Myctophidae (lanternfish)	1.25	0.01
Unidentified organic material	8.04	0.39
Unidentified worm-like organism	1.25	0.06
Fishery offal	5.00	5.27

Table 50.--Continued.

Total non-empty stomachs = 58
Total prey number = 193
Total prey weight = 478.7 g
Total empty stomachs = 1
Number of hauls = 8

Full stomach summary statistics
Average length = 32.3 cm
Standard deviation of length = 12.5 cm
Minimum length = 6 cm
Maximum length = 72 cm

Average fullness = 4.9
Standard deviation of fullness = 0.8
Minimum fullness = 3
Maximum fullness = 6

Empty stomach summary statistics
Average length = 31 cm
Standard deviation of length = 0.0 cm
Minimum length = 31 cm
Maximum length = 31 cm

WHITEBLOTCHED SKATE

The estimated biomass of all skates in the Aleutian Islands area in 2000 was 29,206 t. Whiteblotched skate, *Bathyraja maculata*, was the most abundant skate species. It comprised about 45% of the total skate biomass (Gaichas 2001). Therefore, it is important to study the food habits of the whiteblotched skate in the Aleutian Islands area.

RESULTS

Twenty-seven whiteblotched skate stomachs were collected in the Aleutian Islands in 1997. Table 51 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in whiteblotched skate. Atka mackerel and walleye pollock were the most important prey; they comprised 25% and 12% of the total stomach contents weight of whiteblotched skate, respectively. Whiteblotched skate also consumed some sculpin (6%) and myctophids (2%). Pandalids and hippolytids were two important shrimp consumed by whiteblotched skate; they comprised 7% and 11% of the total stomach contents weight, respectively. Whiteblotched skate also consumed some deep sea king crab, *Lithodes couesi*, Korean horse-hair crab, *Erimacrus isenbeckii*, and squid.

DISCUSSION

Orlov (1998) found that, in the northern Kurils and southeastern Kamchatka, whiteblotched skate fed mainly on invertebrates (80%) and miscellaneous fish occurred in less than 20% of the stomachs examined. Important invertebrate prey included amphipods, pandalid shrimp, *Chionoecetes opilio*, and *Berryteuthis magister*. The important prey fish included *Leuroglossus schmidti*, myctophids, pollock, and Atka mackerel. The difference between this study and Orlov's study was that more Atka mackerel and pollock (about 36% of the total stomach contents weight) were in the diet of whiteblotched skate in the 1997 Aleutian Islands samples than in Orlov's study. Amphipod and squid (about 45% by weight) were a more dominant prey of whiteblotched skates in the Kurils and southeastern Kamchatka.

Table 51.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of whiteblotched skate collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Polychaeta (worm)	1.59	0.00
Cephalopoda (squid and octopus)	11.11	0.39
Teuthoidea (squid)	24.44	3.58
Octopoda (octopus)	4.44	0.07
Eucalanus bungii (copepod)	1.59	0.00
Isopoda (isopod)	5.56	0.27
Gammaridea (amphipod)	7.14	0.07
Euphausiacea (euphausiid)	2.22	0.00
Caridea (shrimp)	16.67	8.35
Hippolytidae (shrimp)	11.11	11.11
Pandalidae (shrimp)	34.26	6.81
Paguridae (hermit crab)	4.44	0.16
Lithodidae (king crab)	5.56	3.79
Placetron wosnessenskii (scale crab)	1.59	0.25
Lithodes couesi (couesi king crab)	2.22	0.19
Oregonia sp. (decorator crab)	18.15	2.17
Erimacrus isenbeckii (Korean horse-hair crab)	5.56	2.86
Larvacea Copelata (tunicate)	1.59	0.00
Osteichthyes Teleostei (fish)	17.04	7.02
Non-gadoid Fish Remains	7.78	2.62
Myctophidae (lanternfish)	16.67	1.52
Theragra chalcogramma (walleye pollock)	13.62	11.48
Pleurogrammus monopterygius (Atka mackerel)	19.42	24.68
Cottidae (sculpin)	10.37	5.69
Triglops scepticus (spectacled sculpin)	2.22	0.10
Hypsagonus quadricornis (four horn poacher)	2.22	0.02
Fishery offal	2.22	6.79

Total non-empty stomachs = 27
Total prey number = 121
Total prey weight = 2,216.0 g
Total empty stomachs = 0
Number of hauls = 9

Full stomach summary statistics
Average wing-to-wing length = 66.0 cm
Standard deviation of length = 12.5 cm
Minimum length = 15 cm
Maximum length = 76 cm

Average fullness = 4.7
Standard deviation of fullness = 1.1
Minimum fullness = 3
Maximum fullness = 6

ROUGHTAIL SKATE

The estimated biomass of all skates in the Aleutian Islands area in 2000 was 29,206 t. Roughtail skate (also called black skate), *Bathyraja trachura*, and six other skate species (big skate, *Raja binoculata*; longnose skate, *R. rhina*; Bering skate, *B. interrupta*; white brow skate, *B. minispinosa*; commander skate, *B. lindbergi*; and Okhotsk skate, *B. violacea*) made up 7% of the skate complex biomass (Gaichas 2001). Little is known about the food habits of roughtail skate. Hence, it is important to study its diet.

RESULTS

Four roughtail skate stomachs with food were collected in the Aleutian Islands in 1994 (Table 52). Table 52 also lists the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in roughtail skate. Polychaetes were the most important prey; they comprised 57% of the total stomach contents weight of roughtail skate. Roughtail skate also consumed some fish (15%, mainly myctophids), cephalopods (8%), pandalid shrimp (5%), mysids (4%) and isopods (4%).

Table 52.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of roughtail skate collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (worm)	100.00	57.38
Cephalopoda (squid and octopus)	25.00	2.28
Teuthoidea (squid)	25.00	5.74
Calanoida (copepod)	25.00	0.22
Mysidae (mysid)	75.00	4.38
Isopoda (isopod)	75.00	4.26
Gammaridea (amphipod)	75.00	2.87
Euphausiacea (euphausiid)	25.00	0.59
Caridea (shrimp)	25.00	0.99
Hippolytidae (shrimp)	25.00	1.11
Pandalidae (shrimp)	50.00	4.88
Osteichthyes Teleostei (fish)	50.00	13.08
Myctophidae (lanternfish)	25.00	2.22

Total non-empty stomachs = 4
Total prey number = 21
Total prey weight = 16.2 g
Total empty stomachs = 0
Number of hauls = 1

Full stomach summary statistics
Average wing-to-wing length = 36.5 cm
Standard deviation of length = 8.2 cm
Minimum length = 26 cm
Maximum length = 44 cm

Average fullness = 3.5
Standard deviation of fullness = 0.6
Minimum fullness = 3
Maximum fullness = 4

BERING SKATE

The estimated biomass of all skates in the Aleutian Islands area in 2000 was 29,206 t. Bering skate (or sandpaper skate), *Bathyraja interrupta*, and six other skate species (big skate, *Raja binoculata*; longnose skate, *R. rhina*; roughtail skate, *B. tracura*; white brow skate, *B. minispinosa*; commander skate, *B. lindbergi*; and Okhotsk skate, *B. violacea*) made up 7% of the skate complex biomass (Gaichas 2001).

RESULTS

One Bering skate stomach was collected in the Aleutian Islands in 1994 (Table 53). Table 53 also lists the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in Bering skate. Polychaetes were the most important prey; they comprised 71% of the total stomach contents weight of Bering skate. Bering skate also consumed some isopod (13%), pandalid shrimp (9%), gammarid amphipods (6%) and mysids (1%).

DISCUSSION

Orlov (1998) found that, in the northern Kurils and southeastern Kamchtaka, amphipods were the most frequently occurring (66%) prey of Bering skate and annelid were the second important prey of Bering skate. In this study, polychaetes were the most important prey. These comprised 72% of the total stomach contents weight of Bering skate. Overall, it seems that Bering skate, similar to roughtail skate, feeds on benthic and epibenthic prey and does not feed on fishes.

Table 53.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Bering skate collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Polychaeta (worm)	100	71.29
Mysidae (mysid)	100	1.03
Isopoda (isopod)	100	13.20
Gammaridea (amphipod)	100	5.77
Pandalidae (shrimp)	100	8.72

Total non-empty stomachs = 1
Total prey number = 0
Total prey weight = 7.8 g
Total empty stomachs = 0
Number of hauls = 1

Wing-to-wing length = 32 cm
Fullness = 5

ALEUTIAN SKATE

The estimated biomass of all skates in the Aleutian Islands area in 2000 was 29,206 t. The Aleutian skate, *Bathyraja aleutica*, was common in the Aleutian Islands area and accounted for 15% of the total skate biomass (Gaichas 2001).

RESULTS

One Aleutian skate stomach was collected in the Aleutian Islands in 1997 (Table 54). Table 54 also lists the percent frequency of occurrence of the prey, and the percent by weight of the prey found in Aleutian skate. Pandalid shrimp were the only prey found in the stomach.

DISCUSSION

Orlov (1998) found that, in the northern Kurils and southeastern Kamchatka, pandalid shrimp were the most frequently occurring prey (24%) in the stomach contents of Aleutian skate. He also found that Aleutian skate fed on snow crabs (*Chionoecetes opilio*), octopus, walleye pollock, Atka mackerel, and miscellaneous sculpins. In this study, pandalid shrimp was the only prey found in the Aleutian skate stomach. Although similarity does exist between the results of these two studies, it is important to collect more stomachs to better determine the diet of Aleutian skate in the Aleutian Islands.

Table 54.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of Aleutian skate collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Pandalus sp. (shrimp)	100	100

Total non-empty stomachs = 1
Total prey number = 1
Total prey weight = 2.9 g
Total empty stomachs = 1
Number of hauls = 1

Full stomach summary statistics
Wing-to-wing Length = 73 cm

Average fullness = 3

Empty stomach summary statistics
Average length = 90 cm

GREAT SCULPIN

There are many sculpin species in the North Pacific. The estimated biomass of all sculpins in the Aleutian Islands area in 2000 was 13,037 t (Gaichas 2001). Great sculpin (*Myoxocephalus polyacanthocephalus*) is one of the larger sculpin species.

RESULTS

General Diet

Tables 55 and 56 list the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in great sculpin in 1994 and 1997, respectively. Tanner crabs were the most important prey of the great sculpin; they comprised 31% and 46% of the total stomach contents weight of great sculpin in 1994 and 1997, respectively. Korean horse-hair crabs were also important food of great sculpin; they comprised about 21% of the total stomach contents weight in both 1994 and 1997. Great sculpin also consumed a high percentage (17%) of lyre crabs in 1994 and a high percentage (30%) of Atka mackerel in 1997. Table 49 also shows that great sculpin consumed many different crabs (golden king crab, scale crab, pinch bug, etc.) and miscellaneous fish (walleye pollock, sculpin, flatfish, etc.) in 1994.

Geographic Distributions of the Important Prey

The geographic distributions of the important prey consumption by great sculpin in 1994 are shown in Figures 103 to 106. Figure 103 illustrates that high percentages (> 75%) of Tanner crabs consumed were observed in the Unalaska and Atka Islands areas. Atka mackerel was found in the diet of great sculpin mainly in the Unimak Pass area (Fig. 104). High percentages of Korean horse-hair crab consumed were found in the Atka, Kiska, and Agattu Island areas (Fig. 105). Figure 106 illustrates that fishery offal consumed by great sculpin was mainly found west of Seguam Island.

Sizes of the Important Prey Consumed

Tables 57 and 58 lists the mean standard length, the standard deviation, the range, and the number of the

miscellaneous prey consumed by great sculpin in 1994 and 1997, respectively. Table 57 shows that the Tanner crabs consumed by great sculpin in 1994 had a mean carapace width (±SD) of 27.6 ± 16.2 mm with a range between 12 and 104 mm; whereas the value for that in 1997 was 30.5 ± 14.2 mm with a range between 18 and 72 mm (Table 58). One measurable walleye pollock, 327 mm SL, was found in a great sculpin stomach collected in 1994. The Atka mackerel measured in the stomach contents of great sculpin in 1994 was 340 mm SL, whereas the two Atka mackerel found in the 1997 stomach contents were 203 mm and 213 mm SL, respectively.

DISCUSSION

Simenstad et al. (1977) found that brachyuran crabs and gammarid amphipods occurred frequently in the great sculpin stomachs collected from the Amchitka Islands area. They noted that great sculpin also fed on some Pacific sand lance and sturgeon poacher (*Agonus acipenserinus*). In the current study, brachyuran crabs (mainly *Chionoecetes bairdi* and *Erimacrus isenbeckii*) and miscellaneous fish were the most important prey. Brodeur and Livingston (1988) also showed that, in the eastern Bering Sea, *Chionoecetes* sp. were the most common prey (about 50% by weight) of great sculpin and walleye pollock was the next most important prey (20% by weight).

Table 55.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of great sculpin collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Argis sp. (shrimp)	2.38	0.09
Placetron wosnessenskii (scale crab)	1.59	0.22
Lithodes aequispina (golden king crab)	9.52	4.42
Cryptolithodes typicus (umbrella crab)	1.19	0.01
Munida quadrispina (Pinch bug)	4.76	4.38
Majidae (spider crab)	1.19	1.09
Oregonia sp. (decorator crab)	1.59	0.09
Hyas sp. (lyre crab)	23.41	16.75
Chionoecetes sp. (snow and Tanner crab)	1.19	0.05
Chionoecetes bairdi (Tanner crab)	77.78	31.16
Erimacrus isenbeckii (Korean horse-hair crab)	35.32	21.14
Sand dollar	4.76	0.33
Theragra chalcogramma (walleye pollock)	3.57	0.13
Pleurogrammus monopterygius (Atka mackerel)	1.19	2.40
Cottidae (sculpin)	1.19	2.31
Agonidae (poacher)	3.57	0.29
Lumpenus maculatus (daubed shanny)	1.19	0.03
Pleuronectidae (flatfish)	4.76	2.95
Atheresthes stomias (arrowtooth flounder)	1.19	2.17
Hippoglossoides elassodon (flathead sole)	1.59	1.96
Lepidopsetta sp. (rock sole type)	2.78	2.22
Fishery offal	3.17	5.55

Total non-empty stomachs = 44
Total prey number = 201
Total prey weight = 7,516.0 g
Total empty stomachs = 9
Number of hauls = 21

Full stomach summary statistics
Average length = 56.5 cm
Standard deviation of length = 10.8 cm
Minimum length = 40 cm
Maximum length = 79 cm

Average fullness = 5
Standard deviation of fullness = 0.9
Minimum fullness = 3
Maximum fullness = 7

Empty stomach summary statistics
Average length = 54.2 cm
Standard deviation of length = 9.3 cm
Minimum length = 43 cm
Maximum length = 67 cm

Table 56.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of great sculpin collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Chionoecetes bairdi (Tanner crab)	55.56	46.18
Erimacrus isenbeckii (Korean horse-hair crab)	11.11	20.61
Strongylocentrotus sp. (sea urchin)	11.11	1.66
Pleurogrammus monopterygius (Atka mackerel)	22.22	30.17
Agonidae (poacher)	11.11	0.80
Pleuronectidae (flatfish)	11.11	0.57

Total non-empty stomachs = 9
Total prey number = 31
Total prey weight = 630.4 g
Total empty stomachs = 4
Number of hauls = 3

Full stomach summary statistics
Average length = 50.6 cm
Standard deviation of length = 9.2 cm
Minimum length = 31 cm
Maximum length = 61 cm

Average fullness = 5
Standard deviation of fullness = 1.1
Minimum fullness = 3
Maximum fullness = 6

Empty stomach summary statistics
Average length = 64 cm
Standard deviation of length = 7.5 cm
Minimum length = 56 cm
Maximum length = 74 cm

Table 57.--Mean standard length (SL) (or carapace width (CW)), standard deviation (SD), and range of standard length (or carapace width) of the miscellaneous prey consumed by great sculpin in the Aleutian Islands in 1994. N = number of measurable prey.

Prey name	N	Mean SL/CW (mm)	SD (mm)	Range(mm)
Walleye pollock	1	327.0	0.0	327-327
Atka mackerel	1	340.0	0.0	340-340
Sculpins	1	310.0	0.0	310-310
Daubed shanny	1	125.0	0.0	125-125
Poacher	1	85.0	0.0	85-85
Arrowtooth flounder	1	350.0	0.0	350-350
Flathead sole	1	250.0	0.0	250-250
Lepidopsetta sp.	2	260.0	56.6	220-300
Tanner crab	108	27.6	16.2	12-104
Korean horse-hair crab	18	50.3	8.5	36-65

Table 58.--Mean standard length (SL)(or carapace width (CW)), standard deviation (SD), and range of standard length (or carapace width) of the miscellaneous prey consumed by great sculpin in the Aleutian Islands in 1997. N = measurable prey.

Prey name	N	Mean SL/CW (mm)	SD (mm)	Range(mm)
Atka mackerel	2	208.0	7.1	203-213
Poacher	1	80.0	0.0	80-80
Tanner crab	25	30.5	14.2	18-72
Korean horse-hair crab	1	51.0	0.0	51-51

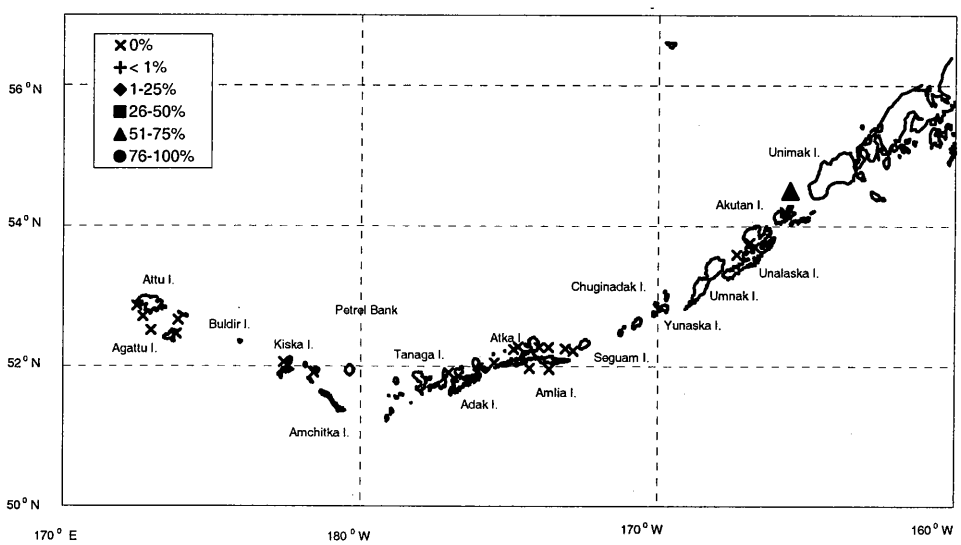

Figure 104.--Geographic distribution of Atka mackerel consumption by great sculpin in the Aleutian Islands area in 1994.

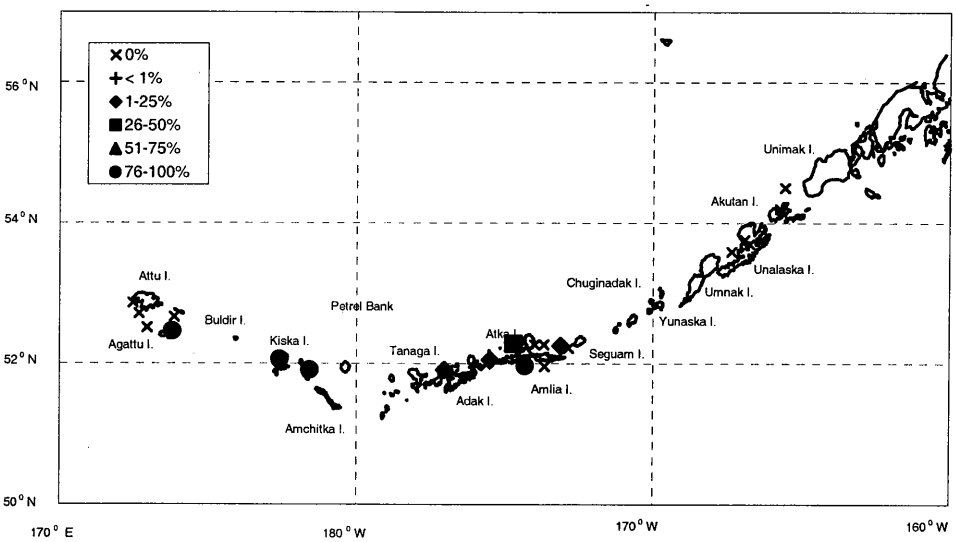

Figure 105.--Geographic distribution of Korean horse-hair crab consumption by great sculpin in the Aleutian Islands area in 1994.

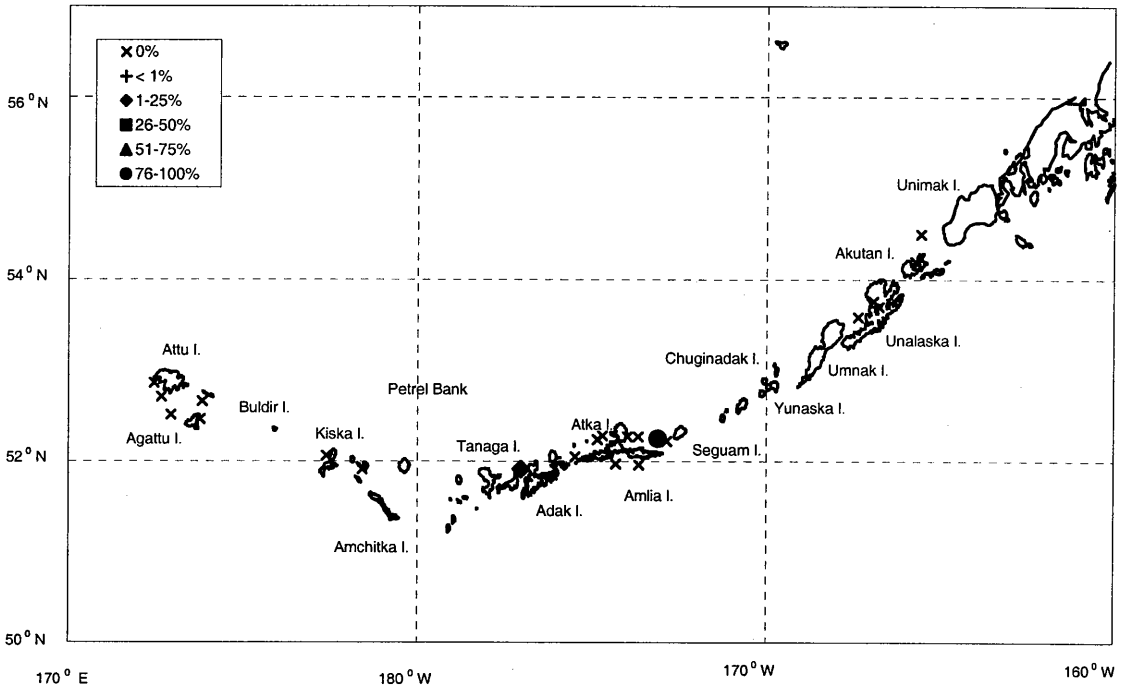

Figure 106.--Geographic distribution of fishery offal consumed by great sculpin in the Aleutian Islands area in 1994.

DARKFIN SCULPIN

The estimated biomass of all sculpins in the Aleutian Islands area in 2000 was 13,037 t (Gaichas 2001). Darkfin sculpin, *Malacocottus zonurus*, is one of the medium-sized (usually less than 25 cm) sculpins.

RESULTS

Table 59 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in darkfin sculpin in 1994. Polychaetes were the most important prey; they comprised 43% of the total stomach contents weight of darkfin sculpin. Pandalid shrimp and gammarid amphipods were also important prey of darkfin sculpin; they comprised 15% and 20% of the total stomach contents weight of darkfin sculpin, respectively. Darkfin sculpin also consumed some comb jellies (5%), brittle stars (4%), and squid (2%).

DISCUSSION

This species is often confused with blackfin sculpin (*Malacocottus kincaidi*). Some authors have used the names interchangeably (Mecklenburg et al. 2002). Some researchers believe these two species are actually the same. Therefore, diets of these two species will be discussed in the current study. Simenstad et al. (1977) found that, in the Amchitka Island area, blackfin sculpin fed mainly on polychaetes, isopods, shrimps, and gammarid amphipods. This diet composition is similar to that observed for darkfin sculpin in the current study. In contrast, Tokranov and Orlov (2001) found that darkfin sculpin fed more on gastropods and octopus (more than 50% by weight) and less on polychaetes and amphipods (less than 30% by weight) in southeastern Kamchatka and the northern Kurils.

Table 59.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of darkfin sculpin collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Ctenophora (comb jelly)	7.50	5.18
Polychaeta (worm)	82.50	42.63
Gastropoda (snail)	15.00	0.73
Cephalopoda (squid and octopus)	2.50	0.04
Teuthoidea (squid)	7.50	1.51
Ostracoda	5.00	0.09
Mysidae (mysid)	5.00	0.04
Cumacea (cumacean)	5.00	0.19
Isopoda (isopod)	15.00	1.73
Gammaridea (amphipod)	85.00	14.96
Caprellidea (amphipod)	75.00	4.54
Euphausiacea (euphausiid)	2.50	0.09
Caridea (shrimp)	10.00	0.47
Hippolytidae (shrimp)	5.00	0.68
Pandalidae (shrimp)	12.50	15.29
Ectoprocta (bryozoan)	12.50	0.51
Asteroidea (starfish)	2.50	0.85
Ophiuroidae ophiurida (brittle star)	10.00	3.59
Osteichthyes Teleostei (fish)	17.50	1.33
Unidentified worm-like organism	5.00	5.54

Total non-empty stomachs = 27
Total prey number = 306
Total prey weight = 31.2 g
Total empty stomachs = 0
Number of hauls = 4

Full stomach summary statistics
Average length = 14.7 cm
Standard deviation of length = 5.3 cm
Minimum length = 6 cm
Maximum length = 28 cm

Average fullness = 5
Standard deviation of fullness = 0.8
Minimum fullness = 3
Maximum fullness = 6

SPINYHEAD SCULPIN

The estimated biomass of all sculpins in the Aleutian Islands area in 2000 was 13,037 t (Gaichas 2001). Spinyhead sculpin, *Dasycottus setiger*, is a medium-sized sculpin.

RESULTS

Two stomachs with food were analyzed for 1994 (Table 60). Table 60 also lists the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in spinyhead sculpin in 1994. The limited sample size indicates that spinyhead sculpin fed on small sculpins, gammarid amphipods, and mysids.

Table 60.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of spinyhead sculpin collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Mysidae (mysid)	50.00	21.95
Gammaridea (amphipod)	100.00	21.95
Cottoidei (Sculpin)	50.00	56.10

Total non-empty stomachs = 2
Total prey number = 3
Total prey weight = 0.41g
Total empty stomachs = 0
Number of hauls = 1

Full stomach summary statistics
Average length = 8 cm
Standard deviation of length = 0 cm
Minimum length = 8 cm
Maximum length = 8 cm

Average fullness = 5.5
Standard deviation of fullness = 0.7
Minimum fullness = 5
Maximum fullness = 6

DISCUSSION

Tokranov and Orlov (2001) found that spinyhead sculpin fed mainly on fish (48% by weight), octopus (24%), and decapod (18%). Similarly, fish (cottids) was the most important prey of spinyhead sculpin in the current study. It comprised 56% by weight of the total stomach contents weight. However, the small sample size (n=2) of the current study limits food habits interpretations. Further stomach collections of this species in the Aleutian Islands is warranted to help describe the diet of this species.

SPECTACLED SCULPIN

The estimated biomass of all sculpins in the Aleutian Islands area in 2000 was 13,037 tons (Gaichas 2001). Spectacled sculpin, *Triglops scepticus*, is a medium-sized sculpin. The largest recorded size is likely a 354 mm TL specimen examined by Pietsch (1994).

RESULTS

Only two stomachs containing food were collected (Table 61). Table 61 also lists the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in spectacled sculpin in 1994. Euphausiids were the most important prey of spectacled sculpin; they comprised 60% of the total stomach contents weight of spectacled sculpin. Amphipods were also important prey of spectacled sculpin; they comprised 27% of the total stomach contents weight. Spectacled sculpin also consumed some calanoid copepods (4%), chaetognaths (3%), and myctophids (3%).

Table 61.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of spectacled sculpin collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (polychaete)	7.41	0.53
Tomopteridae (polychaete)	3.70	0.11
Calanoida (copepod)	8.33	4.05
Candacia sp. (copepod)	4.17	0.27
Isopoda (isopod)	4.76	2.30
Gammaridea (amphipod)	32.41	14.96
Ampelisca sp. (amphipod)	4.17	3.60
Themisto sp. (amphipod)	34.72	2.63
Caprellidea (amphipod)	18.45	5.82
Euphausiacea (euphausiid)	26.79	25.02
Thysanoessa sp. (euphausiid)	22.22	21.41
Thysanoessa raschii (euphausiid)	8.47	13.61
Chaetognatha (arrow worm)	8.93	2.75
Myctophidae (lanternfish)	3.70	2.93

Total non-empty stomachs = 24
Total prey number = 73
Total prey weight = 6.9 g
Total empty stomachs = 13
Number of hauls = 3

Full stomach summary statistics
Average length = 16.8 cm
Standard deviation of length = 4.0 cm
Minimum length = 10 cm
Maximum length = 22 cm

Average fullness = 3.7
Standard deviation of fullness = 1.0
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average length = 16.8 cm
Standard deviation of length = 1.9 cm
Minimum length = 12 cm
Maximum length = 20 cm

BIGMOUTH SCULPIN

The estimated biomass of all sculpins in the Aleutian Islands area in 2000 was 13,037 t (Gaichas 2001). Bigmouth sculpin, *Hemitripterus bolini*, is a large-sized sculpin. This species can reach a size of about 73 cm TL (Mecklenburg et al. 2002).

RESULTS

Two stomachs containing food were collected in 1997 (Table 62). The mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in bigmouth sculpin in 1997 are listed in Table 2. Atka mackerel was the only prey found in bigmouth sculpin in this collection. The sizes of the two Atka mackerel measured in the stomach contents of bigmouth sculpin were 210 and 310 mm SL.

Table 62.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of big mouth sculpin collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Pleurogrammus monopterygius (Atka mackerel)	100	100

Total non-empty stomachs = 2
Total prey number = 2
Total prey weight = 537.1 g
Total empty stomachs = 0
Number of hauls = 1

Full stomach summary statistics
Average length = 66 cm
Standard deviation of length = 2.8 cm
Minimum length = 64 cm
Maximum length = 68 cm

Average fullness = 6
Standard deviation of fullness = 0
Minimum fullness = 6
Maximum fullness = 6

DISCUSSION

The results of the current study shows that bigmouth sculpin is piscivorous. Brodeur and Livingston (1988) found that walleye pollock (71% by weight) was the most important prey of bigmouth sculpin in the eastern Bering Sea. They also found Pacific herring, flathead sole, and eelpouts in the diet of this species, but they were of minor importance. Poltev and Mukhametov (1999) noted that sawback poacher (*Leptagonus frenatus*) and megalops of snow crabs (*Chionoecetes opilio*) were found in the stomachs of bigmouth sculpins in the northern Kurils and southeastern Kamchatka.

PROWFISH

Prowfish, *Zaprora silenus*, is a non-commercial fish in the North Pacific. Little is known about the abundance of prowfish in the Aleutian Islands area. It occurs infrequently in the bottom trawl surveys. As a component of the ecosystem, it is important to study the diet of the prowfish in the Aleutian Islands area.

RESULTS

Tables 63 and 64 list the prey items found in the prowfish stomachs, the mean percentage by weight of prey, and the mean percentage of the frequency of occurrence of the prey in the stomach contents. Total number of stomachs with food, the number of the total empty stomachs, and the numbers of the hauls are also listed in Tables 63 and 64. In 1994, ctenophores were the most important food of prowfish (Table 63), making up 99% of the stomach contents weight. In 1997, jellyfish was the most important prey comprising 65% of the total stomach contents weight (Table 64). Pelagic tunicate (*Salpa* sp.) was the second most important prey of prowfish in 1997. Although calanoid copepods, mysids, amphipods, and euphausiids were frequently found in prowfish stomachs, they were not important (in terms of weight) prowfish food.

DISCUSSION

Based on our study, jellyfish is the most important food of prowfish in the Aleutian Islands area. Tokranov (1999) also found that jellyfish was important food of prowfish in the northern Kuril Islands and southeastern Kamchatka areas. Another study also reported that jellyfish was food of prowfish (Fitch and Lavenberg, 1971). Cailliet and Anderson (1975) found hyperiid amphipods in the intestine of prowfish but did not find food in the stomachs. Brodeur et al. (1998) found that juvenile prowfish were commonly associated with large medusae (mainly *Cyanea* sp.) and they believe that juvenile prowfish is an obligate commensal with large medusae until it descends to the bottom as an adult. Brodeur et al. (1998) did not report that juvenile prowfish consumed medusae as food. Hyperiid amphipods, calanoid copepods, and the larval *Sebastes* sp. found in prowfish stomachs in our study could have been secondarily consumed from the tentacles of

the jellyfish. Based on this information, prowfish can be categorized as a gelatinous material consumer.

Table 63.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of prowfish collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Ctenophora (comb jelly)	100.0	99.02
	0	
Polychaeta (worm)	5.00	0.08
Octopoda (octopus)	5.00	0.91

Total non-empty stomachs = 16
Total prey number = 17
Total prey weight = 170.3 g
Total empty stomachs = 1
Number of hauls = 5

Full stomach summary statistics
Average length = 47.6 cm
Standard deviation of length = 8.5 cm
Minimum length = 33 cm
Maximum length = 61 cm

Average fullness = 4
Standard deviation of fullness = 1.5
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average length = 37 cm
Standard deviation of length = 0.0 cm
Minimum length = 37 cm
Maximum length = 37 cm

Table 64.--Mean percent frequency of occurrence (%FO) and mean percent weight (%wt) of the prey items in the diet of prowfish collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Scyphozoa (jellyfish)	62.47	65.29
Ctenophora (comb jelly)	1.23	0.09
Polychaeta (worm)	5.80	0.03
Calanoida (copepod)	29.14	0.04
Amphipoda (amphipod)	30.49	0.12
Gammaridea (amphipod)	1.11	0.00
Amphipoda Hyperiidea (amphipod)	33.46	0.19
Themisto sp. (amphipod)	36.91	0.14
Euphausiacea (euphausiid)	6.67	0.01
Thysanoessa raschii (euphausiid)	6.67	0.04
Salpa sp. (pelagic salp)	46.79	34.06

Total non-empty stomachs = 58
Total prey number = 284
Total prey weight = 1,446.6 g
Total empty stomachs = 0
Number of hauls = 9

Full stomach summary statistics
Average length = 56.9 cm
Standard deviation of length = 12.2 cm
Minimum length = 30 cm
Maximum length = 79 cm

Average fullness = 4.5
Standard deviation of fullness = 0.9
Minimum fullness = 3
Maximum fullness = 6

GIANT GRENADIER

Giant grenadier, *Albatrossia pectoralis*, is the largest of all of the grenadiers and may reach a length of 150 cm TL (Mecklenburg et al. 2002). They usually occur in slope areas deeper than 200 m (Iwamoto and Stein 1974). Although they are not abundant in the Aleutian Islands survey area, they are potential important apex predators in the deep-sea environment. Giant grenadiers feed mainly in the water column and consume primarily mid-water fish and squid (Drazen et al. 2001).

RESULTS

Table 65 lists the total number of stomachs containing food (n=10), the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in giant grenadier in 1994. Myctophids and squids were the most important prey; they comprised 47% and 45% of the total stomach contents weight of giant grenadier, respectively. Giant grenadier also consumed some comb jellies, gammarid amphipods, and euphausiids.

DISCUSSION

In this study, myctophids and squid were the most important food of giant grenadier. They comprised more than 90% of the total stomach contents weight of giant grenadier collected in the Aleutian Islands area.

Other studies showed similar diets of giant grenadier in different areas. Brodeur and Livingston (1988) found that giant grenadier fed mainly on fish (eelpout and unidentifiable fish) and shrimp in the eastern Bering Sea. In addition to fish and shrimp, Novikov (1970) also found squids were the dominant food of giant grenadiers in the Bering Sea. Buckley et al. (1999) reported that giant grenadier fed mainly on *Gnathophausia* sp., shrimp, and fish along the west coast of the United States. Drazen et al. (2001) indicated that giant grenadier, on the slopes of the west coast of the United States, consumed squids, Pacific viperfish (*Chauliodus macouni*), bathylagids, myctophids, and hake (*Merluccius productus*). However, he also pointed out the importance of the scavenged materials as the food of giant grenadier. He found that the scavenged materials comprised 68% of the total stomach contents weight of the giant grenadier with the fish size 26-41 cm pre-anal fin length.

Table 65.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of giant grenadier collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Ctenophora (comb jelly)	20.00	5.50
Teuthoidea (squid)	100.00	44.73
Gammaridea (amphipod)	20.00	1.65
Themisto sp. (amphipod)	10.00	0.05
Euphausiacea (euphausiid)	10.00	0.18
Non-gadoid fish remains	10.00	1.00
Myctophidae (lanternfish)	70.00	46.88

Total non-empty stomachs = 10
Total prey number = 47
Total prey weight = 61.8 g
Total empty stomachs = 0
Number of hauls = 1

Full stomach summary statistics
Average (PAF) length = 32.9 cm
Standard deviation of length = 3.5 cm
Minimum (PAF) length = 29 cm
Maximum (PAF) length = 38 cm

Average fullness = 3.3
Standard deviation of fullness = 0.9
Minimum fullness = 2
Maximum fullness = 5

PAF length is pre-anal fin length

SAWBACK POACHER

Sawback poacher, *Leptagonus frenatus*, is one of the species in the Family Agonidae. The poachers are bottom-dwelling fishes with bodies completely covered by bony plates. Allen and Smith (1988) reported the distributions of this species in the Alaska are Norton Sound in the north, west along the Aleutian Islands to Stalemate Bank and Bowers Bank.

RESULTS

Ten stomachs (with food) of sawback poacher were collected in the Aleutian Islands in 1994. Table 66 lists details on the samples, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in sawback poacher. Gammarid amphipods were the most important prey; they comprised 90% of the total stomach contents weight of sawback poacher. Sawback poacher also consumed some crangonid shrimp (9%), polychaetes, mysids, and cumaceans.

DISCUSSION

Tokranov (1992) found that amphipods comprised 97% of the total stomach contents weight of sawback poacher collected in the coast waters of Kamchatka. His observations are very similar to the results of the current study (90% by weight).

Table 66.--Mean percent frequency of occurrence (%FO) and mean percent weight (%wt) of the prey items in the diet of sawback poacher collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (polychaete)	10.00	0.33
Tomopteridae (polychaete)	10.00	0.33
Mysidae (mysid)	10.00	0.33
Cumacea (cumacean)	10.00	0.33
Gammaridea (amphipod)	100.00	89.87
Caprellidea (amphipod)	10.00	0.33
Crangonidae (shrimp)	10.00	8.50

Total non-empty stomachs = 10
Total prey number = 153
Total prey weight = 3.1 g
Total empty stomachs = 0
Number of hauls = 1

Full stomach summary statistics
Average length = 22.3 cm
Standard deviation of length = 2.5 cm
Minimum length = 18 cm
Maximum length = 25 cm

Average fullness = 4.8
Standard deviation of fullness = 0.4
Minimum fullness = 4
Maximum fullness = 5

SEARCHER

The searcher, *Bathymaster signatus*, is one of the species in the Family Bathymasteridae. They are elongate, cold-water, bottom-dwelling fishes in the North Pacific Ocean. Allen and Smith (1988) reported the occurrences of this species in the Bering Sea, Gulf of Alaska, and in the Aleutian Islands. Searchers are known to feed on amphipods, gastropods, and bivalves (Simenstad et al. 1977).

RESULTS

Thirty searcher stomachs were collected in the Aleutian Islands in 1994. Table 67 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in searcher. Shrimp (mainly pandalids and *Eualus* sp.) were the most important prey; they comprised 55% of the total stomach contents weight for searcher. Searchers also consumed some gammarid amphipods (15%), polychaetes, and isopods.

DISCUSSION

This study shows that gammarid amphipods and shrimps comprised about 70% of the total stomach contents weight of searchers. This indicates that the searcher mainly feeds on the benthic/epibenthic animals. Other studies have shown similar results. Simenstad et al. (1977) found that amphipods were the most frequently occurring prey of searchers. Tokranov (1998) found that amphipods comprised 42% of the total stomach contents weight of searchers collected in the southeastern Kamchatka and the northern Kurils; other prey items included fish (15%), gastropods (14%) and pagurids (13%).

Table 67.--Mean percent frequency of occurrence (%FO) and mean percent weight (%wt) of the prey items in the diet of searcher collected in the Aleutian Islands in 1994.

Name	%FO	%WT
Polychaeta (polychaete)	38.89	1.08
Isopoda (isopod)	5.56	0.22
Gammaridea (amphipod)	66.67	13.64
Caprellidea (amphipod)	11.11	1.10
Eualus sp. (shrimp)	16.67	26.67
Pandalidae (shrimp)	11.11	24.82
Crangonidae (shrimp)	5.56	3.16
Osteichthyes Teleostei (fish)	5.56	1.54
Unidentified algae	33.33	27.78

Total non-empty stomachs = 9
Total prey number = 27
Total prey weight = 5.6 g
Total empty stomachs = 21
Number of hauls = 3

Full stomach summary statistics
Average length = 26 cm
Standard deviation of length = 3.3 cm
Minimum length = 19 cm
Maximum length = 30 cm

Average fullness = 3.8
Standard deviation of fullness =f1.3
Minimum fullness = 2
Maximum fullness = 6

Empty stomach summary statistics
Average length = 27.1 cm
Standard deviation of length = 2.0 cm
Minimum length = 24 cm
Maximum length = 31 cm

NORTHERN LAMPFISH

The northern lampfish, *Stenobrachius leucopsarus*, is a mesopelagic fish. It is one of the more important prey fishes of the marine ecosystem in the Aleutian Islands (Yang 1996). Many studies have shown that northern lampfish feed mainly on calanoid copepods, euphausiids, ostracods, and amphipods (Adams 1979, Balanov 1994, Nishimura et al. 1999).

RESULTS

Table 68 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in northern lampfish in 1997. Calanoid copepods and euphausiids were the most important prey; they comprised 45% and 32% of the total stomach contents weight of northern lampfish, respectively. Northern lampfish also consumed some chaetognaths, squid and amphipods.

DISCUSSION

In the current study, calanoid copepods (45% by weight) and euphausiids (32%) were the most important foods of northern lampfish; followed by chaetognaths (6%), miscellaneous fish (6%), squid (4%), and amphipods (2%). Other studies show very similar results. Simenstad et al. (1977) found that, in the Amchitka area, copepods were the most frequently occurring prey of northern lampfish. In the Bering Sea area, Nishmura et al. (1999) found that copepods (45%) were numerically the most dominant, followed by ostracods (22%), euphausiids (16%), and amphipods (14%). Balanov (1994) also found that copepods (47% by weight) were the most important prey of northern lampfish, followed by euphausiids (34%), amphipods (5%), larvaceans (1%), and ostracods (1%).

Table 68.--Mean percent frequency of occurrence (%FO) and mean percent weight (%wt) of the prey items in the diet of northern lampfish collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Scyphozoa (jellyfish)	1.39	0.75
Thecosomata (pteropod)	2.81	0.10
Gymnosomata (pteropod)	13.16	1.34
Cephalopoda (squid and octopus)	2.19	0.14
Teuthoidea (squid)	9.31	4.05
Calanoida (copepod)	75.55	44.03
Candacia sp. (copepod)	9.72	1.20
Mysidae (mysid)	2.60	0.15
Gammaridea (amphipod)	3.92	0.37
Amphipoda Hyperiidea (amphipod)	14.33	1.45
Themisto sp. (amphipod)	0.63	0.04
Euphausiacea (euphausiid)	21.30	14.37
Euphausiidae (euphausiid)	27.85	17.41
Caridea (shrimp)	9.54	1.79
Ophiuridae (brittle star)	0.69	0.25
Chaetognatha (arrow worm)	47.53	6.44
Sagitta sp. (arrow worm)	0.63	0.36
Osteichthyes Teleostei (fish)	2.01	0.09
Non-gadoid fish remains	3.82	2.10
Myctophidae (lanternfish)	2.34	3.56
Sebastes polyspinis (northern rockfish)	0.69	0.01

Total non-empty stomachs = 118
Total prey number = 1,291
Total prey weight = 176.1 g
Total empty stomachs = 24
Number of hauls = 16

Full stomach summary statistics
Average length = 30.9 cm
Standard deviation of length = 4.5 cm
Minimum length = 14 cm
Maximum length = 39 cm

Average fullness = 3.9
Standard deviation of fullness = 1.3
Minimum fullness = 2
Maximum fullness = 7

Empty stomach summary statistics
Average length = 31.0 cm
Standard deviation of length = 4.4 cm
Minimum length = 19 cm
Maximum length = 37 cm

BROKENLINE MYCTOPHID

The brokenline myctophid, *Lampanyctus jordani*, is one of the lanternfishes (or lampfishes) found in the Aleutian Islands. Willis et al. (1988) found that brokenline myctophids occurred mainly south of the Alaska Peninsula and the Aleutian Islands, but not in the Bering Sea. Little is known about the food habits of this species.

RESULTS

Five stomachs of brokenline myctophids were collected in the Aleutian Islands in 1997. Table 69 lists the total number of stomachs containing food, the empty stomachs, the mean percent frequency of occurrence of the prey, and the mean percent by weight of the prey found in brokenline myctophids. Mysids were the most important prey; they comprised 86% of the total stomach contents weight. The other prey consumed by brokenline myctophid in this study was unidentified shrimp.

Table 69.--Mean percent frequency of occurrence (%FO) and mean percent weight (%WT) of the prey items in the diet of brokenline myctophids collected in the Aleutian Islands in 1997.

Name	%FO	%WT
Mysidae (mysid)	75.00	86.03
Natantia (shrimp)	25.00	13.97

Total non-empty stomachs = 4
Total prey number = 13
Total prey weight = 1.8 g
Total empty stomachs = 1
Number of hauls = 1

Full stomach summary statistics
Average length = 12.8 cm
Standard deviation of length = 1.0 cm
Minimum length = 12 cm
Maximum length = 14 cm

Average fullness = 5.5
Standard deviation of fullness = 1
Minimum fullness = 4
Maximum fullness = 6

Empty stomach summary statistics
Average length = 11 cm
Standard deviation of length = 0.0 cm
Minimum length = 11 cm
Maximum length = 11 cm

SUMMARY

Important Prey of Groundfish

A total of 6,558 stomachs from 31 species were analyzed to describe the food habits of the major groundfish species in the Aleutian Islands in 1994, and 1997. Our analysis emphasized groundfish predation on commercially important fish, crab, and shrimp. The predator sizes and the number of the stomachs collected for each species are summarized in Tables 70 and 71 for 1994 and 1997, respectively. Although the commercially important species (pollock, Pacific cod, arrowtooth flounder, Pacific halibut, Atka mackerel, Greenland turbot, Pacific ocean perch, northern rockfish, shortraker rockfish, rougheye rockfish, shortspine thornyhead, rock sole, and flathead sole) were the main species for this study, many non-commercial groundfish species (skates, sculpins, poachers) were also included (Tables 70 and 71). In this study, the main focus was the food habits of adult fish, although juveniles of some species (walleye pollock, Pacific cod, Pacific halibut, northern rockfish, arrowtooth flounder, flathead sole, and rock sole) were also sampled.

Tables 72 and 73 list the percent by weight of the commercially important fish, crab, shrimp, and other major prey of prey groups consumed by groundfish in 1994 and 1997, respectively. Arrowtooth flounder, Pacific halibut, Pacific cod, Greenland turbot, Giant grenadier, rougheye rockfish, Alaska skate, whiteblotched skate, great sculpin, and bigmouth sculpin primarily consumed fish. The main predators of Tanner crabs were Pacific halibut, Pacific cod, and great sculpin. Pacific cod, arrowtooth flounder, shortraker rockfish, rougheye rockfish, shortspine thornyhead, flathead sole, Aleutian skate, whiteblotched skate, and searcher were the primary consumers of pandalid shrimp. Atka mackerel, Pacific ocean perch, northern rockfish, pollock, Spectacled sculpin, and northern lampfish fed mainly on zooplankton (primarily euphausiids and calanoid copepods). Rock sole, mud skate, roughtail skate, Bering skate, darkfin sculpin, and sawback poacher were benthic and epibenthic feeders. They fed mainly on polychaetes, mysids, and gammarid amphipods. Prowfish and sablefish were mainly gelatinous feeders. They fed mainly on jellyfish, ctenophores, and pelagic salps.

Table 70.--Number of stomachs and fish size analyzed in the Aleutian Islands in 1994. F, stomachs with food; E. empty stomachs; T, total; SD, standard deviation.

Species	No. of stomachs			Fish size (cm)		
	F	E	T	Range	Mean	SD
Pollock	571	94	665	14-72	42.3	15.6
Pacific cod	500	19	519	13-108	53.9	19.4
Arrowtooth flounder	272	212	484	13-76	40.2	14.2
Pacific halibut	162	54	216	36-149	68.3	16.8
Atka mackerel	192	7	199	20-49	38.3	5.1
Greenland turbot	46	59	105	61-98	70.1	8.4
Pacific ocean perch	273	78	351	20-46	33.5	5.6
Northern rockfish	118	24	142	14-39	30.9	4.5
Shortraker rockfish	58	47	105	29-63	46.8	6.1
Rougheye rockfish	56	70	126	23-47	40.0	5.2
Shortspine thornyhead	109	51	160	21-56	37.9	6.9
Alaska skate	42	7	49	50-86	74.5	8.1
Mud skate	5	1	6	19-48	31.8	10.6
Roughtail skate	4	0	4	26-44	36.5	8.2
Bering skate	1	0	1	32-32	32.0	0.0
Great sculpin	44	9	53	40-79	56.5	10.8
Darkfin sculpin	27	0	27	6-28	14.7	5.3
Spinyhead sculpin	2	0	2	8-8	8.0	0.0
Spectacled sculpin	24	13	37	10-22	16.8	4.0
Prowfish	16	1	17	33-61	47.6	8.5
Giant grenadier	10	0	10	29-38	32.9	3.5
Sawback poacher	10	0	10	18-25	22.3	2.5
Searcher	9	21	30	19-30	26.0	3.3
Flathead sole	35	28	63	16-50	31.7	8.1
Rock sole	84	36	120	19-45	31.7	5.6
Total	2670	831	3501			

Table 71.--Number of stomachs and fish size analyzed in the Aleutian Islands in 1997. F, stomachs with food; E. empty stomachs; T, total; SD, standard deviation.

Species	No. of stomachs			Fish size (cm)		
	F	E	T	Range	Mean	SD
Pollock	526	62	588	14-70	45.0	14.7
Pacific cod	542	21	563	18-361	60.7	19.8
Arrowtooth flounder	234	257	491	14-82	39.7	15.0
Pacific halibut	196	13	209	25-111	68.9	12.3
Atka mackerel	243	9	252	21-48	36.7	5.2
Greenland turbot	10	29	39	62-90	69.7	7.8
Pacific ocean perch	292	173	465	6-46	28.8	11.5
Shortraker rockfish	54	60	114	29-68	46.0	6.8
Alaska skate	6	1	7	62-80	75.2	6.6
Mud skate	58	1	59	6-72	32.3	12.5
Whiteblotched skate	27	0	27	15-76	66.0	12.5
Aleutian skate	1	1	2	73-73	73.0	0.0
Great sculpin	9	4	13	31-61	50.6	9.2
Bigmouth sculpin	2	0	2	64-68	66.0	2.8
Prowfish	58	0	58	30-79	56.9	12.2
Northern lampfish	118	24	142	14-39	30.9	4.5
Brokenline myctophid	4	1	5	12-14	12.8	1.0
Sablefish	21	0	21	51-69	61.6	5.6
Total	2401	656	3057			

The data in Tables 72 and 73 indicate that Atka mackerel were the dominant prey fish and were consumed by Pacific cod, arrowtooth flounder, Pacific halibut, Greenland turbot, Alaska skate, whiteblotched skate, great sculpin, and big mouth sculpin. Pollock was another important prey and was consumed mainly by Pacific cod, arrowtooth flounder, Pacific halibut, Alaska skate, and whiteblotched skate. Pollock cannibalism was not found in this study. In the Aleutian Islands area, myctophids were important prey of many fish. The main predators of myctophids were arrowtooth flounder, Greenland turbot, Pacific ocean perch, pollock, giant grenadier, shortraker rockfish, and rougheye rockfish. Other forage fish such as Pacific herring, osmerids, and Pacific sand lance were consumed by Pacific cod, arrowtooth flounder, and Pacific halibut. However, each of these species comprised no more than 5% of the stomach contents weight (Tables 72 and 73). Some mesopelagic fish, like bathylagids and viperfish, were found in groundfish stomachs. The diet of Greenland turbot contained the highest proportions of these species. Cottids were found in the diet of many species; however, Pacific cod, Pacific halibut, shortspine thornyhead, shortraker rockfish, and spinyhead sculpin tended to have more cottids in their diet than other species. Flatfish were consumed by Pacific cod, arrowtooth flounder, Pacific halibut, and great sculpin. Each of them comprised no more than 5% of the stomach contents weight. *Sebastes* spp. was found in Pacific cod, arrowtooth flounder, Pacific halibut, northern rockfish, Alaska skate, and northern lampfish. Tanner crabs were mainly consumed by Pacific cod, Pacific halibut, and great sculpin though they were also consumed by Alaska skate and flathead sole. Tables 72 and 73 show that many predator species consumed a certain amount of cephalopods (squid and octopus) but the diets of Greenland turbot, shortraker rockfish, Pacific halibut, and giant grenadier contained the most cephalopods. Many predators preyed on pandalid shrimp, which includes all the *Pandalus* and *Pandalopsis* species. The diets of Pacific cod, arrowtooth flounder, shortspine thornyhead, rougheye rockfish, shortraker rockfish, Bering skate, darkfin sculpin, and Aleutian skate contained the most pandalids.

Table 72.--Percent by weight of the main prey consumed by the groundfish in the Aleutian Islands in 1994. "x" indicates less than 1%. POL, pollock; COD, Pacific cod; ATF, arrowtooth flounder; PAH, Pacific halibut; ATK, Atka mackerel; GRT, Greenland turbot; POP, Pacific ocean perch; SHR, shortraker rockfish; ROU, rougheye rockfish; SST, short spine thornyhead; NOR, northern rockfish; FHS,flathead sole; ROS, rock sole; AKS, Alaska skate; MUS, mud skate; RTS, roughtail skate; BES, Bering skate; GRS, great sculpin; DFS, darkfin sculpin; SHS, spinyhead sculpin; SPS, spectacled sculpin; PRF, prowfish; GIG, giant grenadier; SBP, sawback poacher;SEA, searcher.

Predator	ATK	POP	NOR	POL	SPS	COD	ATF	PAH	GRT	GIG	SHR	ROU	SST
Prey													
Scyphozoa & Ctenophora	0	0	1	0	0	0	0	0	0	6	0	0	0
Gastropoda	1	x	1	x	0	x	x	x	0	0	0	0	0
Chaetognatha	1	7	7	4	3	x	x	0	0	0	0	0	0
Larvacea	1	x	0	2	0	x	0	0	0	0	0	0	0
Thaliacea	0	0	0	0	0	0	0	0	0	0	0	0	0
Calanoida	51	46	45	35	4	1	x	0	0	0	0	3	0
Hyperiid amphipod	1	1	2	1	3	0	x	0	0	x	0	0	2
Euphausiacea	35	26	32	27	60	x	15	0	x	x	2	2	x
Cephalopoda	5	4	4	1	0	11	3	11	29	45	23	1	12
Polychaeta	x	x	0	1	1	3	1	x	0	0	0	x	x
Bivalvia	x	0	0	0	0	x	0	x	0	0	0	0	0
Mysidacea	0	1	x	2	0	1	x	0	x	0	9	4	3
Isopoda	0	x	0	x	2	x	x	x	0	0	4	0	0
Gammarid amphipod	x	x	x	2	18	4	x	x	0	2	15	4	8
Other amphipod	x	x	0	x	6	1	0	0	0	0	0	0	x
Misc. shrimp	x	x	2	3	0	8	1	x	0	0	2	7	13
Pandalidae	0	0	0	2	0	11	8	x	0	0	8	13	11
Paguridae	0	0	0	x	0	2	0	3	0	0	0	0	0
Lithodidae	0	0	0	0	0	0	0	x	0	0	0	0	6
Chionoecetes sp.	0	0	0	0	0	8	0	3	0	0	0	0	0
Other majid crabs	0	0	0	0	0	1	0	10	0	0	0	0	0
Erimacrus isenbeckii	0	0	0	0	0	1	0	1	0	0	0	0	0
Misc. crabs	0	0	0	0	0	0	0	1	0	0	0	0	1
Sipuncula & Echiura	0	0	0	0	0	x	0	0	0	0	0	0	0
Ophiuroidae	x	0	x	0	0	0	0	0	0	0	0	0	0
Unidentifiable fish	4	1	2	3	0	1	4	x	1	1	9	1	10
Rajidae	0	0	0	0	0	0	0	0	0	0	0	0	11
Clupeidae	0	0	0	0	0	x	0	0	0	0	0	0	0
Osmeridae	x	0	0	0	0	x	4	0	0	0	1	0	0
Bathylagidae	0	x	0	2	0	0	0	x	8	0	2	0	0
Chauliodontidae	0	3	0	1	0	x	x	0	8	0	0	0	0
Myctophidae	0	11	4	13	3	3	16	1	31	47	22	55	0
Theragra chalcogramma	0	0	0	0	0	13	13	20	6	0	0	0	0
Zoarcidae	0	0	0	x	0	1	0	x	0	0	0	0	2
Scorpaenidae	0	0	x	0	0	1	1	0	0	0	0	0	0
Pleurogrammus monopterygius	0	0	0	2	0	18	24	21	9	0	0	7	6
Cottidae	x	0	0	x	0	9	4	6	x	0	3	0	9
Agonidae	0	0	0	0	0	0	3	1	0	0	0	0	x
Cyclopteridae	0	0	0	0	0	x	0	x	0	0	0	0	6
Bathymasteridae	0	0	0	0	0	1	1	0	0	0	0	0	0
Stichaeidae	0	0	0	0	0	1	x	x	0	0	0	0	0
Ammodytes sp.	0	0	0	0	0	x	0	1	0	0	0	0	0
Pleuronectidae	0	0	0	0	0	1	1	5	0	0	0	0	0

Table 72. --Continued.

Predator	ROS	FHS	MUS	RTS	BES	DFS	SHS	PRF	AKS	SBP	SEA	GRS
Prey												
Scyphozoa & Ctenophora	0	0	0	0	0	5	0	99	0	0	0	0
Gastropod	1	0	0	0	0	1	0	0	0	1	0	0
Chaetognatha	0	0	0	0	0	0	0	0	0	0	0	0
Larvacea	0	0	0	0	0	0	0	0	0	0	0	0
Thaliacea	0	0	0	0	0	0	0	0	0	0	0	0
Calanoida	0	x	1	x	0	0	0	0	0	0	0	0
Hyperiid amphipod	0	1	0	0	0	0	0	0	0	0	0	0
Euphausiacea	0	5	0	1	0	x	0	0	x	0	0	x
Cephalopoda	0	0	0	8	0	2	0	1	0	0	0	0
Polychaeta	64	7	21	57	71	43	0	x	x	0	0	0
Bivalvia	4	3	0	0	0	0	0	0	0	0	0	0
Mysidacea	0	x	0	4	1	0	22	0	0	x	0	0
Isopoda	0	1	0	4	13	2	0	0	0	0	x	0
Gammarid amphipod	17	5	62	3	6	15	22	0	4	90	14	0
Other amphipod	2	x	0	0	0	5	0	0	0	x	1	0
Misc. shrimp	1	27	2	2	0	1	0	0	1	9	55	x
Pandalidae	0	x	4	5	9	15	0	0	x	0	0	0
Paguridae	0	14	0	0	0	0	0	0	x	0	0	0
Lithodidae	0	0	0	0	0	0	0	0	1	0	0	5
Chionoecetes sp.	0	x	0	0	0	0	0	0	3	0	0	31
Other majid crabs	0	12	0	0	0	0	0	0	0	0	0	18
Erimacrus isenbeckii	0	0	0	0	0	0	0	0	0	0	0	21
Misc. crabs	x	0	0	0	0	0	0	0	1	0	0	4
Sipuncula & Echiura	1	6	0	0	0	0	0	0	0	0	0	0
Ophiuroidae	6	17	0	0	0	4	0	0	0	0	0	0
Unidentifiable fish	1	0	x	13	0	1	0	0	x	0	2	0
Rajidae	0	0	0	0	0	0	0	0	0	0	0	0
Clupeidae	0	0	0	0	0	0	0	0	0	0	0	0
Osmeridae	0	0	0	0	0	0	0	0	0	0	0	0
Bathylagidae	0	0	0	0	0	0	0	0	0	0	0	0
Chauliodontidae	0	0	0	0	0	0	0	0	0	0	0	0
Myctophidae	0	0	3	2	0	0	0	0	0	0	0	0
Theragra chalcogramma	0	0	0	0	0	0	0	0	18	0	0	x
Zoarcidae	1	0	0	0	0	0	0	0	0	0	0	0
Scorpaenidae	0	0	0	0	0	0	0	0	11	0	0	0
Pleurogrammus monopterygius	0	0	0	0	0	0	0	0	42	0	0	2
Cottidae	0	0	0	0	0	0	56	0	3	0	0	2
Agonidae	0	0	0	0	0	0	0	0	0	0	0	x
Cyclopteridae	0	0	0	0	0	0	0	0	1	0	0	0
Bathymasteridae	0	0	0	0	0	0	0	0	1	0	0	0
Stichaeidae	0	0	0	0	0	0	0	0	x	0	0	x
Ammodytes sp.	0	0	0	0	0	0	0	0	4	0	0	0
Pleuronectidae	0	0	0	0	0	0	0	0	0	0	0	9

Table 73.--Percent by weight of the main pey consumed by the groundfish in the Aleutian Islands in 1997. "x" indicates less than 1%. POL, pollock; COD, Pacific cod; ATF, arrowtooth flounder; PAH, Pacific halibut; ATK, Atka mackerel; GRT, Greenland turbot; POP, Pacific ocean perch; SHR, shortraker rockfish; SAB, sablefish; WBS, white blotched skate; AIS, Aleutian skate; GRS, great sculpin; AKS, Alaska skate; MUS, mud skate; BMS, bigmouth sculpin; PRF, prowfish; NOL, northern lampfish; BLM, brokenline myctophid.

Predator	ATK	POP	NOL	POL	BLM	COD	ATF	PAH	GRT	WBS	GRS
Prey											
Scyphozoa & Ctenophora	4	0	1	0	0	x	0	0	0	0	0
Gastropoda	x	x	1	0	0	1	0	x	0	0	0
Chaetognatha	1	7	7	2	0	0	0	0	0	0	0
Larvacea	9	1	0	6	0	0	0	0	0	x	0
Thaliacea	2	1	0	0	0	x	0	0	0	0	0
Calanoida	31	28	45	12	0	x	1	0	0	x	0
Hyperiid amphipod	4	4	1	5	0	x	0	0	0	0	0
Euphausiacea	32	30	32	47	0	2	11	x	0	x	0
Cephalopoda	3	1	4	2	0	4	3	18	45	4	0
Polychaeta	10	1	0	5	0	4	0	x	0	x	0
Bivalvia	0	0	0	0	0	x	0	x	0	0	0
Mysidacea	x	1	x	1	86	x	3	0	21	0	0
Isopoda	x	0	0	0	0	x	0	x	0	x	0
Gammarid amphipod	1	1	x	4	0	2	2	x	0	x	0
Other amphipod	x	0	x	0	0	0	x	0	0	x	0
Misc. shrimp	1	1	2	1	14	17	6	x	0	19	0
Pandalidae	0	0	0	1	0	7	10	x	0	7	0
Paguridae	0	0	0	0	0	1	0	5	0	x	0
Lithodidae	0	0	0	0	0	x	0	1	0	4	0
Chionoecetes sp.	0	0	0	0	0	2	0	3	0	0	46
Other majid crabs	0	0	0	0	0	1	0	8	0	2	0
Erimacrus isenbeckii	0	0	0	0	0	2	0	1	0	3	21
Misc. crabs	0	x	0	0	0	2	0	1	0	0	0
Sipuncula & Echiura	0	0	0	0	0	1	0	1	0	0	0
Ophiuroidae	0	0	x	0	0	x	0	x	0	0	0
Unidentifiable fish	x	9	2	6	0	12	2	2	x	10	0
Rajidae	0	0	0	0	0	x	0	x	0	0	0
Clupeidae	0	0	0	0	0	2	2	4	0	0	0
Osmeridae	x	0	0	x	0	0	1	1	0	0	0
Bathylagidae	0	0	0	x	0	1	0	0	0	0	0
Chauliodontidae	0	x	0	1	0	x	x	x	12	0	0
Myctophidae	0	12	4	6	0	1	17	3	22	2	0
Theragra chalcogramma	x	0	0	0	0	7	7	11	0	11	0
Zoarcidae	0	0	0	0	0	1	0	x	0	0	0
Scorpaenidae	0	0	x	0	0	4	0	x	0	0	0
Pleurogrammus monopterygius	0	0	0	0	0	8	4	15	0	25	30
Anoplopoma fimbria	0	0	0	0	0	x	2	0	0	0	0
Cottidae	0	0	0	0	0	12	4	12	0	6	0
Agonidae	0	0	0	0	0	x	0	1	0	x	1
Cyclopteridae	0	0	0	0	0	0	x	x	0	0	0
Bathymasteridae	0	0	0	0	0	0	0	x	0	0	0
Stichaeidae	0	0	0	0	0	1	2	0	0	0	0
Ammodytes sp.	0	0	0	2	0	2	0	5	0	0	0
Pleuronectidae	0	0	0	0	0	x	0	5	0	0	1

Table 73. --Continued.

Predator	SHR	AIS	MUS	PRF	SAB	AKS	BMS
Prey							
Scyphozoa & Ctenophora	0	0	0	65	3	0	0
Gastropod	0	0	0	0	0	0	0
Chaetognatha	0	0	0	0	0	0	0
Larvacea	0	0	x	0	0	0	0
Thaliacea	6	0	0	34	46	0	0
Calanoida	0	0	x	x	0	0	0
Hyperiid amphipod	0	0	x	x	x	0	0
Euphausiacea	x	0	1	x	27	0	0
Cephalopoda	4	0	5	0	16	0	0
Polychaeta	x	0	12	x	0	0	0
Bivalvia	0	0	0	0	0	0	0
Mysidacea	10	0	1	0	0	0	0
Isopoda	0	0	2	0	0	0	0
Gammarid amphipod	14	0	60	x	3	0	0
Other amphipod	0	0	1	x	0	0	0
Misc. shrimp	2	0	4	0	0	0	0
Pandalidae	3	100	3	0	0	0	0
Paguridae	0	0	x	0	0	0	0
Lithodidae	0	0	0	0	0	0	0
Chionoecetes sp.	0	0	0	0	0	0	0
Other majid crabs	0	0	0	0	0	0	0
Erimacrus isenbeckii	0	0	0	0	0	0	0
Misc. crabs	0	0	x	0	0	0	0
Sipuncula & Echiura	0	0	0	0	0	0	0
Ophiuroidae	0	0	0	0	0	0	0
Unidentifiable fish	21	0	2	0	0	0	0
Rajidae	0	0	0	0	0	0	0
Clupeidae	0	0	0	0	0	0	0
Osmeridae	0	0	0	0	0	0	0
Bathylagidae	0	0	x	0	0	0	0
Chauliodontidae	0	0	0	0	0	0	0
Myctophidae	27	0	x	0	0	0	0
Theragra chalcogramma	0	0	0	0	0	0	0
Zoarcidae	0	0	0	0	0	0	0
Scorpaenidae	0	0	0	0	0	0	0
Pleurogrammus monopterygius	0	0	0	0	0	94	100
Anoplopoma fimbria	0	0	0	0	0	0	0
Cottidae	10	0	0	0	0	0	0
Agonidae	0	0	0	0	0	0	0
Cyclopteridae	0	0	0	0	0	0	0
Bathymasteridae	0	0	0	0	0	6	0
Stichaeidae	0	0	0	0	0	0	0
Ammodytes sp.	0	0	0	0	0	0	0
Pleuronectidae	0	0	0	0	0	0	0

Diet Overlap

The percent similarity index (PSI) was calculated by using the proportions of the prey items in the stomachs (values in Tables 72 and 73) to show the diet overlap between groundfish species in the Aleutian Islands area in 1994 and 1997 (Figs. 107 and 108, respectively).

The upper diagonal sections in Figures 107 and 108 show the percent similarity values between different species in 1994 and 1997, respectively. The lower diagonal sections show the diet overlap between species by categorizing the percent similarities into low (< 34%), medium (34-66%), and high (> 66%).

In 1994, the overlap values between Atka mackerel, northern rockfish, Pacific Ocean perch, and pollock were high since they were all planktivorous, feeding mainly on euphausiids and calanoid copepods. All these four planktivorous species had medium overlap values with the spectacled sculpin. Except for the medium overlap values between pollock and arrowtooth flounder (35%), planktivorous species had low (< 34%) overlap values with all of the other species in this study. Figure 107 shows that Pacific cod had medium diet overlap values with arrowtooth flounder (54%) and Pacific halibut (58%) since they all fed mainly on fish plus different proportions of shrimp, crab, and cephalopods. Cod had medium overlap value (51%) with the shortspine thornyhead because they fed both on similar amounts of cephalopods, pandalids, some Atka mackerel, and miscellaneous shrimp. Cod also had medium dietary overlap values with Alaska skate, and rougheye rockfish. Arrowtooth flounder had medium (34-66%) overlap values with Pacific halibut (44%), Greenland turbot (34%), Alaska skate (43%), shortraker rockfish (34%), and rougheye rockfish (35%). Pacific halibut had a medium dietary overlap value (47%) with Alaska skate since they both fed on large amounts of Atka mackerel and pollock. Greenland turbot had a medium overlap value (60%) with giant grenadier since they both fed on large amounts of cephalopods and myctophids. The diet overlap values between the giant grenadier, shortraker rockfish, and rougheye rockfish were medium because of the consumption of the cephalopods and myctophids. The shortspine thornyhead and rougheye rockfish had a low dietary overlap value (32%). Rock sole and darkfin sculpin also had high overlap value (67%) since they all fed large amounts of polychaetes and gammarid amphipods. Flathead sole had an overlap

value (32%) with searchers. They both fed on miscellaneous shrimp and gammarid amphipods.

In 1997, the general trend of the diet overlap between the groundfish species are similar to those in 1994. The diet overlap values between the planktivorous species, Atka mackerel, Pacific ocean perch, and northern lampfish were high (> 66%). Pollock had medium (34-66%) diet overlap values with Atka mackerel, Pacific ocean perch, and northern lampfish. The diet overlap values between sablefish and the planktivorous species were 36% with Atka mackerel, 30% with Pacific ocean perch, 32% with northern lampfish, and 32% with pollock. They all had relatively large proportions of euphausiids in their diets. It is worth noting that sablefish was the only fish that had medium diet overlap value (37%) with prowfish, since they both contained large proportion of pelagic salps in their diets (> 30%). Pacific cod had medium (53%) diet overlap with whiteblotched skate in 1997. Arrowtooth flounder had 33% overlap value with whiteblotched skate and 34% overlap value with shortraker rockfish since they all had similar proportions of shrimp, pollock, and myctophids in their diets. Pacific halibut had a medium diet overlap value (51%) with whiteblotched skate and 32% overlap value with shortraker rockfish because they all contained large proportions of pollock, Atka mackerel, and cottids in their diets. Greenland turbot also had a medium diet overlap value (36%) with shortraker rockfish because they both had high proportions of myctophids in their diets. All of the diet overlap values between the other species were low (< 33%) (Fig. 108).

1994

	ATK	POP	NOR	POL	SPS	COD	ATF	PAH	GRT	AKS	GIG	SHR	ROU	SST	ROS	FHS	DFS	PRF	SBP	SEA	GRS
ATK		78	84	67	41	6	18	5	5	0	5	7	6	6	1	6	3	1	1	0	0
POP			87	79	37	9	29	5	18	0	15	18	18	6	0	6	2	1	0	0	0
NOR				74	44	10	23	5	8	1	8	12	12	8	2	8	5	2	3	2	0
POL					41	16	35	4	19	5	18	26	30	13	4	12	7	1	5	5	2
SPS						10	19	1	3	4	5	22	12	10	24	13	23	0	18	15	0
COD							54	58	29	44	16	32	35	51	10	18	22	1	12	13	15
ATF								44	34	43	19	34	35	22	2	7	12	1	1	1	5
PAH									27	47	12	15	9	23	0	13	2	1	0	0	20
GRT										15	60	47	32	18	0	0	2	1	0	0	2
AKS											2	8	12	17	1	5	5	0	5	5	9
GIG												47	51	14	2	2	9	7	2	2	0
SHR													43	36	16	10	28	1	17	16	18
ROU														32	5	13	19	1	11	11	2
SST															10	19	22	1	17	27	10
ROS																23	67	0	19	23	0
FHS																	18	0	14	32	12
DFS																		6	17	16	0
PRF																			0	0	0
SBP																				23	0
SEA																					0
GRS																					

Diet Overlap

Figure 107.--Percent Similarity Index (%) of dietary overlap of groundfish species in the Aleutian Islands in 1994.
ATK, Atka mackerel; POP, Pacific ocean perch; NOR, northern rockfish; POL, pollock; SPS, spectacled sculpin; COD, Pacific cod; ATF, arrowtooth flounder; PAH, Pacific halibut; GRT, Greenland turbot; GIG, giant grenadier; SHR, shortraker rockfish; ROU, rougheye rockfish; SST, shortspine thornyhead; ROS, rock sole; FHS, flathead sole; DFS, darkfin sculpin; PRF, prowfish; AKS, Alaska skate; SBP, sawback poacher; SEA, searcher; GRS, great sculpin.

1997

	ATK	POP	NOL	POL	SAB	COD	ATF	PAH	GRT	WBS	GRS	SHR	MUS	PRF
ATK		69	69	64	36	7	17	3	3	4	0	7	16	6
POP			72	60	30	7	28	4	14	1	0	17	6	1
NOL				54	32	10	21	7	8	8	0	10	7	1
POL					32	15	25	7	10	6	0	15	15	0
SAB						8	16	16	16	4	0	13	9	37
COD							39	43	5	53	12	22	18	0
ATF								24	23	33	4	34	14	0
PAH									21	51	21	32	5	0
GRT										6	0	36	6	0
WBS											28	17	11	0
GRS												0	0	6
SHR													21	6
MUS														0
PRF														

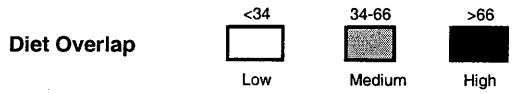

Figure 108.--Percent Similarity Index (%) of dietary overlap of groundfish species in the Aleutian Islands in 1997. ATK, Atka mackerel; POP, Pacific ocean perch NOL, northern lampfish; POL, pollock; COD, Pacific cod; ATF, arrowtooth flounder; PAH, Pacific halibut; GRT, Greenland turbot; WBS, white blotched skate; GRS, great sculpin; SHR, shortraker rockfish; MUS, mud skate; PRF, prowfish; SAB, sablefish.

Prey Sizes Consumed by Predators

Tables 74 and 75 list the sizes of prey fish and crab consumed by each predator species in the Aleutian Islands in 1994 and 1997, respectively. While details of the prey size of each of the predators were presented in the different sections describing each species, this summary compares the prey size of the same prey species consumed by different predators.

Table 74 lists prey pollock size in 1994 as it varies from species to species. The maximum length of prey pollock was 510 mm. It was consumed by Alaska skate. The smallest pollock (22 mm) was consumed by arrowtooth flounder. The length of the capelin consumed by different predators ranged from 53 to 88 mm SL. Most of the flatfish consumed were less than 200 mm SL; however, some arrowtooth flounder, flathead sole, and rock sole consumed by great sculpin were between 250 and 350 mm SL. The length range of Pacific sand lance consumed varied from 36-41 mm consumed by Alaska skate, to 100-170 mm consumed by Pacific cod, to 132-155 mm consumed by Pacific halibut. Pollock and shortspine thornyhead consumed smaller-sized (< 165 mm SL) Atka mackerel, whereas Pacific cod, arrowtooth flounder, Alaska skate, great sculpin, and Pacific halibut consumed larger-sized (340-360 mm SL) Atka mackerel. The length of myctophids consumed by the predator species ranged from 14 to 146 mm SL. The length range of rockfish (*Sebastes* spp.) consumed varied from 200 to 270 mm SL. The carapace width of *Chionoecetes* sp. ranged from 13-17 mm in Alaska skate to 12-104 mm in great sculpin. The Korean horse-hair crab consumed ranged between 24 and 65 mm carapace width.

In 1997, the sizes of the pollock consumed by predator fish were similar to those in 1994; they ranged from 19 to 527 mm SL (Table 75). The range of Pacific herring consumed varied from 201-290 mm SL consumed by Pacific halibut, to 263-295 mm SL consumed by arrowtooth flounder, to 340 mm SL consumed by Pacific cod. The length of the capelin consumed ranged from 49 to 129 mm SL, a little larger than those consumed in 1994. Flatfish were only consumed by Pacific halibut in 1997. They included juvenile Pacific halibut (28-42 mm SL), rock sole (104-147 mm SL), flathead sole (107-122 mm SL) and one 110 mm SL Kamchatka flounder. The length range of Pacific sand lance consumed varied from 56-121 mm SL consumed by pollock, to 98-237 mm SL consumed by Pacific halibut, to 115-240 mm SL consumed by Pacific halibut. Pollock and shortspine

thornyhead consumed smaller-sized (< 165 mm SL) Atka mackerel. Many predator fish--Pacific cod, bigmouth sculpin, great sculpin, Alaska skate, whiteblotched skate, and Pacific halibut--consumed Atka mackerel; they ranged from 137 to 360 mm SL. The length of myctophids consumed by the predator species were a little smaller in 1997 than those consumed in 1994; they ranged from 10 to 110 mm SL. The length range of rockfish (*Sebastes* spp.) consumed varied from 64 to 450 mm SL. The carapace width of the *Chionoecetes* sp. ranged from 8-40 mm in Pacific cod to 9-78 mm in Pacific halibut, to 18-72 mm in great sculpin. The Korean horse-hair crabs consumed were among the range between 11 and 51 mm carapace width.

Table 74. --The length range (mm) of the commercially important prey consumed by the groundfish in the Aleutian Islands in 1994. POL, pollock; COD, Pacific cod; ATF, arrowtooth flounder; ATK, Atka mackerel; DFS, darkfin sculpin; GRS, great sculpin; AKS, Alaska skate; RTS, roughtail sculpin; MUS, mud skate; WBS, white blotched skate; GIG, giant grenadier; ROU, rougheye rockfish; POP, Pacific ocean perch; SHR, shortraker rockfish; SST, short spine thornyhead; SHS, spinyhead sculpin; SPS, spectacled sculpin; PAH, Pacific halibut; GRT, Greenland turbot. SL, standard length; CW, carapace width; CL, carapace length.

Predator	POL	COD	ATF	ATK	DFS	GRS	AKS	RTS	MUS	WBS	GIG	ROU
Prey item	Prey length-range (mm SL, CW, or CL)											
Lithodes aequispina												
Chionoecetes sp.		7-57				12-104	13-17					
Erimacrus isenbeckii		24-54				36-65						
Lampetra sp.		370										
Chondrichthyes												130
Rajidae												
Osmeridae				19-41								
Mallotus villosus		68	53-88									
Bathylagidae	46-115											
Cyclothone sp.	40-47											
Tactostoma macropus	232											
Chauliodontidae	102-185	200	120									
Benthalbella dentata	105											
Myctophidae	14-133	37-128	27-95					31	33		18-88	25-92
Gadus macrocephalus		46										
Theragra chalcogramma		263-468	22-320			327	296-510					
Zoarcidae	54											
Gymnelis rotordorsalis		27-100										
Scorpaenidae			200				265-270					
Sebastes alutus		153										
Hexagrammos decagrammus							166-204					
Pleurogrammus monopterygius	115-165	145-350	128-340			340	96-360			136		255
Anoplopoma fimbria			230									
Cottidae	11-45	28-210	27-81	14-18	27	310	30-97					
Agonidae		90-150	60			85						
Cyclopteridae		16-70	34-101									
Bathymaster signatus		99-180	83-115				143					
Stichaeidae		34-195	83				113					
Lumpenus maculatus						125						
Ammodytes sp.		100-170					36-41					
Atheresthes evermanni				19-21								
Atheresthes stomias		68				350						
Hippoglossoides elassodon						250						
Lepidopsetta sp.		45-57	32			260						
Hippoglossus stenolepis		65	27-29	18			22-34					

Table 74.--Continued.

Predator	SHR	SST	SHS	SPS	PAH	GRT	POP
Prey item Prey length-range (mm SL, CW, or CL)							
Lithodes aequispina		9-30					
Chionoecetes sp.					10-64		
Erimacrus isenbeckii					19-45		
Lampetra sp.							
Chondrichthyes							
Rajidae		55-105					
Osmeridae							
Mallotus villosus							
Bathylagidae	105				90	68-76	38-105
Cyclothone sp.						43-52	
Tactostoma macropus							
Chauliodontidae						96-208	58-92
Benthalbella dentata							
Myctophidae	43-146			27	68-97	32-102	19-96
Gadus macrocephalus							
Theragra chalcogramma					145-424	470-480	
Zoarcidae		64-74			78-85		
Gymnelis rotordorsalis					68-80		
Scorpaenidae							
Sebastes alutus							
Hexagrammos decagrammus							
Pleurogrammus monopterygius		157			123-350	205	
Anoplopoma fimbria							
Cottidae	130	38-102	27		35-216	40	
Agonidae		130			64-125		
Cyclopteridae		23-82			29-50		
Bathymaster signatus							
Stichaeidae					64-340		
Lumpenus maculatus							
Ammodytes sp.					132-155		
Atheresthes evermanni							
Atheresthes stomias					188-196		
Hippoglossoides elassodon					60-190		
Lepidopsetta sp.					43-142		
Hippoglossus stenolepis							

Table 75. --The length range (mm) of the commercially important prey consumed by the groundfish in the Aleutian Islands in 1997. POL, pollock; COD, Pacific cod; ATF, arrowtooth flounder; ATK, Atka mackerel; BMS, bigmouth sculpin; GRS, great sculpin; AKS, Alaska skate; MUS, mud skate; WBS, white blotched skate; NOL, northern lampfish; POP, Pacific ocean perch; SHR, shortraker rockfish; PAH, Pacific halibut; GRT, Greenland turbot. SL, standard length, CW, carapace width; CL, carapace length.

Predator	POL	COD	ATF	ATK	BMS	GRT	GRS	AKS	MUS	WBS
Prey item	Prey length-range (mm SL, CW, or CL)									
Lithodes aequispina										
Chionoecetes sp.		8-40					18-72			
Erimacrus isenbeckii		11-49					51			21
Lampetra sp.										
Chondrichthyes										
Rajidae										
Clupea pallasi		340	263-295							
Osmeridae	42-51		79-132							
Mallotus villosus				54						
Bathylagidae		89-150								
Cyclothone sp.										
Tactostoma macropus										
Chauliodontidae	148		120			130				
Benthalbella dentata										
Paralepidadae		240								
Myctophidae	25-110	25-105	10-99			96			28	22-54
Gadus macrocephalus										
Theragra chalcogramma		61-527	63-99	19						30-350
Zoarcidae		170								
Gymnelis rotordorsalis										
Cololabis saira		145								
Scorpaenidae		98-450								
Sebastes alutus										
Hexagrammidae			380							
Pleurogrammus monopterygius		137-235			210-310		203-213	228-296		150-360
Anoplopoma fimbria			210							
Cottidae		27-220	16-235							29-310
Agonidae		140								32
Cyclopteridae										
Bathymaster signatus										
Stichaeidae		51-160	65							
Lumpenus maculatus										
Ammodytes sp.	56-121	115-240								
Atheresthes evermanni										
Atheresthes stomias										
Hippoglossoides elassodon										
Lepidopsetta sp.										
Hippoglossus stenolepis										

Table 75.--Continued.

Predator	SHR	PAH	NOL	POP
Prey item Prey length-range (mm SL, CW, or CL)				
Lithodes aequispina				
Chionoecetes sp.		9-78		
Telmessus cheiragonus		20-46		
Erimacrus isenbeckii		11-25		
Lampetra sp.				
Chondrichthyes				
Rajidae				
Clupea pallasi		201-290		
Osmeridae				
Mallotus villosus		49-129		
Bathylagidae		112		
Cyclothone sp.				
Tactostoma macropus				68
Chauliodontidae		72-163		
Benthalbella dentata				
Myctophidae	77-100	32-95	21	17-109
Gadus macrocephalus				
Theragra chalcogramma		147-445		
Zoarcidae		86-104		
Gymnelis rotordorsalis		59-96		
Scorpaenidae		64-99		
Sebastes alutus				
Hexagrammos decagrammus				
Pleurogrammus monopterygius		105-335		
Anoplopoma fimbria				
Cottidae	62-142	29-229		
Agonidae		56-183		
Cyclopteridae		29-55		
Bathymaster signatus		83-163		
Ptilichthys goodei		189		
Stichaeidae				
Lumpenus maculatus				
Ammodytes sp.		98-237		
Atheresthes evermanni		110		
Atheresthes stomias				
Hippoglossoides elassodon		107-122		
Lepidopsetta sp.		104-147		
Hippoglossus stenolepis		28-42		

ACKNOWLEDGMENTS

I would like to thank Patricia Livingston for reviewing the earlier draft and for her helpful comments. Thanks also to Geoff Lang and Kerim Aydin for reviewing this manuscript.

CITATIONS

Adams, A.E. 1979. The food habits, age, and growth of three midwater fishes (*Stenobrachius leucopsarus*, *S. nannochir*, and *Leuroglossus schmidti*) from the southeastern Bering Sea. M. Sc. Thesis. Univ. Alaska, Fairbanks.

Allen, M.J., and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 66, 151 p.

Balanov, A.A. 1994. Diet of common mesopelagic fishes of the Bering Sea. J. Ichthyol. 34(6):73-82.

Brodeur, R.D., and P.A. Livingston. 1988. Food habits and diet overlap of various eastern Bering Sea fishes. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-127, 76 p.

Buckley, T.W., G.E. Tyler, D.M.Smith, and P.A. Livingston. 1999. Food habits of some commercially important groundfish off the coasts of California, Oregon, Washington, and British Columbia. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-102, 173 p.

Cailliet, G.M., and M.E. Anderson. 1975. Occurrence of the prowfish, *Zaprora silenus* Jordan, 1896 in Monterey Bay, California. Calif. Dept. Fish and Game, 61(1), 60-62.

Drazen, J.C., T. W. Buckley, and G. R. Hoff. 2001. The feeding habits of slope dwelling macrourid fishes in the eastern North Pacific. Deep-Sea Res. Part I, 48:909-935.

Fitch, J.E., and R. J. Lavenberg. 1971. Marine food and game fishes of California. Univ. California Press, Berkeley and Los Angeles, 179 p.

Gaichas, S. 2001. Squid and other species in the Bering Sea and Aleutian Islands. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery

Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Harrison, R. C. 1993. Data report: 1991 bottom trawl survey of the Aleutian Islands area. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-12, 144 p.

Ianelli, J.N., T.K. Wilderbuer, and T.M. Sample. 2001. Assessment of Greenland turbot stock in the eastern Bering Sea and Aleutian Islands. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

International Pacific Halibut Commission. 2001. Appendix A. Pacific halibut stock assessment and fishery evaluation. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Iwamoto, T., and D.L. Stein. 1974. A systematic review of the rattail fishes (Macrouridae; Gadiformes) from Oregon and adjacent waters. Occasional papers of the California Academy of Sciences 111:1-79.

Lang, G. M. 1992. Food habits of three congeneric flatfishes: yellowfin sole, *Pleuronectes asper*, rock sole, *P. bilineatus*, and Alaska plaice, *P. quadrituberculatus*, in the eastern Bering Sea, 1984-1988. M.S. Thesis, Univ. Washington, Seattle, 125 p.

Lowe, S. A., R.F. Reuter, and H. Zenger. 2001. Assessment of Bering Sea/Aleutian Islands Atka mackerel. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Mecklenburg, C.W., T. W. Mecklenburg, and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesda, Maryland.

Nishimura, A., K. Nagasawa, T. Asanuma, H. Aoki, and T. Kubota. 1999. Age, growth, and feeding habits of lanternfish, *Stenobrachius leucopsarus* (Myctophidae), collected from the near-surface layer in the Bering Sea. Fish. Sci. 65(1):11-15.

North Pacific Fishery Management Council. 2001. Summary, p.1-31. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Novikov, N.P. 1970. Biology of *Chalinura pectoralis* in the North Pacific, p.304-331. In P.A. Moiseev (editor), Soviet fisheries investigations in the northeastern Pacific, part V (in Russian). Proc. All-Union Sci. Res. Inst. Mar. Fish. Oceanogr. (VINRO) vol. 70, and Proc. Pac. Sci. Res. Inst. Fish. Oceanogr. (TINRO), vol. 72. (Transl. by Israel Program Sci. Transl., 1972).

Orlov, A.M. 1998. On feeding of mass species of deep-sea skates (*Bathyraja* spp., Rajidae) from the Pacific waters of the northern Kurils and southeastern Kamchatka. J. Ichthyol. 38, (8):635-644.

Orr, J.W., and A.C. Matarese. 2000. Revision of genus *Lepidopsetta* Gill, 1862 (Teleostei: Pleuronectidae) based on larval and adult morphology, with a description of a new species from the North Pacific Ocean and Bering Sea. Fish. Bull., U.S. 98(3):539-582.

Pacunski, R.E. 1990. Food habits of flathead sole, Hippoglossoides elassodon, in the eastern Bering Sea. M.S. Thesis, Univ. Washington. Seattle, 106 p.

Pietsch, T.W. 1994. Systematics and distribution of cottid fishes of the genus Triglops Reinhardt (Teleostei: Scropaeniformes). Zool. J. Linn. Soc. 109(4):335-393.

Poltev, Y.N. and I.N. Mukhametov. 1999. Captures of big-mouth sculpin *Ulca bolini* in Pacific waters of the northern Kurils and the southeastern extremity of Kamchatka. J. Ichthyol. 39 (8):679-681.

Simenstad, C.A., J.S. Isakson, and R.E. Nakatani. 1977. Marine fish communities of Amchitka Island, Alaska. In M.L. Merritt and R.G. Fuller (ed.), The Environment of Amchitka Island, Alaska. U.S. Energy Research and Development Administration. TID267-12: 451-492.

Reuter, R.F., and P.D. Spencer. 2001. Other rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Spencer, P.D., and J.N. Ianelli. 2001. Pacific ocean perch. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Spencer, P.D., and R.F. Reuter. 2001. Other red rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Spencer, P.D., G.E. Walters, and T. K. Wilderbuer. 2001. Flathead sole. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Stark, J. 1998. Report to industry: fishing log for the 1997 bottom trawl survey of the Aleutian Islands. AFSC Processed Rep. 98-06, 96 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA 7600 Sand Point Way NE. Seattle, WA 98115.

Tokranov, A.M. 1992. Dietary characteristics of sea poachers (Agonidae) in the coastal waters of Kamchatka. J. Ichthyol. 32(4):85-94.

Tokranov, A.M. 1998. Some traits of biology of *Bathymaster signatus* (Bathymasteridae) in the Pacific waters of southeastern Kamchatka and the northern Kurils. J. Ichthyol. 38(6):488-490.

Tokranov, A.M. 1999. Some features of biology of the prowfish *Zaprora silenus* (Zaproridae) in the Pacific waters of the northern Kuril Islands and southeastern Kamchatka. J. Ichthyol. 39(6):475-478.

Tokranov, A.M., and A.M. Orlov. 2001. Some biological features of Psychrolutidae in the Pacific waters off southeastern Kamchatka and the northern Kuril Islands: communication 2. Size-age and sex composition and feeding. J. Ichthyol. 41(8):575-583.

Wilderbuer, T. K., and T. M. Sample. 2001. Arrowtooth flounder. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Wilderbuer, T.K., and G.E. Walters. 2001. Rock sole. In Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian

Islands regions. Compiled by the plan team for the groundfish fisheries of the Bering Sea and Aleutian Islands. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99510.

Willis, J.M., W.G. Pearcy, and N.V.Parin. 1988. Zoogeography of midwater fishes in the Subarctic Pacific Bull Ocean Res. Inst. Univ. Tokyo No. 26 (part II): 79-142.

Yang, M-S. 1996. Diets of the important groundfishes in the Aleutian Islands in summer 1991. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-60, 105 p.

Yang, M-S., and M.W. Nelson. 2000. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990, 1993, and 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-112, 174 p.