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Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Zone of Kodiak Island - Including Ichthyoplankton, Zooplankton, and Fish. A Report on the Fish Component of the Study

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FINAL REPORT

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ABSTRACT

Five types of gear (beach seine, trammel net, try net, otter trawl, and townet) were used to sample the nearshore fish of the Kodiak Archipelago during April-August and November 1978, and March 1979. Over 14,000 stomachs were collected and analyzed from approximately 40 species of fish. Data were examined with respect to season, area, habitat and predator length.

The feeding habits of selected species of fish with respect to time of day was studied: stomach fullness and relative state of digestion were variable, depending on species, size category, and season. The index of stomach fullness was high in the greenlings and cod, and medium in some gunnels, pricklebacks, and sole. Greenling seemed to feed more in the morning, rock sole more at mid-day, Pacific cod less at mid-day, and capelin more in the early morning.

Individuals of twelve species of fish were in spawning condition. Paired sample t-tests were used to compare the amount of feeding between ripe and non-ripe fish of the same species. There was no significant difference between ripe greenling and yellowfin sole and their non-ripe counterparts. Ripe Pacific sand lance, capelin, Pacific tomcod, and Pacific sandfish may have been feeding less than non-ripe fish.

For those fish that contributed over 5% (by weight) to the mean catch-per-unit-effort (CPUE), both traditional food webs (percent composition of prey) and quantitative dot/box diagrams were constructed. Such figures not only show the relationships and the importance of each type of food to each species of predator, but also the relative impact of each species of predator on its food resource.

Predator species and their prey spectra differed among habitats and seasons. Fish in the intertidal or shallow subtidal areas were typically small (with the exception of transient species such as adult pink salmon and Dolly Varden) and generally consumed small pelagic, benthic, and epibenthic crustaceans, and/or polychaetes.

Fish sampled from the rocky/kelp beds tended to be considerably larger, probably because the trammel net selected larger fish. Most important in this habitat were the greenlings. Their diet was quite diverse, and included benthos, epibenthos, and fish.

The important species on the subtidal banks and shelves, which were sampled with a try net, consisted mainly of rock and yellowfin sole (these tended to be smaller than those sampled from deeper waters with an otter trawl) and Myoxocephalus spp. Myoxocephalus largely consumed fish and crab, while the sole relied on a variety of benthic and epibenthic organisms (largely not crustaceans) and fish.

The largest diversity in fish species was in the otter trawl catches. Eleven species of predators were incorporated into the food webs for fish captured in the deep troughs. These fish were generally large and tended to feed predominately on fish, crab and/or shrimp.

Townet samples of the pelagic habitat contained small fish such as Pacific sand lance, juvenile salmon, and capelin, which fed largely on zooplankton. In general, the catches from all habitats were low in autumn and even lower in winter and the fish populations consumed less food during these seasons.

INTRODUCTION

General Nature and Scope of Study

Exploitation of petroleum resources introduces many potential hazards to the marine environment including the direct spillage of crude oil or its refined products. The Continental Shelf east of Kodiak Island is one proposed site of oil exploration; but it is also a highly productive area that supports substantial domestic and foreign commercial fisheries for many finfish and shellfish species. Spillage of toxic hydrocarbons could jeopardize this industry by directly harming the fish or by contaminating or depleting their food supplies.

This project was undertaken in 1978 to provide environmental baseline data on the feeding habits of ecologically and economically important fishes occurring inshore near the Kodiak Archipelago. The coastal area is particularly vulnerable because the biota in the bays and fjords could potentially suffer greater exposure to spilled hydrocarbons than would the biota of the open waters offshore. In addition, these areas are important spawning and rearing sites for many species of fish, including pink salmon. Data obtained from this study will be used in planning the development of oil reserves in the Kodiak Lease Area and in assessing the effects of oil on the feeding relationships of the fish.

Specific Objectives

The specific goals of this project were to create food webs for the ecologically important fish from bays of the Kodiak Archipelago, so that major trophic pathways could be identified and to describe the food habits of several nearshore pelagic and demersal fish with respect to season, area, habitat, and predator size.

Relevance to Problems of Petroleum Development

Petroleum and its by-products may affect fishes directly or indirectly. Direct effects include actually coating the larvae or juvenile life history stages, making food procurement difficult and growth questionable. Also possible are modifications in behavior. For instance, fish may opt to avoid a spill and in so doing, move away from former feeding and spawning grounds.

Indirect effects are more subtle. Studies on herring have indicated that during spawning their sensitivity to oil is increased and that hydrocarbons actually become incorporated in the gonads (Struhsaker 1977), which decreases the survival of the pre-larval stages. McCain, et al. (1978) and others have shown that flatfish maintained on sediments saturated with oil have accumulated hydrocarbons in skin, muscle,

and liver tissue. These fish may then become unpalatable and their economic value may be lost. The amount of algae maybe altered, which may result in a less desirable environment for both predator and prey species. Algal attachment sites may be lost for years, causing a decrease in the algal cover. Alternatively, if herbivores die as a result of exposure to oil, this may cause an increase in the algal cover (Clark and Finley 1977). Oil may also contaminate or deplete prey organisms.

Fish examined in this study basically fed on either planktonic organisms or on a variety of benthic and epibenthic prey. Effects of oil on the former would be more short-term and direct, while effects on the latter would be more long-term and intricate. This was observed by Linden et al. (1979) in studies on the Tsesis oil spill.

Areas where oil is slowly dispersed may be affected more than areas where it is not. Natural dispersion of oil depends on the type and amount of energy present, whether it is biological, chemical, thermal, or mechanical. Owens (1978) states that mechanical energy (winds, waves, tides, water level, ice) is most important, and of these wave action has the greatest effect. Furthermore, sediments may take up and release oil at different rates (Teal et al. 1978). Mud flats tend to be disrupted greatly because of low wave action, high oil absorption, and rich fauna (Sanborn 1977). Kodiak's highly productive, relatively low-energy bays and fjords could be quite susceptible to serious, long term disruptions after an oil spill.

The longer oil remains in an area, the more likely uptake and retention of hydrocarbons by marine organisms is possible. In addition, detritovores readily take up this material and were among the important prey organisms in this study. Roesijade et al. (1978), for example, showed that the detritovorous deposit feeders Macoma inquinata and Phascolosoma agassizii took up and accumulated hydrocarbons faster than the planktivorous suspension feeder Protothaca staminea. Other authors have shown the presence of hydrocarbons in the tissues of polychaetes, bivalves, isopods, and gammarid amphipods. These incorporated hydrocarbons may then be transfered within the food chain, or the toxins may contribute to depletion of prey organisms by killing them or by reducing their reproductive potential. After the Tsesis oil spill, (Linden et al. 1979) most of the benthic amphipods of a spill area rapidly disappeared, presumably through emigration. Among those that remained, there was an increased incidence of abnormal eggs.

CURRENT STATE OF KNOWLEDGE

Prior to the inception of this current study, Gosho (1977) examined the stomachs of juvenile pink salmon that were taken in Alitak and Kiliuda bays on Kodiak Island. Harris and Hartt (1977) reported on the stomach analysis of fish from three bays on the island and, finally, Hunter (1979) studied the food habits of demersal fish taken offshore near the Kodiak Archipelago.

The Fisheries Research Institute (FRI) and the Alaska Department of Fish and Game (ADF&G) sampled the nearshore fish communities of the Kodiak Archipelago between April 1978 and March 1979, collecting stomachs from approximately 40 species of fish (Table 1). These were later analyzed in the laboratory and preliminary results of this analysis are presented in Rogers et al. (1979). Major categories of food that are important to the species examined in this study are summarized in Table 2 along with lists of references from which the information was derived. Species and/or life history stages that have not yet been studied may provide additional information in the future.

Zooplankton and/or small epibenthic crustacea (including harpacticoid copepods, gammarid amphipods, and mysids) are listed as important to most of the species of fish that were studied. In general, however, only very small or very young fish depended primarily on these foods. Many species, as the individuals grew, depended more and more heavily on large food items such as crab, fish, and shrimp, for the bulk of their diets. This phenomenon has been observed frequently in single species (e.g., Miller 1970 on flathead sole; Novikov 1963 on halibut; Bailey and Dunn 1979 on walleye pollock; and Jewett 1978 on Pacific cod) and for communities (e.g., Edwards and Bowman 1979; Rogers et al. 1979). This is probably because small fish cannot manipulate large prey items while very large fish are not usually morphologically adapted to capturing very small foods. In addition, a large fish cannot easily survive if its primary mode of feeding is by pursuing and capturing small, single prey items.

Diets of the more common species studied at Kodiak were categorized as follows:

1) Large Pacific cod, walleye pollock, Myoxocephalus spp., yellow Irish lord, and flathead sole are crab, fish, and/or shrimp specialists.

2) Rock, masked, and whitespotted greenling plus rock and yellowfin sole are generalists.

3) Juvenile pink and chum salmon, Pacific sand lance, and small (<150 mm long) walleye pollock, and Pacific cod relied heavily on zooplankton and/or small epibenthic crustacea.

Table 1. The number of fish stomachs sampled (April-August and November 1978, and March 1979).

Scientific name	Common name	Number sampled
Salmonidae:		
Oncorhynchus gorbuscha	Pink salmon	788
O. keta	Chum salmon	647
O. kisutch	Coho salmon	27
Salvelinus malma	Dolly Varden	11
Osmeridae:		
Mallotus villosus	Capelin	75
Gadidae:		
Gadus macrocephalus	Pacific cod	569
Microgadus proximus	Pacific tomcod	43
Theragra chalcogramma	Walleye pollock	388
Scorpaenidae:		
Sebastes melanops	Black rockfish	4
Hexagrammidae:		
Hexagrammos decagrammus	Kelp greenling	26
H. lagocephalus	Rock greenling	780
H. octogrammus	Masked greenling	1,109
H. stelleri	Whitespotted greenling	715
Ophiodon elongatus	Lingcod	19
Anoplopomatidae:		
Anoplopoma fimbria	Sablefish	73
Cottidae:		
Blepsias cirrhosus	Silverspotted sculpin	8
Gymnocanthus spp.	Armorhead and Threaded sculpin	22
Hemilepidotus hemilepidotus	Red Irish lord	16
H. jordani	Yellow Irish lord	571
Leptocottus armatus	Staghorn sculpin	1
Myoxocephalus spp.	Great sculpin and *Myoxocephalus* spp.	644

Table 1. The number of fish stomachs sampled (April-August and November 1978, and March 1979) - continued.

Scientific name	Common name	Number sampled
Agonidae:		
Pallasina barbata	Tubenose poacher	1
Trichodontidae:		
Trichodon trichodon	Pacific sandfish	88
Zaproridae:		
Zaprora silenus	Prowfish	1
Stichaeidae:		
Lumpenus sagitta	Snake prickleback	72
L. maculatus	Daubed shanny	1
Pholidae:		
Apodichthys flavidus	Penpoint gunnel	2
Pholis laeta	Crescent gunnel	110
Ammodytidae:		
Ammodytes hexapterus	Pacific sand lance	987
Pleuronectidae:		
Atheresthes stomias	Arrowtooth flounder	43
Hippoglossoides elassodon	Flathead sole	1,270
Isopsetta isolepis	Butter sole	3
Lepidopsetta bilineata	Rock sole	2,850
Limanda aspera	Yellowfin sole	2,118
Platichthys stellatus	Starry flounder	7
Hippoglossus stenolepis	Pacific halibut	44
	Total	14,133

Table 2. Summary of the major food categories of fish species examined in this study.

Species	Zooplankton	Insects	Small epibenthic crustacea	Non-crustacean benthos	Crab	Shrimp	Fish	References
Pink salmon juveniles	X	X	X					Bailey et al. (1975); Barraclough (1967a,b,c); Barraclough and Fulton (1967, 1968); Barraclough et al. (1968); Cross et al. (1979); Gosho (1977); Harris and Hartt (1977); Kaczynski et al. (1973); Manzer (1969); Robinson et al. (1968a,b); Rogers et al. (1979); Simenstad et al. (1977).
Pink salmon adults							X	Rogers et al. (1979).
Chum salmon juveniles	X	X	X					Barraclough (1967a,b,c); Barraclough and Fulton (1967, 1968); Feller and Kaczynski (1975); Harris and Hartt (1977); Kaczynski et al. (1973); Robinson et al. (1968a,b); Rogers et al. (1979).
Coho salmon juveniles	X	X	X	X			X	Barraclough and Fulton (1967); Cross et al. (1978); Harris and Hartt (1977); Manzer (1969); Robinson et al. (1968b); Rogers et al. (1979); Ross (1960); Synkova (1951).
Coho salmon adults	(euphausids)						X	Rogers et al. (1979).
Dolly Varden	X		X	X			X	Darda (1964); Harris and Hartt (1977); Lagler and Wright (1962); Narver and Dahlberg (1965); Noerenberg (1960); Rogers et al. (1979) Simenstad et al. (1978); Townsend (1942).
Capelin	X							Andriashev (1954); Harris and Hartt (1977); Jangaard (1974); Pearcy et al. (1979); Rogers et al. (1979); Smith et al. (1978).

Table 2. Summary of the major food categories of fish species examined in this study -- continued.

Species	Zooplankton	Insects	Small epibenthic crustacea	Non-crustacean benthos	Crab	Shrimp	Fish	References
Pacific sand lance	X		(1,2,3)	(1,3)			(1)	Barraclough (1967a,b,[1]c); Barraclough and Fulton (1967, 1968); Barraclough et al. (1968); Cross et al. (1978); Harris and Hartt (1977); Inoue et al. (1967); Meyer et al. (1979); Richards (1963); Robinson et al. (1968a,b); Roessingh (1957); Rogers et al. (1979);[2] Scott (1977); Sekiguchi (1977); Senta (1965); Simenstad et al. (1978); Trumble (1973).[3]
Pacific cod	X		X		X	X	X	Feder (1977); Forrester (1969); Hart (1949); Hunter (1979); Jewett (1978); Karp and Miller (1977); Rogers et al. (1979).
Walleye pollock	X		X			X	X	Andriashev (1957); Bailey and Dunn (1979); Barraclough (1967a,c); Cross et al. (1978); Nikol'skii (1954); Rogers et al. (1979); Simenstad et al. (1977); Smith et al. (1978) Suyehiro (1942); Takahashi and Yamaguchi (1972).
Pacific tomcod	X		X		X	X	X	Hart (1949); Rogers et al. (1979).
Black rockfish	X					X	X	Moulton (1977); Rogers et al. (1979).
Kelp greenling			X	X	X	X	X	Hart (1973); Moulton (1977); Rogers et al. (1979).
Masked greenling	X		X	X	X	X	X	Harris and Hartt (1977); Rogers et al. (1979); Rutenberg (1962).
Rock greenling	X		X	X	X	X	X	Klyashtorin (1962); Rogers et al. (1979); Rutenberg (1962); Simenstad (1971); Simenstad et al. (1978).

Table 2. Summary of the major food categories of fish species examined in this study - continued.

Species	Zooplankton	Insects	Small epibenthic crustacea	Non-crustacean benthos	Crab	Shrimp	Fish	References
Whitespotted greenling	X		X		X	X	X	Barraclough and Fulton (1968); Barraclough et al. (1968); Harris and Hartt (1977); Rogers et al. (1979); Rutenberg (1962); Simenstad et al. (1979).
Lingcod	X		X		X	X	X	Forrester (1969); Hart (1973); Moulton (1977); Rogers et al. (1979); Wilby (1937).
Sablefish						X	X	Grinols and Gill (1968); Rogers et al. (1979); Shubnikov (1963).
Silverspotted sculpin			X			X		Rogers et al. (1979); Simenstad et al. (1979).
Staghorn sculpin			X	X		X	X	Conley (1977); Jones (1962); Rogers et al. (1979); Simenstad et al. (1979).
Gymnocanthus spp.	X		X	X		X	X	Rogers et al. (1979).
Red Irish lord			X	X	X	X	X	Clemens and Wilby (1961); Rogers et al. (1979); Simenstad et al. (1979).
Yellow Irish lord	X		X		X	X	X	Hunter (1979); Rogers et al. (1979).
Myoxocephalus spp.			X		X	X	X	Feder (1977); Harris and Hartt (1977); Hunter (1979); Rogers et al. (1979); Simenstad et al. (1978).
Tubenose poacher			X					Simenstad et al. (1979).
Pacific sandfish	X		X				X	Harris and Hartt (1977); Mineva (1955); Rogers et al. (1979).
Prowfish								No information.

Table 2. Summary of the major food categories of fish species examined in this study - continued.

Species	Zooplankton	Insects	Small epibenthic crustacea	Non-crustacean benthos	Crab	Shrimp	Fish	References
Snake prickleback	X		X	X				Barraclough et al. (1968); Harris and Hartt (1977); Rogers et al. (1979); Simenstad et al. (1979).
Daubed shanny								No information.
Crescent gunnel	X		X	X				Cross et al. (1978); Rogers et al. (1979); Simenstad et al. (1978, 1979).
Penpoint gunnel	X		X	X			X	Hart (1973); Rogers et al. (1979); Simenstad et al. (1979).
Arrowtooth flounder			X			X	X	Gotshall (1969); Hart (1973); Hunter (1979); Rogers et al. (1979); Smith et al. (1978).
Starry flounder			X	X			(4)	Cross et al. (1978); Hunter (1979); Miller (1967); Skalkin (1963); Rogers et al. (1979).
Butter sole				X	X		X	Forrester (1969).
Flathead sole	(euphausids)		X	X	X	X	X	Hayase and Hami (1974); Hunter (1979); Miller (1970); Mineva (1964); Rogers et al. (1979); Skalkin (1963); Smith et al. (1978); Suyehiro (1934).
Rock sole			X	X			X	Cross et al. (1978); Forrester and Thomson (1969); Harris and Hartt (1977); Hunter (1979); Rogers et al. (1979); Skalkin (1963); Smith et al. (1978); Zebold (1970).
Yellowfin sole	X		X	X		X	X	Fadeev (1963); Harris and Hartt (1977); Rogers et al. (1979); Skalkin (1963).
Pacific halibut					X	X	X	Hunter (1979); Novikov (1963); Rogers et al. (1979); Gray (1964).

STUDY AREA

The Kodiak Archipelago is located in the western Gulf of Alaska, southeast of the Alaska Peninsula. It is composed of many islands, 16 of which have an area greater than 18 km^2; Kodiak Island (9,293 km^2) and Afognak Island (1,813 km^2) are the largest. Mountains rise sharply from the ocean floor to elevations of over 1,200 m. The coastline is intricately carved by deep, narrow bays and fjords, and most of the shoreline is composed of rocky bluffs and narrow beaches. The continental shelf, which is about 120 km wide, and the nearshore waters of the archipelago are among the most productive in the world and support commercial fisheries for halibut, salmon, and crab.

There is a strong marine influence on the climate, resulting in cloudy skies, moderately heavy annual precipitation, and mild temperatures for the latitude of the islands. The average maximum air temperature during the summer is about 15°C and the average minimum temperature during the winter is about -5°C (AEIDC 1975). Ice forms in the more protected inlets during the winter months, and surface water temperatures of 1°C are not uncommon. Daylight ranges from 8.25 hr at the winter solstice to 22.50 hr at the summer solstice.

Our study areas included Izhut, Kalsin, Kiliuda, and Kaiugnak bays (Fig. 1). They are located on the east side of Afognak and Kodiak islands and represent most of the nearshore habitats of that area. Izhut Bay, which is located on Afognak Island, opens southward to the Gulf. It is 15 km long and is fringed by many protected inlets and lagoons. The mean depth at midbay is about 135 m and depths of over 200 m are found at the mouth. Izhut Bay has a fairly irregular bottom. The surrounding terrain has a moderate to low relief, and peaks reach just over 600 m. Lower-lying hills predominate at the head. Sitka spruce is the most obvious form of vegetation and some of this has been logged.

Kalsin Bay is only 11 km long and opens to the northeast into Chiniak Bay. Numerous small islands are located near the mouth. Kalsin Bay has a mean depth at midbay of about 50 m. The peaks are larger around Kalsin then around Izhut, but like Izhut, the bay head is less mountainous. Sedimentary rock predominates. Due to glaciation, there is an absence of Sitka spruce, and the principal vegetation consists of Sitka alder and willow, the latter often occurring in dense thickets in depressions such as stream basins.

Kiliuda Bay is the longest bay studied, reaching inland approximately 24 km. It is exposed to the southeast near the northern end of Sitkalidak Strait and has a few protected arms, bays, and small lagoons. The mean depth of midbay is about 70 m, and there is a fairly irregular bottom. A sill is located off Coxcomb Point, thus making Kiliuda a true fjord. The surrounding hillsides and mountains are steep and are

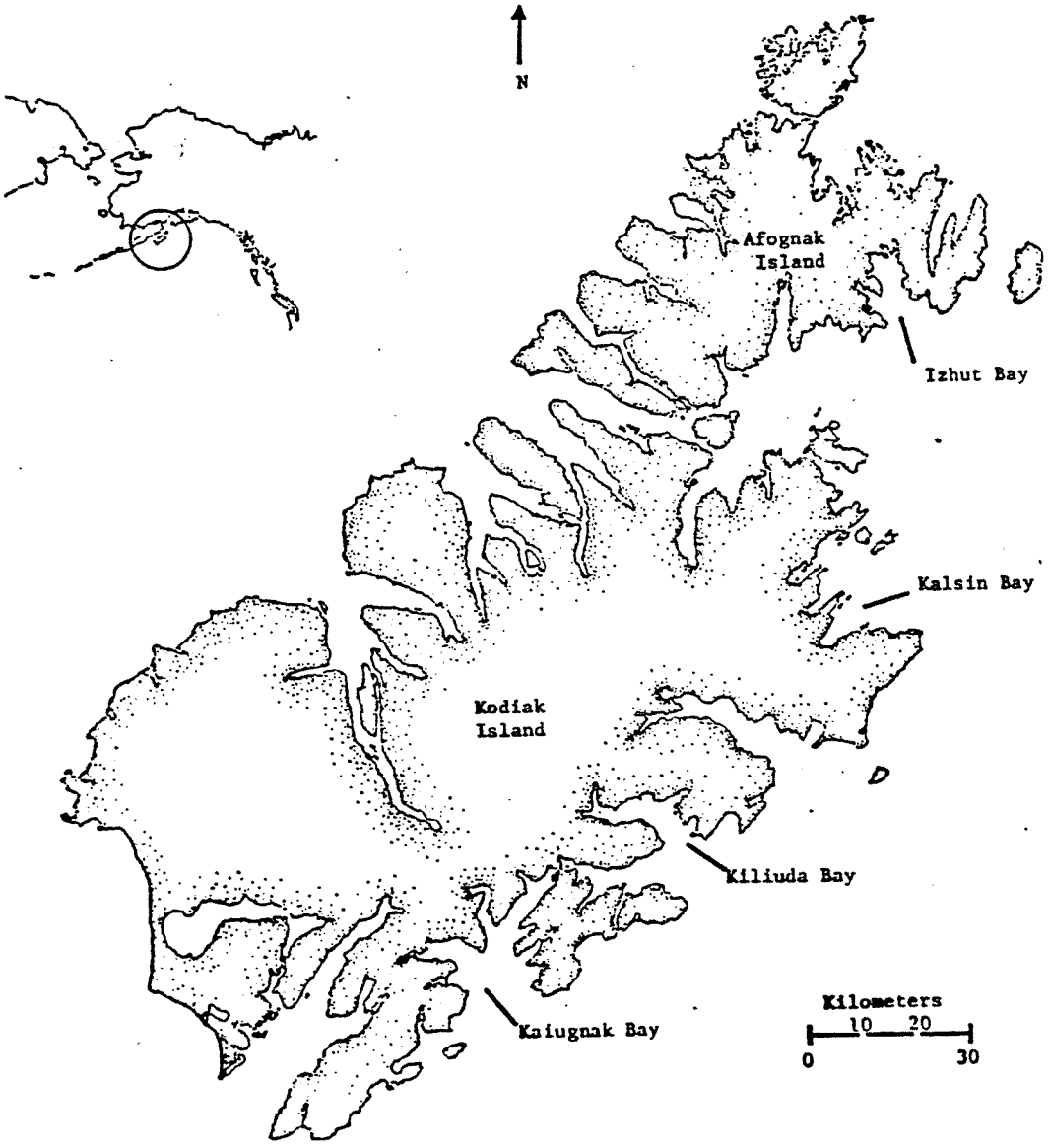

Fig. 1. Locations of bays in which fish were sampled for the Kodiak nearshore food habits studies, 1978 and 1979.

composed primarily of sedimentary rock with a small amount of volcanic rock. The vegetation is much like that in Kalsin Bay, but it also has some areas of moist tundra.

Kaiugnak Bay is about 15 km long and has two large protected lagoons, Kiavak, and Kaiugnak. It opens to the southeast at the southern end of Sitkalidak Strait. The bottom is irregular and the mean depth at midbay is about 80 m; however, the lagoons are quite shallow. Steep hillsides and mountains with vegetation much like those in Kalsin Bay predominate.

SOURCES, METHODS, AND RATIONALE OF DATA COLLECTION

Field

Stomachs were collected during April-August, and November (1978) and March (1979) from four bays on the Kodiak Archipelago: Izhut, Kalsin, Kiliuda, and Kaiugnak. Five types of gear (beach seine, trammel net, townet, trynet, and otter trawl) were used to collect most of the fish. Stomach sampling followed the plan devised by the ADF&G (RU 552) for fish sampling.

The generalized habitats that were sampled are depicted in Fig. 2. With the exception of the otter trawl, which was used only in Izhut and Kiliuda bays, each gear was used in each bay. Beach seine sets were made at varying tide levels and sampled a variety of intertidal and shallow subtidal habitats which included fine sand, cobble, mixed rock and sand, mud, and eelgrass beds. The trammel net was 75 m long and was set perpendicular to the shoreline in the subtidal region in 3-7 m of water and it generally sampled rocky/kelp bed areas. Trynet hauls were made deep (20-50 m) in the subtidal zone on predominantly mud-bottomed banks and shelves of the bays while the otter trawl sampled mud-bottomed troughs deeper (70-100 m) in the neritic zone.

As the fish were landed, they were first sorted to species. The field crew next selected specimens according to species and size: the emphasis was both on the most abundant species and on the economically important fish. Larger fish were measured and dissected in the field. Gonads were examined for level of maturity, then the stomachs were removed and placed in a Whirlpak bag along with 10% formalin. Smaller fish were preserved whole.

Laboratory

In the laboratory, the stomach contents of each large fish were removed, blotted dry, and then weighed to the nearest .01 g. The contents were next sorted into the lowest possible taxonomic categories, and each group was then counted and weighed to the nearest .001 g. If the fish were small, lengths were taken for each fish in a group and then an average length was recorded. Stomach contents were pooled and the contents from the pooled stomachs were treated as above. Average numbers and weights of prey items per stomach were then calculated.

Data Analysis

Food habits data in the annual report were presented solely on the basis of samples taken for stomach analysis and were not adjusted to the size and composition of catches in the bays. In this final report, food habits data used to create the food webs are weighted by both the number of stomachs sampled and the associated mean CPUE (catch-per-unit-effort).

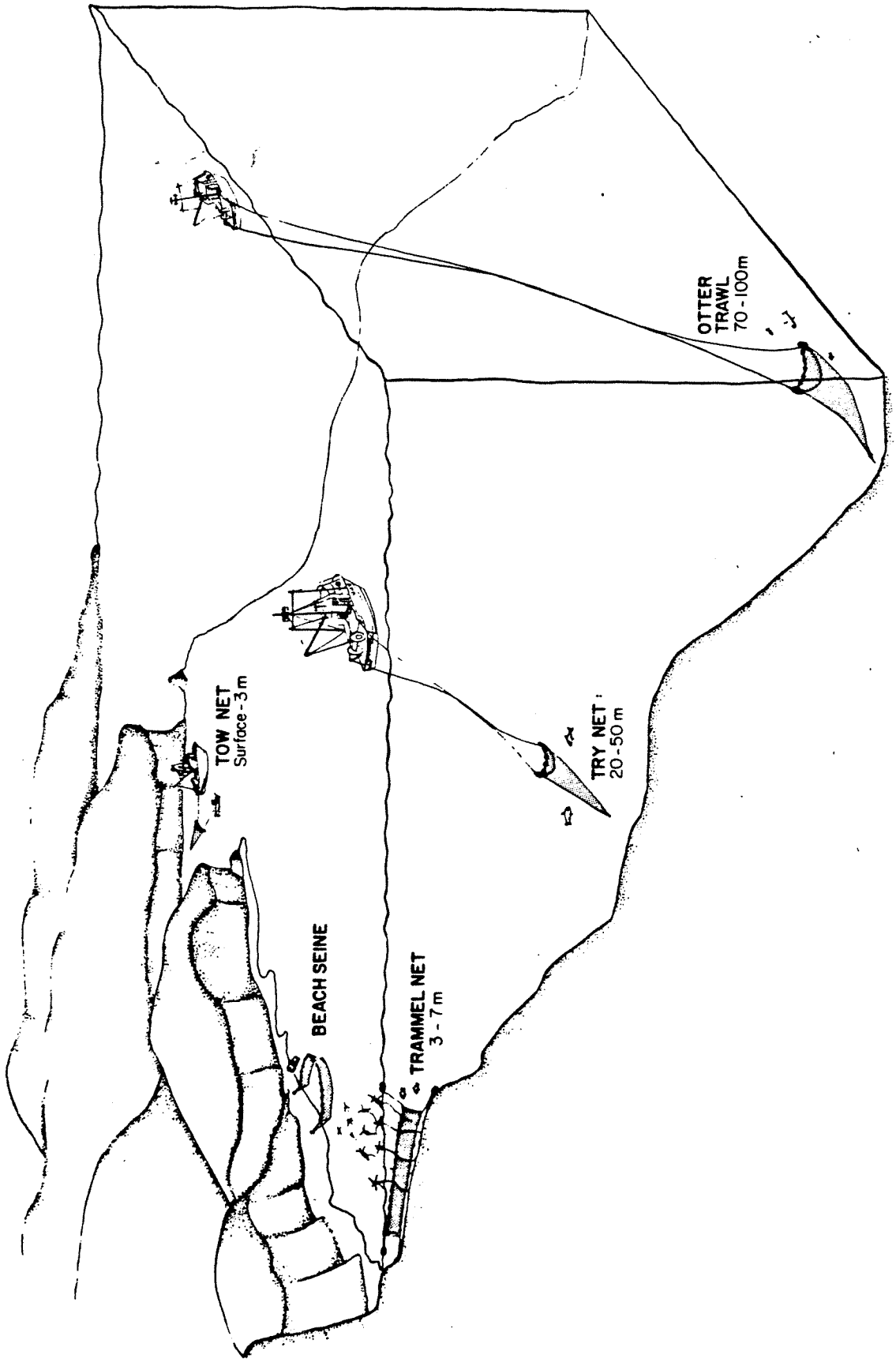

Fig. 2. Gear-habitat relationships in the nearshore zone of the Kodiak Archipelago.

Data on the catches were received from Jim Blackburn of the ADF&G (RU 552).

Catch data from ADF&G were reported by station, date, gear type, and species. We initially calculated the arithmetic means of the catches (by weight) for each bay, month, gear type, and species. Since catches are usually log-normally distributed, we later corrected for a skewed distribution by calculating the geometric means [antilog $\frac{1}{n} \Sigma \log (x + 1)$] of those arithmetic mean CPUE-values to obtain geometric mean values (over bay and month) by season, gear type, and species. Any species that comprised 5% or more of the geometric mean catches by weight (of the species that were weighed) were included in the food webs.

Because the food habits data were highly variable (Rogers et al. 1979), geometric mean weights rather than arithmetic mean weights of the foods were computed for each species of fish by bay, month, size class, and gear. We chose to work with weights of the foods alone rather than with frequency of occurrence (the percentage of stomachs containing a certain food) or abundance because biomass is the single most usable measurement for ecosystem modeling. For instance, biomass is the easiest to translate directly into units of energy. Weights and numbers are also additive. The frequency of occurrence is by contrast, somewhat difficult to use because it is not additive within a grouping of foods (e.g., the frequencies of occurrence of errantiate and sedentariate polychaetes cannot be added to provide the frequency of occurrence of polychaetes in general). A common objection to the sole use of the biomass of foods to categorize diets is that one large item will cause an over estimation of the true importance of that food. This problem, however, is considerably allayed by the use of geometric rather than arithmetic means.

The popular IRI (Index of Relative Importance - Pinkas et al. 1971) combines weight or volume (V), number (N), and frequency of occurrence (F) into one statistic: IRI = %F(%N + %V). Although the IRI was part of our original work statement, we decided against using it because as an index, it can not be tested statistically, and because the IRI numbers (and associated graphs) are weighted by F. (The IRI formula describes the areas of two rectangles, both of which have F as one dimension, and V or N as the other.)

The average weight of each type of food per stomach multiplied by the average CPUE of each species was depicted on quantitative food dot/box diagrams. These weights were determined in the following sequence:

1) Geometric mean weights of food per stomach were first calculated for each species, size class, month, and gear type. The arithmetic mean weights of food per stomach for each size class of fish were then determined for each season (within a species and gear) by weighting the preceding geometric means by the associated number of stomachs sampled (where $n \geq 3$).

The number of stomachs (n) was used as a weighting factor rather than CPUE because occasionally n was small or zero where the CPUE was large. Since we had to maintain a reasonable work load, our original goal was to collect stomachs from 20 fish per species, bay, month, and life history stage. Although we often exceeded that limit, species that were especially abundant were not sampled from all catches. Weighting by the CPUE in such cases would have given the food habits data from these poorly-sampled catches unwarranted importance. Instead, catches that were well-sampled were given the most weight.

2) The geometric mean CPUE in numbers of fish was calculated over bays and months for fish caught in each season, size class, species, and gear and the percent composition by size class was then determined.

3) It was then necessary to make CPUE in abundance comparable to CPUE in biomass, since the weights of the catches were not stratified by size class. To do this, the CPUE in abundance within a bay, month, gear, and species was added over size class and the geometric mean CPUE was calculated on total numbers within a species over bays and months.

4) The percent contribution of each size class in (2) was multiplied by the total geometric mean CPUE in (3) for the numbers of fish in each size class.

5) The average amount of food per stomach for each species of fish was then calculated by taking means weighted by the CPUE of each size class.

6) The mean CPUE of each species multiplied by the mean weight of food per stomach in (5) gave an estimate of the total amount of food in the stomachs of each species of fish per catch.

For the quantitative food dot/box diagrams, the three most important food categories for each species of fish were graphed. Traditional food webs were also drawn to indicate the percent composition of foods in the diet of each species of predator. In these, all foods comprising 5% or more by weight of the diet of each species were graphed. These more traditional webs indicate the importance of each type of food to each species of predator whereas the quantitative dot/box diagrams emphasize the relative impact of each species of predator on its food resource.

RESULTS

Stomach Fullness and Digestion Rates

The relative states of digestion and fullness were noted for each fish so that feeding chronology, digestion rate, biomass consumption, and gross growth efficiency could be determined (Edwards and Bowman 1974).

Both consumption and growth efficiency are, in part, determined by the rate at which food moves through the digestive tract. This rate, known as the gastric elimination rate, depends on many factors (Bagg 1977; Tyler 1970; Daan 1973; Karpevitch and Bokova 1937; Jones 1974; Jobling et al. 1977). Under natural conditions, those most important may be temperature, availability and type of prey, and size of predator and prey. Table 3 shows the variability contributed by the above factors, on the evacuation rates in a few selected species.

Little work has been done on gastric evacuation rates and meal sizes in fish, and whatever has been done includes the Atlantic and North Sea cods, some sculpins, and a few flounders. There is little information on evacuation rates in Pacific fish in the literature. To obtain these rates, it is necessary to have laboratory and/or diel field sampling data. The constraints of the sampling plan for this study (see RU #552, Alaska Department of Fish and Game, ADF&G) were such that it is not possible to compute elimination rates. Because of this and a lack of published values for the fish studied, we concentrated on feeding chronology. We, therefore, analyzed fullness and digestion values versus time of day and monthly gonadal development to gain further insight into this aspect of fish feeding habits.

Fullness and digestion were examined for each predator, size category (≤150 mm, 151-300 mm, >300 mm), season, and habitat. Seasonal and size class differences, regardless of time, were evident, while effect of habitat was not. Only general trends in the daily feeding can be noted, again, due to the constraints of the sampling plan.

Water temperature and prey availability may have been important in seasonal feeding differences. More empty stomachs and lower mean fullness values occurred primarily during winter and secondarily during autumn. During winter, this was especially evident in the three important species of sole (rock, yellowfin, and flathead), large Myoxocephalus spp., and small walleye pollock, masked greenling, and whitespotted greenling. During autumn, sand lance did not eat much, but this may have been because they were in spawning condition.

In some species, there were differences among size classes. For example, Myoxocephalus spp., and pink salmon <150 mm long were quite full and a low percentage of stomachs were empty, while stomachs from

Table 3. Evacuation rates of a few selected species.

Species	Temperature (°C)	Predator size	Meal size	Meal type	Evacuation time (hr)	Reference
Myoxocephalus scorpius (Cottidae)	14-15			Fish	129.6	Bagg (1977)
	8-10			Fish	175.2	
Gadus morhua (Gadidae)	14-15			Fish	110.4	
Gadus morhua	15	23-35 cm			19.2-50.4	Tyler (1977)
	15	23-34 cm	8%[4]	Pandalidae (shrimp)	15-20	
Gadus morhua	12	1240 g (44-56 cm)	46%	*Clupea* sp. (fish)	72	Daan (1973)
Gadus callarius		Mature		Fish	144[1]	Karpevitch and Bokova (1937)
		2-3 yr		Fish	120	
				Gammaridea	72-84	
Gadus virdens		Mature		Fish	144[2]	
		2-3 yr		Fish	120	
				Gammaridea	72-84	
Cottus scorpius (Cottidae)	9	Mature		Fish	144	
		2-3 yr		Fish	120	
				Gammaridea	72-84	
Pleuronectes flexus (Pleuronectidae)		Mature		Gammaridea	60[3]	
Limanda limanda (Pleuronectidae)	16.4	50 g	1%	Fish	9.3	Jobling et al. (1977)
	8.5	50 g	1%	Fish	13.7	
	16.4	50 g	3%	Fish	24.9	
	8.5	50 g	3%	Fish	30.8	
					Time to stomach weight loss	
Melanogrammus aeglefinus (Gadidae) and *Gadus morhua*	12			Fish	1.5	Jones (1974)
	6			Fish	3	
	12			*Crangon* sp. (shrimp)	10-20	
	4.2			*Crangon* sp. (shrimp)	20-40	

[1]Will feed again in 24 hr.
[2]Will feed again in 24-48 hr.
[3]Will feed again in 14-15 hr.
[4]Percent of predator's weight.

adults longer than 300 mm were quite variable, with large numbers of both full and empty stomachs.

During daylight hours, the time of day versus the feeding factors seemed to be variable (random), or consistently high/low/medium, or show periods of highs and/or lows. As noted by various authors, feeding may take place in some species only every few days (see Table 3). This may partly explain the variable nature of stomach fullness and digestion in the samples of large Myoxocephalus spp., yellow Irish lord, and Pacific halibut. The sandfish (when not spawning) and the greenling species were quite full and a low percentage of stomachs were empty, while the three gadids had more empty stomachs but were also quite full for those gadids that were feeding. Snake prickleback and crescent gunnel were in the medium range as were rock and yellowfin sole, but the latter had a higher variance and more empty stomachs. The three hexagrammids may have been feeding more in the morning, the rock sole more at mid-day, the Pacific cod less at mid-day, and the capelin more in the early morning.

Of the 27 adult species analyzed for spawning condition versus feeding (fullness), only 12 were found with "ripe and running" individuals (Table 4). Within the 1978-1979 sampling period, tomcod and sandfish were late winter spawners; rock greenling, masked greenling, whitespotted greenling, and yellowfin sole were summer spawners; and sand lance was an autumn spawner (Table 4, Fig. 3). After spawning periods were identified, fullness and the percentage of empty stomachs were compared between ripe and non-ripe fish.

In March, most of the adult tomcod had not been feeding. Since all were ripe or nearly ripe, this may have been a function of their state of maturity. Sandfish females with mature eggs were found off British Columbia in late February by Clemens and Wilby (1961). The ripe sandfish of this study were taken in March, and five out of six had empty stomachs, as did the single nonripe fish examined. Perhaps tomcod and sandfish do not feed, or feed less during spawning, but this cannot be conclusively shown because of small numbers of non-ripe fish. Capelin in spawning condition occurred in low percentages during March and June. Ripe individuals had empty stomachs about as often as non-ripe fish, but of those that fed, the stomachs of ripe fish were not as full (based on a small number of ripe fish).

Rock greenling, masked greenling, and whitespotted greenling had a very low percentage of empty stomachs and a paired sample t-test showed differences in mean fullness between ripe and non-ripe fish were not significant. Mean fullness between ripe and non-ripe yellowfin sole was also not significantly different and both groups had about 30% empty stomachs. Of rock sole and flathead sole, a small number were in spawning condition during spring and summer. Flathead sole had about the same percentage of empty stomachs in ripe and not ripe fish, but rock sole had a higher percentage in the ripe fish. This, though, could not

Table 4. Months and bays (A = Izhut, B = Kalsin, C = Kiliuda, and D = Kaiugnak) in which adult fish were sampled. Numbers indicate the percentage of adults that were "ripe and running" and numbers in parentheses are from sample sizes of less than five fish.

	March				April				May				June				July				August				November			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Pink salmon																			X	X	X	X						
Dolly Varden							X																					
Capelin		(100)	X										X	X	(25)				X								X	
Pacific cod	X								X		X		X		X			X	X				X				X	
Walleye pollock			X								X						X				X		X		X		X	
Pacific tomcod	33	(100)	(100)																		X				X			
Black rockfish																					X							
Kelp greenling											X	X	X		X		(50)				X				(100)		X	X
Rock greenling	X		X	X	X				X		X	X	X	2	25	28	30	46	16	51	41	68	31	26	X	X	X	X
Masked greenling	X		X	X	X		X	X	X	X	X	X	X	X	6	2	35	39	41	35	42	24	54	40	X	X	X	X
Whitespotted greenling	X	X	X						X		X	X	X	X	9	X	5	X	5	20	39	12	65	64	X	X	X	
Silverspotted sculpin						X																						
***Gymnocanthus* spp.**						X																						
Red Irish lord																X	X		X	X		X	X	X	X			
Yellow Irish lord	X		X						X		X			X	11	(100)	X	X	X	X	26		15	X	X		X	X
***Myoxocephalus* spp.**	X	X	X						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pacific sandfish	83								X		X		X				X		X		X						X	
Snake prickleback			X										X		X	X	X		X	X	X		X					
Penpoint gunnel																					X							
Crescent gunnel				X					X			X	X	X	X	X	X		X	X	X	X	X	X				
Pacific sand lance			X	X		X				X	X		X		X		X	X	X	X	X	(100)		X	100	(100)	93	91
Arrowtooth flounder									X																			
Flathead sole	X		X						X		5		X	X	5		24	(50)	X		9	X	5		7		X	
Rock sole	X	X	X		X	X	X	X	2	X	X		6	X	2	(33)	3	X	2	X	1	X	X	X			5	
Yellowfin sole	X		X		X	X	X		X	X	X		29	41	59	60	73	59	23	13	29	32	63	80	9	X	X	
Starry flounder																										X		
Pacific halibut						X							X		X		X											

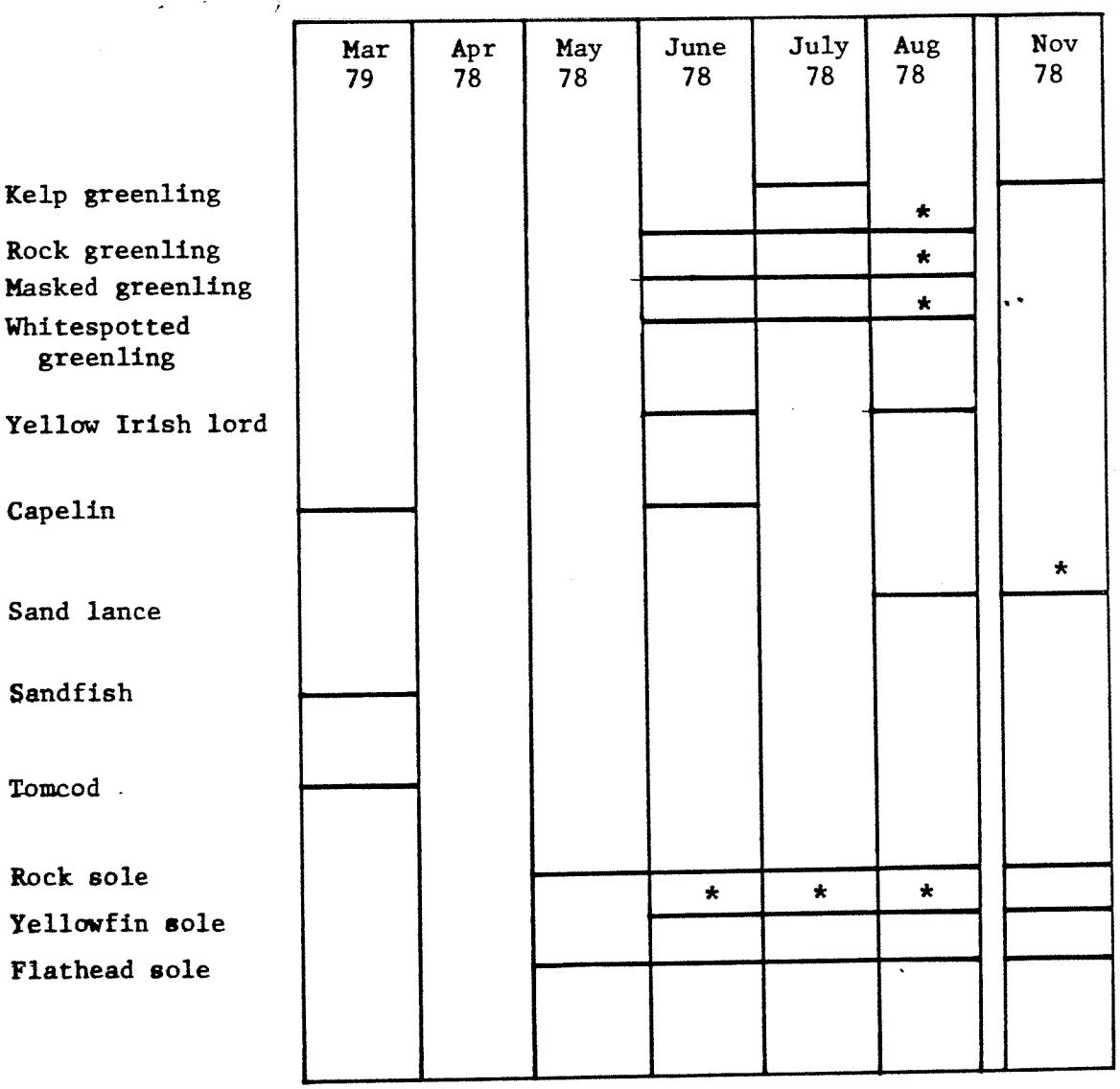

Fig. 3. Occurrence, by month, of "ripe and running" fish in the Kodiak nearshore zone, 1978-1979.

be validated statistically because of the very small numbers of ripe fish. Some yellow Irish lord and kelp greenling were in spawning condition at this time, but no conclusions relative to feeding are possible because of the small numbers of ripe and total fish, respectively.

Trumble (1973) reported that ammodytids spawned in summer, fall, or winter depending on the species and its location and that they apparently feed during all seasons. In this study, sand lance were ripe during autumn when feeding was at its lowest (Rogers et al. 1979): 89% of the stomachs from adults (nearly all ready to spawn) were empty while 70% of the stomachs from juveniles were empty.

Food Web Analysis

The data were stratified by five variables: gear (beach seine, trammel net, townet, trynet, and otter trawl); bay (Izhut, Kalsin, Kiliuda, and Kaiugnak); month (March-August and November); species, and size class ($\leq$ 150, 151-300, and >300 mm long). To reduce the number of potential food webs, levels within each variable were reduced as follows:

1) Gear. Data by gear were kept separate because each gear sampled a substantially different habitat, and also because the food habits of the fish tended to differ with habitat (Rogers et al. 1979). This was, in part, because the gears sampled varying sizes of fish (Table 5) which may be caused by differential selectivity of the nets or because the fish shift to different habitats as they grow. Those caught by beach seine (except for Dolly Varden and adult pink salmon), townet, and trynet (except for Myoxocephalus) tended to be small, while those taken by the trammel net and otter trawl were large.

2) Bay. The fish sampled by otter trawl in Izhut Bay contained more fish and less shrimp in their stomachs than did those from Kiliuda Bay. Data on the food habits of fish taken by other gears were either inconsistent or no significant differences were evident (Rogers et al. 1979).

   Often the CPUE differed noticeably between bays, especially in the otter trawl catches (Fig. 4). For example, yellow Irish lord were very abundant in Kiliuda Bay, but almost nonexistent in Izhut. The average catches in abundance and biomass are presented for all species in Appendix Tables 1-5.

   Instead of creating separate food webs for each bay, differences between bays were handled by taking weighted means of the food habits data (using both the number of stomachs sampled and the CPUE as weighting factors) over all the bays.

Table 5. The mean weight per fish for species used in the food webs.

		Mean weight per fish (g)			
		Winter	Spring	Summer	Autumn
Beach seine	Pink salmon		.5	349.5	
	Dolly Varden	10.0	258.3		404.0
	Pacific sand lance		3.7	1.9	
	Rock greenling	?	69.0		
	Masked greenling	11.2	32.6		18.9
	Myoxocephalus	9.4	47.9		52.6
	Rock sole	19.0	73.5		59.0
Trammel net	Rock greenling	249.2	512.8	354.2	455.2
	Masked greenling		117.8	135.7	255.7
	Whitespotted greenling			258.2	
	Myoxocephalus	419.3			955.3
	Rock sole	130.1	249.7		
Tow net	Pink salmon		.3	3.7	
	Chum salmon		1.2		
	Capelin	?	3.0		.4
	Pacific sand lance	4.7		1.6	
	Threespine stickleback	6.5	2.8		
Try net	*Myoxocephalus*			404.3	161.2
	Gymnocanthus	23.8	56.1		
	Rock sole	43.8	57.3	54.3	47.1
	Yellowfin sole		61.7	91.0	50.9
Otter trawl	Pacific cod		695.6		
	Pacific tomcod				54.4
	Walleye pollock			138.0	44.0
	Myoxocephalus	1162.7	1104.4	1031.6	1399.7
	Gymnocanthus		274.9	410.2	
	Yellow Irish lord		297.7	268.1	461.6
	Rock sole	140.7	258.6	253.0	268.3
	Flathead sole		103.1	170.2	49.0
	Yellowfin sole	155.4	221.4	259.0	199.1
	Arrowtooth flounder				104.2
	Halibut			3351.6	

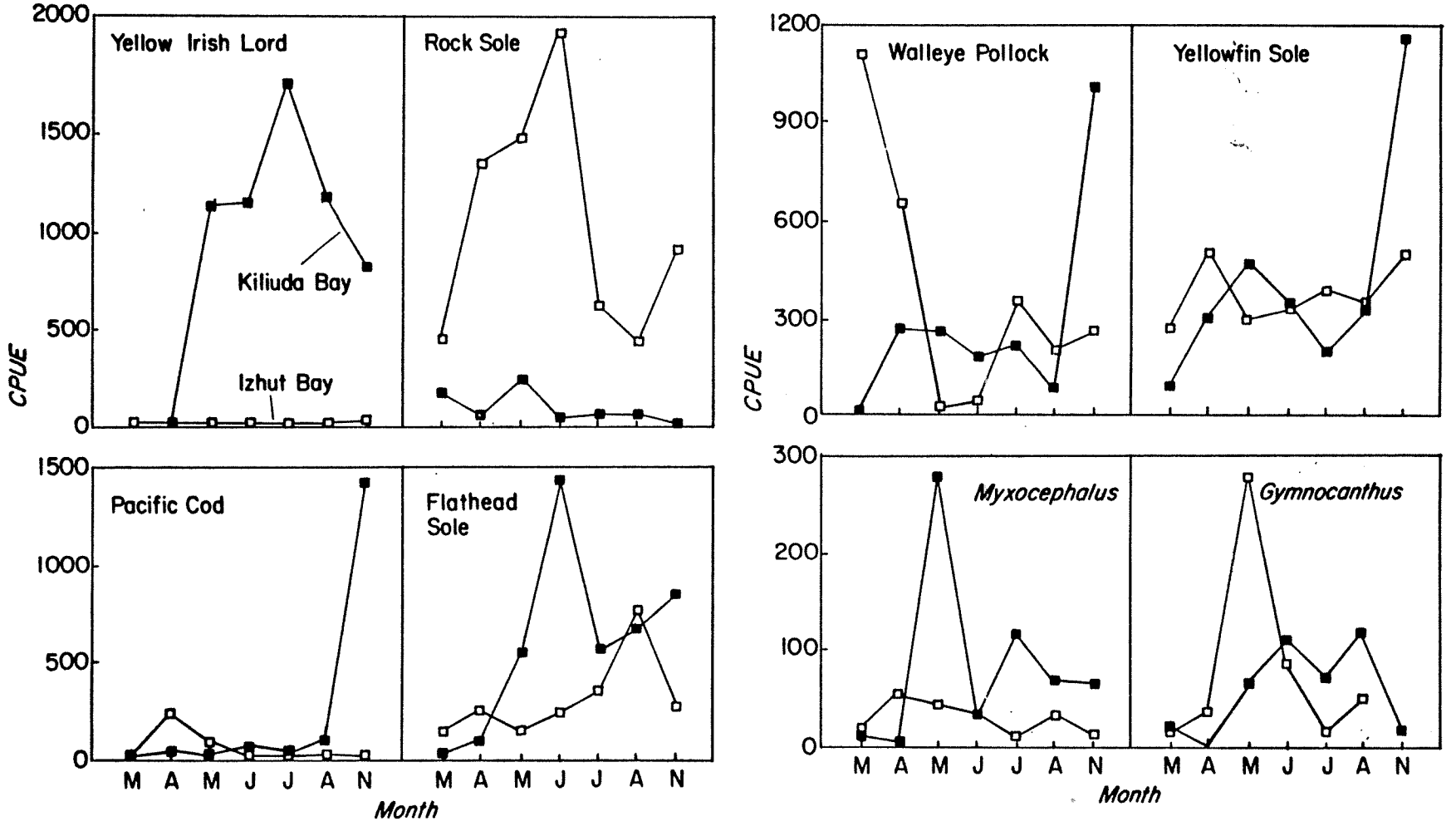

Fig. 4. The average catch of selected species by bay per 20-min otter trawl haul.

3) Month. During March and April, mean sea surface temperatures were at their yearly low (Fig. 5) and temperatures were unstratified by depth (Fig. 6). In May, surface temperatures were still low, but in May and June of 1978, surface waters began to warm. Water temperatures in July and August varied by depth and temperatures, especially at the surface, peaked in August. Sea surface temperatures during November were warmer than those in March and April, but were colder than in August and unstratified.

   Foods tended to differ most in March and November, but were similar during April through August. Also, the total weight of foods in the stomachs tended to be low in March, April, and November (Rogers et al. 1979). Since seasons are useful divisions in time, data for the food webs were stratified into seasons where March and April = winter, May and June = spring, July and August = summer, and November = autumn.

4) Species. Species were kept separate, but only those that contributed 5% or more by weight to the total mean CPUE within a season and gear were included in the food webs.

5) Size class. The food habits of the three size classes of fish were combined to describe the overall diet for each species within a season and gear. This was done by weighting the food habits of each size class with its average CPUE and taking the weighted mean.

The food habits data are presented in the food webs by major food categories (e.g., clams and shrimp). A complete list of foods that were identified during this study is presented in Appendix Table 6, and for predators that were detailed in the food webs, in Appendix Tables 7-22.

Figures 7, 9, 11, 13, and 15 are the quantitative food diagrams where the size of each dot indicates the average number of each species of fish per haul times the average weight per fish of each food category and the size of each square indicates the average biomass of each species per haul. Open circles denote foods of a species whenever sample sizes were too small for quantitative estimates. Abbreviations used to designate species in these diagrams are identified in Table 6. In the food webs (Figs. 8, 10, 12, 14, and 16), the width of each arrow signifies the importance (in percent by weight) of each type of food to each species of fish. Finally, diets by season are presented in Figs. 17, 18, 19, and 20.

Intertidal/Shallow Subtidal (Beach Seine)

Catches of fish by beach seine were lowest during the winter months, increased in the spring, and partly because of an influx of immigrating adult pink salmon, were highest during the summer. The portions of food consumed were correspondingly low during the winter and autumn and high during the spring and summer (Fig. 7).

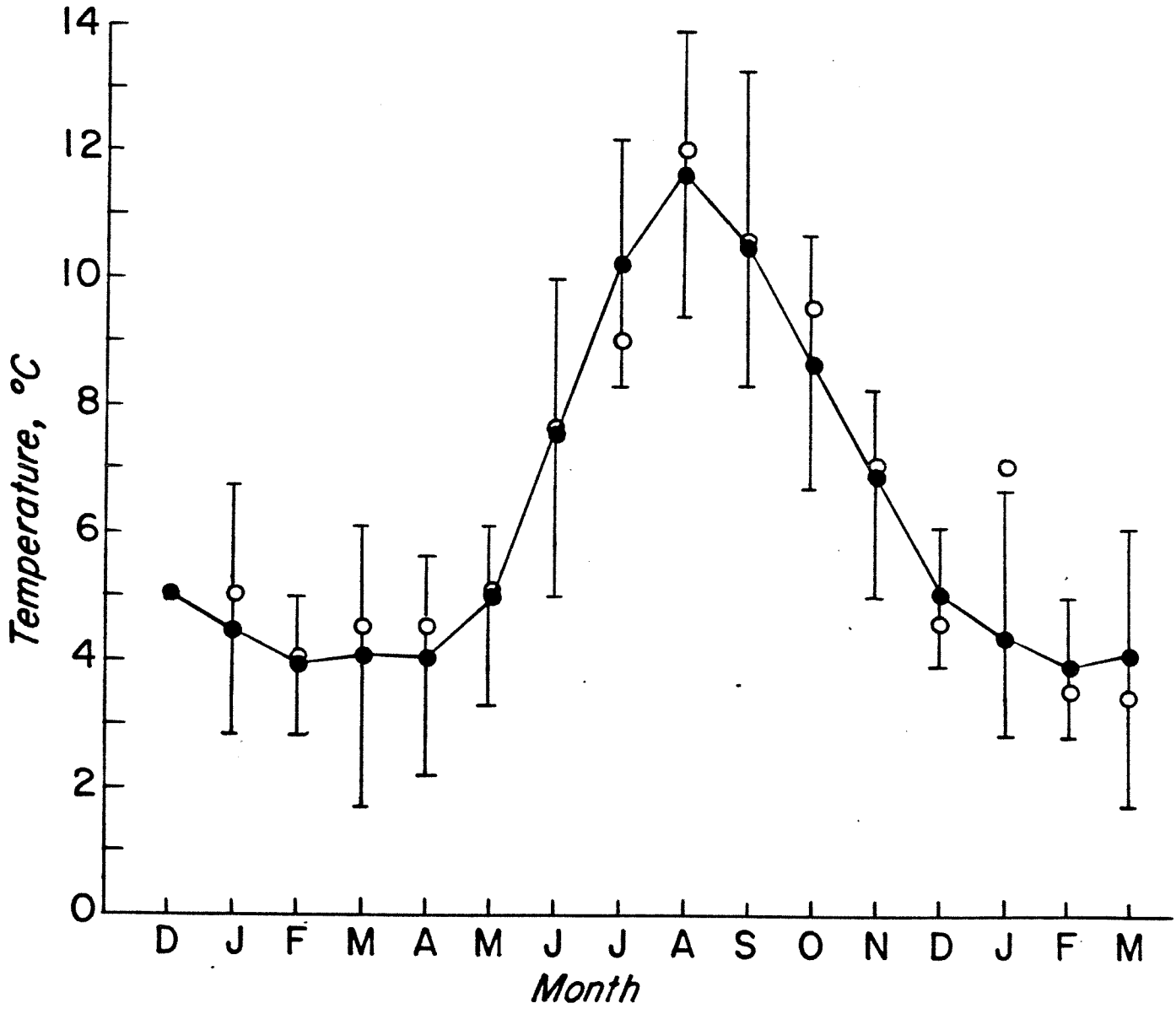

Fig. 5. Means and ranges in means for sea surface temperatures in oceanic waters off the Kodiak Archipelago, 1962-1978. Open circles are for temperatures in 1978 and 1979.

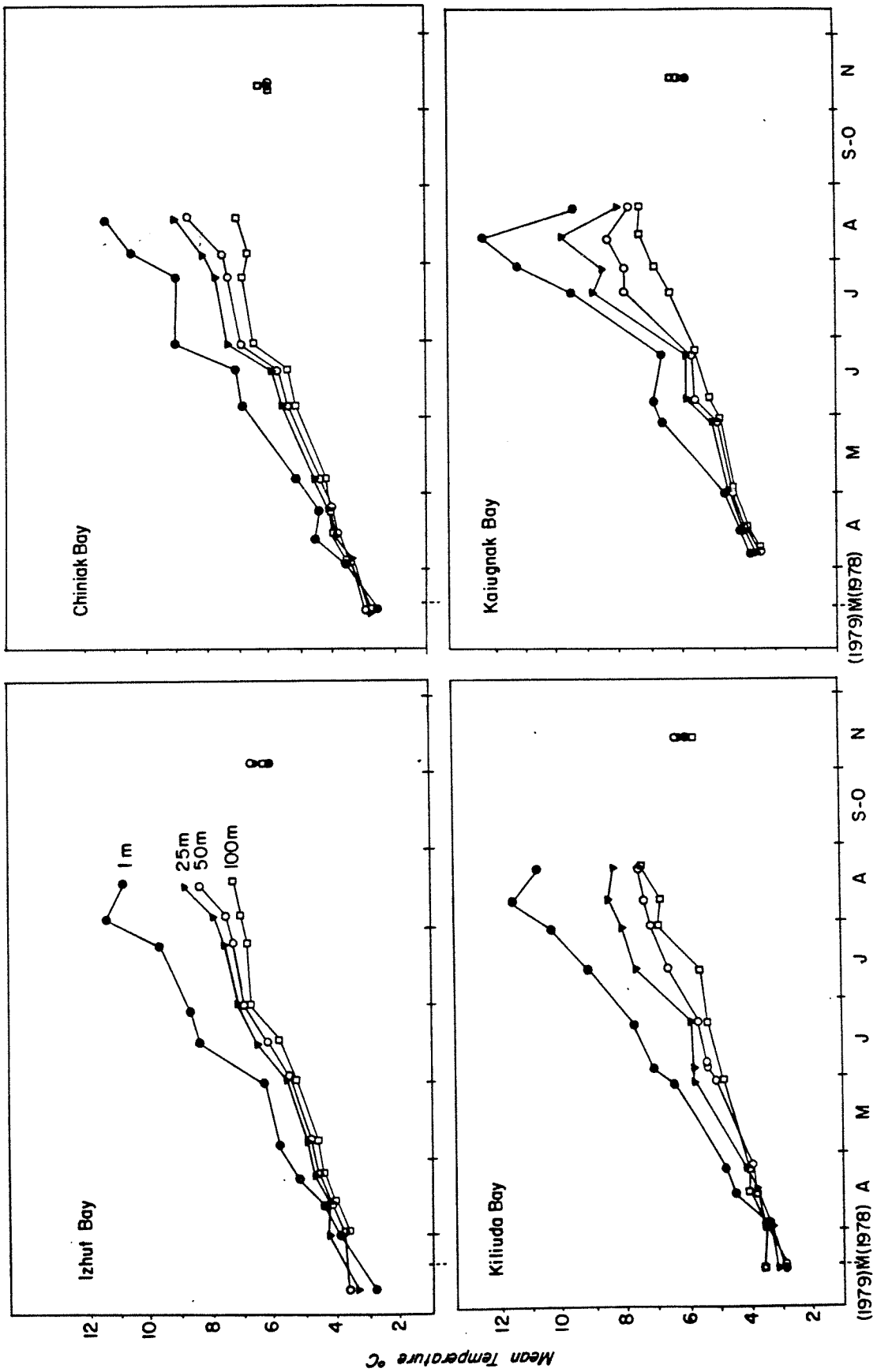

Fig. 6. Water temperatures by depth, date, and bay.

Table 6. Abbreviations used to define species of fish in the food diagrams.

AF	Arrowtooth flounder
CA	Capelin
CS	Chum salmon
DV	Dolly Varden
FH	Flathead sole
GM	*Gymnocanthus* spp.
HA	Halibut
MG	Masked greenling
MX	*Myoxocephalus* spp.
PC	Pacific cod
PS	Pink salmon
RG	Rock greenling
RS	Rock sole
SL	Pacific sand lance
ST	Threespine stickleback
TC	Pacific tomcod
WG	Whitespotted greenling
WP	Walleye pollock
YF	Yellowfin sole
YL	Yellow Irish lord

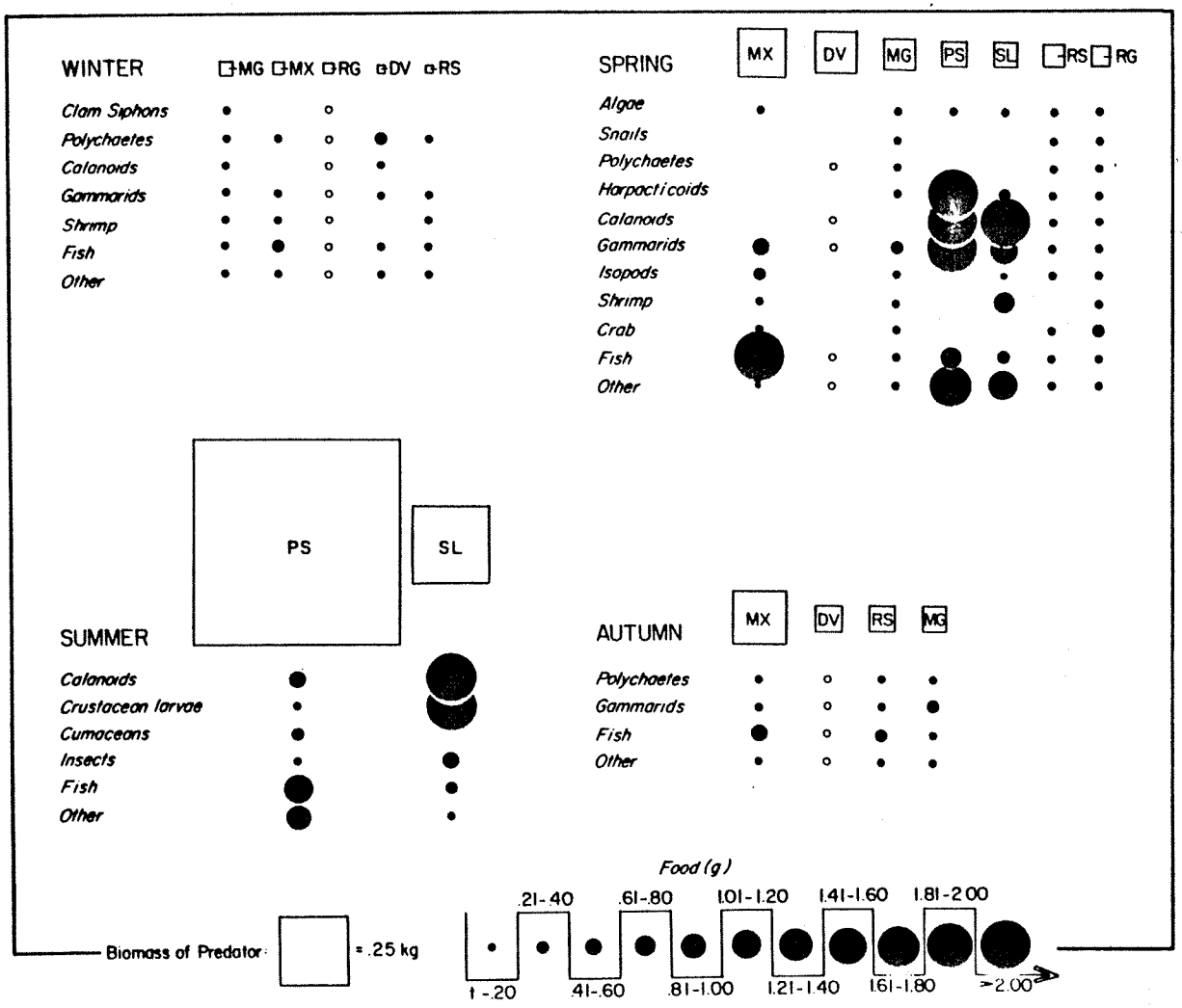

Fig. 7. Quantitative food diagrams, by season, for fish caught by beach seine.

Diets were fairly diverse, although in the winter Myoxocephalus depended mostly on fish while Dolly Varden and rock sole ate mostly polychaetes (Fig. 8). During the autumn, Myoxocephalus and rock sole ate a high proportion of fish while masked greenling concentrated on gammarid amphipods.

Pacific sand lance and juvenile pink salmon consumed large quantities of calanoid copepods and gammarid amphipods in the spring. The pink salmon also devoured large quantities of epibenthic harpacticoids. Only Myoxocephalus ate sizable amounts of fish (mostly Pacific sand lance). In terms of percent composition of the diet, calanoid copepods were important to Pacific sand lance; calanoids and harpacticoids to pink salmon; gammarids to rock sole and masked greenling; crab to rock greenling; and, once again, fish to Myoxocephalus.

During the summer, adult pink salmon fed mostly upon fish (all unidentified), while the few remaining juvenile pink salmon depended upon calanoid copepods. Pacific sand lance ate large amounts of both calanoids and crustacean larvae, although barnacle (crustacean) larvae were proportionately the most significant food in their diet.

Rocky/Kelp Beds (Trammel Net)

Only three species contributed 5% or more by weight to the trammel net catches each season, and throughout the year, rock greenling predominated. As in the intertidal/shallow subtidal areas, catches were smallest in the winter and autumn and correspondingly small amounts of food were consumed then (Fig. 9). Rock greenling, masked greenling, and rock sole had mixed diets during the winter and autumn, but Myoxocephalus focused mostly on fish during both seasons and also on crab during the autumn (Fig. 10).

Rock greenling had quite a varied diet in the spring, which is suggested by a large category of "other" foods. Even so, they also managed to consume sizable amounts of crab. Many species of crab were consumed (see Appendix Table 11); however, 23% by weight of the identifiable crab were Pugettia gracilis, 38% were Telmessus cheiragonus (horse crab), and another 10% were Cancer oregonensis. Masked greenling relied mostly on gammarid amphipods while rock sole ate mostly polychaetes.

Masked and rock greenling both consumed large quantities of crab and miscellaneous foods during the summer. T. cheiragonus was the species of crab most heavily consumed by all three species of greenling. Masked greenling ate large amounts of gammarid amphipods and rock greenling ate large amounts of fish (mostly Pacific sand lance, unidentified greenlings, and crescent gunnel).

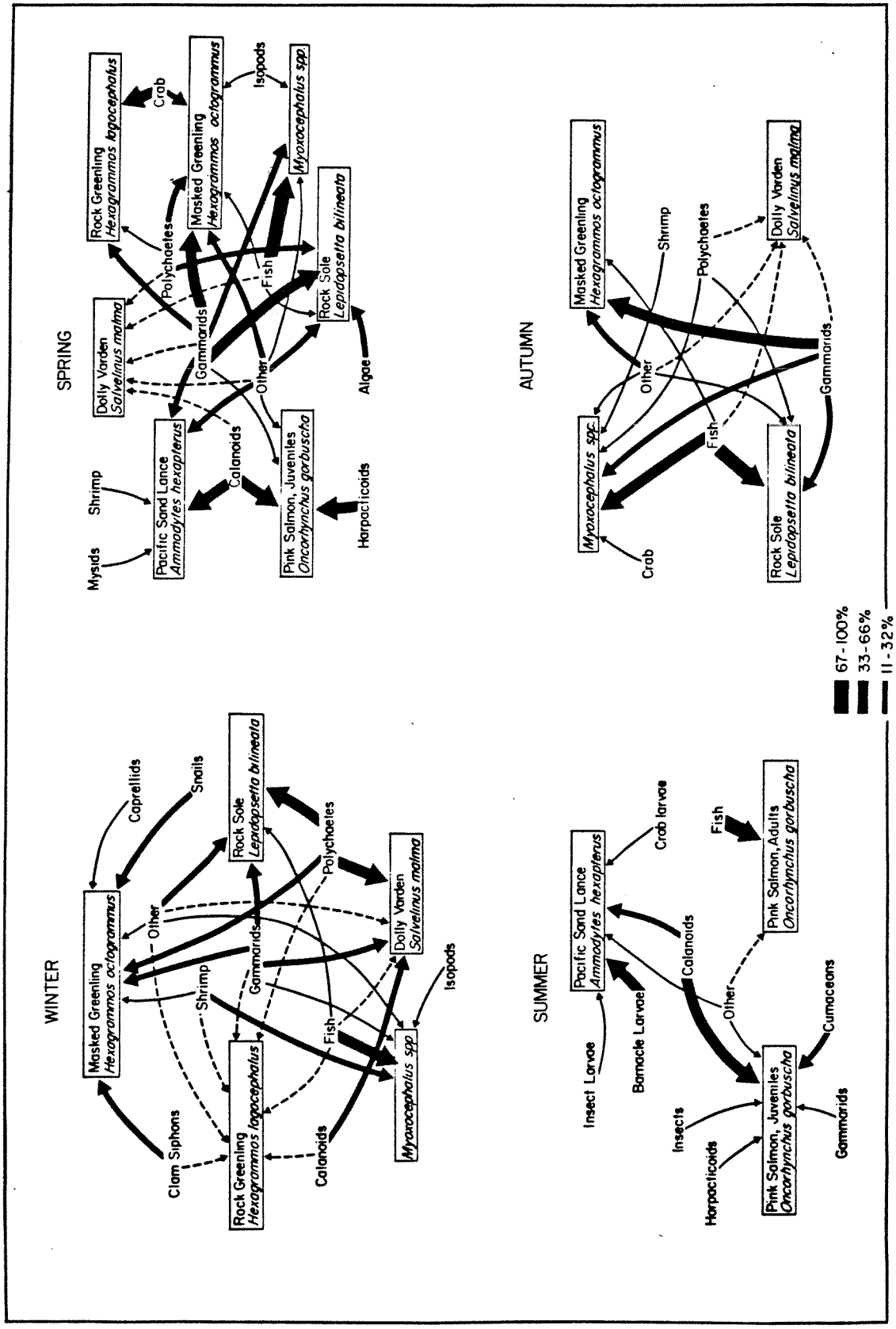

Fig. 8. Food webs, by season, for fish caught by beach seine.

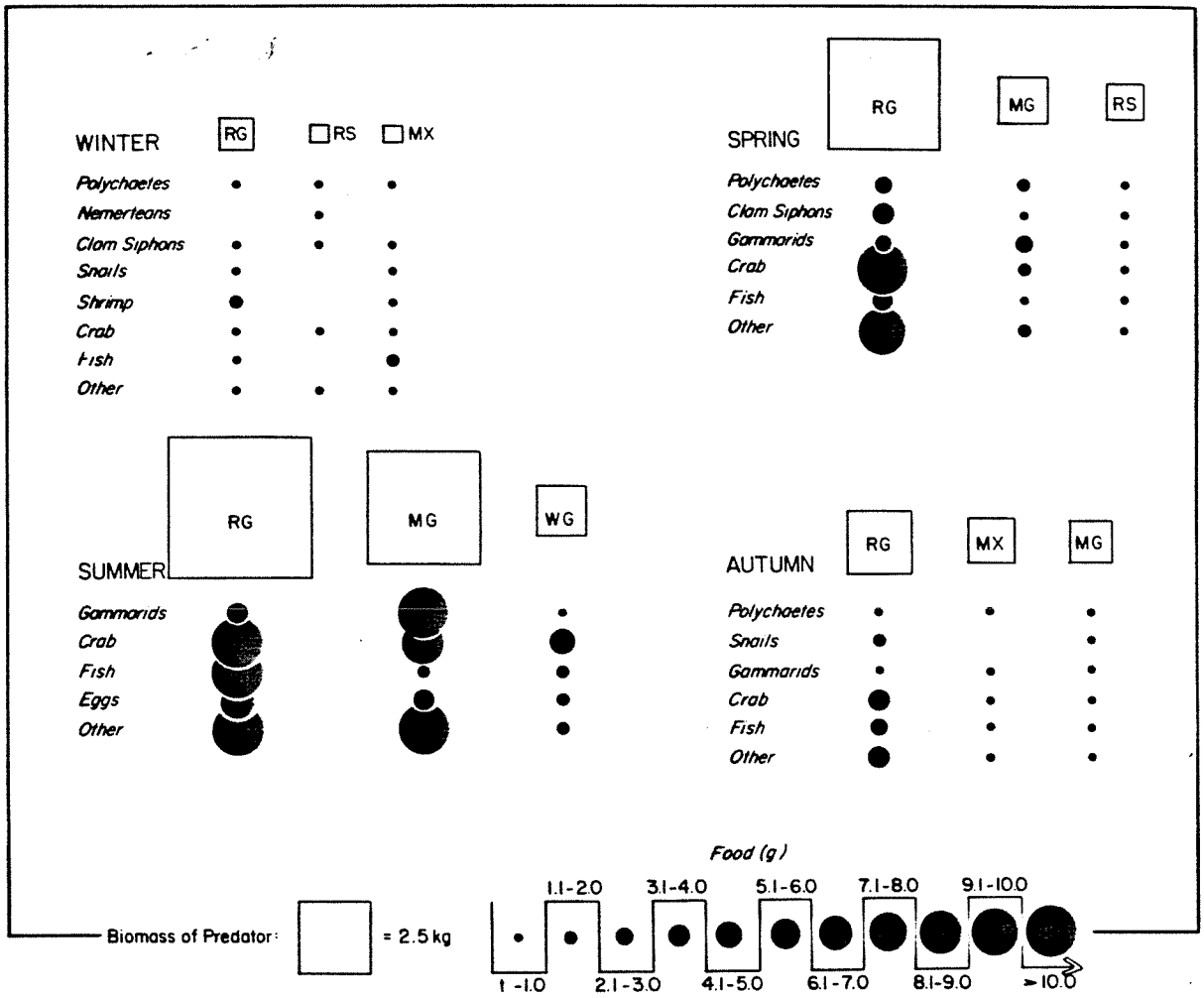

Fig. 9. Quantitative food diagrams, by season, for fish caught by trammel net.

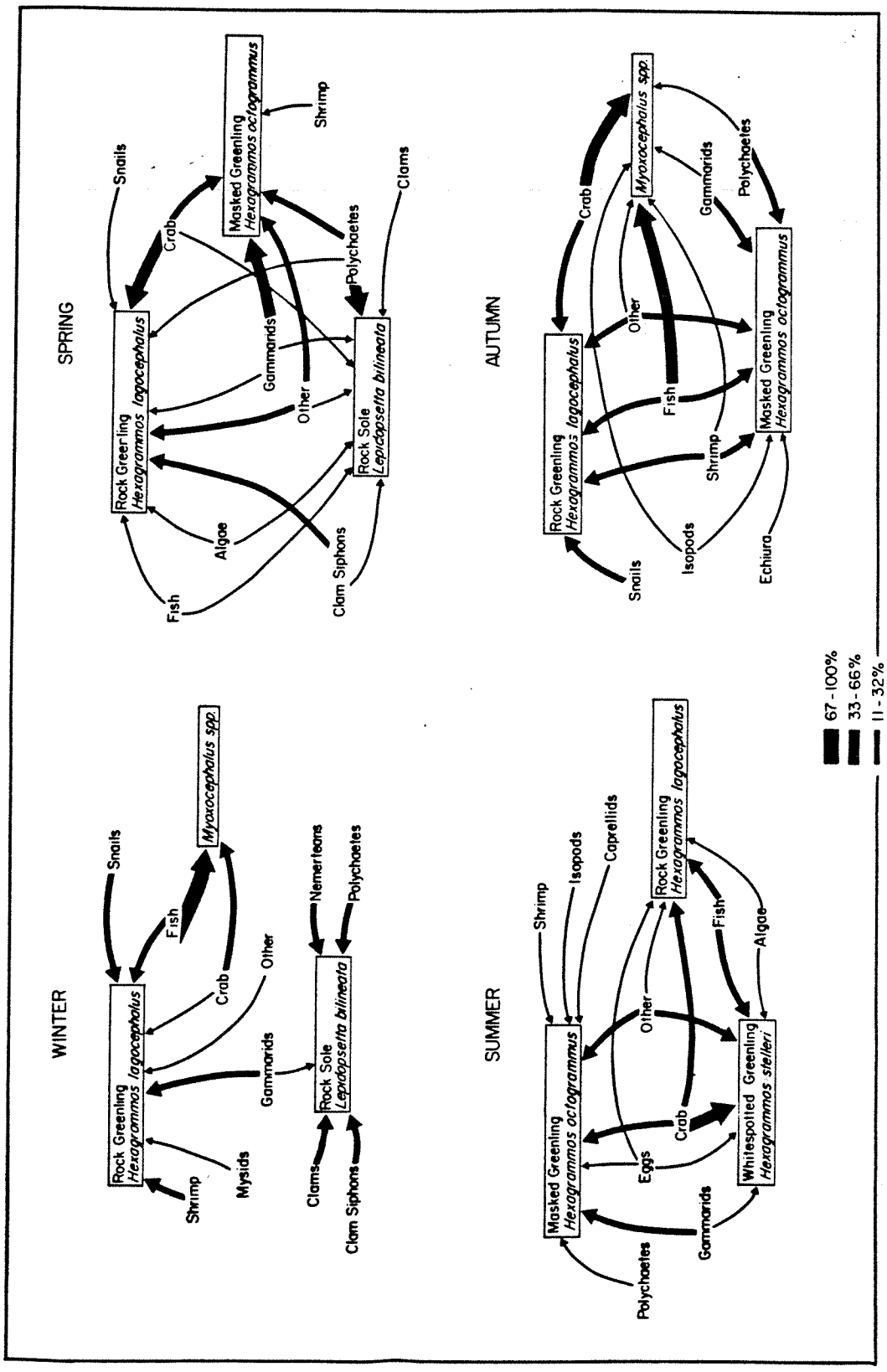

Fig. 10. Food webs, by season, for fish caught in the trammel net.

Pelagic (Townet)

Because of small catches, the surface-dwelling, pelagic "forage" fishes were the most incompletely surveyed group in this study. Townet catches were largest in the summer due to an abundance of Pacific sand lance (Fig. 11). The small fish caught by townet fed on small pelagic and epibenthic prey. For example, calanoid copepods formed the bulk of the sand lance diet during the winter and were also very important to capelin and chum salmon in the spring (Fig. 12). During the summer, sand lance ate large quantities of harpacticoids, calanoids, and crustacean (especially barnacle) larvae, while insects were most important to pink salmon.

Subtidal Banks and Shelves (Trynet)

A maximum of three species contributed 5% or more to the average weight of trynet catches each season, and again, catches were largest in the summer (Fig. 13). One of these species, the sculpin Gymnocanthus, was not sampled enough to generalize about its feeding habits.

A large percentage of the rock sole diet was, in all four seasons, polychaetes plus fish in the winter (Fig. 14). Yellowfin sole, by contrast, did not concentrate on any one food item and a great deal of its diet was comprised of "other" foods. Yellowfin and rock sole together ate most of the polychaetes consumed by fish inhabiting the subtidal banks and shelves. Rock sole also ate sizable amounts of clam siphons during the summer. Myoxocephalus consumed a large quantity of fish as did rock sole during the summer, whereas in the autumn there were large proportions of both fish and crab in the Myoxocephalus stomachs.

Yellowfin and rock sole ate large quantities of fish and polychaetes in the spring and summer and a breakdown of the types eaten in percent by weight is presented in Table 7. Myoxocephalus consumed large amounts of fish in the summer, but was excluded from the table because those fish were largely unidentifiable.

During the spring and summer, yellowfin sole primarily consumed sedentariate (non-motile) polychaetes while the rock sole diet was more evenly distributed between errantiates (motile) and sedentariates. Both species relied mostly on osmerids (smelt) in the spring, whereas Pacific sand lance (Ammodytes hexapterus) and cod (Gadus macrocephalus) were of secondary importance to the rock and yellowfin sole, respectively. Osmerids were again the primary food of rock sole in the summer, but sand lance ranked first with the yellowfin sole. Herring (Clupea harengus pallasi) and walleye pollock (Theragra chalcogramma) ranked second with rock and yellowfin sole, respectively.

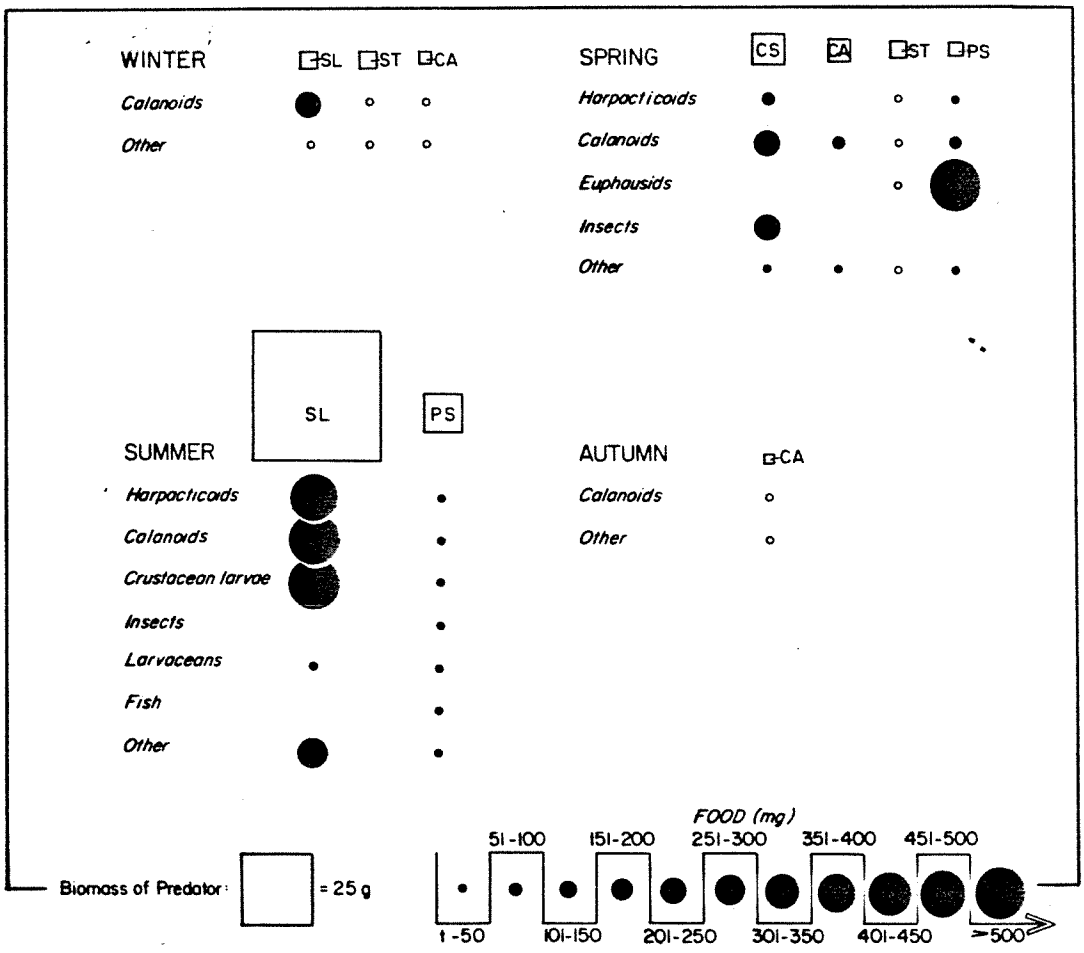

Fig. 11. Quantitative food diagrams by season, for fish caught by townet.

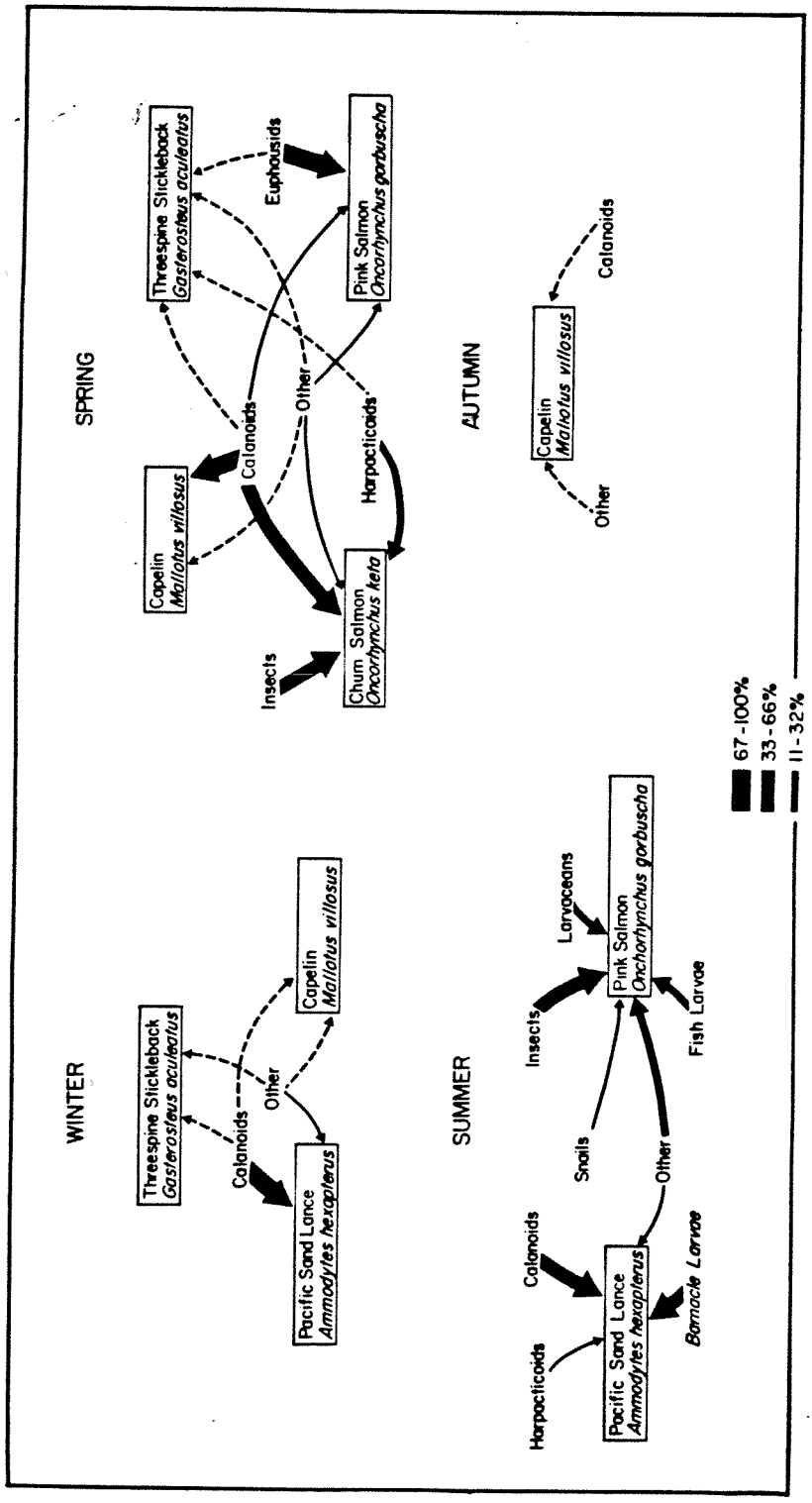

Fig. 12. Food webs, by season, for fish caught in the townet.

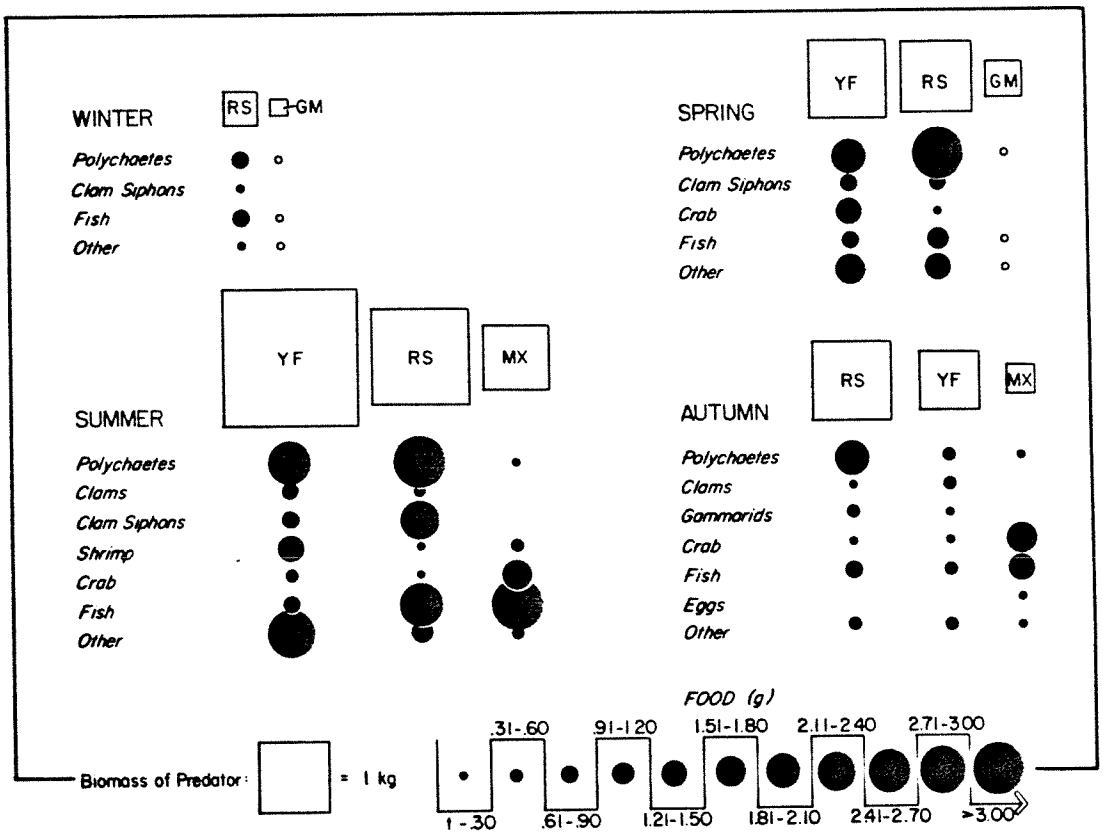

Fig. 13. Quantitative food diagrams, by season, for fish caught by trynet.

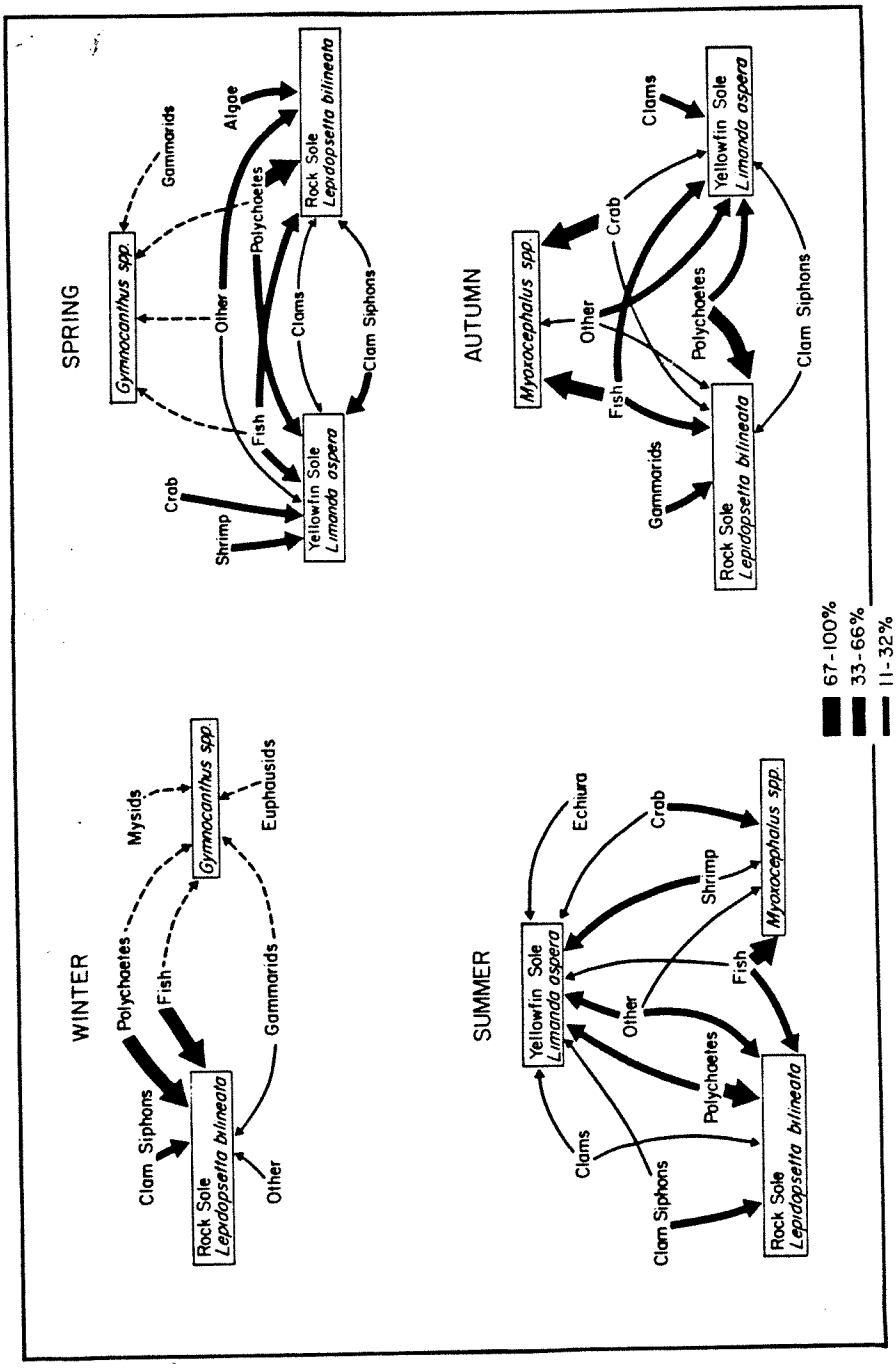

Fig. 14. Food webs, by season, for fish caught in the trynet.

Table 7. The importance (average percent by weight) of categories of shrimp and fish in the diets of fish sampled by the otter trawl during the spring and summer.

	Yellowfin sole	Rock sole
Spring		
Polychaetes		
Glyceridae	0.8	22.0
Lumbrineridae	2.2	11.0
Nephtyidae	11.8	0
Other errantiates	11.8	9.6
Total errantiates	26.6	42.6
Opheliidae	39.8	16.6
Oweniidae	14.8	9.6
Spionidae	7.4	15.3
Other sedentariates	11.4	15.9
Total sedentariates	73.4	57.4
Fish		
Osmeridae	44.9	9.3
Mallotus villosus	16.3	43.0
Total osmerids	61.2	52.3
Ammodytes hexapterus	0	22.4
Clupea harengus pallasi	0	6.0
Gadus macrocephalus	38.8	0
Lumpenus maculatus	0	10.2
Other fish	0	9.1
Summer		
Polychaetes		
Glyceridae	13.0	4.7
Lumprineridae	1.5	10.4
Nephtyidae	1.9	13.6
Nereidae	T	14.6
Other errantiates	8.2	17.4
Total errantiates	24.6	60.7
Flabelligeridae	12.2	0.2
Opheliidae	24.5	4.9
Oweniidae	5.0	13.4
Maldanidae	11.4	5.9
Other sedentariates	22.3	14.9
Total sedentariates	75.4	39.3
Fish		
Osmeridae	0	7.7
Mallotus villosus	0	66.6
Total osmerids	0	74.3
Clupea harengus pallasi	0	13.6
Ammodytes hexapterus	56.0	5.6
Theragra chalcogramma	26.6	0
Perciformes	12.8	0
Other fish	4.6	6.5

Deep Troughs (Otter Trawl)

Catches were lowest in the winter when only three species of fish comprised 5% or more of the average CPUE. The number of species jumped to seven in the spring and eight in the summer and autumn (Fig. 15). In nearly every instance, crab, fish, and/or shrimp were the predominant foods (Fig. 16). These preferences are probably due at least in part to the comparatively large sizes of fish in the otter trawl catches relative to those taken by other gears. Rock sole, the exception, ate large portions of polychaetes in the spring and autumn.

Pacific sand lance was the primary fish eaten by rock sole in the winter. Types of shrimps and fish consumed by the predators during the spring, summer, and autumn are compared in Table 8. Pandalid shrimp, especially Pandalus borealis were in all cases but one (tomcod in the autumn) the primary shrimp eaten. Predation on this single food source appears to be high; however, without comparable data on the abundance of shrimp in the environment, any discussion on dietary overlap or competition among the species of predators would be relatively meaningless (Petraitis 1979).

In the spring, the emphasis on fish varied among the predator species, with Pacific cod eating mostly herring and gadids (codfish). Myoxocephalus concentrated on pleuronectids (flatfish) and a large category of "other" fish which included 19% Hemilepidotus spp. (Irish lords). Yellow Irish lord ate mostly sablefish (Anoplopoma fimbria) and cottids while flathead and yellowfin sole ate mostly cottids and stichaeids (pricklebacks). Myoxocephalus, the primary crab predator during the spring, consumed mostly Chionocetes spp. (tanner crab).

In the summer, the capelin (Mallotus villosus) became the primary fish consumed, although Myoxocephalus ate mostly cottids (sculpins) and flatfish, and rock sole ate a sizable proportion of clupeids (herring).

Gadids (codfish) predominated in the autumn but Pacific sand lance were also important to the walleye pollock and yellowfin sole, pholids (snailfish) to flathead sole, and scorpaenids (rockfish) to Myoxocephalus. The main predators on crab, yellowfin sole, and yellow Irish lord, ate mostly Chionocetes (47 and 38%, respectively). Oregonia gracilis (15 and 17%) and pagurid crabs (13 and 19%) were also important. In addition, 23% of the crabs eaten by yellowfin sole were the horse crab, T. cheiragonus.

Winter

Important foods during the winter (Fig. 17) can be summarized as follows:

1) Zooplankton--calanoid copepods

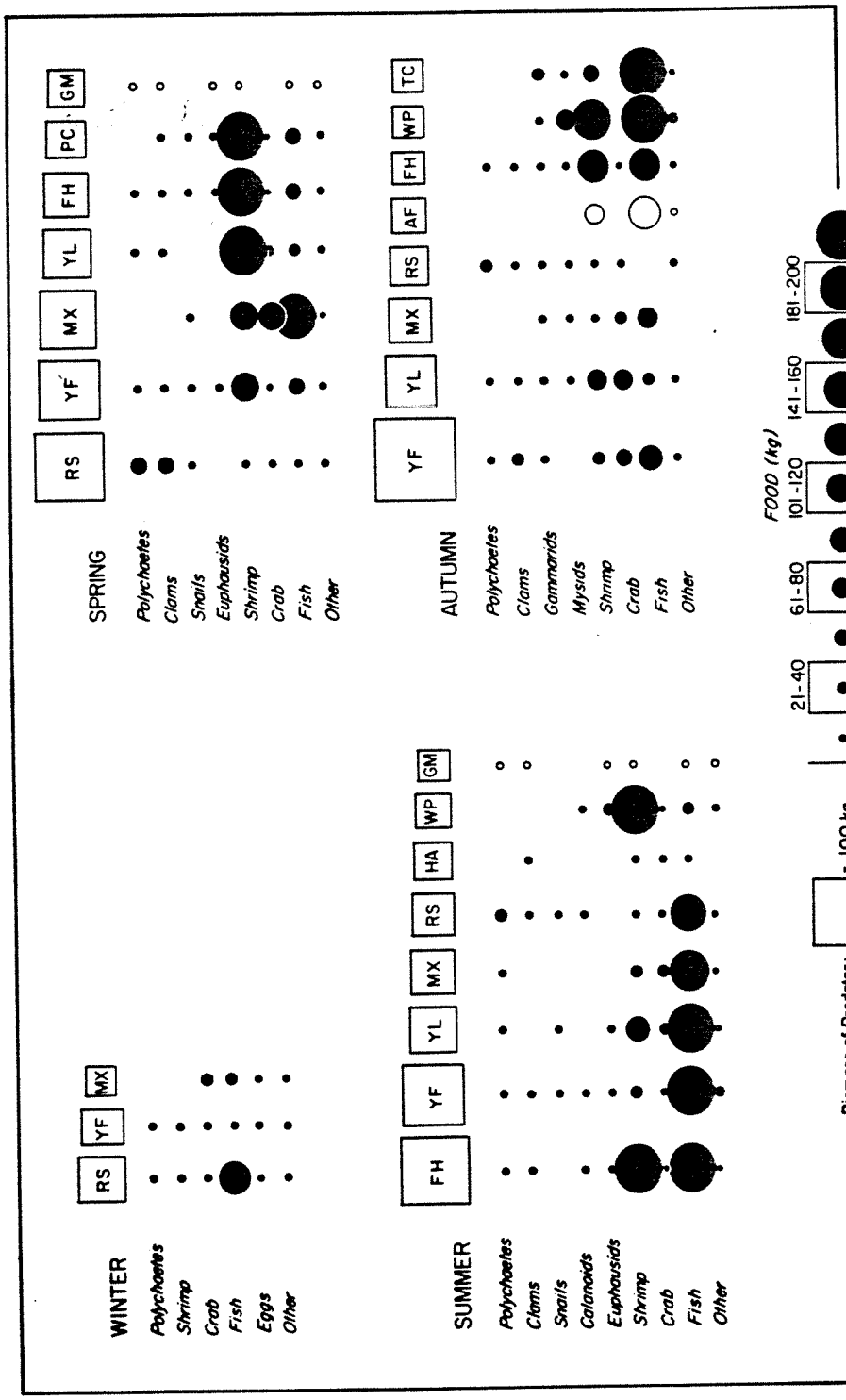

Fig. 15. Quantitative food diagrams, by season, for fish caught by otter trawl.

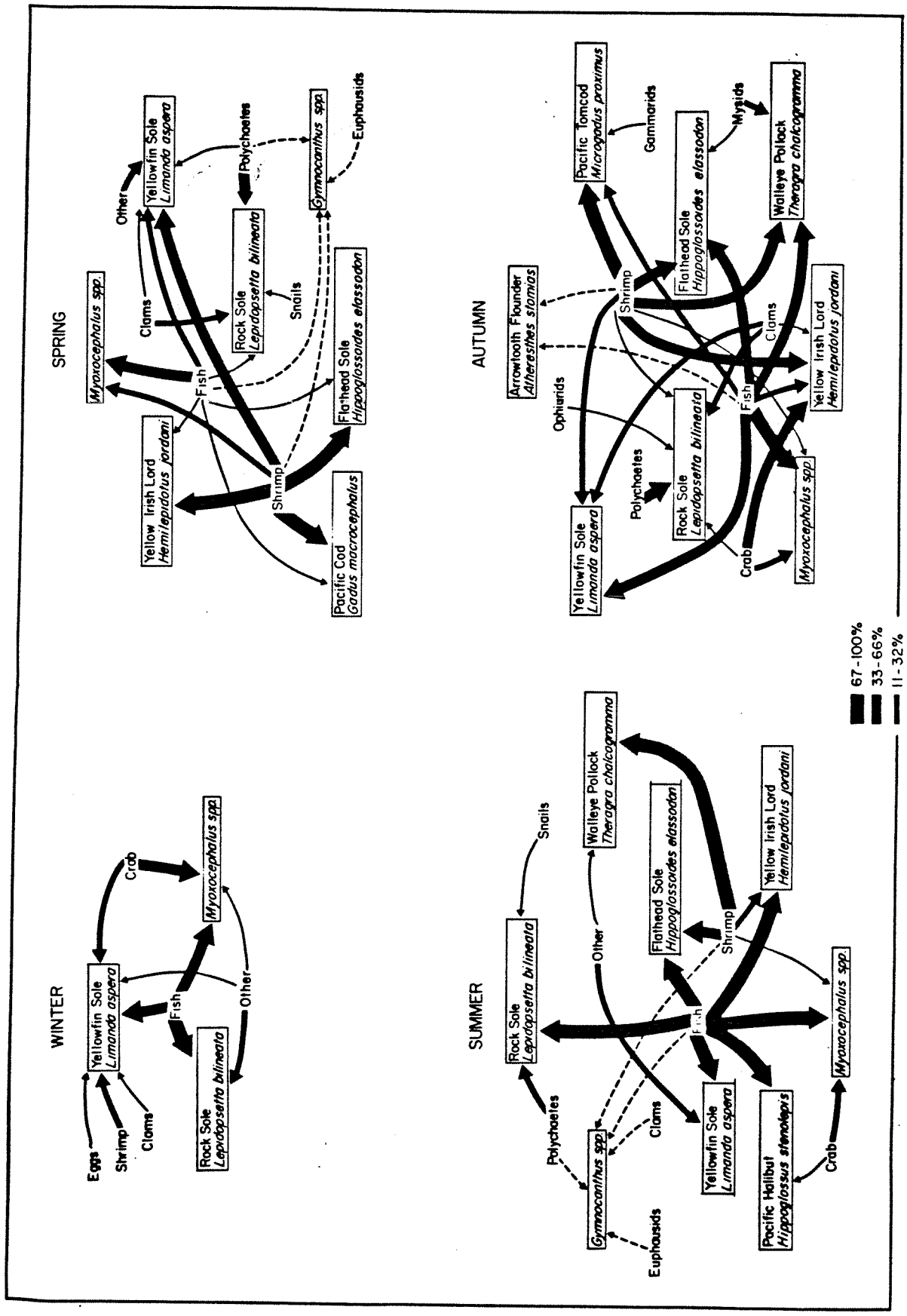

Fig. 16. Food webs, by season, for fish caught in the otter trawl.

Table 8. The importance (average percent by weight) of categories of polychaetes and fish in the diets of fish sampled by otter trawl during the spring, summer, and autumn.

	Pacific cod	Walleye pollock	Pacific tomcod	*Myoxocephalus* spp.	Yellow Irish lord	Flathead sole	Yellowfin sole	Rock sole
Spring								
Shrimp								
Pandalidae	0			8.2	17.9	20.9	29.5	
Pandalus sp.	1.1			11.8	0	2.1	0	
P. borealis	94.9			67.9	75.8	74.7	70.5	
Total panadalids	96.0			87.9	93.7	97.7	100.0	
Other shrimp	4.0			12.1	6.3	2.3	0	
Fish								
Clupea harengus pallasi	42.2					16.6	0	
Gadidae	10.1			19.3	0	0	0	
Theragra chalcogramma	22.2			0	0	0	0	
Total gadids	32.3			19.3	0	0	0	
Cottidae	5.3			10.4	28.1	44.0	58.2	
Anoplopoma fimbria	0			0	71.9	0	0	
Stichaeidae	0			0	0	8.4	41.8	
Lumpenus sagitta	0			0	0	21.1	0	
Total stichaeids	0			0	0	29.5	41.8	
Pleuronectidae	0			26.8	0	0.6	0	
Other fish	20.2			43.5	0	9.3	0	
Summer								
Shrimp								
Pandalidae		30.1			39.1	2.8		
Pandalus sp.		0			0	19.0		
P. borealis		68.9			43.2	71.7		
P. hypsinotus		0			16.5	0		
Total Pandalidae		99.0			98.8	93.5		
Other shrimp		1.0			1.2	6.5		
Fish								
Hallotus villosus				0	85.5	90.2	83.9	64.8
Clupeidae				0	3.9	0	0	30.8
Ammodytes hexapterus				0	2.8	4.6	11.2	0
Cottidae				37.0	5.2	0.3	0	0
Gymnocanthus spp.				38.5	0	0	0	0
Total cottids				75.5	5.2	0.3	0	0
Pleuronectidae				24.5	0	0	0	4.4
Other fish				0	2.6	4.9	4.9	0
Autumn								
Shrimp								
Crangonidae		4.2	0		8.8	10.0	0	
Crangon sp.		0	100.0		0	0	0	
Total crangonids		4.2	100.0		8.8	10.0	0	
Pandalidae		17.3	0		19.9	63.2	100.0	
Pandalus borealis		78.5	0		71.3	26.5	0	
Total pandalids		95.8	0		91.2	89.7	100.0	
Other shrimp		0	0		0	0.3	0	
Fish								
Ammodytes hexapterus		18.0	0	0	0	0	25.7	
Gadidae		13.8	0	0	0	75.6	0	
Theragra chalcogramma		68.2	100.0	0	100.0	0	74.3	
Total gadids		82.0	100.0	0	100.0	75.6	74.3	
Pholidae		0	0	0	0	24.4	0	
Scorpaenidae		0	0	100.0	0	0	0	

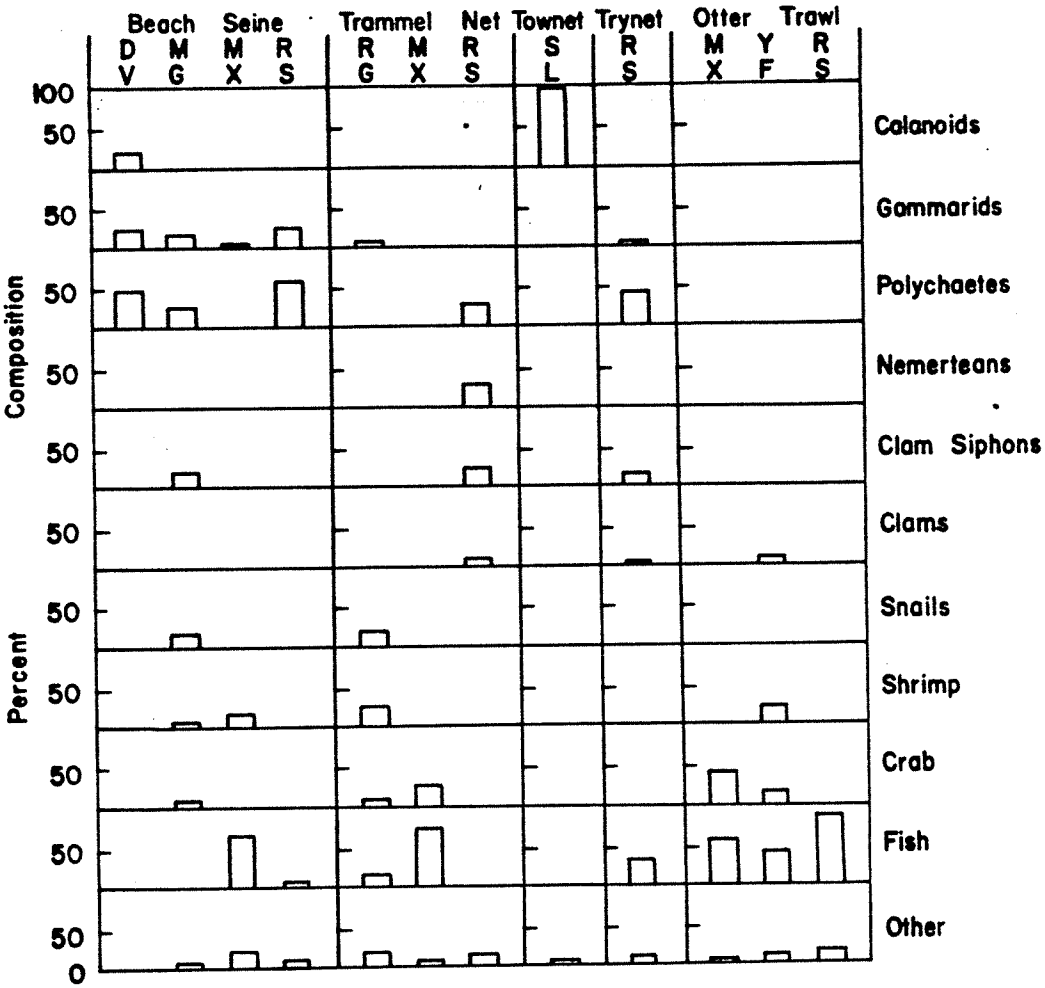

Fig. 17. Summary of important foods, by gear, to fish during the winter.

2) Small epibenthic crustacea--gammarid amphipods

3) Noncrustacean benthos/epibenthos--polychaete and nemertean worms, clam siphons, clams, and snails.

4) Shrimp

5) Crab

6) Fish

Only small Dolly Varden and Pacific sand lance (average weights of 10 and 5 gm, respectively--see Table 5, page 23) ate significant quantities of zooplankton, while gammarid amphipods were primarily consumed by the small fish captured in the beach seine. Polychaete worms were the most important prey in the benthos, forming approximately one-half of the diets of Dolly Varden and rock sole caught by beach seine, and of rock sole in the trynet samples. Nemertean and polychaete worms plus clam siphons fed the larger (average weight-13 gm) rock sole taken by the trammel net. Predation on shrimp was relatively insignificant. Fish comprised over one-half of the Myoxocephalus diet, even though their average sizes ranged from 9 gm in the beach seine to 1163 gm in the otter trawl. Crab was of secondary importance to the large Myoxocephalus in the otter trawl catches. Fish was also important to the yellowfin and rock sole taken by the otter trawl.

Spring

Major foods in the spring (Fig. 18) were:

1) Algae

2) Zooplankton--calanoids and euphausiids

3) Small epibenthic crustacea--harpacticoid copepods and gammarid amphipods

4) Insects
5) Noncrustacean benthos/epibenthos--polychaetes, clam siphons, and clams

6) Shrimp

7) Crab

8) Fish

Algae contributed about 30% of the total diet of rock sole captured by beach seine. Zooplankton was especially important to small (<5 gm average weight--see Table 5, page 23) fish captured, including pink

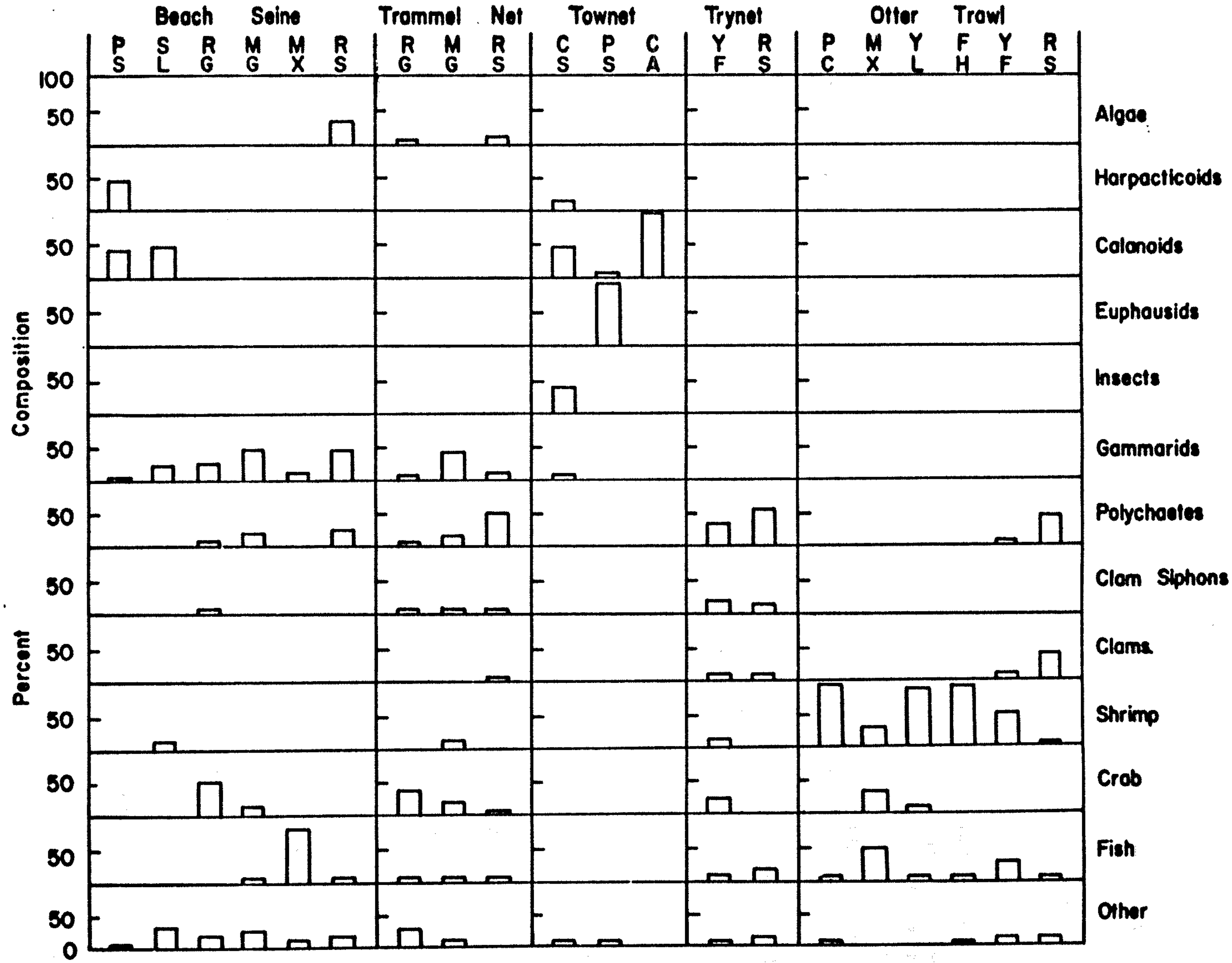

Fig. 18. Summary of important foods, by gear, to fish during the spring.

salmon and Pacific sand lance from the beach seine and chum salmon, pink salmon, and capelin from the townet. All the major species caught by beach seine, with the exception of Myoxocephalus, ate substantial amounts of gammarids and/or harpacticoids. Insects, however, were consumed to any significant degree by only chum salmon. Rock sole consistently relied upon benthic organisms, especially polychaetes. Shrimp were eaten by all species of fish over 100 gm in weight that were captured by otter trawl. These included Pacific cod, yellow Irish lord, flathead, and yellowfin soles. The largest precentages of crab were consumed by rock greenling sampled by the beach seine and trammel net, yellowfin sole from the try net, and Myoxocephalus from the otter trawl. Fish was most important to Myoxocephalus.

Summer

During the summer, the primary foods (Fig. 19) were:

1) Zooplankton--barnacle larvae, calanoid copepods, and larvaceans

2) Insects

3) Small epibenthic crustacea--cumaceans and gammarid amphipods

4) Noncrustacean benthos/epibenthos--polychaetes and clam siphons

5) Shrimp

6) Crab

7) Fish

Zooplankton were mostly consumed by the small (<5 gm average weight--see Table 5, page 23) pink salmon and Pacific sand lance captured by the beach seine and townet. Insects formed nearly 50% of the diet of the small, pelagic, pink salmon. Small epibenthic crustaceans were relatively unimportant during the summer and only juvenile pink salmon from the beach seine and masked greenling from the trammel net consumed any significant amounts of cumaceans or gammarid amphipods. The small rock and yellowfin soles (average weights of 54 and 91 gm, respectively) captured by trynet relied mostly on benthos--both polychaetes and clam siphons. Shrimp were most important to walleye pollock and flathead sole (138 and 170 gm, respectively) taken by otter trawl, while crabs were important to all the greenling species. All major predator species taken by otter trawl, with the exception of walleye pollock, relied upon fish. These predators were large, averaging between 170 to 3352 gm in weight. Other major fish predators were adult pink salmon and the large Myoxocephalus (averaging 404 gm) captured by

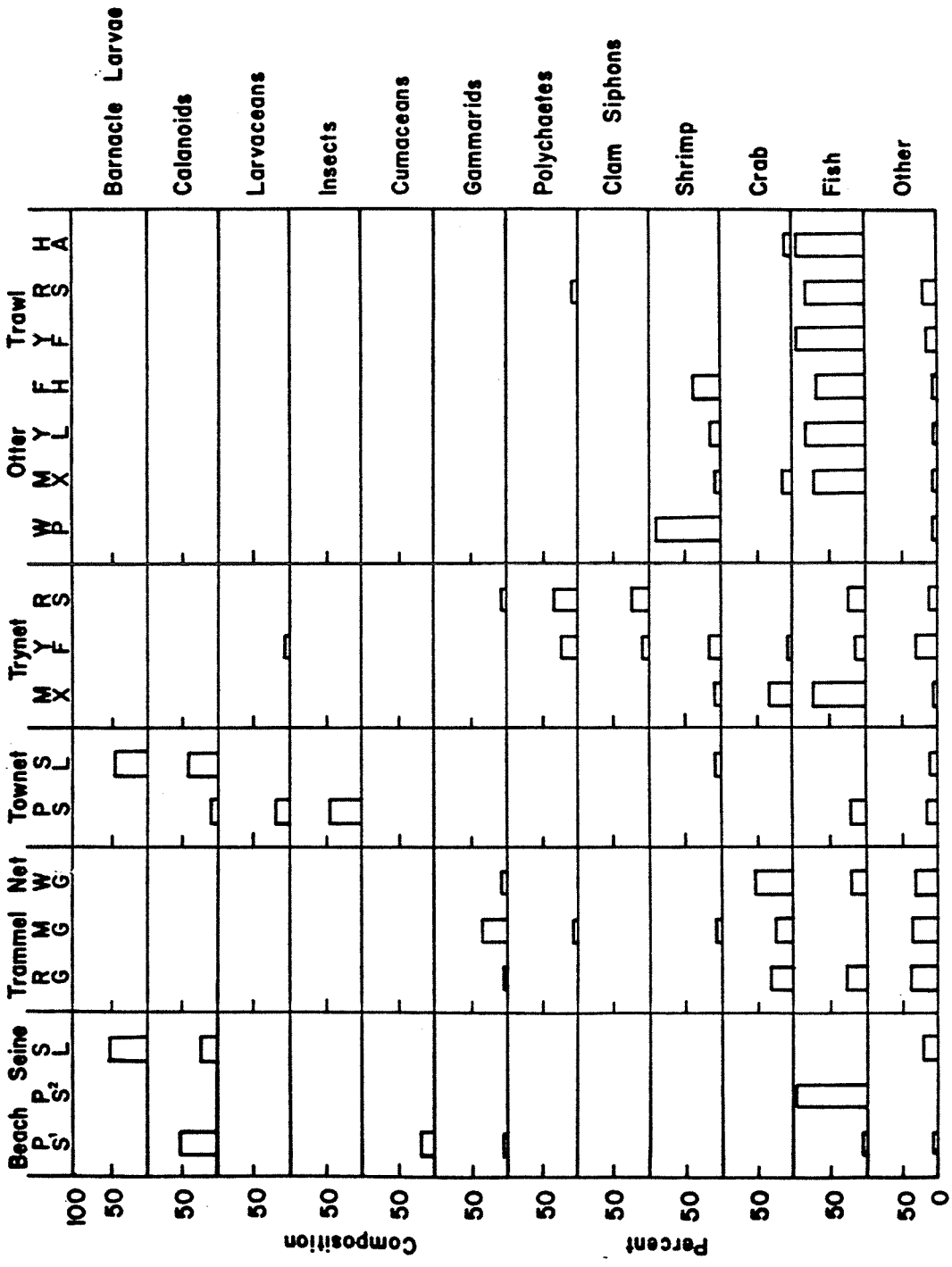

Fig. 19. Summary of important foods, by gear, to fish during the summer (1 = juveniles; 2 = adults).

trynet. Greenlings, which are highly ominiverous, also consumed high proportions of miscellaneous foods.

Autumn

Primary foods during this season were (Fig. 20):

1) Small epibenthic crustacea--gammarid amphipods and mysids.

2) Noncrustacean benthos/epibenthos--polychaetes, clams, and snails

3) Shrimp

4) Crab

5) Fish

During autumn, epibenthic crustaceans were important primarily to predators caught by the beach seine. Small masked greenling and Myoxocephalus (19 and 53 gm, respectively--see Table 5, page 23) ate significant amounts of gammarid amphipods, which were among major food items for these predators. Gammarids were also important to large masked greenling captured by trammel net. Mysids were relatively unimportant but did occur in the diet of walleye pollock and flathead sole caught in the otter trawl. The most important noncrustacean epibenthic/benthic food was polychaete worms. Masked greenling from the beach seine, yellowfin sole from the trynet, and rock sole from both the trynet and otter trawl ate significant amounts of polychates. Shrimp were consumed by all the major predators from the otter trawl, but were of lesser significance to Myoxocephalus and rock sole. However, shrimp were by far the main food for Pacific tomcod, comprising over 80% of their food. Crab was important to many predators, but it never contributed over 50% of the total diet of any one species. Myoxocephalus and rock greenling from the trammel net, Myoxocephalus from the trynet, and yellow Irish lord, yellowfin sole, and Myoxocephalus from the otter trawl were major crab predators. Fish was consumed by every major predator except large (268 gm average weight) rock sole captured by the otter trawl. Fish was particularly important to the rock sole and Myoxocephalus from the beach seine, all three species taken by the trammel net, Myoxocephalus and yellowfin sole from the trynet, and to all major predators from the otter trawl, except for yellow Irish lord and rock sole. For Myoxocephalus, fish was very important, comprising 40% or more of the total diet, even through the average size of Myoxocephalus sampled ranged from 47 gm in the trynet to 1400 gm in the otter trawl.

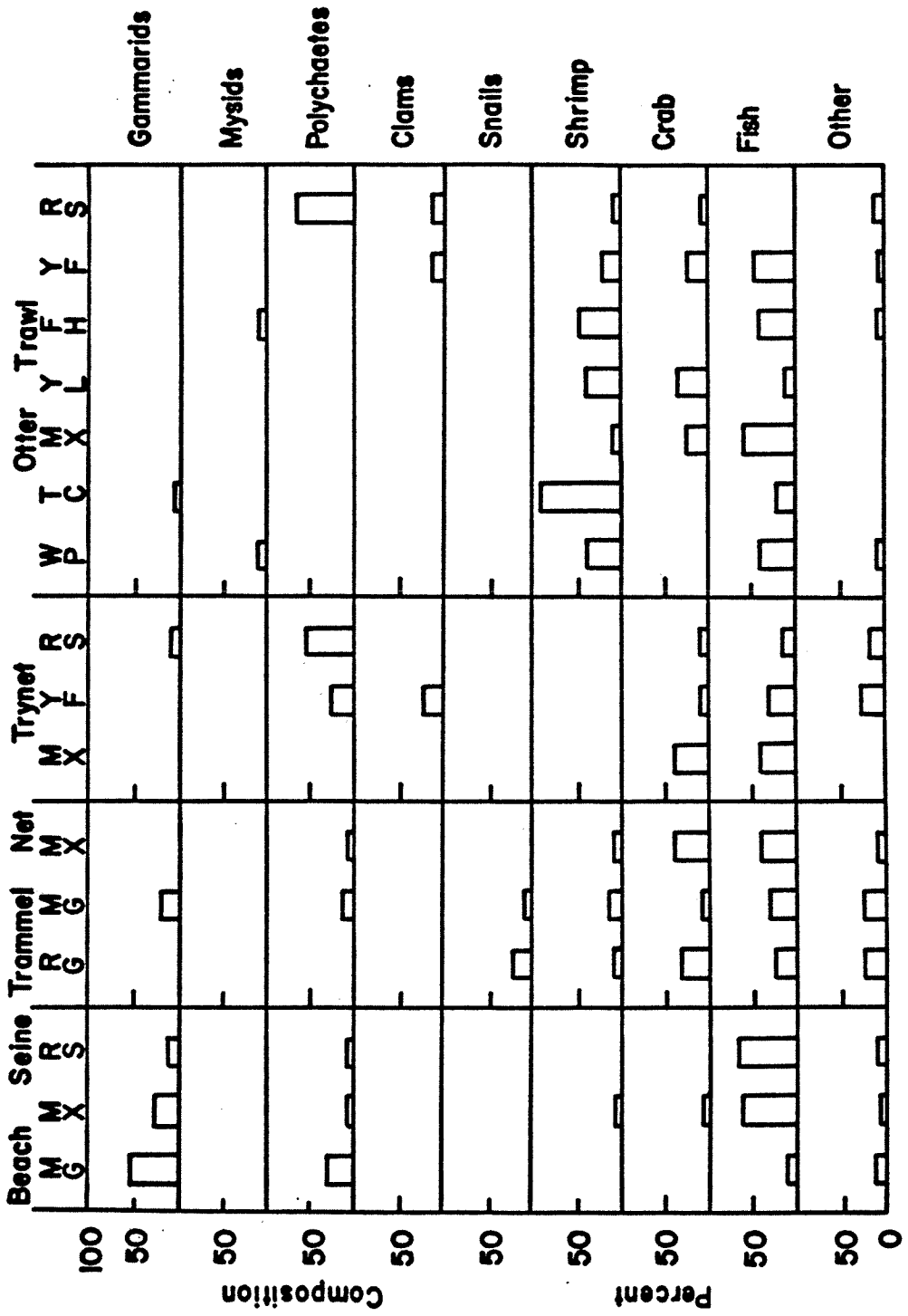

Fig. 20. Summary of important foods, by gear, to fish during the autumn.

SUMMARY

During April through August and November of 1978, and March of 1979, fish were sampled from four bays along the southeast coast of the Kodiak Archipelago. Most of the fish were taken from five types of gear, each sampling a different habitat. These were:

Beach seine - intertidal/shallow subtidal
Trammel net - rocky/kelp beds
Try net - subtidal banks and shelves
Otter trawl - deep troughs
Townet - pelagic

The resulting collection totaled over 14,000 stomachs from about 40 species of fish. Results of subsequent analyses have been reported in two phases. In the first phase (Rogers et al. 1979), food habits were presented for all species of fish that were sampled. The emphasis of the second phase (presented in this report) was to construct quantitative food webs for the ecologically important fish. These included juvenile and adult pink salmon, juvenile chum salmon, Dolly Varden, Pacific sand lance, Pacific cod, Pacific tomcod, walleye pollock, yellow Irish lord, Myoxocephalus spp., Gymnocanthus spp., capelin, threespine stickleback, rock, masked and whitespotted greenling, rock, yellowfin, and flathead sole, arrowtooth flounder, and Pacific halibut.

Feeding intensity with respect to time of day was analyzed and the stomach fullness and relative state of digestion seemed to be variable, or consistently high/low/medium, or show peaks of highs and/or lows depending on species, size category, and season. Pacific sandfish and rock, masked, and whitespotted greenling had relatively full stomachs and a low percentage of empty stomachs; Pacific cod, Pacific tomcod, and walleye pollock also had relatively full stomachs but more were empty. Snake prickleback and crescent gunnel were in the medium range, as were rock and yellowfin sole, but the latter had a higher percentage of empty stomachs. Data indicated that the three major greenling species may have been feeding more in the morning, the rock sole more at mid-day, the Pacific cod less at mid-day, and the capelin more in the early morning.

Species were examined for gonad maturation and this was compared to stomach fullness. Pacific tomcod and Pacific sandfish were late winter spawners; rock, masked, and whitespotted greenling and yellowfin sole were summer spawners; and Pacific sand lance was an autumn spawner. Paired sample t-tests showed that "ripe and running" greenling and yellowfin sole did not feed more or less intensely than those adults that were not ripe. Data suggested that ripe capelin, Pacific tomcod, Pacific sand lance, and Pacific sandfish may feed less than their non-ripe counterparts.

To construct the food webs, food habits of the three size classes of fish (<150, 151-300, and >300 mm long) were combined to describe the overall diet for each species within a season and habitat. Twenty traditional food webs (percent composition) and twenty quantitative dot/box diagrams were drawn for those fish that contributed over 5% by weight to the mean CPUE. The number of species, and the species composition differed among habitats and seasons. Generally, the number of species was low for the trammel net, townet, and try net and higher for the beach seine and otter trawl. The catches in all habitats tended to be lowest in the winter and low in autumn as well. The potential impact of the predators on their food supply also tended to be lower during those seasons than during spring and summer.

Beach seine and trammel net catches were somewhat similar. Greenling, rock sole, and Myoxocephalus spp. were common to both gears, while pink and chum salmon and Dolly Varden were common in the beach seine catches. Fish sampled by the beach seine were typically quite small (with the exceptions of adult pink salmon in the summer and Dolly Varden in the spring and autumn) and consumed a diverse array of primarily small epibenthic, benthic, and pelagic foods such as calanoid and harpacticoid copepods, gammarid amphipods, and polychaetes. In general, fish caught by the trammel net were larger than those caught by the beach seine. This was probably a result of differing size selectivity of the two gears. Rock greenling predominated in these catches and also tended to have the largest impact on the food resources. Along with the other greenlings, it maintained a diverse diet of benthos, epibenthos, and fish throughout its growth.

The small "forage" fish caught by the townet reflected their pelagic habitat in their diet. Sand lance, juvenile salmon, capelin and sticklebacks consumed mostly small pelagic and epibenthic foods such as copepods, amphipods, and insects.

The try net generally captured small individuals (with the exception of Myoxocephalus spp.); important were rock and yellowfin sole, Myoxocephalus spp., and Gymnocanthus spp. Myoxocephalus fed mostly on crab and fish while the other species fed on a variety of benthic and epibenthic organisms and fish. Unlike the diets of fish taken from beach seine catches, the benthic and epibenthic organisms found in the stomachs of fish from the try net were largely not crustaceans, and included such foods as polychaetes and bivalves.

Otter trawl catches also included large quantities of pleuronectids and cottids, along with some gadids. A total of 11 species was incorporated into the food webs for fish caught by this gear. On the average, these individuals were larger than those caught in any other gear and there was a pronounced tendency for these predators to eat predominantly crab, fish, and/or shrimp.

The three major species of greenling (rock, masked, and to a lesser extent, whitespotted) tended to have a generalized diet as did the rock sole (although polychaetes often formed a high proportion of their diet), yellowfin sole, small flathead sole, Dolly Varden, and Gymnocanthus spp. The other ecologically important species tended to specialize on certain prey types, such as zooplankton, fish, crab, or shrimp.

NEEDS FOR FURTHER STUDY

If the exploration of oil proceeds in the Kodiak Lease Area, further baseline work is a necessity. A large and complex study such as this often brings up many new questions while it answers others. The Kodiak nearshore fish survey is no exception.

Temporal considerations are important in ecological studies. Although this study considered seasonal aspects, annual and diel effects have not been examined. At least one more year of sampling would be useful. Diel sampling could be used to better pinpoint when fish are feeding and sampling at night (which was not done in this study) would probably be effective in capturing a wider variety of fish, particularly the "forage" fish that are more likely to be high in the water column at night and vulnerable to capture by townet or midwater trawl.

Food habits of fish that were not captured by the gears used in this study could be further sampled. For example, tide pool fish could be examined. Additional stomachs from some important species of fish that were insufficiently sampled, such as Gymocanthus and arrowtooth flounder, could also be examined. Needed also is an in-depth study of the food habits of adult pink and chum salmon that have entered the nearshore zone on their spawning migration. The large influx of these fish, many of which are feeding, undoubtedly has a significant impact on the food resources of the bays; however, this aspect of their biology remains virtually unstudied.

Detailed habitat descriptions of the sampling sites are lacking. These could be compiled, possibly by, including benthic survey (SCUBA) of intertidal and subtidal areas in which data would also be collected on spawning habitats of nearshore fish species.

Finally, we feel a single-source reference on the biota of the Kodiak area would make a significant scientific contribution towards the understanding of biological interactions in this highly productive, totally fascinating region.

ACKNOWLEDGMENTS

A project of this magnitude takes a cooperative effort by many talented and hard working people to be successful. We wish to thank all those involved for making the field, laboratory, computer analysis, and report writing phases of the work go smoothly.

We are indebted to the crews of the R/V COMMANDO and the M/V YANKEE CLIPPER, Jim Blackburn's group at Kodiak (ADF&G), and FRI biologists Chris Wilson, Michael Gross, and Steven Quinnell for braving the cold, often stormy, waters of the Gulf of Alaska. The foul weather frequently made their jobs difficult, but their hard work yielded over 14,000 fish stomachs.

The laboratory personnel examined all of these stomachs. For a job well done, we thank Julianne Fegley, Mark Hunter, Thomas Kline, Kelly McAllister, and Carolyn Wesch.

We would also like to acknowledge the help of Katie Swanson and Mark Hunter with the computer analysis and Lawrence Gales with preparation of the data type.

Many other people helped produce this final report. Our secretary Ingrid Pearson and Dorothy Beall's excellent production personnel were particularly helpful. Laura Lewis drew the final versions of the food web diagrams. Laura and Colleen Clarke completed most of the figures and graphs that appear in this report.

Thank you, all.

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APPENDIX

Appendix Table 1. The average catch, by species, per beach seine haul. Asterisks indicate species used in the food webs.

	Abundance				Biomass (g)
	Size Class				
	I	II	III	Total	Total
Winter					
Salmonidae					
Pink salmon	3.2	0	0	3.2	1.4
Chum salmon	1.0	0	0	1.0	.5
Dolly Varden*	0	.2	.1	.3	3.0
Ammodytidae					
Sand lance	.4	0	0	.4	.1
Gadidae					
Pacific cod				T	.1
Tomcod				?	.6
Hexagrammidae					
Rock greenling*				.1	4.1
Masked greenling*	.3	.5	T	.8	9.0
Whitespotted greenling				T	.4
Kelp greenling				T	T
Cottidae					
Yellow Irish lord				T	.3
Silverspotted sculpin	.2	0	0	.2	1.3
Buffalo sculpin				.1	.3
Myoxocephalus spp.*	.6	.1	T	.7	6.6
Padded sculpin				T	T
Sharpnose sculpin				T	T
Tidepool sculpin				T	T
Gasterosteidae					
Threespine stickleback				.1	.2
Agonidae					
Tubenose poacher				.1	.1
Pholidae					
Crescent gunnel				.1	.5
Stichaeidae					
Arctic shanny				.1	T
Pleuronectidae					
Rock sole*				.1	1.9
Starry flounder				.1	.9
					31.3
Spring					
Salmonidae					
Pink salmon*	68.8	0	0	68.8	36.7
Chum salmon	12.8	0	0	12.8	10.3
Coho salmon	.3	0	0	.3	1.8

Appendix Table 1. The average catch, by species, per beach seine haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Dolly Varden*	.1	.1	.1	.3	77.5
Osmeridae					
Capelin				T	.1
Clupeidae					
Herring				T	.6
Ammodytidae					
Sand lance*	8.4	.5	0	8.9	33.0
Gadidae					
Pacific cod				.1	.6
Walleye pollock				T	.1
Tomcod	.4	0	0	.4	.3
Hexagrammidae					
Rock greenling*	.1	.1	.1	.3	20.7
Masked greenling*	.7	.7	.0	1.4	45.7
Whitespotted greenling	.5	.1	T	.6	9.1
Kelp greenling				?	.2
Cottidae					
Myoxocephalus spp.*	1.8	.4	.4	2.6	124.5
Buffalo sculpin				.1	1.0
Padded sculpin				.1	.1
Silverspotted sculpin	1.1	T	0	1.1	1.6
Staghorn sculpin				.1	1.4
Yellow Irish lord				T	.1
Gasterosteidae					
Threespine stickleback	.3	0	0	.3	1.6
Agonidae					
Tubenose poacher	.7	0	0	.7	.9
Stichaeidae					
Arctic shanny				T	.3
Snake prickleback	.2	T	T	.2	.7
Pholidae					
Crescent gunnel	.2	.1	0	.3	2.4
Penpoint gunnel				T	.1
Trichodontidae					
Sandfish				T	T
Pleuronectidae					
Rock sole*	.1	.2	.1	.4	29.4
Yellowfin sole				T	T
Butter sole				T	T
Sand sole				.1	.4
Starry flounder	T	.1	T	.1	5.4
Alaska plaice				T	T
					406.6
Summer					
Salmonidae					
Pink salmon*	3.9	0	2.4	6.3	2201.9
Chum salmon	.8	0	0	.8	4.3
Coho salmon				T	.1
Dolly Varden	.1	.3	.4	.8	118.2

Appendix Table 1. The average catch, by species, per beach seine haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Osmeridae					
Surf smelt				T	T
Clupeidae					
Herring				T	.4
Ammodytidae					
Pacific sand lance*	153.7	.1	0	153.8	299.0
Gadidae					
Pacific cod	5.9	0	0	5.9	7.8
Hexagrammidae					
Rock greenling	.3	T	.1	.4	23.7
Masked greenling	3.6	.8	T	4.4	77.7
Whitespotted greenling	5.4	.4	T	5.8	55.8
Lingcod	.2	0	0	.2	.6
Cottidae					
Myoxocephalus spp.	3.9	.5	.2	4.6	52.2
Buffalo sculpin				.1	2.0
Manacled sculpin				.1	.1
Yellow Irish lord				.1	2.9
Red Irish lord				T	.4
Staghorn sculpin	T	.2	0	.2	26.8
Silverspotted sculpin	1.0	T	0	1.0	2.6
Gymnocanthus spp.	.6	0	0	.6	?
Padded sculpin				.1	.2
Sharpnose sculpin				T	?
Megalocottus sp.				.2	.2
Gasterosteidae					
Threespine stickleback	.3	0	0	.3	.8
Trichodontidae					
Sandfish				T	T
Agonidae					
Tubenose poacher	1.0	0	0	1.0	.6
Stichaeidae					
Arctic shanny				T	T
High cockscomb				T	T
Snake prickleback	.1	.1	.1	.3	1.1
Pholidae					
Crescent gunnel	.4	.2	0	.6	2.2
Penpoint gunnel				T	T
Saddleback gunnel				.1	.3
Cyclopteridae					
Spotted snailfish				.1	.2
Zaproridae					
Prowfish				.1	.2
Bathymasteridae					
Searcher				T	.1
Pleuronectidae					
Rock sole	.2	.2	T	.4	35.1

Appendix Table 1. The average catch, by species, per beach seine haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Yellowfin sole				T	.6
Sand sole				.1	.5
English sole	.1	0	0	.1	.6
Halibut				T	T
Starry flounder	T	.1	.1	.2	9.5
Alaska plaice				T	.1
					2928.8
Autumn					
Salmonidae					
Dolly Varden*				.1	40.4
Clupeidae					
Herring				.1	?
Osmeridae					
Surf smelt				T	.3
Ammodytidae					
Pacific sand lance	1.6	T	0	1.6	12.9
Gadidae					
Pacific cod	.2	0	0	.2	.9
Tomcod				T	?
Walleye pollock				T	.2
Hexagrammidae					
Rock greenling	.3	T	0	.3	7.7
Masked greenling*	1.2	.2	0	1.4	26.4
Whitespotted greenling				.2	3.3
Cottidae					
Myoxocephalus spp.*	2.4	.3	.2	2.9	152.4
Yellow Irish lord				T	.2
Silverspotted sculpin	.1	0	0	.1	.2
Staghorn sculpin				T	.3
Buffalo sculpin				T	.7
Padded sculpin				T	.3
Sharpnose sculpin				T	?
Tidepool sculpin					
Stichaeidae					
Arctic shanny				.1	.2
Agonidae					
Tubenose poacher	.3	0	0	.3	.6
Pholidae					
Crescent gunnel				T	?
Penpoint gunnel				T	?
Pleuronectidae					
Rock sole*	.1	.3	.1	.5	29.5
Starry flounder	.1	.1	0	.2	9.8
					286.3

Appendix Table 2. The average catch, by species, per 2-hour trammel net set. Asterisks indicate species used in the food webs.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Winter					
Gadidae					
Tomcod				T	1.9
Hexagrammidae					
Rock greenling*	T	.9	1.0	1.9	473.5
Masked greenling	0	.6	T	.6	19.7
Whitespotted greenling				.1	2.1
Kelp greenling	0	T	.1	.1	3.2
Cottidae					
Myoxocephalus spp.*	0	0	.3	.3	125.8
Gymnocanthus spp.				T	.4
Staghorn sculpin				T	.6
Scorpaenididae					
Black rockfish				T	1.2
Pleuronectidae					
Rock sole*	T	.3	.5	.9	117.1
Starry flounder				.1	1.7
					747.2
Spring					
Salmonidae					
Dolly Varden				T	.9
Clupeidae					
Pacific herring	0	.8	0	.8	4.9
Gadidae					
Pacific cod	0	.3	0	.3	3.6
Hexagrammidae					
Rock greenling*	T	6.4	6.6	13.0	6717.1
Masked greenling*	T	7.6	T	7.6	894.9
Whitespotted greenling	0	1.3	.4	1.7	334.9
Kelp greenling	0	T	.2	.2	34.4
Cottidae					
Myoxocephalus spp.	0	.1	.5	.6	255.2
Staghorn sculpin	0	.1	.1	.2	5.4
Silverspotted sculpin				T	.1
Gymnocanthus spp.				T	.4
Red Irish lord				.1	1.0
Scorpaenidae					
Dusky rockfish				T	.6
Black rockfish				.1	1.1
Bathymasteridae					

Appendix Table 2. The average catch, by species, per 2-hour trammel net set. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Alaskan ronquil				T	.4
Searcher				T	.2
Stichaeidae					
Stout eelblenny				?	.8
Pleuronectidae					
Rock sole*	.1	1.4	1.2	2.7	674.3
Yellowfin sole	0	1	.2	.3	5.3
Starry flounder	0	T	.1	.1	2.8
Butter sole				?	1.5
Halibut				.1	4.6
					8944.4
Summer					
Salmonidae					
Pink salmon	.2	0	0	.2	9.6
Dolly Varden	T	.2	.6	.8	95.7
Clupeidae					
Pacific herring	0	.1	0	.1	3.0
Gadidae					
Pacific cod	0	.9	0	.9	51.0
Walleye pollock				.1	1.3
Tomcod	0	.2	0	.2	2.0
Hexagrammidae					
Rock greenling*	.1	13.9	14.1	28.1	9951.9
Masked greenling*	.2	47.3	.3	47.9	6497.9
Whitespotted greenling*	0	4.3	.7	5.0	1290.8
Kelp greenling	0	.2	.2	.4	20.8
Cottidae					
Myoxocephalus spp.	0	.2	.6	.8	248.8
Yellow Irish lord				.1	2.3
Red Irish lord	0	T	.3	.3	66.6
Staghorn sculpin	0	.1	.1	.2	5.5
Silverspotted sculpin				.1	.8
Northern sculpin				?	.4
Crested sculpin				T	T
Gymnocanthus spp.	1	T	0	.1	1.4
Scorpaenidae					
Black rockfish	0	0	.2	.2	2.0
Dusky rockfish	0	.1	.1	.2	1.6
Anarhichadidae					
Wolf-eel				T	0.7
Agonidae					

Appendix Table 2. The average catch, by species, per 2-hour trammel net set. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Sturgeon poacher	0	.1	0	.1	1.8
Pleuronectidae					
Rock sole	T	1.3	.5	1.8	61.0
Halibut				T	3.9
Yellowfin sole	0	.2	.3	.5	11.5
Dover sole				.3	1.8
Flathead sole				T	0.4
Starry flounder	0	.1	T	.1	3.3
					18,337.8
Autumn					
Gadidae					
Pacific cod	T	.2	0	.2	3.2
Hexagrammidae					
Rock greenling*	T	2.2	2.5	4.7	2139.3
Masked greenling*	0	3.2	0	3.2	818.2
Whitespotted greenling	0	1.5	.3	1.8	82.0
Kelp greenling	0	.1	.2	.3	68.0
Cottidae					
Myoxocephalus spp.*	0	0.3	0.6	.9	859.8
Buffalo sculpin				T	1.3
Red Irish lord				.1	3.3
Megalocottus sp.				.1	1
Unidentified sculpins				.1	23.1
Pleuronectidae					
Rock sole	.1	.5	.3	.9	78.3
					4076.5

Appendix Table 3. The average catch, by species, per 10-min townet haul. Asterisks indicate species used in the food webs.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Winter					
Salmonidae					
Pink salmon	.1	0	0	.1	?
Chum salmon				.1	?
Osmeridae					
Capelin*				T	0.6
Ammodytidae					
Sand lance*	.1	.2	0	.3	1.4
Gasterosteidae					
Threespine stickleback*	.2	0	0	.2	1.3
					3.3
Spring					
Salmonidae					
Pink salmon*	2.9	0	0	2.9	0.8
Chum salmon*	4.0	0	0	4.0	4.6
Coho salmon	0	.3	0	.3	?
Osmeridae					
Capelin*	.8	0	0	.8	2.4
Ammodytidae					
Sand lance				T	?
Hexagrammidae					
Whitespotted greenling	.2	0	0	.2	?
Gasterosteidae					
Threespine stickleback*	.4	0	0	.4	1.1
					8.9
Summer					
Salmonidae					
Pink salmon*	1.9	0	0	1.9	7.1
Chum salmon	.1	0	0	.1	.2
Osmeridae					
Capelin				.1	.3
Ammodytidae					
Pacific sand lance*	51.7	0	0	51.7	80.6
Gadidae					
Pacific cod	.2	0	0	.2	?
Hexagrammidae					
Whitespotted greenling				.1	.3
Lingcod	.2	0	0	.2	1.1
Cottidae					
Silverspotted sculpin				.0	.1

Appendix Table 3. The average catch, by species, per 10-min townet haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Zaproridae					
Prowfish	.2	0	0	.2	.8
Gasterosteidae					
Threespine stickleback	.2	0	0	.2	.4
					90.9
		Autumn			
Osmeridae*					
Capelin	1.0	0	0	1.0	.4
Ammodytidae					
Sand lance	.4	0	0	.4	?
					.4

Appendix Table 4. The average catch, by species, per 10-min trynet haul. Asterisks indicate species used in the food webs.

	Winter				
	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Clupeidae					
Herring				T	?
Osmeridae					
Capelin	.2	0	0	.2	.3
Gadidae					
Pacific cod	.2	.1	0	.3	1.4
Walleye pollock				.1	.5
Hexagrammidae					
Whitespotted greenling	.1	.1	0	.2	3.6
Masked greenling	.1	.1	0	.2	1.0
Cottidae					
Myoxocephalus spp.	.1	T	.1	.2	12.4
Yellow Irish lord	.2	0	0	.2	.9
Ribbed sculpin	.2	0	0	.2	.6
Red Irish lord				.1	.6
Scissortail sculpin				.1	.3
Silverspotted sculpin	.2	0	0	.2	1.3
Buffalo sculpin				.1	.1
Bigmouth sculpin				T	.2
Spinyhead sculpin				.1	.5
Gymnocanthus spp.*	1.6	.4	0	2.0	47.5
Padded sculpin				T	?
Sailfin sculpin				T	?
Staghorn sculpin				.1	1.5
Scorpaenidae					
Darkblotched rockfish				T	?
Stichaeidae					
High cockscomb				T	.1
Snake prickleback				T	T
Daubed shanny				T	.4
Agonidae					
Tubenose poacher				.1	.3
Sturgeon poacher	.2	T	0	.2	1.2
Pholidae					
Crescent gunnel	.1	.1	0	.2	.8
Cyclopteridae					
Marbled snailfish				T	.3
Unidentified snailfish				?	2.8
Trichodontidae					
Sandfish				T	.4
Pleuronectidae					
Rock sole*	3.5	1.3	.7	5.5	240.8

Appendix Table 4. The average catch, by species, per 10-min trynet haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Flathead sole	.3	.2	0	.5	3.0
Yellowfin sole	1.1	.3	T	1.4	12.9
Starry flounder				T	2.0
Alaska plaice				T	.3
Halibut				.1	.5
					338.5
Spring					
Osmeridae					
Capelin				.1	.4
Gadidae					
Pacific cod	.1	.1	0	.2	4.7
Walleye pollock	.3	.2	0	.5	3.7
Tomcod	.2	.1	0	.3	1.3
Hexagrammidae					
Masked greenling				T	.5
Whitespotted greenling	.4	.5	0	.9	76.1
Cottidae					
Myoxocephalus spp.	.3	.1	.3	.7	102.3
Yellow Irish lord	.5	.3	.1	.9	14.4
Northern sculpin				T	.1
Padded sculpin				T	.1
Spinyhead sculpin				.1	1.2
Gymnocanthus spp.*	1.4	2.6	.2	4.2	235.6
Ribbed sculpin	.3	T	0	.3	1.3
Staghorn sculpin				.1	4.8
Silverspotted sculpin	.2	0	0	.2	.8
Scissortail sculpin				.1	.2
Crested sculpin				T	T
Slim sculpin				T	T
Longfin sculpin				T	T
Bathymasteridae					
Searcher				?	1.5
Trichodontidae					
Sandfish				?	.1
Scorpaenidae					
Darkblotched rockfish				?	.1
Stichaeidae					
Daubed shanny				T	.T
Snake prickleback	.1	.1	T	.2	1.2
Stout eelblenny	.3	0	0	.3	.5

Appendix Table 4. The average catch, by species, per 10-min trynet haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Arctic shanny				.1	.3
Agonidae					
Smooth alligatorfish				T	.1
Sturgeon poacher	.2	0	0	.2	.7
Tubenose poacher				T	.1
Crescent gunnel				.1	.4
Zoarcidae					
Shortfin eelpout				T	T
Pleuronectidae					
Rock sole*	11.3	6.2	1.0	18.5	1060.9
Flathead sole	3.4	.8	T	4.2	47.3
Yellowfin sole*	9.1	9.6	.6	19.3	1187.1
Butter sole	0	.7	.1	.8	15.6
Sand sole				.1	2.6
Dover sole				.1	.5
Alaska plaice				T	.7
English sole				T	.3
Starry flounder	.1	.1	.1	.3	13.9
Arrowtooth flounder	.6	.1	.1	.8	3.7
Halibut	.1	.2	0	.3	10.8
					2796.0
Summer					
Gadidae					
Pacific cod	.1	.2	0	.3	4.6
Walleye pollock	.2	T	0	.2	3.0
Tomcod	0	.2	0	.2	1.4
Hexagrammidae					
Rock greenling				.1	.3
Kelp greenling				T	.4
Whitespotted greenling	.8	.2	0	1.0	120.1
Masked greenling	0	.1	0	.1	2.1
Lingcod				T	.1
Cottidae					
Myoxocephalus spp.*	.5	.5	1.1	2.1	849.1
Yellow Irish lord	.5	1.4	.4	2.3	184.7
Scissortail sculpin				?	.8
Gymnocanthus spp.	4.5	2.8	0	7.3	323.1
Spinyhead sculpin	.3	0	0	.3	1.8
Sailfin sculpin				?	.1
Staghorn sculpin	0	.2	0	.2	4.5
Ribbed sculpin	.3	T	0	.3	2.0
Scorpaenidae					
Dusky rockfish				T	.1

Appendix Table 4. The average catch, by species, per 10-min trynet haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Anoplopomatidae					
Sablefish				.1	1.9
Agonidae					
Sturgeon poacher	.7	0	0	.7	2.4
Bering poacher				T	.2
Stichaeidae					
Arctic shanny	.1	0	0	.1	.3
Daubed shanny	.2	0	0	.2	.9
Snake prickleback	.2	.2	T	.4	2.7
Zoarcidae					
Stout eelblenny	.3	0	0	.3	1.3
Shortfin eelpout				T	.4
Bathymasteridae					
Searcher				?	8.6
Trichodontidae					
Sandfish				T	.3
Pleuronectidae					
Rock sole*	25.2	6.7	1.9	33.8	1834.4
Flathead sole	6.5	2.1	.3	8.9	226.8
English sole				T	.4
Dover sole	.2	0	0	.2	1.8
Butter sole	0	1.0	.1	1.1	56.1
Rex sole				T	.3
Yellowfin sole*	13.5	25.1	.7	39.3	3576.0
Sand sole				.1	10.3
Starry flounder				.1	3.3
Halibut	.1	.3	.2	.6	51.5
Arrowtooth flounder	.2	.1	0	.3	22.5
Alaska plaice				T	2.2
					7302.8
Autumn					
Gadidae					
Pacific cod	.1	.1	0	.2	.7
Tomcod				.1	1.1
Walleye pollock				.1	.6
Hexagrammidae					
Lingcod	.3	T	0	.3	7.4
Rock greenling	.2	0	0	.2	2.0
Masked greenling				.1	.6
Whitespotted greenling	1.2	.1	T	1.3	69.1
Cottidae					
Myoxocephalus spp.*	.2	.3	.6	1.1	177.3
Yellow Irish lord	.3	.1	0	.4	3.0

Appendix Table 4. The average catch, by species, per 10-min trynet haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Gymnocanthus spp.	3.5	.5	0	4.0	61.3
Ribbed sculpin	.8	T	0	.8	6.3
Silverspotted sculpin				?	.5
Northern sculpin				?	1.2
Staghorn sculpin				.1	.9
Red Irish lord	.1	T	0	.2	.8
Scissortail sculpin				?	.8
Bathymasteridae					
Searcher				?	.7
Agonidae					
Sturgeon poacher	0	T	.1	.1	.8
Cyclopteridae					
Unidentified snailfish				?	.4
Pleuronectidae					
Rock sole*	23.8	3.7	1.6	29.1	1370.2
Flathead sole	1.9	.4	0	2.3	14.6
Butter sole	0	.2	T	.2	12.9
Yellowfin sole*	7.6	4.5	.2	12.3	626.1
English sole	.4	T	0	.4	3.1
Sand sole				.1	2.2
Arrowtooth flounder	.5	T	0	.5	3.9
Halibut	.8	.1	T	.9	11.3
Starry flounder	0	.1	.1	.1	2.8
Alaska plaice				.1	2.5
					2385.1

Appendix Table 5. The average catch, by species, per 20-min otter trawl haul. Asterisks indicate species used in the food webs.

	Winter				
	Abundance				Biomass (kg)
	Size class				
	I	II	III	Total	Total
Rajidae					
Big skate	0	0	5	.5	T
Osmeridae					
Eulachon	0	.3	0	.3	.04
Capelin	5.7	0	0	5.7	.03
Clupeidae					
Herring	.5	.5	0	1.0	.01
Gadidae					
Pacific cod	8.3	9.3	3.5	21.1	1.67
Walleye pollock	193.4	14.9	1.3	209.6	.37
Tomcod	.1	9.4	.5	10.0	.20
Hexagrammidae					
Rock greenling	0	.2	0	.2	T
Masked greenling	0	1.1	0	1.1	.01
Whitespotted greenling	.1	1.2	0	1.3	.03
Kelp greenling	.4	0	0	.4	T
Lingcod	.2	0	0	.2	T
Cottidae					
Myoxocephalus spp.*	3.7	.4	10.9	15.0	17.44
Yellow Irish lord	.1	2.3	1.1	3.5	.17
Northern sculpin				T	T
Staghorn sculpin	0	1.6	.4	2.0	.19
Ribbed sculpin	.6	0	0	.6	T
Gymnocanthus spp.	.5	9.8	1.1	11.4	3.01
Spinyhead sculpin	3.0	.3	0	3.3	.09
Unidentified sculpin				?	.03
Trichodontidae					
Sandfish	.8	0	0	.8	.01
Anoplopomatidae					
Sablefish	0	.2	0	.2	T
Agonidae					
Sturgeon poacher	.2	1.7	0	1.9	.03
Smooth alligatorfish				.1	?
Bathymasteridae					
Searcher	1.9	1.3	0	3.2	.02
Northern ronquil	.1	.4	.2	.7	.01
Stichaeidae					
Whitebarred prickleback	2	0	0	.2	T
Snake prickleback				1.2	.01
Daubed shanny	.2	0	0	.2	T
Pleuronectidae					
Rock sole*	9.0	183.7	116.5	309.2	43.49
Flathead sole	37.7	59.3	1.1	98.1	3.89
Yellowfin sole*	5.1	224.4	6.9	236.4	36.73
English sole	.9	0	0	.9	.02
Butter sole	.4	4.8	.2	5.4	.25

Appendix Table 5. The average catch, by species, per 20-min otter trawl haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (kg)
	Size class				
	I	II	III	Total	Total
Rex sole	0	.6	0	.6	.01
Sand sole	0	.4	.3	.7	1.07
Starry flounder	0	.1	3.2	3.3	2.90
Arrowtooth flounder	9.3	4.8	0	14.1	.15
Halibut	.3	.8	.8	1.8	4.57
					116.46
			Spring		
Rajidae					
Big skate	0	.1	.4	.5	.19
Clupeidae					
Herring	0	.5	0	.5	.01
Osmeridae					
Capelin	2.9	.5	0	3.4	.09
Eulachon	0	4.0	0	4.0	.01
Gadidae					
Pacific cod*	.9	11.6	32.5	45.0	31.30
Walleye pollock	58.2	15.2	1.9	75.3	3.16
Tomcod	0	4.7	0	4.7	.06
Hexagrammidae					
Whitespotted greenling	0	1.0	.1	1.1	.03
Lingcod	.2	0	0	.2	T
Cottidae					
Myoxocephalus spp.*	.3	3.4	60.3	64.0	70.68
Yellow Irish lord*	11.2	112.7	46.1	170.0	50.61
Spinyhead sculpin	1.5	.7	0	2.2	.07
Gymnocanthus spp.*	0	96.4	13.9	110.3	30.32
Staghorn sculpin	0	1.1	.4	1.5	.04
Scissortail sculpin	.9	0	0	.8	T
Ribbed sculpin	.2	0	0	.2	T
Anoplopomatidae					
Sablefish	0	87.3	17.3	104.6	21.15
Trichodontidae					
Sandfish	.3	.4	0	.7	.01
Stichaeidae					
Snake prickleback	1.0	1.8	.9	3.6	.04
Daubed shanny	.4	0	0	.4	?
Arctic shanpy	.9	0	0	.9	?
Agonidae					
Sturgeon poacher	0	6.1	0	6.1	.11
Zoarcidae					
Shortfin eelpout	0	.9	.4	1.3	.02
Bathymasteridae					
Searcher	6.6	5.7	.3	12.6	.94
Pleuronectidae					
Rock sole*	21.1	271.5	104.2	396.8	102.60
Flathead sole*	74.0	270.8	59.9	404.7	41.71

Appendix Table 5. The average catch, by species, per 20-min otter trawl haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (kg)
	Size class				
	I	II	III	Total	Total
Yellowfin sole*	6.3	258.1	84.2	348.6	77.19
Rex sole	0	3.1	0	3.1	.06
Dover sole	0	1.1	0	1.1	T
Butter sole	0	8.8	2.3	11.1	.67
Sand sole				0.5	T
English sole	0	1.2	.9	2.1	.04
Starry flounder	0	0	5.1	5.1	6.78
Arrowtooth flounder	7.0	8.8	2.3	97.9	12.47
Halibut	0	.8	13.5	14.3	10.85
					461.21
Summer					
Squalidae					
Spiny dogfish				.1	T
Rajidae					
Longnose skate				.1	.01
Big skate	0	0	.5	.5	.12
Clupeidae					
Herring	0	.7	0	.7	.02
Osmeridae					
Capelin	1.9	0	0	1.9	.01
Gadidae					
Pacific cod	0	5.0	5.2	10.2	7.12
Walleye pollock*	6.5	146.6	37.0	190.1	26.23
Tomcod	1.7	13.9	1.8	17.4	.84
Hexagrammidae					
Whitespotted greenling	0	1.4	.8	2.2	.55
Myoxocephalus spp.*	0	1.2	38.0	39.2	40.44
Ribbed sculpin	.2	.5	0	.6	.01
Yellow Irish lord*	8.9	113.7	49.2	171.8	46.06
Gymnocanthus spp.*	0	43.2	7.9	51.1	20.96
Spinyhead sculpin	1.2	1.6	0	2.8	0.13
Scissortail sculpin				?	T
Bigmouth sculpin	0	.2	0	.2	T
Trichodontidae					
Sandfish	1.5	2.5	0	4.0	.12
Bathymasteridae					
Searcher	3.7	12.0	.4	16.0	.66
Anoplopomatidae					
Sablefish	.5	6.3	7.9	14.7	4.56
Stichaeidae					
Daubed shanny	1.2	1.3	0	2.5	.02
Snake prickleback	.4	.8	.5	1.7	.01

Appendix Table 5. The average catch, by species, per 20-min otter trawl haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (g)
	Size class				
	I	II	III	Total	Total
Arctic shanny	.5	0	0	.5	T
Agonidae					
Sturgeon poacher	.4	.7	0	1.1	T
Zoarcidae					
Wattled eelpout	0	.6	.5	1.1	.07
Shortfin eelpout	0	1.4	0	1.4	.02
Pleuronectidae					
Rock sole*	10.9	94.8	48.4	154.1	38.98
Flathead sole*	109.8	282.1	164.9	556.8	94.76
Dover sole	0	.9	0	.9	.01
Butter sole	0	6.6	5.3	11.9	3.25
Yellowfin sole*	.9	198.4	100.9	300.2	77.76
Rex sole	0	1.8	0	1.8	.03
Halibut*	0	.1	9.4	9.5	31.84
Starry flounder	0	0	1.3	1.3	2.19
Arrowtooth flounder	17.7	36.2	13.1	67.0	8.92
					405.70
Autumn					
Osmeridae					
Eulachon	0	5.1	0	5.1	?
Clupeidae					
Herring	0	.7	0	.7	.47
Gadidae					
Pacific cod	27.3	20.5	41.0	88.8	19.60
Walleye pollock*	299.4	175.9	41.3	516.6	22.73
Tomcod*	115.1	266.5	36.8	418.4	22.74
Hexagrammidae					
Whitespotted greenling	0	1.6	.2	1.8	.03
Kelp greenling				?	.04
Cottidae					
Myoxocephalus spp.*	1.6	3.7	24.4	29.7	41.57
Staghorn sculpin	0	13.9	12.1	26.0	17.24
Yellow Irish lord*	.2	67.0	53.0	120.2	55.48
Red Irish lord	0	.4	.7	1.1	.05
Spinyhead sculpin	.3	.4	0	.7	.02
Gymnocanthus spp.	0	1.5	1.5	3.0	.06
Unidentified sculpins				T	.19
Scorpaenidae					
Darkblotched rockfish	0	.3	.2	.5	.02
Anoplopomatidae					
Sablefish				?	.12
Trichodontidae					
Sandfish	0	.4	0	.4	.01

Appendix Table 5. The average catch, by species, per 20-min otter trawl haul. Asterisks indicate species used in the food webs - continued.

	Abundance				Biomass (kg)
	Size class				
	I	II	III	Total	Total
Bathymasteridae					
Searcher	0	2.2	.7	2.9	.05
Agonidae					
Sturgeon poacher	0	3.3	0	3.3	.02
Pleuronectidae					
Rock sole*	12.6	70.5	32.2	115.3	30.93
Flathead sole*	214.9	226.0	37.8	478.7	23.48
Dover sole	.6	.9	0	1.4	.03
Butter sole	0	4.4	3.3	7.7	10.41
Yellowfin sole*	1.5	614.5	139.5	755.5	150.44
English sole	0	2.0	.7	2.7	.07
Sand sole	0	0	.1	.1	3.86
Rex sole	0	1.1	0	1.1	.04
Halibut	0	.9	9.7	10.6	20.01
Starry flounder	0	.4	4.9	5.3	7.16
Arrowtooth flounder*	9.6	229.7	13.3	252.6	26.31
					453.18

Appendix Table 6. A complete list of foods that were identified during this study.

Algae
Chlorophyta
Ulotrichales
Ulvaceae
Cladophoraceae
Phaeophyta
Haplogloia sp.
Laminariales
Laminaria sp.
Alaria sp.
Desmarestia sp.
Fucales
Fucus sp.
Cystoseira geminata
Rhodophyta
Bangiales
Bangiaceae
Porphyra sp.
Ahnfeltia sp.
Gigartina sp.
Rhodoglossum sp.
Corallinacea
Corallina sp.
Callophyllis sp.
Rhodymenia sp.
Hallosaccion sp.
Ceramiales
Polyneura latissima
Rhodomela sp.
Odonthalia sp.

Zostera marina
Phyllospadix sp.
P. scouleri

Foraminifera

Porifera

Cnidaria
Hydrozoa
Sertulariidae
Sertularia sp.
Abietinaria sp.
Leptomedusae
Scyphazoa
Anthozoa
Metridiidae

Ctenophora

Nemertea

Annelida
Polychaeta
Polynoidae
Euphrosinidae
Phyllodocidae
Syllidae
Nereidae
Neanthes sp.
Nephtyidae
Glyceridae
Goniadidae
Onuphidae
Lumbrineridae
Orbinidae
Spionidae
Flabelligeridae
Scalibregmidae
Ophellidae
Ammotrypane sp.
Ophelia sp.
Maldanidae
Oweniidae
Sabellariidae
Pectinariidae
Ampharetidae
Terebellidae
Sabellidae
Serpulidae
Pilargidae
Eunicidae
Cirratulidae
Capitellidae
Aphroditidae
Magelonidae
Arabellidae

Mollusca
Gastropoda
Prosobranchia
Archaeogastropoda
Puncturella sp.
Puncturella multistriata
Acmaeidae
Notoacmaea spp.
N. persona
N. fenestrata
Lepeta (Cryptobranchia) sp.

Appendix Table 6. A complete list of foods that were identified during this study - continued.

Trochidae
Calliostoma spp.
C. ligatum
Margarites spp.
Lirularia lirulatus
Mesogastropoda
Lacunidae
Lacuna spp.
Lacuna vincta
Lacuna carinata
Littorina spp.
Littorina sitkana
Littorina scutulata
Tachyrhyncha sp.
Bittium sp.
Trichotrophis sp.
Trichotrophis conica
Velutina sp.
Lamellaria stearnsii
Naticidae
Natica sp.
Fusitriton oregonensis
Ocenebra sp.
Buccium sp.
Volutharpa sp.
Volutharpa ampullacea
Olivella sp.
Olivella baetica
Odostomia sp.

Opistobranchia
Cylichna sp.
Aglaja diomedeum
Gastropteron pacificum
Bullidae
Haminoeidae
Haminoea sp.
Haminoea vesicula
Retusa sp.

Nudibranchia
Anisodoris nobilis
Doridídae
Eolidoidea
Tritonidae

Polyplacophora
Ischnochitonidae
Tonicella sp.
Tonicella lineata
Katharina tunicata
Mopalidae
Mopalia sp.

Bivalvia
Nuculoida
Nucula spp.
N. tenuis
N. bellotti
Nuculanidae
Nuculana spp.
Yoldia spp.
Yoldia scissurata
Yoldiella sp.
Mytiloida
Mytilidae
Mytilus sp.
Mytilus edulis
Musculus sp.
Modiolus sp.
Pectinidae
Chlamys sp.
Chlamys rubida
Limidae
Veneroida
Axinopsida serricata
Mysella sp.
Cardiidae
Clinocardium spp.
Clinocardium ciliatum
Clinocardium nuttallii
Neocardium centrifolium
Serripes groenlandicus
Tellinidae
Macoma spp.
Tellina spp.
Tellina nuculoides
Veneridae
Transennella tantilla
Protothaca staminea
Psephidia lordi
Myidae
Mya spp.
Hiatellidae
Panomya sp.

Cephalopoda
Octopodia
Octopodidae

Appendix Table 6. A complete list of foods that were identified during this study - continued.

Arachnida
Halacaridae

Pycnogonida

Crustacea
Eucladocera
Podon sp.

Ostracoda

Copepoda
Calanoida
Harpacticoida
Cyclopoida
Caligoida
Caligidae

Cirripedia
Balanomorpha
Balanus sp.
Balanus glandula
Lepas sp.

Malacostraca
Leptostraca
Nebaliidae

Mysidacea

Cumacea

Tanaidacea

Isopoda
Flabellifera
Sphaeromatidae
Gnorimosphaeroma spp.
G. lutea
G. oregonensis
Exosphaeroma amphlicauda
Dynamenella sheareri
Limnoria spp.
Valvifera
Idoteidae
Saduria sp.
Saduria entomon
Idotea spp.
Idotea resecata
Idotea fewkesi
Idotea wosnesenskii
Idotea rufescens
Idotea ochotensis

Asellota
Munnidae
Munna spp.

Amphipoda
Gammaridea
Ampithoidae
Corophiidae
Ampeliscidae
Calliopiidae
Halirages sp.
Eusiridae
Pontogeneia sp.
Gammaridae
Ischyroceridae
Lysianassidae
Phoxocephalidae
Pleustes sp.
Isaeidae

Hyperiidae

Caprellidea
Caprellidae

Eucarida

Euphausiacea
Thysanoessa sp.

Natantia
Hippolytidae
Lebbeus sp.
Lebbeus granimanus
Heptocarpus spp.
Heptocarpus brevirostris
Heptocarpus cristata
Eualis biunguis
Eualis townsendii
Spirontocaris sp.
Spirontocaris prionota
Spirontocaris ochotensis
Pandalidae
Pandalus spp.
Pandalus borealis
Pandalus goniurus
Pandalus hypsinotus
Pandalus montigui tridens
Crangonidae
Crangon spp.
Crangon septemspinosa
Crangon dalli
Sclerocrangon sp.

Appendix Table 6. A complete list of foods that were identified during this study - continued.

Argis sp.
Argis dentata

Reptantia
Anomura
Callianassidae
Paguridae
Pagurus spp.
Pagurus beringanus
P. hirsutiusculus
Pagurus capillatus
Pagurus granosimanus
Pagurus ochotensis
Labidochirus splendescens
Elassochirus tenimanus
Lithodidae
Parolithodes sp.
Cyptolithodes typicus
Phyllotithodes papillosa
Porcellanidae
Brachyura
Oxyrhyncha
Majiidae
Oregonia gracilis
Hyas lyratus
Chionocetes spp.
Pugettia spp.
Pugettia gracilis
Brachyrhyncha
Telemessus cheiragonus
Cancridae
Cancer spp.
Cancer magister
Cancer productus
Cancer oregonensis
Pinnotheridae
Pinnixa sp.

Insecta
Collembola
Homoptera
Coleoptera
Trichoptera
Diptera
Chironomidae
Hymenoptera

Sipuncula
Golfingia sp.

Echiura
Echiuroidea
Echiuridae
Echiurus sp.
Echiurus echiurus

Priapulida
Priapulus sp.
Priapulus caudatus

Bryozoa

Brachiopoda

Asteriidae

Ophiuroidea

Echinoidea
Strongylocentrotidae
Dendraster excentricus

Holothuroidea
Leptosynapta sp.

Chaetognatha
Saggitta sp.

Urochordata
Ascidacea
Thaliacea-Salpida
Larvacea
Oikopleura sp.

Teleostei
Clupeiformes
Clupeoidea
Clupeidae
Clupea harengus pallasi
Oncorhynchus gorbuscha
Osmeridae
Mallotus villosus
Gadiformes
Gadoidea
Gadidae
Gadus macrocephalus
Theragra chalcogramma
Lycodes sp.
Scorpaeniformes
Scorpaenidae

Appendix Table 6. A complete list of foods that were identified during this study - continued.

Hexagrammoidei
Hexagrammidae
Hexagrammos sp.
H. lagocephalus
H. octogrammus
Hexagrammos stelleri
Anoplopomatidae
Anoplopoma fimbria
Cottoidei
Cottidae
Leptocottus armatus
Gymnocanthus sp.
Gymnocanthus galeatus
Hemilepidotus sp.
Hemilepidotus jordani
Myoxocephalus spp.
Synchirus gilli
Agonidae
Cyclopteridae
Liparis rutteri
Perciformes
Trichodon trichodon
Bathymaster sp.
Bathymaster signatus
Stichaeidae
Lumpenus spp.
Lumpenus maculatus
Lumpenus sagitta
Anoplarchus purpurescences
Pholidae
Apodichthys flavidus
Pholis sp.
Pholis laeta
Ammodytes hexapterus
Pleuronectiformes
Pleuronectidae
Hippoglossoides elassodon
Lepidopsetta bilineata
Unidentified eggs
Plants & plant parts
Exuvia
Sand
Wood
Rock
Unidentified

Appendix Table 7. A complete list of foods eaten by species whose food habits were included in the beach seine – winter food web.

	Masked Greenling	*Mycoxocephalus* spp.	Rock Greenling	Dolly Varden	Rock Sole
Polychaeta	+	+	+	+	+
Nereidae	+			+	+
Opheliidae	+		+		+
Pectinariidae	+				
Serpulidae	+				
Bivalvia siphons	+		+		
Calanoida	+		+	+	
Gammaridea	+	+	+	+	+
Amphithoidae	+				
Calliopiidae	+			+	
Corophiidae	+				
Eusiridae	+	+			
Gammaridae		+			
Haliragcs sp.		+			
Ischyroceridae	+				
Pontogeneia sp.		+			
Natantia	+	+			
Crangonidae	+	+			
Hippolytidae	+				
Heptacarpus spp.	+		+		
H. brevirostris	+				
Teleostei	+	+	+		
Hexagrammidae larvae				+	
Pholidae		+			
Pholis laeta		+			

Appendix Table 8. A complete list of foods eaten by species whose food habits were included in the beach seine - spring food web.

	Myoxocephalus spp.	Dolly Varden	Masked Greenling	Pink Salmon	Pacific Sand Lance	Rock Sole	Rock Greenling
Algae			+	+		+	+
Chlorophyta						+	
Ulotricales			+			+	+
Phaeophyta	+		+				
Rhodophyta			+			+	+
Porphyra sp.						+	
Ahnfeltia sp.							+
Odonthalia sp.	+						
Phyllospadix sp.							+
Polychaeta		(+)	+		+	+	+
Amphar tidae			+				
Glyceridae			+			+	
Maldanidae			+				
Nereidae			+			+	+
Opheliidae			+			+	+
Oweniidae			+			+	
Pectinariidae			+				
Phyllodocidae			+				
Sepulidae			+				+
Spionidae						+	
Terebellidae			+				
Prosobranchia			+		+		+
Acmaeidae						+	
Notoacmaea fenistrata							+
Mesogastrooda			+				
Littorina spp.			+				
Littorina sitkana			+				+
Lacuna spp.			+				+
Lacuna carinata			+				+
Harpacticoida			+	+	+	+	+
Calanoida		(+)		+	+	+	+
Isopoda			+				
Flabellifera			+		+		+
Gnorimosphaeroma spp.			+				
G. oregonensis	+		+		+	+	+
Valvifera							
Idoteidae			+				
Idotea spp.			+				
I. wosnesenskii	+		+				+
Saduria entomon	+						
Asellota			+				
Munnidae			+				
Gammaridea	+	(+)	+	+	+	+	+
Amphithoidae					+		
Corophiidae			+	+			
Eusiridae							+
Gammaridae			+			+	
Natantia	+		+		+		
Hippolytidae							
Heptacarpus spp.			+				+
H. brevirostris			+				+
Pandalidae							
Pandalus spp.			+		+		+
Crangonidae			+				

Appendix Table 8. A complete list of foods eaten by species whose food habits were included in the beach seine - spring food web - continued.

	Myoxocephalus spp.	Dolly Varden	Masked Greenling	Pink Salmon	Pacific Sand Lance	Rock Sole	Rock Greenling
Reptantia	+		+				+
Reptantia zoea and megalops				+	+		
Anomura			+				
Paguridae			+	+			+
Paguridae megalops					+		
Pagurus beringanus			+				
P. granosimanus			+				
P. hirsutiusculus							+
Oxyrhyncha	+		+			+	+
Oxyrhyncha megalops					+		
Chionoecetes spp.	+						
Pugettia gracilis							+
Brachyrhyncha			+				
Telmessus cheiragonus	+		+				+
Cancer spp.			+				+
Cancer oregonensis	+		+				+
Cancer productus			+				
Teleostei	+	(+)	+				+
Teleostei larvae				+	+		
Ammodytes hexapterus	+						
Clupea harengus pallasi	+						
Cottoidei							+
Cottidae	+		+			+	
Myoxocephalus spp.			+			+	+
Pleuronectidae			+				

Appendix Table 9. A complete list of foods eaten by species whose food habits were included in the beach seine - summer (top) and autumn (bottom) food webs.

	Pink Salmon	Pacific Sand lance
Calanoida	+	+
Crustacea zoea		+
Cirripedia nauplius, cypris	+	+
Eucarida larvae	+	
Reptantia zoea	+	+
Reptantia megalops		+
Cumacea	+	
Insecta	+	
Insecta larvae, pupae	+	
Chironomidae larvae	+	+
Chironomidae pupae		+
Teleostei*	+	
Teleostei larvae		+
Hexagrammidae larvae	+	
Leptocottus armatus larvae		+

* prey of pink salmon adults >300 mm

	Dolly Varden	Masked Greenling	*Myoxocephalus* spp.	Rock Sole
Polychaeta	(+)	+	+	+
Goniadidae				+
Glyceridae		+		
Nereidae		+	+	
Nacnthes sp.		+		
Ophelidae		+		+
Pectinariidae				+
Phyllodocidae				+
Scalibregmidae				+
Serpulidae		+		
Spionidae				+
Gammaridea	(+)	+	+	+
Amphithoidae			+	
Corophiidae		+		
Teleostei	(+)		+	+
Ammodytes hexapterus			+	+
Cottidae		+		
Myoxocephalus spp.			+	
Cyclopteridae				
Liparis ruttari			+	
Pleuronectiformes			+	

Appendix Table 10. A complete list of foods eaten by species whose food habits were included in the trammel net - winter food web.

	Rock Greenling	Rock Sole	*Myoxocephalus* spp.
Polychaeta	+	+	+
Flabelligeridae	+	+	
Goniadidae		+	
Nereidae	+		
Opheliidae		+	
Pectinariidae	+	+	
Phyllodocidae		+	
Polynoidae	+		
Sabellidae	+		+
Serpulidae	+		
Spionidae		+	
Syllidae	+		
Nemertea		+	
Prosobranchia	+		(+)
Margarites spp.	+		
Calliostoma spp.	+		
Lacuna spp.	+		
Lacuna vincta	+		
Volutharpa ampullacea	+		
Lamellaria stearnsii	+		
Bivalvia siphons	+	+	
Natantia	+		(+)
Hippolytidae	+		
Heptacarpus spp.	+		
H. brevirostris	+		
Spirontocaris ochotensis	+		
Pandalidae			
Pandalus montagui tridens	+		
Reptantia		+	(+)
Anomura	+		
Paguridae		+	
Pagurus spp.			
Pagurus hirsutiusculus	+		
Lithodidae			
Paralithodes sp.	+		
Oxyrhyncha			
Oregonia gracilis	+		
Brachyrhyncha			
Cancer oregonensis	+		
Telmessus cheiragonus	+		
Teleostei	+		(+)
Cottidae	+		
Synchirus gilli	+		

Appendix Table 11. A complete list of foods eaten by species whose food habits were included in the trammel net - spring food web.

	Rock Greenling	Masked Greenling	Rock Sole
Polychaeta	+	+	+
Ampharetidae	+	+	
Capitellidae		+	
Flabelligeridae	+	+	
Glyceridae	+	+	+
Goniadidae		+	
Lumbrineridae	+		+
Maldanidae	+	+	+
Nereidae	+	+	
Opheliidae	+	+	+
Orbinidae			+
Oweniidae	+	+	+
Pectinariidae		+	+
Phyllodocidae			+
Polynoidae	+		
Sabellariidae	+		
Sabellidae		+	
Serpulidae	+	+	+
Spionidae			+
Syllidae			+
Bivalvia siphons	+	+	+
Gammaridea	+	+	+
Amphithoidae	+	+	+
Corophiidae	+	+	
Gammaridae		+	
Decapoda	+	+	+
Anomura	+	+	
Paguridae	+	+	+
Pagurus sp.	+	+	
P. beringanus	+	+	
P. hirsutiusculus	+	+	+
Lithodidae	+		
Brachyura	+	+	+
Oxyrhyncha	+	+	+
Chionoecetes spp.		+	
Oregonia gracilis	+	+	+
Pugettia spp.	+	+	
Pugettia gracilis	+	+	
Brachyrhyncha	+	+	
Cancer spp.	+	+	
Cancer magister	+		
Cancer oregonensis	+	+	
Telemessus cheiragonus	+	+	+
Teleostei	+	+	+
Perciformes	+		
Ammodytes hexapterus	+		+
Stichaeidae	+		
Pholidae			
Pholis laeta	+		
Scorpaeniformes (larvae)	+		
Hexagrammidae	+		
Cottoidei	+	+	
Cottidae	+	+	
Hemilepidotus sp.	+		
Myoxocephalus spp.		+	
Gadiformes	+		
Pleuronectidae		+	

Appendix Table 12. A complete list of foods eaten by species whose food habits were included in the trammel net - summer food web.

	Rock Greenling	Masked Greenling	Whitespotted Greenling
Gammaridea	+	+	+
Amphithoidae	+		
Corophiidae	+	+	+
Eusiridae		+	
Gammaridae		+	
Pleustes sp.		+	
Reptantia	+	+	+
Callianassidae			+
Paguridae	+	+	+
Pagurus spp.	+	+	+
P. beringanus	+	+	+
P. hirsutiusculus	+	+	+
Lithodidae	+	+	+
Paralithodes sp.	+		+
Cryptolithodes typicus	+		
Phyllolithodes papillosus	+		
Porcellanidae			+
Brachyura	+	+	+
Oxyrhyncha	+	+	+
Majidae	+		
Chionocetes spp.	+	+	+
Hyas lyratus	+	+	+
Oregonia gracilis	+		
Pugettia spp.	+	+	+
Pugettia gracilis	+	+	+
Brachyrhyncha	+		
Cancer spp.	+	+	
Cancer magister	+		+
Cancer oregonensis	+	+	+
Telmessus cheiragonus	+	+	+
Teleostei	+	+	+
Perciformes	+		+
Ammodytes hexapterus	+	+	+
Pholidae			
Pholis sp.	+		
Pholis laeta	+		
Stichaeidae			+
Lumpenus spp.			+
Hexagrammidae	+	+	+
Hexagrammos spp.	+		
Cottidae	+	+	+
Myoxocephalus spp.	+	+	+
Cyclopteridae	+	+	
Pleuronectiformes			+
Pleuronectidae			+
Hippoglossoides elassodon			+
Teleostei eggs	+	+	+
Unidentified eggs	+	+	+

Appendix Table 13. A complete list of foods eaten by species whose food habits were included in the trammel net - autumn food web.

	Rock Greenling	*Hyoxocephalus* spp.	Masked Greenling
Polychaeta	+	+	+
Flabelligeridae	+		+
Goniadidae			+
Glyceridae			+
Nephtyidae	+		
Nereidae	+		+
Opheliidae	+		+
Pectinariidae	+		+
Phyllodocidae			+
Polynoidae			+
Sabellidae	+		
Serpulidae	+		+
Prosobranchia	+		+
Acmaeidae	+		
Margarites spp.	+		
Littorina sitkana	+		
Lacuna spp.	+		+
Lacuna vincta	+		
Buccium sp.	+		
Volutharpa ampullacea	+		
Olivella sp.	+		
Gammaridea	+	+	+
Corophiidae	+		
Heptantia	+		+
Paguridae	+		
Pagurus spp.	+		+
P. hirsutiusculus	+		+
Brachyura	+		+
Oxyrhyncha			
Chionoecetes spp.	+		
Oregonia gracilis	+		
Pugettia gracilis	+		+
Brachyrhyncha			
Cancer magister		+	
Cancer oregonensis	+		
Telmessus cheiragonus			+
Pinnotheridae			
Pinnixa sp.	+		
Teleostei	+	+	+
Ammodytes hexapterus			+
Pholidae	+		
Pholis laeta	+		
Stichaeidae			
Anoplarchus purpurescens	+		+
Cottidae	+		+
Hemilepidotus jordani			+

Appendix Table 14. A complete list of foods eaten by species whose food habits were included in the townet - winter (top) through townet - autumn (bottom) food webs.

	Pacific Sand Lance	Capelin
Calanoida	+	(+)

	Chum Salmon	Capelin	Threespine Stickleback	Pink Salmon
Harpacticoida	+		(+)	+
Calanoids	+	+	(+)	+
Euphausiacea			(+)	
Insecta	+			+
Diptera	+			+
Chironomidae larvae	+			

	Pacific Sand Lance	Pink Salmon
Harpacticoida	+	+
Calanoida	+	+
Cirripedia nauplius	+	
Cirripedia cypris	+	+
Reptantia zoea	+	+
Reptantia megalops	+	+
Paguridae zoea	+	
Paguridae megalops	+	
Diptera		+
Diptera larvae		+
Larvacea		+
Oikopleura sp.	+	+
Teleostei		+
Ommeridae larvae		+

	Capelin
Calanoida	(+)

Appendix Table 15. A complete list of foods eaten by species whose food habits were included in the trynet - winter food web.

	Rock Sole	*Gymnacanthus* spp.
Polychaeta	+	(+)
Capitellidae	+	
Cirratulidae	+	
Flabelligeridae	+	
Glyceridae	+	
Goniadidae	+	
Lumbrineridae	+	
Maldanidae	+	
Nephytidae	+	
Nereidae	+	
Opheliidae	+	
Orbinidae	+	
Pectinariidae	+	
Phyllodocidae	+	
Polynoidae	+	
Sabellidae	+	
Serpulidae	+	
Spionidae	+	
Bivalvia siphons	+	
Teleostei	+	+
Ammodytes hexapterus	+	
Osmeridae larvae	+	
Cottidae	+	

Appendix Table 16. A complete list of foods eaten by species whose food habits were included in the trynet - spring food web.

	Yellowfin Sole	Rock Sole	*Gymnocanthus* spp.
Polychaeta	+	+	(+)
Ampharetidae	+	+	
Cirratulidae		+	
Eunicidae	+		
Glyceridae	+	+	
Goniadidae		+	
Lumbrineridae	+	+	
Maldanidae	+	+	
Nephtyidae	+		
Nereidae	+	+	
Opheliidae	+	+	
Orbinidae		+	
Oweniidae	+	+	
Pectinariidae	+	+	
Phyllodocidae	+	+	
Pilargidae		+	
Polynoidae	+	+	
Sabellariidae	+	+	
Sabellidae		+	
Serpulidae	+	+	
Spionidae	+	+	
Terebellidae	+	+	
Bivalvia siphons	+	+	
Reptantia	+	+	
Anomura	+		
Lithodidae	+		
Paralithodes sp.	+	+	
Paguridae		+	
Pagurus spp.	+	+	
Pagurus capillatus	+		
Brachyura	+	+	
Oxyrhyncha	+	+	
Chionoecetes spp.	+	+	
Oregonia gracilis	+		
Brachyrhyncha		+	
Teleostei	+	+	(+)
Ammodytes hexapterus		+	
Lumpenus maculatus		+	
Clupeiformes		+	
Osmeridae	+	+	
Mallotus villosus	+	+	
Gadidae	+		
Hexagrammidae		+	
Cottidae		+	
Agonidae		+	
Pleuronectidae		+	

Appendix Table 17. A complete list of foods eaten by species whose food habits were included in the trynet - summer food web.

	Yellowfin Sole	Rock Sole	*Myoxocephalus* spp.
Polychaeta	+	+	+
Ampharetidae	+	+	
Euphrosinidae	+		
Flabelligeridae	+	+	
Glyceridae	+	+	
Goniadidae	+	+	
Lumbrineridae	+	+	
Maldanidae	+	+	
Nephthyidae	+	+	
Nereidae	+	+	
Onuphidae		+	
Opheliidae	+	+	
Orbinidae	+	+	
Oweniidae	+	+	
Pectinariidae	+	+	
Phyllodocidae	+	+	
Polynoidae	+	+	
Sabellariidae	+	+	
Sabellidae	+	+	
Scalibregmidae	+	+	
Serpulidae		+	
Spionidae		+	
Syllidae	+	+	
Terebellidae	+	+	
Bivalvia siphons	+	+	
Bivalvia	+	+	
Nuculoida	+		
Nuculanidae	+	+	
Nuculana sp.			
Yoldia spp.		+	
Nuculidae			
Nucula sp.		+	
Cardiidae	+		
Clinocardium spp.	+	+	
Tellinidae	+	+	
Tellina spp.		+	
Veneridae			
Protothaca staminea		+	
Natricidae			
Spisula sp.	+		
Pectinidae		+	
Myidae		+	
Hiatellidae	+		
Natantia	+	+	
Hippolytidae	+	+	
Pandalidae			
Pandalus borealis	+		
Pandalus goniurus	+		
Pandalus hypsinotus		+	
Crangonidae	+		
Reptantia	+	+	
Paguridae	+	+	+
Pagurus spp.	+		+
Brachyura	+	+	
Oxyrhyncha	+	+	+
Chionoecetes spp.	+	+	+
Hyas lyratus	+	+	+
Oregonia gracilis			+

Appendix Table 17. A complete list of foods eaten by species whose food habits were included in the trynet - summer food web - continued.

	Yellowfin Sole	Rock Sole	*Myoxocephalus* spp.
Teleostei	+	+	+
Perciformes	+		
Ammodytes hexapterus	+	+	+
Stichaeidae		+	
Lumpenus spp.			+
Pholidae		+	
Apodichthys flavidus		+	
Clupeiformes		+	
Clupea harengus pallasi		+	
Osmeridae		+	
Mallotus villosus			
Gadidae			
Theragra chalcogramma	+		+
Pleuronectiformes	+		+
Lepidopsetta bilineata		+	

Appendix Table 18. A complete list of foods eaten by species whose food habits were included in the trynet - autumn food web.

	Rock Sole	Yellowfin Sole	*Myoxocephalus* spp.
Polychaeta	+	+	+
Ampharetidae	+	+	
Arabellidae	+		
Capitellidae	+	+	
Cirratulidae	+		
Flabelligeridae	+		
Glyceridae	+	+	
Goniadidae	+	+	
Lumbrineridae	+	+	
Maldanidae	+	+	
Nephtyidae	+	+	
Nereidae	+	+	
Onuphidae	+		
Opheliidae	+	+	
Orbinidae	+		
Oweniidae		+	
Pectinariidae	+	+	
Phyllodocidae	+	+	
Polynoidae	+	+	
Scalibregmidae	+	+	
Serpulidae	+		
Spionidae	+	+	
Syllidae	+	+	
Terebellidae	+		
Bivalvia	+	+	
Nuculidae			
Nucula sp.		+	
Nucula tenuis	+		
Nuculanidae	+	+	
Nuculana sp.	+	+	
Yoldia spp.		+	
Cardiidae		+	
Tellinidae			
Tellina nuculoides		+	
Thyasiridae			
Axinopsida serricata		+	
Gammaridea	+	+	
Isaeidae	+		
Euphausiacea	+		
Paguridae	+	+	+
Pagurus spp.		+	
Pagurus capillatus		+	
Pagurus hirsutiusculus	+		
Labidochirus splendescens	+		
Oxyrhyncha	+		
Chionoecetes spp.	+	+	+
Brachyrhyncha	+	+	
Cancer spp.	+	+	
Cancer magister	+		
Pinnotheridae	+		
Teleostei	+	+	+
Perciformes	+		
Ammodytes hexapterus	+	+	
Stichaeidae			
Lumpenus spp.		+	
Lumpenus sagitta		+	+
Osmeridae larvae	+	+	
Mallotus villosus		+	
Gadidae			
Theragra chalcogramma	+	+	
Cottidae			
Gymnocanthus spp.			+
Pleuronectiformes		+	
Eggs			(+)

Appendix Table 19. A complete list of foods eaten by species whose food habits were included in the otter trawl - winter food web.

	Rock Sole	Yellowfin Sole	*Myoxocephalus* spp.
Polychaeta	+		
Glyceridae	+		
Goniadidae	+		
Phyllodocidae	+		
Polynoidae		+	
Natantia	+	+	
Hippolytidae			
Pandalidae			
Pandalus borealis	+	+	
Crangonidae	+		
Reptantia			+
Pagurus spp.	+	+	
Pagurus capillatus	+		
Brachyura		+	
Chionoecetes spp.			+
Hyas lyratus			+
Oregonia gracilis		+	
Teleostei	+	+	+
Ammodytes hexapterus	+	+	+
Pholis laeta		+	
Trichodon trichodon			+
Gymnocanthus galeatus			+
Lepidopsetta bilineata			+
Teleostei eggs	+	+	+

Appendix Table 20. A complete list of foods eaten by species whose food habits were included in the otter trawl - spring food web.

	Rock Sole	Yellowfin Sole	*Myoxocephalus* spp.	Yellow Irish Lord	Flathead Sole	Pacific Cod	*Gymnocanthus* spp.
Polychaeta	+	+		+	+	+	(+)
Ampharetidae	+	+					
Capitellidae					+		
Eunicidae				+			
Glyceridae	+						
Goniadidae				+			
Lumbrineridae	+	+					
Maldanidae	+	+			+		
Onuphidae	+						
Phyllodaidae	+						
Spionidae		+					
Prosobranchia	+	+			+		
Acmaeidae	+		+				
Lepeta (Cryptobranchia) sp.	+	+					
Puncturella sp.	+	+					
P. multistriata			+				
Bullidae	+						
Cymatiidae							
Fusitriton oregonensis						+	
Naticidae							
Natica sp.			+				
Bivalvia	+	+	+	+	+	+	(+)
Nuculidae							
Nucula sp.					+		
Nuculanidae							
Nuculana sp.					+		
Yoldia spp.	+	+		+		+	
Tellinidae	+						
Macoma spp.	+	+					
Pectinidae		+					
Limidae		+					
Veneridae				+			
Mytilidae							
Mytilus edulus						+	
Cardiidae							
Clinocardium spp.		+					
Clinocardium ciliatum		+					
Natricidae							
Spisula sp.		+					
Euphausiacea		+			+		(+)
Natantia	+	+	+	+	+	+	(+)
Hippolytidae							
Eualus biunguis						+	
Pandalidae	+	+	+	+	+	+	
Pandalus spp.			+		+		
Pandalus borealis	+	+	+	+	+	+	
Pandalus goniurus			+	+		+	
Pandalus hypsinotus			+	+	+	+	
Crangonidae			+				
Crangon spp.						+	
Crangon septemspinosa						+	
Argis dentata			+				
Reptantia	+	+	+	+	+	+	
Lithodidae			+				
Paguridae		+		+		+	
Brachyura		+	+	+		+	
Oxyrhyncha	+	+	+	+	+	+	
Chionoecetes spp.		+	+	+	+	+	
Oregonia gracilis				+			
Brachyrhyncha				+			

Appendix Table 20. A complete list of foods eaten by species whose food habits were included in the otter trawl - spring food web - continued.

	Rock sole	Yellowfin Sole	*Myoxocephalus* spp.	Yellow Irish Lord	Flathead Sole	Pacific Cod	*Gymnocanthus* spp.
Cancer spp.			+				
Pinnotheridae				+			
Teleostei	+	+	+	+	+	+	(+)
Perciformes			+		+		
Ammodytes hexapterus						+	
Stichaeidae		+					
Lumpenus sagitta					+		
Pholidae							
Apodichthys flavidus					+		
Zoarcidae							
Lycodes spp.					+		
Clupeidae							
Clupea harengus pallasi					+	+	
Osmeridae			+			+	
Salmonidae							
Oncorhynchus gorbuscha						+	
Gadoidea			+				
Gadidae			+			+	
Theragra chalcogramma						+	
Scorpaenidae			+				
Anoplopomatidae							
Anoplopoma fimbria			+	+			
Cottidae	+	+	+	+	+	+	
Gymnocanthus spp.			+				
Hemilepidotus sp.			+				
Hemilepidotus jordani			+			+	
Agonidae							
Pleuronectidae			+		+		

Appendix Table 21. A complete list of foods eaten by species whose food habits were included in the otter trawl - summer food web.

	Flathead Sole	Yellowfin Sole	Yellow Irish Lord	*Myoxocephalus* spp.	Rock Sole	Pacific Halibut	Walleye Pollock	*Gymnocanthus* spp.
Polychaeta		+	+	+	+			(+)
Ampharetidae					+			
Cirratulidae					+			
Glyceridae					+			
Goniadidae		+			+			
Lumbrineridae		+			+			
Maldanidae	+				+			
Nageloniidae					+			
Nephtyidae					+			
Onuphidae			+		+			
Pectinariidae					+			
Phyllodocidae		+			+			
Sabellariidae					+			
Serpulidae					+			
Spionidae					+			
Terebellidae					+			
Prosobranchia		+	+					
Lepeta (Cryptobranchia) sp.		+			+			
Puncturella sp.			+		+			
Bivalvia	+	+			+	+		(+)
Nuculidae								
Nucula sp.					+			
Nuculanidae								
Nuculana sp.					+			
Yoldia spp.					+			
Pectinidae								
Chlamys sp.		+						
Cardiidae								
Clinocardium ciliatum		+						
Tellinidae					+			
Macoma spp.		+			+			
Calanoida	+	+			+		+	
Euphausiacea	+	+	+				+	(+)
Natantia	+	+	+	+	+	+	+	(+)
Pandalidae	+		+	+			+	
Pandalus spp.	+							
Pandalus borealis	+	+	+	+			+	
Pandalus goniurus							+	
Pandalus hypsinotus	+		+	+				
Crangonidae			+					
Crangon dalli								+
Reptantia	+	+			+			+
Paguridae	+	+	+			+		+
Pagurus spp.					+			
Brachyura	+	+	+		+			+
Oxyrhyncha			+		+			
Majidae								+
Chionoecetes spp.		+	+	+	+	+		
Hyas lyratus				+				
Oregonia gracilis				+				
Brachyrhyncha				+				
Cancer oregonensis				+				

Appendix Table 21. A complete list of foods eaten by species whose food habits were included in the otter trawl - summer food web - continued.

	Flathead Sole	Yellowfin Sole	Yellow Irish Lord	*Myoxocephalus* spp.	Rock Sole	Pacific Halibut	Walleye Pollock	*Gymnocanthus* spp.
Teleostei	+	+	+	+	+	+	+	(+)
Perciformes	+						+	
Ammodytes hexapterus	+	+	+				+	
Stichaeidae	+							
Lumpenus spp.	+							
Lumpenus maculatus			+					
Pholidae								
Pholis laeta							+	
Clupeiformes			+		+			
Clupeoidei			+		+			
Clupea harengus pallasi	+	+						
Osmeridae								
Mallotus villosus	+		+	+			+	
Hexagrammidae	+							
Cottidae	+		+	+				
Gymnocanthus sp.				+				
Pleuronectidae				+	+			

Appendix Table 22. A complete list of foods eaten by species whose food habits were included in the otter trawl - autumn food web.

	Yellowfin Sole	Yellow Irish Lord	*Hyoxocephalus* spp.	Rock Sole	Arrowtooth Flounder	Flathead Sole	Walleye Pollock	Pacific Tomcod
Polychaeta	+			+		+		
Ampharetidae	+			+				
Arabellidae				+				
Capitellidae						+		
Eunicidae				+				
Glyceridae				+				
Goniadidae	+			+				
Lumbrineridae				+				
Maldanidae	+							
Nereidae	+							
Opheliidae				+		+		
Onuphidae				+				
Pectinariidae	+					+		
Phyllodocidae	+	+		+				
Polynoidae	+					+		
Sabellidae	+			+		+		
Serpulidae				+				
Syllidae	+							
Bivalvia	+	+		+				
Nuculidae								
Nucula sp.	+							
Nucula bellotti				+				
Nuculanidae								
Yoldia spp.				+				
Tellinidae	+	+		+				
Tellina spp.				+		+		
Macoma spp.						+		
Pectinidae		+						
Chlamys rubida	+							
Thyasiridae								
Axinopsida serricata	+			+				
Gammaridea	+	+	+	+		+	+	+
Mysidacea		+	+	+		+	+	+
Natantia	+	+	+	+	(+)	+	+	+
Hippolytidae						+		
Eptacarpus brevirostris								
Pandalidae	+	+		+		+	+	
Pandalus borealis		+	+			+	+	
Pandalus hypsinotus		+						
Crangonidae		+				+	+	
Crangon sp.								+
Reptantia	+	+						
Paguridae	+	+	+	+		+		
Pagurus spp.		+						
Pagurus ochotensis		+						
Elassochirus tenuimanus		+						
Brachyura	+	+						
Oxyrhyncha		+	+	+		+		
Chionoecetes spp.	+	+	+	+		+		
Oregonia gracilis	+	+				+		
Brachyrhyncha								
Telmessus cheiragonus	+							
Cancridae		+						
Cancer oregonensis		+						
Pinnotheridae		+						
Teleostei	+	+	+		(+)	+	+	+
Ammodytes hexapterus	+							
Pholidae						+		
Gadidae						+	+	
Theragra chalcogramma	+	+					+	+
Scorpaeniformes			+					