NOAA Technical Report NMFS 57 July 1987

Food Habits and Dietary Variability of Pelagic Nekton off Oregon and Washington, 1979-1984

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National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA TECHNICAL REPORT NMFS

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ABSTRACT

The food habits of 20 species of pelagic nekton were investigated from collections made with small-mesh purse seines from 1979-84 off Washington and Oregon. Four species (spiny dogfish, *Squalus acanthias*; soupfin shark, *Galeorhinus zyopterus*; blue shark, *Prionace glauca*; and cutthroat trout, *Salmo clarki*) were mainly piscivorous. Six species (coho salmon, *Oncorhynchus kisutch*; chinook salmon, *O. tshawytscha*; black rockfish, *Sebastes melanops*; yellowtail rockfish, *S. flavidus*; sablefish, *Anoplopoma fimbria*; and jack mackerel, *Trachurus symmetricus*) consumed both nektonic and planktonic organisms. The remaining species (market squid, *Loligo opalescens*; American shad, *Alosa sapidissima*; Pacific herring, *Clupea harengus pallasi*; northern anchovy, *Engraulis mordax*; pink salmon, *O. gorbuscha*; surf smelt, *Hypomesus pretiosus*; Pacific hake, *Merluccius productus*; Pacific saury, *Cololabis saira*; Pacific mackerel, *Scomber japonicus*; and medusafish, *Icichthys lockingtoni*) were primarily planktonic feeders. There were substantial interannual, seasonal, and geographic variations in the diets of several species due primarily to changes in prey availability. Juvenile salmonids were not commonly consumed by this assemblage of fishes.

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INTRODUCTION

A recent approach to feeding ecology has been to study the food habits of an entire assemblage of fishes, or at least the important components within that assemblage (Tyler 1972; Sedberry and Musick 1978; Hacunda 1981; MacPherson 1981; Langton 1982; Sedberry 1983). Such an approach may be valuable to many of the recent multispecies management models that consider the trophic interactions (competition or predation) that occur among the species being managed (Anderson and Ursin 1977; May et al. 1979; Jones 1982; Tyler et al. 1982; Livingston 1986). Unfortunately, data on trophic parameters needed for these models are either unknown or widely scattered throughout the literature (Livingston 1985).

The pelagic upwelling ecosystem in the northeast Pacific Ocean includes high standing stocks of a diverse assemblage of nektonic consumers (Brodeur and Pearcy 1986). Although trophic interactions among the dominant nektonic species found in the coastal pelagic ecosystem off Oregon and Washington have been examined (Brodeur et al. 1987), little information exists on the detailed food habits of the species comprising this assemblage.

This paper provides details on interannual variability in the taxonomic composition of the diet of 20 species of pelagic nekton sampled on the continental shelf off Oregon and Washington from 1979 to 1984. Seasonal and geographic variations in the diets of the dominant species are also discussed. Predation upon juvenile salmonids by this assemblage of nekton is evaluated and discussed.

MATERIALS AND METHODS

Collection of stomachs

Stomach contents used in this study were collected during six years (1979-84) of purse seining surveys operating between Cape Flattery (lat. 48°20′) in northern Washington to Cape Blanco (lat. 43°00′) in southern Oregon (Fig. 1). A detailed description of the sampling methodology is given in Pearcy (1984). A total of 843 round haul sets were made with a herring purse seine of 32-mm mesh, 457 to 495 m long, that fished to depths of 15 to 65 m. Each set encompassed a large volume (up to 10^6 m^3) of water. Sets were made at predetermined locations to quantitatively assess nekton distributions within the sampling area. Most sets were made along parallel transect lines (37 km apart) extending offshore from 6 to 56 km from the coastline. The sets were generally completed in less than 1 h and the majority were made during daylight hours. Of the 15 cruises conducted, six were in June (1979-84), three in May (1981-83), three in September (1982-84), two in July (1981 and 1984), and one in August (1981).

On board, fish were identified and measured. A random subsample of five individuals per species per set (when available) were set aside for stomach collections. When one species dominated the catch in a set, up to 10 stomachs of that species were collected. Stomachs from the larger specimens were excised on board the vessel and individually placed in labelled bags and immersed in 10% formalin-seawater mixture. Smaller specimens were preserved whole and their stomachs were later dissected out in the laboratory. Adult salmonids were differentiated from juveniles based on aging of scales and length-frequency analysis.

In the laboratory, stomachs were opened and the fullness of each was visually estimated and rated on a scale from 0 (empty) to 5 (distended). The state of digestion was then noted and assigned a value between 0 (well digested) and 4 (fresh). Prey were identified

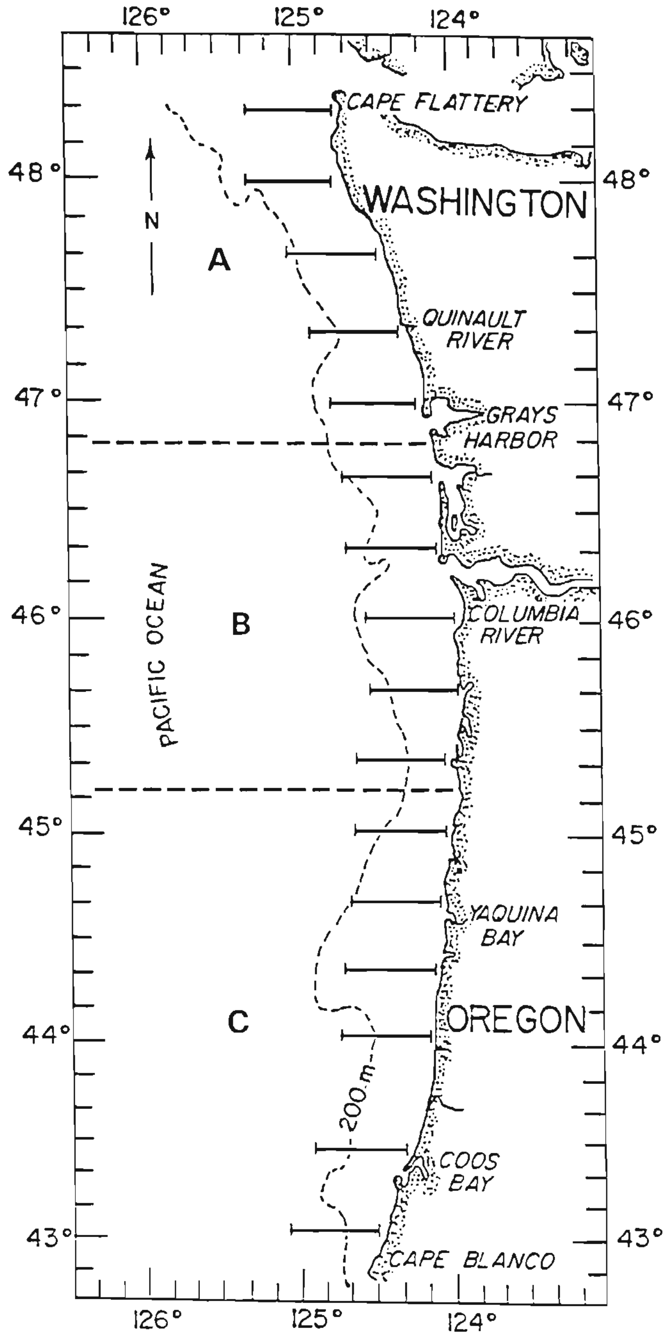

Figure 1
Location of area and transect lines sampled for nekton food habits. The geographic areas analyzed in detail are A) Washington, B) Columbia, and C) Oregon.

to the lowest possible taxonomic level using a dissecting microscope. Life history stage was also noted for all prey taxa. Each prey taxon was then enumerated, blotted with absorbent paper to remove excess moisture, and weighed to the nearest 0.01 g on an analytical balance. A total of 1,634 stomachs from 20 species of pelagic nekton were examined (Table 1). Included were adults of four major salmonid species and 16 species of squid and fishes which accounted for over 98% of the total abundance of nekton collected during the purse seine surveys (Brodeur and Pearcy 1986).

Table 1
Summary of stomach analysis of 20 species of pelagic nekton collected off Oregon and Washington, 1979-84.

	No. stomachs analyzed						
Species	1979	1980	1981	1982	1983	1984	Total
Loligo opalescens	—	—	43	—	—	17	60
Squalus acanthias	10	5	23	81	34	22	175
Galeorhinus zyopterus	—	—	1	6	3	4	14
Prionace glauca	—	—	6	3	3	2	14
Alosa sapidissima	—	—	20	—	8	—	28
Clupea harengus pallasi	—	—	49	11	27	7	94
Engraulis mordax	—	—	18	—	—	—	18
Oncorhynchus kisutch	22	11	87	65	33	40	258
O. tshawytscha	2	5	20	31	26	19	103
O. gorbuscha	—	—	10	—	—	—	10
Salmo clarki	—	—	32	6	4	6	48
Hypomesus pretiosus	—	—	5	—	12	—	17
Merluccius productus	—	—	35	65	18	66	184
Cololabis saira	—	—	5	—	28	29	62
Sebastes melanops	—	—	5	29	20	34	88
S. flavidus	—	—	—	6	—	8	14
Anoplopoma fimbria	—	—	98	14	18	16	146
Trachurus symmetricus	—	—	—	25	48	59	132
Scomber japonicus	—	—	—	—	57	88	145
Icichthys lockingtoni	—	—	—	13	11	—	24
Totals	34	21	457	355	349	417	1,634

Data Analysis

The contribution to the overall diet made by each prey taxa was examined by calculating the percent frequency of occurrence (F), percent of total number (N), and percent of total weight (W) for all prey taxa identified from the stomachs of a predator collected during a particular year of sampling. These three measures were then combined into an Index of Relative Importance [$IRI = F(N + W)$], modified from Pinkas et al. (1971) to include weight instead of volume measurements. Prey taxa with number and weight percentages of less than 0.1% of the total were automatically assigned a value of 0.1 in computing the IRI value. Occurrences of stomach contents that were completely unidentifiable to any taxonomic category were noted and these contents were weighed but were not assigned IRI values. In some cases, when the sample sizes for each year were small, the data for two or more years were combined in the tables.

In addition to year-to-year variation in food habits, the seasonal and geographic variation in the percentage weight composition of higher level categories (Classes to Phyla; see Table 2) were compared for the ten most abundant predator species. Although some information is lost when combining prey taxa into higher taxonomic categories, this approach was justified by the limited availability in time and space of many important prey items (ie., decapod larvae, fish larvae, and other meroplankton) to a particular predator. Thus, basic comparisons can be made of the utilization of main prey groups by a particular predator as they vary among the seasons and geographic areas.

To analyze seasonal changes in diets, the stomach collections were grouped by month of capture for all years in which they were collected. Seasonal analyses were based on the following months and number of sets (in parentheses): May (182), June (329), July-August (177), and September (155). To compare geographic variations within the area sampled, food habits were summarized for all years

Table 2
Major prey categories and some dominant taxa represented in this study.

Prey category	Major taxa represented
Cnidaria	*Velella*, Hydromedusae, Siphonophores
Ctenophores	*Pleurobrachia*
Annelida	*Tomopteris, Pelagobia*
Gastropoda	*Limacina*, Clionidae
Cephalopoda	*Loligo opalescens*, Gonatidae
Copepoda	*Neocalanus cristatus, N. plumchrus, Calanus* spp.
Mysidacea	*Neomysis*
Amphipoda	*Atylus tridens, Themisto pacifica, Hyperoche medusarum, Vibilia* spp.
Euphausiacea	*Thysanoessa spinifera, Euphausia pacifica, Nyctiphanes simplex*
Decapoda	*Cancer* spp., Pinnotheridae, Reptantia
Chaetognatha	*Sagitta elegans*
Thaliacea	Salpidae
Osteichthyes	Osmeridae, Clupeidae, Gadidae, Scorpaenidae, Cottidae, Hexagrammidae, Pleuronectidae

combined for the following regions (Fig. 1): Washington (north of 46°40′N), Columbia (46°40′N to 45°20′N), and Oregon (south of 45°20′N).

As the yearly, seasonal, and areal factors examined may not be totally independent of one other, the diets were examined from one year within one sampling month and one geographic area to examine the variability in feeding habits on a smaller scale when the sample size was sufficiently large to make meaningful comparisons.

RESULTS AND DISCUSSION

Summary of food habits

Loligo opalescens—Stomach contents of market squid were generally well masticated and it was often difficult to distinguish the specific identity of many prey items, despite the relative fullness of most stomachs. Identifiable prey were mostly small zooplankton or meroplankton species (Table 3). The dominant prey in 1981, by all the criteria examined, were chaetognaths. One species, *Sagitta elegans*, accounted for almost half the food by weight and numbers. Calanoid copepods were next most abundant although only a small percentage of these could be identified to species. Larval fish remains were found in a few stomachs, but only one rockfish (*Sebastes* sp.) specimen was identified based on opercular spines. Most of the stomachs examined from 1984 were empty. Decapod larvae, fish larvae, and hydromedusae were by weight the dominant prey.

A number of previous studies conducted off California showed that *Loligo* consumes a wide range of prey, including crustaceans (mostly euphausiids, mysids, copepods, and decapod larvae), polychaetes, cephalopods, and fishes (Fields 1965; Loukashkin 1977; Karpov and Cailliet 1978, 1979). Size, depth, and location of capture, but not the sex of the squid, made a substantial difference in the diet (Karpov and Cailliet 1979). Similar results were seen for *Loligo pealei* in the western Atlantic Ocean (Macy 1982).

Loligo opalescens collected off Oregon and Washington have a diet similar to those previously reported. However, none of the previous studies have shown chaetognaths to be even represented in the diet although we found them to be the major prey consumed in 1981. This discrepancy could be partly attributable to differences in sampling location but also may be the result of relatively fast digestion of these soft-bodied prey organisms, thereby causing some difficulty in specific identification. Since *Loligo* feeds by biting off smaller pieces of prey (Fields 1965), most of our chaetognaths were well macerated and our identifications were made from intact heads and hooked setae. As found in previous studies (Fields 1965; Loukashkin 1977), only one type of food was generally found in any particular stomach suggesting that market squid feed on concentrations of prey. Most of the squid with empty stomachs examined from 1984 had well-developed gonads and were collected from inshore spawning grounds. Fields (1965) and Karpov and Cailliet (1978) have noted a low incidence of feeding associated with spawning individuals.

Squalus acanthias—Stomach contents of spiny dogfish were well digested and often were unidentifiable beyond major taxonomic categories (Table 4). Digested fish remains such as bones or pieces of flesh were quite common. Occasionally, fully distended stomachs were found containing numerous whole adult fish such as herring (*Clupea harengus pallasi*) or northern anchovy (*Engraulis mordax*), or parts of a single large fish such as lingcod (*Ophiodon elongatus*) or Pacific hake (*Merluccius productus*). Euphausiids and *Cancer magister* megalopae dominated by number and adult fish by weight in the small 1979 and 1980 samples. Stomachs from 1981 contained mostly *Velella velella*, whereas the diet in 1982 was much more diverse. Fishes dominated by weight and euphausiids by number in 1983 and 1984.

Fishes dominated in weight composition for all months examined (Table 5). Cnidarians and euphausiids were the only other categories represented by more than 1.0% of prey weight. Geographically, euphausiids decreased substantially from north to south while the proportion of cnidarians increased to the south (Table 5). These prey categories were much less important than fishes in all three areas.

Squalus acanthias was common, especially in the northern part of the study area (Brodeur and Pearcy 1986). It is a highly mobile predator capable of inflicting heavy mortality on commercially utilized fish species (Alverson and Stansby 1963). Chatwin and Forrester (1953) and Jones and Geen (1977) studied spiny dogfish food habits off the West Coast of British Columbia and found that principal prey were euphausiids, decapods, and fishes such as herring (*Clupea harengus pallasi*), eulachon (*Thaleichthys pacificus*), Pacific hake (*Merluccius productus*) and several species of flatfish. In a study in Puget Sound and offshore waters of Washington, Bonham (1954) found *S. acanthias* preyed mainly on ratfish (*Hydrolagus colliei*), herring, and euphausiids, although a number of prey items were identified including several benthic species. Many of these same prey items were consumed by *S. acanthias* during our study. An exception to this was the pleustonic chondrophore, *Velella velella*, which occurred in over half the stomachs analyzed from 1981 but was not found in any other collection year. Euphausiids were a main food of many smaller specimens, while small fishes appear to be a preferred prey of larger specimens. *Squalus acanthias* may consume other foods, such as euphausiids and larger fishes, when available. The larger fishes, such as Pacific hake (*M. productus*), were found in small chunks as documented by Shippen and Alton (1967). The well-digested fish found in many of the stomachs may well be a result of infrequent meals and a protracted digestion period rather than continual consumption and rapid digestion (Jones and Geen 1977). The occurrence of both surface-dwelling (*V. velella*) and demersal (adult flatfishes) prey suggests that *S. acanthias* forages throughout the water column.

Galeorhinus zyopterus—Although only 14 soupfin shark stomachs were examined, most contained some food which consisted of mostly adult fishes and squid (Table 6). An adult American shad (*Alosa sapidissima*; FL=258 mm) and adult Pacific hake (heads only) were the main fishes eaten in 1981 and 1982, although in 1983 a more varied fish diet of anchovy, sculpins, and juvenile flatfish was consumed. Several of the stomachs collected in 1984 also contained cephalopod parts including one gonatid beak.

Although not commonly collected in our sampling, soupfin sharks are probably important consumers in the ecosystem due to their large size and voracious habits. Hart (1973) describes *G. zyopterus* as feeding throughout the water column on fishes and squids. Soupfin sharks have been observed feeding on saury and lanternfish at the surface off northern Oregon (Grinols and Gill 1968). Our data, although limited to the twelve fish which contained food, show similar feeding patterns. Adult Pacific hake (*M. productus*) were the most common fish consumed, indicating that soupfin sharks probably feed in midwater. The occurrence of *V. velella* in one stomach suggests that some surface feeding takes place. Cephalopods were represented only by hard parts (beaks and eyes) making it difficult to assess their importance to the diet of this species.

Prionace glauca—Fourteen blue shark stomachs were examined from four years, most of which contained some food (Table 7). The majority of the identifiable contents from 1981 and 1982 were species of pelagic fishes (herring, anchovy, and hake), whereas more benthic species of flatfishes (bothids and pleuronectids) predominated in 1983. The only other identifiable prey items were one unidentified squid in 1981 and beaks of the jumbo squid, *Moroteuthis robustus*, in 1984.

Blue sharks were commonly collected in late summer in warmer water during our collections. In pelagic regions of the open ocean, blue sharks consume mainly bony fishes (saury, salmon, lanternfish, and pomfret), squids, mesopelagic shrimp, and salps (Strasburg 1958; LeBrasseur 1964; Grinols and Gill 1968). Off California, *P. glauca* eats mostly schooling fishes (mainly anchovies) and cephalopods, as well as euphausiids and the pelagic red crab, *Pleuroncodes planipes* (Morejohn et al. 1978; Mearns et al. 1981; Tricas 1979). In addition to these prey, blue sharks are also known to eat marine mammals, birds, and inanimate objects floating at the surface (Compagno 1984). Our data, although including only a few individuals, show that *P. glauca* off Oregon and Washington consumes relatively large, actively-swimming nekton such as fishes and cephalopods.

Alosa sapidissima—Only a few prey taxa were identified from the stomachs of American shad (Table 8). Calanoid copepods were commonly consumed during both years in which stomach collections were made but were most important in 1981. Euphausiids were common in stomachs collected in 1981 and were the dominant prey (>95% by weight) in 1983. A larval squid, hyperiid amphipod, and a decapod larva were the only other prey identified.

There is a general dearth of knowledge on the feeding of American shad in Pacific marine waters. *Alosa sapidissima* from the Atlantic feed mainly on large copepods, euphausiids, and mysids (Grosslein and Azarovitz 1982). Shad from the Pacific feed on crustacean plankton and occasionally fishes (Hart 1973). Except for a single larval squid, all prey identified in the limited number of stomachs we examined were small crustaceans, which supports the contention that they are probably obligate planktivores specializing on euphausiids and copepods.

Clupea harengus pallasi—Herring consumed mostly smaller planktonic prey including copepods, pteropods, hyperiid amphipods, euphausiids, decapod and fish larvae (Table 9). In most cases, the contents were in an advanced stage of digestion and identifications were made from parts or appendages only. The greatest weight proportions from 1981-83 were euphausiids, with *Calanus* spp. and several hyperiids contributing much of the remainder. The limited number of herring stomachs collected from 1984, however, contained mostly *Calanus* spp., *Cancer* zoea, and a few euphausiids.

Euphausiids dominated the diet of herring during all time periods with the exception of July-August when copepods were more important by weight (Table 10). Decapod larvae were also important only during the July-August period. Examination by geographic area shows that euphausiids were most important off Washington and in the Columbia River area. Copepods and crab zoea were relatively more important off Oregon than the other areas (Table 10).

Adult Pacific herring appear to be one of the main vertebrate planktivores in coastal waters of the northeast Pacific. According to a detailed study by Wailes (1936) off British Columbia, *C. harengus pallasi* consumes exclusively pelagic crustaceans, namely euphausiids, copepods, and amphipods. Food appears to vary according to size of herring, area, and season of capture. Copepods and larval fishes dominate the diet of *C. harengus pallasi* by number and weight, respectively, in the Strait of Juan de Fuca (Simenstad et al. 1979). Pacific herring consumed many of the larger-sized copepods available in Yaquina Bay, Oregon, as well as clupeid fish larvae, ostracods, and detritus during periods of low copepod abundance (Russell 1964). Our results were similar to these studies. In addition, we found decapod larvae to be an important but never dominant part of the diet. Pacific herring appear to be opportunistic feeders, providing that the proper size of prey organisms are present.

Engraulis mordax—Northern anchovy stomachs ($n = 18$) were examined only from the 1981 collections and generally contained well-digested material (Table 11). Unidentified calanoid copepods and the pteropod, *Limacina helicina*, together accounted for almost 78% of the total weight. Euphausiids and *Cancer magister* megalopae were commonly found in the stomachs but represented a fairly low percentage of the weight and number totals.

Quantitative studies on the food habits of the northern subpopulation of northern anchovy, centered off the Columbia River, are limited. Anchovy fed on a wide variety of planktonic prey including fish larvae, copepods, decapod and barnacle larvae, and insects in northern Puget Sound (Simenstad et al. 1979). Loukashkin (1970), in the most detailed study of *E. mordax* food habits, found diatoms to be the dominant food item in northern anchovy stomachs collected in Monterey Bay and off Baja California, while anchovy off southern California and northern Baja consumed little plant matter but instead fed mostly on euphausiids and copepods. Mearns et al. (1981) found some evidence of herbivory in *E. mordax* off southern California but copepods made up the vast majority of identified contents.

We did not find any plant material in the stomachs we analyzed, yet the possibility cannot be ruled out, due to the limited number of stomachs examined, that *E. mordax* may subsist partly on phytoplankton off Oregon and Washington. As Loukashkin (1970) found, increasing the sample size of stomachs examined invariably increases the species list of prey taxa. Copepods, pteropods, euphausiids, and decapod larvae were often consumed by northern anchovy in our study area suggesting a broad diet for this species.

Oncorhynchus kisutch—Adult coho salmon consumed a wide variety of organisms (Table 12). In particular, euphausiids, decapod larvae (especially *Cancer* megalopae and pinnotherid larvae), and juvenile and adult fishes (especially *Engraulis mordax*) made up the majority of the diet in most years. Pronounced yearly differences were apparent in coho salmon diets. One or two prey species dominated the diet each year, although these were not always the same prey from year to year. The pelagic gastropod, *Limacina helicina*, and *Velella velella* were important components of the diet only during 1981. Euphausiids were the dominant prey in 1982 whereas crab larvae were more important numerically and gravimetrically in 1983 and 1984 than in other years.

Fishes were the most important prey of adult coho salmon for all cruise months. The percent weight of fishes increased throughout the summer so that by September about 95% of the diet was made up of this prey (Table 13). Euphausiids were of major importance in May and to a lesser extent in later months. Prey biomass consisting of decapod larvae peaked in June. Squid biomass was high during the July-August period due to the presence of eight adult *Loligo* in three stomachs. Geographically, euphausiids were consumed mainly off Washington and most of the cephalopods were consumed off Oregon (Table 13). Decapod larvae were taken in low proportions off the Columbia River compared with the other regions.

The feeding of adult coho salmon in coastal waters of the northeast Pacific is well studied due to the importance of this species in the commercial and sport fisheries. Off Washington in June, Silliman (1941) found that herring, sardines, and rockfishes were the major fish species consumed, and euphausiids and crab larvae were the important invertebrates in the diet. Similar results were found for coho salmon feeding off Vancouver Island (Prakash 1962; Beacham 1986) and off Oregon (Heg and Van Hyning 1951; Reimers 1964) although northern anchovies and sand lance were also found to be important components of the diet. Fresh et al. (1981) found that 96% of the prey biomass consumed by coho salmon caught off the Columbia River consisted of fishes, mainly anchovies. Morejohn et al. (1978) found euphausiids (almost exclusively *T. spinifera*) to be the dominant food of coho salmon in Monterey Bay, California. All these authors found substantial seasonal and geographic variations in the diet of *O. kisutch* suggesting that this species may prey on whatever is most available in a particular place and time.

Our results show that fishes are an important component of the adult coho diet. The importance of invertebrate prey may have been underestimated in past studies using mainly troll-caught specimens. Although the diversity of prey in our purse seine stomachs was high, only a few taxa made up most of the IRI proportions. In addition to the taxa found in previous studies, we found pteropods, *Velella*, and crab zoea to be important at certain times. Coho salmon stomachs from this study were often distended, with one prey species suggesting that this species may be opportunistic in its feeding.

Oncorhynchus tshawytscha—Adult chinook salmon fed mainly on fishes, especially northern anchovy (*Engraulis mordax*). Also consumed were *Cancer* spp. megalopae and several species of euphausiids (Table 14). Year-to-year variations in the diet of this species were not substantial. Many more prey species were identified in the 1983 stomachs despite a smaller sample size and similar overall state of digestion compared with 1982. Many juvenile lanternfishes (*Stenobrachius leucopsarus*) were found in three chinook salmon stomachs collected at one station off northern Washington in 1983. The condition of the 1981 stomach contents was poor and few prey items could be identified (Table 14).

There was little change with season in the major food categories eaten by adult chinook salmon. Fishes were the most important food throughout the summer (Table 15). Euphausiids, however, were secondarily important early in the summer. Pteropods were consumed mainly in July-August and were the only other prey of any importance. As with coho salmon, euphausiids were the dominant food category off Washington, particularly during 1984, while fishes represented almost the entire diet off the Columbia River and Oregon.

The feeding habits of northeastern Pacific chinook salmon are also well known, especially off the west coast of North America. Most of the studies of coho salmon mentioned previously, with the exception of Reimers (1964), also included data on chinook. These authors found chinook salmon to be even more piscivorous than coho, consuming primarily anchovy, herring, and juvenile rockfishes. Euphausiids generally comprised less than 10% of the diet in most studies, although Beacham (1986) found euphausiids made up about 40% of the diet of troll-caught chinook off southern Vancouver Island. Merkel (1957) also confirmed the piscivorous habits of chinook salmon in a sampling from the sport fishery off California. However, he found that euphausiids, squid, and crab larvae were also important during spring and early summer months.

Adult chinook salmon captured in our purse seines ate substantially more crustaceans than previous studies have indicated. A possible reason for this could be that most of the previous studies examined troll-caught fishes, which may have been feeding mainly on fish prey prior to capture. This would have underestimated feeding on crustaceans. In addition, many of the stomachs from our study were collected in May and June (Table 15), when the proportion of non-fish prey is relatively high (Merkel 1957). Hyperiid amphipods, small decapod larvae, and *Limacina* were generally less important food items for chinook than coho, implying that the former species utilizes mainly larger zooplankton and fish prey.

Oncorhynchus gorbuscha—A limited number (n = 10) of adult pink salmon stomachs were examined from 1981. The dominant food item was the pteropod, *Limacina helicina*, on both a number and weight basis (Table 16). When *L. helicina* was present, it was the only prey item found and large numbers were compacted into a tight bolus in these stomachs. *Cancer* crab megalopae and zoea were also important forage items for some pink salmom. Larval and juvenile fishes were also found but were usually unidentifiable.

The offshore food habits of adult pink salmon in the North Pacific Ocean are well known (see review by Takagi et al. 1981). Hyperiid amphipods, euphausiids, and fishes were the main foods found in most studies. The feeding of *O. gorbuscha* in coastal waters is more poorly known. Pink salmon stomachs collected in inshore waters of Puget Sound and the Strait of Juan de Fuca contained primarily crustaceans (euphausiids, hyperiid amphipods, and decapod larvae) while those collected off the Columbia River contained anchovies and *Cancer magister* larvae (Fresh et al. 1981; Beacham 1986). From our limited number of collections, all taken off Washington in 1981, most of the pink salmon diet consisted of smaller zooplankton species such as *Limacina* and decapod larvae and, to a lesser degree, euphausiids and fish larvae.

Salmo clarki—Cutthroat trout adults were mostly piscivorous, although several invertebrate taxa were often consumed (Table 17). Juvenile and adult northern anchovies were the dominant prey in stomachs collected from 1981 and 1984. There was also evidence of predation on juvenile salmonids during these two years which will be discussed in detail later in this paper. Cutthroat stomachs from 1982 contained many juvenile kelp greenlings (*Hexagrammos decagrammus*) and several other juvenile fishes, whereas juvenile rockfishes were the dominant food gravimetrically and numerically in the few stomachs collected in 1983. The highest numbers of euphausiids and insects were from stomachs collected in 1984.

Virtually no previous studies have been conducted on the marine food of anadromous cutthroat trout. In estuaries, they feed on other salmonids, scorpaenids, sticklebacks, pleuronectids and other fishes, crustaceans, and insects (Hart 1973). Fresh et al. (1981) found that cutthroat trout in Puget Sound utilized mainly fishes (74% of diet biomass) and gammarid amphipods. Our findings show this species to be highly piscivorous consuming mainly juvenile northern anchovies (*E. mordax*), salmonids, and several species commonly associated with the neustonic layer (Shenker 1985) such as rockfishes (*Sebastes* spp.), sauries (*Cololabis saira*), and greenlings (*Hexagrammos decagrammus*). A preponderance of insects and floating plant material such as wood chips and conifer needles in the diet also suggests that this species feeds indiscriminantly in the surface layer.

Hypomesus pretiosus—Surf smelt fed on a variety of small planktonic prey species (Table 18). Only two of five stomachs examined from 1981 contained food which was well digested. Stomachs collected during 1983 contained mostly calanoid copepods and hyperiid amphipods; high numbers of decapod larvae and larvaceans occurred in some stomachs. The only fishes found were sand lance and flatfish larvae. The greatest proportion of food found in the stomachs during 1983 was unidentifiable.

There have been few studies on the food habits of surf smelt from open marine waters. The offshore food of *H. pretiosus* consists of a wide variety of crustaceans such as copepods, amphipods, decapods, and euphausiids as well as insects, marine worms, larvaceans, ctenophores, and larval fishes (Hart 1973). Calanoid copepods made up more than 80% of the IRI diet of surf smelt caught in the neritic waters of the Strait of Juan de Fuca; harpacticoid copepods and polychaetes made up much of the remaining diet (Simenstad et al. 1979). Our results support those previously reported. However, most of the fish we examined had been feeding on only one or two food types. Small crustaceans comprised most of the diet, although one individual had eaten many larvaceans. The occurrence of only one type of food in most stomachs suggests that *H. pretiosus* is opportunistic, possibly feeding in monospecific prey patches.

Merluccius productus—Stomach samples of Pacific hake collected from 1981 through 1984 indicated that a limited food spectrum was consumed by this predator. The dominant prey for all years were euphausiids (Table 19). Although only a few species were identified, the dominant euphausiid species varied among years between *Euphausia pacifica* (1981 and 1984) and *Thysanoessa spinifera* (1982 and 1983). Other important prey by weight included *E. mordax* and unidentified fishes with decapod larvae and *Crangon* shrimp making up a large part of the total numbers.

The food habits of Pacific hake varied greatly between the two major prey categories, euphausiids and fishes, in the monthly comparisons (Table 20). Euphausiids were almost nonexistent during May but completely dominated the diet from June through September. Fishes were dominant during May but were of lesser importance from June through September. The geographic comparisons show euphausiids completely dominating the diet by weight off Washington and Oregon. Fishes, particularly *E. mordax* adults, were important off the Columbia River, with the exception of the 1984 stomachs when euphausiids were predominant in all three geographic areas.

Because of the importance of Pacific hake to the pelagic ecosystem in the California Current, a number of studies have been devoted to their feeding habits (Livingston and Bailey 1985). Pandalid shrimp and euphausiids were the dominant foods of *M. productus* off northern California (Gotshall 1969). Subsequent studies (Alton and Nelson 1970; Outram and Haegele 1972; Livingston 1983; Rextad and Pikitch 1986) found that euphausiids were by far the dominant prey of Pacific hake collected from northern California to British Columbia. Fishes became increasingly important to the diet of larger-sized hake which are captured further north (Livingston 1983; Livingston and Bailey 1985; Rexstad and Pikitch 1986). Our results corroborate those found in previous studies that *M. productus* subsisted predominantly on euphausiids although small pelagic fishes were also an important part of the diet in some months or areas. Pacific hake appear, therefore, to be highly selective feeders specializing on euphausiids; however, at larger sizes and in areas where euphausiids may not be abundant, they may also consume fishes.

Cololabis saira—As Pacific saury do not possess a distinct stomach region, the entire gastrointestinal canal was examined for prey. The digestive state of the prey was advanced for most fish examined, and, possibly for this reason, total prey diversity was quite low (Table 21). The bulk of the food consumed in 1983 and 1984 consisted of small planktonic organisms such as immature and adult copepods, hyperiid amphipods, and larval fishes. Euphausiids and unidentified larval fishes were the only prey identified in the small number (n = 5) of 1981 stomachs.

Saury were caught mainly in late summer and in the southern part of the sampling region (Brodeur and Pearcy 1986) so that discussion of seasonal and geographic variations in their feeding habits is necessarily limited. The identified fractions of saury gut contents were very similar between June and September although the sample size for June was fairly small (Table 22). On a geographic basis, hyperiid amphipods and larval fishes were the most commonly identified prey from off the Columbia River, whereas saury off Oregon contained more copepods and a slightly higher proportion of larval fishes (Table 22).

There have been few studies on the feeding ecology of Pacific saury in the eastern North Pacific. Studies in the western Pacific show that *C. saira* consumes mainly small crustaceans such as copepods, euphausiids, decapod megalopae and hyperiid amphipods, as well as chaetognaths, appendicularians, and fish larvae (Hatanaka 1956; Hotta and Odate 1956). According to these studies, Pacific saury appear to be somewhat selective particulate feeders exhibiting some change in diet with body size of predator. Our findings off Washington and Oregon show a diet limited to copepods, amphipods, euphausiids, and larval fishes. Decapod larvae were not present, but this may be due in part to the time of year (September) when most of the stomachs were collected (Table 22). Late summer and fall are normally times of low larval decapod abundances (Lough 1975).

Sebastes melanops—Black rockfish fed on a wide variety of planktonic, nektonic, and epibenthic prey (Table 23). Principal food items by weight included euphausiids, decapod larvae, and fishes for all years although the order of importance varied among years. Euphausiids were a major food item in 1981 and 1982; decapod larvae were highest in 1983 and 1984; and fishes made up a relatively major part of the diet in 1981 and 1983. Adult epibenthic decapods and a cumacean (*Diastylopsis dawsoni*) were faily important in 1984. Many species of juvenile fishes were consumed, including chinook (132 mm FL) and coho (125 mm FL) salmon, lamprey (*Lampetra tridentata*; 190 mm TL), and quillfish (*Ptilichthys goodei*; 165 mm TL).

The food habits of black rockfish showed some variation through the summer (Table 24). Fishes and euphausiids were of primary importance to the diet in May, followed by decapod larvae. Euphausiids were substantially more important to the diet in June. Larval and juvenile decapods were the major food identified in stomachs collected during July-August and September, although little of the September stomach contents were identifiable. Comparison of prey categories by area showed euphausiids to be most important off Washington, fishes most important off the Columbia River, and decapod larvae and ctenophores most important in the limited number of stomachs collected off Oregon (Table 24).

Previous studies of the food of *S. melanops* have been conducted mostly on specimens collected from neritic, rocky reefs, or kelp beds. Black rockfish off Vancouver Island, British Columbia, consumed mainly mysids and clupeiform fishes (Leaman 1976). On rocky reefs off central Oregon, they ate mainly pelagic fishes such as osmerids and clupeids but also decapod megalopae (Steiner 1978). In kelp beds of central California, however, black rockfish consumed mostly juvenile rockfish and euphausiids (Hallacher and Roberts 1985). In our purse seine collections, *S. melanops* consumed a variety of prey including plankton (ctenophores, amphipods, euphausiids, and decapod megalopae), pelagic nekton (clupeids, salmonids, and cottids), and epibenthic prey (cumaceans, mysids, and crangonid shrimp). This broad diet, and substantial shifts between major prey items with area and time of collection, suggests that black rockfish may feed opportunistically on whatever prey is available.

Sebastes flavidus—Euphausiids made up a major portion of the diet of the yellowtail rockfish examined (Table 25). The largest prey consumed were juvenile fishes (50-60 mm TL) and a juvenile squid. The sample sizes of yellowtail rockfish examined from each of the two years were too small to delineate any major differences between the years in types of food consumed. Fishes were found only in stomachs collected during 1982, and gelatinous zooplankton and calanoid copepods were collected only during 1984. Much of the stomach contents in 1984 was unidentifiable.

Most other studies on the food habits of *S. flavidus* have utilized trawl-caught specimens from midwater and offshore banks. These studies show that although the yellowtail rockfish eat a wide variety of zooplanktonic and nektonic organisms, most of the diet consists mainly of euphausiids and fishes (Pereyra et al. 1969; Lorz et al. 1983; Brodeur and Pearcy 1984). These authors suggest that yellowtail rockfish may selectively forage on prey aggregated by special oceanographic features such as upwelling near offshore banks and canyons. There was substantial variability in consumption of many prey types in accordance with season, area, and size of predator examined (Brodeur and Pearcy 1984). In the present study, there was a wide prey diversity even among the limited number of stomachs examined. The dominant prey types (euphausiids, decapod larvae, and fishes) included highly aggregated or schooling species.

Anoplopoma fimbria—Juvenile sablefish consumed a wide variety of zooplankton species and some fishes (Table 26). Euphausiids and crab megalopae numerically dominated the diet in most years, with the exception of 1983. Fishes were important by weight in 1981 and 1982 but were relatively unimportant in 1983 and 1984. Several unusual fishes were found in the stomachs including adult saury (*Cololabis saira*; TL = 140 mm), juvenile king-of-the-salmon (*Trachipterus altivelis*; 149 mm), and wolfeel (*Anarrhichthys ocellatus*; TL > 300 mm). Many species of hyperiids, including some rarer species seldom encountered in other predators in this study, were identified from sablefish guts. The surface-dwelling chondrophore, *Velella velella*, and pelagic gastropods were important food items in 1981, while salps were a major food item in 1983.

Only a few sablefish stomachs were examined from May and these contained mostly euphausiids. Most of the food for the rest of the summer was split between euphausiids and fishes. Pteropods (June), decapod larvae (July-August), and hyperiid amphipods and salps (September) were other important prey items consumed (Table 27). Geographic variations in sablefish food habits were more pronounced. Hyperiid amphipods and euphausiids were dominant off Washington. Fishes, and secondarily cnidarians and decapod larvae, were consumed in the Columbia River region. Euphausiids, fishes, and pteropods were all important off Oregon (Table 27).

Little is known of the food habits of pelagic juvenile sablefish. Juveniles caught in surface purse seines off California consumed mainly crustaceans (copepods and euphausiids) and larvaceans with only a very minor contribution by fishes (Conway 1967). Generally only one type of food was found in the stomachs at any one time. Myctophid fishes, saury, and euphausiids were eaten by juvenile sablefish feeding at night off Oregon, suggesting that sablefish are opportunistic predators (Grinols and Gill 1968). Fishes, specifically herring, and euphausiids were the dominant prey of trawl-caught juveniles off northern British Columbia (McFarlane and Beamish 1983). Our data show that crustaceans (mainly euphausiids, hyperiid amphipods, and decapod larvae) were the dominant prey of *A. fimbria* during most years. Other prey categories were of importance only during one year or in a particular area or month of sampling. This variability may be related to increased prey abundance or availability. Our findings lead us to agree with Grinols and Gill (1968) on the opportunistic feeding strategy of this species, providing the prey are within the proper size range.

Trachurus symmetricus—Jack mackerel fed on a variety of planktonic and small nektonic organisms (Table 28). Northern anchovy juveniles dominated the diet in 1982, based mainly on three stomachs at one station which contained over 100 juveniles (40-50 mm) each. Euphausiids, particularly *T. spinifera* and *E. pacifica*, were the most important food in 1983 and 1984 making up over one-half of the total number and weight percentages. Euphausiids were often the only food found in the stomachs of all jack mackerel collected at some stations. Pteropods (*Limacina helicina* and *Euclio pyramidata*) were moderately important by percent number during 1982 and 1983. Decapod and fish larvae were a significant part of the diet only in 1984.

Jack mackerel fed consistently on euphausiids throughout most of the summer with fairly low proportions of fishes being consumed (Table 29). By September, their diet was composed mainly of fishes. Although many other major prey categories were consumed, they represented only a small proportion of the biomass consumed. Similarly, euphausiids were the most important food in all three areas examined, but with the exception of the Columbia River region, they were not much more important than fishes. Pteropods and decapod larvae were also important off Washington.

Jack mackerel were the second most abundant species collected in our surveys during 1983 and 1984 (Pearcy et al. 1985; Brodeur and Pearcy 1986). Dietary information for jack mackerel is available mainly from southern California, which is approximately the center of abundance for this species. Carlisle (1971) found copepods, euphausiids, and pteropods to be the numerically dominant food items, accounting for over 90% of the identified food. Euphausiids appeared to be actively selected for when comparisons were made with available prey in the plankton. In another study from southern California, copepods and other crustaceans were the main prey of *T. symmetricus* (Mearns et al. 1981). Off Oregon, jack mackerel consumed myctophids and saury at night at the surface (Grinols and Gill 1968). Based on our findings, euphausiids appear to be the preferred prey of *T. symmetricus* off Oregon and Washington throughout much of the summer. Contrary to past studies, we did not find copepods to be a major prey of jack mackerel but instead found pteropods, decapod larvae, and fishes (especially *Engraulis mordax*) to be important in the the diet in some cases.

Scomber japonicus—Different foods were consumed by Pacific mackerel in the two years in which this species was examined. Stomachs were relatively full in 1983 and contained euphausiids (mostly *E. pacifica*) and several unidentified species of salps (Table 30). In 1984, euphausiids were of secondary importance in the diet following several very abundant copepod species. Fishes were relatively unimportant in the diet during both years and those that were consumed appeared to be mostly surface-dwelling juveniles.

Some shifts in the main forage items consumed by Pacific mackerel occurred through the summer. Euphausiids were the major food consumed by this species in May (Table 31). The June diet was more diverse with several prey categories (euphausiids, fishes, decapod larvae, and copepods) being of somewhat equal importance. Copepods dominated the identifiable fraction of the diet in July-August. Fishes were most important by weight during September. This species shows a reverse pattern of prey consumption by area compared with many of the other species. Decapod larvae and fishes made up the bulk of the food eaten off Washington. Copepods and salps were important in the Columbia River region; euphausiids made up about two-thirds of the food consumed off Oregon (Table 31).

This pelagic schooling species was observed in great numbers during our 1983 and 1984 surveys and was the most numerous species collected in both years (Pearcy et. al. 1985; Brodeur and Pearcy 1986). Few studies have examined the food habits of adult *S. japonicus*. Pacific mackerel have been described as "gluttonous feeders" consuming a variety of crustaceans, squids, fishes, and gelatinous zooplankton such as the neustonic *Velella* (Hart 1973). Mysids and fishes (mostly *E. mordax*) were the main prey of Pacific mackerel collected in the Southern California Bight (Mearns et al. 1981). In Barkley Sound, British Columbia, juvenile herring made up the majority of the stomach content weight of adult Pacific mackerel caught in 1984, but northern anchovy and euphausiids were also important (Ashton et al. 1985).

We found euphausiids to be the dominant food in 1983. In addition to the samples collected for this study, many *S. japonicus* stomachs were examined at sea and on several occasions all the individuals in large schools were engorged with euphausiids (mostly *Euphausia pacifica*). The diet was different in 1984, consisting mainly of copepods. Our data indicate that this species feeds predominantly near the surface on highly concentrated prey patches, which, for the most part, were pelagic crustaceans.

Icichthys lockingtoni—Stomach contents of medusafish examined from 1982 and 1983 were well digested and yielded few identifiable prey items (Table 32). Hyperiid amphipods, salps (*Salpa* spp.), and larvaceans (*Oikopleura*) were the main prey during both years. The pelagic polychaete *Tomopteris* was found commonly in stomachs from 1982. All fishes were well digested and were mainly pieces of unidentified larvae.

The food habits of medusafish are poorly known. This species is frequently associated with gelatinous zooplankton, and it is believed that medusafish subsist on discarded prey of the jellyfish or possibly nip tentacles or other parts off their "hosts" (Fitch and Lavenberg 1968; Horn 1977). Our limited data collected mainly from off Oregon shows *I. lockingtoni* consumed mainly gelatinous zooplankton (salps) or hyperiid amphipods which are known to be commensal with or even parasitic upon gelatinous zooplankton (Laval 1980).

Patterns in dietary variability

Many of the interannual trends in diet observed in this study were associated with yearly differences in physical conditions such as upwelling, onshore and alongshore transport, and their effects on primary productivity and, ultimately, prey abundances. There were substantial interannual variations in oceanographic conditions and nektonic species composition during our study period which were mostly associated with the occurrence of a strong El Niño warming trend during 1983 and 1984 (Pearcy et al. 1985; Brodeur and Pearcy 1987) We discuss the changes in the overall ecosystem observed during the years 1981-83 in relation to the varied environmental conditions occurring during those years elsewhere (Brodeur et al. 1987). In the present discussion, we will emphasize interannual variations in major prey taxa from 1981 to 1984, considering mainly the predators for which we have several years of data.

Relaxed upwelling conditions during the early part of the summer of 1981 resulted in a convergence of high-temperature clear oceanic water close to shore (Brodeur and Pearcy 1986). An offshore species of euphausiid, *E. pacifica*, was commonly found along with the oceanic chondrophore, *V. velella*, in the stomachs collected at this time. Strong upwelling from mid-June to the end of August (Mason and Bakun 1986) resulted in higher chlorophyll levels and diets dominated by herbivorous *Limacina* and *E. mordax* juveniles. Conditions were reversed in 1982 with strong upwelling in early summer and below-normal upwelling later in the summer (Brodeur and Pearcy 1986). An inshore species of euphausiid, *T. spinifera*, and *C. magister* megalopae were important prey items early in the summer while *E. pacifica* and *E. mordax* larvae were more important in September, indicating some onshore transport at this time.

Oceanographic conditions were anomalous throughout the summer of 1983 due to northward and onshore transport of warm low-productivity water and reduced effectiveness of upwelling throughout the sampling region (Brodeur et al. 1985; Brodeur and Pearcy 1986). Euphausiids were relatively less important in the diet of most species, whereas gelatinous zooplankton (ctenophores and salps), decapod larvae, and offshore species of hyperiids (especially *Vibilia* sp.) were more important. During the El Niño of 1983, however, oceanographic conditions were favorable for *E. mordax* spawning close to shore resulting in high larval abundances in the plankton (Brodeur et al. 1985) and high juvenile abundances in many predator stomachs late in the summer. Adult northern anchovy were inexplicably absent from the diet of most predators in 1983, resulting in lower weight proportions for this species during that year. The effects of the El Niño continued through June of 1984, but strong upwelling prevailed in July allowing chlorophyll concentrations to return to nearly normal late-summer levels (Brodeur and Pearcy 1986). Decapod larvae (especially pinnotherid zoea and *C.*

oregonensis megalopae) and *E. pacifica* were the main foods in June and July while both common species of euphausiids were important prey during September of 1984. Stomachs were generally less full during 1984 than in previous years for many species.

Similar seasonal trends were evident among several species in their utilization of important prey resources. Food habits of the dominant pelagic species changed considerably in some cases, over the relatively short (5-month) sampling period. Euphausiids made up a large proportion of the prey biomass of many species during the early part of the summer (May and June) but their relative proportions declined as the summer progressed. Much of this early biomass peak consisted of adult *E. pacifica* and juvenile *T. spinifera*. Adult *T. spinifera* were more prevalent later in the season. Decapod larvae (mostly brachyuran megalopae) and pteropods showed a similar seasonal decline in importance in the diets of many predators. Fishes exhibited the opposite pattern in weight composition. Larval fishes made up a major portion of the stomach content biomass in the early part of the summer and were replaced by juveniles later in the summer, which substantially increased the weight proportion made up by fishes for most predators. Copepods, hyperiid amphipods, and gelatinous zooplankton also increased in importance later in the summer.

Apparent changes in the diet of these predators may represent actual shifts in the food preferences or changes in the abundance and taxonomic composition of available prey. It appears clear from the species list of prey consumed by this assemblage of nekton that most species forage in the water column on various species of plankton and micronekton, although a few species, such as *Salmo clarki* and *Sebastes melanops*, may also consume prey that are primarily neustonic or epibenthic. There are a number of studies (Hebard 1966; Lough 1975, 1976; Lorz and Pearcy 1975; Peterson and Miller 1976; Richardson and Pearcy 1977; Mundy 1984; and Shenker 1985) which have examined seasonal changes in abundance of many of the important planktonic prey taxa from one transect (lat. 44°40′) of stations off central Oregon over several years. These studies show that many of the same seasonal patterns evident in the plankton were also observed in the prey composition from this investigation, with some notable differences.

Peak abundances of both *E. pacifica* and *T. spinifera* occurred in fall off Oregon, but a large number of these individuals were juveniles (Hebard 1966; Smiles and Pearcy 1971). Adult *E. pacifica* were more prevalent in the spring, which may account for the high biomass of this species in many predator stomachs during May. *Cancer magister*, and other brachyuran crab larvae commonly consumed by this assemblage of fishes, reached peak megalopal abundances from May through July and generally settled out of the plankton by September (Lough 1975, 1976; Shenker 1985). Ctenophores and pteropods (notably *L. helicina*) were also most numerous in plankton samples in May and June (Peterson and Miller 1976); however, they were more important dietary components later in the summer. As seen in the stomach contents of many species, most copepod and hyperiid amphipod species generally attained the highest abundance levels in late summer and early fall (Lorz and Pearcy 1975; Peterson and Miller 1976).

The abundance patterns of fishes available to these predators are more complex than those for other prey because of the large number of species involved and the prolonged pelagic existence of many species. A full range of life history stages from larvae to adults was represented in the diets examined in this study, although juvenile fishes were probably most important. Richardson and Pearcy (1977) and Mundy (1984) found that peaks in abundance of larval fishes occurred both before (February and March) and during (May-July) the upwelling season. Larval smelts (Osmeridae) generally dominated the inshore larval ichthyofauna while *E. mordax* larvae dominated the Columbia River plume and offshore fauna (Richardson 1973; Richardson and Pearcy 1977).

Although the geographic variations were not as consistent as the seasonal trends, some trends were observed. For most of the common species examined, euphausiid prey were most important by weight off Washington and decreased substantially in importance off Oregon and in the Columbia River region. Fish prey, mostly juvenile and adult northern anchovy (*E. mordax*) or herring (*C. harengus pallasi*), generally dominated the diets of nekton collected from the Columbia River area. Adults of these species were abundant in purse seine collections from the Columbia River plume (Brodeur and Pearcy 1986). Cnidarians, copepods, and pteropods also tended to be more important by weight in this region. Off Oregon, fishes generally dominated the diet but cephalopods and amphipods were more important relative to the other regions. Unfortunately, the large-scale geographic distributions of many of the dominant prey organisms consumed by this assemblage are poorly known.

Evidently, both large-scale hydrographic events (variations in upwelling and inshore-offshore flow) and ontogenetic factors (timing and duration of larval stages) may affect the prey composition available during any particular time or in any area. Prey patchiness in the vertical or horizontal plane, whether caused by physical factors (frontal structure and environmental gradients) or biological mechanisms (spawning or swarming), may also affect prey composition on a smaller scale such as within-station variability.

Predation on juvenile salmonids

Only two species, cutthroat trout (*Salmo clarki*) and black rockfish (*Sebastes melanops*), were found to prey upon juvenile salmon in this study. Four separate incidences of salmonid predation by adult cutthroat were seen in 1981, including one cutthroat (328 mm FL) which contained two juvenile chinook (*O. tshawytscha*; 77 and 82 mm FL) and another well-digested juvenile salmon. Other cutthroat contained a juvenile chinook (91 mm FL) and well-digested but easily recognized juvenile salmon. One additional occurrence of an unidentified juvenile salmon was noted from a stomach collected during 1984. All these occurrences were from cutthroat trout collected offshore of the Columbia River, where they appeared to prey on newly outmigrating juveniles. Despite the high incidence (11.6% of stomachs containing food) of juvenile salmonids in *S. clarki* stomachs, this species occurs in low adult abundance during the season that juvenile salmon are present and may have a negligible impact on juvenile salmon in offshore waters.

Juvenile salmon were much less common in black rockfish stomachs with only two occurrences (2.6%) during the four years from which *S. melanops* were examined. A juvenile chinook (132 mm FL) was found in one of five stomachs examined from 1981 and a juvenile coho (125 mm FL) from one of 25 stomachs from 1984. Both of these prey were in very good condition which could indicate that they might have been consumed in the net and thus not represent a normal occurrence. However, juvenile salmon are frequently found in *S. melanops* collected by hook and line from neritic rocky reefs (Brodeur, pers. observ.).

These purse seine collections have not identified a major fish or squid predator of juvenile salmon during the summer months off Washington and Oregon, although many species of sufficient size to feed on juvenile salmonids were caught, frequently in the same collections. However, marine birds and mammals, which were at times very abundant, were not sampled, nor were collections made in estuaries and shallow nearshore waters, where predation could still limit salmon production.

ACKNOWLEDGMENTS

We wish to thank Craig Banner, Alton Chung, Joseph Fisher, Dean Gushee, Jon Shenker, and Waldo Wakefield for their generous assistance in the field and laboratory. The comments of two anonymous reviewers improved the clarity of the manuscript. This research was supported by the Oregon State University Sea Grant College Program and by Contract No. 85-ABC-0041 from the Northwest and Alaska Fisheries Center of the National Marine Fisheries Service, NOAA.

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Table 3—*Loligo opalescens*
Taxonomic composition of overall diet.

Prey taxa	1981 F	1981 N	1981 W	1981 IRI	1984 F	1984 N	1984 W	1984 IRI
Cnidaria								
Hydromedusae	2.4	0.1	0.2	<1	16.7	0.9	20.3	354
Unidentified	9.5	0.3	0.8	10	—	—	—	—
Mollusca								
Pteropoda								
Limacina helicina	4.8	0.4	0.1	2	—	—	—	—
Cephalapoda								
Unidentified	—	—	—	—	16.7	0.9	1.7	58
Arthropoda								
Copepoda								
Neocalanus cristatus	2.4	0.1	*	<1	—	—	—	—
Calanus pacificus	14.3	3.3	0.8	59	—	—	—	—
Calanus spp. copepodites	7.1	0.5	0.1	4	—	—	—	—
Unidentified	19.1	22.1	4.2	502	—	—	—	—
Amphipoda								
Atylus tridens	—	—	—	—	16.7	0.9	1.7	43
Unidentified Hyperiidea	4.8	0.2	0.1	1	—	—	—	—
Euphausiacea								
Thysanoessa spinifera	7.1	0.8	3.5	31	—	—	—	—
Unidentified	9.5	0.3	0.3	6	33.3	1.8	5.1	230
Decapoda								
Cancer oregonensis megalopae	2.4	0.4	0.3	2	33.3	2.8	3.4	206
Cancer sp. zoea	7.1	1.3	2.0	23	—	—	—	—
Pinnotheridae zoea	7.1	6.9	5.1	85	33.3	87.8	30.5	3929
Unidentified megalopae	2.4	0.1	0.5	1	—	—	—	—
Chaetognatha								
Eukronia hamata	4.8	0.6	0.8	7	—	—	—	—
Sagitta decipiens	7.1	1.4	1.7	22	—	—	—	—
Sagitta elegans	21.4	48.0	45.1	1992	—	—	—	—
Unidentified	19.1	12.1	15.7	531	—	—	—	—
Chordata								
Thaliacea								
Unidentified	2.4	0.1	0.1	<1	—	—	—	—
Osteichthyes								
Sebastes spp. juvenile	2.4	0.1	0.9	2	—	—	—	—
Unidentified larvae	7.1	0.3	1.4	12	16.7	4.8	28.8	561
Unidentified remains	11.9	0.6	11.1	139	—	—	—	—

	1981	1984
Number of stomachs examined	43	17
Number of empty stomachs	11	11
Mean dorsal mantle length (mm)	136	104
Range dorsal mantle length (mm)	103-171	93-116
Mean fullness	3.0	1.0
Mean digestion	1.6	0.6

*<0.1%; F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 4—*Squalus acanthias*

Taxonomic composition of overall diet.

Prey taxa	1979 and 1980				1981				1982				1983				1984			
	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI
Cnidaria																				
Siphonophora	—	—	—	—	—	—	—	—	1.8	41.8	*	75	—	—	—	—	—	—	—	—
Chondrophora																				
Velella velella	—	—	—	—	58.8	94.2	46.8	8291	—	—	—	—	—	—	—	—	—	—	—	—
Unidentified	—	—	—	—	—	—	—	—	1.8	0.5	*	1	—	—	—	—	14.3	0.1	2.5	37
Ctenophora	11.0	4.5	*	51	—	—	—	—	1.8	1.0	*	2	5.9	26.0	0.2	155	—	—	—	—
Mollusca																				
Gastropoda																				
Limacina helicina	—	—	—	—	—	—	—	—	1.8	0.5	*	1	—	—	—	—	—	—	—	—
Cephalopoda																				
Unidentified	—	—	—	—	5.9	0.4	1.1	9	1.8	*	0.3	1	—	—	—	—	—	—	—	—
Arthropoda																				
Copepoda																				
Unidentified	—	—	—	—	—	—	—	—	3.6	1.5	*	6	—	—	—	—	—	—	—	—
Mysidacea																				
Unidentified	—	—	—	—	—	—	—	—	—	—	—	—	11.8	7.8	*	93	—	—	—	—
Amphipoda																				
Unidentified Gammaridea	—	—	—	—	—	—	—	—	—	—	—	—	11.8	7.8	*	93	—	—	—	—
Hyperoche medusarum	—	—	—	—	—	—	—	—	3.6	1.5	*	6	—	—	—	—	—	—	—	—
Themisto pacifica	—	—	—	—	—	—	—	—	5.4	4.4	*	24	—	—	—	—	—	—	—	—
Unidentified Hyperiidea	11.0	1.8	*	21	—	—	—	—	1.8	1.0	*	2	—	—	—	—	—	—	—	—
Euphausiacea																				
Euphausia pacifica	11.0	10.0	*	111	—	—	—	—	5.4	1.5	*	9	—	—	—	—	21.4	99.8	28.8	2752
Thysanoessa spinifera	22.0	23.6	*	521	—	—	—	—	5.4	2.9	*	16	5.9	45.5	0.9	274	7.1	*	*	1
Unidentified	44.0	11.8	*	524	5.9	0.4	0.1	3	8.9	13.6	0.1	122	—	—	—	—	—	—	—	—
Decapoda																				
Pandalus jordani	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7.1	*	0.3	3
Cancer magister megalopae	11.0	37.3	*	411	—	—	—	—	8.9	4.4	*	40	—	—	—	—	—	—	—	—
Chordata																				
Osteichthyes																				
Clupea harengus pallasi	22.0	2.7	5.3	176	—	—	—	—	1.8	2.9	0.6	6	—	—	—	—	—	—	—	—
Engraulis mordax	—	—	—	—	5.9	3.5	17.8	126	1.8	0.5	0.3	1	5.9	2.6	7.5	60	—	—	—	—
Merluccius productus	11.0	0.9	18.3	211	—	—	—	—	8.9	2.4	31.2	299	—	—	—	—	7.1	*	6.5	47
Ophiodon elongatus	—	—	—	—	—	—	—	—	1.8	*	5.6	10	—	—	—	—	—	—	—	—
Citharichthys spp.	—	—	—	—	—	—	—	—	1.8	0.5	3.8	8	—	—	—	—	7.1	*	1.7	13
Pleuronectidae	11.0	6.4	60.0	730	5.9	0.4	3.5	23	1.8	1.5	3.1	8	—	—	—	—	7.1	*	7.6	55
Glyptocephalus zachirus	—	—	—	—	—	—	—	—	1.8	0.5	1.8	4	—	—	—	—	7.1	*	7.1	51
Parophrys vetulus	—	—	—	—	—	—	—	—	1.8	0.5	1.6	4	—	—	—	—	—	—	—	—
Unidentified flatfish	11.0	0.9	12.5	147	—	—	—	—	1.8	0.5	0.8	2	17.7	3.9	38.5	750	7.1	*	6.6	48
Unidentified	—	—	—	—	17.7	1.2	24.9	462	60.7	16.5	46.7	3836	29.4	6.5	52.8	1743	42.9	0.3	34.2	1480
Unidentified	22.0	—	2.5	—	29.4	—	5.9	—	23.2	—	4.2	—	5.9	—	0.2	—	35.7	—	4.5	—
Number of stomachs examined	15				23				81				34				22			
Number of empty stomachs	6				6				25				17				8			
Mean fork length (mm)	699				666				760				842				665			
Range fork length (mm)	534-1110				386-975				420-1070				360-1190				320-1005			
Mean fullness	1.7				2.0				1.9				1.2				1.2			
Mean digestion	1.6				2.1				1.3				1.7				0.9			

<0.1%; F = percent frequency occurrence; N = percent number, W = percent weight; IRI = index of relative importance.

Table 5—*Squalus acanthius*

Percent total weight composition of major prey categories consumed for all years.

Prey category	May	June	July-August	Sept.	Wash.	Columbia River	Oregon
	Cruise month				Area		
Cnidaria	18.2	2.3	—	—	2.1	5.2	9.4
Cephalopoda	—	0.3	—	—	—	0.3	1.5
Copepoda	*	—	—	—	*	—	—
Mysidacea	—	*	—	—	—	—	*
Amphipoda	—	*	—	—	*	—	—
Euphausiacea	0.7	5.0	0.1	—	24.1	0.3	*
Decapoda	—	0.1	—	—	0.2	0.1	—
Osteichthyes	81.0	87.8	49.5	100.0	73.4	90.4	73.0
Unidentified	0.1	4.4	50.5	—	0.2	3.7	16.1
No. stomachs	25	123	14	13	60	91	24
No. empty stomachs	10	38	9	5	31	25	6

*<0.1%

Table 7—*Prionace glauca*

Taxonomic composition of overall diet.

Prey taxa	F	N	W	IRI
	1981-84			
Mollusca				
Cephalopoda				
Moroteuthuis robustus beaks	8.3	5.6	0.1	47
Unidentified	8.3	2.8	1.6	37
Chordata				
Osteichthyes				
Clupea harengus pallasi	8.3	2.8	2.9	47
Engraulis mordax	16.7	44.4	10.4	915
Merluccius productus	16.7	11.1	53.9	1086
Citharichthys sp.	8.3	5.6	8.0	113
Pleuronectidae	16.7	11.1	2.4	225
Unidentified	50.0	16.7	3.4	1005
Unidentified	16.7	—	17.2	—
Number of stomachs examined			14	
Number of empty stomachs			2	
Mean total length (mm)			1590	
Range total length (mm)			995-3330	
Mean fullness			2.7	
Mean digestion			1.6	

F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 6—*Galeorhinus zyopterus*

Taxonomic composition of overall diet.

Prey taxa	F	N	W	IRI
	1981-84			
Cnidaria				
Velella velella	8.3	24.8	0.5	210
Mollusca				
Cephalopoda				
Gonatus sp. beak	8.3	0.9	*	8
Unidentified parts	8.3	11.9	*	100
Chordata				
Osteichthyes				
Engraulis mordax	8.3	0.9	0.3	10
Alosa sapidissima	8.3	0.9	7.0	66
Merluccius productus	58.3	33.0	81.1	6652
Hemilepidotus spinosus	8.3	0.9	0.2	9
Pleuronectidae	8.3	0.9	0.2	9
Unidentified	25.0	25.7	10.1	895
Unidentified	8.3	—	0.6	—
Number of stomachs examined			14	
Number of empty stomachs			2	
Mean total length (mm)			1523	
Range total length (mm)			1080-1830	
Mean fullness			1.7	
Mean digestion			1.5	

*<0.1%; F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 8—*Alosa sapidissima*

Taxonomic composition of overall diet.

Prey taxa	F	N	W	IRI
	1981 and 1984			
Mollusca				
Cephalopoda				
Unidentified	3.7	*	0.6	3
Arthropoda				
Copepoda				
Calanus spp.	40.7	85.5	39.2	5075
Amphipoda				
Hyperia medusarum	3.7	*	0.7	3
Euphausiacea				
Euphausia pacifica	22.2	0.3	1.4	38
Nyctiphanes simplex	3.7	*	0.1	<1
Thysanoessa spinifera	25.9	2.7	23.9	689
Unidentified	55.6	11.4	25.6	2057
Decapoda				
Cancer magister zoea	3.7	*	0.1	<1
Unidentified	7.4	*	0.1	1
Unidentified	44.4	—	8.3	—
Number of stomachs examined			28	
Number of empty stomachs			1	
Mean fork length (mm)			320	
Range fork length (mm)			235-435	
Mean fullness			2.2	
Mean digestion			2.0	

*<0.1%; F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 9—*Clupea harengus pallasi*
Taxonomic composition of overall diet.

Prey taxa	1981				1982				1983				1984			
	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI
Mollusca																
Gastropoda																
Limacina helicina	11.1	3.0	0.2	36	—	—	—	—	—	—	—	—	—	—	—	—
Arthropoda																
Copepoda																
Calanus spp.	14.8	85.1	7.9	1376	11.1	1.0	*	12	47.8	27.1	11.6	1850	50.0	76.8	67.2	7200
Amphipoda																
Hyperia medusarum	3.7	0.2	0.1	1	11.1	23.7	3.7	304	13.0	1.6	0.9	33	—	—	—	—
Hyperoche medusarum	—	—	—	—	—	—	—	—	13.0	0.9	0.9	23	—	—	—	—
Themisto pacifica	—	—	—	—	22.2	2.4	0.2	58	17.4	2.5	1.5	70	—	—	—	—
Primno brevidens	—	—	—	—	—	—	—	—	4.4	0.1	*	1	—	—	—	—
Vibilia armata	—	—	—	—	—	—	—	—	39.1	8.3	3.4	457	—	—	—	—
Unidentified Hyperiidea	7.4	0.2	0.3	3.7	—	—	—	—	4.4	0.1	*	1	—	—	—	—
Euphausiacea																
Euphausia pacifica	33.3	5.3	37.3	1419	44.4	16.9	31.7	2158	4.4	0.1	*	1	—	—	—	—
Nyctiphanes simplex	—	—	—	—	—	—	—	—	8.7	10.7	7.8	161	—	—	—	—
Thysanoessa spinifera	7.4	1.8	14.3	119	33.3	53.6	51.7	3506	—	—	—	—	16.7	0.1	0.5	10
Unidentified	51.9	4.2	36.5	2112	11.1	0.5	7.8	92	56.5	48.8	33.6	4656	—	—	—	—
Decapoda																
Paguridae	—	—	—	—	—	—	—	—	4.4	0.1	0.1	1	—	—	—	—
Cancer magister megalopae	—	—	—	—	11.1	0.5	*	7	—	—	—	—	—	—	—	—
Cancer spp. zoea	—	—	—	—	—	—	—	—	—	—	—	—	16.7	23.1	31.3	908
Unidentified	—	—	—	—	22.2	1.0	1.2	49	4.4	0.1	*	1	—	—	—	—
Chordata																
Osteichthyes																
Engraulis mordax	—	—	—	—	—	—	—	—	—	—	—	—	16.7	*	0.2	5
Osmeridae	3.7	0.1	1.1	4.4	—	—	—	—	—	—	—	—	—	—	—	—
Unidentified	7.4	0.3	0.2	3.7	—	—	—	—	4.4	0.1	0.7	4	16.7	*	0.1	3
Unidentified	22.2	—	2.2	—	22.2	—	3.7	—	60.9	—	39.6	—	16.7	—	1.2	—
Number of stomachs examined	49				11				27				7			
Number of empty stomachs	18				2				4				1			
Mean fork length (mm)	191				195				147				203			
Range fork length (mm)	160-250				159-220				105-182				178-255			
Mean fullness	0.8				1.9				1.0				1.6			
Mean digestion	1.4				1.7				1.4				1.4			

<0.1%; F = percent frequency occurrence; N = percent number, W = percent weight; IRI = index of relative importance.

Table 10—*Clupea harengus pallasi*

Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Gastropoda	3.9	—	0.2	—	—	1.3	0.2
Copepoda	15.1	0.3	40.4	4.0	0.3	5.4	36.0
Amphipoda	0.3	—	0.2	6.8	—	0.4	3.4
Euphausiacea	66.0	83.9	40.9	62.1	89.0	85.5	31.8
Decapoda	—	0.3	16.5	0.2	0.3	—	14.1
Osteichthyes	—	—	0.8	0.3	—	1.2	0.4
Unidentified	14.8	15.5	1.1	26.7	10.4	6.2	14.2
No. stomachs	15	6	41	27	4	41	44
No. empty stomachs	4	1	17	3	0	15	10

Table 11—*Engraulis mordax*

Taxonomic composition of overall diet.

Prey taxa	1981 F	N	W	IRI
Mollusca				
Gastropoda				
Limacina helicina	33.3	35.5	18.5	1798
Cephalopoda				
Unidentified	6.7	0.1	0.2	2
Arthropoda				
Copepoda				
Unidentified	60.0	53.8	5.4	3552
Amphipoda				
Themisto pacifica	13.3	0.3	0.3	8
Euphausiacea				
Euphausia pacifica	33.3	1.0	7.4	280
Thysanoessa spinifera	6.7	1.3	1.2	17
Unidentified	20.0	1.6	5.0	132
Decapoda				
Cancer magister megalopae	33.3	6.0	2.7	290
Vertebrata				
Osteichthyes				
Unidentified eggs	13.3	0.4	0.4	11
Unidentified	73.3	—	59.0	—
Number of stomachs examined			18	
Number of empty stomachs			3	
Mean fork length (mm)			146	
Range fork length (mm)			139-204	
Mean fullness			2.2	
Mean digestion			1.1	

F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 12—*Oncorhynchus kisutch*

Taxonomic composition of overall diet.

	1979 and 1980				1981				1982				1983				1984			
Prey taxa	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI
Cnidaria																				
Velella velella	—	—	—	—	16.4	1.9	8.1	252	—	—	—	—	—	—	—	—	—	—	—	—
Unidentified	—	—	—	—	1.4	*	*	<1	1.7	*	*	<1	10.3	*	0.2	3	7.7	*	*	2
Annelida																				
Tomopteris spp.	3.1	*	*	<1	1.4	*	*	<1	—	—	—	—	3.4	0.1	*	<1	2.6	*	*	<1
Pelagobia spp.	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	—	—	—	—
Mollusca																				
Gastropoda																				
Limacina helicina	3.1	*	*	<1	12.3	42.8	1.1	579	18.3	4.8	0.2	92	20.7	2.4	0.2	524	2.6	*	*	<1
Cephalopoda																				
Gonatus spp.	—	—	—	—	1.4	*	*	<1	—	—	—	—	—	—	—	—	—	—	—	—
Loligo opalescens	3.1	*	1.8	6	5.5	0.1	10.3	57	3.3	*	3.8	13	—	—	—	—	2.6	*	3.9	—
Unidentified	3.1	*	0.4	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Arthropoda																				
Copepoda																				
Heterorhabdus spp.	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	—	—	—	—
Calanus marshallae	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	—	—	—	—
Unidentified	—	—	—	—	—	—	—	—	1.7	*	*	<1	—	—	—	—	—	—	—	—
Mysidacea																				
Unidentified	3.1	*	*	<1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amphipoda																				
Atylus tridens	15.6	0.7	0.1	13	—	—	—	—	1.7	*	*	<1	10.3	0.1	*	2	5.1	*	*	1
Unidentified Gammaridea	3.1	0.1	*	<1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hyperia medusarum	3.1	*	*	<1	1.4	*	*	<1	1.7	*	*	<1	3.4	0.1	*	<1	2.6	*	*	<1
Hyperoche medusarum	6.2	*	*	1	4.1	*	*	<1	10.0	0.3	*	4	10.3	0.9	*	10	7.7	*	*	2
Parathemisto pacifica	6.2	*	*	1	2.7	0.1	*	<1	3.3	0.1	*	<1	17.2	0.4	*	9	25.6	0.4	0.1	—
Dairella californica	—	—	—	—	—	—	—	—	1.7	*	*	<1	—	—	—	—	—	—	—	—
Phronima sedentaria	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	—	—	—	—
Primno macropa	3.1	*	*	<1	—	—	—	—	6.7	*	*	1	3.4	*	*	<1	5.1	*	*	1
Oxycephalus clausi	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	—	—	—	—
Vibilia pyripes	—	—	—	—	—	—	—	—	1.7	*	*	<1	—	—	—	<1	—	—	—	—
Vibilia spp.	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	—	—	—	—
Paraphronima crassipes	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.6	*	*	<1
Unidentified Hyperiidea	3.1	*	*	<1	1.4	*	*	<1	1.7	0.1	*	<1	13.8	0.4	*	7	—	—	—	—
Euphausiacea																				
Euphausia pacifica	6.2	*	*	1	6.8	6.8	1.5	56	21.7	11.6	5.0	360	6.9	0.1	*	1	20.5	9.1	23.3	—
Thysanoessa spinifera	31.2	11.1	10.0	659	8.2	0.3	0.1	3	45.0	52.6	38.6	4104	13.8	0.4	0.3	10	30.8	5.7	7.0	—
Thysanoessa longipes	—	—	—	—	—	—	—	—	—	—	—	—	3.4	0.1	*	<1	—	—	—	—
Unidentified	9.4	0.6	0.5	10	9.6	1.5	0.3	17	16.7	3.5	1.9	90	10.3	0.1	0.1	2	12.8	3.7	6.0	—
Decapoda																				
Pandalus spp. zoea	—	—	—	—	—	—	—	—	—	—	—	—	6.9	0.1	0.1	1	—	—	—	—
Crangon stylorostris	3.1	*	*	<1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Crangon spp. zoea	9.4	1.2	0.1	12	—	—	—	—	—	—	—	—	3.4	0.1	*	1	7.7	*	*	2
Pagurus spp. megalopae	9.4	0.1	*	2	1.4	*	*	<1	3.3	0.1	*	<1	10.3	0.4	*	5	20.5	0.3	*	8
Petrolisthes spp. megalopae	—	—	—	—	—	—	—	—	—	—	—	—	6.9	*	*	1	—	—	—	—
Porcellanidae zoea	—	—	—	—	—	—	—	—	—	—	—	—	10.3	1.4	*	15	2.6	*	*	<1
Emerita analoga megalopae	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	2.6	*	*	<1
Oregonia gracilis megalopae	3.1	*	*	<1	—	—	—	—	1.7	0.3	*	<1	—	—	—	—	10.3	*	*	<1
Chionoecetes tanneri megalopae	—	—	—	—	—	—	—	—	—	—	—	—	6.9	0.8	*	6	—	—	—	—
Pugettia productus zoea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.6	*	*	<1
Cancer antennarius megalopae	—	—	—	—	—	—	—	—	1.7	*	*	<1	3.4	*	*	<1	—	—	—	—
Cancer magister megalopae	50.0	51.7	23.3	3750	20.5	14.4	2.2	340	40.0	13.5	3.2	668	48.3	51.0	28.6	3845	43.6	2.3	2.8	222
Cancer oregonensis megalopae	9.4	4.8	0.3	48	6.8	2.1	0.1	15	10.0	8.6	0.9	95	10.3	5.9	0.6	67	41.0	27.5	7.9	1451
Cancer spp. zoea	6.2	0.1	*	1	5.5	0.1	0.2	2	8.3	0.7	*	7	27.6	9.3	0.7	38	2.6	0.6	0.1	2
Fabia subquadrata zoea	—	—	—	—	—	—	—	—	—	—	—	—	6.9	8.5	0.5	62	30.8	48.1	10.3	1799
Pinnixia spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.1	*	*	1
Pinnotheridea megalopae	25.0	28.2	4.2	810	11.0	27.6	0.8	312	3.3	*	*	<1	17.2	14.3	3.0	298	—	—	—	—
Unidentified	12.4	0.2	0.1	4	2.7	0.1	*	<1	1.7	*	*	<1	—	—	—	—	—	—	—	—
Insecta																				
Choristoneura occidentalis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.6	1.5	1.3	7
Diptera	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	5.1	0.3	0.3	3
Unidentified	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.9	0.3	0.3	4

Table 12—*Oncorhynchus kisutch*
(Continued)

Prey taxa	1979 and 1980 F	N	W	IRI	1981 F	N	W	IRI	1982 F	N	W	IRI	1983 F	N	W	IRI	1984 F	N	W	IRI
Chordata																				
Osteichthyes																				
Clupea harengus pallasi	—	—	—	—	5.5	0.1	13.5	75	10.0	0.4	6.2	68	6.9	0.1	18.1	126	7.7	*	18.2	141
Engraulis mordax	31.2	0.4	44.0	1385	24.7	1.4	55.3	1401	11.7	0.4	25.2	300	24.1	1.2	35.1	875	2.6	*	9.6	25
Hypomesius pretiosus	6.2	*	1.6	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Allosmerus elongatus	15.6	0.1	6.2	98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Osmeridae	—	—	—	—	1.4	*	*	<1	3.3	*	*	<1	—	—	—	—	2.6	*	*	<1
Gadidae	—	—	—	—	—	—	—	—	3.3	*	0.2	1	—	—	—	—	—	—	—	—
Cololabis saira	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.6	*	2.2	6
Sebastes spp.	18.7	0.1	2.1	41	1.4	*	0.1	<1	15.0	0.4	3.5	59	17.2	0.2	2.7	50	2.6	*	*	<1
Cottidae	—	—	—	—	—	—	—	—	1.7	0.2	0.2	<1	—	—	—	—	2.6	*	0.1	1
Artedius fenestralis	—	—	—	—	—	—	—	—	3.3	0.1	*	<1	—	—	—	—	—	—	—	—
Hemilepidotus hemilepidotus	—	—	—	—	—	—	—	—	1.7	*	*	<1	—	—	—	—	—	—	—	—
Hemilepidotus spinosus	—	—	—	—	2.7	*	0.2	<1	13.3	0.2	0.3	7	—	—	—	—	—	—	—	—
Scorpaenichthys marmoratus	—	—	—	—	—	—	—	—	1.7	*	*	<1	3.4	*	0.4	2	—	—	—	—
Ronquilus jordani	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.6	*	*	<1
Ammodytes hexapterus	—	—	—	—	—	—	—	—	15.0	0.3	1.9	33	10.3	0.2	0.3	5	2.6	*	*	<1
Citharichthys spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.6	*	1.5	4
Glyptocephalus zachirus	—	—	—	—	—	—	—	—	—	—	—	—	6.9	0.1	0.2	2	—	—	—	—
Isopsetta isolepis	—	—	—	—	—	—	—	—	—	—	—	—	6.9	0.1	0.1	1	—	—	—	—
Lepidopsetta bilineata	—	—	—	—	—	—	—	—	—	—	—	—	3.4	*	*	<1	—	—	—	—
Psettichthys melanostictus	—	—	—	—	—	—	—	—	—	—	—	—	10.3	0.1	0.1	2	—	—	—	—
Unidentified	—	—	—	—	—	—	—	—	31.7	1.3	0.7	63	6.9	0.1	0.2	2	—	—	—	—
Unidentified remains	—	—	—	—	—	—	—	--	35.0	—	8.0	—	51.7	0.8	8.4	476	23.1	*	5.5	129
Unidentified	40.6	—	4.4	—	32.9	—	6.2	—	8.3	—	0.1	—	10.3	—	2.6	—	14.7	—	0.6	—
Number of stomachs examined		33				87				65				33				40		
Number of empty stomachs		1				14				5				4				1		
Mean fork length (mm)		547				521				499				469				504		
Range fork length (mm)		358-709				344-741				321-720				330-640				327-784		
Mean fullness		3.3				2.1				2.7				2.6				2.0		
Mean digestion		2.6				2.0				2.4				2.6				2.3		

<0.1%; F = percent frequency occurrence; N = percent number, W = percent weight; IRI = index of relative importance.

Table 13—*Oncorhynchus kisutch*
Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Cnidaria	7.1	0.7	3.8	—	—	4.0	4.1
Annelida	*	0.1	0.6	—	*	*	—
Gastropoda	0.3	*	1.3	0.1	0.1	0.3	1.0
Cephalopoda	4.3	3.1	10.9	5.0	—	1.1	15.1
Copepoda	*	*	—	—	*	—	*
Mysidacea	—	—	*	—	—	*	—
Amphipoda	*	—	*	—	*	*	*
Euphausiacea	36.9	9.6	16.0	0.6	66.3	6.5	2.4
Decapoda	9.2	29.4	0.6	*	16.8	4.5	17.9
Thaliacea	—	—	*	*	*	—	0.1
Osteichthyes	42.2	56.1	66.8	94.3	15.9	83.6	59.3
Unidentified	*	1.1	*	0.1	1.0	0.2	0.3
No. stomachs	63	101	67	27	64	109	85
No. empty stomachs	4	6	12	3	5	14	6

*<0.1%

Table 14—*Oncorhynchus tshawytscha*

Taxonomic composition of overall diet.

Prey taxa	1979 and 1980				1981				1982				1983				1984			
	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI
Cnidaria																				
Hydromedusae	—	—	—	—	6.7	*	0.3	3	—	—	—	—	—	—	—	—	—	—	—	—
Unidentified	—	—	—	—	—	—	—	—	—	—	—	—	8.7	*	0.1	2	—	—	—	—
Mollusca																				
Gastropoda																				
Limacina helicina	—	—	—	—	6.7	88.5	1.3	602	3.6	2.1	0.2	8	8.7	3.0	*	27	—	—	—	—
Cephalopoda																				
Loligo opalescens	—	—	—	—	—	—	—	—	3.6	*	0.4	2	8.7	0.7	0.1	7	—	—	—	—
Octopus spp.	—	—	—	—	—	—	—	—	—	—	—	—	4.3	0.7	0.2	4	—	—	—	—
Unidentified	—	—	—	—	—	—	—	—	3.6	*	0.4	2	—	—	—	—	6.7	0.3	0.7	7
Arthropoda																				
Mysidacea																				
Neomysis kadiakensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6.7	0.3	*	3
Euphausiacea																				
Euphausia pacifica	—	—	—	—	—	—	—	—	10.7	15.0	2.9	192	4.3	1.3	0.1	6	13.3	3.0	1.7	63
Nyctiphanes simplex	—	—	—	—	—	—	—	—	—	—	—	—	4.3	0.2	*	1	—	—	—	—
Thysanoessa spinifera	—	—	—	—	—	—	—	—	39.3	77.0	39.0	4559	13.0	24.3	5.3	385	46.7	12.0	9.6	1009
Unidentified	—	—	—	—	—	—	—	—	—	—	—	—	8.7	9.5	1.8	98	—	—	—	—
Amphipoda																				
Primno brevidens	—	—	—	—	—	—	—	—	3.6	*	*	1	—	—	—	—	6.7	0.3	*	3
Decapoda																				
Pugettia producta meglopae	—	—	—	—	—	—	—	—	—	—	—	—	4.3	0.2	*	1	—	—	—	—
Cancer antennarius megalopae	—	—	—	—	—	—	—	—	—	—	—	—	8.7	0.6	*	6	—	—	—	—
C. magister megalopae	40.0	79.4	1.0	3216	—	—	—	—	25.0	4.0	0.6	115	26.1	15.6	1.9	457	13.3	34.3	16.1	670
C. oregonensis megalopae	—	—	—	—	—	—	—	—	—	—	—	—	8.7	1.1	*	10	13.3	37.3	3.4	541
Pinnotheridae zoea	—	—	—	—	—	—	—	—	—	—	—	—	8.7	0.7	*	7	—	—	—	—
Fabia subquadrata zoea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13.3	10.5	0.7	149
Chordata																				
Osteichthyes																				
Clupea harengus pallasi	40.0	13.7	84.2	3916	—	—	—	—	3.6	*	2.6	10	8.7	0.4	15.4	138	—	—	—	—
Engraulis mordax	40.0	2.7	12.0	588	60.0	8.6	86.8	5724	21.4	0.7	34.6	755	21.7	8.9	46.9	1211	6.7	0.3	43.9	296
Allosmerus elongatus	—	—	—	—	—	—	—	—	3.6	0.1	2.2	8	—	—	—	—	—	—	—	—
Stenobrachius leucopsarus	—	—	—	—	—	—	—	—	—	—	—	—	13.0	9.5	15.2	321	—	—	—	—
Theragra chalcogramma	—	—	—	—	—	—	—	—	—	—	—	—	4.3	1.3	0.2	7	—	—	—	—
Merluccius productus	—	—	—	—	—	—	—	—	3.6	*	10.0	36	—	—	—	—	—	—	—	—
Sebastes spp. juvenile	—	—	—	—	5.0	0.2	0.2	2	7.1	*	0.1	1	4.3	0.2	0.2	2	6.7	0.6	8.1	58
Hemilepidotus spinosus	—	—	—	—	—	—	—	—	14.3	0.3	0.3	9	8.7	4.5	3.6	70	6.7	0.3	0.4	5
Cottidae	—	—	—	—	—	—	—	—	—	—	—	—	4.3	0.4	1.0	6	—	—	—	—
Ammodytes hexapterus	20.0	1.4	0.6	40	—	—	—	—	7.1	*	0.1	1	—	—	—	—	—	—	—	—
Glyptocephalus zachirus	—	—	—	—	—	—	—	—	—	—	—	—	8.7	0.7	0.2	8	—	—	—	—
Isopsetta isolepis	—	—	—	—	—	—	—	—	—	—	—	—	4.3	0.2	*	1	—	—	—	—
Lyopsetta exilis	—	—	—	—	—	—	—	—	—	—	—	—	4.3	0.2	*	1	—	—	—	—
Psettichthys melanostictus	—	—	—	—	—	—	—	—	—	—	—	—	13.0	15.6	3.8	252	—	—	—	—
Unidentified fish larvae	—	—	—	—	—	—	—	—	7.1	0.3	0.3	4	4.3	0.2	*	1	—	—	—	—
Unidentified fish remains	40.0	2.7	2.3	200	60.0	2.8	11.3	846	50.0	*	6.3	320	30.4	*	3.1	97	13.3	0.6	14.1	196
Unidentified	—	—	—	—	—	—	—	—	3.6	—	*	—	4.3	—	1.4	—	6.7	—	1.1	—
Number of stomachs examined	7				20				31				26				19			
Number of empty stomachs	2				5				3				3				4			
Mean fork length (mm)	609				549				525				405				467			
Range fork length (mm)	489-872				357-805				308-795				292-600				344-856			
Mean fullness	2.0				2.2				2.8				2.6				1.2			
Mean digestion	2.2				1.6				2.3				2.2				1.6			

<0.1%; F = percent frequency occurrence; N = percent number, W = percent weight; IRI = index of relative importance.

Table 15—*Oncorhynchus tshawytscha*
Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Cnidaria	—	0.3	—	—	—	0.2	—
Gastropoda	—	0.3	7.0	—	—	0.9	*
Cephalopods	0.7	0.2	—	2.0	0.3	0.9	0.2
Mysidacea	—	—	—	*	*	—	—
Amphipoda	—	*	—	—	*	*	—
Euphausiacea	43.7	*	2.1	1.6	78.9	1.5	6.1
Decapoda	0.2	2.6	—	—	0.6	1.8	0.3
Osteichthyes	55.3	96.6	90.4	96.4	20.2	94.7	93.1
Unidentified	*	—	0.5	—	0.1	—	0.2
No. stomachs	33	40	17	13	25	56	22
No. empty stomachs	1	7	5	4	3	12	2

*<0.1%

Table 16—*Oncorhynchus gorbuscha*
Taxonomic composition of overall diet.

Prey taxa	1981 F	N	W	IRI
Mollusca				
Gastropoda				
Limacina helicina	33.3	75.2	42.0	3903
Arthropoda				
Amphipoda				
Primno macropa	11.1	*	0.1	2
Euphausiacea				
Thysanoessa spinifera	11.1	2.0	13.3	170
Decapoda				
Cancer magister megalopae	33.3	3.5	15.4	629
C. oregonensis megalopae	22.2	2.3	1.6	87
Chordata				
Osteichthyes				
Osmeridae larvae	11.1	*	*	2
Sebastes spp. larvae	11.1	*	*	2
Hemilepidotus spinosus	11.1	*	0.5	7
Unidentified	11.1	*	16.5	187
Unidentified	11.1	—	0.3	—
Number of stomachs examined			10	
Number of empty stomachs			1	
Mean fork length (mm)			515	
Range fork length (mm)			364-638	
Mean fullness			1.4	
Mean digestion			1.9	

*<0.1%; F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 17—*Salmo clarki*

Taxonomic composition of overall diet.

Prey taxa	1981 F	1981 N	1981 W	1981 IRI	1982-84 F	1982-84 N	1982-84 W	1982-84 IRI
Cnidaria								
Hydromedusae	—	—	—	—	13.3	2.1	0.2	31
Mollusca								
Pteropoda								
Limacina helicina	3.6	38.4	0.2	139	—	—	—	—
Cephalapoda								
Unidentified	3.6	0.4	*	2	—	—	—	—
Arthropoda								
Amphipoda								
Hyperoche medusarum	10.7	5.4	*	59	—	—	—	—
Themisto pacifica	—	—	—	—	6.7	1.0	0.3	9
Euphausiacea								
Euphausia pacifia	3.6	0.4	*	2	—	—	—	—
Thysanoessa spinifera	10.7	4.6	0.3	52	6.7	1.0	*	7
Unidentified	—	—	—	—	20.0	19.8	1.6	428
Decapoda								
Pachycheles spp. megalopae	—	—	—	—	6.7	1.0	*	7
Pugettia producta megalopae	3.6	0.4	*	2	—	—	—	—
Cancer magister megalopae	3.6	1.2	*	5	13.3	4.2	0.1	57
Insecta								
Hymenoptera	—	—	—	—	6.7	13.5	0.6	94
Unidentified	3.6	1.2	*	5	6.7	5.2	0.5	38
Chordata								
Osteichthyes								
Engraulis mordax	53.6	27.8	69.9	5237	13.3	2.1	26.0	374
Clupea harengus pallasi	—	—	—	—	6.7	2.1	0.5	17
Oncorhynchus tshawytscha	7.1	1.2	5.4	47	—	—	—	—
Oncorhynchus spp.	7.1	0.8	1.5	16	6.7	1.0	6.0	47
Cololabis saira	—	—	—	—	6.7	1.0	1.3	15
Sebastes spp.	10.7	5.0	5.6	113	6.7	1.0	11.3	82
Ophiodon elongatus	3.6	1.2	2.0	12	—	—	—	—
Hexagrammos decagrammus	—	—	—	—	33.3	21.9	31.9	1792
Cottidae	—	—	—	—	6.7	1.0	0.5	10
Scorpaenichthys marmoratus	3.6	0.4	0.5	3	6.7	1.0	0.6	11
Ronquilus jordani	3.6	0.4	*	2	—	—	—	—
Ammodytes hexapterus	3.6	1.2	0.4	6	6.7	1.0	0.2	8
Unidentified	42.9	9.9	13.7	1012	66.7	18.7	17.5	2415
Plant material	—	—	—	—	6.7	1.0	0.5	10
Unidentified	10.7	—	0.5	—	13.3	—	0.8	—

	1981	1982-84
Number of stomachs examined	32	16
Number of empty stomachs	4	1
Mean total length (mm)	327	328
Range total length (mm)	300-397	305-395
Mean fullness	3.0	3.3
Mean digestion	1.9	2.2

*<0.1%; F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 18—*Hypomesus pretiosus*

Taxonomic composition of overall diet.

Prey taxa	1981 and 1983 F	N	W	IRI
Mollusca				
Gastropoda				
Limacina helicina	7.1	2.5	0.5	21
Arthropoda				
Copepoda				
Eucalanus bungii	7.1	0.6	*	5
Calanus spp.	35.7	26.1	3.8	1067
Amphipoda				
Themisto pacifica	41.7	26.7	5.7	1351
Vibilia spp.	8.3	0.6	*	6
Decapoda				
Paguridae	16.7	6.8	1.7	142
Cancer magister megalopae	8.3	0.6	0.2	7
Unidentified	16.7	2.5	0.5	50
Chordata				
Larvacea				
Oikopleura spp.	8.3	15.5	4.2	164
Osteichthyes				
Ammodytes hexapterus	8.3	0.6	0.2	7
Pleuronectidae	8.3	0.6	2.0	22
Unidentified	75.0	—	68.0	—

	1981 and 1983
Number of stomachs examined	17
Number of empty stomachs	3
Mean fork length (mm)	167
Range fork length (mm)	151-190
Mean fullness	1.1
Mean digestion	0.9

*<0.1%; F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 19—*Merluccius productus*

Taxonomic composition of overall diet.

Prey taxa	1981 F	1981 N	1981 W	1981 IRI	1982 F	1982 N	1982 W	1982 IRI	1983 F	1983 N	1983 W	1983 IRI	1984 F	1984 N	1984 W	1984 IRI
Arthropoda																
Mysidacea																
Acanthomysis macropsis	—	—	—	—	—	—	—	—	30.0	1.1	*	36	1.7	*	*	<1
Neomysis kadiakensis	—	—	—	—	—	—	—	—	—	—	—	—	1.7	*	*	<1
Unidentified	—	—	—	—	1.8	*	*	<1	—	—	—	—		—	—	—
Cumacea																
Diastylopsis dawsoni	—	—	—	—	—	—	—		—	—	—	—	1.7	*	*	<1
Amphipoda																
Atylus tridens	—	—	—	—	1.8	*	*	<1	—	—	—	—	—	—	—	
Themisto pacifica	—	—	—	—	1.8	*	*	<1	—	—	—	1.7	*	*	<1	
Euphausiacea																
Euphausia pacifica	57.1	37.4	13.3	2895	30.9	8.5	1.3	303	20.0	1.6	0.2	36	73.3	63.4	45.4	7975
Nyctiphanes simplex	—	—	—	—	—	—	—	—	50.0	4.4	0.1	225	—	—	—	—
Thysanoessa spinifera	46.4	8.8	26.7	1647	60.0	62.1	18.0	4806	60.0	60.0	57.2	7032	68.3	33.9	37.9	4904
Unidentified	57.1	49.2	37.2	4933	29.1	26.5	12.1	1123	40.0	11.4	26.1	1500	30.0	1.9	14.4	489
Decapoda																
Crangon spp.	—	—	—	—	—	—	—	—	—	—	—	—	3.3	0.4	1.4	6
Pachycheles spp.	—	—	—	—	—	—	—	—	10.0	17.2	0.1	173	—	—	—	—
Cancer magister megalopae	14.3	0.6	0.1	10	9.1	0.2	*	3	30.0	2.5	0.5	90	1.7	*	*	<1
Cancer magister zoea	—	—	—	—	1.8	*	*	<1	—	—	—	—	—	—	—	—
Cancer oregonensis megalopae	—	—	—	—	—	—	—	—	—	—	—	—	5.0	0.1	0.1	1
Pinnotheridae	3.6	0.4	*	2	—	—	—	—	10.0	0.7	*	8	—	—	—	—
Unidentifed	3.6	0.1	*	1	5.5	0.1	0.4	3	—	—	—	—	—	—	—	—
Chordata																
Thaliacea																
Unidentified	—	—	—	—	1.8	*	*	<1	—	—	—	—	—	—	—	—
Osteichthyes																
Clupea harengus pallasi	—	—	—	—	3.6	*	3.2	12	—	—	—	—	—	—	—	—
Engraulis mordax	—	—	—	—	16.4	2.0	47.4	810	10.0	0.2	3.2	34	—	—	—	—
Myctophidae	—	—	—	—	—	—	—	—	—	—	—	—	1.7	*	0.6	1
Sebastes spp.	—	—	—	—	1.8	*	0.9	2	—	—	—	—	—	—	—	—
Hemilepidotus spp.	—	—	—	—	—	—	—	—	10.0	0.2	*	3	—	—	—	—
Ammodytes hexapterus	3.6	0.4	0.3	3	—	—	—	—	—	—	—	—	—	—	—	—
Citharichthys stigmaeus	3.6	0.1	0.3	1	—	—	—	—	—	—	—	—	—	—	—	—
Unidentified	21.4	0.6	21.9	482	16.4	0.5	16.7	282	30.0	0.7	12.3	390	3.3	0.1	0.1	1
Unidentified	7.1	2.4	0.1	18	1.8	—	*	—	20.0	—	0.4	—	1.7	—	0.1	—

	1981	1982	1983	1984
Number of stomachs examined	35	65	18	66
Number of empty stomachs	7	7	8	6
Mean fork length (mm)	513	483	514	467
Range fork length range (mm)	434-598	310-630	457-619	372-590
Mean fullness	1.5	3.3	1.7	2.9
Mean digestion	1.0	2.3	2.5	2.3

<0.1%; F = percent frequency occurrence; N = percent number, W = percent weight; IRI = index of relative importance.

Table 20—*Merluccius productus*

Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Amphipoda	—	*	*	*	—	*	*
Euphausiacea	1.2	85.9	92.0	98.0	98.7	13.4	92.5
Decapoda	0.3	0.1	1.4	1.3	1.0	*	0.2
Thaliacea	—	—	—	0.1	—	—	*
Osteichthyes	98.5	14.0	6.6	0.2	0.1	86.2	7.3
Unidentified	0.1	*	*	0.4	0.1	0.2	*
No. stomachs	27	53	80	24	39	76	69
No. empty stomachs	7	7	8	6	5	10	13

*<0.1%

Table 21—*Cololabis saira*
Taxonomic composition of overall diet.

Prey taxa	1981 and 1983 F	N	W	IRI	1984 F	N	W	IRI
Arthropoda								
Copepoda								
Calanus pacificus	3.3	9.4	0.8	34	—	—	—	—
Calanus spp.	10.0	33.9	2.9	368	3.7	0.6	0.4	4
Calanoid copepodites	—	—	—	—	3.7	32.9	0.3	123
Unidentified	—	—	—	—	3.7	27.7	0.3	104
Amphipoda								
Phoxocephalidae	—	—	—	—	3.7	0.6	0.1	3
Vibilia armata	10.0	16.1	4.2	203	—	—	—	—
Hyperoche medusarum	—	—	—	—	7.4	29.4	1.2	226
Unidentified Hyperiidea	10.0	6.1	1.1	72	3.7	0.6	0.1	3
Euphausiacea								
Euphausia pacifica	3.3	0.2	1.2	5	—	—	—	—
Nyctiphanes simplex	3.3	1.6	3.6	17	—	—	—	—
Thysanoessa spinifera	3.3	0.2	1.2	5	3.7	0.6	1.5	8
Unidentified	3.3	5.1	1.2	21	3.7	0.6	0.1	3
Chordata								
Osteichthyes								
Engraulis mordax	—	—	—	—	7.4	5.9	4.6	78
Ammodytes hexapterus	3.3	11.9	4.8	55	—	—	—	—
Unidentified	16.7	15.4	18.4	564	7.4	1.8	11.1	95
Unidentified	96.7	—	60.5	—	92.6	—	80.3	—
Number of stomachs examined		33				29		
Number of empty stomachs		3				2		
Mean fork length (mm)		239				219		
Range fork length (mm)		181-297				178-258		
Mean fullness		1.1				1.6		
Mean digestion		0.6				0.6		

F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 22—*Cololabis saira*
Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Copepoda	—	—	—	2.6	—	—	3.7
Amphipoda	—	5.7	—	4.1	—	11.2	2.1
Euphausiacea	—	1.8	—	1.0	—	3.1	0.4
Osteichthyes	—	28.1	—	13.3	—	11.8	18.7
Unidentified	—	64.5	100.0	79.0	100.0	74.0	75.2
No. stomachs	0	6	6	50	5	20	37
No. empty stomachs	—	1	2	2	1	2	2

Table 23—*Sebastes melanops*

Taxonomic composition of overall diet.

Prey taxa	1981				1982				1983				1984			
	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI
Cnidaria																
Siphonophora	—	—	—	—	—	—	—	—	5.3	0.1	*	1	—	—	—	—
Ctenophora																
Pleurobrachia bachei	—	—	—	—	—	—	—	—	15.8	6.1	13.3	307	12.0	3.5	1.7	62
Mollusca																
Gastropoda																
Limacina helicina	—	—	—	—	6.9	1.1	0.2	9	—	—	—	—	4.0	0.1	0.1	1
Cephalopoda																
Unidentified	—	—	—	—	—	—	—	—	5.3	0.1	0.1	1	—	—	—	—
Arthropoda																
Copepoda																
Calanus pacificus	—	—	—	—	—	—	—	—	—	—	—	—	12.0	2.4	0.2	31
Mysidacea																
Neomysis kadiakensis	—	—	—	—	3.5	0.1	*	1	—	—	—	—	—	—	—	—
Cumacea																
Lamprops sp.	—	—	—	—	—	—	—	—	—	—	—	—	4.0	0.1	0.1	1
Diastylopsis dawsoni	—	—	—	—	3.5	*	*	1	—	—	—	—	20.0	55.0	4.4	1188
Isopoda																
Unidentified	—	—	—	—	3.5	*	*	1	—	—	—	—	—	—	—	—
Amphipoda																
Atylus tridens	—	—	—	—	—	—	—	—	—	—	—	—	12.0	0.5	0.8	16
Lysianassidae	—	—	—	—	3.5	*	*	1	—	—	—	—	—	—	—	—
Hyperia medusarum	—	—	—	—	—	—	—	—	5.3	0.1	0.1	1	4.0	0.1	*	1
Hyperoche medusarum	—	—	—	—	3.5	*	*	1	—	—	—	—	16.0	2.0	0.8	45
Themisto pacifica	—	—	—	—	—	—	—	—	—	—	—	—	8.0	0.9	*	8
Primno macropa	—	—	—	—	—	—	—	—	—	—	—	—	4.0	0.1	0.1	1
Unidentified Hyperiidea	—	—	—	—	3.5	*	*	1	—	—	—	—	4.0	0.4	0.1	2
Euphausiacea																
Euphausia pacifica	20.0	68.5	15.1	1672	10.3	3.0	1.1	42	—	—	—	—	12.0	0.4	0.3	8
Nyctiphanes simplex	—	—	—	—	—	—	—	—	—	—	—	—	4.0	0.1	0.1	1
Thysanoessa spinifera	20.0	0.5	0.6	22	72.4	65.7	57.8	8841	21.1	6.9	3.2	213	40.0	22.8	3.1	1036
Unidentified	40.0	21.4	6.0	1096	31.0	0.7	8.1	273	—	—	—	—	12.0	0.3	5.0	64
Decapoda																
Caridea	—	—	—	—	—	—	—	—	—	—	—	—	4.0	0.1	0.1	1
Pandalus spp.	20.0	*	*	4	—	—	—	—	5.3	0.1	0.1	1	—	—	—	—
Crangon alaskensis	—	—	—	—	—	—	—	—	—	—	—	—	12.0	0.5	0.7	14
Crangon franciscorum	—	—	—	—	—	—	—	—	—	—	—	—	4.0	0.1	0.7	3
Crangon spp.	—	—	—	—	10.3	0.1	0.3	4	5.3	0.1	*	1	8.0	0.8	0.1	7
Callianassa californiensis	—	—	—	—	—	—	—	—	—	—	—	—	4.0	3.2	14.4	70
Cancer productus megalopae	—	—	—	—	—	—	—	—	5.3	1.0	0.1	6	—	—	—	—
Cancer magister megalopae	—	—	—	—	86.2	25.3	9.4	2991	68.4	23.0	12.9	2456	8.0	0.4	0.1	4
Cancer oregonensis megalopae	—	—	—	—	—	—	—	—	26.3	55.3	3.0	1533	16.0	1.3	0.1	22
Cancer spp. megalopae	—	—	—	—	—	—	—	—	15.8	2.0	0.2	35	—	—	—	—
Pinnotheridae megalopae	20.0	5.8	0.2	120	10.3	0.1	*	2	—	—	—	—	—	—	—	—
Pinnotheridae zoea	—	—	—	—	3.5	*	*	1	5.3	0.5	*	3	—	—	—	—
Unidentified megalopae	20.0	0.5	*	12	—	—	—	—	21.1	1.7	2.0	78	—	—	—	—
Unidentified	—	—	—	—	3.5	0.1	*	1	10.5	0.4	0.2	6	4.0	0.1	0.4	2
Chaetognatha																
Sagitta elegans	—	—	—	—	6.9	0.1	*	1	—	—	—	—	—	—	—	—

Table 23—*Sebastes melanops*
(Continued)

Prey taxa	1981 F	1981 N	1981 W	1981 IRI	1982 F	1982 N	1982 W	1982 IRI	1983 F	1983 N	1983 W	1983 IRI	1984 F	1984 N	1984 W	1984 IRI
Chordata																
Osteichthyes																
Lampetra tridentata	—	—	—	—	3.5	*	4.7	17	—	—	—	—	—	—	—	—
Clupea harengus pallasi	20.0	0.5	38.3	776	—	—	—	—	—	—	—	—	—	—	—	—
Engraulis mordax	—	—	—	—	—	—	—	—	10.5	0.6	41.9	446	—	—	—	—
Oncorhynchus tshawytscha	20.0	0.5	35.8	726	—	—	—	—	—	—	—	—	—	—	—	—
Oncorhynchus kisutch	—	—	—	—	—	—	—	—	5.3	0.1	13.5	72	—	—	—	—
Allosmerus elongatus	—	—	—	—	—	—	—	—	5.3	0.4	3.9	23	—	—	—	—
Osmeridae	20.0	0.5	*	12	6.9	0.2	0.1	2	—	—	—	—	16.0	3.5	2.3	93
Microgadus proximus	—	—	—	—	—	—	—	—	5.3	0.1	1.6	9	4.0	0.1	0.1	1
Cottidae	—	—	—	—	—	—	—	—	5.3	0.1	*	1	—	—	—	—
Hemilepidotus spinosus	40.0	1.0	2.0	120	14.0	0.5	1.5	28	—	—	—	—	—	—	—	—
Ronquilus jordani	—	—	—	—	—	—	—	—	—	—	—	—	4.0	0.1	0.2	1
Ptilichthys goodei	—	—	—	—	3.5	*	0.1	1	—	—	—	—	—	—	—	—
Ammodytes hexapterus	—	—	—	—	24.1	0.1	1.8	46	5.3	0.1	*	1	—	—	—	—
Citharichthys sp.	—	—	—	—	—	—	—	—	—	—	—	—	4.0	0.1	0.2	1
Glyptocephalus zachirus	—	—	—	—	24.1	0.1	1.8	46	—	—	—	—	4.0	0.3	0.3	2
Psettichthys melanostictus	—	—	—	—	—	—	—	—	—	—	—	—	4.0	0.1	0.1	1
Unidentified	60.0	1.5	2.1	216	62.1	1.9	3.6	342	36.8	0.9	4.1	184	8.0	0.4	0.1	4
Unidentified	20	—	0.1	—	37.9	—	10.9	—	5.3	—	1.1	—	68.0	—	63.9	—
Number of stomachs examined	5				29				20				34			
Number of empty stomachs	0				0				1				9			
Mean fork length (mm)	462				472				431				469			
Range fork length (mm)	395-504				171-535				395-511				365-532			
Mean fullness	3.2				4.0				2.8				1.4			
Mean digestion	2.2				2.6				2.5				1.2			

<0.1%; F = percent frequency occurrence; N = percent number, W = percent weight; IRI = index of relative importance.

Table 24—*Sebastes melanops*

Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Cnidaria	—	0.1	—	0.7	*	—	—
Ctenophora	—	3.8	1.1	1.2	1.3	—	24.5
Gastropoda	*	0.2	*	—	*	0.4	—
Cephalopoda	—	*	—	—	—	—	0.1
Mysidacea	—	*	—	*	*	—	—
Amphipoda	0.1	*	0.2	0.4	0.2	—	*
Euphausiacea	34.9	58.0	21.1	6.0	64.0	6.0	8.5
Decapoda	12.5	9.9	19.6	9.7	10.4	9.6	33.0
Chaetognatha	—	*	—	—	—	—	—
Osteichthyes	39.0	22.3	23.7	4.9	12.1	66.9	1.2
Unidentified	13.5	5.7	34.4	77.2	12.0	17.2	32.7
No. stomachs	12	41	15	20	70	12	6
No. empty stomachs	0	3	6	1	9	1	0

*<0.1%

Table 25—*Sebastes flavidus*

Taxonomic composition of overall diet.

Prey taxa	F (1982 and 1984)	N	W	IRI
Cnidaria				
Unidentified	15.3	0.8	*	14
Mollusca				
Gastropoda				
Limacina helicina	23.1	3.7	*	88
Unidentified	7.7	0.6	*	5
Cephalopoda				
Loligo opalescens	7.7	0.3	*	3
Arthropoda				
Copepoda				
Neocalanus plumchrus	7.7	0.3	*	3
Pseudocalanus minutus	7.7	0.6	*	5
Calanus pacificus	15.3	1.0	*	17
Amphipoda				
Hyperia medusarum	30.8	2.1	*	68
Themisto pacifica	7.7	0.3	*	3
Primno macropa	23.1	0.8	*	21
Euphausiacea				
Euphausia pacifica	23.1	20.6	1.2	504
Thysanoessa spinifera	38.5	32.8	11.2	1694
Unidentified	61.5	15.4	15.0	1870
Decapoda				
Cancer magister megalopae	30.8	15.9	3.1	585
Chaetognatha				
Sagitta elegans	7.7	0.3	*	3
Chordata				
Osteichthyes				
Clupea harengus pallasi	7.7	0.3	19.3	151
Sebastes sp.	7.7	0.3	1.1	11
Ophiodon elongatus	15.3	1.0	1.4	37
Unidentified flatfish	15.3	0.8	1.4	34
Unidentified	38.5	2.3	4.5	262
Unidentified	61.5	—	40.9	—

Number of stomachs examined	14
Number of empty stomachs	1
Mean fork length (mm)	430
Range fork length (mm)	290-586
Mean fullness	2.7
Mean digestion	2.0

*<0.1%; F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 26—*Anoplopoma fimbria*
Taxonomic composition of overall diet.

Prey taxa	1981				1982				1983				1984			
	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI	F	N	W	IRI
Cnidaria																
Hydromedusae																
Eutonina indicans	—	—	—	—	7.7	0.1	0.1	2	—	—	—	—	—	—	—	—
Chondrophora																
Velella velella	8.3	1.2	12.4	113	—	—	—	—	—	—	—	—	—	—	—	—
Unidentified	2.1	0.2	0.4	1	23.1	0.3	1.4	39	6.7	0.6	0.2	5	—	—	—	—
Unidentified	—	—	—	—	—	—	—	—	—	—	—	—	23.1	0.8	12.2	300
Ctenophora																
Unidentified	2.1	0.2	*	1	—	—	—	—	—	—	—	—	—	—	—	—
Annelida																
Tomopteris spp.	1.0	0.1	*	<1	—	—	—	—	6.7	0.6	0.6	8	—	—	—	—
Mollusca																
Gastropoda																
Limacina helicina	9.0	25.3	1.4	240	—	—	—	—	—	—	—	—	—	—	—	—
Clionidae	29.9	16.0	3.8	592	—	—	—	—	—	—	—	—	—	—	—	—
Calvolina spp.	—	—	—	—	—	—	—	—	13.3	1.8	0.4	29	—	—	—	—
Unidentified	2.1	0.1	0.3	1	—	—	—	—	—	—	—	—	—	—	—	—
Cephalopoda																
Unidentified	5.2	0.3	0.2	3	—	—	—	—	—	—	—	—	—	—	—	—
Arthropoda																
Copepoda																
Unidentified	1.0	0.1	0.1	<1	—	—	—	—	—	—	—	—	—	—	—	—
Amphipoda																
Atylus tridens	—	—	—	—	7.7	0.1	*	2	—	—	—	—	—	—	—	—
Phoxocephalidae	—	—	—	—	—	—	—	—	—	—	—	—	7.7	0.3	0.1	3
Hyperia medusarum	1.0	0.1	*	<1	23.1	0.7	0.2	21	—	—	—	—	23.1	0.8	0.5	30
Hyperia spinigera	—	—	—	—	7.7	0.1	0.1	2	—	—	—	—	—	—	—	—
Hyperoche medusarum	—	—	—	—	53.9	10.2	0.5	577	13.3	2.4	0.2	35	—	—	—	—
Themisto pacifica	2.1	0.2	*	1	38.5	12.6	1.3	535	20.0	3.6	0.2	76	—	—	—	—
Primno macropa	—	—	—	—	7.7	0.1	*	2	13.3	1.2	0.2	19	—	—	—	—
Primno brevidens	—	—	—	—	—	—	—	—	6.7	1.2	0.4	11	—	—	—	—
Oxycephalus spp.	1.0	0.1	*	<1	—	—	—	—	—	—	—	—	—	—	—	—
Streetsia challengeri	—	—	—	—	7.7	0.1	*	2	—	—	—	—	—	—	—	—
Vibilia viatrix	—	—	—	—	23.1	0.4	0.1	12	—	—	—	—	—	—	—	—
Vibilia propinqua	—	—	—	—	—	—	—	—	6.7	1.2	1.1	15	—	—	—	—
Vibilia sp.	—	—	—	—	7.7	0.1	*	2	33.3	6.1	1.1	240	—	—	—	—
Paraphronima spp.	1.0	0.1	*	<1	—	—	—	—	—	—	—	—	—	—	—	—
Paraphronima crassipes	—	—	—	—	—	—	—	—	—	—	—	—	15.4	1.0	0.3	20
Unidentified Hyperiidea	24.7	2.5	0.1	64	7.7	0.7	0.1	6	33.3	13.9	0.8	490	—	—	—	—
Euphausiacea																
Euphausia pacifica	18.6	19.2	11.9	578	53.9	28.6	12.5	2215	6.7	0.6	0.6	8	23.1	24.0	22.0	1063
Thysanoessa spinifera	8.3	3.6	3.0	55	46.2	27.0	22.7	2296	13.3	1.8	1.9	49	—	—	—	—
Unidentified	24.7	11.5	9.5	519	15.4	0.2	11.8	185	6.7	1.8	0.8	17	23.1	3.7	14.0	409
Decapoda																
Sergestes similis	1.0	0.1	0.3	<1	—	—	—	—	—	—	—	—	—	—	—	—
Crangon spp. zoea	—	—	—	—	—	—	—	—	6.7	0.6	0.2	5	—	—	—	—
Porcellanidae	—	—	—	—	—	—	—	—	—	—	—	—	7.7	0.3	*	3
Pugettia producta	—	—	—	—	—	—	—	—	6.7	4.9	0.2	34	—	—	—	—
Cancer magister megalopae	23.7	9.9	4.4	339	30.8	6.1	3.5	296	—	—	—	—	7.7	0.5	0.4	7
Cancer oregonensis megalopae	7.2	4.0	0.4	32	30.8	1.1	0.1	37	—	—	—	—	7.7	29.2	3.2	249
Cancer antennarius megalopae	—	—	—	—	—	—	—	—	13.3	8.5	0.8	124	—	—	—	—
Cancer spp. megalopae	7.2	0.7	0.2	7	7.7	9.6	1.6	86	40.0	13.3	1.1	576	7.7	0.3	5.4	44
Fabia subquadrata	—	—	—	—	—	—	—	—	—	—	—	—	15.4	38.1	3.2	636

Table 26—*Anoplopoma fimbria*
(Continued)

Prey taxa	1981 F	1981 N	1981 W	1981 IRI	1982 F	1982 N	1982 W	1982 IRI	1983 F	1983 N	1983 W	1983 IRI	1984 F	1984 N	1984 W	1984 IRI
Chordata																
Thaliacea																
Doliolidae	—	—	—	—	—	—	—	—	40.0	25.5	38.8	2572	—	—	—	—
Salpidae	1.0	0.1	0.7	1	15.4	0.5	1.4	29	26.7	7.3	6.3	363	—	—	—	—
Larvacea																
Oikopleura spp.	1.0	2.3	*	2	—	—	—	—	—	—	—	—	—	—	—	—
Osteichthyes																
Allosmerus elongatus	—	—	—	—	7.7	0.1	4.1	32	—	—	—	—	—	—	—	—
Cololabis saira	1.0	0.1	10.8	11	—	—	—	—	—	—	—	—	—	—	—	—
Trachipterus altivelis	—	—	—	—	7.7	0.1	7.2	56	—	—	—	—	—	—	—	—
Sebastes spp. juvenile	3.1	0.2	2.3	8	—	—	—	—	—	—	—	—	—	—	—	—
Hemilepidotus spinosus	1.0	0.1	0.6	1	7.7	0.1	0.6	5	—	—	—	—	—	—	—	—
Scorpaenichthys marmoratus	2.1	0.2	*	<1	—	—	—	—	—	—	—	—	—	—	—	—
Liparididae	—	—	—	—	7.7	0.2	0.7	7	—	—	—	—	—	—	—	—
Anarrhichthys ocellatus	—	—	—	—	7.7	0.1	21.8	169	—	—	—	—	—	—	—	—
Glyptocephalus zachirus	1.0	0.1	0.2	<1	—	—	—	—	—	—	—	—	—	—	—	—
Unidentified larvae	—	—	—	—	7.7	0.8	3.0	29	—	—	—	—	30.8	1.0	1.9	89
Unidentified	32.0	2.0	14.7	534	7.7	0.1	0.2	2	36.7	3.0	4.0	257	—	—	—	—
Unidentified	91.8	—	22.6	—	69.2	—	5.3	—	93.3	—	40.3	—	46.2	—	36.7	—

	1981	1982	1983	1984
Number of stomachs examined	98	14	18	16
Number of empty stomachs	1	1	3	3
Mean fork length (mm)	198	277	239	275
Range fork length (mm)	130-330	219-350	157-307	214-410
Mean fullness	2.7	2.9	2.7	1.8
Mean digestion	2.0	2.8	3.0	1.0

*<0.1%; F = percent frequency occurrence; N = percent number, W = percent weight; IRI = index of relative importance.

Table 27—*Anoplopoma fimbria*
Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Cnidaria	—	0.6	8.6	19.4	*	13.8	0.7
Ctenophora	—	*	—	—	—	—	*
Annelida	—	*	*	—	—	*	*
Gastropoda	—	16.1	0.2	0.1	*	1.0	18.0
Cephalopoda	—	0.4	0.2	—	—	0.1	4.9
Copepoda	—	*	0.1	—	—	*	*
Amphipoda	*	0.3	0.5	7.4	47.3	0.7	1.9
Euphausiacea	87.1	22.3	34.0	14.4	39.7	7.6	27.6
Decapoda	3.8	5.7	16.5	0.7	3.9	13.1	0.8
Thaliacea	—	0.2	2.5	9.9	1.5	1.6	1.4
Osteichthyes	8.6	30.2	19.5	32.8	0.5	1.6	1.4
Unidentified	0.5	24.0	17.7	15.4	7.2	12.1	22.0
No. stomachs	3	73	39	31	23	55	68
No. empty stomachs	0	1	0	7	3	3	2

*<0.1%

Table 28—*Trachurus symmetricus*
Taxonomic composition of overall diet.

Prey taxa	1982 F	1982 N	1982 W	1982 IRI	1983 F	1983 N	1983 W	1983 IRI	1984 F	1984 N	1984 W	1984 IRI
Mollusca												
Gastropoda												
Limacina helicina	30.0	12.5	1.0	405	2.6	3.5	0.1	9	—	—	—	—
Euclio pyramidata	—	—	—	—	13.2	13.6	5.7	255	—	—	—	—
Cephalopoda												
Japetella heathi	—	—	—	—	—	—	—	—	16.1	1.2	0.9	34
Unidentified	5.0	0.1	*	1	2.6	0.1	*	1	—	—	—	—
Arthropoda												
Copepoda												
Neocalanus cristatus	—	—	—	—	2.6	0.3	*	1	—	—	—	—
Calanus marshallae	—	—	—	—	18.4	5.8	0.1	109	22.6	3.4	0.2	81
Amphipoda												
Unidentified Gammaridea	—	—	—	—	2.6	0.1	0.4	1	—	—	—	—
Hyperia medusarum	10.0	0.2	*	3	2.6	0.1	*	1	—	—	—	—
Hyperoche medusarum	25.0	5.0	0.1	128	—	—	—	—	—	—	—	—
Themisto pacifica	—	—	—	—	2.6	0.1	*	1	9.7	0.2	0.1	3
Primno macropa	—	—	—	—	7.9	0.3	*	3	—	—	—	—
Vibilia propinqua	—	—	—	—	2.6	0.1	*	1	—	—	—	—
Vibilia spp.	5.0	0.1	*	1	13.2	2.1	0.2	30	—	—	—	—
Paraphronima gracilis	—	—	—	—	—	—	—	—	3.2	0.1	0.1	1
Unidentified Hyperiidea	15.0	0.4	*	8	7.9	0.3	*	3	—	—	—	—
Euphausiacea												
Euphausia pacifica	25.0	4.5	0.8	133	26.3	2.9	7.2	266	54.8	44.9	40.7	4691
Nyctiphanes simplex	—	—	—	—	2.6	0.3	*	1	—	—	—	—
Thysanoessa spinifera	40.0	16.8	5.2	880	50.0	58.6	48.0	5330	61.3	7.6	9.4	1042
Unidentified	35.0	2.9	5.4	291	39.5	10.2	16.5	1055	35.5	0.2	22.5	806
Decapoda												
Pandalus spp. zoea	—	—	—	—	—	—	—	—	6.5	0.2	0.1	2
Crangon spp.	—	—	—	—	—	—	—	—	9.7	0.1	0.1	2
Callianassa spp. zoea	—	—	—	—	10.5	0.9	*	11	—	—	—	—
Pagurus spp. megalopae	—	—	—	—	—	—	—	—	9.7	0.2	0.1	3
Lithodidae	—	—	—	—	—	—	—	—	6.5	0.4	0.1	3
Galatheidae	—	—	—	—	—	—	—	—	3.2	*	0.1	1
Porcellanidae	—	—	—	—	—	—	—	—	9.7	0.2	0.1	3
Pachycheles pubescens	—	—	—	—	—	—	—	—	3.2	0.1	0.1	1
Oregonia gracilis	—	—	—	—	—	—	—	—	3.2	0.1	0.1	1
Cancer antennarius megalopae	—	—	—	—	—	—	—	—	6.5	0.2	0.1	2
Cancer magister megalopae	—	—	—	—	—	—	—	—	9.7	5.5	2.9	81
Cancer magister zoea	—	—	—	—	—	—	—	—	29.0	23.6	1.2	719
Cancer oregonensis megalopae	—	—	—	—	—	—	—	—	16.1	3.0	0.4	55
Cancer spp. megalopae	—	—	—	—	7.9	0.3	*	3	—	—	—	—
Cancer spp. zoea	—	—	—	—	5.3	0.2	*	2	—	—	—	—
Fabia subquadrata	—	—	—	—	—	—	—	—	16.1	2.3	0.2	40
Pinnixia sp. megalopae	—	—	—	—	—	—	—	—	12.9	0.4	0.1	6
Unidentified	—	—	—	—	—	—	—	—	12.9	0.4	1.4	23
Chaetognatha												
Unidentified	—	—	—	—	—	—	—	—	6.5	*	0.3	3

Table 28—*Trachurus symmetricus*
(Continued)

Prey taxa	1982 F	1982 N	1982 W	1982 IRI	1983 F	1983 N	1983 W	1983 IRI	1984 F	1984 N	1984 W	1984 IRI
Chordata												
Osteichthyes												
Clupea harengus pallasi	—	—	—	—	2.6	0.3	13.2	35	—	—	—	—
Engraulis mordax	35.0	56.0	70.6	4431	2.6	0.1	*	1	—	—	—	—
Osmeridae	—	—	—	—	—	—	—	—	3.2	0.1	0.1	1
Microgadus proximus	—	—	—	—	—	—	—	—	3.2	0.3	0.6	3
Sebastes spp.	5.0	0.1	0.7	4	—	—	—	—	3.2	0.2	0.2	1
Cottidae	—	—	—	—	—	—	—	—	3.2	0.2	0.1	1
Agonopsis vulsa	—	—	—	—	—	—	—	—	3.2	*	0.1	1
Liparis spp.	5.0	0.5	0.4	5	—	—	—	—	—	—	—	—
Ronquilus jordani	—	—	—	—	—	—	—	—	3.2	0.4	1.0	4
Stichaeidae	—	—	—	—	—	—	—	—	3.2	*	0.1	1
Ammodytes hexapterus	—	—	—	—	—	—	—	—	9.7	0.2	0.2	4
Hippoglossoides elassodon	—	—	—	—	—	—	—	—	3.2	0.2	0.6	3
Isopsetta isolepis	—	—	—	—	—	—	—	—	3.2	0.4	0.5	3
Lyopsetta exilis	—	—	—	—	—	—	—	—	3.2	0.1	0.3	1
Parophrys vetulus	—	—	—	—	—	—	—	—	3.2	0.4	1.1	5
Psettichthys melanostictus	—	—	—	—	—	—	—	—	3.2	1.3	2.0	11
Unidentified flatfish	—	—	—	—	—	—	—	—	6.5	0.4	0.8	8
Unidentified larvae	15.0	0.6	0.7	20	—	—	—	—	—	—	—	—
Unidentified	20.0	0.2	12.5	26	15.8	0.5	8.3	139	12.9	1.6	2.8	57
Unidentified	20.0	—	2.7	—	23.7	—	0.6	—	67.7	—	8.7	—
Number of stomachs examined		25				48				59		
Number of empty stomachs		5				10				14		
Mean fork length (mm)		574				451				513		
Range fork length (mm)		535-605				265-610				230-756		
Mean fullness		2.2				1.9				2.0		
Mean digestion		1.7				1.6				1.0		

<0.1%; F = percent frequency occurrence; N = percent number, W = percent weight; IRI = index of relative importance.

Table 29—*Trachurus symmetricus*
Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Gastropoda	—	0.2	—	3.2	8.2	—	0.5
Cephalopoda	—	1.0	0.1	*	1.5	—	*
Copepoda	—	0.3	—	*	0.1	0.6	*
Amphipoda	—	0.1	—	0.2	0.4	0.2	0.1
Euphausiacea	92.2	70.4	89.6	33.3	44.5	65.6	47.9
Decapoda	—	7.5	*	—	8.0	3.5	0.3
Chaetognatha	—	0.4	—	—	0.5	—	—
Osteichthyes	7.8	12.1	0.8	61.8	35.3	15.6	47.5
Unidentified	—	8.1	9.6	1.6	1.4	14.4	3.6
No. stomachs	7	50	26	49	18	34	80
No. empty stomachs	4	4	10	11	0	12	17

*<0.1%

Table 30—*Scomber japonicus*
Taxonomic composition of overall diet.

Prey taxa	1983 F	1983 N	1983 W	1983 IRI	1984 F	1984 N	1984 W	1984 IRI
Cnidaria								
Unidentified	—	—	—	—	2.9	*	2.7	8
Ctenophora	—	—	—	—	7.4	*	0.4	4
Mollusca								
Gastropoda								
Limacina helicina	1.8	*	*	<1	—	—	—	—
Cephalopoda								
Teuthoidea	—	—	—	—	4.4	*	*	1
Octopoda	3.6	*	*	1	—	—	—	—
Unidentified	1.8	*	0.1	<1	—	—	—	—
Arthropoda								
Copepoda								
Neocalanus cristatus	3.6	0.3	0.1	1	—	—	—	—
Pseudocalanus sp.	—	—	—	—	13.2	69.9	14.4	1113
Calanus spp.	12.7	9.8	0.6	132	36.8	25.3	10.2	1306
Acartia sp.	—	—	—	—	1.5	*	0.1	<1
Copepodites	—	—	—	—	1.5	0.2	0.1	<1
Amphipoda								
Atylus tridens	3.6	*	*	1	7.4	*	0.3	3
Hyperia medusarum	—	—	—	—	2.9	*	*	1
Hyperoche medusarum	3.6	*	*	1	2.9	*	0.1	1
Themisto pacifica	12.7	1.6	0.1	22	11.8	0.1	0.3	5
Vibilia australis	1.8	*	*	<1	—	—	—	—
Paraphronima gracilis	1.8	*	*	<1	—	—	—	—
Unidentified Hyperiidea	7.3	0.1	*	2	5.9	*	0.2	2
Euphausiacea								
Euphausia pacifica	12.7	76.0	72.4	1885	11.8	0.4	3.4	45
Nyctiphanes simplex	9.1	3.2	0.8	36	—	—	—	—
Thysanoessa spinifera	9.1	0.5	0.3	7	11.8	0.1	2.2	27
Unidentified	16.4	3.3	2.7	98	14.7	*	15.8	234
Decapoda								
Caridea	—	—	—	—	1.5	*	0.1	<1
Pandalidae	—	—	—	—	2.9	0.1	0.1	1
Crangon sp.	—	—	—	—	2.9	0.2	0.3	1
Callianassa spp. zoea	7.3	0.1	*	2	—	—	—	—
Paguridae	1.8	0.1	*	<1	—	—	—	—
Pagurus spp.	—	—	—	—	7.4	*	0.1	1
Pachycheles spp.	3.6	0.3	*	1	—	—	—	—
Pugettia producta	3.6	*	*	1	—	—	—	—
Cancer magister megalopae	7.3	0.3	0.3	4	8.8	0.1	0.6	6
Cancer spp. megalopae	12.7	0.2	0.1	4	—	—	—	—
Cancer spp. zoea	7.3	0.4	*	4	2.9	*	1.0	3
Cancer oregonensis megalopae	3.6	0.1	*	1	8.8	0.2	0.5	6
Pinnotheres spp. megalopae	—	—	—	—	4.4	0.1	0.1	1
Fabia subquadrata	—	—	—	—	7.4	3.4	4.4	58
Pinnotheridae zoea	1.8	0.9	0.2	2	—	—	—	—
Unidentified	—	—	—	—	14.7	*	4.0	60
Chordata								
Thaliacea								
Salpa sp.	—	—	—	—	1.5	*	0.1	<1
Unidentified	30.9	1.9	6.4	256	—	—	—	—
Osteichthyes								
Microgadus proximus	—	—	—	—	1.5	*	0.2	<1
Sebastes spp.	3.6	0.1	0.1	1	—	—	—	—
Ophiodon elongatus	1.8	*	0.1	<1	—	—	—	—
Hexagrammos sp.	—	—	—	—	1.5	*	0.1	<1
Hemilepidotus spinosus	7.3	0.2	0.8	7	—	—	—	—
Ammodytes hexapterus	5.5	0.3	0.8	6	2.9	*	0.1	<1
Pleuronectidae	1.8	*	0.1	<1	—	—	—	—
Unidentified	23.6	0.2	3.0	76	7.4	*	10.5	78
Unidentified	65.5	—	11.0	—	52.9	—	27.8	—
Number of stomachs examined			57			88		
Number of empty stomachs			2			20		
Mean fork length (mm)			292			324		
Length range (mm)			228-390			252-403		
Mean fullness			2.4			1.7		
Mean digestion			2.0			1.3		

*<0.1%; F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.

Table 31—*Scomber japonicus*

Percent total weight composition of major prey categories consumed for all years.

Prey category	Cruise month: May	June	July-August	Sept.	Area: Wash.	Columbia River	Oregon
Cnidaria	—	2.7	—	—	—	7.3	0.1
Ctenophora	—	—	—	1.6	—	*	—
Gastropoda	—	*	—	—	—	0.1	—
Cephalopoda	*	*	*	1.6	0.5	*	*
Copepoda	0.1	17.5	43.9	—	1.1	25.4	11.2
Amphipoda	0.2	0.4	0.1	0.5	0.4	0.8	0.1
Euphausiacea	90.4	21.5	6.0	6.2	7.9	5.9	67.4
Decapoda	0.5	12.8	0.1	—	27.1	1.5	2.8
Thaliacea	1.1	8.4	—	7.0	6.7	21.3	0.4
Osteichthyes	3.3	14.6	0.8	19.4	20.9	15.2	2.4
Unidentified	4.5	22.1	49.2	63.7	35.4	22.5	15.6
No. stomachs	19	84	30	12	38	44	63
No. empty stomachs	1	10	10	1	8	11	3

*<0.1%

Table 32—*Icichthys lockingtoni*

Taxonomic composition of overall diet.

Prey taxa	1982 and 1983: F	N	W	IRI
Annelida				
Tomopteris spp.	8.7	10.2	1.7	104
Arthropoda				
Amphipoda				
Hyperia medusarum	34.8	17.0	14.0	1079
Hyperoche medusarum	4.4	1.4	0.1	7
Themisto pacifica	8.7	1.4	0.3	15
Phronima sedentaria	4.4	0.7	0.3	4
Vibilia spp.	4.4	0.7	0.1	4
Unidentified	8.7	1.4	3.2	40
Chordata				
Thaliacea				
Salpa sp.	47.8	38.7	35.8	3609
Larvacea				
Oikopleura sp.	4.4	27.2	4.3	139
Osteichthyes				
Unidentified	8.7	1.4	5.4	59
Unidentified	34.8	—	34.0	—

Number of stomachs examined	24
Number of empty stomachs	1
Mean fork length (mm)	141
Range fork length (mm)	83-189
Mean fullness	1.2
Mean digestion	1.3

F = percent frequency occurrence; N = percent number; W = percent weight; IRI = index of relative importance.