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NEARSHORE FISH AND MACROINVERTEBRATE ASSEMBLAGES ALONG THE STRAIT OF JUAN DE FUCA INCLUDING FOOD HABITS OF THE COMMON NEARSHORE FISH

Report of Two Years of Sampling

by

Jeffrey N. Cross, Kurt L. Fresh, Bruce S. Miller,
Charles A. Simenstad, S. Nancy Steinfort, and Julianne C. Fegley

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ABSTRACT

The possibility of transport of Alaskan North Slope oil to proposed refinery and transshipment sites in the Strait of Juan de Fuca or Puget Sound has increased the probability of oil pollution in those waters. A baseline study was initiated in May 1976 to document the distribution, abundance, and biomass of nearshore fishes along the Strait of Juan de Fuca, to determine their food habits, and to identify the macroinvertebrates collected incidentally with the fish.

A total of 93 species of fish was collected from May 1976 to June 1978. Trends in occurrence, abundance, and biomass for individual species were fairly consistent between 1976-77 and 1977-78.

The predominant nearshore demersal fish species in beach seine collections were the Pacific staghorn sculpin, English sole, and sand sole. The predominant neritic fish species in townet collections were the Pacific herring and longfin smelt. The predominant intertidal fish species were the northern clingfish, tidepool sculpin, and high cockscomb.

Species richness generally increased from west to east in beach seine and townet collections; the opposite trend was observed in tidepool collections. Species richness was highest in summer and fall collections and lowest in winter collections. The density of fish was greatest in summer and fall in beach seine and tidepool collections and in spring and summer in townet collections. Standing crop values and timing of the peaks varied widely for both beach seine and tidepool collections but were considerably more consistent in townet collections.

A total of 191 species of macroinvertebrates was identified between May 1976 and June 1978. Epibenthic invertebrates occurred in both the beach seine and the townet collections, whereas benthic species were collected only by the beach seine and pelagic species only by the townet. The eastern sites were generally richer in species than the western sites.

A total of 7,000 stomachs from 88 species has been analyzed during the two years of study. Polychaete annelids, calanoid and harpacticoid copepods, mysids, sphaeromatid and idoteid isopods, gammarid amphipods, and hippolytid shrimp were the most commonly consumed prey taxa. Of the 55 species of fish that were considered common residents of the nearshore zone, 53 preyed upon gammarid amphipods. Gammarids composed more than 50% of the total Index of Relative Importance (IRI) for 31 fish species, and more than 75% for 9 species. Calanoid copepods were the dominant prey of neritic fishes.

I. INTRODUCTION

The possibility of transport of Alaskan North Slope oil to proposed refinery and transshipment sites in the Strait of Juan de Fuca or Puget Sound has increased the probability of oil pollution in these waters. Under proposals presently being considered, oil could be transferred to refinery, holding, or pipeline facilities at one of a number of sites on the Strait of Juan de Fuca or the eastern shore of Rosario Strait.

The State of Washington and the federal government, concerned with minimizing the incidence and impact of oil pollution, have conducted a number of programs designed to evaluate the detrimental effects of oil pollution on the biological and economic resources of Puget Sound. One of these, the Washington State Department of Ecology's (DOE) Northern Puget Sound Biological Baseline Study (1974-76), focused on documenting biological communities in the nearshore habitats of northern Puget Sound (Miller et al. 1977).

When the eastern Strait of Juan de Fuca came under consideration as a possible oil transshipment terminal site, the National Oceanic and Atmospheric Administration's (NOAA) Marine Ecosystem Analysis (MESA) Puget Sound Project initiated similar biological baseline studies in the Strait of Juan de Fuca in spring 1976 and along the west coast of Whidbey and Fidalgo islands in spring 1977. An important part of the NOAA studies is the ecological survey of nearshore fishes and their food habits. Nearshore, as opposed to offshore, fishes were emphasized because: (1) Nearshore habitats are more likely to be adversely affected by spilled oil than offshore habitats, and (2) fish provide a direct link to man for the transfer of hydrocarbons.

The principal objectives of this study were to document: (1) The occurrence, abundance, and distribution of nearshore fishes; (2) food habits of abundant and economically important species; and (3) occurrence and distribution of macroinvertebrates collected incidentally with the fishes.

Results of the first year of investigation (May 1976 - June 1977) were summarized in a previous progress report (Simenstad et al. 1977). The present progress report summarizes the combined results of the two years of studies (May 1976 - June 1978). The project will continue for one more year, and a final report incorporating the results of three years of studies and a more thorough interpretation of the data should be available by the end of summer 1979.

II. MATERIALS AND METHODS

II-A. Study Sites and Sampling Frequency

A major consideration in determining sampling sites and sampling design was the desire to make the results of the nearshore fish section of the MESA Puget Sound Project comparable to the DOE Northern Puget Sound Biological Baseline Study, thus facilitating between-area comparison. Further considerations used to determine sampling sites were: (1) The desire to sample throughout the Strait of Juan de Fuca and Whidbey and Fidalgo islands; (2) sites had to be accessible to both the land-based beach seine operation and the ship-based townet operation; (3) sites were chosen to reflect the variety of habitats encountered in the Strait of Juan de Fuca.

Six beach seine sites and seven townet sites were established along the Strait of Juan de Fuca in 1976. An additional beach seine and townet site was established on Whidbey Island and on Fidalgo Island in 1977, and seven tidepool sites were established along the Strait of Juan de Fuca in 1977. Sampling sites were characterized as to habitat and sampled with three methods designed to capture nearshore demersal (beach seine), neritic (townet), and intertidal (tidepool) fishes (Fig. 1, Table 1). Collection periods were quarterly--winter (December, January), spring (May), summer (August), and fall (October). Thus, eight seasonal periods were sampled, spring 1976 through winter 1977-78.

II-B. Sampling Techniques

II-B-1. Beach Seine

A 37-m (120-ft) beach seine was used to sample demersal fish occurring within 30 m of shore during slack water at low tide. The beach seine consisted of two wings with 3-cm mesh joined to a 0.6-m x 2.4-m x 2.3-m bag with 6-mm mesh. A weighted lead line kept the seine on the bottom. Floating sets were made with seven floats attached to the cork line at regular intervals. The net was set 30 m from the stern of a rowed skiff. Polypropylene lines 30 m long and 2 cm diameter were used to retrieve the net. Two-person teams situated 40 m apart hauled the net at about 10 m/minute. For the first 20 m of hauling the teams remained 40 m apart; the final 10 m was hauled with the teams 10 m apart. When the net was entirely on the beach, fish and invertebrates were removed, placed in plastic bags, and labeled for later processing. Replicate hauls were made at each site except when weather conditions made that impossible. Care was taken so that the area swept by one set was not included in the replicate. Time between sets was at least 30 minutes; this increased with increasing catches. At sites where the depth of water was less than 3 m, only sinking sets were made. Where water depth exceeded 3 m (two sites), both floating and sinking sets were made. Beach seining was conducted during slack water at low tide, which involved sampling at night between October and March and during the day between March and October.

II-B-2. Townet

A two-boat surface trawl (townet) was utilized to sample neritic fish occurring in the upper 3.5 m of the water column adjacent to the shoreline. The townet measured 3 m x 6 m (10 x 20 ft), with mesh sizes grading from 76 mm (3 inches) at the brail to 6 mm (1/4 inch) at the bag. The net was towed at 800 rpm (about 3.7 km/hr) between the 12-m (39-ft) FRI research vessel MALKA and a 3.7-m (12-ft) purse seine skiff. At each site, two 10-minute tows were made. One tow was made with the prevailing tidal current along the shoreline and the other tow was made in the opposite direction.

To reduce net avoidance by pelagic species and to optimize sampling of those pelagic species which migrate into shallow water nocturnally, sampling was conducted at night. We also sought to sample during periods of minimal

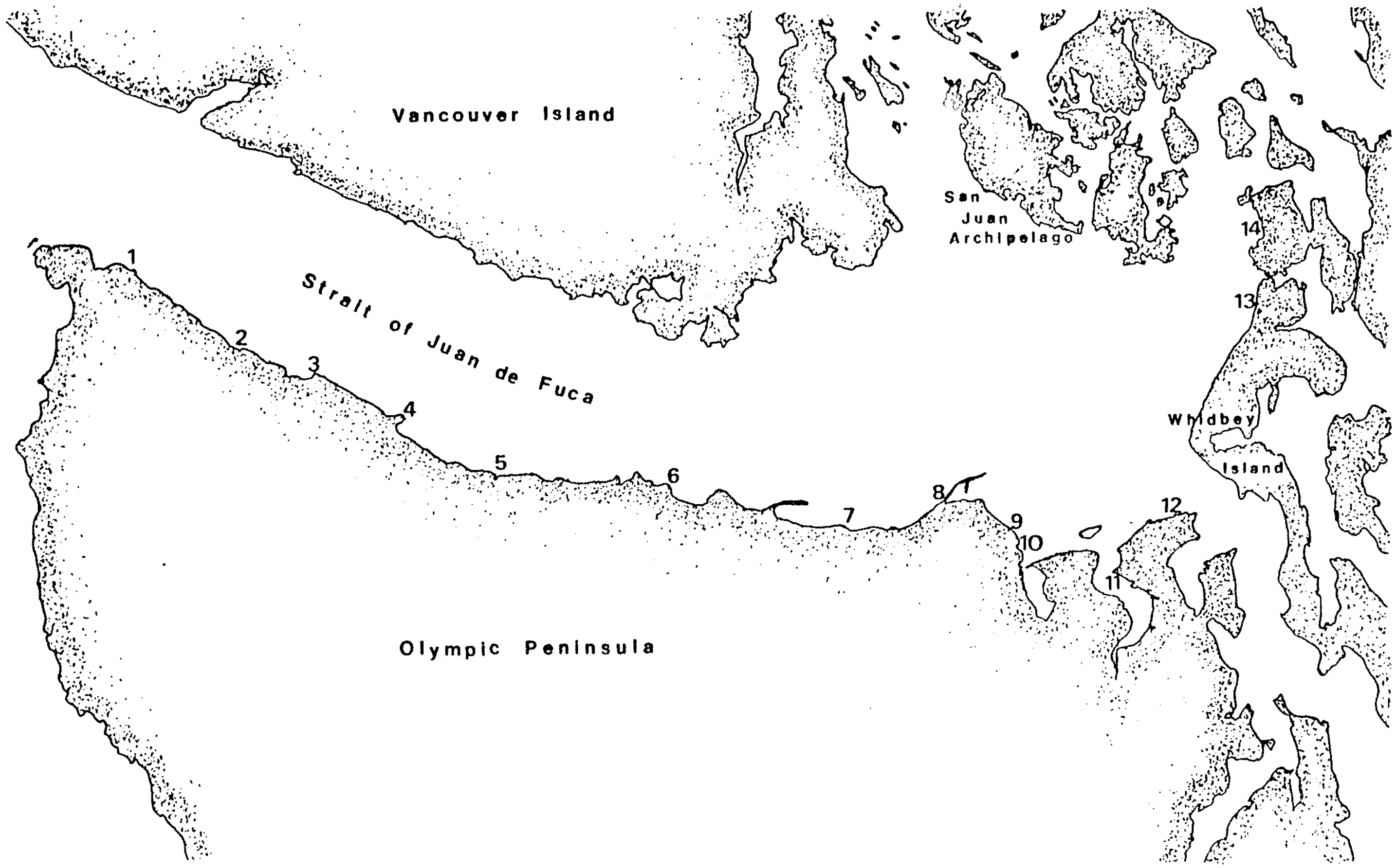

Fig. 1. Location map of sampling sites.

Table 1. Characterization of study sites along the Strait of Juan de Fuca. BS = beach seine, TN = townet, TP = tidepool.

Site	Habitat	Sampling method
1 Neah Bay	Moderate gradient, high energy, direct exposure, boulder beach, abundant algae	TP
2 Kydaka Beach	Moderate gradient, high energy, direct exposure, sand substrate, no algae, little detritus	BS, TN
3 Slip Point	Moderate gradient, high energy, direct exposure, rock substrate, abundant algae	TP
4 Pillar Point	Moderate gradient, moderate energy, moderate exposure, rocky kelp bed with adjacent sand flats	TN
5 Twin Rivers	Low gradient, moderate energy, moderate exposure, sand and cobble beach, abundant algae and kelp	BS, TN, TP
6 Observatory Point	High gradient, high energy, direct exposure, rock substrate, abundant algae	TP
7 Morse Creek	Low gradient, moderate energy, moderate exposure, sand and cobble beach, abundant algae and kelp	BS, TN, TP
8 Dungeness Spit	High gradient, high energy, high exposure, sand and gravel beach, no algae, little detritus	BS, TN
9 Jamestown	Low gradient, low exposure, low energy, mudflat with extensive eelgrass beds	BS, TN
10 Point Williams	Low gradient, low exposure, low energy mudflat with extensive eelgrass beds	BS, TN
11 Beckett Point	Moderate gradient, low exposure, low energy, sand and gravel beach, abundant algae and eelgrass	BS, TN
12 North Beach	Low gradient, low energy, low exposure, sand and cobble beach, some algae	TP
13 West Beach	Moderate gradient, high energy, direct exposure sand-gravel substrate, little algae	BS, TN
14 Alexander's Beach	Low gradient, low energy, low exposure, sand substrate, little algae	BS, TN

tidal currents and moonlight to reduce sampling variation, but this was not always possible.

The net was towed as close to the shoreline as depth, kelp growth, and flotsam would allow. The net dragged bottom in 5 m (15 ft) of water.

Seldom were we able to follow a consistent transect over the same depth, distance from shore, and length at the townet sites; conditions during the collection periods varied because of tide, flotsam, weather, etc. However, the towing setup proved to be quite maneuverable, allowing us to work along the shoreline rather easily. Townet sampling was generally conducted within one week of beach seine collections.

II-B-3. Intertidal

Two types of intertidal habitat were sampled during low tide: Tidepools and the area beneath large rocks. Both types of habitat were encountered at all intertidal sites. The sites were categorized as rocky headlands (Observatory Point, Slip Point, Neah Bay) and cobble beaches (North Beach, Morse Creek, Twin Rivers) based upon their geomorphology.

Tidepools were randomly selected at various heights to ensure sampling over the entire vertical range of the fish. Each tidepool was partly drained to concentrate fish into a small area; a small amount of quinaldine (10% solution in ethyl alcohol) was added to narcotize the fish, facilitating the collection of secretive and elusive species. Rocks were also randomly selected over the vertical range of the fish. The rocks were rolled and the fish beneath them were captured by hand. Fish were preserved in 10% buffered formalin immediately after capture.

II-B-4. Macroinvertebrate Cataloguing

Epibenthic macroinvertebrates were collected at the eight beach seine sites and pelagic macroinvertebrates were collected at the nine townet sites. The macroinvertebrates were handpicked from the beach seine and townet and placed in 10% buffered formalin, except for large, readily identifiable crabs and asteroids which were measured (or the size estimated) and released at the time of collection. Preserved samples were brought to the laboratory and identified, weighed, and measured. Species were sorted using a dissecting microscope. For species occurring in numbers greater than 100, subsamples of 50 individuals were weighed and measured, the remainder of the sample was counted and a total weight taken.

Weights were taken to the nearest 0.01 g and lengths were measured to the nearest millimeter. Carapace lengths, eye to posterior edge of carapace, were taken on the shrimp. In the laboratory, crabs were measured at their widest point (carapace width). The remainder of the invertebrates were not measured.

Species identifications were made using a variety of dichotomous keys, illustrated references, descriptions, and an existing reference collection of verified species. The principal references used for taxonomic identification were Banner (1947, 1948, 1950), Barnard (1969), Barnes (1974), Johnson and Snook (1955), Kozloff (1974), Ricketts and Calvin (1968), Schultz (1969), Smith and Carlton (1975), and Staude et al. (1977). A reference collection was organized and maintained for the purpose of comparing prey organisms to verified specimens. Amphipods were identified by Craig Staude of Friday Harbor Laboratories.

II-C. Collection Information

The following data were recorded for all sampling methods: Location, date, time, tide stage and height, weather conditions (air temperature, wind speed and direction, visibility, precipitation, and cloud cover), sea surface temperature, salinity and dissolved oxygen, sea state and color, bottom depth, area sampled (beach seine), volume sampled (townet), distance fished, sampling duration, compass heading, light intensity, and current direction and velocity. All information was recorded on computer data forms.

Water samples were obtained for salinity and dissolved oxygen measurements. For beach seine samples, salinity was determined by the potentiometric method and dissolved oxygen by Winkler titration. During townet collections, salinity was measured with a Beckman salinity-temperature probe, and dissolved oxygen was determined by Winkler titration.

II-D. Biological Information

Catches from the beach seine and townet were bagged, labeled, and placed on ice until processing. Fish retained for stomach analysis were separated from the catch and preserved in 10% formalin immediately after collection. A representative sample of macroinvertebrates was collected and bagged separately.

Generally, catches were taken in their entirety. It became necessary to subsample when the catch of one or more species was too large to permit proper handling within the available time. The less abundant species were sorted from the catch and saved. The abundant species were thoroughly mixed and a known volume greater than or equal to 10% of the sample was removed and saved. The volume of the remaining sample was measured and the fish were discarded.

II-E. Processing the Catches

Fish samples were sorted to species and individuals were counted, measured (total length), and weighed (to the nearest 0.1 g wet weight). Where possible the following information was taken for an individual: Sex, life-history stage, external diseases, parasites, and other abnormalities. When the number of individuals of a species in a sample exceeded 100, 50 or more individuals were weighed and measured; the remaining fish were counted and an aggregate weight was taken. All information was recorded on computer data forms. Hart (1973) was used as a reference for identification of the fishes.

Fish to be used for stomach analysis were dissected; the stomach was removed, tagged, and preserved in 10% formalin. In those fish without well-defined stomachs, the first one-third of the intestine was removed and preserved.

II-F. Stomach Analyses

Whole fish specimens or intact stomach samples of economically important fishes were examined according to a systematic, standard procedure (Terry 1977) which identifies the numerical and gravimetric composition of prey organisms, the stage of digestion of the contents, and the degree of stomach fullness. In the laboratory, the stomach samples were removed from the preservative, or from the preserved whole fish, and soaked in cold water for at least two or three hours before examination. The stomach was then identified according to information on the label and then processed. Processing involved taking a total (damp) weight (to nearest 0.1 g), removing the contents from the stomach and weighing (including unidentifiable material) by subtraction. Subjective numerical evaluations of the stomach condition or degree of fullness--scaled from 1 (empty) to 7 (distended)--and stage of digestion--scaled from 1 (all digested) to 5 (no digestion)--were made at this time. The stomach contents were then sorted and identified as far as was practical, and the sorted organisms were counted and a total (damp) weight of each taxon obtained (to nearest 0.001 g). If a sorted taxon was represented by too many individuals to count, the number was estimated using a random grid-counting procedure.

II-G. Sources of Sampling Error

A major source of sampling error was gear selectivity. Each gear type possessed its own selectivity which must be taken into account when comparing results of different gear types. Sample variation also resulted from bottom conditions, weather conditions, light intensity (diurnal-nocturnal), sea conditions, bioluminescence, turbidity, and sampling duration.

Density and standing crop estimates for both beach seine and townet were biased because we assumed 100% gear efficiency (e.g., all fish occurring in the 11,500 m^3 section sampled by the townet were assumed captured). The large mesh wings of the townet and beach seine were not as effective in retaining larvae and small juveniles as the bag, so that quantitative results concerning small fish were likely to be underestimates. Also, certain fast-swimming and fast-reacting species probably were able to avoid the sampling gear.

The topography of the substrate affected the performance of the beach seine. Smooth substrates were swept more efficiently than uneven substrates. Furthermore, large quantities of algae or eelgrass reduced sampling efficiency.

Sampling at Jamestown was discontinued after the first year of the study because of insufficient water depth on zero or minus tides. Point Williams, east of Jamestown near the entrance to Sequim Bay, was added to the sampling plan.

Sample bias was also introduced by the crew during the picking of the net. Transparent larvae and small fish may have been overlooked, particularly when sampling was conducted at night in inclement weather. Inclement weather also affected gear performance.

Beach seining was conducted on the lowest tides of the sampling period. During October through January, sampling occurred at night whereas in May through August it occurred during day. Comparison of these two periods must take into consideration potential diel changes in the fish fauna.

Bias also occurred in sampling the macroinvertebrates collected with the fish. The more fish and algae present in the net, the less efficient was the invertebrate sampling effort because of the difficulty in finding invertebrates among the algae and also because of time constraints involved in setting and retrieving the net.

II-H. Statistics and Quantitative Definitions

II-H-1. Occurrence

"Occurrence" defines the number or percentage of discrete samples in which a species was present.

II-H-2. Abundance

"Abundance" refers to the overall number of individuals.

III-H-3. Biomass

"Biomass" indicates the total organic matter, here measured as the wet weight of the organisms in grams and kilograms.

II-H-4. Density

"Density" describes the ratio of total number of organisms to the sampling area (beach seine) or volume (townet and tidepool collections) in a discrete sample and is expressed as number/m^2 or number/m^3. In the special case of tidepool collections made beneath single rocks, it is defined as number/rock.

II-H-5. Standing Crop

"Standing crop" is the ratio of the total biomass of organisms to the sampling area (beach seine) or volume (townet and tidepool collections) in a discrete sample and is expressed as grams/m^2 or grams/m^3. In the special case of tidepool collections made beneath single rocks, it is defined as grams/rock.

II-H-6. Species Richness

"Species richness" describes the number of species present in a described sample or group of samples. Where the species is not determinable, as is often the case with specimens of fish and macroinvertebrate larvae, more than one species of a genus might be involved but undistinguishable, and the species richness value might be underestimated.

II-H-7. IRI Trophic Diagrams

A modification of Pinkas et al. (1971) "Index of Relative Importance" (IRI) was used to rank the importance of prey organisms. The IRI values for prey taxa are displayed both graphically and in tabular form where justified by sample size (n > 25). The three-axis IRI graphs illustrate frequency of occurrence (the proportion of stomachs containing a specific prey organism) plotted sequentially on the horizontal axis, and percentage of total abundance and percentage of total biomass plotted above and below the horizontal axis, respectively (Fig. 2). All prey groups, including those assigned to a broad taxonomic level (family, order, class) because of advanced digestion, have been arranged from left to right by decreasing frequency of occurrence. Prey taxa in differing stages of digestion (e.g., partly digested shrimp, "Natantia-unidentified," as opposed to family, "Pandalidae," or species, "*Pandalus borealis*") are graphed separately.

The IRI value was computed as follows:

$$\text{IRI} = \%\ \text{Frequency of occurrence}_i \left[\%\ \text{Numerical composition}_i + \%\ \text{Gravimetric composition}_i \right]$$

and is equivalent to the area encompassed by the bar for each prey category i composing the IRI diagrams. In order to compare the IRI values between prey spectra with different sample sizes, the overall importance of general prey taxa (e.g., all shrimp, including "unidentified Natantia" and those identified to family and species, added together) has been discussed as a percentage of the total combined IRI (areas) of the different prey taxa. Table 2 illustrates an example of the IRI values and percentages of total IRI generated from the data diagrammed in Fig. 2. The advantage of the IRI value is that the more representative prey are not dominated by numerically rare but high biomass prey (e.g., prey_8, Fig. 2), by infrequently occurring but abundant or high biomass (when eaten) taxa, or by numerically abundant or frequently occurring taxa which contribute little in the way of biomass (e.g., prey_1, Fig. 2).

II-H-8. Trophic Diversity

Three quantitative indices of the numerical and biomass composition of predator diets are used to describe trophic diversity:

(1) Percent dominance index:

$$\%\ \text{Dominance} = \Sigma(p_i)^2$$

where the p_i's are ratios of the number or biomass of prey_i to the total prey abundance or biomass.

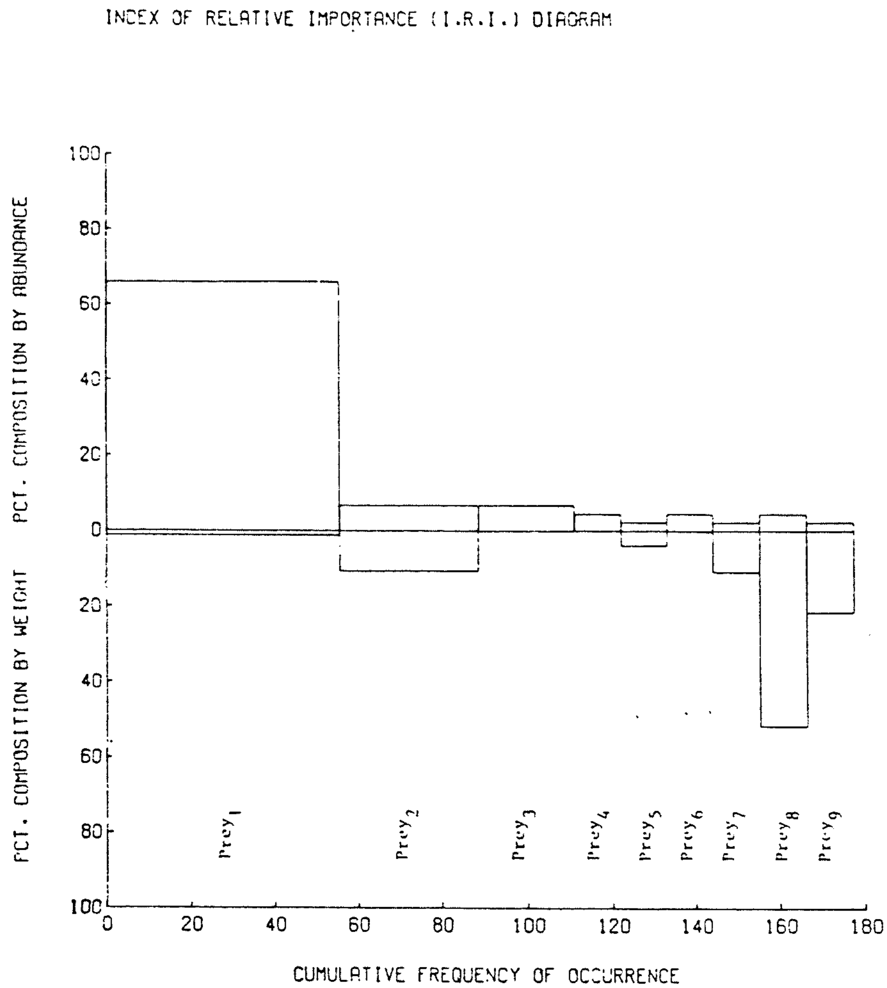

Fig. 2. Example IRI (Index of Relative Importance) diagram.

Table 2. Example computation of IRI values and percentages of total IRI from data illustrated in Fig. 2.

Prey Category	% Freq. of occurrence	% Numerical composition	% Gravimetric composition	Prey IRI	% Total IRI
1	55.56	65.91	1.22	3729.5	65.76
2	33.33	6.82	10.69	583.7	10.29
3	22.22	6.82	0.04	152.5	2.69
4	11.11	4.55	< 0.01	50.5	0.89
5	11.11	2.27	3.84	67.9	1.20
6	11.11	4.55	0.12	51.8	0.91
7	11.11	2.27	10.89	146.3	2.58
8	11.11	4.55	51.67	624.6	11.01
9	11.11	2.27	21.52	264.4	4.66

(2) Shannon-Weiner diversity index:

$$H = -\sum_{i=1}^{s} (p_i \; Ln_2 p_i)$$

where p_i's are the same as in the percent dominance index and s is the total number of species. H incorporates both the number of prey taxa present and the evenness of the distribution (either numbers or biomass) among these taxa, and is relatively insensitive to sample size.

(3) Evenness index:

$$e = H/Lns$$

where H is the Shannon-Weiner index and s is the total number of species.

II-J. Disposition of Data

All data were initially recorded on computer sheets of format according to MESA/EDS specification. Codes utilized in data recording were developed by NODC. The data were then checked for errors, keypunched on 80-column IBM cards, and verified. All data cards were systematically organized, transferred onto magnetic tape, and submitted to NODC quarterly.

III. RESULTS AND DISCUSSION

III-A. Oceanographic Conditions

Data on temperature, salinity, and dissolved oxygen measured during beach seine, townet, and tidepool collections are presented in Appendix 1.

III-B. Nearshore Fish Species Composition

A total of 93 species was collected during sampling from 1976 to 1978 (Tables 3 and 4). There was a decrease in the number of species collected by beach seine and townet in 1977-78.

Table 3. Number of species collected by each sampling method.

Gear / Year	1976-77	1977-78	Total
Beach seine	69	59	77
Townet	48	42	55
Tidepool	--	24	24
Total	76	76	93

Table 4. Nearshore fish species collected by beach seine (BS), townet (TN), and tidepool (TP).

Species	Common name	Gear
Squalus acanthias	spiny dogfish	BS,TN
Raja binoculata	big skate	BS
R. stellulata	starry skate	BS
Hydrolagus colliei	ratfish	BS,TN
Clupea harengus pallasi	Pacific herring	BS,TN
Engraulis mordax	northern anchovy	BS,TN
Oncorhynchus gorbuscha	pink salmon	BS,TN
O. keta	chum salmon	BS,TN
O. kisutch	coho salmon	BS,TN
O. tshawytscha	chinook salmon	BS,TN
Salmo clarki	cutthroat trout	BS
S. gairdneri	rainbow trout	BS
Salvelinus malma	Dolly Varden	BS
Hypomesus pretiosus	surf smelt	BS,TN
Mallotus villosus	capelin	TN
Spirinchus thaleichthys	longfin smelt	BS,TN
Porichthys notatus	plainfin midshipman	BS
Gobiesox maeandricus	northern clingfish	BS,TN,TP
Gadus macrocephalus	Pacific cod	BS
Microgadus proximus	Pacific tomcod	BS,TN
Theragra chalcogramma	walleye pollock	BS,TN
Aulorhynchus flavidus	tube-snout	BS,TN
Gasterosteus aculeatus	threespine stickleback	BS,TN
Syngnathus griseolineatus	bay pipefish	BS,TN
Amphistichus rhodoterus	redtail surfperch	BS
Cymatogaster aggregata	shiner perch	BS,TN
Brachyisticus frenatus	kelp perch	BS
Embiotoca lateralis	striped seaperch	BS,TN
Rhacochilus vacca	pile perch	BS,TN
Trichodon trichodon	Pacific sandfish	BS,TN
Anoplarchus purpurescens	high cockscomb	TN,TP
Lumpenus sagitta	snake prickleback	BS,TN
Phytichthys chirus	ribbon prickleback	TP
Xiphister atropurpureus	black prickleback	TP
X. mucosus	rock prickleback	TP
Apodichthys flavidus	penpoint gunnel	BS,TN,TP
Pholis laeta	crescent gunnel	BS,TN,TP
P. ornata	saddleback gunnel	BS,TN,TP
Anarrhichthys ocellatus	wolf eel	TN
Ammodytes hexapterus	Pacific sand lance	BS,TN
Sebastes flavidus	yellowtail rockfish	BS
S. melanops	black rockfish	TN
Hexagrammos decagrammus	kelp greenling	BS
H. stelleri	whitespotted greenling	BS
Ophiodon elongatus	lingcod	BS,TN
Artedius fenestralis	padded sculpin	BS,TP
A. harringtoni	scalyhead sculpin	BS
A. lateralis	smoothhead sculpin	BS,TP

Table 4, cont'd

Species	Common name	Gear
Ascelichthys rhodorus	rosylip sculpin	BS,TN,TP
Blepsias cirrhosus	silverspotted sculpin	BS,TN,TP
Chitonotis pugetensis	roughback sculpin	BS
Clinocottus acuticeps	sharpnose sculpin	BS,TN,TP
C. embryum	calico sculpin	TP
C. globiceps	mosshead sculpin	TP
Enophrys bison	buffalo sculpin	BS,TN,TP
Hemilepidotus hemilepidotus	red Irish lord	BS,TN,TP
Leptocottus armatus	Pacific staghorn sculpin	BS,TN
Myoxocephalus polyacanthocephalus	great sculpin	BS,TN
Nautichthys oculofasciatus	sailfin sculpin	BS,TN
Oligocottus maculosus	tidepool sculpin	BS,TP
O. rimensis	saddleback sculpin	TP
O. snyderi	fluffy sculpin	TP
Radulinus boleoides	darter sculpin	TN
Rhamphocottus richardsoni	grunt sculpin	TN
Scorpaenichthys marmoratus	cabezon	BS
Synchirus gilli	manacled sculpin	TN
Gilbertidia sigalutes	soft sculpin	TN
Psychrolutes paradoxus	tadpole sculpin	BS,TN
Agonopsis emmelane	northern spearnose poacher	BS
Agonus acipenserinus	sturgeon poacher	BS,TN
Bathyagonus nigripinnis	blackfin poacher	TN
Occella verrucosa	warty poacher	BS
Odontopyxis trispinosa	pygmy poacher	BS
Pallasina barbata	tubenose poacher	BS,TN
Xeneretmus latifrons	blacktip poacher	BS,TN
Eumicrotremus orbis	Pacific spiny lumpsucker	BS,TN
Liparis callyodon	spotted snailfish	BS,TN
L. cyclopus	ribbon snailfish	BS,TP
L. dennyi	marbled snailfish	BS
L. florae	tidepool snailfish	BS,TN,TP
L. mucosus	slimy snailfish	BS
L. pulchellus	showy snailfish	BS,TN
L. rutteri	ringtail snailfish	BS,TN,TP
Citharichthys stigmaeus	speckled sanddab	BS
C. sordidus	Pacific sanddab	BS
Eopsetta jordani	petrale sole	BS
Isopsetta isolepis	butter sole	BS
Lepidopsetta bilineata	rock sole	BS,TN
Parophrys vetulus	English sole	BS,TN
Platichthys stellatus	starry flounder	BS,TN
Pleuronichthys coenosus	C-O sole	BS
Psettichthys melanostictus	sand sole	BS
Microstomus pacificus	Dover sole	BS

III-B-1. Dominant Species--Beach Seine

Pacific staghorn sculpin, English sole, and sand sole were the most widely distributed species collected (Table 5). This is not entirely unexpected since substrate characteristics at the beach seine sites are similar. Sand is the predominant substrate at Kydaka Beach and Dungeness Spit while sand mixed with gravel and sediment is present at the remaining sites.

A general consistency of rankings between years is apparent (Table 5). Between-year differences were largely a result of the sporadic occurrence of a few large individuals (spiny dogfish, chinook salmon) which greatly influenced biomass measurements, and the occurrence of schooling species (Pacific herring, surf smelt, Pacific tomcod), which, because of their wide-ranging habits, were not consistently collected. The presence of the tidepool sculpin in only the 1977-78 collections was a result of substituting Point Williams for Jamestown during the second year. Located adjacent to the Point Williams beach seining site is a moderately large rock outcrop which is inhabited by the tidepool sculpin at high tide. On an ebbing tide the tidepool sculpin moves off the rock outcrop and inhabits the shallow water where the beach seining is conducted.

The between-year consistency suggests that, for at least the abundant species, habitat associations are fairly constant from year to year and that quarterly sampling with a beach seine is effective in documenting major trends in the nearshore fish assemblages.

III-B-2. Dominant Species--Townet

Pacific herring, accounting for 77% of the total number of fish and 81.3% of the total biomass, was the dominant fish species occurring in townet collections in the Strait of Juan de Fuca in both years (Table 6). Herring were most abundant in spring and summer of both years. Larval herring occurred predominantly in spring and juveniles were found throughout the rest of the year; no adult herring were caught during the study. Herring appeared to move out of the sampling areas by fall, since less than 0.5% of the total number of herring caught occurred during fall and winter. Herring occurred at all sites and in the majority (89.3%) of the collections. During 1976-77, herring were most abundant at Twin Rivers and Beckett Point, whereas in 1977-78 the greatest catches of herring occurred at Morse Creek and Twin Rivers. Spring catches (primarily larvae) were evently distributed among the sites, whereas summer catches (juveniles) tended to be more abundant at a single site (Beckett Point in 1976-77 and Morse Creek in 1977-78).

The second most abundant species was the longfin smelt. This species accounted for 16.8% of the total abundance and 11.4% of the total biomass of fish. Over 99% of the longfin smelt collected were caught at Twin Rivers and Pillar Point; the majority were caught in summer and fall. Most of the longfin smelt were young-of-the-year but a few adults (some ripe) also occurred.

After herring and longfin smelt, the next most abundant species was the Pacific sand lance. Most were larvae and occurred in spring; no adults were caught. Most sand lance were caught during the second year of sampling,

Table 5. Dominant species collected by beach seine ranked according to frequency of occurrence in collections, density, and biomass for 1976-77 and 1977-78. Results are summations for all sites for all seasons, and combine the floating and sinking beach seine data.

Species	Occurrence		Density		Biomass	
	76-77	77-78	76-77	77-78	76-77	77-78
Pacific staghorn sculpin	1.5	1.5	5	4	5	2
English sole	1.5	1.5	8	8		
Sand sole	3	2.5	7	6	8	7
Starry flounder	4	5			2	3
Buffalo sculpin	5	6				
Striped seaperch	6	9			7	9
Pacific tomcod	7.5		10	9		10
Redtail surfperch	10.5	9		10	1	6
Pacific herring	10.5	9	2		9	
Surf smelt	10.5		9			5
Tube-snout	10.5		4	7		
Shiner perch		7	3	3	4	4
Rosylip sculpin			6	5		
Chinook salmon					3	
Spiny dogfish					6	
Pacific sand lance			1	1	10	1
Padded sculpin	7.5	2.5				
Tidepool sculpin				2		8

Table 6. Dominant species collected by townet ranked according to frequency of occurrence in collections, density, and biomass for 1976-77 and 1977-78. Results are summations for all sites for all seasons.

Species	Occurrence		Density		Biomass	
	76-77	77-78	76-77	77-78	76-77	77-78
Pacific herring	1	1	1	1	1	1
Surf smelt	2	4.5	6	4	9	9
Tadpole sculpin	3	4.5	5	5		
Pacific sand lance	5	2	8	3		4
Walleye pollock	5		4			
Crescent gunnel	5	9		10		
Longfin smelt	7	6.5	2	2	4	2
Tube-snout	8	6.5	9			
English sole	9		10			
Shiner perch	10.5	9	3	6.5	2	7
Pink salmon	10.5					
Pacific tomcod		3	7	6.5	7	
Spiny dogfish					3	3
Starry flounder					5	
Coho salmon					6	
Pile perch					8	
Striped seaperch					10	
Northern anchovy		9				
Darter sculpin				8		
Chum salmon				9		
Chinook salmon						5
Black rockfish						6
Pacific staghorn sculpin						8
Wolf eel						10

and catches were greatest at Twin Rivers, Morse Creek, and Dungeness Spit.

Surf smelt, like sand lance, were much more abundant in 1977-78. Catches of this species, primarily as larvae, were greatest at Twin Rivers during the spring.

Walleye pollock and shiner perch were almost exclusively caught during 1976-77. Juvenile walleye pollock were caught at all sites and occurred primarily in spring and summer. Shiner perch were caught largely in summer and fall, and over 99% were caught at Beckett Point, especially on occasions when the net was observed to drag bottom. Some of the unidentified larval gadoids caught in 1977-78 may have been walleye pollock, in which case their relative abundance may have been underestimated.

Although numerically not abundant, catches of juvenile salmonids should be mentioned because of their economic importance. During both years, all but one salmon (a coho caught at Pillar Point in spring 1977) were caught at the four sites east of Port Angeles. The majority of the salmon were caught in summer. Pink salmon was the most abundant salmonid in 1976-77 and chum salmon was the most abundant salmonid in 1977-78. The largest salmonid catches occurred at Morse Creek and Jamestown in 1976-77 and at Beckett Point in 1977-78.

Dominant species at the Whidbey Island area sites were generally similar to those species in the strait. Herring was overwhelmingly the dominant species followed by surf smelt and sand lance. One conspicuous difference between the strait sites and Whidbey Island sites was the small catches of longfin smelt at the Whidbey Island sites.

III-B-3. Dominant Species--Tidepool

Three species dominated the tidepool and rock collections--tidepool sculpin, high cockscomb, and northern clingfish (Table 7). They occurred at all sites but made up varying proportions of the fauna. They constituted a higher proportion of the fauna on the cobble beaches (North Beach, Morse Creek, and Twin Rivers) than on the rocky headlands (Observatory Point, Slip Point, and Neah Bay). The tidepool sculpin occurred exclusively in tidepools while the high cockscomb and the northern clingfish occurred beneath rocks both in and out of tidepools.

III-C. Nearshore Fish Species Richness

III-C-1. Beach Seine

Species richness (defined as the number of species collected) exhibited a similar seasonal pattern in both years: Maximum values occurred in summer and fall and minimum values occurred in winter and spring (Fig. 3, Appendix 2a). Fewer species were collected at the exposed sites, Kydaka Beach, Dungeness Spit, and West Beach. The exposed sites also exhibited the greatest fluctuations in species richness between seasons. The greatest number of

Table 7. Dominant species collected in the intertidal zone ranked according to frequency of occurrence in collections, density, and biomass for 1977-78. Results are summations for all sites for all seasons.

Species	Occurrence	Density	Biomass
Tidepool sculpin	1	1	1
Northern clingfish	2	3	5
High cockscomb	3	2	4
Black prickleback	4	4	2
Rosylip sculpin	5	6	6
Mosshead sculpin	6	5	7
Fluffy sculpin	7	7	8
Rock prickleback	8	9	3
Calico sculpin	10	8	9
Smoothhead sculpin	10		10
Tidepool snailfish	10		
Sharpnose sculpin		10	

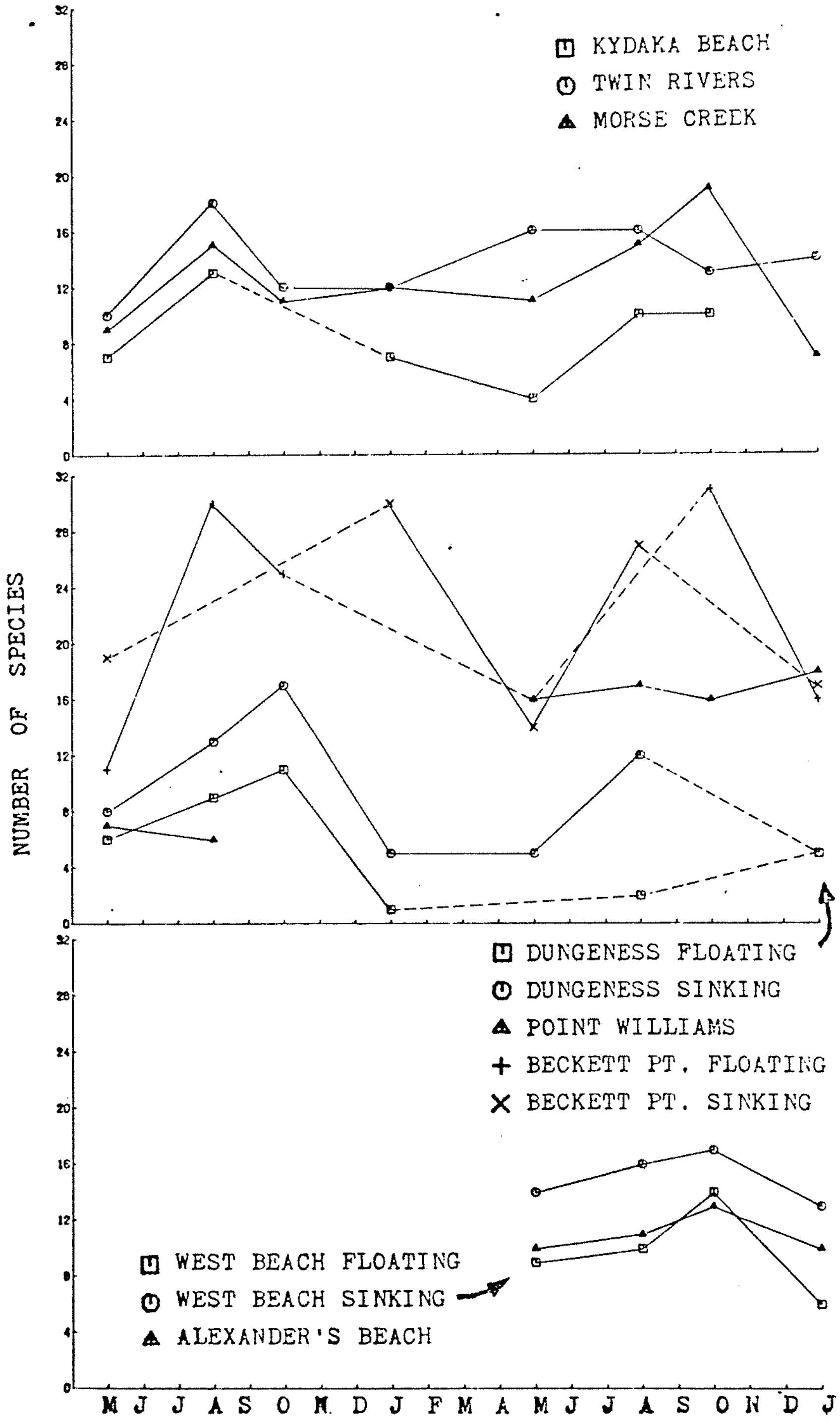

Fig. 3. Species richness of nearshore fish from beach seine collections in the Strait of Juan de Fuca and Whidbey Island, 1976-78.

species were collected at Beckett Point; species richness values were up to two times greater during most seasons than values recorded for the remaining sites. The more protected sites (Twin Rivers, Morse Creek, Point Williams, and Alexander's Beach) exhibited the least variation between seasons.

Combined species richness (the total number of species collected at a site over all collections) generally increased from west to east in the Strait of Juan de Fuca (Fig. 4). Disregarding Beckett Point, species richness values at the Whidbey Island sites were consistent with this trend.

Species richness at four sites varied little between 1976-77 and 1977-78. At Dungeness Spit, ten fewer species were collected during the second year. The large difference between years at Jamestown was the result of a relocation of the sampling site. Jamestown was sampled in 1976-77, and Point Williams, less than two kilometers to the east, was sampled in 1977-78. The two sites are equivalent habitats--mud and eelgrass covered by shallow water at low tide--and will be treated as such throughout the remainder of this report. The total number of species collected at a site over both years was in all cases greater than the number of species collected in either year. This can be attributed to the patchy distribution of rare species (fish occurring in low numbers over their entire range) or to straying of individuals from their center of distribution (fish are more abundant in areas we do not sample).

Species richness values recorded during this study were comparable to species richness at sites in the San Juan Islands (Miller et al. 1977), with the exception of Beckett Point. Species richness values at Beckett Point were higher in all seasons than species richness for comparable habitats in the San Juan Islands, e.g., Deadman Bay. The high values at Beckett Point may be due to one or more of the following: (1) High abundance of food; (2) use of Discovery Bay as a nursery area by many species; or (3) the close proximity of two dissimilar habitats--a steep sand slope and an eelgrass-covered mudflat.

III-C-2. Townet

Although seasonal trends in 1976-77 were more variable than in 1977-78, maximum species richness generally occurred in summer or fall and minimum species richness occurred in winter (Fig. 5). Morse Creek and Pillar Point in 1976-77 were exceptions to this trend in that spring values were higher at these two sites. In nearly all cases, species richness was higher in 1976-77 than in 1977-78 (Appendix 3a). Differences in species richness between years were primarily due to a larger number of rarer species, mostly demersal, captured in 1976-77. Many of these demersal species (e.g., northern clingfish, English sole) occurred as larvae, particularly in spring 1976, and accounted for the high spring species richness observed at Morse Creek and Pillar Point.

The exposed Kydaka Beach site exhibited the lowest species richness during both years. The highest species richness was recorded at Morse Creek (moderate exposure) in 1976-77 and Dungeness Spit (high exposure) in 1977-78. High species richness also occurred at some exposed sites (particularly cobble) in northern Puget Sound (Miller et al. 1977). Movements of species from adjacent habitats may partly account for the high species richness observed at exposed sites.

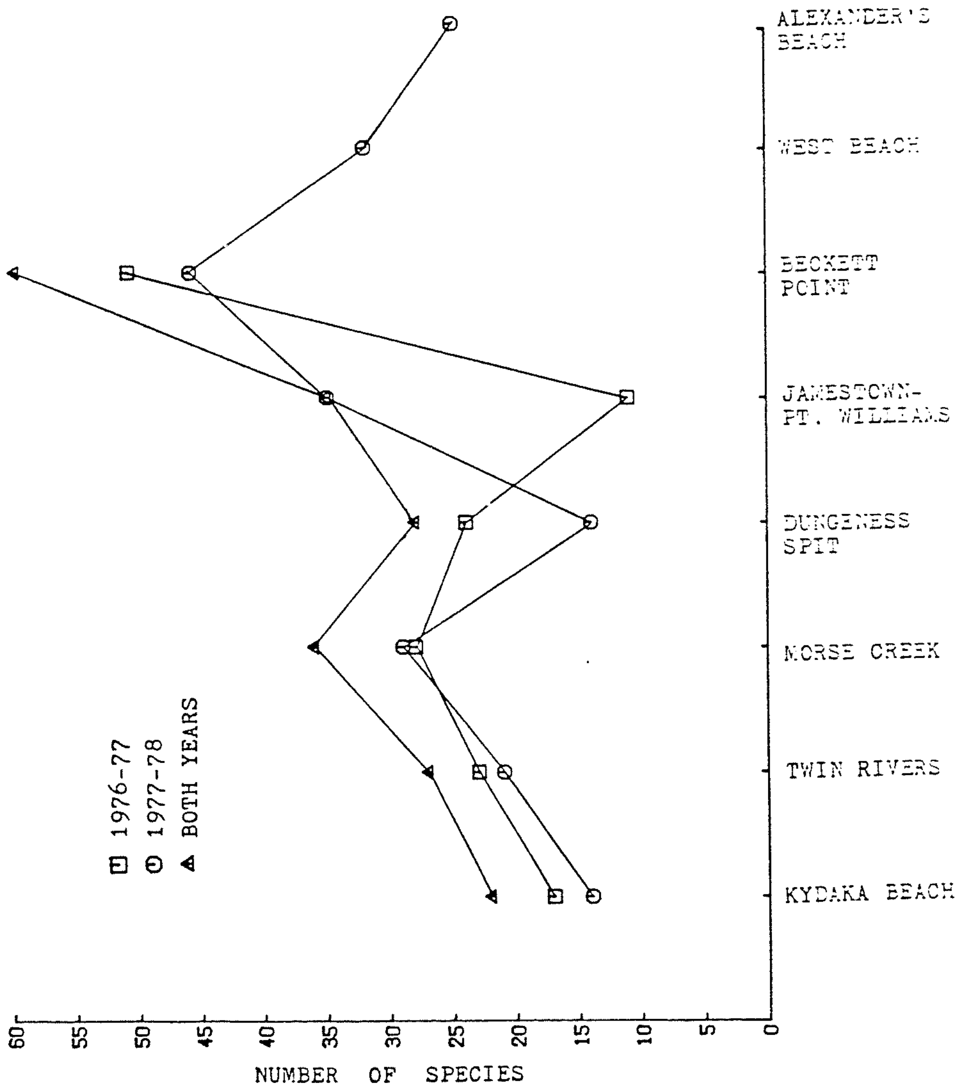

Fig. 4. Total number of species of fish caught at each site by beach seine, 1976-77, 1977-78, and the combined total for both years.

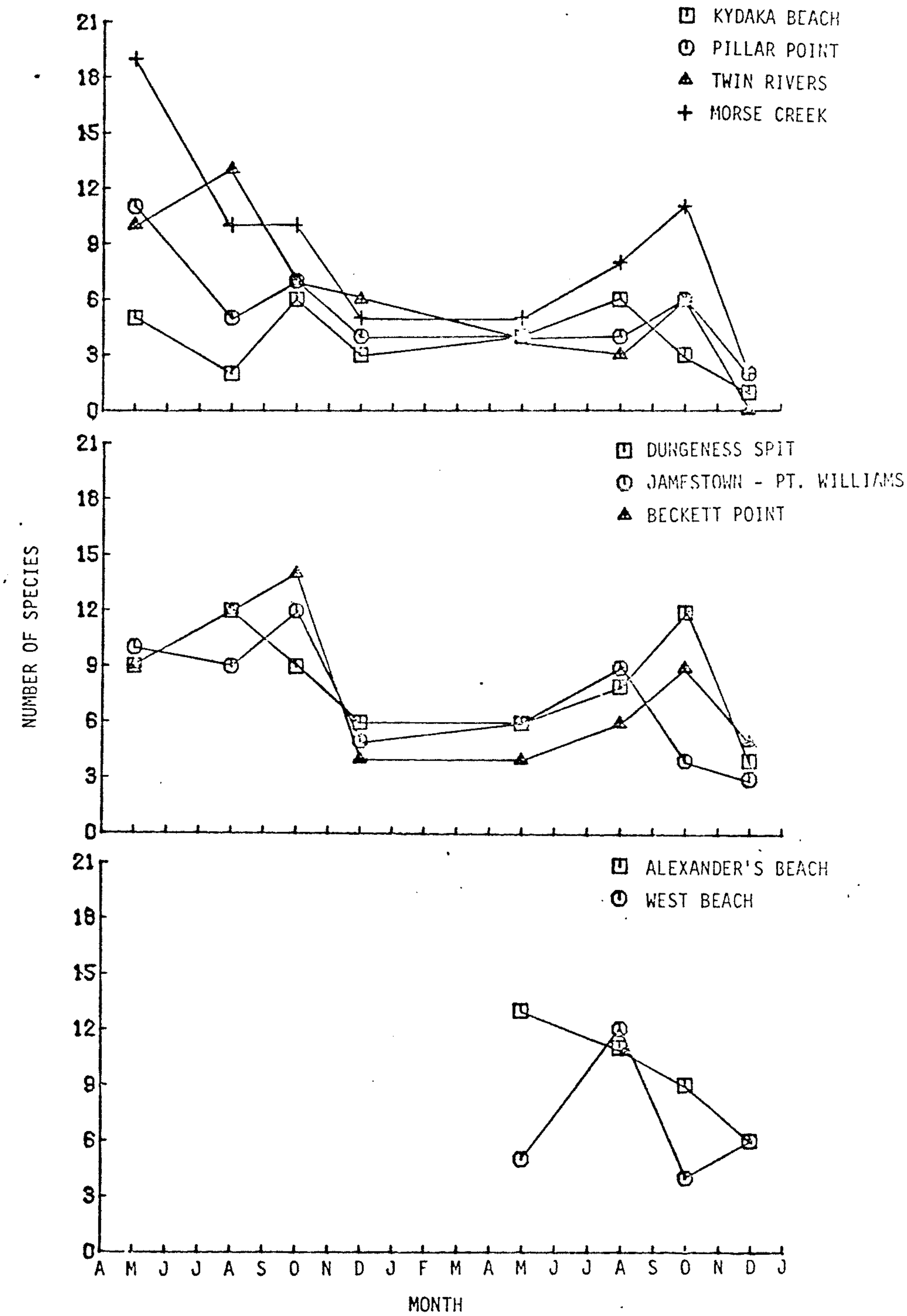

Fig. 5. Species richness of nearshore fish from townet collections in the Strait of Juan de Fuca and Whidbey Island area, 1976-78.

Combined species richness generally increased from west to east in the strait, especially in 1976-77 (Fig. 6). At all sites, more species were caught during 1976-77 than in 1977-78. Comparison of similar sites in the western and eastern strait indicated that sites in the eastern strait were more species-rich than corresponding sites in the western strait. Dungeness Spit had more species than Kydaka Beach, whereas Morse Creek was more species-rich than Twin Rivers.

The two Whidbey Island sites were similar to the sites in the strait in species richness. However, mean species richness at these two sites was higher than all but one site (Beckett Point) sampled in 1977-78 in the strait.

III-C-3. Intertidal

Total species richness (the number of species collected at a site) was higher on the rocky headlands than on the cobble beaches (Fig. 7; Appendix 4a). This is likely a result of the "predictability" of the habitat; tidepools on the rocky headlands are discrete and persist for a number of years, whereas tidepools on the cobble beaches are less well defined and may change in size and shape or disappear several times a year following turbulent sea conditions.

III-D. Nearshore Fish Density

III-D-1. Beach Seine

Density (number of fish per m^2) exhibited a marked seasonal trend, peak densities occurring in summer and fall (Fig. 8, Appendix 2b). Maximum densities occurred at the most exposed sites (Kydaka Beach and Dungeness Spit) in summer as a result of large schools of herring and sand lance. No sand lance and only a few herring were collected at Dungeness Spit in summer 1977, illustrating their unpredictable distribution in space and time.

Densities at the remaining sites were lower but more consistent between years. Beckett Point and Point Williams had densities ($> 1.5/m^2$) approaching those of the most exposed sites. The species responsible for the high densities at Beckett Point and Point Williams included schooling species (tomcod, shiner perch, tubesnout) and non-schooling species (staghorn sculpin, tidepool sculpin). Densities at the exposed Whidbey Island site (West Beach) were comparable to densities at an exposed site (Dungeness Spit) in the Strait of Juan de Fuca.

III-D-2. Townet

At all sites in the strait except Kydaka Beach in 1976-77, the density of fish was maximum in spring or summer (Fig. 9; Appendix 6). High spring densities were due primarily to large numbers of larvae of several species, particularly herring and sand lance, and, to a lesser extent, surf smelt and

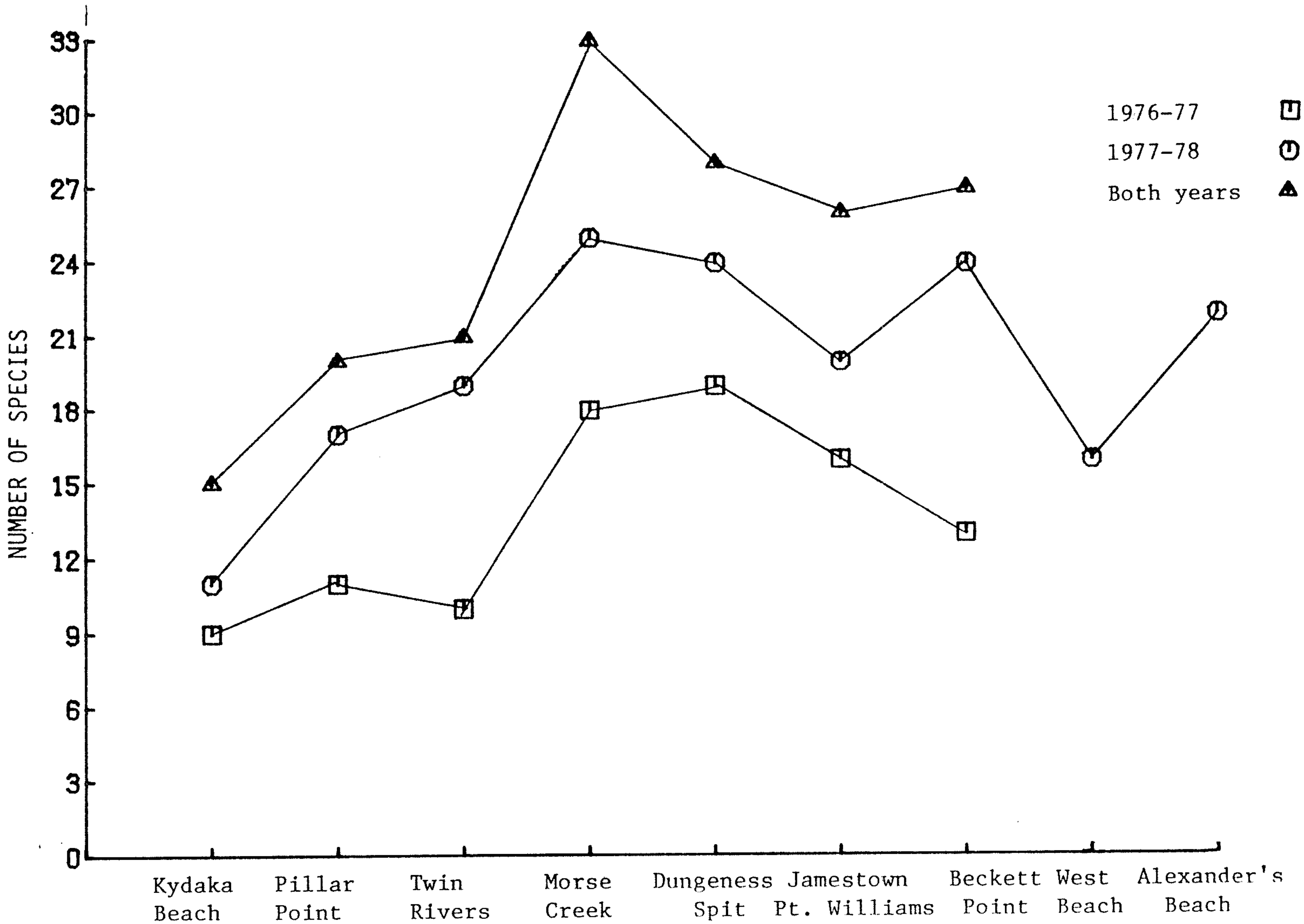

Fig. 6. Total number of species of fish caught at each site by townet, 1976-77, 1977-78, and the combined total for both years.

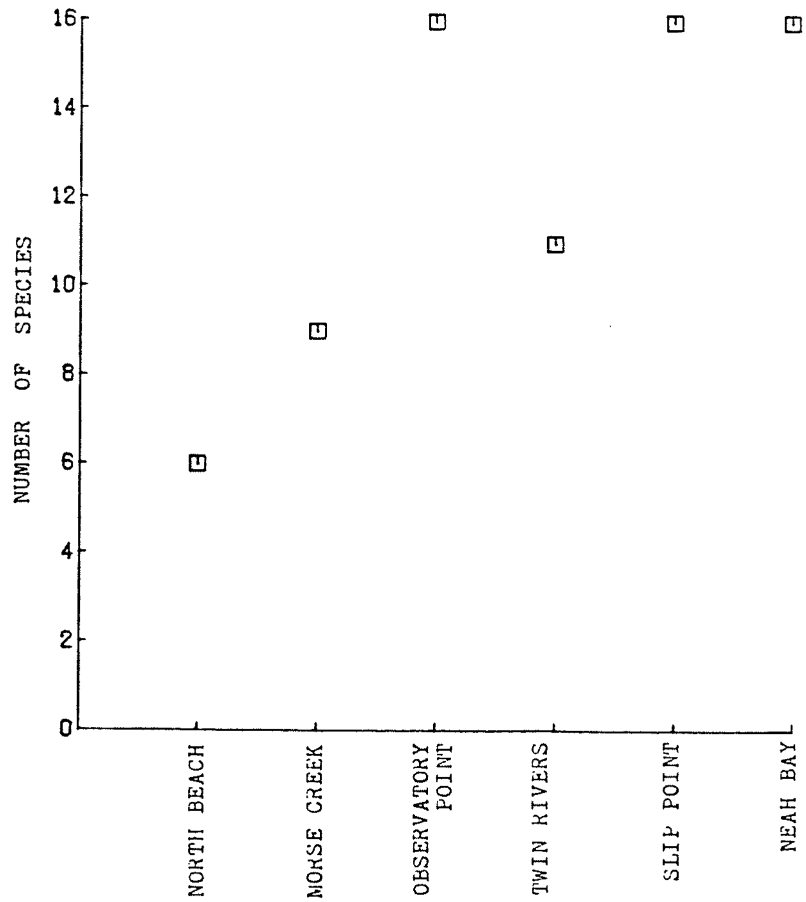

Fig. 7. Total number of species of fish collected in tidepools and beneath rocks in the Strait of Juan de Fuca, 1977.

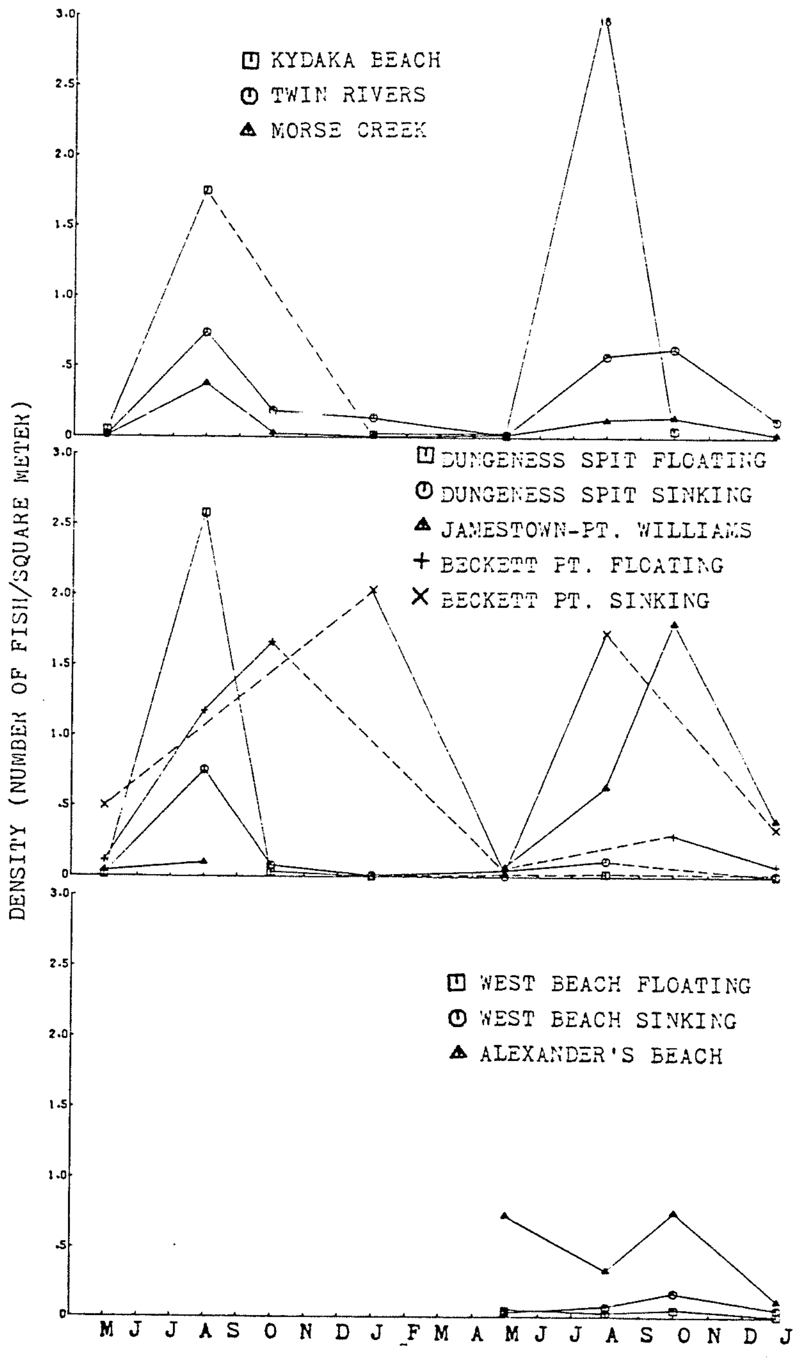

Fig. 8. Mean density (fish/m^2) of nearshore fish from beach seine collections in the Strait of Juan de Fuca and Whidbey Island, 1976-78.

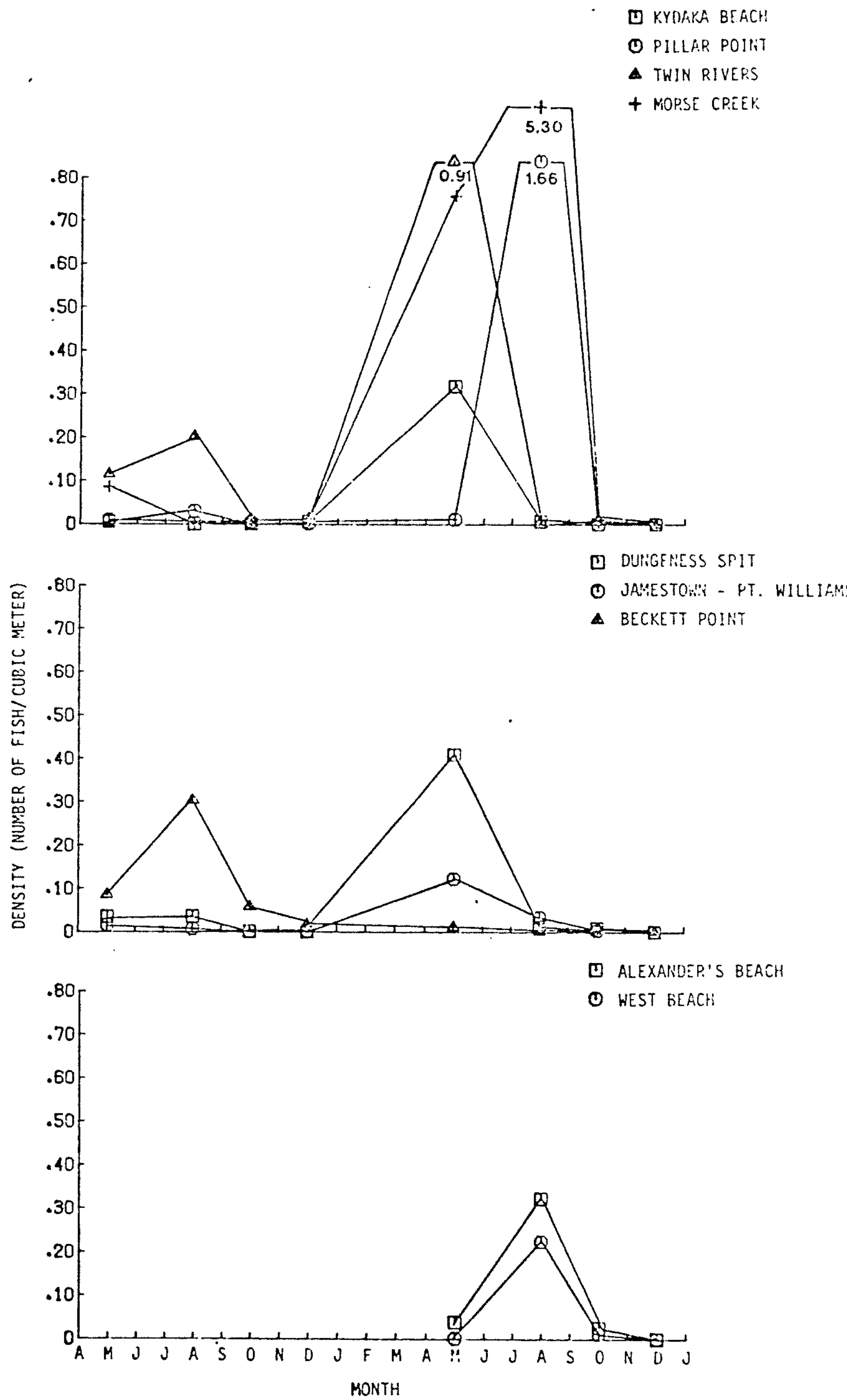

Fig. 9. Mean density (fish/m^3) of nearshore fish from townet collections in the Strait of Juan de Fuca and Whidbey Island area, 1976-78.

larval gadoids, probably walleye pollock. High summer densities were due mainly to herring (all sites) and longfin smelt (two sites, Pillar Point and Twin Rivers).

Similar seasonal trends in density of nearshore pelagic species were noted at northern Puget Sound habitats (Miller et al. 1977). Spring and summer densities in northern Puget Sound were also due primarily to herring and sand lance. Threespine stickleback, however, contributed significantly to densities in northern Puget Sound but not in the strait.

Densities were considerably lower in 1976-77 than in 1977-78 at all sites except Beckett Point. The difference in densities between years was most pronounced in spring and summer. Densities during the first year did not exceed 0.4 fish/m^3 whereas in the second year densities as high as 5.3 fish/m^3 were recorded. Beckett Point had the lowest densities of all seven strait sites in 1977-78, yet was highest in 1976-77. The higher spring catches in 1977-78 were due to greater numbers of larvae. At the two exposed sites, Dungeness Spit and Kydaka Beach, substantially larger influxes of larvae occurred in 1977-78 than in 1976-77.

It is difficult to interpret the significance of between-year variations. Variability may be (1) a result of sampling techniques, (2) a function of biological changes in the fish populations, or (3) an indication of the patchiness of neritic fish populations (Fresh, in prep.). However, the consistency of seasonal trends between years suggests that the between-year differences are a reflection of the natural changes occurring in the Strait of Juan de Fuca.

The Whidbey Island sites exhibited seasonal trends similar to those observed in the Strait of Juan de Fuca (Fig. 9). The large concentrations of larval herring found in the strait in 1977-78 were not evident at these two sites. Juvenile herring and to a lesser extent surf smelt were the predominant species in summer collections.

In northern Puget Sound (Miller et al. 1977), densities were highest in protected eelgrass bays or at sites closely associated with protected bays. This was the case in the strait in 1976-77; however, during 1977-78, the highest densities were found at a moderately exposed site, Morse Creek, which was not closely associated with a protected eelgrass bay.

III-D-3. Intertidal

Density of fish in tidepools did not exhibit a consistent trend among the sites (Fig. 10, Appendix 4). Densities for all sites except Twin Rivers were higher in late summer and early fall as a result of juvenile settlement. The high spring densities at Twin Rivers may have been a result of fish concentrating in a few tidepools. The density of fish beneath rocks (Fig. 11) exhibited similar trends at all sites except Observatory Point. The increase in densities in late summer and fall was the result of juvenile settlement. The high winter densities at Observatory Point may have resulted from concentration of the fish beneath some rocks as a prelude to spawning.

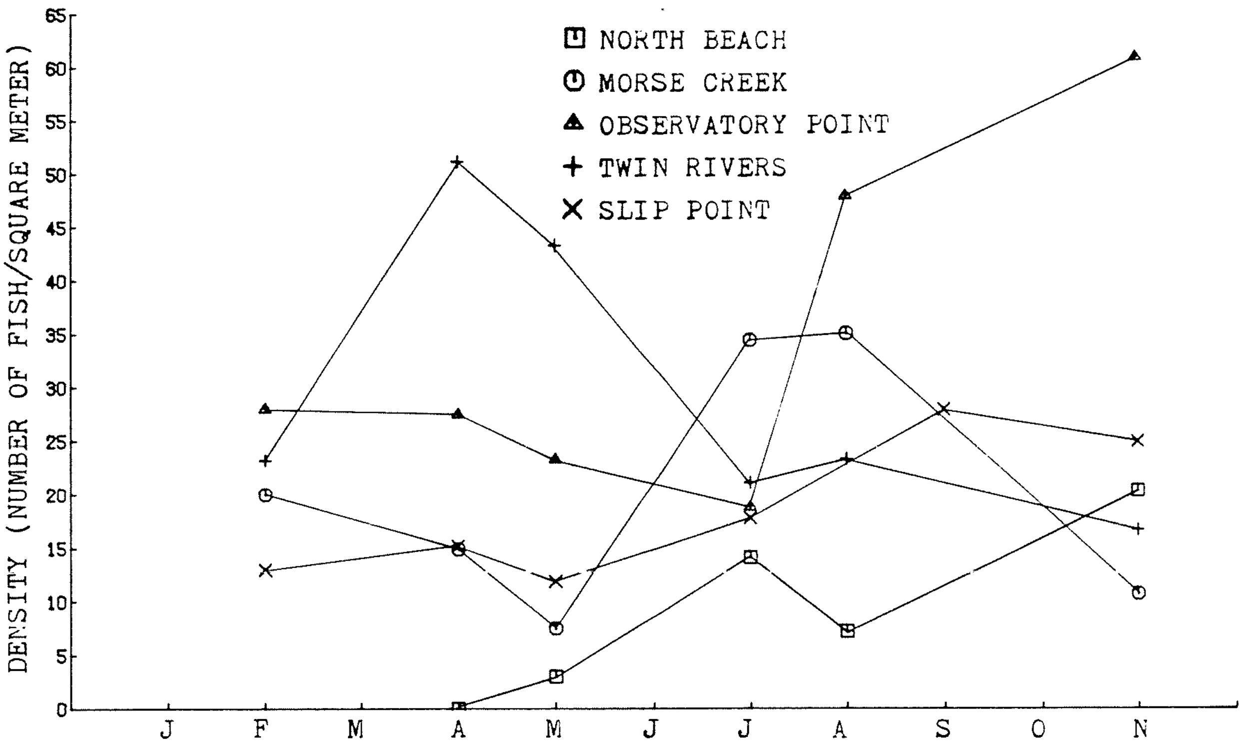

Fig. 10. Mean density (fish/m^2) of tidepool fish in the Strait of Juan de Fuca, 1977.

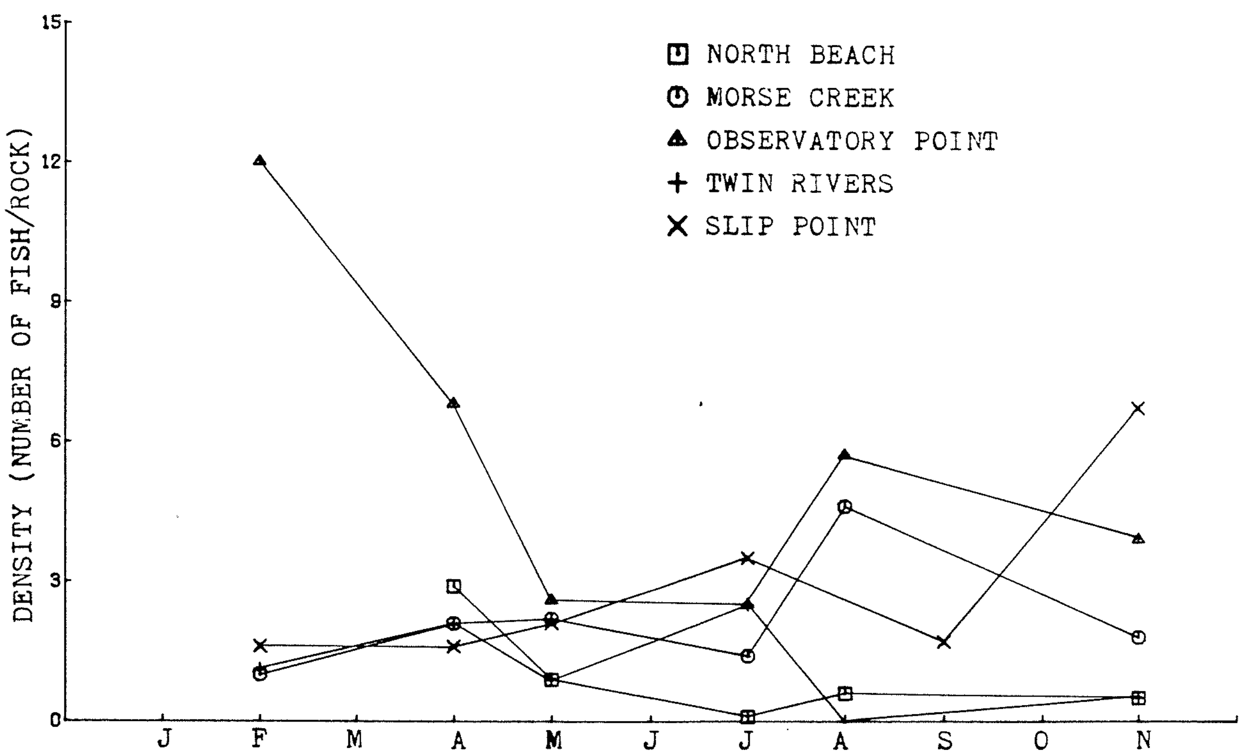

Fig. 11. Mean density (fish/rock) of fish collected beneath rocks in the strait of Juan de Fuca, 1977.

III-E. Nearshore Fish Standing Crop

III-E-1. Beach Seine

Standing crop (g/m^2) exhibited seasonal variation (Fig. 12, Appendix 2c) with maxima in summer, fall, and occasionally winter, and minima in winter and spring. However, sites exhibiting the greatest densities did not always correspond to sites with the highest standing crop. High values of standing crop ($> 8\ g/m^2$) were recorded at the more protected sites (Twin Rivers, Point Williams, Beckett Point, Alexander's Beach) as well as at the more exposed sites (Kydaka Beach, Dungeness Spit). Non-schooling species (staghorn sculpin, starry flounder, spiny dogfish, chinook salmon) and schooling species (redtail seaperch) accounted for the greatest portion of standing crop at the exposed sites.

Standing crop values for sites along the Strait of Juan de Fuca and Whidbey Island were comparable to standing crop values recorded in the San Juan Islands (Miller et al. 1977).

III-E-2. Townet

Seasonal patterns in standing crop in the strait were more distinct and exhibited less between-year variation than either density or species richness (Fig. 13, Appendix 3c). During both years, standing crop was usually maximum in summer, and occasionally fall, and least in winter. Maxima were due primarily to herring at Twin Rivers, Kydaka Beach, and Morse Creek; herring, shiner perch, and juvenile salmonids at Beckett Point; herring and longfin smelt at Pillar Point; and spiny dogfish at Dungeness Spit and Jamestown - Port Williams.

Seasonal trends in standing crop in the strait were similar to those observed in northern Puget Sound (Miller et al. 1977). In both regions, species that were not numerically abundant at times contributed significantly to standing crop.

Significant between-year differences in standing crop occurred at some sites, although there was no particular pattern to the variability.

The Whidbey Island sites exhibited trends in standing crop similar to trends observed in the strait. Herring and surf smelt contributed the greatest proportion of the standing crop at the Whidbey Island sites.

III-E-3. Intertidal

The standing crop of fish in tidepools increased from winter through summer at all sites except Twin Rivers (Fig. 14, Appendix 4c). The trends in standing crop paralleled trends in density. The standing crop of fish beneath rocks (Fig. 15) fluctuated widely but was higher in the summer at all sites except Observatory Point. The increase in standing crop in summer and fall reflect the settlement of juveniles into tidepools and beneath rocks.

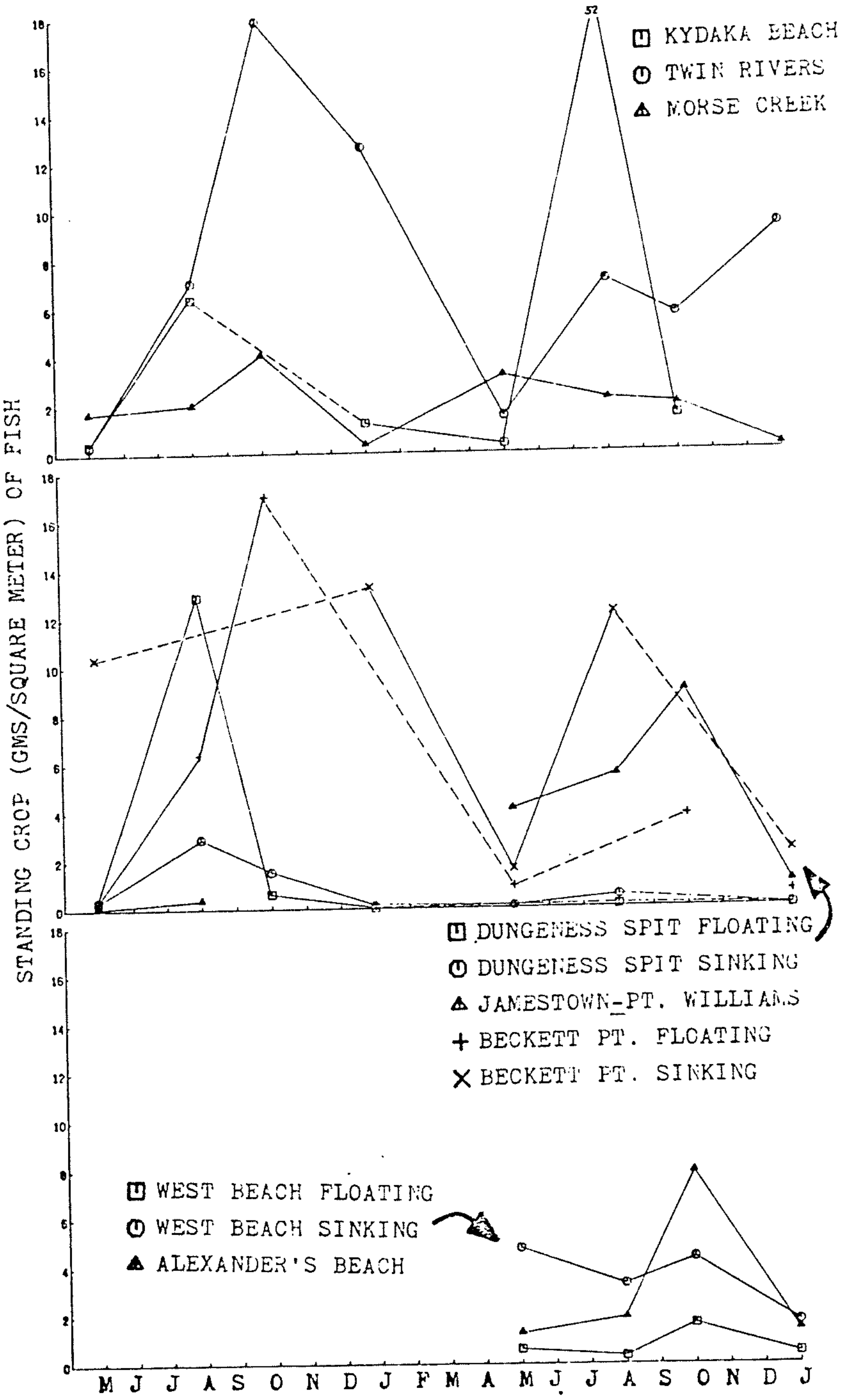

Fig. 12. Mean standing crop (grams/m^2) of nearshore fish collected by beach seine in the Strait of Juan de Fuca and Whidbey Island, 1976-78.

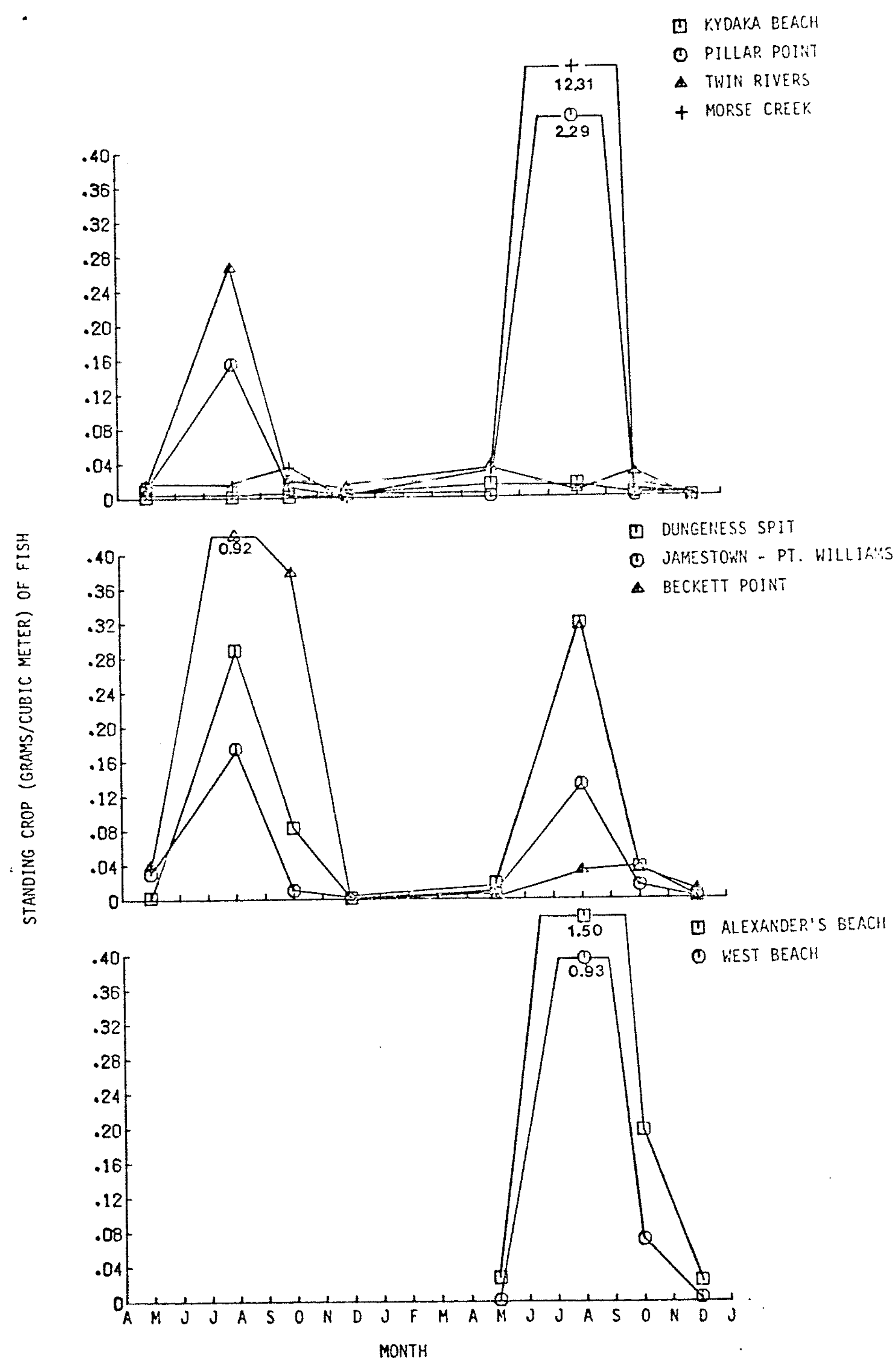

Fig. 13. Mean standing crop (grams/m^3) of nearshore fish from townet collections in the Strait of Juan de Fuca and Whidbey Island area, 1976-78.

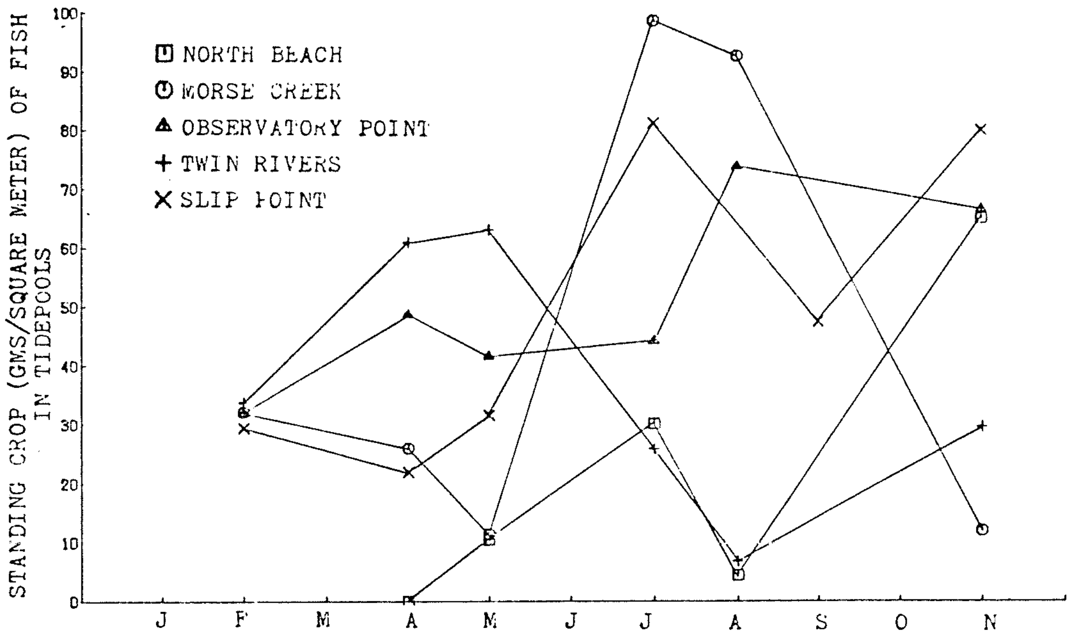

Fig. 14. Mean standing crop (grams/m^2) of tidepool fishes in the Strait of Juan de Fuca, 1977.

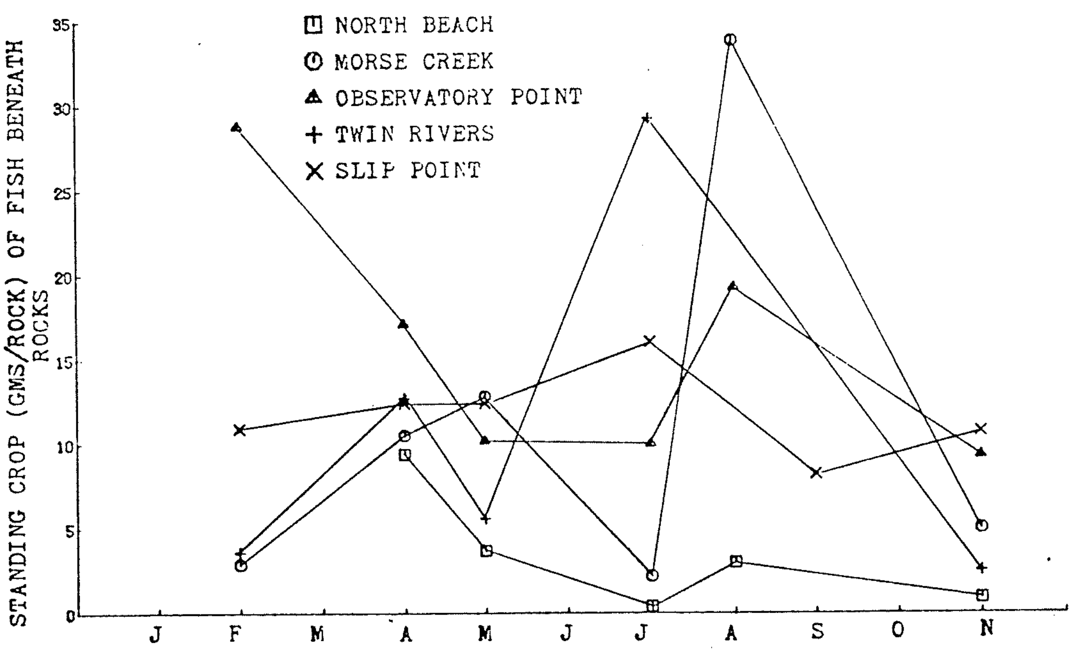

Fig. 15. Mean standing crop (grams/rock) of fish beneath rocks in the Strait of Juan de Fuca, 1977.

III-F. Macroinvertebrates

A total of 191 species of macroinvertebrates was identified from the 1977-78 nearshore fish collections (Appendix 5a). Decapod crustaceans and gastropod molluscs constituted the most diverse taxa collected, followed by isopods, mysids, amphipods, polychaetes, and other less common taxa. Abundance data for the macroinvertebrates are included in Appendix 5b.

The beach seine collected 92 species and the townet 95. Beach seine samples consisted of demersal and shallow water epibenthic species, whereas townet samples contained pelagic as well as epibenthic invertebrates. Asteroids, an echinoid, and the majority of crab species (9/12) were taken in the beach seine. Cephalopods, euphausiids, an ophiuroid, chaetognaths, and bryozoans were collected in the townet, as was the majority of ctenophores and mysids. One species of kelp crab and two species of pinnotherid (pea) crabs were collected exclusively by the townet.

Errantiate polychaete worms were collected by both net types--four species by beach seine and six species by townet; one nereid species was collected by both. Amphipods, isopods, and shrimp were commonly collected by both net types.

The parasitic isopod, *Argeia pugettensis*, was found parasitizing *Crangon stylirostris*. Other bopyrid isopods were found parasitizing *Crangon alaskensis*, *Heptacarpus pictus*, *Heptacarpus taylori*, and *Pagurus granosimanus*. However, the overall amount of parasitism was low and occurred mainly in spring.

The differences in species composition between 1976-77 and 1977-78 (Tables 8a,b) are difficult to interpret as no definite trends are apparent in the data, and especially as in many instances the invertebrate samples were not obtained or were lost. In addition, species of gammarid amphipods are not comparable between years because in 1977, only the obvious gammarid amphipod species were recorded (the rest being identified only to family), whereas in 1976 they were more thoroughly identified.

Some of the species that were found both years were not always found at the same sites. Other taxa were much more widely distributed in 1977-78 than in 1976-77, especially shrimp and euphausiids. For example, euphausiids were found almost exclusively in townet samples from Pillar Point in 1976-77 but were found at several locations in 1977-78.

Even considering the missing data points, species richness in 1976-77 collections generally increased from west to east. Data for 1977-78, however, indicate comparable species richness values at all sites, except Beckett Point, Point Williams, and Whidbey Island where richness was nearly twice that of the other sites (Table 9). These comparisons should not be considered quantitative, however, because of the grouping of the two gear types and the effect of completely missing data points, especially with the townet. Seasonal species richness values for 1976-77 exhibited a minimum in fall and a maximum in spring. Data for 1977-78 exhibited a maximum in spring and similar numbers of species through the other seasons. There were no consistent

Table 8a. Number of macroinvertebrate species collected seasonally by beach seine during nearshore fish sampling along the Strait of Juan de Fuca and Whidbey Island, May 1976 - June 1978. NS = not sampled.

Site	Spring (May)		Summer (August)		Autumn (October)		Winter (Dec. - Feb.)	
	1976	1977	1976	1977	1976	1977	76-77	77-78
Kydaka Beach	3	2	3	9	NS	4	6	NS
Twin Rivers	7	5	10	8	1	7	5	5
Morse Creek	15	3	10	8	6	12	13	5
Dungeness Spit	12	3	13	7	9	NS	11	5
Jamestown*	19	NS	8	NS	NS	NS	NS	NS
Point Williams*	NS	17	NS	20	NS	12	NS	15
Beckett Point	35	26	15	13	7	17	22	15
Alexander's Beach	NS	5	NS	10	NS	6	NS	9
West Beach	NS	17	NS	15	NS	NS	NS	3

*As a result of sampling difficulties at Jamestown in 1977, operations were shifted to Point Williams in 1978.

Table 8b. Number of macroinvertebrate species collected seasonally by townet during nearshore fish sampling along the Strait of Juan de Fuca and Whidbey Island, May 1976 - June 1978. NS = not sampled.

	Spring (May)		Summer (August)		Autumn (October)		Winter (Dec. - Feb.)	
Site	1976	1977	1976	1977	1976	1977	76-77	77-78
Kydaka Beach	NS	11	NS	6	NS	12	12	5
Pillar Point	16	24	7	2	NS	12	NS	14
Twin Rivers	5	11	8	4	NS	2	17	NS
Morse Creek	11	19	4	3	NS	16	13	NS
Dungeness Spit	11	16	17	7	NS	11	23	3
Jamestown*	8	NS	10	NS	16	NS	8	NS
Point Williams*	NS	21	NS	9	NS	11	NS	9
Beckett Point	6	10	1	1	NS	5	NS	NS
Alexander's Beach	NS	13	NS	10	NS	14	NS	17
West Beach	NS	17	NS	6	NS	11	NS	17

*As a result of sampling difficulties at Jamestown in 1977, operations were shifted to Point Williams in 1978.

Table 9. Total number of macroinvertebrate species, according to general taxonomic group, collected during nearshore fish sampling, May 1976 - June 1978, along the Strait of Juan de Fuca and Whidbey Island.

Site	Decapods		Gastropods		Amphipods, isopods		Mysids, euphausiids		Misc. Groups		Total # of species		% Total # of species*	
	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78
Kydaka Beach	4	12	0	4	8	6	4	4	3	5	19	31	15	21
Pillar Point	5	9	0	2	5	11	11	5	3	14	24	41	19	28
Twin Rivers	13	13	0	0	9	8	11	5	2	4	35	30	28	20
Morse Creek	14	19	3	1	14	11	8	4	0	6	39	41	31	28
Dungeness Spit	14	14	0	1	20	8	10	4	6	4	50	31	40	20
Jamestown**	26	--	0	--	13	--	6	--	7	--	52	--	41	--
Point Williams**	--	32	--	6	--	13	--	8	--	12	--	71	--	48
Beckett Point	29	29	8	9	12	5	0	5	7	8	56	56	44	38
Alexander Beach	--	18	--	3	--	11	--	6	--	12	--	50	--	34
West Beach	--	16	--	5	--	12	--	13	--	10	--	56	--	38

*Total species, 1976-77, 126; total species, 1977-78, 148.
**As a result of sampling difficulties at Jamestown in 1977, operations were shifted to Point Williams in 1978.

seasonal trends in species richness based on habitat, exposure, or geographical location. The spring maximum may be due to species moving inshore to reproduce as the greatest number of gravid females were encountered in spring samples.

Although the data are not quantitative, macroinvertebrate abundance and biomass for both beach seine and townet catches appear to peak in fall and winter. Size frequency distributions were plotted for the most common species, pooled by season of collection (Appendix 6).

III-G. Nearshore Fish Food Habits

Since initiation of the nearshore fish survey in the Strait of Juan de Fuca, nearly 7,000 stomachs from 88 species have been analyzed (Appendix 7); 5,483 of these were examined in 1977, an increase due to the inclusion of tidepool fishes in the second year's collections and analyses of tidepool fish stomachs collected independently during 1976.

On the basis of occurrence in the collections, 55 fish species may be considered common residents of the nearshore zone. Their principal prey taxa, ranked by the percentage of the total IRI composing the fish species' overall prey spectra, are listed in Appendix 8. Detailed discussion, including indications of diet variability as a function of site, habitat, season, and year of collection, is presented in Appendix 9 for the 44 species which were represented by sufficient sample sizes.

The overall prey list (Appendix 8) includes 91 taxa, some of which are taxonomic subunits (e.g., families) of larger taxa which could not be identified further. Gammarid amphipods, mysids, calanoid and harpacticoid copepods, polychaete annelids, hippolytid shrimp, and sphaeromatid and idoteid isopods were the most commonly consumed prey taxa of nearshore fish along the Strait of Juan de Fuca. On the basis of IRI contribution, gammarid amphipods were of paramount importance (Table 10). Gammarids made up more than half of the total IRI prey spectrum for 38% of the 55 common fish species and more than 75% of the total IRI for 9 species (juvenile coho salmon; juvenile Pacific tomcod; fluffy sculpin; spotted, ribbon, and tidepool snailfish; ribbon prickleback; and crescent and saddleback gunnel), the majority of which are tidepool fishes. In most cases the gammarid amphipods were predominantly epibenthic rather than benthic (e.g., tube-dwelling) or pelagic forms. Epibenthic mysids and harpacticoids also ranked relatively high in trophic importance, especially for juvenile chum salmon, bay pipefish, silverspotted sculpin, tubenose poacher, spotted snailfish, and juvenile butter and sand sole. Polychaete annelids were the most important benthic prey organisms, principally for juvenile flatfish (rock, C-O, and English sole, and starry flounder), but also ranked high in the diets of several sculpins and some of the intertidal pricklebacks. Shrimp occurred primarily in the prey spectra of the sculpins. Isopods were important prey to the tidepool fishes. Fish (principally juveniles and larvae) were never a main food item and were important only in the diet of the Pacific staghorn sculpin. Algae did not appear to be a constant constituent in any of the fish diets but often occurred in two sculpins (buffalo and mosshead) and four intertidal pricklebacks.

On the basis of their IRI prey spectra, the trophic position of 44 nearshore fish species can be described by five functional feeding groups:

Table 10. Relative contribution of major prey taxa of 55 common nearshore fishes of the Strait of Juan de Fuca, expressed as the occurrences of fish species in five IRI categories.

Prey	No occurrence	Percent total IRI				
		< 10	11-25	26-50	51-75	76-100
Gammarid amphipods	2	13	9	9	13	9
Mysids	21	25	4	1	1	3
Calanoid copepods	38	9	1	2	2	3
Harpacticoid copepods	21	26	4	2	2	0
Polychaetes	20	25	7	1	2	1
Shrimp	13	33	6	1	0	2
Isopods	18	28	5	4	0	0
Fish	24	26	4	1	0	0
Algae	38	13	1	3	0	0
Crabs	31	23	1	0	0	0
Gastropods	35	13	0	2	0	0
Insects	45	9	0	1	0	0
Bivalves	43	11	1	0	0	0

1. Pelagic planktivore: Fish which feeds upon pelagic plankton--e.g., those organisms occupying the upper water column. Representative prey include calanoid copepods, hyperiid amphipods, and larvaceans.

2. Epibenthic planktivore: Fish which feeds upon planktonic organisms associated with the bottom. Representative prey include gammarid amphipods, mysids, harpacticoid copepods, and certain isopods and shrimp.

3. Epibenthic benthivore: Fish which feeds upon organisms on or attached to the bottom. Representative prey include gastropods, crabs, limpets, certain isopods, and polychaete annelids.

4. Meiobenthic benthivore: Fish which feeds upon infaunal organisms living within the sediment but periodically available for capture on the surface. Representative prey include some polychaete annelids and clam siphons.

5. Omnivore: Fish which feeds upon both organisms and algae. Representative prey organisms are typically those of an epibenthic benthivore, and the algae usually include species of Ulotrichales and Bangiales.

Further definition of the breadth of diet can be made by describing fishes as either "obligate" feeders, feeding only upon prey within that group, or "facultative" feeders, feeding principally upon prey within that group but supplementing their diet with prey from other groups.

The distribution of the fish amongst these feeding groups is shown in Table 11. The characteristic neritic fishes are mainly pelagic planktivores, and only two, juvenile Pacific herring and Pacific sand lance, are obligate feeders; three species were classified as epibenthic planktivores. Of those fishes characterizing the shallow sublittoral habitats along the Strait of Juan de Fuca, half are epibenthic planktivores, including three species which appear to feed solely upon epibenthic Crustacea; eight fishes are facultative epibenthic benthivores, one each meiobenthic benthivore and omnivore. Among the common intertidal fishes, 11 (75%) are facultative epibenthic planktivores because of the prevalence of gammarid amphipods in their diet, three are epibenthic benthivores, and one, the rock prickleback, may be omnivorous because of the high proportion (44% of total IRI) of algae in the diet.

Overall, more than half of the species listed were epibenthic planktivores which utilized epibenthic crustaceans--gammarid amphipods, harpacticoid copepods, mysids, cumaceans, tanaids, sphaeromatid isopods--as the principal constituent of their diet. In that most of these organisms are processors of detritus, it would appear that the production of detritus, its reduction by microfauna and subsequent utilization of the detritus-microfauna particles by epibenthic crustaceans, is one of the most important trophic pathways leading to the production of nearshore fish in the region.

Fishes which feed facultatively upon non-planktonic epibenthic fauna are second in importance (25%). Their prey organisms also include detritivores such as gastropods, isopods, and some polychaete annelids, as well as grazing molluscs and gastropods and scavengers and predators such as crabs. The trophic pathways to the neritic fish assemblage are supported primarily by

Table 11. Functional feeding groups of prominent nearshore fishes of the Strait of Juan de Fuca, 1976-1978. O = obligate feeder within that group and F = facultative feeder utilizing primarily that group's prey organisms but also feeding on prey of other groups.

Habitat	Species	Functional feeding group				
		Pelagic planktivore	Epibenthic planktivore	Epibenthic benthivore	Meiobenthic benthivore	Omnivore
Neritic	Pacific herring*	O				
	Surf smelt	F				
	Pacific sand lance	O				
	Walleye pollock*	F				
	Longfin smelt		F			
	Tube-snout	F				
	Pink salmon*	F				
	Coho salmon*		F			
	Threespine stickleback		O			
Shallow sublittoral	Pacific staghorn sculpin			F		
	English sole*			F		
	Sand sole*		F			
	Starry flounder			F		
	Buffalo sculpin					F
	Striped seaperch		F			
	Pacific tomcod*		F			
	Redtail surfperch		O			
	Shiner perch		F			
	Chinook salmon*		F			
	Spiny dogfish			F		
	Padded sculpin			F		
	Chum salmon*		F			
	Silverspotted sculpin		O			
	Rock sole				F	
	Whitespotted greenling			F		
	Roughback sculpin			F		
	Sturgeon poacher			F		

Table 11, cont'd

Habitat	Species	Functional feeding group: Pelagic planktivore	Epibenthic planktivore	Epibenthic benthivore	Meiobenthic benthivore	Omnivore
	Tubenose poacher		O			
	Saddleback gunnel		F			
Intertidal	Tidepool sculpin		F			
	Northern clingfish			F		
	High cockscomb			F		
	Black prickleback		F			
	Rosylip sculpin		F			
	Mosshead sculpin			F		
	Fluffy sculpin		F			
	Crescent gunnel		F			
	Smoothhead sculpin		F			
	Sharpnose sculpin		F			
	Saddleback sculpin		F			
	Ribbon snailfish		F			
	Tidepool snailfish		F			
	Rock prickleback					F?
	Penpoint gunnel		F			

*Predominantly juveniles.

pelagic plankton which are based upon an autotrophic food web, i.e., phytoplankton, although all but two depend upon heterotrophic-based epibenthic plankton to supplement their diet. Omnivory was evident in only two nearshore fish species. It remains to be seen, however, whether the algae they consume can actually be broken down and utilized by the fish. Only one fish had a diet which significantly included deposit-feeding infaunal benthic organisms.

Annual variabilities in diet spectra were examined for ten representative nearshore fish species which had large stomach sample sizes (Appendix 9). In almost all cases, the principal prey (e.g., ranked #1 or #2 by IRI) did not vary between 1976 and 1977. Only in northern clingfish, where limpets replaced sphaeromatid isopods as the most important prey taxa between 1976 and 1977, and longfin smelt, where mysids and gammarid amphipods switched in importance between the two years, did the most important prey taxon change; the #2 ranked prey taxon also shifted in Pacific herring, surf smelt, and English sole. Two species, tidepool sculpin and sand sole, had essentially identical prey spectra over the two years.

Prey spectra from comparable collections at different sites were also examined for eight species (Appendix 9). Although the important prey taxa were typically the same or similar in most cases, there were some notable exceptions. Epibenthic shrimp were apparently more available for juvenile chinook salmon at Beckett Point and Point Williams than at any other site. Limpets tended to be more important in the diet spectra of northern clingfish in the western (Neah Bay and Slip Point) tidepool collection sites. Tidepool sculpins also showed differences in diet between eastern sites (North Beach, Morse Creek, and Twin Rivers), where sphaeromatid isopods and gammarid amphipods predominated, compared to sites to the west (Observatory Point, Slip Point, and Neah Bay), where gammarid amphipods, barnacles, and harpacticoid copepods were the main prey taxa. Harpacticoid copepods were similarly prominent (#2) in the prey spectrum of tidepool snailfish collected at Observatory Point. Mysids and gammarid amphipods were always the primary prey of sand sole at four beach seine sites, but the third most important prey taxon shifted from shrimp at the eastern sites to fish at the western sites.

Dramatic seasonal changes in diet spectra were detected only for tubesnout and juvenile English sole. The former species shifted completely from epibenthic plankton in January 1977 to pelagic plankton in October 1977. English sole appeared to change from an epibenthic feeding behavior, where gammarid amphipods were of primary importance, to a more benthic orientation, where polychaete annelids assumed importance.

III-H. Occurrence of Fin Rot, Lesions, and Tumors

No fin rot, lesions, or tumors were encountered on any species of fish collected in the Strait of Juan de Fuca during the two years of study. Five English sole (70-182 mm TL) from beach seine collections at Alexander's Beach and West Beach in August and October 1977 were observed to have tumors (epidermal papillomas). The tumor incidence, however, was less than one percent. No fin rot or lesions were encountered on any fish species collected in the Whidbey Island area in 1977-78.

IV. CONCLUSIONS

IV-A. Beach Seine

The nearshore fish fauna, as sampled by the beach seine, was dominated by demersal and, to a lesser extent, neritic species. Demersal species, e.g., cottids and flatfishes, were present in more collections than neritic species, due to the sedentary habits of the demersal fishes which make them especially vulnerable to the beach seine. Neritic species, e.g., surfperches, clupeids, osmerids, and gadoids, were frequently encountered but their wide-ranging habits precluded their consistent occurrence in beach seine collections. Trends in density and biomass were not so clearly defined. The neritic species were generally small schooling fishes; consequently, although not occurring consistently, when they were collected they were in greater densities, and concomitantly at higher biomass levels than the demersal species.

Habitat associations are of interest in assessing the impact of environmental perturbations. All of the habitats sampled by beach seine have a major structural feature in common--composition of the substrate. Although it varies somewhat between sites, the substrate at all sites is a fairly homogeneous mixture of small particles, primarily coarse sand (Kydaka Beach, Alexander's Beach) mixed with varying amounts of gravel (Dungeness Spit, Morse Creek, West Beach) or mud (Twin Rivers, Jamestown, Point Williams, Beckett Point). Consequently, the abundant demersal species frequenting sandy habitats (Pacific staghorn sculpin, English sole, sand sole) were found at nearly all the sites sampled. The presence or absence of macroscopic algae and eelgrass at a particular site appeared to be a major determinant of the associated neritic species. For example, surfperches and tube-snouts regularly occurred where algal and eelgrass cover was abundant (Twin Rivers, Morse Creek, Point Williams, Beckett Point) while Pacific herring and sand lance occurred primarily where there was little or no vegetative cover (Kydaka Beach, Dungeness Spit, West Beach).

Values of species richness, density, and standing crop obtained in the Strait of Juan de Fuca were within the range of values obtained in northern Puget Sound by Miller et al. (1977). Protected embayments with abundant vegetative cover generally exhibited the highest values for the three parameters measured, whereas exposed beaches exhibited the lowest values. Of all the sites in northern Puget Sound and the Strait of Juan de Fuca, Beckett Point consistently yielded the highest values recorded for the three parameters. As mentioned previously, this was most likely the result of the close proximity of a variety of habitats at Beckett Point, the presence of extensive algal and eelgrass cover, and perhaps the productivity of Discovery Bay.

IV-B. Townet

Nearshore fishes sampled by the townet were dominated by schooling neritic species, including Pacific herring, longfin smelt, Pacific sand lance, and surf smelt. Except for a lack of threespine stickleback in the strait, these predominant species were similar to those occurring in northern Puget Sound (Miller et al. 1977). Neritic species generally were caught in large numbers, especially during spring and summer. Demersal species (e.g., cottids and pleuronectids) occurred in small numbers in relatively few collections. Many of these demersal species occurred as larvae in spring and were largely responsible for the high spring species richness observed at several sites (e.g., Morse Creek). Demersal species also contributed to the higher species richness levels in 1976-77 than in 1977-78.

For the predominant schooling species, distributional trends did not appear to be based solely on habitat as defined in this study. Other factors such as proximity to spawning areas, geographic location, and vegetative cover were also important in determining fish distributions. For instance, longfin smelt and surf smelt were most abundant at sites near known spawning areas, whereas juvenile salmonids were caught almost entirely in the eastern strait. For schooling species, ranging over a wide area would be of advantage in exploiting pelagic food resources and avoiding predation.

Seasonal patterns in species richness, density, and standing crop in the Strait of Juan de Fuca were similar to those in northern Puget Sound (Miller et al. 1977). Highly exposed sites such as Kydaka Beach in the strait and South Beach in northern Puget Sound had the lowest values for the three parameters, whereas protected areas with some associated vegetative cover had high values. However, associations of neritic fishes with these protected areas may be coincidental rather than a result of factors such as food resources or protection from predation.

IV-C. Intertidal

The intertidal fish fauna was dominated by cottids and stichaeids. All fish collected in the intertidal were highly thigmotactic, demersal species. The absence of neritic species was a function of the turbulent water conditions encountered during flood, ebb, and high tides. At those times a refuge from turbulence would be essential to survival. Neritic species lacking the behavioral ability to seek shelter during turbulent conditions would suffer high mortalities.

Three species dominated the intertidal fauna--tidepool sculpin, high cockscomb, and northern clingfish. They occurred at every intertidal site sampled but made up varying proportions of the fauna. This was a function of the intertidal habitat. Both tidepools and beneath-rock habitat occur at all intertidal sites but physical oceanographic processes affect rocky headlands (Neah Bay, Slip Point, Observatory Point) and cobble beaches (Twin Rivers, Morse Creek, North Beach) differently. The three predominant species constituted a lower proportion of the fauna on the rocky headlands where a variety of microhabitats occurred, allowing for habitat specializations and relatively high species richness. They composed a higher proportion of the fauna on cobble beaches where fewer microhabitats occurred, leading to lower species richness. The cobble beaches are generally inundated with sand and sediments in winter and spring. Sedimentation reduces the amount of beneath-rock habitat which would account for the lower number of stichaeids and pholids on cobble beaches than on rocky headlands. Sedimentation may also reduce the amount of sessile invertebrate and algal cover (e.g., mussels, algae) which would account for the decrease in number of microhabitats encountered.

IV-D. Macroinvertebrates

Any conclusions regarding the composition, abundance, and biomass of macroinvertebrates collected incidentally during beach seine and townet collections must consider that these collection methods were not designed to provide quantitative data for these assemblages. Accordingly, comparisons between years, sites, and seasons can be considered as only relative, qualitative differences in the macroinvertebrate assemblages.

In both years, species richness, abundance, and biomass of collected epibenthic (beach seine caught) macroinvertebrates were generally highest at the more protected sites, Beckett Point and Point Williams. In many cases this was due to the abundance and diversity of crangonid (especially *Crangon alaskensis*), hippolytid (especially *Eualus* sp. and *Hippolyte clarki*), and pandalid (especially *Pandalus danae*) shrimps and gammarid amphipods at these two sites. The two new sites located at the eastern end of the strait, Alexander's Beach and West Beach, had epibenthic macroinvertebrate catches similar to Dungeness Spit and Twin Rivers except that gammarid amphipods (especially *Atylus tridens*) were more abundant. Over the four quarters, catches were lowest and least diverse in winter and generally highest in October; the high autumn catches, however, may be an artifact of the nighttime collections.

Neritic macroinvertebrates captured incidentally by townet indicated fewer distinct trends and a more patchy distribution than the epibenthic macroinvertebrates. Mysids (specifically *Archaeomysis grebnitzki* and *Neomysis rayi*) were the major cause of the high fluctuations in abundance and standing crop (Appendix 5b), occurring abundantly at all Strait of Juan de Fuca sites at one time or another and during all seasons except summer. They were not, however, significantly abundant in the catches from the two sites at the eastern end of the strait. In several instances there was a slight increase in the contribution by mysids to the diet spectra of several fish (juvenile sand sole and English sole, tubenose poacher, silverspotted sculpin, redtail surfperch) during periods of high mysid abundance, but there were also several instances where no such relationship was evident. The lack of truly comparable data sets does not allow us to determine whether there was a numerical response to increased prey densities on the part of the predator.

IV-E. Nearshore Fish Food Web

Although there is some overlap in prey resources among the fish faunas occupying the three basic nearshore zones along the Strait of Juan de Fuca--neritic, shallow sublittoral, and intertidal--there are important differences in the trophic base contributing to each. In the neritic zone, autotrophic production by pelagic phytoplankton is the principal energy source of the herbivorous and carnivorous zooplankton, the dietary mainstays of neritic fishes. Epibenthic zooplankton and macroinvertebrates, which derive trophic energy at least partly from the heterotrophic processing of detritus particles, provide alternative prey resources to the patchily distributed pelagic zooplankton. There are no nearshore oceanographic studies (an obvious gap in the information base of this and other regions) which describe the basis and dynamics of primary production and the origin of zooplankton populations in the nearshore zone. Thus, it is impossible to evaluate the dependence of neritic fishes upon the prey resources that they exploit in the nearshore zone. The highly variable townet catches of neritic fishes suggest that, as mobile, fast-swimming schooling fishes, they must range over a large area in order to exploit successfully the patchy concentrations of prey such as calanoid copepods, larvaceans, and hyperiid amphipods. One consequence of this mobility is that this fish assemblage would be less vulnerable to a local perturbation affecting the prey resources as long as adequate resources were available adjacent to the affected region.

Shallow sublittoral fishes, however, represent the opposite situation. A detritus-based food web which supports the dense populations of epibenthic zooplankton is the major trophic base of these fish assemblages. In most cases, these prey resources are closely associated with the nearshore sediments and associated algal and eelgrass guilds, and so are confined to characteristic habitats. As described earlier, the habitat diversity and exposure of the nearshore environs appear to be a principal determinant of the composition, abundance, and standing crop of the habitat's nearshore fish assemblage. The associated diversity of littoral and shallow sublittoral benthos would appear to be a major factor explaining these associations. Accordingly, the diversity of the nearshore fish assemblages at the beach seine sites generally followed the diversity of the benthic assemblages documented for these sites (Nyblade 1978). This appears to be especially true for Beckett Point, the most productive, diverse site under study.

The association between the nearshore fish assemblages and epibenthic organisms is especially evident for juvenile fishes. The shallow sublittoral environment is the prevailing habitat for juvenile flatfish (e.g., English and sand sole, starry flounder), sculpin (e.g., Pacific staghorn sculpin, buffalo sculpin), and salmon (e.g., chum salmon), which in conjunction with providing a possible refuge from predation, provides the highest densities of small (100-500 μ) epibenthic crustaceans, the optimum prey of the juveniles in their first few months of feeding.

The importance of the detritus energy source and the specific association between the fish assemblages and shallow sublittoral habitats imply an extreme vulnerability to perturbations such as the introduction of petroleum hydrocarbons. Not only have the fish assemblages evolved a complex ecological association with the shallow sublittoral habitats (the principal area of impact in most oil spills) which places them in direct, prolonged contact with a pollutant, but the prey resources upon which they are based are more sensitive to the toxic components of petroleum hydrocarbons, and are associated with the bottom sediments wherein the oil is typically entrained. The critical insult, however, may be to the trophic link between the detritus processors and detritivorous zooplankton. Disruption of the conversion of algal and eelgrass detritus to epibenthic zooplankton biomass could appreciably disrupt the major trophic pathways supporting the habitat's nearshore fishes. Unlike the neritic fishes, they are not adapted to emigrate and consume alternate prey resources.

Tidepool and littoral fish assemblages characteristically utilize both epibenthic zooplankton associated within the littoral habitat and that transported in from the shallow sublittoral with each tidal exchange as well as benthic fauna residing within the habitat. If there is a limited resource of resident benthic and epibenthic organisms, the periodic transport of epibenthic organisms into and about the littoral area is extremely important to the trophic maintenance of the resident fishes. The structure of the littoral food web, apparently based both on the resident grazing and filtering macroinvertebrates and on the "renewable" epibenthic detritivores, would also be extremely vulnerable to impact of a toxic pollutant. Loss of the epibenthic emigrants would remove the only alternative prey resource to the limited resident prey populations. But many of the resident prey, specifically the sessile organisms, by their confinement in the tidepool or beneath rocks, are the most vulnerable prey resources of the nearshore environment. Of course the tidepool fishes themselves, similarly limited to the littoral habitats, would be subjected to high concentrations of spilled oil deposited in their midst with each tide. Thus, of all the fish assemblages documented in this study, the tidepool fish assemblages have the greatest probability of being adversely affected by a pollutant incident, whether through direct toxicity, or indirectly through the food web.

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APPENDIX 1

OCEANOGRAPHIC DATA FROM BEACH SEINE, TOWNET, AND TIDEPOOL COLLECTIONS

Appendix 1a. Beach seine temperature (^{o}C) summary.

Location	Spring		Summer		Autumn		Winter		Total			
									76-77		77-78	
	1976	1977	1976	1977	1976	1977	76-77	77-78	$\overline{X}$	SD	$\overline{X}$	SD
Kydaka Beach	11.5	11.6	10.4	11.0	--	9.3	8.5	--	10.1	1.24	10.6	1.19
Twin Rivers	13.5	9.2	12.2	11.5	7.7	9.0	9.0	8.0	10.6	2.34	9.4	1.48
Morse Creek	11.5	10.0	10.6	11.3	8.3	10.0	8.5	7.5	9.7	1.36	9.7	1.59
Dungeness Spit	9.6	9.2	10.4	11.2	8.4	--	7.5	9.0	9.0	1.12	9.8	1.22
Jamestown-Point Williams	10.4	10.0	12.6	11.5	--	10.0	--	7.0	11.5	1.10	9.6	1.89
Beckett Point	13.5	13.6	13.8	5.9	9.8	10.1	7.7	7.0	11.2	2.56	10.2	3.30
West Beach		11.5		12.0		10.0		9.0			10.6	1.38
Alexander's Beach		13.4		13.6		9.1		8.0			11.0	2.89
$\overline{X}$	11.7	11.1	11.7	11.7	8.6	9.6						
SD	1.45	1.76	1.29	0.88	0.77	0.49						

Appendix 1b. Beach seine salinity (ppt) summary.

Location	Spring		Summer		Autumn		Winter		Total 76-77		Total 77-78	
	1976	1977	1976	1977	1976	1977	76-77	77-78	$\overline{X}$	SD	$\overline{X}$	SD
Kydaka Beach	31.3	29.9	30.8	31.5	--	32.0	30.2	--	30.8	0.45	31.3	1.10
Twin Rivers	26.8	19.4	29.6	31.0	29.7	30.2	23.2	14.3	27.3	2.65	23.7	8.21
Morse Creek	31.4	31.4	28.8	29.7	31.2	30.9	30.7	27.2	30.5	1.03	29.8	1.87
Dungeness Spit	31.3	31.3	30.4	31.1	31.3	--	30.9	29.7	31.0	0.37	30.7	0.87
Jamestown-Point Williams	--	24.4	--	27.1	--	29.9	--	23.3	--		26.2	2.95
Beckett Point	30.2	31.1	30.7	29.7	31.2	31.4	30.8	30.1	30.7	0.36	30.6	0.81
West Beach		29.6		29.3		30.5		28.6			29.5	0.79
Alexander's Beach		26.9		29.7		30.6		24.2			27.9	2.90
$\overline{X}$	30.2	28.0	30.1	29.9	30.9	30.8	29.6					
SD	1.76	4.25	0.76	1.39	0.67	0.72	2.99					

Appendix 1c. Beach seine dissolved oxygen (% saturation) summary.

Location	Spring 1976	Spring 1977	Summer 1976	Summer 1977	Autumn 1976	Autumn 1977	Winter 76-77	Winter 77-78	Total 76-77 $\overline{X}$	Total 76-77 SD	Total 77-78 $\overline{X}$	Total 77-78 SD
Kydaka Beach	109.0	72.4	--	87.1	--	94.0	101.3	--	105.2	3.90	84.5	11.03
Twin Rivers	113.0	64.7	71.9	54.9	107.1	109.2	100.8	98.0	98.2	15.79	81.7	26.01
Morse Creek	95.0	59.5	84.9	45.7	89.8	106.9	94.5	106.7	91.1	4.09	79.7	31.80
Dungeness Spit	110.0	103.5	107.2	112.2	58.5	--	98.0	117.1	93.4	20.65	110.9	6.89
Jamestown-Point Williams	116.0	106.5	93.8	76.2	--	78.8	--	95.4	104.9	11.10	89.2	14.32
Beckett Point	153.0	156.0	104.1	66.5	66.2	91.1	82.6	63.0	101.5	32.64	94.2	43.09
West Beach		113.5		94.0		--		101.1			102.9	9.87
Alexander's Beach		140.6		131.9		--		101.1			124.5	20.75
$\overline{X}$	116.0	102.1	92.4	83.6	80.4	96.0	95.4					
SD	17.81	35.12	12.92	28.98	19.25	12.42	6.86					

Appendix 1d. Townet surface temperature (^{o}C) summary.

Location	Spring		Summer		Autumn		Winter		Totals			
	1976	1977	1976	1977	1976	1977	76-77	77-78	76-77		77-78	
									$\bar{X}$	SD	$\bar{X}$	SD
Kydaka Beach	9.4	8.2	9.5	13.2	9.0	8.2	8.5	7.1	9.1	0.45	9.2	2.73
Pillar Point	8.6	8.4	9.8	9.4	8.9	8.6	8.5	7.2	8.9	0.59	8.4	0.91
Twin Rivers	8.9	8.5	10.7	9.4	9.7	8.1	7.9	7.4	9.3	1.19	8.4	0.83
Morse Creek	8.4	8.8	10.0	9.4	9.6	8.4	7.5	7.0	8.9	1.14	8.4	1.02
Dungeness Spit	9.5	8.5	10.0	9.3	9.3	8.5	7.7	6.2	9.1	0.99	8.1	1.34
Jamestown - Point Williams	9.3	8.9	10.0	10.1	8.9	8.6	7.1	6.7	8.8	1.23	8.6	1.41
Beckett Point	12.4	10.2	13.5	12.1	10.8	9.7	7.3	6.1	11.0	2.70	9.5	2.51
West Beach	-	8.8	-	10.6	-	9.4	-	7.1	-	-	8.9	1.46
Alexander's Beach	-	8.9	-	10.2	-	9.8	-	6.8	-	-	8.9	1.52
$\bar{X}$	9.5	8.8	10.5	10.4	9.5	8.8	7.8	6.8				
SD	1.34	0.58	1.37	1.37	0.68	0.65	0.55	0.44				

Appendix 1e. Townet surface salinity ($^{o}/oo$) summary.

Location	Spring		Summer		Autumn		Winter		Totals			
	1976	1977	1976	1977	1976	1977	76-77	77-78	76-77		77-78	
									$\bar{X}$	SD	$\bar{X}$	SD
Kydaka Beach	32.6	33.1	32.4	33.1	32.6	33.0	28.3	32.7	31.5	2.12	33.0	0.19
Pillar Point	32.5	32.8	32.2	33.4	32.7	32.3	31.6	32.8	32.3	0.48	32.8	0.45
Twin Rivers	31.9	33.1	31.9	33.4	32.6	32.9	31.5	33.1	32.0	0.46	33.1	0.21
Morse Creek	28.1	31.6	31.8	33.4	32.2	32.9	31.8	33.0	31.0	1.93	32.7	0.78
Dungeness Spit	31.0	32.4	32.2	33.3	32.5	33.3	32.7	33.2	32.1	0.76	33.1	0.44
Jamestown - Point Williams	30.5	32.3	31.7	32.8	32.7	32.8	32.2	32.7	31.8	0.94	32.7	0.24
Beckett Point	31.3	32.2	31.6	32.4	32.0	32.5	33.1	32.6	31.7	0.32	32.4	0.17
West Beach	-	31.2	-	31.1	-	31.4	-	30.9			31.2	0.21
Alexander's Beach	-	31.1	-	31.4	-	31.3	-	31.0			31.2	0.18
$\bar{X}$	31.1	32.2	32.0	32.7	32.5	32.5	31.6	32.6				
SD	1.54	0.76	0.30	0.89	0.27	0.71	1.57	0.97				

Appendix 1f. Townet dissolved oxygen (% saturation) summary.

Location	Spring		Summer		Autumn		Winter		Totals			
	1976	1977	1976	1977	1976	1977	76-77	77-78	76-77		77-78	
									$\bar{X}$	SD	$\bar{X}$	SD
Kydaka Beach	97.0	92.3	75.3	105.5	68.0	71.3	101.6	88.2	84.5	2.12	89.3	14.10
Pillar Point	84.0	100.6	82.2	74.5	64.9	71.5	96.3	86.3	81.9	0.48	83.2	13.23
Twin Rivers	90.0	88.6	84.8	74.1	75.9	63.2	95.5	83.3	86.6	0.46	77.3	11.15
Morse Creek	86.0	92.9	82.6	62.7	69.9	79.4	87.6	84.2	81.5	1.93	79.8	12.70
Dungeness Spit	86.0	89.8	72.6	66.3	64.6	60.6	80.3	81.3	75.9	0.76	82.0	11.28
Jamestown - Point Williams	94.0	97.9	76.8	68.9	62.8	65.2	78.3	85.2	78.0	0.94	79.3	15.14
Beckett Point	136.0	137.0	116.0	92.6	92.3	104.3	81.9	89.6	106.6	0.32	105.9	21.70
West Beach	-	85.6	-	-	-	71.3	-	82.5	-	-	79.8	7.52
Alexander's Beach	-	92.7	-	68.9	-	80.2	-	86.0	-	-	82.0	10.09
$\bar{X}$	96.1	97.5	84.3	76.7	71.3	74.1	88.8	85.2				
SD	18.19	15.50	14.64	14.73	10.27	13.13	9.10	2.68				

Appendix 1g. Tidepool temperature (^{o}C) summary; Strait of Juan de Fuca surface temperature - mean tidepool temperature, 1977-78.

Location		Spring	Summer	Autumn	Winter	Strait $\overline{x}$	Strait SD	Tidepools $\overline{x}$	Tidepools SD
North Beach		10.3 - 11.0	15.6 - 15.8	10.0 - 10.3		12.0	3.15	12.4	2.99
Morse Creek		10.0 - 10.7	11.0 - 11.8	9.8 - 9.8	8.1 - 8.8	9.7	1.20	10.3	1.28
Observatory Point		8.2 - 10.2	10.7 - 10.8	10.0 - 9.9	7.8 - 9.7	9.2	1.40	10.2	0.48
Twin Rivers		11.2 - 11.5	12.5 - 13.2	9.9 - 9.9	9.0 - 9.5	10.7	1.53	11.3	2.13
Slip Point		9.6 - 10.5	11.2 - 11.3	10.0 - 10.5	9.5 - 9.8	10.1	0.78	10.5	0.61
Neah Bay		10.7 - 10.8	12.8 - 12.8			11.8	1.48	11.8	1.41
Strait	$\overline{x}$	10.0	12.3	9.9	8.6				
	SD	1.04	1.82	0.09	0.79				
Tidepools	$\overline{x}$	10.8	12.6	10.1	9.5				
	SD	0.44	1.80	0.30	0.45				

Appendix 1h. Tidepool salinity (ppt) summary; Strait of Juan de Fuca surface salinity - mean tidepool salinity, 1977-78.

Location		Spring	Summer	Autumn	Winter	Strait		Tidepools	
						$\bar{x}$	SD	$\bar{x}$	SD
North Beach		30.1 - 29.7	31.1 - 30.4	31.3 - 31.4		30.8	0.64	30.5	0.85
Morse Creek		29.6 - 30.3	26.2 - 25.3	30.8 - 27.1	28.3 - 24.0	28.7	1.97	26.7	2.73
Observatory Point		30.3 - 29.7	31.9 - 31.2	31.0 - 30.7	29.3 - 28.4	30.6	1.10	30.0	1.24
Twin Rivers		27.3 - 21.6	29.9 - 28.7	27.3 - 27.3	24.4 - 25.6	27.2	2.25	25.8	3.07
Slip Point		29.4 - 28.9	31.4 - 31.0	29.4 - 29.3	29.9 - 29.7	30.0	0.95	29.7	0.91
Neah Bay		30.8 - 29.9	32.0 - 31.8			31.4	0.85	30.9	1.34
Strait	$\bar{x}$	29.6	30.4	30.0	28.0				
	SD	1.23	2.20	1.66	2.47				
Tidepools	$\bar{x}$	28.4	29.7	29.2	26.9				
	SD	3.34	2.42	1.94	2.59				

APPENDIX 2

SUMMARY OF BIOLOGICAL DATA FROM BEACH SEINE SAMPLING

Appendix 2a. Summary of species richness (number of species) in beach seine samples, 1976-78.

Location	Spring		Summer		Autumn		Winter		Totals			
									76-77		77-78	
	1976	1977	1976	1977	1976	1977	76-77	77-78	$\bar{x}$	SD	$\bar{x}$	SD
Kydaka Beach	7	4	13	10	--	10	7	--	9.0	3.5	8.0	3.5
Twin Rivers	10	16	18	16	12	13	12	14	13.0	3.5	14.8	1.5
Morse Creek	9	11	15	15	11	19	12	7	11.8	2.5	13.0	5.2
Dungeness Spit	8	5	13	12	17	--	5	5	10.8	5.3	7.3	4.0
Jamestown-Point Williams	7	16	6	17	--	16	--	18	6.5	0.7	16.8	1.0
Beckett Point	19	16	30	27	25	31	30	17	26.0	5.2	22.8	7.4
West Beach	--	14	--	16	--	17	--	13	--	--	15.0	1.8
Alexander's Beach	--	10	--	11	--	13	--	10	--	--	11.0	1.4
$\bar{x}$	10.0	11.5	15.8	15.5	16.3	17.0	13.2	12.0				
SD	4.6	4.9	8.0	5.3	6.4	6.9	9.9	4.9				

Appendix 2b. Summary of fish density (fish/m^2) in beach seine samples, 1976-78.

Location	Spring		Summer		Autumn		Winter		Totals 76-77		Totals 77-78	
	1976	1977	1976	1977	1976	1977	76-77	77-78	$\bar{x}$	SD	$\bar{x}$	SD
Kydaka Beach	0.05	0.01	1.75	18.36	--	0.05	0.02	--	0.61	0.99	6.14	10.58
Twin Rivers	0.13	0.02	0.74	0.58	0.19	0.64	0.14	0.12	0.30	0.29	0.34	0.32
Morse Creek	0.01	0.02	0.38	0.13	0.03	0.15	0.02	0.03	0.11	0.18	0.08	0.07
Dungeness Spit	0.01	0.01	0.76	0.11	0.08	--	0.01	0.01	0.22	0.36	0.04	0.06
Jamestown-Point Williams	0.04	0.07	0.10	0.64	--	1.81	--	0.40	0.07	0.04	0.73	0.76
Beckett Point	0.50	0.03	1.18	1.74	1.66	0.30	2.03	0.34	1.34	0.66	0.60	0.77
West Beach	--	0.02	--	0.07	--	0.17	--	0.54	--	--	0.20	0.24
Alexander's Beach	--	0.73	--	0.33	--	0.75	--	0.12	--	--	0.48	0.31
$\bar{x}$	0.12	0.11	0.82	2.75	0.49	0.55	0.44	0.22				
SD	0.19	0.25	0.59	6.33	0.78	0.61	0.89	0.20				

Appendix 2c. Summary of fish standing crop (g/m^2) in beach seine samples, 1976-78.

Location	Spring		Summer		Autumn		Winter		Totals 76-77		Totals 77-78	
	1976	1977	1976	1977	1976	1977	76-77	77-78	$\bar{x}$	SD	$\bar{x}$	SD
Kydaka Beach	0.39	0.35	6.39	52.07	--	1.49	1.23	--	2.67	3.25	17.97	29.54
Twin Rivers	0.32	1.49	7.06	7.08	17.85	5.67	12.61	9.31	9.46	7.52	5.89	3.29
Morse Creek	1.70	3.18	2.03	2.17	4.09	1.95	0.36	0.20	2.05	1.54	1.88	1.24
Dungeness Spit	0.33	0.08	2.89	0.48	1.52	--	0.11	0.04	1.21	1.28	0.20	0.24
Jamestown-Point Williams	0.12	4.09	0.38	5.47	--	8.93	--	1.01	0.25	0.18	4.88	3.28
Beckett Point	10.35	1.61	6.36	12.16	17.00	3.78	13.25	2.31	11.74	4.50	4.97	4.88
West Beach	--	4.78	--	3.30	--	4.38	--	1.74	--	--	3.55	1.36
Alexander's Beach	--	1.29	--	1.91	--	7.92	--	1.43	--	--	3.14	3.20
$\bar{x}$	2.20	2.11	4.19	10.58	10.12	4.87	5.51	2.29				
SD	4.03	1.72	2.78	17.17	8.51	2.82	6.79	3.20				

APPENDIX 3

SUMMARY OF BIOLOGICAL DATA COLLECTED BY TOWNET

Appendix 3a. Summary of nearshore fish species richness during quarterly townet collections, 1976-78.

Location	Spring 76-77	Spring 77-78	Summer 76-77	Summer 77-78	Autumn 76-77	Autumn 77-78	Winter 76-77	Winter 77-78	Totals 76-77 $\bar{X}$	Totals 76-77 SD	Totals 77-78 $\bar{X}$	Totals 77-78 SD
Kydaka Beach	5	4	2	6	6	3	3	1	4.0	1.83	2.3	1.5
Pillar Point	11	4	5	4	7	6	4	2	6.7	3.10	4.0	1.6
Twin Rivers	10	4	13	3	7	6	6	0	9.0	3.16	3.3	2.5
Morse Creek	19	5	10	8	10	11	5	2	11.0	5.83	6.5	3.9
Dungeness Spit	9	6	12	8	9	12	6	4	9.0	2.45	7.5	3.4
Jamestown - Point Williams	10	6	9	9	12	4	5	3	9.0	2.94	5.5	2.7
Beckett Point	9	4	12	6	14	9	4	5	9.8	4.35	6.0	2.2
West Beach	-	5	-	12	-	4	-	6			6.8	3.6
Alexander's Beach	-	13	-	11	-	9	-	6			9.7	3.0
$\bar{X}$	10.4	5.7	9.0	7.4	9.3	7.1	4.7	3.2				
SD	4.2	2.9	4.1	3.0	2.9	3.3	1.1	2.2				

Appendix 3b. Summary of nearshore fish density (fish/m^3) from quarterly townet collections, 1976-78.

Location	Spring		Summer		Autumn		Winter		Totals			
	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77		77-78	
									$\bar{X}$	SD	$\bar{X}$	SD
Kydaka Beach	0.01	0.32	<0.01	0.01	0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.08	0.16
Pillar Point	0.01	0.01	0.03	1.66	0.01	<0.01	0.01	<0.01	0.01	0.01	0.42	0.83
Twin Rivers	0.11	0.90	0.20	0.01	0.01	0.01	<0.01	0.0	0.09	0.10	0.23	0.45
Morse Creek	0.09	0.76	<0.01	5.28	0.01	<0.01	0.01	<0.01	0.02	0.04	1.51	2.54
Dungeness Spit	0.03	0.41	0.04	0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	0.11	0.20
Jamestown - Point Williams	0.02	0.12	0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.04	<0.06
Beckett Point	0.09	0.01	0.30	<0.01	0.06	<0.01	<0.01	<0.01	0.12	0.01	0.01	0.01
West Beach	-	0.01	-	0.23	-	< 0.01	-	< 0.01			0.06	0.11
Alexander's Beach	-	0.04	-	0.32	-	< 0.03	-	< 0.01			0.10	0.15
$\bar{X}$	0.05	0.29	0.08	0.84	0.01	< 0.01	0.01	< 0.01				
SD	0.44	0.34	0.12	1.75	0.02	< 0.01	0.01	< 0.01				

Appendix 3c. Summary of nearshore fish standing crop (g/m^3) from quarterly townet collections, 1976-78.

Location	Spring		Summer		Autumn		Winter		Totals			
	76-77	77-78	76-77	77-78	76-77	77-78	76-77	77-78	76-77		77-78	
									$\bar{X}$	SD	$\bar{X}$	SD
Kydaka Beach	<0.01	0.02	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Pillar Point	0.01	<0.01	0.16	2.29	0.01	<0.01	<0.01	<0.01	0.05	0.07	0.57	1.14
Twin Rivers	0.01	0.04	0.27	0.01	0.02	0.03	0.01	0	0.08	0.13	0.02	0.02
Morse Creek	0.01	0.03	0.01	12.31	0.04	0.01	<0.01	<0.01	0.02	0.01	3.09	6.15
Dungeness Spit	<0.01	0.02	0.29	0.32	0.08	0.04	<0.01	<0.01	0.09	0.14	0.09	0.15
Jamestown - Point Williams	0.03	0.01	0.17	0.13	0.01	0.02	<0.01	<0.01	0.05	0.08	0.04	0.06
Beckett Point	0.04	0.01	0.92	0.03	0.38	0.03	<0.01	0.01	0.34	0.43	0.02	0.02
West Beach	-	< 0.01	-	0.93	-	0.07	-	< 0.01	-	-	0.26	0.45
Alexander's Beach	-	0.03	-	1.50	-	0.20	-	0.02	-	-	0.44	0.71
$\bar{X}$	0.02	0.02	0.26	2.06	0.08	0.05	< 0.01	< 0.01				
SD	0.01	0.01	0.31	3.92	0.14	0.06	< 0.01	< 0.01				

APPENDIX 4

SUMMARY OF TIDEPOOL BIOLOGICAL DATA

Appendix 4a. Species of fish collected at each tidepool site; residents (o), transients (*).

Species	Neah Bay	Slip Point	Twin Rivers	Observatory Point	Morse Creek	North Beach
Gobiesox maeandricus	o	o	o	o	o	o
Artedius fenestralis		*		*		*
A. harringtoni				*		
A. lateralis	o	o	o	o	o	*
Ascelichthys rhodorus	o	o	o	o	o	o
Blepsias cirrhosus				*		
Clinocottus acuticeps	o	o	o	o	o	o
C. embryum	o	o		o		*
C. globiceps	o	o		o	*	*
Enophrys bison			*	*		*
Hemilepidotus hemilepidotus	*	*				
Oligocottus maculosus	o	o	o	o	o	o
O. rimensis	o	o		o	*	*
O. snyderi	o	o	*	o	*	
Anoplarchus purpurescens	o	o	o	o	o	o
Phytichthys chirus	o	o		o		
Xiphister atropurpureus	o	o	o	o	*	*
X. mucosus	o	o	o	o	*	
Apodichthys flavidus	o	o	o	o	o	*
Pholis laeta	o	o	o	o	o	o
P. ornata				*		
Liparis florae	o	o	o	o	o	*
L. cyclopus		*	*	*		*
L. rutteri					*	

Appendix 4b. Density of intertidal fish: Above, density of fish in tidepools (fish/m^2); below, density of fish beneath rocks (fish/rock), 1977.

Month	Neah Bay	Slip Point	Twin Rivers	Observatory Point	Morse Creek	North Beach
Feb	--	13.0	23.2	28.0	20.0	--
	--	1.6	1.1	12.0	1.0	--
Apr	--	15.2	51.1	27.5	14.9	--
	--	1.6	2.1	6.8	2.1	2.9
May	65.8	11.9	43.3	23.3	7.5	3.0
	--	2.1	0.9	2.6	2.2	0.9
July	--	17.8	21.1	18.8	34.4	14.1
	--	3.5	2.5	2.5	1.4	0.1
Aug	1.3	27.9	23.3	47.8	35.0	7.2
	--	1.7	--	5.7	4.6	0.6
Nov	--	24.9	16.7	60.7	10.7	20.3
	--	6.7	0.5	3.9	1.8	0.5

Appendix 4c. Standing crop of intertidal fish: Above, standing crop of tidepool fish (g/m^2); below, standing crop of fish beneath rocks (g/rock), 1977.

Month	Neah Bay	Slip Point	Twin Rivers	Observatory Point	Morse Creek	North Beach
Feb	--	29.4	33.7	31.9	32.1	--
	--	10.9	3.6	28.8	2.9	--
Apr	--	21.9	60.8	48.6	25.9	--
	--	12.4	12.7	17.1	10.5	9.4
May	107.0	31.5	62.9	41.5	11.3	10.4
	--	12.4	5.6	10.2	12.8	3.7
July	--	80.9	25.8	44.0	98.2	30.0
	--	16.0	29.2	10.0	2.2	0.4
Aug	1.5	47.2	6.8	73.5	92.2	4.4
	--	8.2	--	19.2	33.8	3.0
Nov	--	79.5	29.4	66.1	11.9	64.6
	--	10.7	2.5	9.3	5.0	0.9

APPENDIX 5

SUMMARY OF MACROINVERTEBRATES COLLECTED INCIDENTAL TO BEACH SEINE AND TOWNET COLLECTIONS

Appendix 5a. Macroinvertebrates collected coincidentally with nearshore fish surveys in the Strait of Juan de Fuca, May 1977 - February 1978. Sites are indicated by A = Alexander's Beach, B = Beckett Point, D = Dungeness Spit, J = Jamestown, K = Kydaka Beach, M = Morse Creek, P = Pillar Point, PW = Point Williams, T = Twin Rivers, W = West Beach. (Note: Jamestown and Point Williams are equivalent sites.)

SPECIES (148 total)	BEACH SEINE (92 spp)	TOWNET (95 spp)
Phylum Cnidaria		
Class Hydrozoa		
Aequorea aequorea	D	D,PW,P
Aurelia aurita	M	
Cyanea capillata	K	M
Gonionemus vertens	J	P
Polyorchis penicillatus		P
Unidentified jellyfish	T	M,B,A,W
Unidentified hydroids		P
Phylum Ctenophora		
Beröe spp.		P,M
Pleurobranchia spp.	B	B,K,A,W
Unidentified ctenophore		T,A
Phylum Nemertinea		
Unidentified nemertean		PW
Phylum Mollusca		
Class Gastropoda		
Aglaja diomedia	B	
Calliostoma ligatum		K
Collisella instabilis		P
Collisella pelta	B	
Haminoea spp.	B	
Haminoea virescens		K,M,A,W
Hermissenda crassicornis	B	
Littorina spp.	J,W	
L. planaxis	J,B	
L. scutulata	B	
L. sitkana		A
Melibe leonina	B	D
Notoacmaea persona	J,W	
Notoacmaea scutum	J	
Nudibranch spp.	B,K	
Philine spp.		PW
Pollinices lewisi	K,B	
Pteropod spp.		PW,W
Thais lamellosa	A,W	
Unidentified snail		P
Class Bivalvia		
Clinocardium nuttalli	J,W	P
Mytilus edulis	B	
Tresus capax	B	

Appendix 5a, cont'd

Class Cephalopoda		
Gonatus fabricii		P,PW,A,W
Loligo opalescens		P,PW,A,W
Octopus spp.		A
Phylum Annelida		
Class Polychaeta		
Flabelligera infundibularis		A
Halosydna brevisetosa		P
Lepidasthenia interrupta		K
Nereis verillosa	A	
Nereid spp.	B,J	K,A
Nothria elegans		PW
Phyllodocid spp.	B	
Polychaeta spp.	B,A,W	
Tomopteris septentrionalis		P,M,D,W
Class Hirudinea		
Unidentified leech	B	
Phylum Arthropoda		
Class Crustacea		
Order Mysidacea		
Acanthomysis columbiae		W
Acanthomysis davisi		T,M,PW
A. macropsis		K,P,PW,B,W
A. nephrophthalma		T,PW,B
A. pseudomacropsis	W	
A. sculpta	A,W	K,D
Archaeomysis grebnitzkii	W	K,P,M,D,PW,A,W
A. maculata		D,W,M
Mysid spp.	W	
Mysis oculata		PW
Neomysis awatschenensis		W
N. Kadiakensis		W
N. rayii		R,P,T,M,PW,B,A,W
Order Cumacea		
Unidentified spp.	J	P,T,D,PW,A,W
Order Isopoda		
Dynamenella glabra		P
Dynamenella sheari		P
Gnorimosphaeroma oregonensis	M,W	K,M,D,W
Idotea spp.	W	
Idotea fewkesi	T,W	
Pentidotea aculeata	M	
P. montereyensis	M,J,A,W	A
P. resecata	J,B	K,P,T,M,D,PW,A,W
P. wosnesenskii	T,M,J	P
Rocinela belliceps	M,D,A	K,P,M,PW,B,A,W
Rocinela propodialis		T,D,A
Synidotea angulata		P,PW,B
Synidotea bicuspida	W	A,W
Tecticeps pugettensis		M

Appendix 5a, cont'd

Order Amphipoda		
Amphithöe spp.	W	M
Amphithöe humeralis		K,P
A. lacertosa	J,B,A	
Anonyx laticoxae	K,M,D,J	K,P,M,D,PW,A
Atylus collingi	T	
Atylus tridens	T,M,J,A,W	K,P,M,D,PW,B,A,W
Calliopius spp.	W	
Caprella penantis		T
Gammaridae spp.	K,T,M,J,A,W	K,P,T,M,D,PW,B,A,W
Hyperiidae spp.		D,A
Westwoodilla caecula	W	P,A,W
Order Euphausiacea		
Euphausid spp.		A
Euphausia pacifica		PW,A,W
Thysanoessa raschii		P,D,B,W
T. spinifera		P,T,B,A,W
Order Decapoda		
Callianassa californiensis		PW
C. gigas		PW
Cancer gracilis	B,A,W	
Cancer magister	K,T,M,D,J,B,A,W	
C. oregonensis	D,B	
C. productus	T,J,B	
Crangonidae spp.		PW
Crangon alaskensis	K,T,M,D,J,B,A,W	K,P,M,D,PW,A,W
Crangon nigricauda	K,T,M,J,B	
Crangon stylirostris	K,T,M,D	
Eualus spp.	B	
Eualus avinus	J,A,W	
Dualus fabricii	W	K,M,PW
Dualus pusiolus		PW
Eualus townsendi	B	
Hemigrapsus oregonensis	T	
Heptacarpus brevirostris	K,T,M,D,J,A	A,W
H. flexus	M,B	K,P,T,M,D,PW,B,A,W
H. kincaidi	B	P,M,PW,A
H. paludicola	J	
H. pictus	J	
H. stimpsoni	B	A
H. stylus	B	T,M
H. taylori	T,J,B,A	T,PW
H. tenuissimus	W	
H. tridens	M	M
Hippolyte clarki	J,B	
Hippolytidae spp.	B	K,P,M,D,PW,B
Lebbeus grandimanus	B	P
Megalops		K,M,D,W
Oregonia gracilis	J,B	
Pagurus beringanus	B	
P. capillatus	J,B	

Appendix 5a, cont'd

P. hirsutisculus	J,B,A,W	
P. granosimanus	J,B,A,W	
Pagurus spp.	M	
Pandalidae spp.	B	K,P,M,D,PW
Pandalus danae	T,M,D,J,B,A	K,M,D,PW,B,W
P. goniurus		K,M,D,A,W
P. montagui tridens	A	P,M,PW,B,A
P. platyceros	B	B
P. stenolepis		M
Pinnotheres pugettensis		P,D
P. taylori		D
Pugettia gracilis	M,J,B,A	D
P. producta	J,B	
P. richii	B,A,W	
Sclerocrangon alata		P,W
Spirontocaris sp.		A
Telmessus cheiragonus	T,J,B	
Upogebia pugettensis	J	
Zoea		T,A,W
Phylum Echinodermata		
Class Asteroidea		
Henricia leviuscula	D	
Leptasterias hexactus	J	
Class Echinoidea		
Dendraster excentricus	W	
Class Ophiuroidea		
Ophiopholis aculeata		P
Phylum Chaetognatha		
Unidentified chaetognaths		P,T,M,PW,A,W
Phylum Bryozoa		
Unidentified bryozoans		K,P

Appendix 5b. Raw abundance and biomass (grams) of macroinvertebrates collected by beach seine and townet in 1977-78.

Site: Kydaka	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Cyanea					1	-[b]										
Pleurobranchia spp.					+	+										
Calliostoma ligatum			1	.04												
Haminoea virescens											1	.07				
Nudibranch spp.					1	.56										
Pollinices lewisi									1	b						
Lepidasthenia interrupta			3	.28												
Nereid spp.															2	.08
Acanthomysis macropsis			3	.03												
A. sculpta			1	.01												
Archaeomysis grebnitzkii											6	.21				
Neomysis rayii			3	.10							4	.08			856	36.66
Gnorimosphaeroma oregonensis											1	.01				
Pentidotea resecata			2	.95							2	.16				
Rocinela belliceps							2	.28								
Amphithoe humeralis							3	.08			17	3.11				
Anonyx laticoxae					14	1.09					2	.16			11	.28
Atylus tridens							2	.04			12	.60				
Gammaridae spp.			6	.07					3	1.16						
Cancer magister	1	.60			33[a]	55.99			39[c]	174.28						
Crangon alaskensis					9	3.45	5	1.28	116	177.08	2	.03			1	.05
C. nigricauda					1	.30										
C. stylirostris	7	10.35			5	6.81										
Eualus fabricii							97	21.09								
Heptacarpus brevirostris					1	.32										
H. flexus											15	3.34			2	.23
Hippolytidae			+	+												
Megalops			2	.06			11	.27								
Pandalidae			2	.03												
Pandalus danae											1	1.42				
P. goniurus											1	1.78				
Unidentified bryozoans			1	.27												
Total	8	10.95	24	1.78	65	68.52	120	23.04	159	352.52	64	10.97	-	-	872	37.38

[a]Immature *C. magister* filled the wings, too numerous to count, size approximately 20-25 mm.
[b]*Cyanea* bell measured 200 mm; not weighed, measured in field (*Pollinices*).
[c]62 *C. magister* were measured but only 39 weighed; 23 were measured in field and released.
+Present, but not enumerated or weighed.

Appendix 5b, cont'd

Site: West Beach	May 1977				August 1977				October 1977				Dec. 1977 - Feb. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Synidotea bicuspida			1	.04											2	.04
Amphithoe spp.	+	+														
Atylus tridens			280	11.76	12	.09	13	.90			15	1.08			117	7.33
Calliopius spp.					1	.01										
Gammaridae	1230	7.19	8	.12							4	.08			23	.69
Westwoodilla caecula	+	+													10	.32
Euphausia pacifica															25	.73
Thysanoessa raschii			20	1.35												
T. spinifera			104	8.60			1	.08			1	.07			15	.96
Cancer gracilis					1	10.50										
C. magister	10	13.37			1	.68							3	46.75		
Crangon alaskensis	16	8.92	7	3.08	23	10.29							16	13.15	68	7.85
Eualus avinus	10	6.26														
E. fabricii	1	.61														
Heptacarpus brevirostris															16	.74
H. flexus											14	-				
H. tenuissimus	1	.21														
Megalops			+	+	6	.14										
Pagurus hirsutiusculus													1	.61		
P. granosimanus					1	1.54										
Pandalus danae											1	-				
P. goniurus											1	-			1	1.86
Pugettia richii					2	4.10										
Sclerocrangon alata															2	.08
Zoea			+	+												
Dendraster excentricus	1	53.55														
Chaetognath			+	+												
Total	1402	90.76	684	34.48	90	68.57	19	3.22			77	23.39	20	60.51	401	30.54

+Present but not quantified.

Appendix 5b, cont'd

Site: West Beach	May 1977				August 1977				October 1977				Dec. 1977 - Feb. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Jellyfish			+	+												
Pleurobranchia sp.							2	.56								
Haminoea virescens			1	.24											2	.45
Littorina spp.	107	.04														
Notoacmaea persona					1	.15										
Pteropod											1	.15				
Thais lamellosa					3	34.07										
Clinocardium nuttalli					1	5.85										
Gonatus fabricii							1	1.16								
Loligo opalescens											6	18.89			1	3.72
Polychaeta	1	-														
Tomopteris septentrionalis															1	.02
Acanthomysis columbiae							1	.06								
A. macropsis			8	.44												
A. pseudomacropsis					1	.02										
A. sculpta	10	.19			35	.66										
Archaeomysis grebnitzkii	1	.06			1	.03									43	1.78
A. maculata			102	2.64												
Mysid	33	.18														
Neomysis awatschensis											7	.43				
N. kadiakensis			120	5.08												
N. rayii			32	1.00							24	1.31			70	2.92
Cumacean			+	+												
Gnorimosphaeroma oregonensis	1	.15													2	.06
Idotea sp.	3	.01														
Idotea fewkesi	1	.02														
Pentidotea montereyensis					1	.50										
P. resecata			1	.13												
Rocinela bellicepa							1	.46			3	1.38			3	.78

Appendix 5b, cont'd

Site: Alexander Beach	May 1977				August 1977				October 1977				Dec. 1977 - Feb. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Cancer gracilis					2	9.93										
C. magister					6	11.70							2	19.14		
Crangon alaskensis	3	1.16	21	15.33	70	25.56	3	.79	30	12.41	1	.23	28	14.88	7	1.11
Eualus avinus					5	1.10										
Heptacarpus brevirostris													46	19.24	2	.17
H. flexus											2	.96				
H. kincaidi											1	.52				
H. stimpsoni											1	.11				
H. taylori									5	2.00			2	2.61		
Pagurus hirsutiusculus	3	27.70											2	1.75		
P. granosimanus	2	2.35			1	.31							4	10.77		
Pandalus danae					2	.94										
P. goniurus							8	3.84								
P. montagui tridens			2	1.98			1	.46	4	18.33	11	18.58				
Pugettia gracilis									1	.47						
P. richii					3	.18										
Spirontocaris spp.							1	.05								
Zoea			+	+												
Chaetognaths			+	+												
Total	10	31.23	1627	131.50	103	115.47	130	41.12	58	34.69	89	24.53	87	71.23	283	28.67

+Present but not enumerated

Appendix 5b, cont'd

Site: Alexander Beach	May 1977				August 1977				October 1977				Dec. 1977 - Feb. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Jellyfish			+	+												
Pleurobranchia sp.							100	23.73								
Ctenophora											2	-				
Haminoea virescens															1	.42
Littorina sitkana			7	.88												
Thais lamillosa					4	63.11										
Gonatus fabricii			1	29.61												
Loligo opalescens							1	9.79								
Octopus spp.															1	.29
Flabelligera infundibularis			1	.32												
Nereis vexillosa													1	2.68		
Nereid															1	.26
Polychaeta									1	.26						
Acanthomysis sculpta	1	-														
Archaeomysis grebnitzkii											3	.07			12	.31
Neomysis rayii			2	.06			1	.10			3	.12			9	.35
Cumaceans											1	.02				
Pentidotea montereyensis					5	2.24									2	.08
P. resecata															1	.31
Rocinela belliceps			3	1.05			3	.75					1	.08	1	.03
R. propodialis							2	.66								
Synidotea bicuspida			5	.16												
Westwoodilla caecula															3	.06
Amphithoe lacertosa					5	.40										
Anonyx laticoxae											1	.04			155	14.53
Atylus tridens			1560	81.80			11	.95	17	1.22	56	3.80	1	.08	41	9.13
Gammaridae	1	.02	25	.31							4	.04			2	.32
Hyperiidae											1	.02			1	.04
Euphausiid											2	.02				
Euphausia pacifica															41	1.11
Thysanoessa spinifera															3	.15

Appendix 5b, cont'd

Site: Beckett Point	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Cancer oregonensis					3	-										
C. productus	1	-			9(3)*	78.73			2	140.20						
Crangon alaskensis	14	23.95			1	1.16			13	12.75			42	40.33		
C. nigricauda	3	1.78														
Eualus spp.	14	6.98														
E. townsendi	1	.24														
Heptacarpus flexus											41	12.60	3	1.26		
H. kincaidi	9	.81							2	.31			1	.08		
H. stimpsoni					8	.87										
H. stylus													1	.22		
H. taylori									8	5.76			7	1.27		
Hippolyte clarki	150	11.98														
Hippolytidae			2	.01					+	+						
Lebbeus grandimanus	1	.01							1	.14						
Oregonia gracilis					9	.94										
Pagurus beringanus													3	97.20		
P. capillatus													1	.11		
P. hirsutiusculus	10	3.21			1	.21			1	1.44			14	6.96		
P. granosimanus	7	.98			2	1.80										
Pandalidae									+	+						
Pandalus danae					66	77.70			182	580.86	7	9.38	2	7.60		
P. montagui tridens											11	23.20				
P. platyceros									59	220.80	2	9.81				
Pugettia gracilis									4	8.10			1	1.02		
P. producta	4	18.45							1	3.50			8	22.68		
P. richii					3	.21										
Telmessus cheiragonus					55(52)*	135.12			25	306.00						
Total	274	112.70	151	6.77	110	318.85	1	.36	308	1419.88	9501	823.39	94	314.93		

*Telmessus: 55 caught but only 52 weighed = 135.12g. C. productus: 9 caught but only 3 weighed.
+Present but not enumerated.

Appendix 5b, cont'd

Site: Beckett Point	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Jellyfish			50	3.18												
Pleurobranchia sp.	15	6.89	50	2.04												
Aglaja diomedia	2	.56														
Collisella pelta	1	.06														
Haminoea spp.	3	.29														
Hermissenda crassicornis	2	2.91														
Littorina planaxis	10	.18														
L. scutulata	1	.05														
Melibe leonina	1	19.67														
Nudibranch									1	2.16						
Pollinices lewisi													4	-		
Mytilus edulis	1	.02														
Tresus capax													2	92.61		
Nereid	2	.11														
Phyllodocid	1	.02														
Polychaeta	2	.03														
Leech	1	.02														
Acanthomysis macropsis			5	.06												
A. nephrophthalma			1	.02												
Neomysis rayii											9440	768.40				
Pentidotea resecata	8	3.75							3	1.26			3	.46		
Rocinela belliceps							1	.36								
Synidotea angulata			1	.03												
Amphithoe lacertosa					2	.13										
Atylus tridens			10	.64												
Gammaridae			7	.10												
Thysanoessa raschii			20	.44												
Thysanoessa spinifera			5	.24												
Cancer gracilis	10	9.75			3	1.79			2	136.60						
Cancer magister					8	20.19			4	-			2	43.13		

Appendix 5b, cont'd

Site: Jamestown BS Point Williams TN	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Euphausia pacifica															4	.17
Callianassa californiensis											1	2.05				
C. gigas			5	2.62												
Cancer magister					2	2.65			37	289.44			16	14.97		
C. productus	1	-			1	-			3	-			1	4.22		
Crangonidae			+	+												
Crangon alaskensis	1	.57	10	3.93	3	1.51			67	101.92	1	1.53	66	50.38	2	1.25
C. nigricauda	1	4.23														
Eualus avinus	27	16.36														
E. fabricii							1	.11								
E. pusiolus							1	.04								
Heptacarpus brevirostris									30	25.09			30	18.60		
H. flexus											82	45.62	2	.31		
H. kincaidi											3	1.71				
H. paludicola					1	.24										
H. pictus	2	.22														
H. taylori			1	.19	47	14.88					3	1.76				
Hippolyte clarki	10	1.14														
Hippolytidae			+	+			3	.58								
Oregonia gracilis	1	.44			4	1.01										
Pagurus capillatus													1	2.04		
P. hirsutiusculus	1	1.95			4	21.02			5	8.13			5	6.76		
Pagurus granosimanus	1	.14														
Pandalidae			+	+												
Pandalus danae					64	58.80			2	6.40	37	72.27				
P. montagui tridens							1	1.20			25	49.36				
Pugettia gracilis	23	26.77			14	17.37			1	2.53			7	3.88		
P. producta	1	23.73														
Telmessus cheiragonus	9	145.77			1	13.78			16(2)[a]	6.18			1	8.60		
Upogebia pugettensis					1	1.04										
Leptasterias hexactus													1	2.01		
Chaetognaths			+	+												
Total	93	227.52	207	31.94	164	201.73	15	3.67	166	440.36	183	192.22	137	112.38	48	2.92

+Present but not quantified.
[a]16 were measured but only 2 weighed. The two weighed 6.18.

Appendix 5b, cont'd

Site: Point Williams	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Aequorea aequorea											21	16.34				
Gonionemis vertens					3	2.15										
Nemertean			1	.40												
Littorina spp.	1	.02														
L. planaxis					1	.03										
Notoacmaea persona					2	.07										
N. scutum													2	.17		
Philine spp.											2	.60				
Pteropod															1	.50
Clinocardium nuttalli					1	65.88							1	-		
Gonatus fabricii			5	11.48												
Loligo opalescens							2	1.23								
Nereid									1	.28						
Nothria elegans			1	.11												
Acanthomysis davisi			1	.01												
A. macropsis			5	.06			2	.02								
A. nephrophthalma			1	.01												
A. pseudomacropsis															2	.10
Archaeomysis grebnitzkii			5	.19												
Mysis oculata			1	.03												
Neomysis rayii			1	.04			1	.03								
Cumaceans	+	+	+	+												
Pentidotea montereyensis					1	.19			1	.13			2	.20		
P. resecata	9	6.03	1	.14											1	.07
P. wosnesenskii					3	.80										
Rocinela bellicepe			1	.07											1	.54
Synidotea angulata															3	.12
Amphithoe lacertosa					2	.05										
Anonyx laticoxae													1	.20	33	8.10
Atylus tridens	1	.11	52	3.05	6	.24	1	.05	1	.13	3	.41				
Gammaridae	4	.04	116	2.02	3	.02	3	.41	2	.13	5	.57	1	.04	1	.17

Appendix 5b, cont'd

Site: Dungeness Spit	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Aequorea aequorea					1	-					26	16.02				
Melibe leonina											1	1.79				
Tomopteris septentrionalis			1	.03												
Acanthomysis sculpta			60	.83												
Archaeomysis grebnitzkii			45	3.33			1	.06			202	9.90				
A. maculata			398	13.54												
Cumaceans			3	.03												
Gnorimosphaeroma oregonensis			10	.37			3	.24								
Pentidotea resecata							1	.25								
Rocinela belliceps													1	.31		
R. propodialis			2	.09												
Anonyx laticoxae			1	.04									15	5.31	4	.99
Atylus tridens			43	1.85			1	.09			32	6.18				
Gammaridae			12	.21							51	4.36				
Hyperiidae											1	.01				
Thysanoessa raschii			7	.17												
Cancer magister					42(29)	41.10*							33	156.87		
C. oregonensis					1	.04										
Crangon alaskensis	8	12.49	13	6.64	68	127.4	11	5.07			45	21.23	120	184.29	9	5.81
C. stylirostris	5	11.29			3	.75										
Heptacarpus brevirostris													3	2.77		
H. flexus											337	29.97			3	1.38
Hippolytidae			+	+												
Megalops			+	+			8	.13								
Pandalidae			+	+												
Pandalus danae	3	3.79			51	169.2					74	153.24				
P. goniurus											2	3.80				
Pinnotheres pugettensis							3	.18								
P. taylori			6	.17												
Pugettia gracilis											1	10.12				
Henricia leviuscula					4	16.97										
Total	16	39.06	541	27.30	170	355.46	28	6.02			772	256.62	172	349.55	16	8.18

*29/41 were weighed, therefore, 29 weighed 41.10g.
+Present but not quantified.

Appendix 5b, cont'd

Site: Morse Creek	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Hippolytidae			1	.04												
Megalops			2	.10												
Pagurus spp.									1	.10						
Pandalidae			√	√												
Pandalus danae									4	31.98	11	28.46				
P. goniurus											4	3.96				
P. montagui tridens											22	39.08				
P. stenolepis			10	.20												
Pugettia gracilis					1	1.68			1	3.79						
Chaetognaths			14	1.46												
Total	16	27.81	227	10.05	27	4.71	52	8.29	114	144.19	412	139.50	181	336.72		

√Present but not quantified.
*Measured in field and released, not weighed.
+31/37 were weighed. 31 weighed 49.95g.; 45/51 weighed, 45 weighed 175.79.

Appendix 5b, cont'd

Site: Morse Creek	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Aurelia aurita					4	2.03										
Cyanea capillata			1	.62												
Jellyfish			✓	✓												
Beroe spp.			4	.28												
Haminoea virescens											1	.72				
Tomopteris septentrionalis			3	.08												
Acanthomysis davisi			4	.05												
Archaeomysis grebnitzkii			71	2.94							52	1.46				
A. maculata			17	.39												
Neomysis rayii											29	.50				
Gnorimosphaeroma oregonensis			1	.02					6	.88						
Pentidotea aculeata									4	2.65						
P. monteyensis													2	.37		
P. resecata			7	1.75							12	3.40				
P. wosnesenskii					1	.66										
Rocinela belliceps							1	.05	2	.60	2	.73				
Tectoceps pugettensis			1	.03												
Amphithoe spp.											1	.02				
Anonyx laticoxae			1	.11					2	.27	43	5.97				
Atylus tridens			51	1.38	4	.22					27	.98				
Gammaridae			38	.47			1	.02	1	.27	12	1.10				
Cancer magister	4	16.50			5	*			37(31)	49.95+			51(45)	175.79+		
Crangon alaskensis					1	1.23			54	52.61	25	20.44	123	157.24		
C. nigricauda	4	2.25														
C. stylirostris	4	9.06			9	*										
Eualus fabricii							50	8.22								
Heptacarpus brevirostris									1	1.12						
H. flexus					2	.63			1	.57	110	28.70	4	2.53		
H. kincaidi											47	16.05				
H. stylus			1	.13												
H. tridens											14	2.99	1	.79		

Appendix 5b, cont'd

Site: Twin Rivers	May 1977				August 1977				October 1977				Dec. 1977 - Jan. 1978			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Jellyfish													2	137.20		
Ctenophore			+	+												
Acanthomysis davisi			1	.01												
A. nephrophthalma			7	.22												
A. pseudomacropsis							2	.04								
Neomysis rayii							7	.28			8640	521.44				
Cumaceans			+	+												
Idotea fewkesi													1	.19		
Pentidotea resecata							1	.04								
P. wosnesenskii					1	.35										
Rocinela propodialis			2	.03												
Atylus collingi					14	.25										
Atylus tridens	2	.21														
Caprella penantis							1	.03								
Gammaridae			9	.14					1	.41						
Thysanoessa spinifera			1	.09												
Cancer magister	4	*			52	*			21	*			2	*		
C. productus					1	*										
Crangon alaskensis	24	31.41			9	4.98			163	198.37			51	128.80		
C. nigricauda					107	69.39										
C. stylirostris	10	16.56			10	2.81										
Hemigrapsus oregonensis									1	5.46						
Heptocarpus brevirostris					1	.21			31	*						
H. flexus			3	1.04							36	15.24				
H. stylus			4	1.49												
H. taylori	1	.70	5	20.17									1	.87		
Pandalus danae									11	20.60						
Telmessus cheiragonus									3	29.02						
Zoea			+	+												
Chaetognaths			+	+												
Total	41	48.88	32	23.29	195	77.99	11	.39	231	253.86	8676	536.68	57	267.06		

*Measured and released, not weighed.

Appendix 5b, cont'd

Site: Pillar Point	May 1977				August 1977				October 1977				Dec. 1977			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
H. kincaidi											4	1.67				
Hippolytidae			1	.02												
Lebbeus grandimanus															1	.28
Pandalidae			4	.07												
Pandalus montagui tridens											1	1.78				
Pinnotheres pugettensis			3	.11												
Sclerocrangon alata															1	.03
Ophiopholis aculeata			1	.84												
Chaetognaths			+	+												
Bryozoans			1[a]	2.88												
Total	-	-	144	11.78	-	-	11	44.82	-	-	78	7.72	-	-	559	85.32

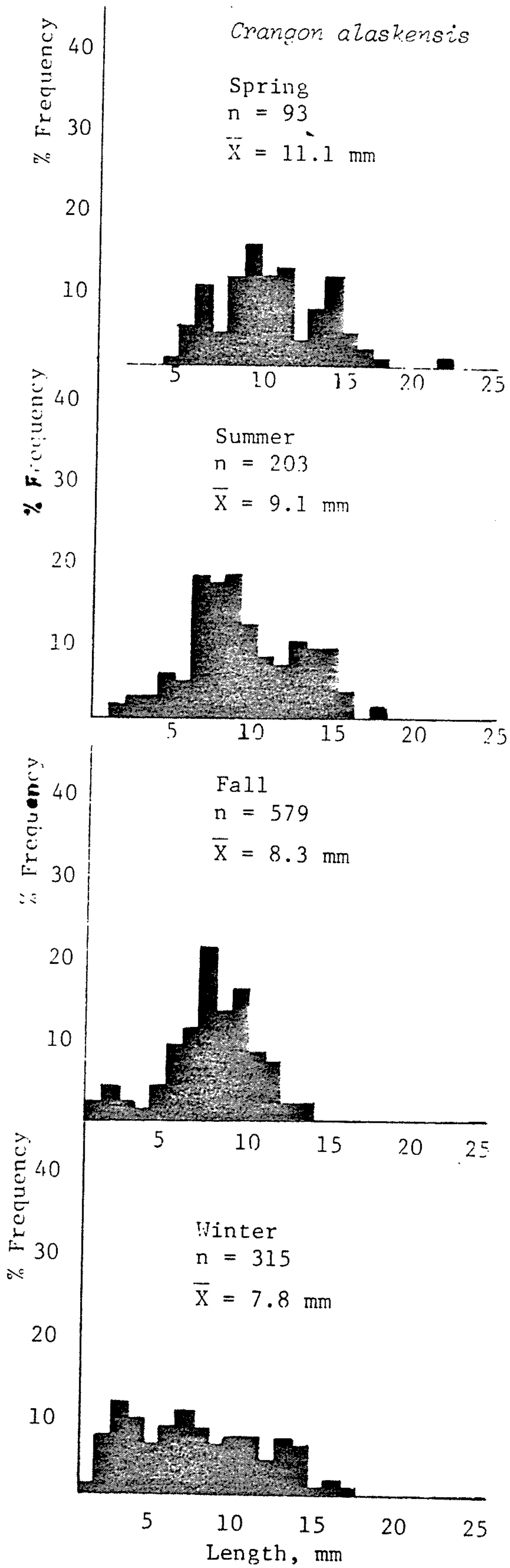
+Present but not quantified.
[a]A clump of organisms was counted as 1.

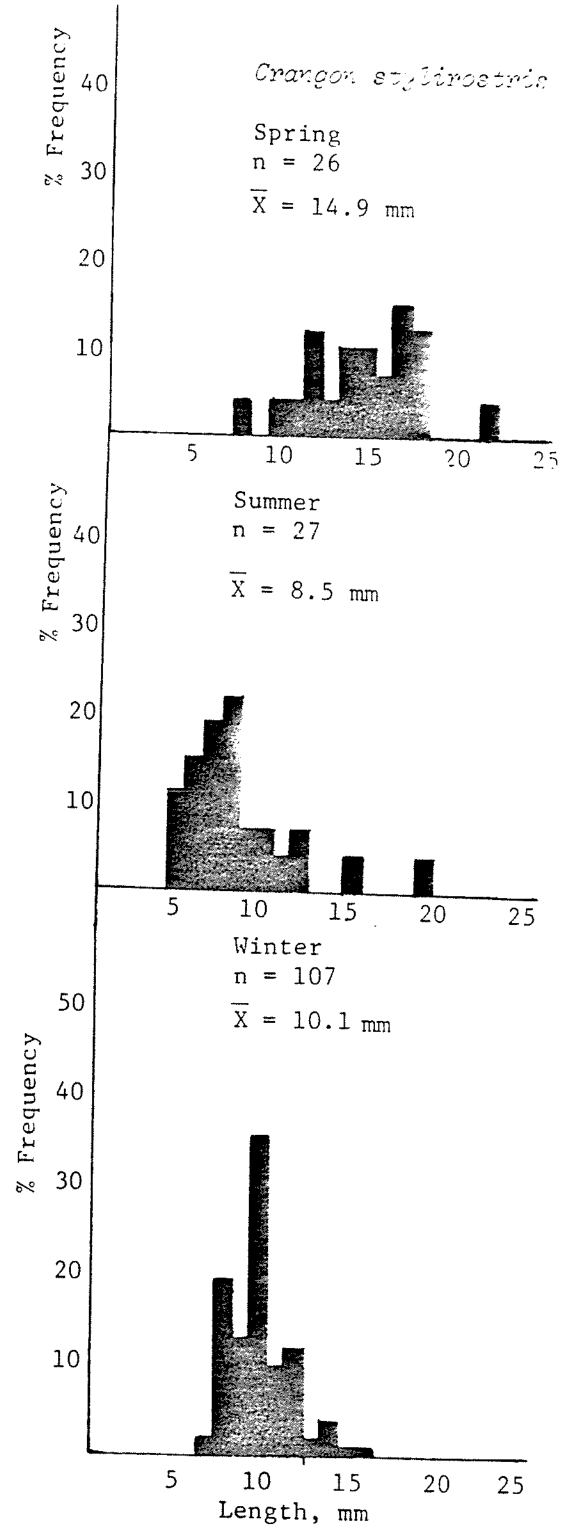
Appendix 5b, cont'd

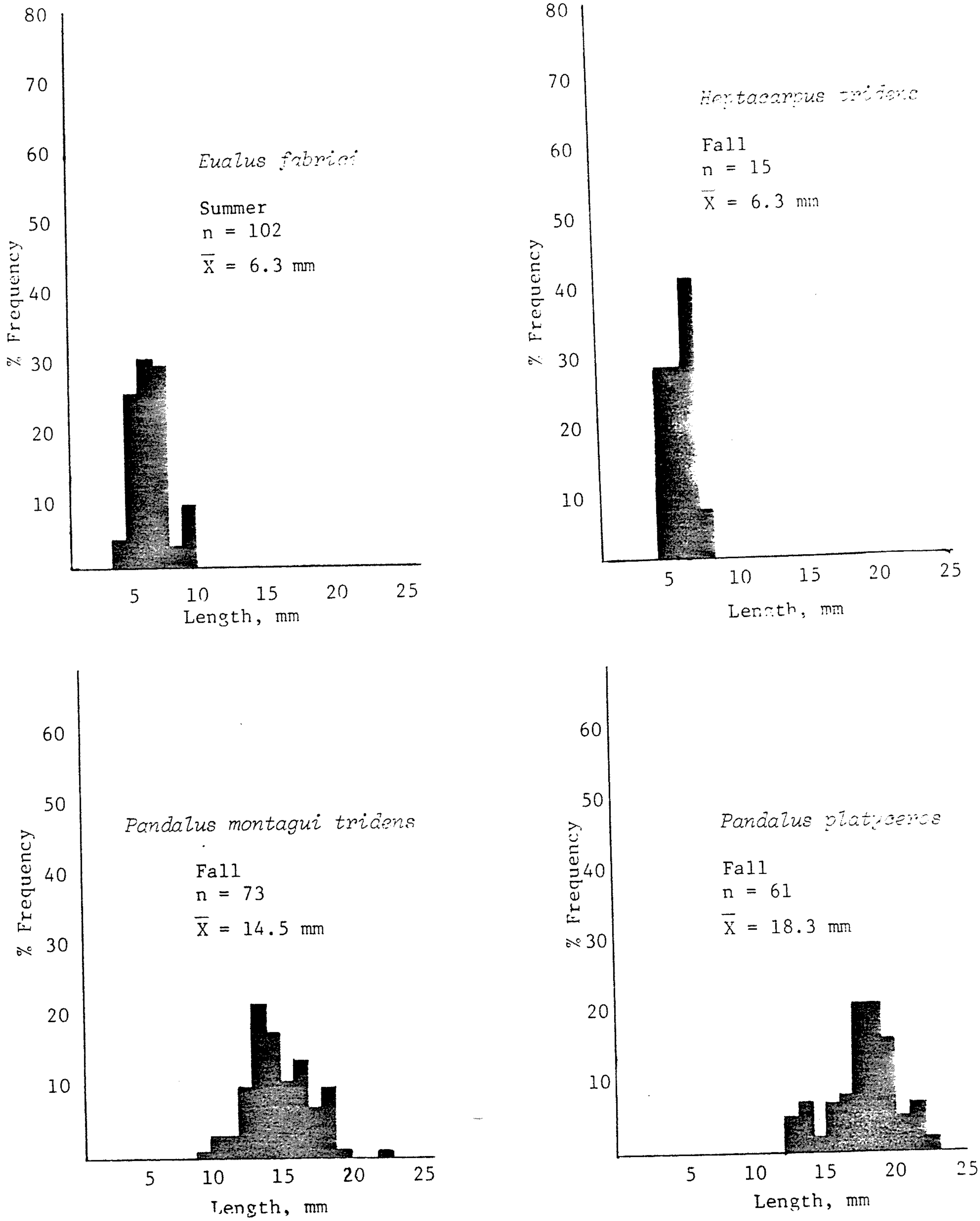
Site: Pillar Point	May 1977				August 1977				October 1977				Dec. 1977			
	Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet		Beach Seine		Townet	
Species	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass
Aequorea aequorea															5	21.50
Gonionemus vertens															191	29.95
Polyorchis penecillatus			1	.18												
Hydroids			1[a]	.55												
Beroe spp.			12	1.15												
Collisella instabilis			1	.22												
Unidentified snail			1	.04												
Clinocardium nuttalli			2	.07												
Gonatus fabricii							10	44.47								
Loligo opalescens											1	1.11				
Halosydna brevisetosa			13	1.94												
Tomopteris septentrionalis			3	.05												
Acanthomysis macropsis			13	.12												
Archaeomysis grebnitzkii											4	.07				
Neomysis rayii			53	1.63			1	.08			22	1.21			248	17.70
Cumaceans			+	+												
Dynamenella glabra			1	.01												
D. sheari											1	.06				
Pentidotea resecata			1	.08							3	.09			1	.03
P. wosnesenskii											1	.09				
Rocinela bellicePs															2	.21
Synidotea angulata															1	.03
Westwoodilla caecula															6	.17
Amphithoe humeralis											9	.41				
Anonyx laticoxae															2	.04
Atylus tridens											10	.03				
Gammaridae			27	.46											12	5.25
Thysanoessa raschi			16	.43												
Thysanoessa spinifera			2	.22											6	.16
Crangon alaskensis			1	.26							17	.61			1	.04
Heptacarpus flexus			1	.45							5	.59			82	17.93

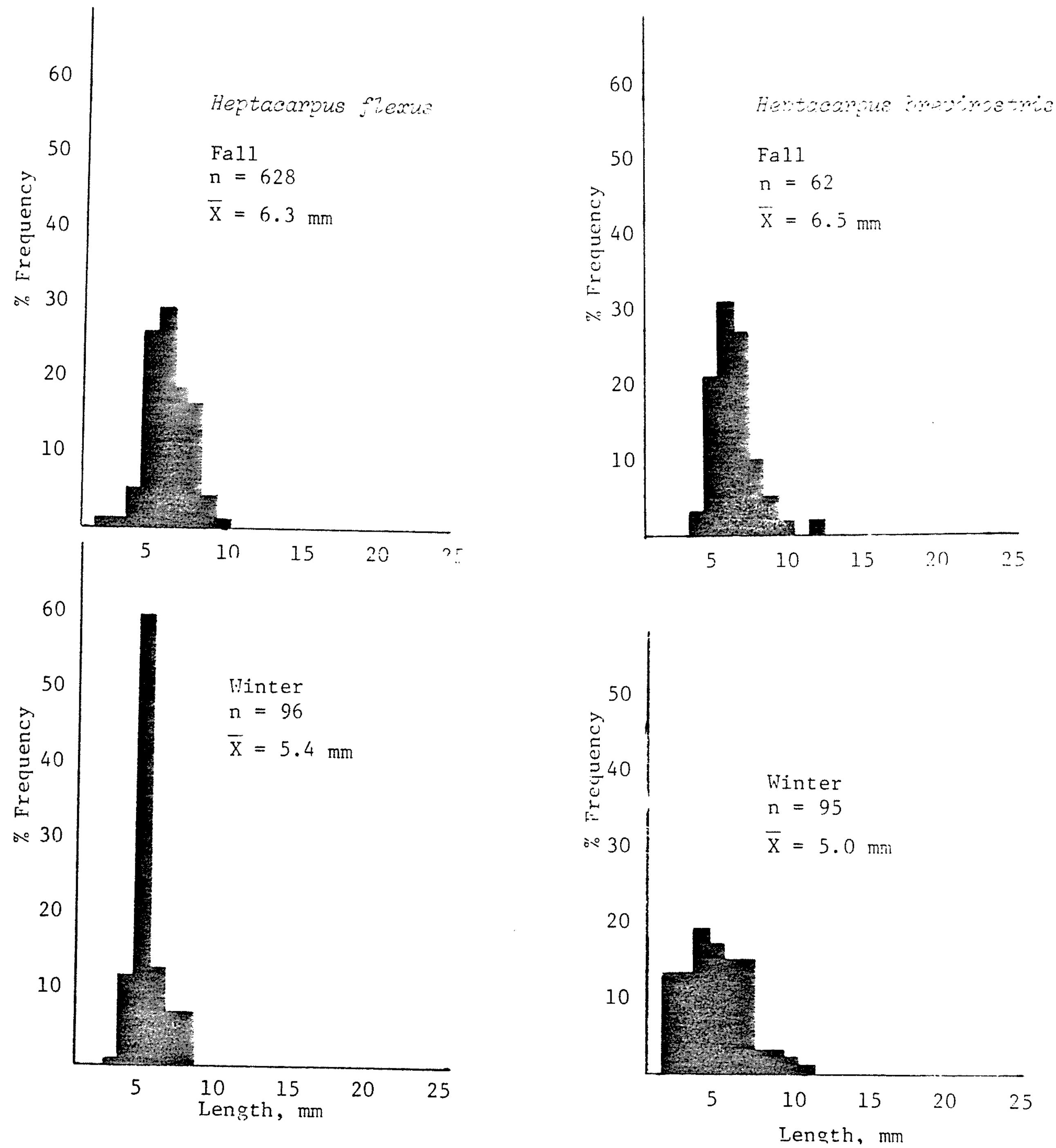
APPENDIX 6

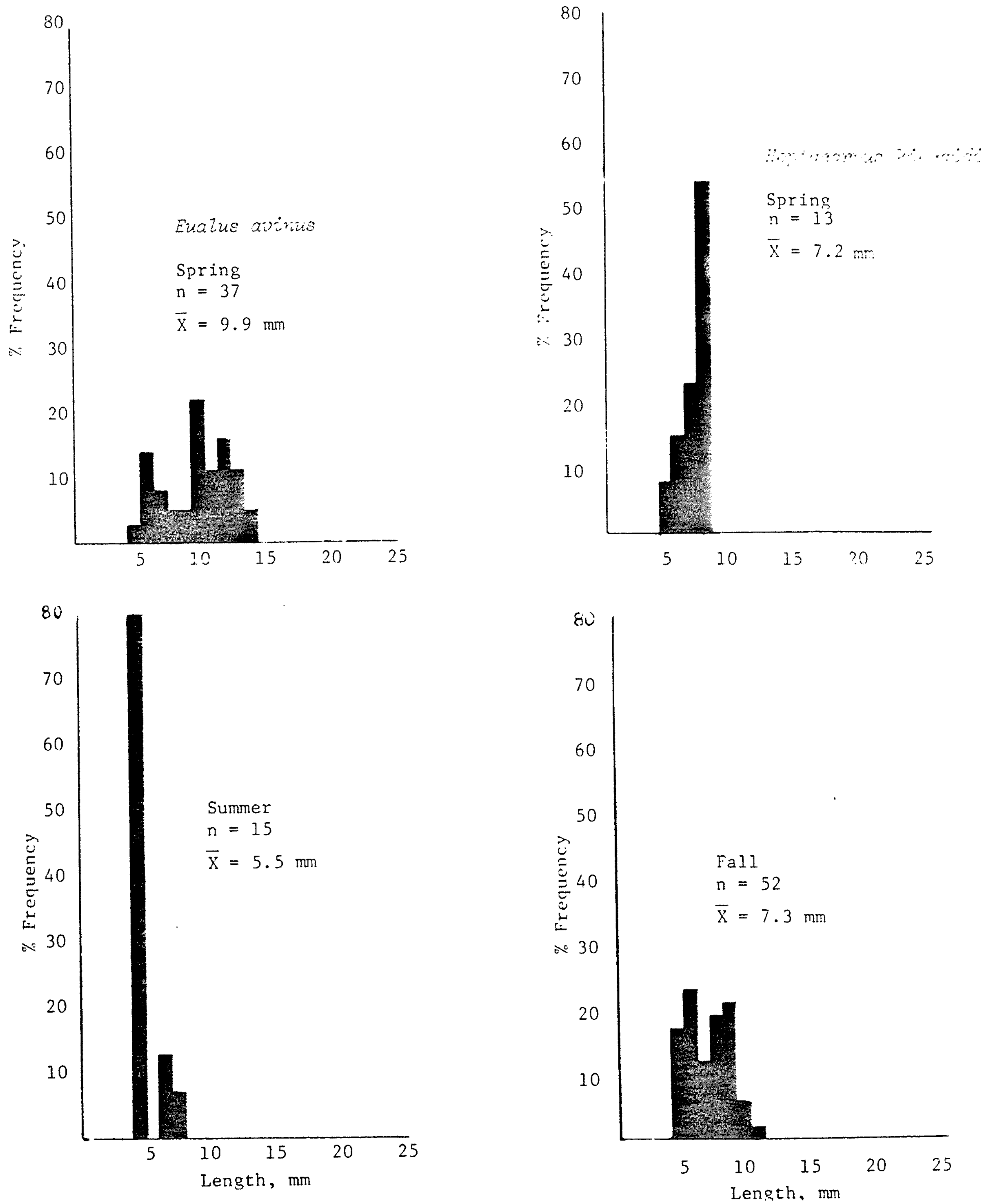
LENGTH FREQUENCIES OF COMMON MACROINVERTEBRATES COLLECTED INCIDENTAL TO BEACH SEINE AND TOWNET COLLECTIONS


Crangon alaskensis
Spring
n = 93
X̄ = 11.1 mm
Summer
n = 203
X̄ = 9.1 mm
Fall
n = 579
X̄ = 8.3 mm
Winter
n = 315
X̄ = 7.8 mm
% Frequency
Length, mm

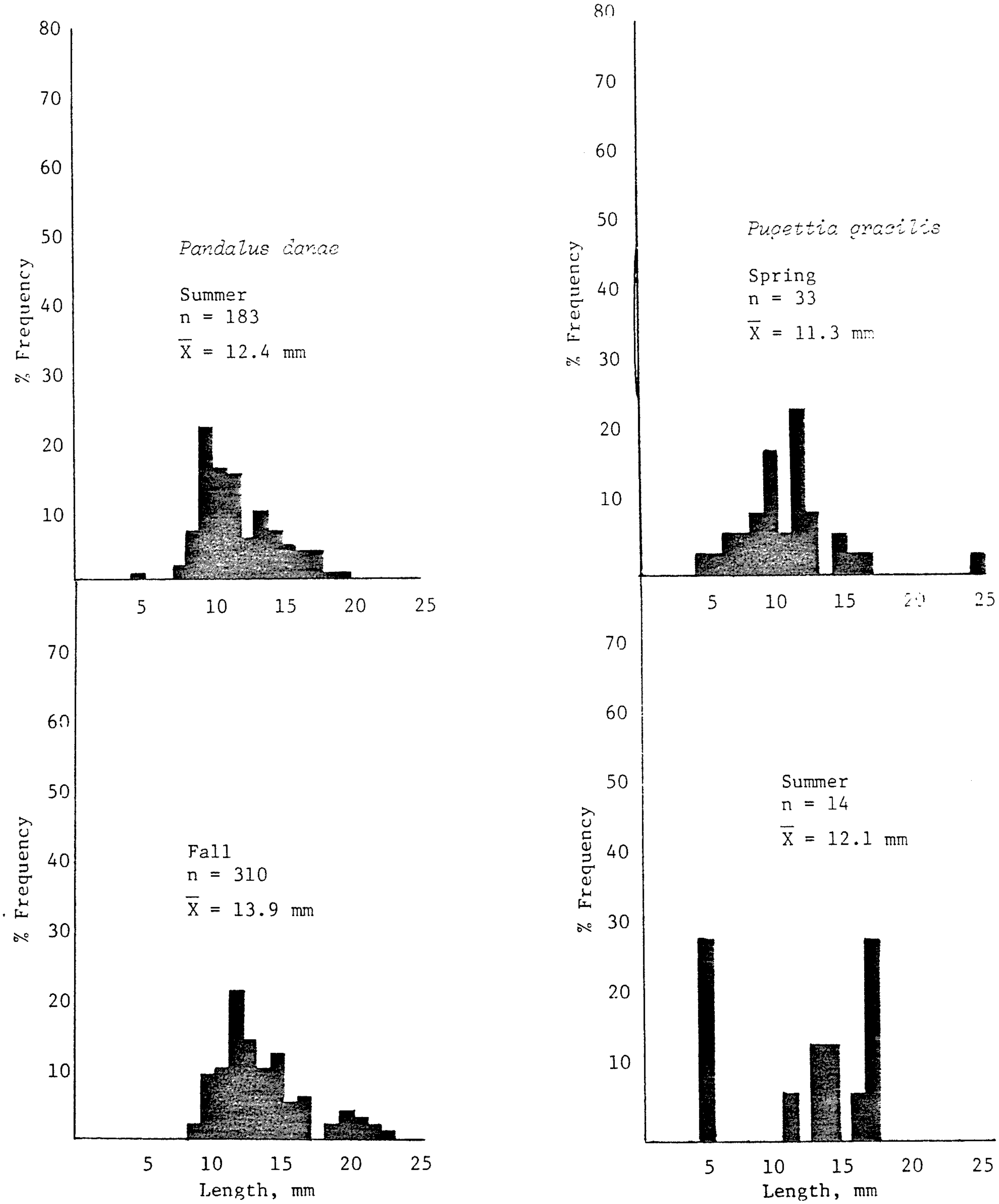

Crangon stylirostris
Spring
n = 26
X̄ = 14.9 mm
Summer
n = 27
X̄ = 8.5 mm
Winter
n = 107
X̄ = 10.1 mm
% Frequency
Length, mm

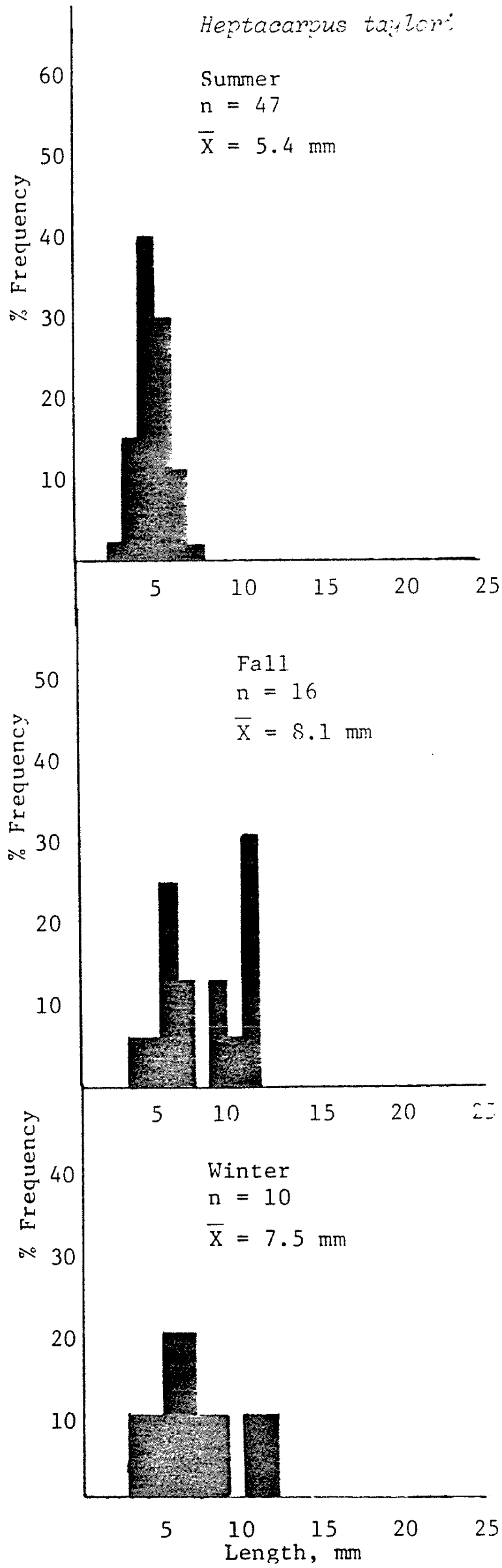

% Frequency
Summer
n = 102
X̄ = 6.3 mm
Length, mm
Fall
n = 15
X̄ = 6.3 mm
Pandalus montagui tridens
Fall
n = 73
X̄ = 14.5 mm
Fall
n = 61
X̄ = 18.3 mm

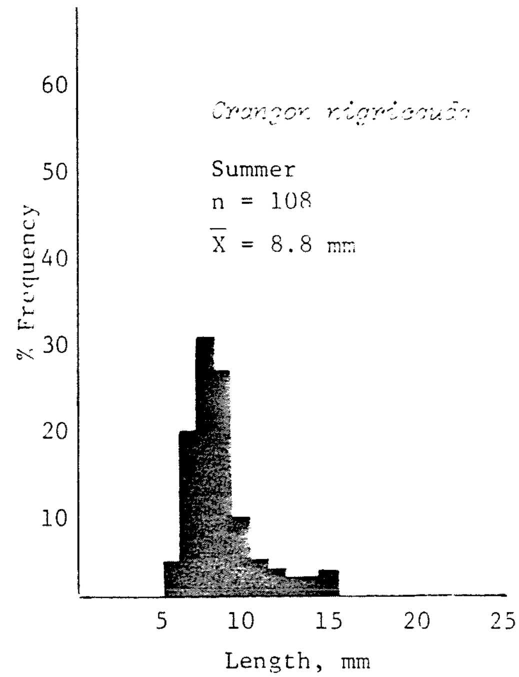

Heptacarpus flexus
Fall
n = 628
X̄ = 6.3 mm
Winter
n = 96
X̄ = 5.4 mm
Heptacarpus brevirostris
Fall
n = 62
X̄ = 6.5 mm
Winter
n = 95
X̄ = 5.0 mm
% Frequency
Length, mm

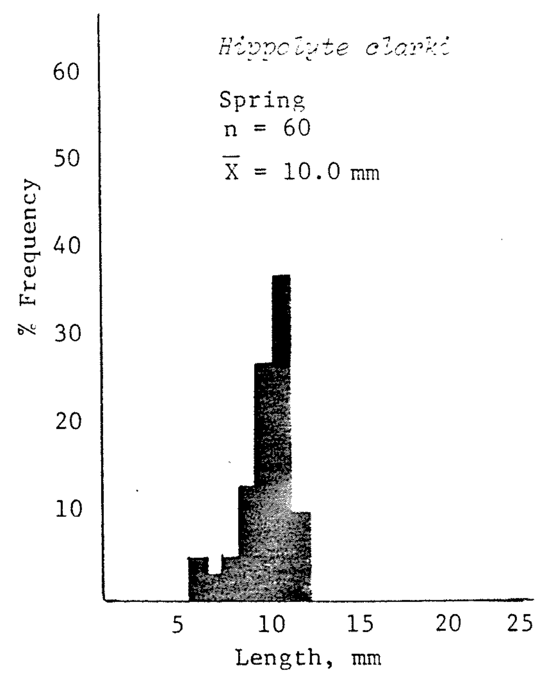


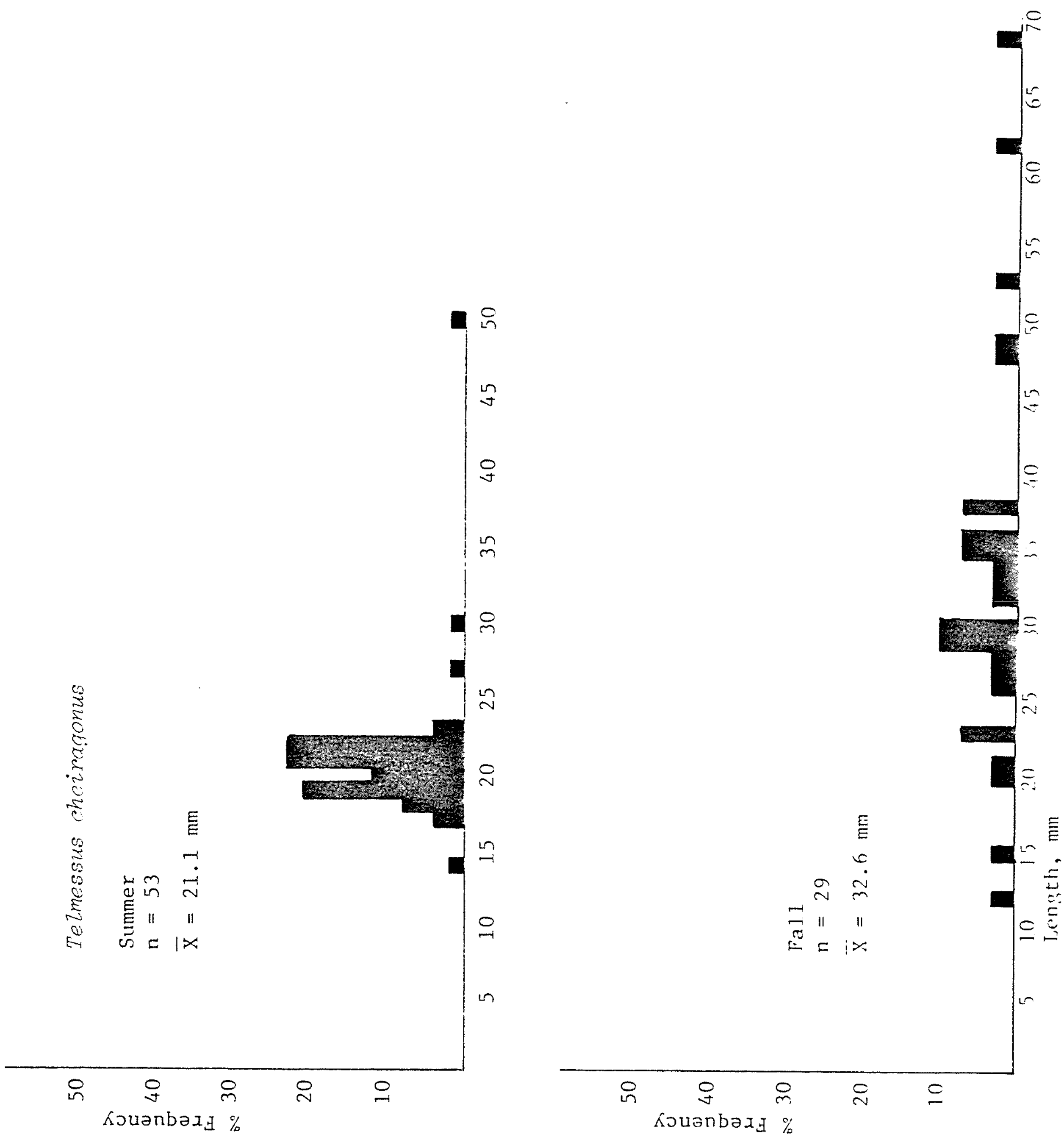
Eualus avinus
Spring
n = 37
X̄ = 9.9 mm
% Frequency
Spring
n = 13
X̄ = 7.2 mm
% Frequency
Summer
n = 15
X̄ = 5.5 mm
% Frequency
Length, mm
Fall
n = 52
X̄ = 7.3 mm
% Frequency
Length, mm

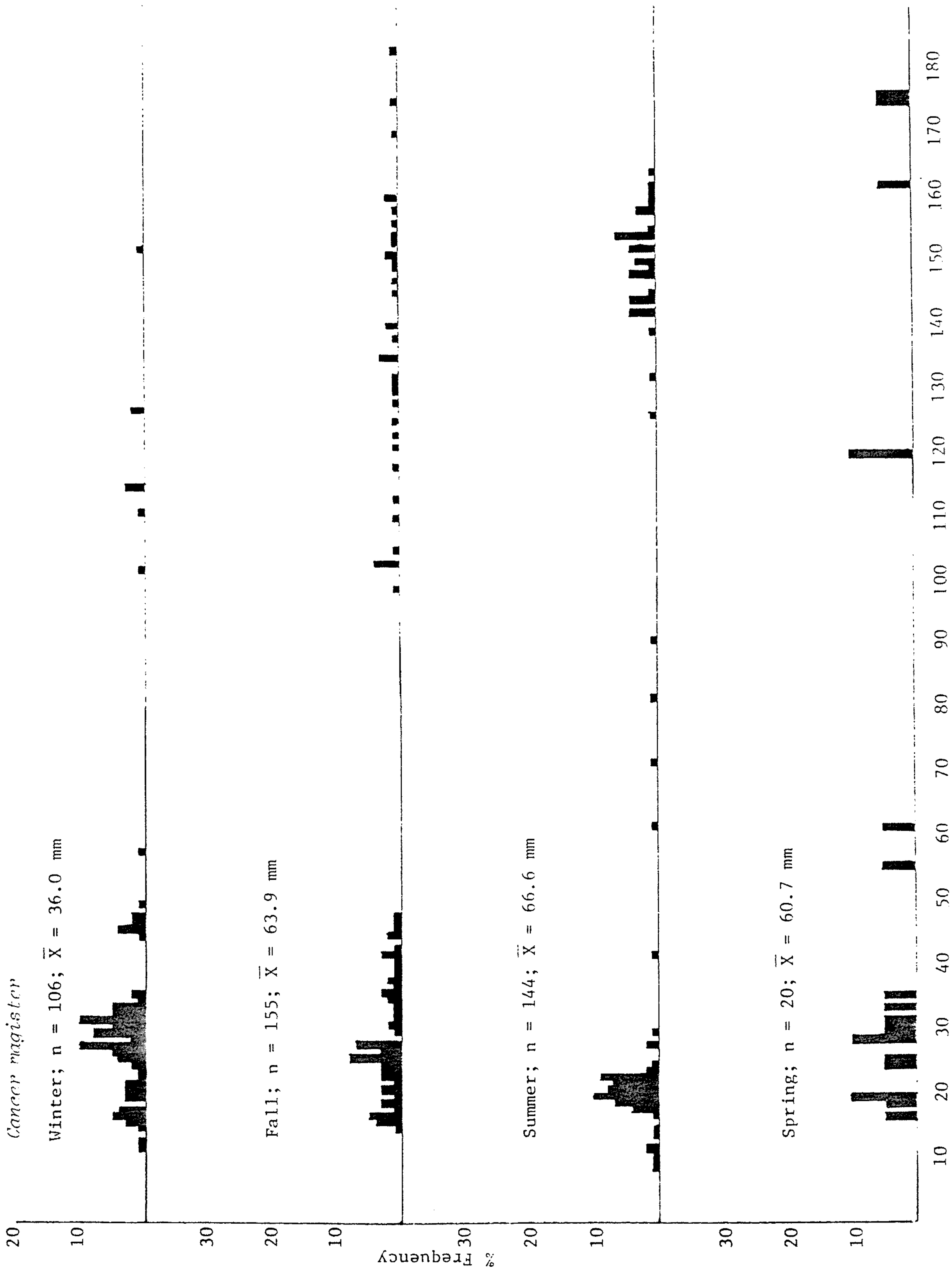

Pandalus danae
Summer
n = 183
X̄ = 12.4 mm
Fall
n = 310
X̄ = 13.9 mm
Pugettia gracilis
Spring
n = 33
X̄ = 11.3 mm
Summer
n = 14
X̄ = 12.1 mm
% Frequency
Length, mm
80
70
60
50
40
30
20
10
5
10
15
20
25


Heptacarpus taylori
Summer
n = 47
X̄ = 5.4 mm
% Frequency
60
50
40
30
20
10
5
10
15
20
25
Fall
n = 16
X̄ = 8.1 mm
Winter
n = 10
X̄ = 7.5 mm
Length, mm


Crangon nigricauda
Summer
n = 108
X̄ = 8.8 mm
% Frequency
Length, mm


Hippolyte clarki
Spring
n = 60
X̄ = 10.0 mm
% Frequency
Length, mm


Telmessus cheiragonus
Summer
n = 53
X̄ = 21.1 mm
Fall
n = 29
X̄ = 32.6 mm
% Frequency
Length, mm



Cancer magister
Winter; n = 106; X̄ = 36.0 mm
Fall; n = 155; X̄ = 63.9 mm
Summer; n = 144; X̄ = 66.6 mm
Spring; n = 20; X̄ = 60.7 mm
% Frequency
Length, mm

APPENDIX 7

SOURCES AND NUMBER OF STOMACH SAMPLES OBTAINED FROM

NEARSHORE FISH COLLECTIONS, 1976-78

Appendix 7. Sources and number of stomach samples obtained from nearshore fish collections, 1976-78.

Species	Beach seine								Tow net									Tidepool										
	Kydaka Beach	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Kydaka Beach	Pillar Point	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Capa Alava	Neah Bay	Slip Point	Tongue Point	Observatory Point	Twin Rivers	Morse Creek	North Beach	Total sample size n	Number (%) empty stomachs	Adjust. sample size n'
Squalus acanthias, spiny dogfish				6																						6	0(0)	6
Raja abyssicola, deepsea skate						1																				1	0(0)	1
R. binoculata, big skate		1																								1	0(0)	1
R. stellulata, starry skate						2																				2	0(0)	2
Hydrolagus colliei, ratfish			1																							1	0(0)	1
Clupea harengus pallasi, Pacific herring juv.	13		6	10		2		1	36	42	70	59	79	94	43	60	49									564	87(15)	477
Engraulis mordax, northern anchovy				3						3	5				1											12	1(8)	11
Oncorhynchus gorbuscha, pink salmon			2									19	4	19	5	1										50	12(24)	38
O. keta, chum salmon	16	1			5	10	14					1		2	14											63	0(0)	63
O. kisutch, coho salmon	1	2	9	1		1									1	2										17	1(5)	16
O. tshawytscha, chinook salmon	7		14									2	4	9	22	5	4									67	0(0)	67
Salmo clarki, cutthroat trout					4																					4	0(0)	4
S. gairdneri, rainbow trout		1	1																							2	1(50)	1

Appendix 7, cont'd

Species	Beach seine								Tow net									Tidepool								Total sample size n	Number (%) empty stomachs	Adjust. sample size n'
	Kydaka Beach	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Kydaka Beach	Pillar Point	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Capa Alava	Neah Bay	Slip Point	Tongue Point	Observatory Point	Twin Rivers	Morse Creek	North Beach			
Hypomesus pretiosus, surf smelt			34	9	4	5	40	3		6	27	3	8	7	2	54	53									255	67(26)	188
Mallotus villosus, capelin																	4									4	0(0)	4
Spirinchus thaleichthys, longfin smelt				3				24		56	33			3			4									123	30(24)	93
Porichthys notatus plainfin midshipman						1																				1	0(0)	1
Gobiesox maeandricus, northern clingfish			4	4															3	57		25	46	63	58	260	32(12)	228
Gadus macrocephalus, Pacific cod juv.						2								2												4	0(0)	4
Microgadus proximus, Pacific tomcod		6	30	18	11	52	19	74			2	4	6	23	26	3	1									275	3(1)	272
Theragra chalcogramma walleye pollock			1	12		23					9		5	26			1									77	3(3)	74
Gasterosteus aculeatus, threespine stickleback					13	18							1		5											37	4(10)	33
Aulorhynchus flavidus, tube-snout			11	4		62					2	10	3		16	1										109	27(24)	82
Syngnathus griseolineatus, bay pipefish						18																				18	1(5)	17
Sebastes melanops, black rockfish											1															1	0(0)	1

Appendix 7, cont'd

Species	Beach seine: Kydaka Beach	Beach seine: Twin Rivers	Beach seine: Morse Creek	Beach seine: Dungeness Spit	Beach seine: Jamestown/Pt. Williams	Beach seine: Beckett Point	Beach seine: Alexanders Beach	Beach seine: West Beach	Tow net: Kydaka Beach	Tow net: Pillar Point	Tow net: Twin Rivers	Tow net: Morse Creek	Tow net: Dungeness Spit	Tow net: Jamestown/Pt. Williams	Tow net: Beckett Point	Tow net: Alexanders Beach	Tow net: West Beach	Tidepool: Capa Alava	Tidepool: Neah Bay	Tidepool: Slip Point	Tidepool: Tongue Point	Tidepool: Observatory Point	Tidepool: Twin Rivers	Tidepool: Morse Creek	Tidepool: North Beach	Total sample size n	Number (%) empty stomachs	Adjust. sample size n'
Hexagrammos decagrammus, kelp greenling					3	1																				4	0(0)	4
H. stelleri, whitespotted greenling					9	37																				46	0(0)	46
Ophiodon elongatus, lingcod						2																				2	0(0)	2
Artedius fenestralis, padded sculpin		62	2	12	16	34	6	6												1		5				144	2(1)	142
A. harringtoni, scalyhead sculpin						2																4				6	0(0)	6
A. lateralis, smoothhead sculpin					1	17												2	9	19		28	5	6	4	91	12(13)	79
Ascelichthys rhodorus, rosylip sculpin		48	4	2		1				1			1						19	59		41	44	28	42	290	14(4)	276
Blepsias cirrhosus, silverspotted sculpin	1	67	39		15	5					1		1		1	1						1				132	0(0)	132
Clinocottus acuticeps, sharpnose sculpin				1	37	1	1				15									25		7		34	18	139	15(10)	124
C. embryum, calico sculpin																				7		12		2	1	22	2(9)	20
C. globiceps, mosshead sculpin																			3		46	40	2	1	1	93	16(17)	77
Enophrys bison, buffalo sculpin		33	1	8	6	50	4	8														5	1		4	120	4(3)	116
Hemilepidotus hemilepidotus, red Irish lord						4																				4	0(0)	4
Leptocottus armatus, Pacific staghorn sculpin	20	36	37	13	60	87	24	23				1				1										302	8(2)	294

Appendix 7, cont'd

Species	Beach seine: Kydaka Beach	Beach seine: Twin Rivers	Beach seine: Morse Creek	Beach seine: Dungeness Spit	Beach seine: Jamestown/Pt. Williams	Beach seine: Beckett Point	Beach seine: Alexanders Beach	Beach seine: West Beach	Tow net: Kydaka Beach	Tow net: Pillar Point	Tow net: Twin Rivers	Tow net: Morse Creek	Tow net: Dungeness Spit	Tow net: Jamestown/Pt. Williams	Tow net: Beckett Point	Tow net: Alexanders Beach	Tow net: West Beach	Tidepool: Capa Alava	Tidepool: Neah Bay	Tidepool: Slip Point	Tidepool: Tongue Point	Tidepool: Observatory Point	Tidepool: Twin Rivers	Tidepool: Morse Creek	Tidepool: North Beach	Total sample size n	Number (%) empty stomachs	Adjust. sample size n'
Myoxocephalus polyacanthocephalus, great sculpin					4	19								1												24	1(4)	23
Nautichthys oculofasciatus, sailfin sculpin																			1							1	0(0)	1
Oligocottus maculosus, tidepool sculpin			81		49	10												1	28	82		106	106		84	547	35(6)	512
O. rimensis, saddleback sculpin																			1	29		60		3	1	94	19(20)	75
O. snyderi, fluffy sculpin		2																	26	34		27	7			96	10(10)	86
Scorpaenichthys marmoratus, cabezon			1			3																				4	0(0)	4
Thyriscus anoplus, sculpin						3																				3	1(33)	2
Chitonotis pugetensis, roughback sculpin						45																				45	6(13)	39
Bathragonus swani, rockhead																									1	1	0(0)	1
Psychrolutes paradoxus, tadpole sculpin					11	1																				12	1(8)	11
Agonus acipenserinus, sturgeon poacher	7		7	1		45		26									1									87	5(5)	82
Ocella verrucosa, warty poacher		7	3	12																						22	0(0)	22
Odontopyxis trispinosa, pygmy poacher						1																				1	0(0)	1

Appendix 7, cont'd

Species	Beach seine								Tow net									Tidepool										
	Kydaka Beach	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Kydaka Beach	Pillar Point	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Capa Alava	Neah Bay	Slip Point	Tongue Point	Observatory Point	Twin Rivers	Morse Creek	North Beach	Total sample size n	Number (%) empty stomachs	Adjust. sample size n'
Pallasina barbata, tubenose poacher	1	15	11	5	4	1																				37	2(5)	35
Eumicrotremis orbis, spiny lumpsucker						1		1																		2	0(0)	2
Liparis agassizi																				1		1				2	1(50)	1
L. callyodon, spotted snailfish					11	1						1														13	0(0)	13
L. cyclopus, ribbon snailfish		15	6		9	3														1		3	2	1	1	41	2(4)	39
L. florae, tidepool snailfish		2	3		9	1													4	13		18	6	30	3	89	2(2)	87
L. mucosus, slimy snailfish	8	5																								13	0(0)	13
L. pulchellus, showy snailfish			3	5	1	1																				10	0(0)	.10
L. rutteri, ringtail snailfish		1	1	3	1																					6	1(17)	5
Brachyistius frenatus, kelp perch						1																				1	0(0)	1
Cymatogaster aggregata, shiner perch			4	7	36	88	30	20				5		1	33	7	2									233	65(27)	168
Embiotoca lateralis, striped seaperch		26	14	4		19									6	6	2									77	18(23)	59
Rhacochilus vacca, pile perch			1		10										18											29	16(55)	13

Appendix 7, cont'd

Species	Beach seine								Tow net									Tidepool								Total sample size n	Number (%) empty stomachs	Adjust. sample size n'
	Kydaka Beach	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Kydaka Beach	Pillar Point	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Capa Alava	Neah Bay	Slip Point	Tongue Point	Observatory Point	Twin Rivers	Morse Creek	North Beach			
Amphisticus rhodoterus, redtail surfperch	14	124	4																							142	0(0)	142
Trichodon trichodon, Pacific sandfish	1								3				1		1		6									12	1(8)	11
Anarrhichthys ocellatus, wolf-eel									1																	1	0(0)	1
Anoplarchus purpurescens, high cockscomb					1														11	88		87	64	78	3	332	57(17)	275
Lumpenus sagitta, snake prickleback						11																				11	0(0)	11
Phytichthys chirus, ribbon prickleback																			3	2		10				15	1(6)	14
Xiphister atropurpureus, black prickleback																			1	102		46	14	3	5	171	39(22)	132
X. mucosus, rock prickleback																		7	2	43		15	29	11		107	20(18)	87
Apodichthys flavidus, penpoint gunnel		19	5	1	11	13												37	8	19			7	11	15	146	58(39)	88
Pholis laeta, crescent gunnel		12	1		8	6					1	3						42	5	3			12	19	16	128	31(24)	97
P. ornata, saddleback gunnel		13			3	11											1					6	1		1	36	4(11)	32
P. schultzi, red gunnel																				1						1	0(0)	1
Ammodytes hexapterus, Pacific sand lance	14	1	10	16	6	4							12			1	7									71	28(39)	43

Appendix 7, cont'd

Species	Beach seine: Kydaka Beach	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Tow net: Kydaka Beach	Pillar Point	Twin Rivers	Morse Creek	Dungeness Spit	Jamestown/Pt. Williams	Beckett Point	Alexanders Beach	West Beach	Tidepool: Capa Alava	Neah Bay	Slip Point	Tongue Point	Observatory Point	Twin Rivers	Morse Creek	North Beach	Total sample size n	Number (%) empty stomachs	Adjust. sample size n'
Citharichthys sordidus, Pacific sanddab	3		1	1		4																				9	0(0)	9
C. stigmaeus, speckled sanddab	14					5																				19	1(5)	18
Eopsetta jordani, petrale sole				1																						1	0(0)	1
Isopsetta isolepis, butter sole	3	9																								12	0(0)	12
Lepidopsetta bilineata, rock sole					5	59		2							1											67	1(2)	66
Microstomus pacificus, Dover sole						1																				1	0(0)	1
Parophrys vetulus, English sole	37	68	41	36	60	75	55	28									1									400	34(8)	366
Platichthys stellatus, starry flounder	12	29	9		42	35	3	3							1		1									135	18(13)	117
Pleuronichthys coenosus, C-O sole					1	19																				20	1(5)	19
Psettichthys melanostictus, sand sole	83	95	67	65	4	2		1																		317	9(2)	308
Total	255	700	469	263	470	922	196	220	40	108	166	108	125	187	196	141	126	89	73	587	46	547	346	290	260	6993	830(12)	6163

APPENDIX 8

RELATIVE TROPHIC IMPORTANCE OF PRINCIPAL PREY TAXA, EXPRESSED AS PERCENTAGE OF THE TOTAL IRI, OF 55 NEARSHORE FISHES COMMON TO THE STRAIT OF JUAN DE FUCA

Appendix 8. Relative trophic importance of principal prey taxa, expressed as percentage of the total IRI, of 55 nearshore fishes common to the Strait of Juan de Fuca. (Column totals may not total 100% due to the elimination of detritus, rocks, and incidental material which originally entered the IRI calculations.)

	Chlorophyta	Ulotrichales	Ulvaceae	Acrosiphoniaceae	Phaeophyta	Desmarestiaceae	Scytosiphonaceae	Rhodophyta	Rhodophyceae-Bangiales	Gigartinaceae	Potamogetonaceae	Hydroida	Ctenophora	Nemertea	Nematoda	Polychaeta	Aphroditidae	Phyllodocidae	Syllidae
Squalus acanthias																			
Clupea harengus pallasi																			
Oncorhynchus gorbuscha													0.3						
O. keta																			
O. kisutch	<0.0															1.9			
O. tshawytscha																1.8			0.2
E. pretiosus											0.1					3.6	0.2		
Spirinchus thaleichthys																0.4			
Gobiesox maeandricus									<0.0							0.3			
Microgadus proximus																1.0			
Theragra chalcogramma																0.2			
Gasterosteus aculeatus																0.3			
Aulorhynchus flavidus																			
Syngnathus griseolin.																			
Hexagrammos stelleri																7.1			
Artedius fenestralis												0.1				15.2			
A. lateralis								<0.0	0.1		0.2					1.6			
Ascelichthys rhod.												<0.0				2.9			
Blepsias cirrhosus																			
Clinocottus acuticeps																			
C. embryum																			
C. globiceps	4.2	25.2		0.2				2.3	0.3	1.0				1.5		0.2			
Enophrys bison	1.8	7.0	18.8					0.4	3.5							15.5		0.1	
Leptocottus armatus																3.2			
M. poly.								0.4											
Oligocottus maculosus														0.1		4.9			
O. rimensis	0.2															0.1			
O. snyderi														0.1		3.3			
Chidontis pugetensis	1.1															4.0			
Agonus acipenserinus																0.7			
Ocella verrucosa																			
Pallasina barbata																			
Liparis callyodon		0.1																	
L. cyclopus																			
L. florae																			
Cymatogaster aggregata		2.5														0.9			
Embiotoca lateralis																0.4			
Rhacochilus vacca																			
Amphisticus rhodoterus																2.6			
Anoplarchus purpurescens	0.8	0.8					<0.0	<0.0	0.9	0.3				43.1		21.4			
Lumpenus sagitta		3.9													49.2	23.2			
Phytichthys chirus						0.3			0.7	0.4						11.0			
Xiphister atropurpureus	0.8	0.2					0.7		5.7	3.8				0.2		3.3			
X. mucosus	6.2	7.9				2.9			14.2	11.3	2.5	0.2		7.0		5.2			
Apodichthys flavidus																0.4			
Pholis laeta														0.9					
P. ornata																1.0			
Ammodytes hexapterus																			
Citharichthys stigmaeus	0.3													0.1		17.2			
Isopsetta isolepis																			
Lepidopsetta bilineata															0.1	74.8			
Parophrys vetulus														0.1		32.0			
Platichthys stellatus																68.1			
Pleuronichthys coenosus												<0.0				82.1			
Psettichthys melanostictus															<0.0				

Appendix 8, cont'd

	Cumacea	Tanaidacea	Anthuridae	Flabellifera	Sphaeromatidae	Valvifera	Idoteidae	Asselota	Munnidae	Gammaridae	Corophiidae	Caprellidae	Hyperiidae	Euphausiacea	Decapoda	Natantia	Hippolytidae	Pandalidae	Crangonidae	Callianassidae	Brachyura Brachyrhyncha	Paguridae	Oxyrhyncha	Majidae	Atelecyclidae
Squalus acanthias					2.7					23.4									11.5						
Clupea harengus pallasi																									
Oncorhynchus gorbuscha	0.2									0.5					<0.0	<0.0									
O. keta	1.1									6.1						1.4									
O. kisutch	2.5				1.8					90.4		<0.0													
O. tshawytscha							0.1			15.6		<0.0				17.2	0.7								
H. pretiosus										1.0			0.1			0.2	0.2								
Spirinchus thaleichthys	5.1				0.4					61.2				0.1		0.2									
Gobiesox maeandricus					34.9		3.4			33.2							<0.0							<0.0	
Microgadus proximus	1.2				0.9					84.3				0.2		1.0	3.5	<0.0	0.7						
Theragra chalcogramma	1.1									15.8				1.0		0.7	8.8	1.3	<0.0		<0.0				
Gasterosteus aculeatus										17.6						0.1									
Aulorhynchus flavidus										0.7						8.3	0.1								
Syngnathus griseolin.		0.6								37.0							5.1								
Hexagrammos stelleri		8.0								60.9		0.2				1.5	5.3		4.0			1.0		2.0	0.8
Artedius fenestralis		0.3			3.3		0.5			51.2	0.1					4.7	10.3		2.0		0.3	0.3			
A. lateralis		0.1			4.5					62.4						0.9	21.6	0.1	0.1			1.5			
Ascelichthys rhod.					20.8		4.3			67.8						0.3	0.1		0.1			0.3	0.1		
Blepsias cirrhosus							0.6			45.4						0.3	0.3		<0.0						
Clinocottus acuticeps					27.6		0.2		0.2	66.7															
C. embryum					20.1					65.9															
C. globiceps					0.1					0.6															
Enophrys bison		1.3			2.8					40.8							0.3			0.1		0.1			0.1
Leptocottus armatus		1.3			0.5					6.9						1.7	1.5	2.4	12.0		1.3				0.5
M. poly.										0.5						0.9	81.6	1.1	1.2						
Oligocottus maculosus		0.1		0.1	25.7		0.2			54.6										<0.0		0.4			
O. rimensis					10.0					74.2						0.1									
O. snyderi		0.9			8.1		1.1			81.6		0.1													
Chidontis pugetensis		0.2								7.3						14.0	44.0	1.0	24.5						
Agonus acipenserinus	36.3				0.2					29.6						2.8	0.3	6.0			0.6				
Ocella verrucosa	0.7									51.5							0.1								
Pallasina barbata	0.1									0.5						0.4									
Liparis callyodon					<0.0		2.3			83.9		1.2					1.1								
L. cyclopus					2.3		0.2			94.1						0.6			0.1			0.2			
L. florae					0.8		3.0			94.1		0.1				<0.0	0.1								
Cymatogaster aggregata	22.4	8.5			5.9		0.7			46.9						0.1				0.2					
Embiotoca lateralis					2.9	0.2	3.5			20.5						0.1							<0.0		
Rhacochilus vacca		2.8	1.0		2.6	5.9	0.9			13.7						1.8					11.5	2.6			
Amphisticus rhodoterus				2.7	8.1	0.3	2.1			70.6								0.1							
Anoplarchus purpurescens					0.6					25.4									0.1						
Lumpenus sagitta	<0.0	16.0								4.8															
Phytichthys chirus		0.1				0.1	0.4	0.2	4.3	78.9		0.1				1.9						0.7			
Xiphister atropurpureus					0.7		0.1	0.1		73.4						0.1									
X. mucosus					0.7		0.6			43.0													<0.0		
Apodichthys flavidus				0.4	0.9	11.9	0.6			55.4						0.4						0.3			
Pholis laeta	0.1	0.3			4.3	1.6	1.5		3.4	80.3									0.1			0.2			
P. ornata					0.2		2.9			75.1															
Ammodytes hexapterus																									
Citharichthys stigmaeus	0.9				0.1	0.1				20.9						14.8			30.7		0.2	0.1			
Isopsetta isolepis	0.1				0.6		1.7			0.1						2.5			5.3						
Lepidopsetta bilineata		3.8	<0.0							12.6		0.1				0.1		<0.0							0.1
Parophrys vetulus	23.9	2.7								28.9						0.1	<0.0		<0.0						<0.0
Platichthys stellatus	0.3	7.6			0.3					17.2														<0.0	
Pleuronichthys coenosus		0.5								2.0															

Appendix 8, cont'd

	Nereidae	Glyceridae	Lumbrineridae	Arenicolidae	Sabellaridae	Terebellidae	Sipunculida	Gastropoda	Acmaeidae	Haminoeidae	Polyplacophora	Ischnochitonidae	Bivalvia	Cardiidae	Octopodiea	Eucarida-Decapoda & Crustacea larvae	Ostracoda	Calanoida	Harpacticoida	Argulidea	Cirripedia	Malacostraca-Phyllocarida	Mysidacea
Squalus acanthias				4.0											37.1								
Clupea harengus pallasi																		96.4	0.7				0.8
Oncorhynchus gorbuscha																0.3	<0.0	49.2	0.5		<0.0		0.1
O. keta																	0.1	21.2	66.2				
O. kisutch																			<0.0				1.4
O. tshawytscha																	3.8	2.0					1.4
H. pretiosus																		80.6	12.7				0.7
Spirinchus thaleichthys	0.1		0.3															6.1			0.2		24.8
Gobiesox maeandricus					0.1			1.5	24.0			0.1					0.4		0.5		0.1		
Microgadus proximus																		0.9	1.2				4.0
Theragra chalcogramma																	0.1	66.9	0.2				3.3
Gasterosteus aculeatus																		39.4	38.5				4.2
Aulorhynchus flavidus																		58.5	26.6				2.7
Syngnathus griseolin.								<0.0									<0.0	0.7	55.1				1.3
Hexagrammos stelleri								0.3					2.3			1.1							
Artedius fenestralis																							0.7
A. lateralis								0.2								0.1			<0.0				
Ascelichthys rhod.																0.2							1.1
Blepsias cirrhosus																							53.3
Clinocottus acuticeps																		0.1	1.9				0.1
C. embryum																0.5			0.2		12.8		
C. globiceps					2.1			0.1									1.5		2.7		42.2		
Enophrys bison										0.1			0.3										
Leptocottus armatus													0.7			1.1							11.7
M. poly.																0.7							0.2
Oligocottus maculosus		<0.0														0.3	0.2		8.2		4.3		0.1
O. rimensis																			14.7	0.1	0.2		
O. snyderi					0.1												0.1		4.4		0.2		
Chidontis pugetensis																2.8			0.7			0.2	0.2
Agonus acipenserinus													<0.0				<0.0		22.9				0.4
Ocella verrucosa																			0.1				47.1
Pallasina barbata																							99.0
Liparis callyodon								<0.0					<0.0					2.7	3.2				0.5
L. cyclopus																							1.6
L. florae																<0.0			1.8				
Cymatogaster aggregata																		1.4	10.0				0.7
Embiotoca lateralis								0.4	0.1							0.2							
Rhacochilus vacca								32.0								5.5							
Amphisticus rhodoterus		<0.0		0.1																			10.7
Anoplarchus purpurescens	0.1	<0.0			1.3	0.5		0.9								1.2			1.3		0.2		
Lumpenus sagitta													2.2			<0.0			0.7		<0.0		
Phytichthys chirus						0.1											0.1		0.6				
Xiphister atropurpureus					7.7	0.1	<0.0	0.1											0.8		0.1		
X. mucosus																			0.1				
Apodichthys flavidus																			10.6				10.2
Pholis laeta																0.1	0.3	<0.0	2.7		0.4		0.3
P. ornata	0.2				8.3			0.5					0.1						0.2				3.0
Ammodytes hexapterus																		97.3					
Citharichthys stigmaeus								0.1					1.6				0.1	0.3					0.3
Isopsetta isolepis																							89.5
Lepidopsetta bilineata								<0.0					6.4	0.8		0.1							
Parophrys vetulus													2.0						8.1				1.5
Platichthys stellatus	0.1												1.4										0.6
Pleuronichthys coenosus								0.8					12.7				<0.0		0.2				
Psettichthys melanostictus																							89.4

	Grapsidae	Lithodidae	Insecta	Diptera	Chilopoda	Coleoptera	Articulata	Echnoidea	Holothuroidea	Larvacea	Urochordata	Osteichthys	Teleostei	Clupeidae	Aulorhynchidae	Scorpaenidae	Cottidae	Stichaeidae	Pholididae	Ammodytidae	Embiotocidae	Cyclopteridae	Pleuronectidae
Squalus acanthias		5.8										6.0	6.3							3.3			
Clupea harengus pallasi													1.3	0.4						<0.0			
Oncorhynchus gorbuscha			0.1							48.1	<0.0	>0.0											
O. keta				1.7									2.2										
O. kisutch			1.2	0.3		<0.0						0.2	9.7							0.2			
O. tshawytscha			0.2	52.6								0.7	2.8			0.3				0.3			
H. pretiosus													0.1				0.2						
Spirinchus thaleichthys												0.2											
Gobiesox maeandricus	0.1												0.2										
Microgadus proximus												0.3		<0.0	<0.0								
Theragra chalcogramma												0.4											
Gasterosteus aculeatus																							
Aulorhynchus flavidus										1.8		1.1											
Syngnathus griseolin.																							
Hexagrammos stelleri												0.1					0.2			0.1			
Artedius fenestralis																		0.2					
A. lateralis													5.7						[illegible]				
Ascelichthys rhod.																	0.2						
Blepsias cirrhosus																						<0.0	
Clinocottus acuticeps				1.0							<0.0	0.6											
C. embryum			0.1	0.1																			
C. globiceps																							
Enophrys bison												0.7		0.1			0.4						
Leptocottus armatus												20.7	14.6				1.1			0.1	1.6		0.3
M. poly.												1.5	1.3				8.4				1.7		
Oligocottus maculosus	<0.0		0.1	0.3																			
O. rimensis																	0.1						
O. snyderi																							
Chidontis pugetensis																							
Agonus acipenserinus																							
Ocella verrucosa																							
Pallasina barbata																							
Liparis callyodon																							
L. cyclopus	0.2																						
L. florae																							
Cymatogaster aggregata																							
Embiotoca lateralis																							
Rhacochilus vacca																							
Amphisticus rhodoterus			0.2									0.5											
Anoplarchus purpurescens																							
Lumpenus sagitta																							
Phytichthys chirus																							
Xiphister atropurpureus																		0.1					
X. mucosus			0.1		0.4																		
Apodichthys flavidus																							
Pholis laeta				3.3																			
P. ornata																				0.3			5.5
Ammodytes hexapterus																				2.6			
Citharichthys stigmaeus													9.2							2.5			
Isopsetta isolepis																							
Lepidopsetta bilineata																			0.1	<0.0			
Parophrys vetulus									0.5														
Platichthys stellatus												<0.0	<0.0						<0.0	1.3			
Pleuronichthys coenosus							0.1	<0.0											0.3				
Psettichthus melanostictus																							

APPENDIX 9

PREY SPECTRA OF NEARSHORE FISH SPECIES

APPENDIX 9

PREY SPECTRA OF NEARSHORE FISH SPECIES

Pacific Herring, Clupea harengus pallasi

Pacific herring were the most commonly encountered neritic fish throughout the study area, occurring at all townet sites as post-larvae and juveniles through midwinter. Although fish larvae (primarily Clupea harengus pallasi and Ammodytes hexapterus) accounted for over 80% of the prey biomass, calanoid copepods were the most common prey both in occurrence and numerical composition and thus formed 96.4% of the total IRI (App. Fig. 9a). While calanoid copepods were overwhelmingly the primary prey taxon, the secondary prey taxa included fish larvae in 1977 only (App. Table 9a).

Pink Salmon, Oncorhynchus gorbuscha

Due to the cyclic abundance of pink salmon in Puget Sound, juvenile pinks were encountered only in 1976; Morse Creek and Jamestown townet collections provided the most stomach samples. Larvaceans and calanoid copepods were the only important prey organisms composing the overall prey spectrum (App. Fig. 9b). Prey compositions from Jamestown and Morse Creek were quite similar in the proportional contributions of calanoid copepods and larvaceans (App. Table 9b), which suggests selective feeding behavior by pink fry and similar neritic plankton communities at the two sites.

Chum Salmon, Oncorhynchus keta

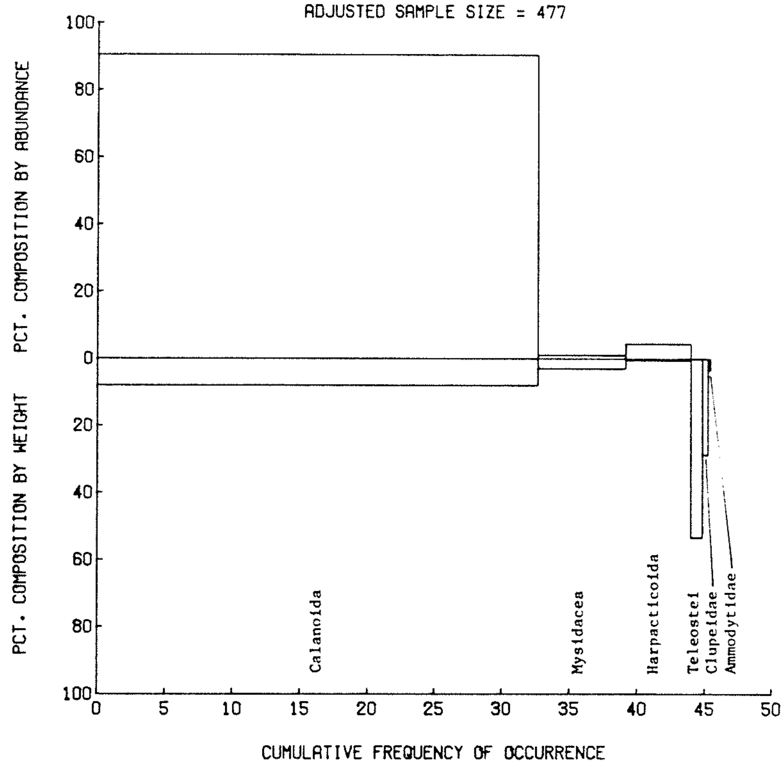
Juvenile chum salmon were captured in high numbers during spring beach seine collections at Kydaka Beach, Beckett Point, and Alexander's Beach, and townet collections at Beckett Point. Main prey of chum fry included epibenthic organisms (harpacticoid copepods and gammarid amphipods) and pelagic organisms (calanoid copepods and fish larvae) (App. Fig. 9c). The feeding specificity of juvenile chum is illustrated by the diet composition at Beckett Point and Alexander's Beach, two distant and somewhat dissimilar sites (App. Table 9c), where the relative importance of the three epibenthic Crustacea was quite similar. The shift from epibenthic to neritic feeding with season and growth of the juveniles is illustrated by the May 1977 beach seine collection and the August townet collection at Beckett Point (App. Table 9d).

Coho Salmon, Oncorhynchus kisutch

Coho salmon juveniles were frequently encountered in spring and summer beach seine collections at almost all sites, though never in high numbers. Gammarid amphipods (over 90% of the total IRI) and fish larvae (including Ammodytes hexapterus) were the most important prey; cumaceans, polychaetes, sphaeromatid isopods (Gnorimosphaeroma oregonensis), insects, and mysids were of secondary importance (App. Fig. 9d).

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8747010201 - CLUPEA HARENGUS PALLASI
PACIFIC HERRING
ADJUSTED SAMPLE SIZE = 477



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
CALANOIDA	32.70	90.53	8.00	3222.3	96.40
MYSIDACEA	6.50	1.09	2.98	26.5	.79
HARPACTICOIDA	4.82	4.48	.54	24.2	.72
TELEOSTEI	.84	.02	53.43	44.8	1.34
CLUPEIDAE	.42	.03	28.66	12.0	.36
AMMODYTIDAE	.21	.00	3.41	.7	.02

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.82	.38	.93
SHANNON-WEINER DIVERSITY	.72	1.90	.31
EVENNESS INDEX	.15	.39	.06

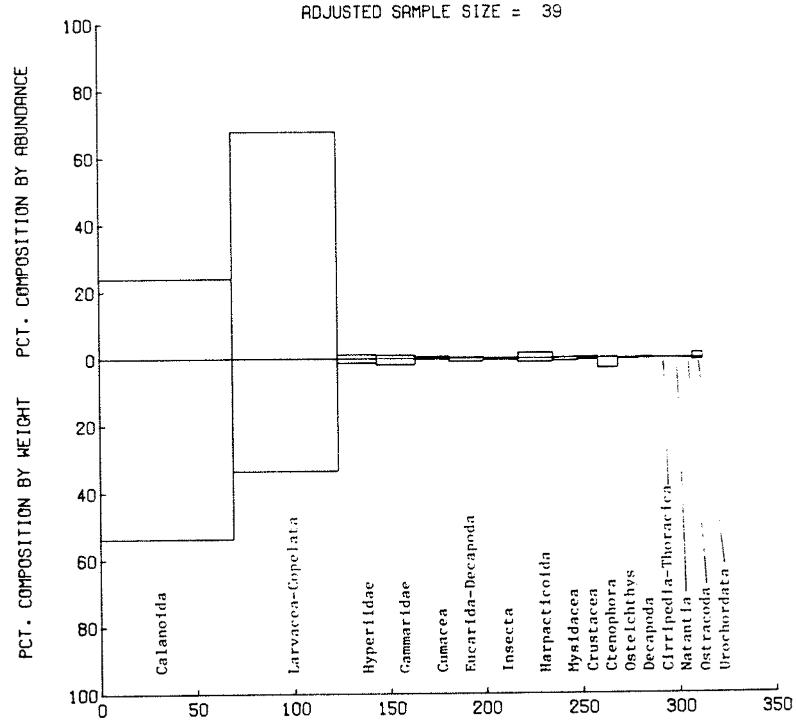
App. Fig. 9a. IRI prey spectrum of Pacific herring along the Strait of Juan de Fuca, 1976-78.

App. Table 9a. IRI comparison of principal prey organisms of juvenile Pacific herring in 1976 (n=54) and 1977 (n=404).

Prey	Freq. occur., %		Numer. comp., %		Grav. comp., %		Total IRI %		IRI rank	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Calanoid copepods	64.8	27.7	93.9	88.9	65.9	5.7	94.1	95.4	1	1
Mysids	18.5	4.5	1.3	0.6	29.7	1.8	5.2	1.1	2	3
Fish larvae	--	1.0	--	0.1	--	89.5	--	2.6	--	2

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78. STATION ALSTA

8755010201 - ONCORHYNCHUS GORBUSCHA
PINK SALMON
ADJUSTED SAMPLE SIZE = 39



CUMULATIVE FREQUENCY OF OCCURRENCE

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
CALANOIDA	69.23	23.86	53.78	5375.0	48.32
LARVACEA COPELATA	53.85	67.68	33.55	5451.0	49.00
HYPERIIDAE	20.51	1.18	1.42	53.4	.48
GAMMARIDAE	20.51	1.01	1.94	60.5	.54
CUMACEA	17.95	.63	.32	17.2	.15
EUCARIDA-DECAPODA	17.95	.39	.91	23.3	.21
INSECTA	17.95	.19	.50	12.5	.11
HARPACTICOIDA	17.95	1.70	1.13	50.7	.46
MYSIDACEA	12.82	.35	.80	14.8	.13
CRUSTACEA	10.26	.39	.56	9.7	.09
CTENOPHORA	10.26	.26	2.94	32.8	.29
OSTEICHTHYS	10.26	.11	.27	3.8	.03
DECAPODA	7.69	.25	.16	3.1	.03
CIRRIPEDIA THORACICA	7.69	.03	.01	.3	.00
NATANTIA	7.69	.03	.02	.4	.00
OSTRACODA	5.13	.02	.11	.7	.01
UROCHORDATA	5.13	1.51	.59	10.8	.10

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM. COMP.	GRAV. COMP.	PERCENT TOTAL IRI
PERCENT DOMINANCE INDEX	.52	.40	.47
SHANNON-WEINER DIVERSITY	1.46	1.82	1.24
EVENNESS INDEX	.33	.41	.28

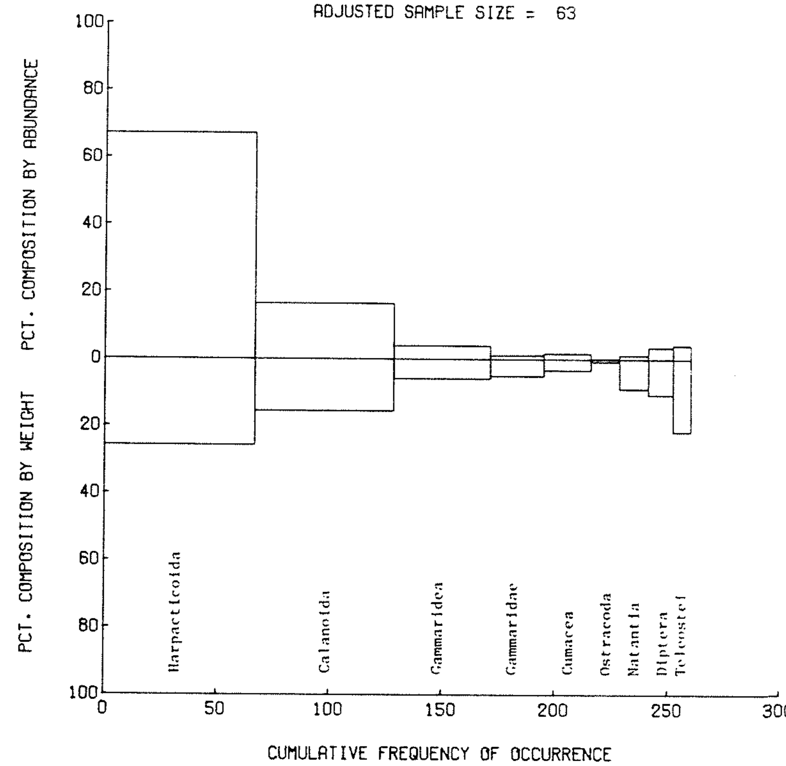
App.Fig. 9b. IRI prey spectrum of pink salmon along the Strait of Juan de Fuca, 1976-78.

App. Table 9b. IRI comparison of principal prey organisms of juvenile pink salmon at Jamestown (J, n=12) and Morse Creek (MC, n=20), May 1976.

Prey	Freq. occur. %		Numer. comp. %		Grav. comp. %		Total IRI %		IRI rank	
	J	MC	J	MC	J	MC	J	MC	J	MC
Calanoid copepods	90.00	66.67	23.75	26.39	55.22	52.37	47.48	49.83	1	2
Larvaceans	70.00	50.00	72.58	56.23	35.57	28.37	50.57	40.14	2	1
Harpacticoid copepods	10.00	41.67	0.07	8.36	<0.00	6.22	<0.00	5.77	3	
Gammarid amphipods	25.00	16.67	0.37	2.51	0.83	6.01	0.20	1.35	4	6
Crustean larvae	35.00	25.00	0.50	1.86	1.14	2.87	0.38	1.12	5	11
Cumaceans	20.00	25.00	0.11	2.79	0.09	1.39	0.03	0.99	6	8

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8755010202 - ONCORHYNCHUS KETA
CHUM SALMON
ADJUSTED SAMPLE SIZE = 63



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	66.67	67.14	25.83	6198.4	66.16
CALANOIDA	61.90	16.50	15.55	1983.8	21.17
GAMMARIDEA	42.86	3.97	5.87	421.6	4.50
GAMMARIDAE	23.81	1.23	5.06	149.6	1.60
CUMACEA	20.63	1.71	3.33	104.0	1.11
OSTRACODA	12.70	.22	.74	12.2	.13
NATANTIA	12.70	1.23	8.91	128.8	1.37
DIPTERA	11.11	3.54	10.68	158.0	1.69
TELEOSTEI	7.94	4.12	21.76	205.4	2.19

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.48	.16	.49
SHANNON-WEINER DIVERSITY	1.67	2.92	1.57
EVENNESS INDEX	.38	.66	.36

App. Fig. 9c. IRI prey spectrum of chum salmon along the Strait of Juan de Fuca, 1976-78.

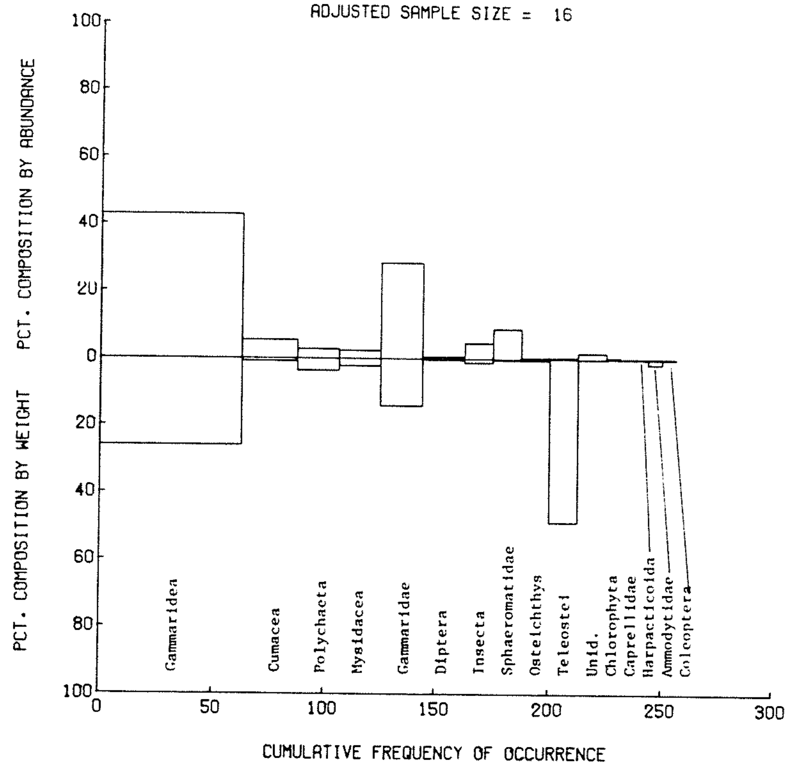
App. Table 9c. IRI comparison of principal prey organisms of juvenile chum salmon at Beckett Point (BP, n=10) and Alexander's Beach (AB, n=14), May 1977.

Prey	Freq. occur. %		Numer. comp. %		Grav. comp. %		Total IRI %		IRI rank	
	BP	AB	BP	AB	BP	AB	BP	AB	BP	AB
Harpacticoid copepods	80.0	100.0	80.6	69.0	72.2	50.6	85.3	63.8	1	1
Calanoid copepods	30.0	92.9	16.8	19.1	18.9	25.8	7.5	22.2	2	2
Gammarid amphipods	100.0	78.6	2.2	8.9	7.6	20.8	6.8	12.4	3	3
Cumaceans	--	50.0	--	2.9	--	2.9	--	1.5	--	4

App. Table 9d. IRI comparison of principal prey organisms of juvenile chum salmon at Beckett Point in May 1977 beach seine collection (n=10) and in August 1977 townet collections (n=14).

Prey	Freq. occur. %		Numer. comp. %		Grav. comp. %		Total IRI %		IRI rank	
	May	Aug	May	Aug	May	Aug	May	Aug	May	Aug
Harpacticoid copepods	80.0	--	80.6	--	72.2	--	85.3	--	1	--
Calanoid copepods	30.0	50.0	16.8	16.0	18.9	9.5	7.5	18.5	2	3
Gammarid amphipods	100.0	--	2.2	--	7.6	--	6.8	--	3	--
Fish larvae	10.0	28.6	<0.0	42.8	0.2	52.3	<0.0	39.5	6	1
Dipteran insects	--	35.7	--	28.3	--	20.4	--	25.3	--	2
Shrimp juveniles	--	42.9	--	10.9	--	14.2	--	15.7	--	4

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA
8755010203 - ONCORHYNCHUS KISUTCH
COHO SALMON
ADJUSTED SAMPLE SIZE = 16



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	62.50	42.83	26.02	4303.3	67.80
CUMACEA	25.00	5.45	.87	158.1	2.49
POLYCHAETA	18.75	2.83	3.68	122.1	1.92
MYSIDACEA	18.75	2.42	2.24	87.5	1.38
GAMMARIDAE	18.75	28.48	14.10	798.5	12.58
DIPTERA	18.75	.61	.42	19.3	.30
INSECTA	12.50	4.65	1.23	73.4	1.16
SPHAEROMATIDAE	12.50	8.89	.45	116.7	1.84
OSTEICHTHYS	12.50	.40	.44	10.6	.17
TELEOSTEI	12.50	.40	48.81	615.2	9.69
UNIDENTIFIED	12.50	1.82	.17	24.8	.39
CHLOROPHYTA	6.25	.40	.00	2.5	.04
CAPRELLIDAE	6.25	.20	.02	1.4	.02
HARPACTICOIDA	6.25	.20	.00	1.3	.02
AMMODYTIDAE	6.25	.20	1.52	10.8	.17
COLEOPTERA	6.25	.20	.00	1.3	.02

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.28	.33	.49
SHANNON-WEINER DIVERSITY	2.38	2.06	1.69
EVENNESS INDEX	.59	.51	.42

App. Fig. 9d. IRI prey spectrum of coho salmon along the Strait of Juan de Fuca, 1976-78.

Chinook Salmon, Oncorhynchus tshawytscha

Chinook salmon juveniles and a few maturing residents were common to both beach seine and townet collections in May and August 1977, especially at Morse Creek and Beckett Point. Dipteran insects, shrimp larvae, and gammarid amphipods predominated in the most diverse prey spectrum of all the juvenile salmonids (App. Fig. 9e). Ostracods, post-larval fishes (including Ammodytes hexapterus and Scorpaenidae), polychaetes (including Syllidae), mysids, and calanoid copepods were of secondary importance. Although the sample sizes were too low to be considered representative, the diet composition of juvenile chinook salmon in August 1977 was basically the same across five different townet sites. The primary and secondary prey were either epibenthic gammarid amphipods, juvenile shrimp, or drift insects (App. Table 9e).

Surf Smelt, Hypomesus pretiosus

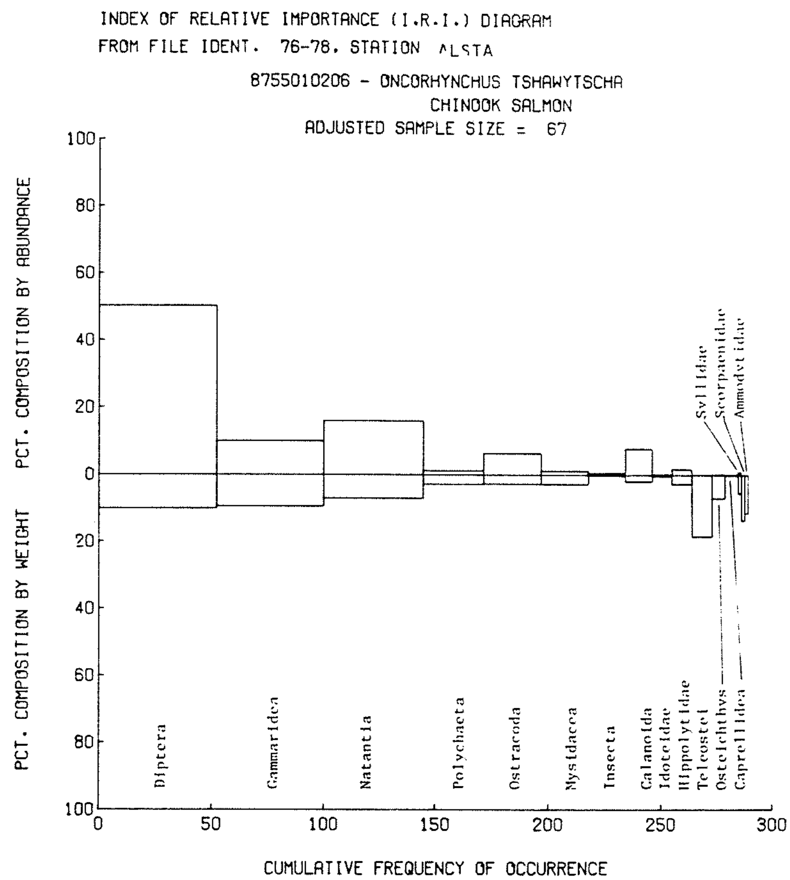
All life history stages of surf smelt were commonly caught throughout the study area, but surf smelt were especially abundant at Twin Rivers, Morse Creek, Alexander's Beach, and West Beach. Calanoid copepods provided the most trophic input (80.6% of total IRI) to the overall surf smelt prey spectrum (App. Fig. 9f). Harpacticoid copepods (12.7%) and polychaete annelids (3.8%) were second in importance. Fish, although infrequently consumed, accounted for 27.4% of the total prey biomass. That surf smelt utilize nearshore epibenthic Crustacea was more evident in 1977 when harpacticoid copepods appeared in far greater proportions than in 1976 (App. Table 9f). This is seen to be a result of the surf smelt collected at West Beach on the west side of Whidbey Island which appeared to shift from neritic to epibenthic prey between August and October 1977 (App. Table 9g).

Longfin Smelt, Spirinchus thaleichthys

Longfin smelt of all life-history stages were frequently caught in abundance in August and October townet collections at Twin Rivers and Pillar Point and in January beach seine collections at West Beach. Epibenthic crustaceans predominated the overall prey spectrum of longfin smelt (App. Fig. 9g). Gammarid amphipods accounted for 61.1% of the total IRI; mysids (Archaeomysis grebnitzki and Neomysis sp.), 24.4%; and cumaceans, 5.1%. Pelagic prey organisms were not important. The primary prey taxon shifted from mysids in 1976 to gammarid amphipods in 1977 but still remained centered in epibenthic organisms (App. Table 9h).

Northern Clingfish, Gobiesox maeandricus

Northern clingfish were common members of the intertidal fish assemblages at North Beach, Morse Creek, Observatory Point, Twin Rivers, and Slip Point. Epibenthic and benthic Crustacea and benthic molluscs were the most important prey organisms (App. Fig. 9h). Gammarid amphipods and isopods (Gnorimosphaeroma oregonensis, Exosphaeroma amplicauda, Dynamenella sheareri, Idotea urotoma, and Pentidotea montereyensis) made up 68.1% of the total IRI, and limpets (Collisella pelta, C. digitalis, C. strigatella, Notoacmea scutum, N. persona, and N. fenestrata) 24%. Primary prey organisms appeared to switch dramatically from sphaeromatid isopods in 1976 to limpets (Acmaeidae) in 1977 (App. Table 9i). This was principally a result of a dietary shift from



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
DIPTERA	52.24	50.23	10.15	3154.1	52.55
GAMMARIDEA	47.76	10.03	9.55	935.2	15.58
NATANTIA	44.78	16.02	7.06	1033.7	17.22
POLYCHAETA	26.87	1.24	2.78	108.0	1.80
OSTRACODA	25.37	6.37	2.70	229.9	3.83
MYSIDACEA	20.90	1.22	2.81	84.3	1.40
INSECTA	16.42	.57	.29	14.1	.24
CALANOIDA	11.94	7.83	1.97	117.0	1.95
IDOTEIDAE	8.95	.22	.37	5.3	.09
HIPPOLYTIDAE	8.96	1.74	2.74	40.1	.67
TELEOSTEI	8.96	.13	18.49	166.7	2.78
OSTEICHTHYS	5.97	.22	7.00	43.1	.72
CAPRELLIDEA	5.97	.09	.05	.8	.01
SYLLIDAE	1.49	.83	5.50	9.4	.16
SCORPAENIDAE	1.49	.02	13.64	20.4	.34
AMMODYTIDAE	1.49	.02	11.44	17.1	.28

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.30	.10	.33
SHANNON-WEINER DIVERSITY	2.50	3.64	2.21
EVENNESS INDEX	.48	.69	.42

App. Fig. 9e. IRI prey spectrum of chinook salmon along the Strait of Juan de Fuca, 1976-78.

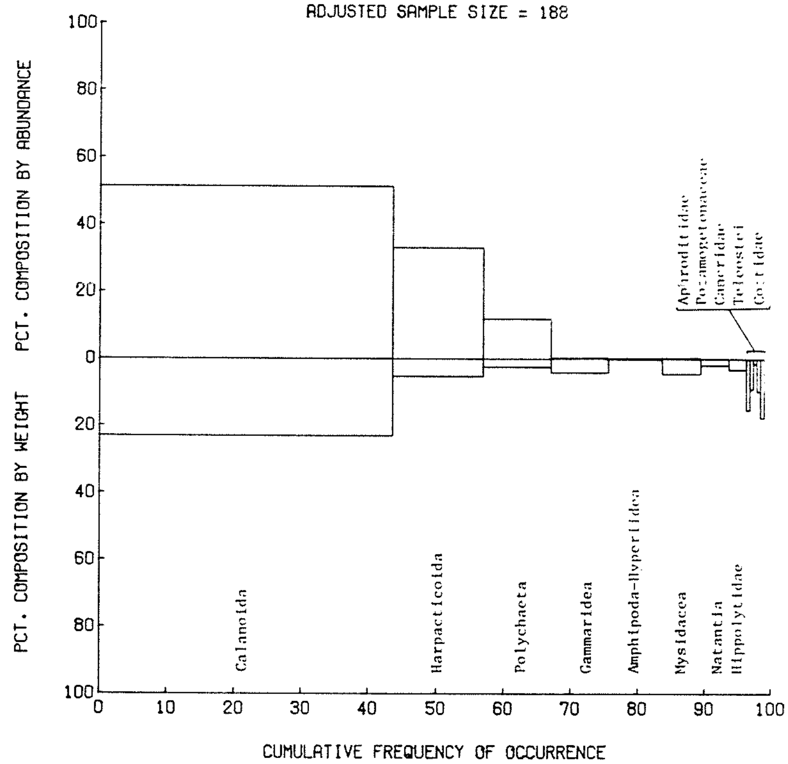
App. Table 9e. Comparison of IRI of principal prey organisms of juvenile chinook salmon from townet collections at Dungeness Spit (DS, n=4), Point Williams (PW, n=9), Beckett Point (BP, n=18), Alexander's Beach (AB, n=5), and West Beach (WB, n=4), August 1977.

Prey	Freq. occur., % DS	PW	BP	AB	WB	Numer. comp., % DS	PW	BP	AB	WB
Gammarid amphipods	75.0	55.6	66.7	40.0	25.0	6.2	1.9	3.8	46.3	2.4
Dipteran insects	25.0	88.9	88.9	20.0	75.0	77.8	84.4	50.2	50.3	86.7
Mysids	75.0	22.2	5.6	--	--	5.1	0.6	0.1	--	--
Decapod larvae	25.0	--	5.6	20.0	25.0	10.1	--	0.1	0.7	6.1
Shrimp juveniles	--	100.0	83.3	20.0	25.0	--	9.5	28.5	0.7	2.4
Ostracods	--	22.2	77.8	--	25.0	--	2.0	11.9	--	--
Polychaetes	--	22.2	66.7	--	--	--	0.2	2.2	--	2.4
Fish larvae	--	--	11.1	60.0	--	--	--	0.1	2.0	--

Prey	Grav. comp., % DS	PW	BP	AB	WB	Total IRI, % DS	PW	BP	AB	WB	IRI rank DS	PW	BP	AB	WB
Gammarid amphipods	45.4	3.3	9.8	16.2	3.5	43.7	1.6	6.3	29.6	1.3	1	3	4	2	3
Dipteran insects	23.1	47.4	21.2	5.3	48.8	28.4	65.5	45.5	13.2	86.3	2	1	1	3	1
Mysids	20.7	8.0	<0.0	--	--	21.8	1.1	<0.0	--	--	3	4	10	--	--
Decapod larvae	8.4	--	0.0	0.0	45.7	5.2	--	0.0	0.2	11.0	4	--	11	5	2
Shrimp juveniles	--	31.2	21.2	0.6	0.8	--	27.0	29.0	0.3	0.7	--	2	2	4	5
Ostracods	--	3.2	10.9	--	--	--	0.6	12.5	--	--	--	5	3	--	--
Polychaetes	--	4.8	5.7	--	1.2	--	0.6	3.7	--	0.8	--	6	5	--	4
Fish larvae	--	--	24.1	77.8	--	--	--	1.9	56.7	--	--	--	6	1	--

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78. STATION ALSTA

8755030101 - HYPOMESUS PRETIOSUS
SURF SMELT
ADJUSTED SAMPLE SIZE = 188



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
CALANOIDA	43.62	51.34	23.08	3246.1	80.60
HARPACTICOIDA	13.30	33.06	5.24	509.3	12.65
POLYCHAETA	10.11	11.88	2.47	145.1	3.60
GAMMARIDEA	8.51	.40	4.11	38.4	.95
AMPHIPODA-HYPERIIDEA	7.98	.31	.19	4.0	.10
MYSIDACEA	5.85	.42	4.46	28.6	.71
NATANTIA	4.26	.11	1.88	8.5	.21
HIPPOLYTIDAE	2.66	.08	3.23	8.8	.22
APHRODITIDAE	.53	.01	15.30	8.1	.20
POTAMOGETONACEAE	.53	.01	9.12	4.9	.12
CANCRIDAE	.53	.01	1.44	.8	.02
TELEOSTEI	.53	.01	9.72	5.2	.13
COTTIDAE	.53	.01	17.68	9.4	.23

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.39	.13	.67
SHANNON-WEINER DIVERSITY	1.70	3.28	1.06
EVENNESS INDEX	.34	.65	.21

App. Fig. 9f. IRI prey spectrum of surf smelt along the Strait of Juan de Fuca, 1976-78.

App. Table 9f. IRI comparison of principal prey organisms of surf smelt in 1976 (n=15) and 1977 (n=100) townet collections.

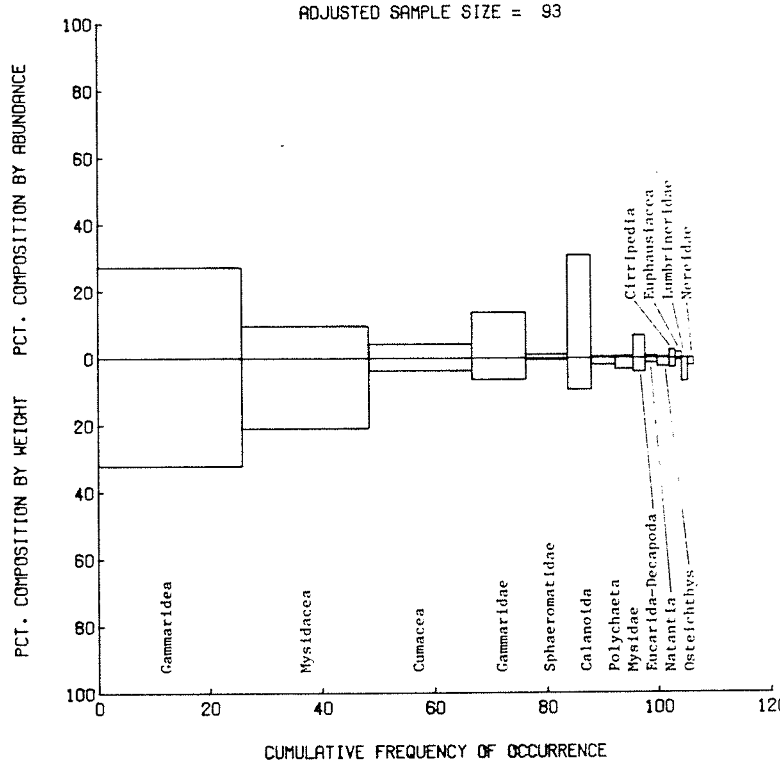
Prey	Freq. occur. % 1976	Freq. occur. % 1977	Numer. comp. % 1976	Numer. comp. % 1977	Grav. comp. % 1976	Grav. comp. % 1977	Total IRI % 1976	Total IRI % 1977	IRI rank 1976	IRI rank 1977
Calanoid copepods	73.3	35.0	92.6	17.1	90.4	35.2	98.1	50.6	1	1
Cumaceans	26.7	--	3.1	--	2.1	--	1.0	--	2	--
Harpacticoid copepods	13.3	13.0	0.5	77.5	<0.1	42.8	0.1	43.2	8	2
Polychaetes	6.7	15.0	0.6	3.3	1.5	7.4	0.1	4.4	6	3
Gammarid amphipods	20.0	5.0	0.7	0.3	1.2	1.8	0.3	0.3	3	5
Mysids	6.7	5.0	0.4	0.1	3.0	1.3	0.2	0.2	4	6
Hyperiid amphipods	--	14.0	--	0.7	--	1.5	--	0.9	--	4

App. Table 9g. IRI comparison of principal prey organisms of surf smelt caught in August and October 1977 at Alexander's Beach (n=27,22) and West Beach (n=25,19).

Prey	Freq. occur., % Alex. Beach Aug	Freq. occur., % Alex. Beach Oct	Freq. occur., % West Beach Aug	Freq. occur., % West Beach Oct	Numer. comp., % Alex. Beach Aug	Numer. comp., % Alex. Beach Oct	Numer. comp., % West Beach Aug	Numer. comp., % West Beach Oct	Grav. comp., % Alex. Beach Aug	Grav. comp., % Alex. Beach Oct	Grav. comp., % West Beach Aug	Grav. comp., % West Beach Oct	Total IRI, % Alex. Beach Aug	Total IRI, % Alex. Beach Oct	Total IRI, % West Beach Aug	Total IRI, % West Beach Oct	IRI rank Alex. Beach Aug	IRI rank Alex. Beach Oct	IRI rank West Beach Aug	IRI rank West Beach Oct
Calanoid copepods	44.4	72.7	16.0	--	66.2	57.2	94.8	--	58.2	58.5	91.3	--	90.0	80.6	98.2	--	1	1	1	--
Harpac. copepods	7.4	18.2	--	36.8	27.6	16.4	--	98.9	25.8	19.8	--	86.2	6.4	6.3	--	96.5	2	3	--	1
Hyperiid amphipods	14.8	27.3	--	15.8	3.3	3.1	--	0.1	4.9	1.3	--	1.3	2.0	1.2	--	0.3	3	4	--	4
Poly-chaetes	7.4	31.8	--	31.6	1.5	20.4	--	0.5	5.5	17.0	--	4.4	0.9	1.2	--	2.2	4	2	--	2
Shrimp juvs.	7.4	13.6	--	5.3	0.7	0.6	--	0.1	3.7	0.7	--	0.1	0.6	0.2	--	0.1	5	6	--	7
Insecta	--	9.1	4.0	--	--	1.6	4.5	--	--	1.9	7.8	--	--	0.3	1.6	--	--	5	2	--

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8755030402 - SPIRINCHUS THALEICHTHYS
LONGFIN SMELT
ADJUSTED SAMPLE SIZE = 93



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	25.81	27.17	32.21	1532.3	54.31
MYSIDACEA	22.58	9.58	20.96	689.6	24.44
CUMACEA	18.28	4.20	3.70	144.4	5.12
GAMMARIDAE	9.68	13.65	6.41	194.1	6.88
SPHAEROMATIDAE	7.53	.98	.56	11.6	.41
CALANOIDA	4.30	30.64	9.40	172.2	6.10
POLYCHAETA	4.30	.46	1.97	10.5	.37
MYSIDAE	3.23	.52	3.34	12.5	.44
EUCARIDA-DECAPODA	2.15	6.76	4.14	23.4	.83
NATANTIA	2.15	.59	1.48	4.5	.16
OSTEICHTHYS	2.15	.26	2.47	5.9	.21
CIRRIPEDIA	1.08	2.43	2.82	5.6	.20
EUPHAUSIACEA	1.08	1.64	.52	2.3	.08
LUMBRINERIDAE	1.08	.07	6.90	7.5	.27
NEREIDAE	1.08	.07	2.16	2.4	.08

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM.	GRAV.	PERCENT IRI
PERCENT DOMINANCE INDEX	.20	.17	.37
SHANNON-WEINER DIVERSITY	2.74	3.13	1.96
EVENNESS INDEX	.63	.72	.45

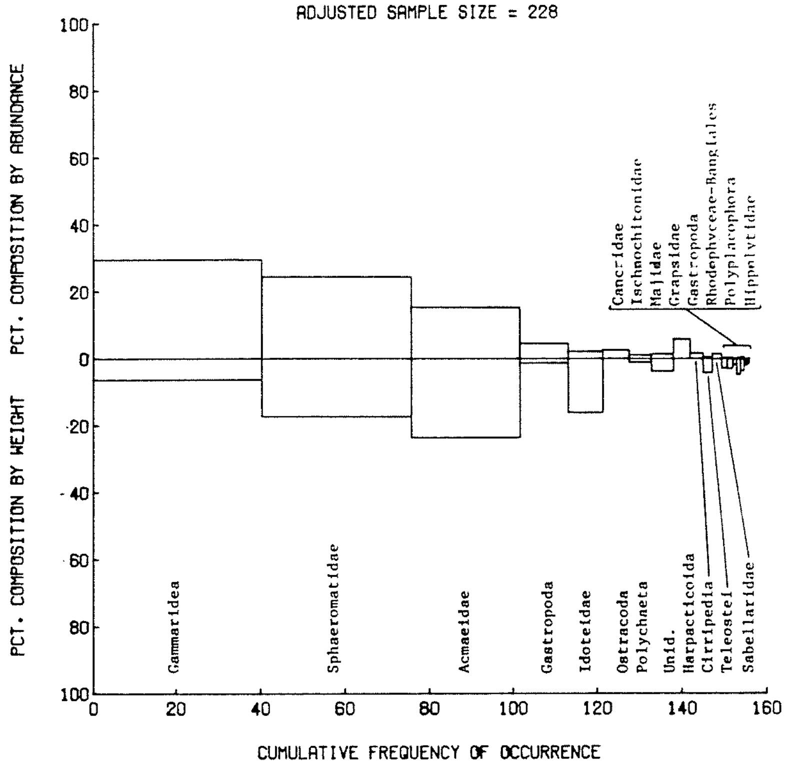
App. Fig. 9g. IRI prey spectrum of longfin smelt along the Strait of Juan de Fuca, 1976-78.

App. Table 9h. IRI comparison of principal prey organisms of longfin smelt in 1976 (n=17) and 1977 (n=51).

Prey	Freq. occur. %		Numer. comp. %		Grav. comp. %		Total IRI %		IRI rank	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Mysids	58.8	2.0	9.7	26.3	33.4	56.6	44.9	22.7	1	2
Calanoid copepods	17.7	--	12.1	--	11.5	--	4.9	--	3	--
Gammarid amphipods	47.1	5.9	15.9	52.6	5.6	30.3	18.0	68.0	2	1
Decapod larvae	11.8	--	12.1	--	11.5	--	4.9	--	4	--
Cumaceans	29.4	2.0	3.4	15.8	4.7	2.5	4.2	5.0	5	3
Shrimp juveniles	11.8	2.0	1.1	5.3	4.1	10.6	1.1	4.3	6	4

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8784010101 - GOBIESOX MEANDRICUS
N. CLINGFISH
ADJUSTED SAMPLE SIZE = 228



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	40.35	29.51	6.36	1447.4	33.77
SPHAEROMATIDAE	35.53	24.40	17.32	1482.3	34.59
ACMAEIDAE	25.88	15.25	23.63	1006.2	23.48
GASTROPODA	11.40	4.53	1.31	66.6	1.55
IDOTEIDAE	8.33	2.06	16.14	151.6	3.54
OSTRACODA	6.14	2.56	.02	15.8	.37
POLYCHAETA	5.26	1.07	1.08	11.3	.26
UNIDENTIFIED	5.26	1.32	3.73	26.6	.62
HARPACTICOIDA	3.95	5.77	.02	22.9	.53
CIRRIPEDIA	3.07	1.57	.02	4.9	.11
TELEOSTEI	2.19	.41	4.20	10.1	.24
SABELLARIDAE	2.19	1.40	.08	3.2	.08
CANCRIDAE	1.32	.25	2.82	4.0	.09
ISCHNOCHITONIDAE	1.32	.25	2.93	4.2	.10
MAJIDAE	.88	.16	1.81	1.7	.04
GRAPSIDAE	.88	.16	4.75	4.3	.10
GASTROPODA	.88	.49	3.67	3.7	.09
RHODOPHYCEAE-BANGIALES	.44	.08	1.25	.6	.01
POLYPLACOPHORA	.44	.08	1.96	.9	.02
HIPPOLYTIDAE	.44	.08	1.38	.6	.01

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.18	.13	.29
SHANNON-WEINER DIVERSITY	3.32	3.66	2.09
EVENNESS INDEX	.57	.63	.36

App. Fig. 9h. IRI prey spectrum of northern clingfish along the Strait of Juan de Fuca, 1976-78.

App. Table 9i. IRI comparison of principal prey organisms of northern clingfish in 1976 (n=61) and 1977 (n=165).

Prey	Freq. occur. % 1976	Freq. occur. % 1977	Numer. comp. % 1976	Numer. comp. % 1977	Grav. comp. % 1976	Grav. comp. % 1977	Total IRI % 1976	Total IRI % 1977	IRI rank 1976	IRI rank 1977
Sphaeromatid isopods	39.3	34.6	44.1	15.8	36.9	11.2	60.4	21.2	1	3
Gammarid amphipods	45.9	38.8	27.6	30.4	6.7	6.3	29.8	32.3	2	2
Gastropods	18.0	9.1	8.4	2.9	0.9	1.4	3.2	0.9	3	6
Idoteid isopods	6.6	9.1	1.6	2.3	8.9	18.4	1.3	4.3	4	4
Limpets	8.2	32.7	2.7	20.8	2.9	30.1	0.9	37.8	7	1

gammarid amphipods to limpets in the fish collected in the North Beach and Slip Point tidepools (App. Table 9j). The northern clingfish at Morse Creek had basically the same prey spectrum in the two years.

Pacific Tomcod, Microgadus proximus

Pacific tomcod, mainly juveniles (65%), were often caught in abundance in both beach seine and townet collections. Beckett Point, Jamestown and Point Williams, Morse Creek, and West Beach contributed the most stomach sample specimens. The overall prey spectrum (App. Fig. 9i) is composed almost exclusively of epibenthic Crustacea, including gammarid amphipods (84.3% of total IRI), mysids (4.0%, including Archaeomysis grebnitzki), hippolytid shrimp (3.5%, including Heptacarpus brevirostris), harpacticoid copepods, cumaceans, and unidentified shrimp. Yearly variation in diet between 1976 and 1977 was not significant in either the beach seine or the townet collected fish (App. Table 9k). Gammarid amphipods were the primary prey in all cases, except in 1976 beach seine collections where gammarid amphipods were equal to the usual secondary prey, shrimp.

Walleye pollock, Theragra chalcogramma

Juvenile walleye pollock occurred mainly in fall and winter beach seine collections at Beckett Point and Dungeness Spit and townet collections at Jamestown and Point Williams. Calanoid copepods, because of their numerical predominance, constituted the most important item in the IRI prey spectrum (67.1% of the total IRI). Gammarid amphipods (15.8%), hippolytid shrimp (including Heptacarpus brevirostris, 8.8%), mysids (including Archaeomysis grebnitzki, 3.1%), and cumaceans (1.1%) were the other prey of significance (App. Fig. 9j).

Threespine Stickleback, Gasterosteus aculeatus

Threespine stickleback, mainly adult, were most common in Beckett Point, Jamestown, and Point Williams beach seine collections. Unlike northern Puget Sound, where it is documented as one of the most common neritic species (Miller et al. 1977), it was not often encountered in the townet collections along the Strait of Juan de Fuca. Threespine stickleback appeared to be feeding throughout the nearshore water column, as pelagic calanoid copepods and epibenthic harpacticoid copepods were equally important (App. Fig. 9k). Limited sample sizes, however, do not allow us to determine whether this catholic feeding behavior is due to diel changes, site differences, or collection methods. Secondary prey organisms were mostly epibenthic forms, including gammarid amphipods and mysids.

Tube-Snout, Aulorhynchus flavidus

Beach seine and townet collections at Beckett Point and Morse Creek produced numerous tube-snouts. As in the case of threespine stickleback, both calanoid and harpacticoid copepods were the principal prey species of tube-snouts feeding in nearshore habitats (App. Fig. 9-1). Shrimp larvae, though constituting 28.9% of the total prey biomass, were not abundant prey items. Samples obtained at Beckett Point permitted comparison between January and October 1977 (App. Table 9-1), and suggested a diet based on epibenthic Crustacea in winter and neritic organisms in fall.

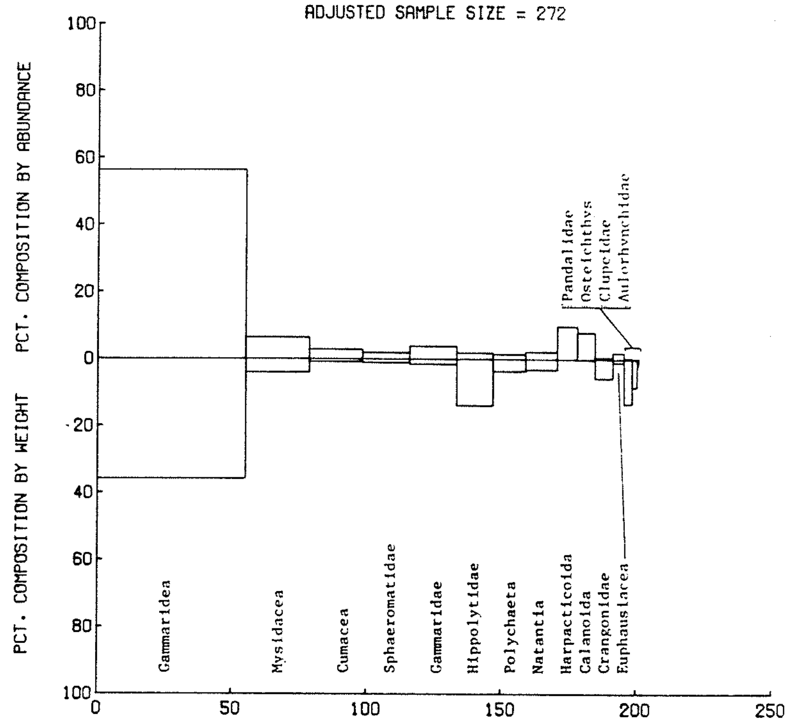
App. Table 9j. IRI comparison of principal prey organisms of northern clingfish in 1976 and 1977 at North Beach (NB, n=17,25), Morse Creek (MC, n=17,37), and Slip Point (SP, n=12,41).

Prey	Freq. occur., % 1976 NB	1976 MC	1976 SP	1977 NB	1977 MC	1977 SP	Numer. comp., % 1976 NB	1976 MC	1976 SP	1977 NB	1977 MC	1977 SP
Sphaeromatid isopods	61.5	17.7	--	44.0	43.2	26.8	71.1	20.0	--	18.9	19.5	17.3
Gammarid amphipods	38.5	58.8	58.3	32.0	56.8	17.1	12.8	42.1	48.2	13.5	38.1	19.9
Limpets	--	5.9	25.0	44.0	43.2	43.9	--	1.1	9.4	49.6	16.1	25.6
Gastropoda	11.5	29.4	25.0	8.0	--	14.6	3.4	22.1	5.9	1.8	--	7.7
Idoteid isopods	7.7	11.8	--	--	18.9	--	1.3	4.2	--	--	3.4	--

Prey	Grav. comp., % 1976 NB	1976 MC	1976 SP	1977 NB	1977 MC	1977 SP	Total IRI, % 1976 NB	1976 MC	1976 SP	1977 NB	1977 MC	1977 SP	IRI rank 1976 NB	1976 MC	1976 SP	1977 NB	1977 MC	1977 SP
Sphaeromatid isopods	79.1	--		11.0	10.6	4.2	91.6	14.0	--	17.5	21.8	13.7	1	2	--	2	2	2
Gammarid amphipods	4.0	14.1	6.6	1.5	5.5	1.9	6.4	60.5	54.2	6.4	42.5	8.8	2	1	1	3	1	3
Limpets	--	1.4	5.9	76.7	11.8	36.3	--	0.3	6.5	73.7	20.2	64.3	--	10	5	1	3	1
Gastropoda	1.4	2.0	0.2	0.4	--	5.4	0.5	13.0	2.6	0.2	--	4.5	4	3	6	6	--	4
Idoteid isopods	7.9	35.9	--	--	26.2	--	0.7	8.6	--	--	9.4		3	4	--	--	4	--

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8791030601 - MICROGADUS PROXIMUS
PACIFIC TOMCOD
ADJUSTED SAMPLE SIZE = 272



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	55.15	56.40	35.79	5083.9	82.84
MYSIDACEA	23.53	6.41	4.09	246.9	4.02
CUMACEA	19.85	2.78	.84	71.9	1.17
SPHAEROMATIDAE	17.65	1.88	1.16	53.6	.87
GAMMARIDAE	17.28	3.85	1.55	93.3	1.52
HIPPOLYTIDAE	13.60	1.86	13.86	213.8	3.48
POLYCHAETA	12.13	1.44	3.62	61.4	1.00
NATANTIA	11.76	2.17	3.14	62.4	1.02
HARPACTICOIDA	7.35	9.78	.09	72.6	1.18
CALANOIDA	6.62	7.95	.20	54.0	.88
CRANGONIDAE	6.62	.55	5.65	41.1	.67
EUPHAUSIACEA	4.04	1.84	1.01	11.5	.19
PANDALIDAE	2.94	.24	13.32	39.9	.65
OSTEICHTHYS	1.84	.06	8.34	15.5	.25
CLUPEIDAE	.37	.01	2.19	.8	.01
AULORHYNCHIDAE	.37	.01	1.21	.4	.01

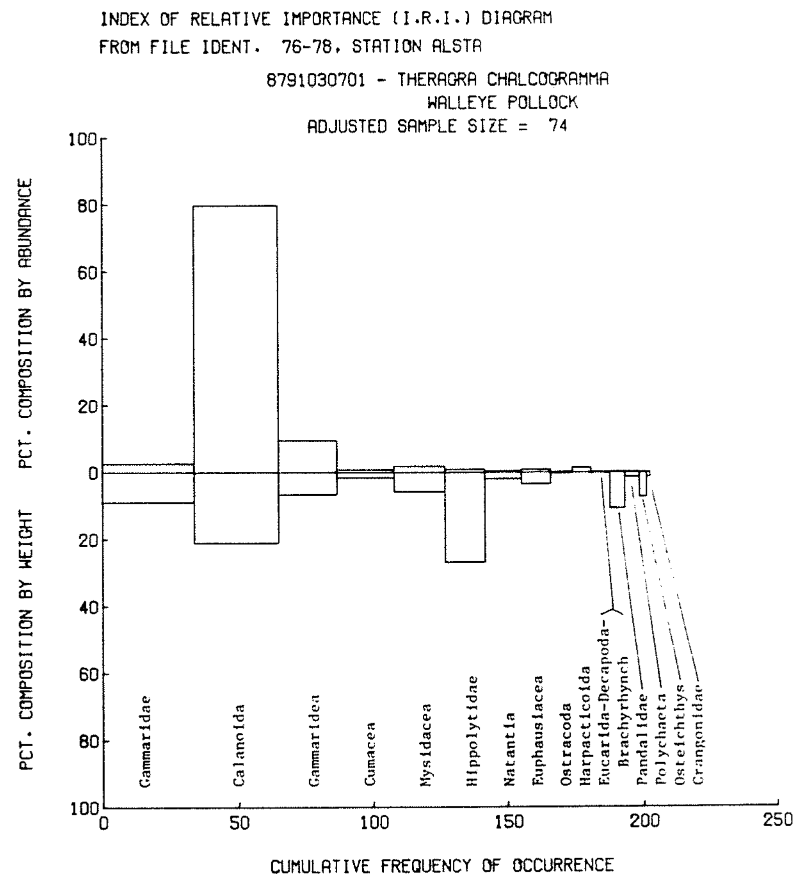
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.34	.18	.69
SHANNON-WEINER DIVERSITY	2.50	3.20	1.24
EVENNESS INDEX	.47	.60	.23

App. Fig. 9i. IRI prey spectrum of Pacific tomcod along the Strait of Juan de Fuca, 1976-78.

App. Table 9k. IRI comparison of principal prey organisms of Pacific tomcod in 1976 and 1977 for beach seine (BS, n=37,16) and townet (TN, n=40,179) collections.

	Freq. occur., %				Numer. comp., %				Grav. comp., %				Total IRI, %				IRI rank			
	1976		1977		1976		1977		1976		1977		1976		1977		1976		1977	
Prey	BS	TN	BS	TN	BS	TN	BS	TN	BS	TN	BS	TN	BS	TN	BS	TN	BS	TN	BS	TN
Gammarid amphipods	50.0	73.0	78.2	62.5	12.7	29.4	69.9	32.9	5.2	2.9	59.5	28.5	33.4	45.6	89.9	65.7	2	1	1	1
Shrimp	17.5	35.1	16.8	12.5	9.0	16.1	1.9	1.8	71.3	10.2	21.0	22.0	33.9	17.9	3.4	5.1	1	2	2	3
Euphausiids	--	27.0	--	--	--	19.1	--	--	--	5.0	--	--	--	12.6	--	--	--	3	--	--
Calanoid copepods	7.5	24.3	1.1	25.0	54.8	13.5	1.0	45.3	0.3	0.5	0.0	1.3	15.4	6.6	0.0	19.9	3	4	12	2
Fish	5.0	8.1	--	6.3	0.3	0.4	--	0.6	15.4	29.3	--	29.5	2.9	4.7	--	3.2	5	5	--	4
Mysids	15.0	10.8	29.1	12.5	8.7	2.8	6.7	3.5	2.6	0.7	5.7	2.4	6.3	0.7	3.2	1.3	4	9	3	5



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDAE	33.78	2.58	8.92	388.6	8.32
CALANOIDA	31.08	79.71	21.07	3132.3	67.06
GAMMARIDEA	21.62	9.52	6.61	348.9	7.47
CUMACEA	21.62	.82	1.57	51.6	1.10
MYSIDACEA	18.92	1.82	5.75	143.2	3.07
HIPPOLYTIDAE	14.86	.90	26.84	412.3	8.83
NATANTIA	13.51	.49	1.90	32.3	.69
EUPHAUSIACEA	10.81	.77	3.48	45.9	.98
OSTRACODA	8.11	.20	.26	3.7	.08
HARPACTICOIDA	6.76	1.38	.08	9.9	.21
EUCARIDA-DECAPODA-BRACHYRHYNCH	6.76	.15	.15	2.0	.04
PANDALIDAE	5.41	.20	10.70	58.9	1.26
POLYCHAETA	5.41	.15	1.30	7.9	.17
OSTEICHTHYS	2.70	.05	7.24	19.7	.42
CRANGONIDAE	1.35	.03	1.35	1.9	.04

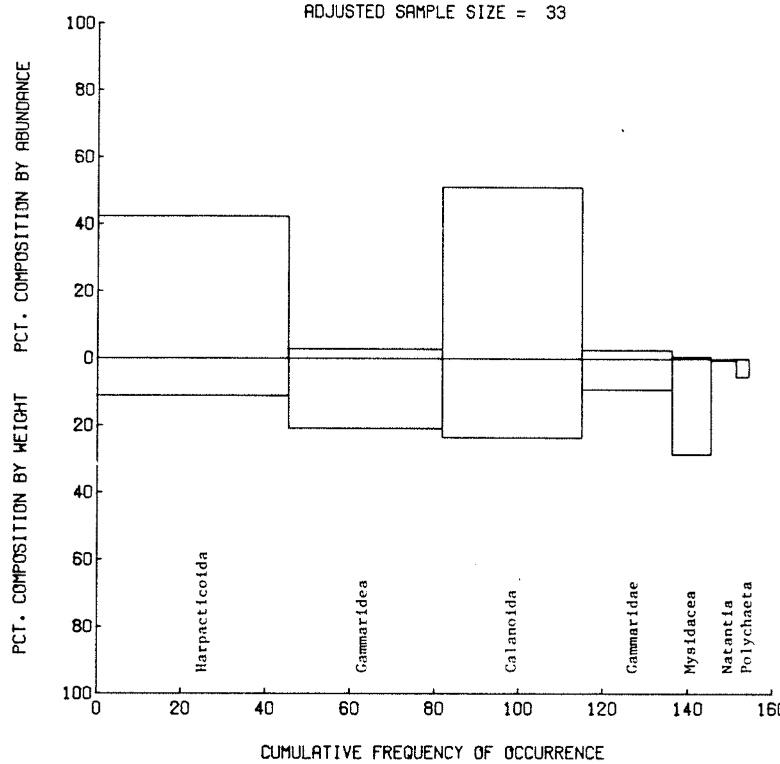
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.65	.15	.47
SHANNON-WEINER DIVERSITY	1.31	3.22	1.81
EVENNESS INDEX	.27	.67	.38

App. Fig. 9j. IRI prey spectrum of walleye pollock along the Strait of Juan de Fuca, 1976-78

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8818010101 - GASTEROSTEUS ACULEATUS
THREESPINE STICKLEBK
ADJUSTED SAMPLE SIZE = 33



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HARPACTICOIDA	45.45	42.34	11.13	2430.6	38.47
GAMMARIDEA	36.36	2.81	20.84	859.9	13.61
CALANOIDA	33.33	51.15	23.60	2491.5	39.43
GAMMARIDAE	21.21	2.57	9.15	248.7	3.94
MYSIDACEA	9.09	.65	28.46	264.7	4.19
NATANTIA	6.06	.07	.42	3.0	.05
POLYCHAETA	3.03	.10	5.31	16.4	.26

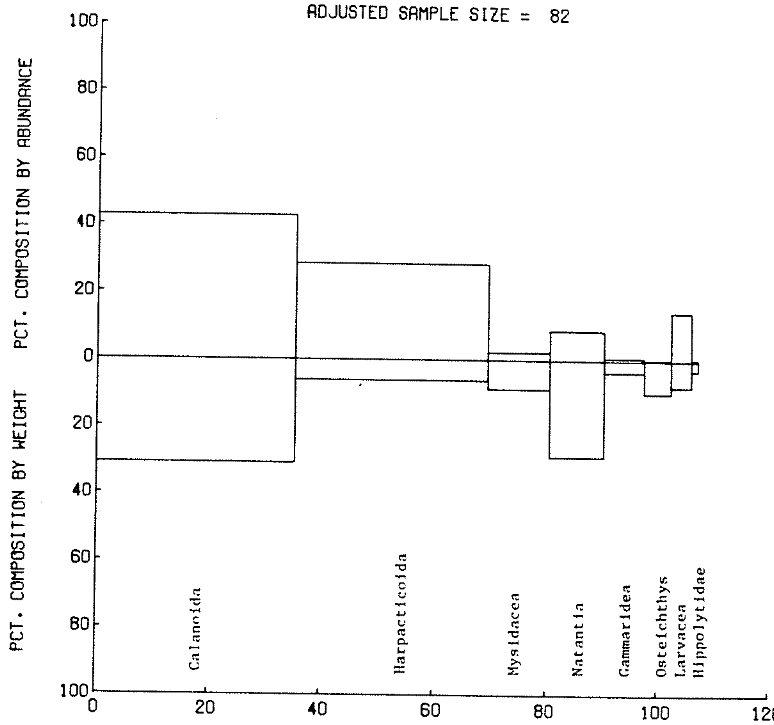
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.44	.20	.33
SHANNON-WEINER DIVERSITY	1.40	2.49	1.86
EVENNESS INDEX	.40	.72	.54

App. Fig. 9k. IRI prey spectrum of threespine stickleback along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8818020101 - AULORHYNCHUS FLAVIDUS
TUBE-SNOUT
ADJUSTED SAMPLE SIZE = 82



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
CALANOIDA	35.37	42.78	30.92	2606.5	58.53
HARPACTICOIDA	34.15	28.59	6.11	1184.7	26.60
MYSIDACEA	10.98	2.34	8.64	120.5	2.71
NATANTIA	9.76	8.85	28.89	368.2	8.27
GAMMARIDEA	7.32	.82	3.47	31.5	.71
OSTEICHTHYS	4.88	.26	9.73	48.7	1.09
LARVACEA	3.66	14.53	7.84	81.9	1.84
HIPPOLYTIDAE	1.22	.35	2.98	4.1	.09

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.29	.21	.42
SHANNON-WEINER DIVERSITY	2.11	2.65	1.65
EVENNESS INDEX	.55	.70	.43

App. Fig. 9-1. IRI prey spectrum of tube-snout along the the Strait of Juan de Fuca, 1976-78.

App. Table 9-1. IRI comparison of principal prey organisms of tube-snout at Beckett Point in January 1977 (n=25) and October 1977 (n=17).

Prey	Freq. occur. % Jan.	Freq. occur. % Oct.	Numer. comp. % Jan.	Numer. comp. % Oct.	Grav. comp. % Jan.	Grav. comp. % Oct.	Total IRI % Jan.	Total IRI % Oct.	IRI rank Jan.	IRI rank Oct.
Harpacticoid copepods	36.0	--	95.5	--	86.8	--	98.2	--	1	--
Gammarid amphipods	8.0	--	1.4	--	10.5	--	1.4	--	2	--
Calanoid copepods	4.0	58.8	3.1	66.5	2.6	70.6	0.3	87.9	3	1
Larvaceans	--	17.7	--	33.3	--	29.0	--	12.0	--	2
Hyperiid amphipods	--	11.8	--	0.2	--	0.4	--	0.1	--	3

Whitespotted Greenling, Hexagrammos stelleri

Whitespotted greenling, the majority of which were juveniles, were commonly encountered only during Beckett Point beach seine collections; summer collections at Point Williams also provided some specimens. The overall prey spectrum of whitespotted greenling is one of the most diverse encountered. Gammarid amphipods were the most important prey (60.9% of total IRI) but tanaids, polychaete annelids, hippolytid shrimp (Heptacarpus sp.), crangonid shrimp, bivalves and bivalve siphons, and majid and pagurid crabs all composed more than 1% of the total IRI (App. Fig. 9m).

Padded Sculpin, Artedius fenestralis

Padded sculpin were common in collections at Twin Rivers and Beckett Point, and were especially abundant in winter. Epibenthic Crustacea--gammarid (including Corophiidae) amphipods, hippolytid shrimp (Heptacarpus kincaidi, H. tenuissimus), crangonid shrimp, sphaeromatid isopods (Gnorimosphaeroma oregonensis and Exosphaeroma amplicauda), and idoteid isopods (Synidotea sp. and Idotea wosnesenski)--were more abundant than benthic prey organisms such as polychaetes (App. Fig. 9n).

Smoothhead Sculpin, Artedius lateralis

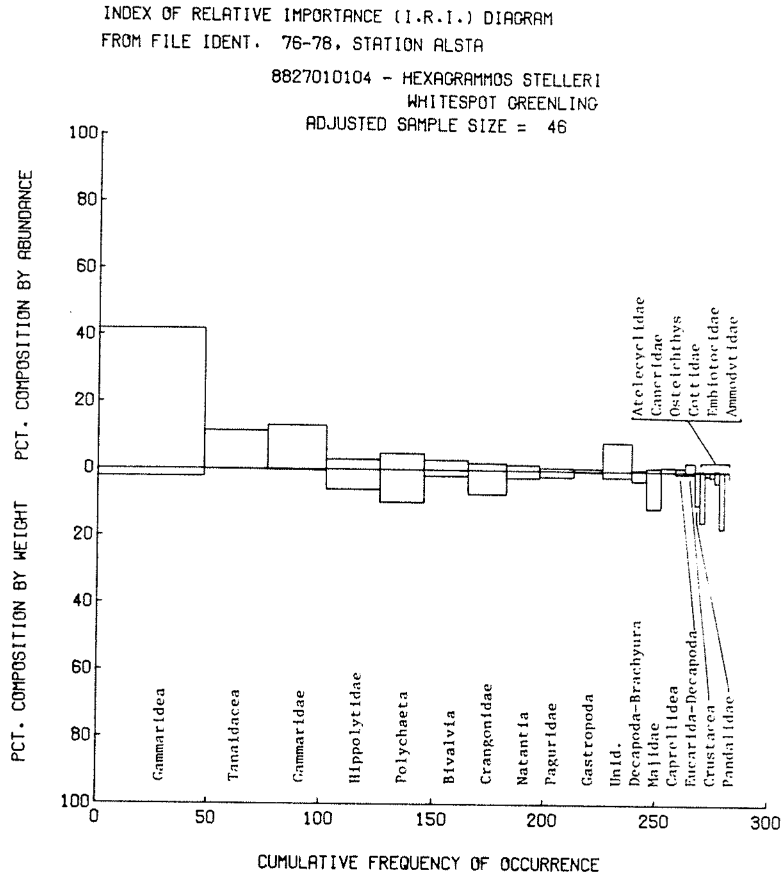
Although not common in beach seine collections, smoothhead sculpin appeared in almost all the tidepool collections and were especially common at Observatory Point and Slip Point. Gammarid amphipods and hippolytid shrimp together formed 84.0% of the total IRI. Fish (including Pholis sp.), sphaeromatid isopods (including Gnorimosphaeroma oregonensis, Exosphaeroma amplicauda, and Dynamenella sheareri), polychaete annelids, and pagurid (hermit) crabs (including Pagurus beringanus) were of secondary importance (App. Fig. 9o).

Rosylip Sculpin, Ascelichthys rhodorus

Rosylip sculpin appeared commonly only in the Twin Rivers beach seine collections but were ubiquitously distributed among the intertidal collections at all sites along the strait. Gammarid amphipods at 67.8% of total IRI and sphaeromatid isopods (including Gnorimosphaeroma oregonensis, Exosphaeroma amplicauda, and Dynamenella sheareri) at 20.8% composed the majority of the IRI prey spectrum (App. Fig. 9p). Idoteid isopods (including Idotea wosnesenski), polychaete annelids, crustacean larvae, and mysids (including Archaeomysis grebnitzki) composed most of the remaining important prey organisms.

Silverspotted Sculpin, Blepsias cirrhosus

Beach seine collections at Twin Rivers, Morse Creek, and Jamestown generally provided the most silverspotted sculpin. The prey spectrum (App. Fig. 9q) was fairly evenly divided between mysids and gammarid amphipods.



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	47.83	41.86	2.34	2114.0	52.28
TANAIDACEA	28.26	11.32	.17	324.7	8.03
GAMMARIDAE	26.09	12.98	.33	347.0	8.58
HIPPOLYTIDAE	23.91	2.93	6.09	215.6	5.33
POLYCHAETA	19.57	4.83	9.81	286.6	7.09
BIVALVIA	19.57	2.93	1.86	93.7	2.32
CRANGONIDAE	17.39	2.04	7.19	160.5	3.97
NATANTIA	15.22	1.65	2.34	60.8	1.50
PAGURIDAE	15.22	.89	1.87	42.0	1.04
GASTROPODA	13.04	.76	.25	13.3	.33
UNIDENTIFIED	13.04	8.52	1.94	136.6	3.38
DECAPODA-BRACHYURA	6.52	.38	2.94	21.7	.54
MAJIDAE	6.52	1.02	11.16	79.4	1.96
CAPRELLIDEA	6.52	1.27	.13	9.1	.23
EUCARIDA-DECAPODA	4.35	1.15	.66	7.9	.19
CRUSTACEA	4.35	2.67	.58	14.1	.35
PANDALIDAE	2.17	.25	9.84	21.9	.54
ATELECYCLIDAE	2.17	.25	15.06	33.3	.82
CANCRIDAE	2.17	.13	1.11	2.7	.07
OSTEICHTHYS	2.17	.13	1.58	3.7	.09
COTTIDAE	2.17	.38	3.18	7.7	.19
EMBIOTOCIDAE	2.17	.13	16.96	37.1	.92
AMMODYTIDAE	2.17	.13	1.92	4.5	.11

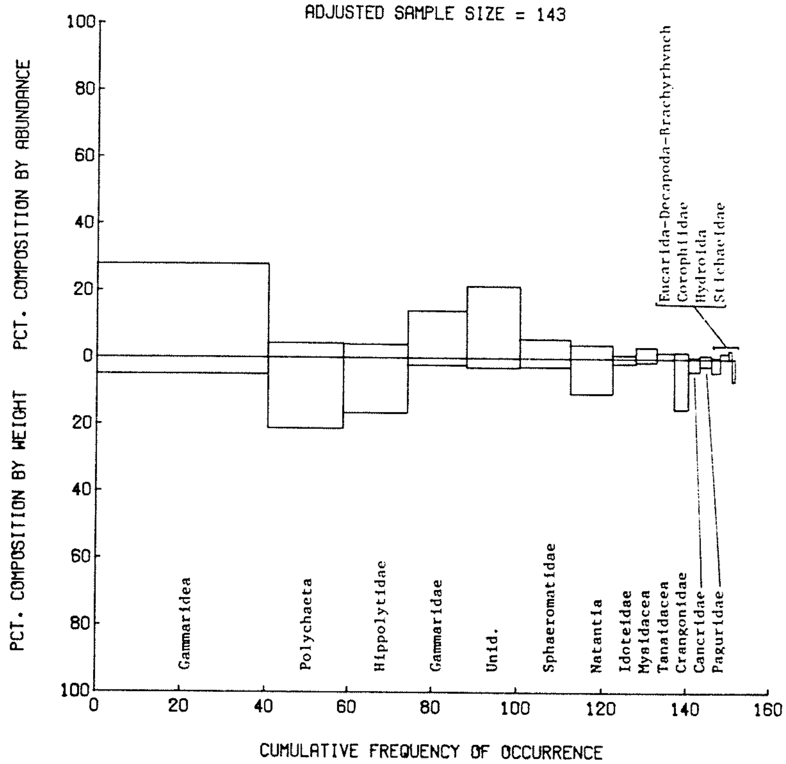
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.22	.10	.30
SHANNON-WEINER DIVERSITY	3.03	3.77	2.68
EVENNESS INDEX	.63	.78	.56

App. Fig. 9m. IRI prey spectrum of whitespotted greenling along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831020401 - ARTEDIUS FENESTRALIS
PADDED SCULPIN
ADJUSTED SAMPLE SIZE = 143



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	40.56	27.88	5.06	1335.8	43.73
POLYCHAETA	18.18	4.27	21.25	463.8	15.19
HIPPOLYTIDAE	15.38	3.97	16.53	315.4	10.33
GAMMARIDAE	13.99	14.09	2.23	228.2	7.47
UNIDENTIFIED	12.59	21.53	2.96	308.3	10.09
SPHAEROMATIDAE	11.89	5.75	2.67	100.2	3.28
NATANTIA	9.79	4.07	10.62	143.8	4.71
IDOTEIDAE	5.59	1.09	1.63	15.2	.50
MYSIDACEA	4.90	3.37	1.15	22.1	.72
TANAIDACEA	4.20	1.79	.12	8.0	.26
CRANGONIDAE	3.50	1.88	15.23	59.9	1.96
CANCRIDAE	2.80	.40	3.96	12.2	.40
PAGURIDAE	2.80	.99	2.35	9.4	.31
EUCARIDA-DECAPODA-BRACHYRHYNCH	2.10	.40	4.10	9.4	.31
COROPHIIDAE	2.10	1.59	.09	3.5	.12
HYDROIDA	.70	2.48	.21	1.9	.06
STICHAEIDAE	.70	.10	6.79	4.8	.16

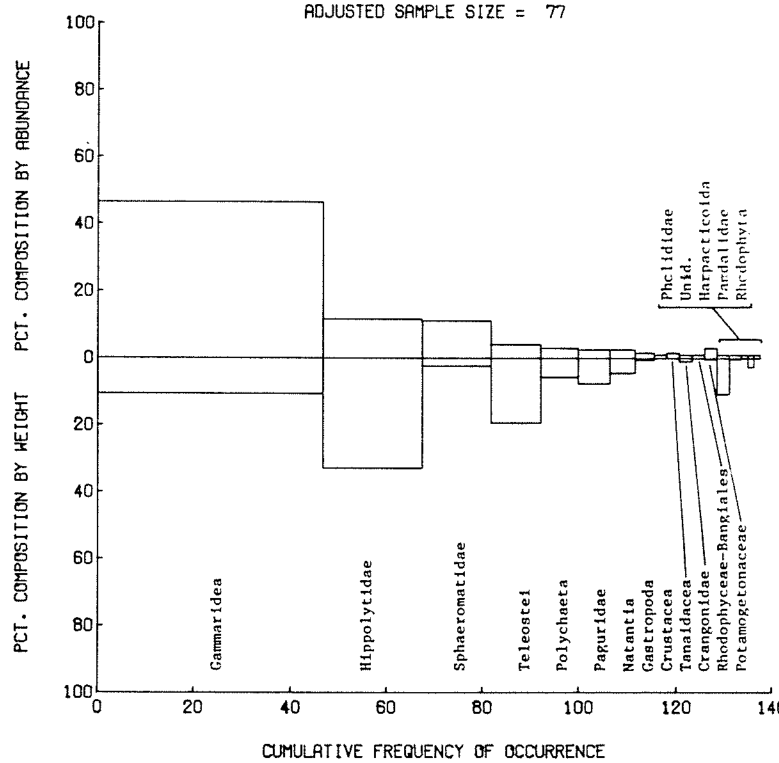
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM. COMP.	GRAV. COMP.	PERCENT TOTAL IRI
PERCENT DOMINANCE INDEX	.16	.12	.24
SHANNON-WEINER DIVERSITY	3.37	3.51	2.64
EVENNESS INDEX	.66	.69	.51

App. Fig. 9n. IRI prey spectrum of padded sculpin along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831020403 - ARTEDIUS LATERALIS
SMOOTHHEAD SCULPIN
ADJUSTED SAMPLE SIZE = 77



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	46.75	46.46	10.69	2672.2	62.37
HIPPOLYTIDAE	20.78	11.62	32.91	925.1	21.59
SPHAEROMATIDAE	14.29	11.11	2.42	193.3	4.51
TELEOSTEI	10.39	4.04	19.37	243.2	5.68
POLYCHAETA	7.79	3.03	5.70	68.0	1.59
PAGURIDAE	6.49	2.53	7.66	66.2	1.54
NATANTIA	5.19	2.53	4.47	36.4	.85
GASTROPODA	3.90	1.52	.53	8.0	.19
CRUSTACEA	2.60	1.01	.08	2.8	.07
TANAIDACEA	2.60	1.52	.02	4.0	.09
CRANGONIDAE	2.60	1.01	.94	5.1	.12
RHODOPHYCEAE-BANGIALES	2.60	1.01	.04	2.7	.06
POTAMOGETONACEAE	2.60	3.03	.25	8.5	.20
PHOLIDIDAE	2.60	1.01	10.80	30.7	.72
UNIDENTIFIED	2.60	1.01	.25	3.3	.08
HARPACTICOIDA	1.30	1.01	.00	1.3	.03
PANDALIDAE	1.30	1.01	2.64	4.7	.11
RHODOPHYTA	1.30	1.01	.02	1.3	.03

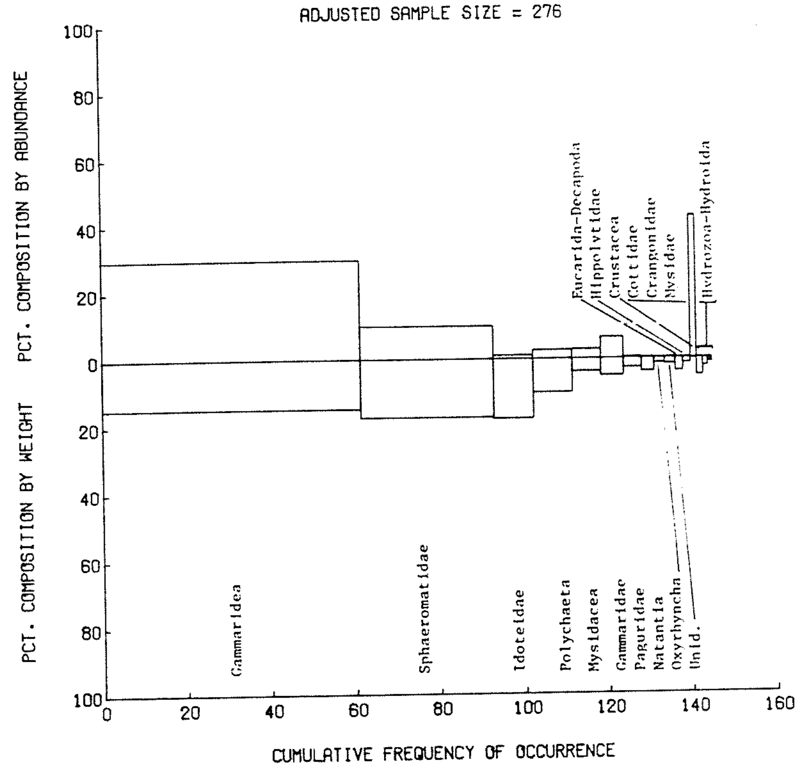
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM.	GRAV.	PERCENT TOTAL IRI
PERCENT DOMINANCE INDEX	.25	.18	.44
SHANNON-WEINER DIVERSITY	3.05	2.93	1.75
EVENNESS INDEX	.64	.62	.37

App. Fig. 9o. IRI prey spectrum of smoothhead sculpin along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831020501 - ASCELICHTHYS RHODORUS
ROSYLIP SCULPIN
ADJUSTED SAMPLE SIZE = 276

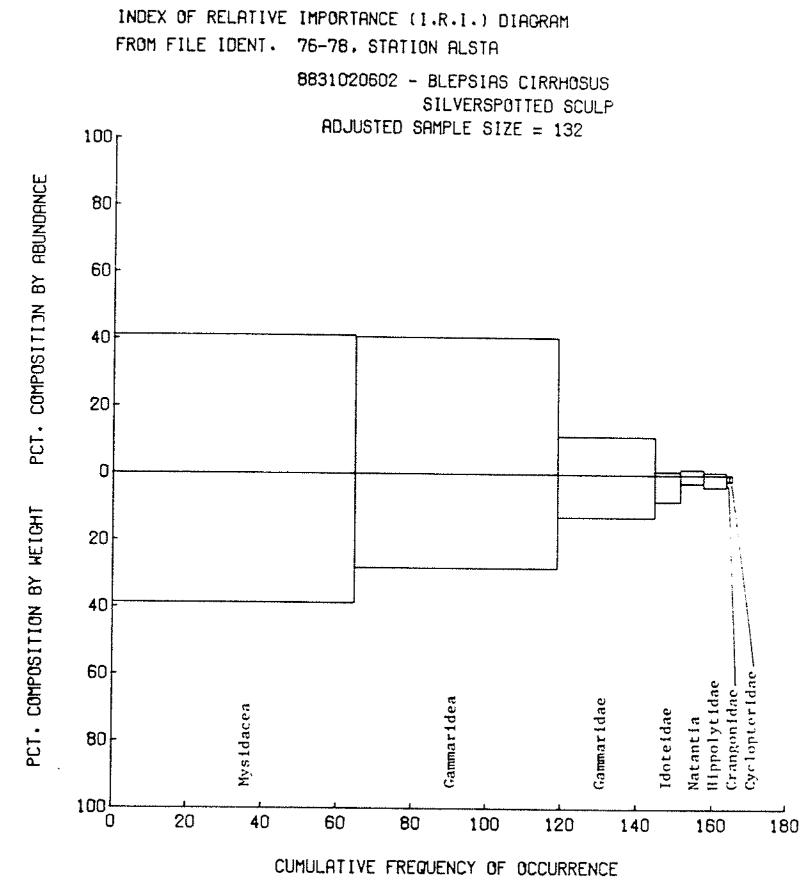


PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	61.59	29.66	14.76	2735.9	66.32
SPHAEROMATIDAE	31.52	9.87	17.33	857.2	20.78
IDOTEIDAE	9.42	1.01	17.76	176.9	4.29
POLYCHAETA	9.42	2.54	10.07	118.8	2.88
MYSIDACEA	6.88	2.73	3.93	45.9	1.11
GAMMARIDAE	5.43	6.20	5.21	62.0	1.50
PAGURIDAE	4.35	.37	2.89	14.2	.34
NATANTIA	2.90	.28	3.98	12.4	.30
OXRHYNCHA	2.54	.23	1.53	4.4	.11
UNIDENTIFIED	2.54	.25	1.72	5.0	.12
EUCARIDA-DECAPODA	1.81	.23	3.87	7.4	.18
HIPPOLYTIDAE	1.81	.17	1.55	3.1	.08
CRUSTACEA	1.45	42.37	.15	61.6	1.49
COTTIDAE	1.45	.11	5.23	7.7	.19
CRANGONIDAE	1.09	.08	2.47	2.8	.07
MYSIDAE	.72	.23	1.29	1.1	.03
HYDROZOA-HYDROIDA	.36	.03	1.31	.5	.01

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX		.28	.11		.49
SHANNON-WEINER DIVERSITY		2.48	3.75		1.61
EVENNESS INDEX		.44	.66		.28

App. Fig. 9p. IRI prey spectrum of rosylip sculpin along the Strait of Juan de Fuca, 1976-78.



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
MYSIDACEA	64.39	41.13	38.76	5144.3	53.32
GAMMARIDEA	54.55	40.65	28.21	3756.4	38.93
GAMMARIDAE	25.76	11.35	12.81	622.4	6.45
IDOTEIDAE	6.82	1.00	8.02	61.5	.64
NATANTIA	6.06	1.64	2.46	24.8	.26
HIPPOLYTIDAE	6.06	.90	3.61	27.3	.28
CRANGONIDAE	.76	.11	1.85	1.5	.02
CYCLOPTERIDAE	.76	.05	1.85	1.4	.01

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX		.35	.26		.44
SHANNON-WEINER DIVERSITY		1.91	2.44		1.38
EVENNESS INDEX		.44	.56		.32

App. Fig. 9q. IRI prey spectrum of silverspotted sculpin along the Strait of Juan de Fuca, 1976-78.

Sharpnose Sculpin, Clinocottus acuticeps

Sharpnose sculpin were familiar members of the tidepool fish assemblages at Slip Point, Morse Creek, and North Beach, but only at Point Williams were they collected by the beach seine. Gammarid amphipods and sphaeromatid isopods (Gnorimosphaeroma oregonensis, Exosphaeroma amplicauda, and Dynamenella sheareri) made up 94% of the total IRI (App. Fig. 9r).

Calico Sculpin, Clinocottus embryum

Stomach samples from calico sculpin originated only from tidepool collections, mostly at Observatory Point and Slip Point. As with the sharpnose sculpin, gammarid amphipods and sphaeromatid isopods made up the majority of the IRI prey spectrum for the calico sculpin; however, barnacles were also a numerous (40% of total prey abundance) component in the diet.

Mosshead Sculpin, Clinocottus globiceps

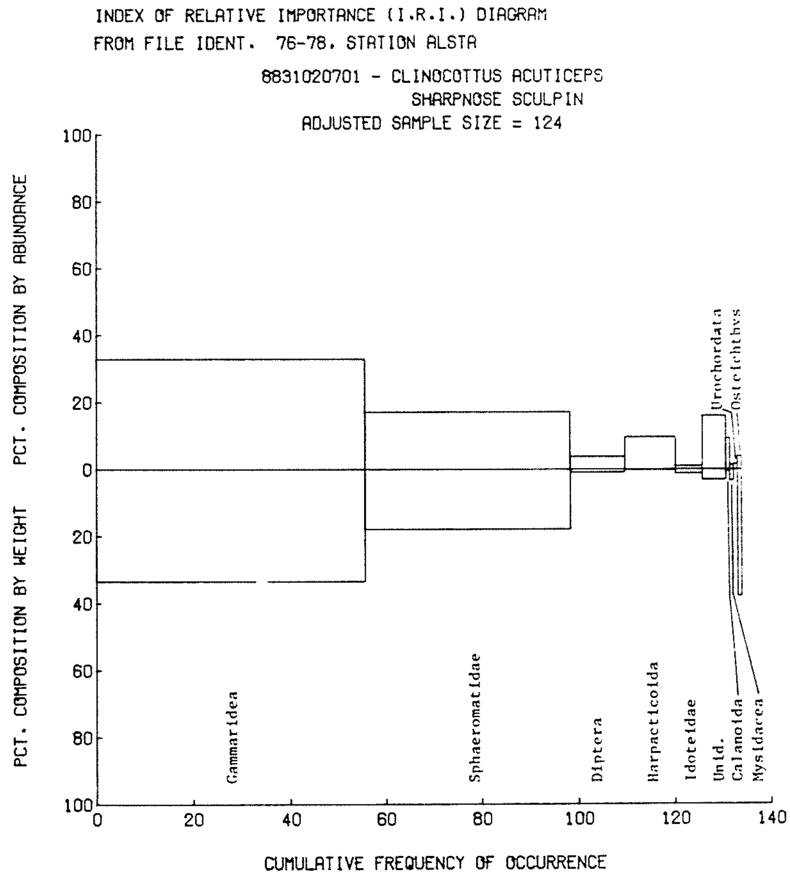
Also restricted to tidepool collections, mosshead sculpin were particularly abundant at Slip Point and Observatory Point. Their diet was more diverse and quite different from the other two Clinocottus species. Barnacles were the predominant prey organism while gammarid amphipods and sphaeromatid isopods did not contribute significantly to the diet (App. Fig. 9s). Algae (including Urospora mirabilis, Porphyra sp., and Iridaea sp.) composed 38.7% of the total IRI, followed by harpacticoid copepods, sabellid annelids, nemertean worms, and ostracods.

Buffalo Sculpin, Enophrys bison

Among the beach seine collections, buffalo sculpin, mainly juveniles, were most common at Twin Rivers and Beckett Point. Tidepool collections at Observatory Point and North Beach also provided a few specimens. Gammarid amphipods, algae (including Enteromorpha intestinalis, Ulva fenestrata, Porphyra sp., and Phyllospadix sp.), and polychaete annelids were identified as the principal components of the overall prey spectrum (App. Fig. 9t). The high incidence (31.5% of total IRI) of algae suggests that they may constitute more than an incidentally consumed food item.

Pacific Staghorn Sculpin, Leptocottus armatus

Pacific staghorn sculpin were one of the few nearshore demersal species which occurred commonly in the beach seine collections at all sites; however, collections at Jamestown and Beckett Point provided more specimens than the other sites. The diverse prey spectrum (App. Fig. 9u) included both benthic and epibenthic organisms, dominated by fish (46% of total IRI, including Enophrys bison, Cymatogaster aggregata, Ammodytes hexapterus, Aulorhynchus flavidus, Oncorhynchus sp., Leptocottus armatus, and unidentified pleuronectids), true shrimp (17.5% of total IRI, including Heptacarpus taylori, Pandalus danae, Crangon alaskensis, and C. stylirostris), mysids (11.7% of total IRI, including Neomysis awatschensis), polychaete annelids, and crabs (6.2% of total IRI, including Pugettia richi, Telmessus cheiragonus, Cancer magister, and Hemigrapsis oregonensis).



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	55.65	32.86	33.49	3692.4	67.08
SPHAEROMATIDAE	42.74	17.14	17.87	1496.2	27.18
DIPTERA	11.29	3.76	.94	53.0	.96
HARPACTICOIDA	10.48	9.62	.23	103.3	1.88
IDOTEIDAE	5.65	.94	1.35	12.9	.24
UNIDENTIFIED	4.84	15.96	3.11	92.3	1.68
CALANOIDA	.81	9.27	.56	7.9	.14
MYSIDACEA	.81	1.17	3.44	3.7	.07
UROCHORDATA	.81	1.53	.01	1.2	.02
OSTEICHTHYS	.81	3.87	37.86	33.7	.61

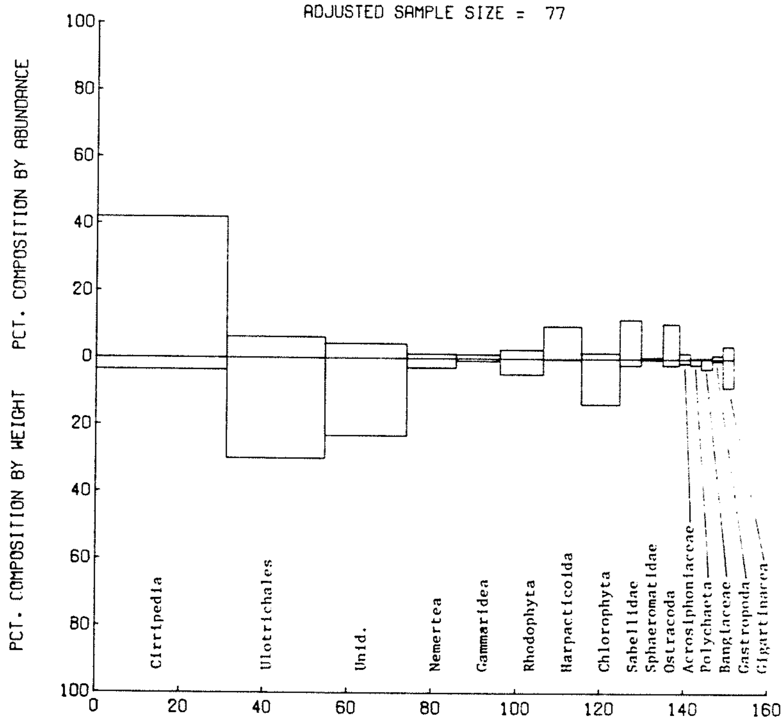
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.18	.29	.52
SHANNON-WEINER DIVERSITY	2.92	2.14	1.27
EVENNESS INDEX	.66	.49	.29

App. Fig. 9r. IRI prey spectrum of sharpnose sculpin along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831020703 - CLINOCOTTUS GLOBICEPS
MOSSHEAD SCULPIN
ADJUSTED SAMPLE SIZE = 77



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
CIRRIPEDIA	31.17	41.89	3.68	1420.3	42.17
ULOTRICHALES	23.38	6.22	30.04	847.6	25.17
UNIDENTIFIED	19.48	4.32	23.22	536.7	15.93
NEMERTEA	11.69	1.35	2.85	49.1	1.46
GAMMARIDEA	10.39	1.22	.78	20.7	.62
RHODOPHYTA	10.39	2.70	4.75	77.4	2.30
HARPACTICOIDA	9.09	9.73	.26	90.8	2.70
CHLOROPHYTA	9.09	1.76	13.63	139.9	4.15
SABELLIDAE	5.19	11.76	1.95	71.2	2.11
SPHAEROMATIDAE	5.19	.54	.24	4.1	.12
OSTRACODA	3.90	10.54	1.95	48.7	1.45
ACROSIPHONIACEAE	2.60	1.76	1.35	8.1	.24
POLYCHAETA	2.60	.27	1.72	5.2	.15
BANGIACEAE	2.60	.27	3.00	8.5	.25
GASTROPODA	2.60	1.08	.68	4.6	.14
GIGARTINACEA	2.60	3.78	8.54	32.0	.95

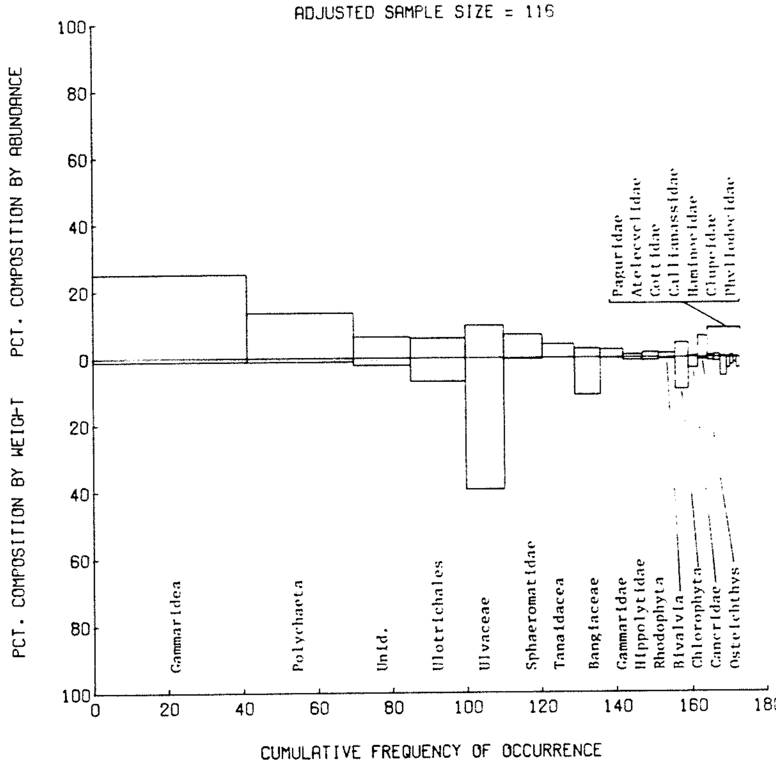
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.22	.18			.27
SHANNON-WEINER DIVERSITY	2.92	3.05			2.40
EVENNESS INDEX	.67	.69			.55

App. Fig. 9s. IRI prey spectrum of mosshead sculpin along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831021001 - ENOPHRYS BISON
BUFFALO SCULPIN
ADJUSTED SAMPLE SIZE = 116



PREY ITEM	FREQ. OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	41.38	25.06	1.13	1083.6	40.25
POLYCHAETA	28.45	13.49	1.22	418.5	15.54
UNIDENTIFIED	15.52	6.27	2.17	131.0	4.86
ULOTRICHALES	14.66	5.90	7.01	189.3	7.03
ULVACEAE	10.34	9.64	39.26	505.8	18.79
SPHAEROMATIDAE	10.34	6.87	.40	75.2	2.79
TANAIDACEA	8.62	3.98	.03	34.5	1.28
BANGIACEAE	6.90	2.65	11.16	95.3	3.54
GAMMARIDAE	6.03	2.41	.21	15.8	.59
HIPPOLYTIDAE	5.17	.84	.88	8.9	.33
RHODOPHYTA	4.31	1.45	.92	10.2	.38
BIVALVIA	4.31	1.20	.47	7.2	.27
CHLOROPHYTA	3.45	4.34	9.50	47.7	1.77
CANCRIDAE	2.59	.36	3.22	9.3	.34
OSTEICHTHYS	2.59	6.27	.67	17.9	.67
PAGURIDAE	1.72	.60	1.01	2.8	.10
ATELECYCLIDAE	1.72	.84	1.17	3.5	.13
COTTIDAE	1.72	.24	5.60	10.1	.37
CALLIANASSIDAE	.86	.12	3.33	3.0	.11
HAMINOEIDAE	.86	.60	2.33	2.5	.09
CLUPEIDAE	.86	.12	1.62	1.5	.06
PHYLLODOCIDAE	.86	.12	3.27	2.9	.11

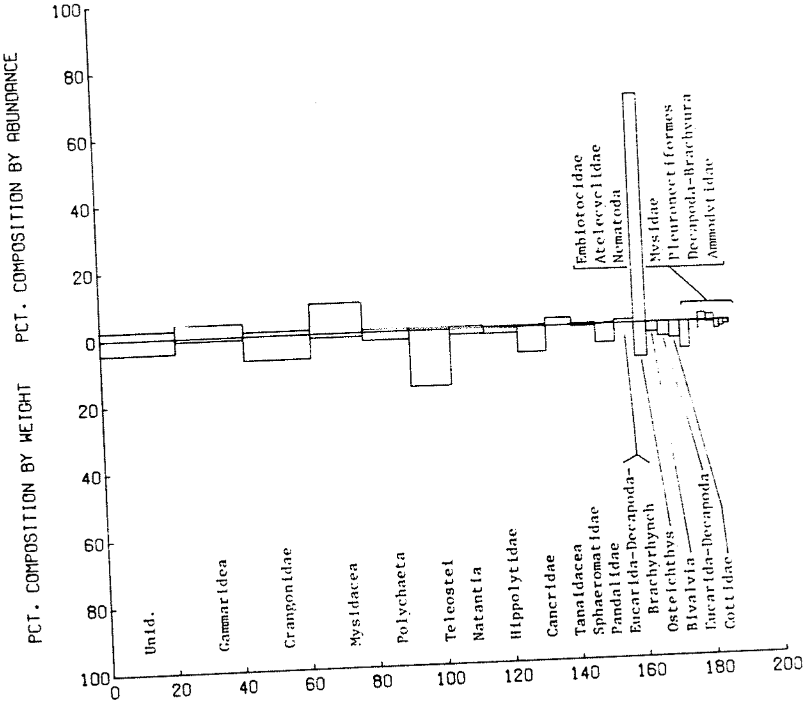
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.11	.19	.23
SHANNON-WEINER DIVERSITY	3.85	3.36	2.73
EVENNESS INDEX	.71	.62	.50

App. Fig. 9t. IRI prey spectrum of buffalo sculpin along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-76, STATION ALSTA

8831021801 - LEPTOCOTTUS ARMATUS
PAC. STAGHORN SCULPN
ADJUSTED SAMPLE SIZE = 294



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
UNIDENTIFIED	22.45	2.33	4.46	152.4	10.73
GAMMARIDEA	20.41	3.85	.93	97.6	6.87
CRANGONIDAE	20.07	1.24	7.22	169.7	11.95
MYSIDACEA	15.65	9.06	1.19	160.4	11.29
POLYCHAETA	13.61	.90	2.45	45.6	3.21
TELEOSTEI	11.90	.74	16.68	207.3	14.60
NATANTIA	10.20	.72	1.58	23.5	1.65
HIPPOLYTIDAE	9.86	.49	1.73	21.8	1.54
CANCRIDAE	8.50	.50	7.69	69.6	4.90
TANAIDACEA	7.82	2.30	.03	18.2	1.28
SPHAEROMATIDAE	7.14	.54	.38	6.6	.46
PANDALIDAE	5.78	.29	5.60	34.0	2.40
EUCARIDA-DECAPODA-BRACHYRHYNCH	5.78	.98	1.80	16.0	1.13
OSTEICHTHYS	3.74	68.44	10.23	294.4	20.73
BIVALVIA	3.40	.18	2.84	10.3	.72
EUCARIDA-DECAPODA	3.40	.12	4.29	15.0	1.06
COTTIDAE	3.06	.10	4.86	15.2	1.07
EMBIOTOCIDAE	2.72	.12	8.05	22.2	1.57
ATELECYCLIDAE	2.72	.08	2.71	7.6	.54
NEMATODA	2.38	2.21	.05	5.4	.38
MYSIDAE	2.38	1.76	.48	5.3	.37
PLEURONECTIFORMES	1.36	.04	2.63	3.6	.26
DECAPODA-BRACHYURA	1.36	.16	1.84	2.7	.19
AMMODYTIDAE	1.36	.05	1.30	1.8	.13
CLUPEIDAE	.34	.01	1.12	.4	.03

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM. COMP.	GRAV. COMP.	PERCENT TOTAL IRI
PERCENT DOMINANCE INDEX	.48	.07	.11
SHANNON-WEINER DIVERSITY	2.14	4.40	3.63
EVENNESS INDEX	.36	.73	.61

App. Fig. 9u. IRI prey spectrum of Pacific staghorn sculpin along the Strait of Juan de Fuca, 1976-78.

Tidepool Sculpin, Oligocottus maculosus

Tidepool sculpin were the predominant fish in the intertidal collections. They were especially abundant at four sites--Slip Point, Observatory Point, Twin Rivers, and North Beach. As in the diet of the sharpnose and calico sculpins, gammarid amphipods and the three sphaeromatid isopod species dominated the prey spectrum of the tidepool sculpin (App. Fig. 9v), combining for 80.3% of the total IRI. Harpacticoid copepods (8.2% of total IRI), polychaete annelids (4.9%), and barnacles (4.3%) constituted the more important secondary prey items. Composition of the principal prey was almost identical in 1976 and 1977 (App. Table 9m); only barnacles, a secondary food taxon, shifted from third to fifth in importance between the two years. Gammarid amphipods, the dietary mainstay, ranked either first or second at all tidepool sites (App. Table 9n). Sphaeromatid isopods were quite important at the sites in the eastern half of the strait but were only fourth or fifth in importance at the three western sites; there, barnacles and harpacticoid copepods or hermit crabs replaced sphaeromatid isopods.

Saddleback Sculpin, Oligottus rimensis

The saddleback sculpin, a tidepool species, was abundant only at Slip Point and Observatory Point. Like the tidepool sculpin, the saddleback sculpin fed primarily upon gammarid amphipods; but, unlike the tidepool sculpin, the second most important prey for the saddleback sculpin was harpacticoid copepods instead of sphaeromatic isopods (App. Fig. 9w). The dissimilar contributions by these isopods were reflected in the species composition: Gnorimosphaeroma oregonensis and Exosphaeroma amplicauda were the principal species (183/53 ratio) in tidepool sculpin whereas saddleback sculpin fed almost exclusively upon Dynamenella sheareri.

Fluffy Sculpin, Oligocottus snyderi

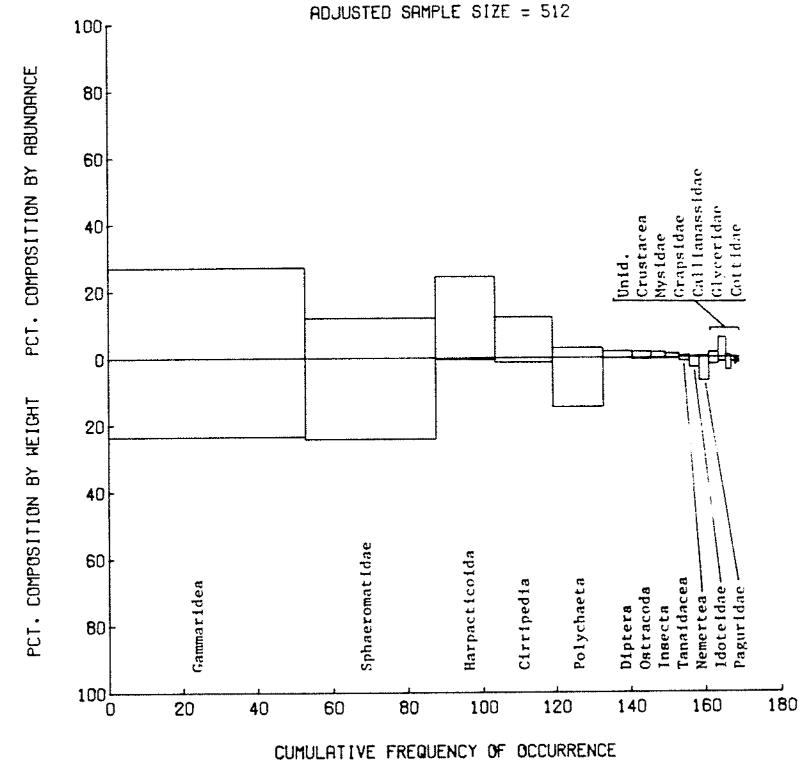
Another tidepool sculpin, O. snyderi, was common in collections from Slip Point, Observatory Point, and Neah Bay. Among the three Oligocottus species, gammarid amphipods contributed more to the prey spectrum of the fluffy sculpin; accordingly, sphaeromatid isopods were the least important in the diet of this species (App. Fig. 9x). The three isopod species--Gnorimosphaeroma oregonensis, Exosphaeroma amplicauda, and Dynamenella sheareri--were equally represented. Harpacticoid copepods, polychaetes, and idoteid isopods were secondary food organisms.

Roughback Sculpin, Chitonotis pugetensis

Roughback sculpin typically occurred only in winter beach seine collections at Beckett Point. Shrimp, including hippolytids such as Heptacarpus tenuissimus, crangonids such as Sclerocrangon alata and Crangon sp., and unidentified pandalids, composed 83.5% of the total IRI. Gammarid amphipods and polychaete annelids were of minor importance (App. Fig. 9y).

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831022401 - OLIGOCOTTUS MACULOSUS
TIDEPOOL SCULPIN
ADJUSTED SAMPLE SIZE = 512



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	52.93	27.07	23.46	2674.7	54.62
SPHAEROMATIDAE	34.77	11.96	24.17	1255.9	25.65
HARPACTICOIDA	16.02	24.30	.61	399.0	8.15
CIRRIPEDIA	15.63	12.16	1.38	211.6	4.32
POLYCHAETA	13.67	2.64	14.72	240.0	4.90
DIPTERA	7.81	1.77	.26	15.9	.32
OSTRACODA	5.08	1.68	.59	11.5	.24
INSECTA	3.91	1.52	.37	7.4	.15
TANAIDACEA	3.71	1.09	.30	5.2	.11
NEMERTEA	2.73	.54	1.08	4.4	.09
IDOTEIDAE	2.54	.36	3.00	8.5	.17
PAGURIDAE	2.54	.39	7.00	18.8	.38
UNIDENTIFIED CRUSTACEA	2.54	1.45	2.00	8.8	.18
MYSIDAE	1.95	5.79	1.24	13.7	.28
GRAPSIDAE	1.37	.75	3.84	6.3	.13
CALLIANASSIDAE	.98	.20	1.35	1.5	.03
GLYCERIDAE	.39	.05	2.36	.9	.02
COTTIDAE	.39	.11	1.76	.7	.01
	.39	.05	1.57	.6	.01

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.17	.15	.38
SHANNON-WEINER DIVERSITY	3.27	3.63	1.90
EVENNESS INDEX	.55	.61	.32

App. Fig. 9v. IRI prey spectrum of tidepool sculpin along the Strait of Juan de Fuca, 1976-78.

App. Table 9m. IRI comparison of principal prey organisms of tidepool sculpin from 1976 (n=136) and 1977 (n=376) tidepool collections.

Prey	Freq. occur. % 1976	Freq. occur. % 1977	Numer. comp. % 1976	Numer. comp. % 1977	Grav. comp. % 1976	Grav. comp. % 1977	Total IRI % 1976	Total IRI % 1977	IRI rank 1976	IRI rank 1977
Sphaeromatid isopods	41.2	32.4	18.9	9.6	34.4	21.3	37.6	21.1	2	2
Gammarid amphipods	54.4	52.4	24.0	28.1	18.2	24.9	39.4	58.4	1	1
Barnacles	26.5	11.7	32.3	5.3	2.8	1.0	15.9	1.6	3	5
Harpacticoid copepods	14.0	16.8	13.2	28.1	0.5	0.5	3.3	10.1	4	3
Polychaetes	8.8	15.4	3.6	2.6	12.7	15.3	2.5	5.8	5	4

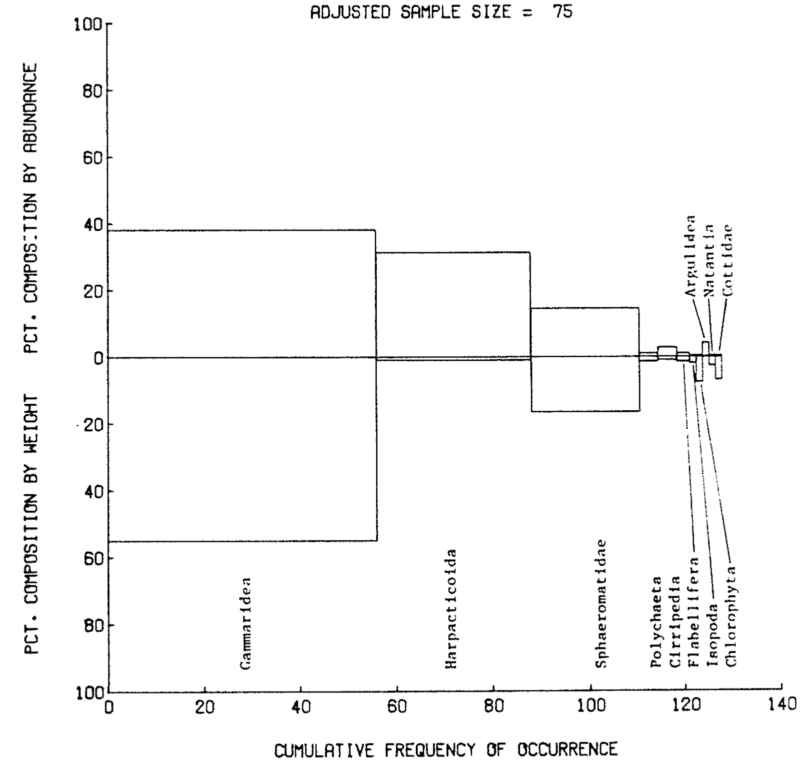
App. Table 9n. IRI comparison of principal prey organisms of tidepool sculpin at North Beach (NO, n=81), Morse Creek (MC, n=74), Twin Rivers (TR, n=90), Observatory Point (OP, n=102), Slip Point (SP, n=78), and Neah Bay (NE, n=27), in 1976-77 tidepool collections.

Prey	Freq. occur., % NO	MC	TR	OP	SP	NE	Numer. comp., % NO	MC	TR	OP	SP	NE
Sphaeromatid isopods	69.1	34.1	50.0	19.6	20.5	18.5	33.7	11.4	26.7	1.6	6.0	5.2
Gammarid amphipods	58.1	60.8	43.3	49.0	52.6	51.9	40.2	35.6	41.7	8.2	32.7	30.5
Barnacles	24.7	--	6.7	22.6	28.2	--	15.6	--	4.1	13.2	22.8	--
Harpacticoid copepods	--	10.8	--	50.0	14.1	25.9	--	22.5	--	54.5	4.9	19.3
Polychaetes	9.9	5.4	15.6	13.7	19.2	18.5	1.2	1.9	10.7	1.1	3.1	3.3
Hermit crabs	--	--	4.4	1.0	2.6	22.2	--	--	0.9	0.1	0.3	4.7

Prey	Grav. comp., % NO	MC	TR	OP	SP	NE	Total IRI, % NO	MC	TR	OP	SP	NE	IRI rank NO	MC	TR	OP	SP	NE
Sphaeromatid isopods	37.9	32.9	44.3	6.3	3.5	11.4	54.2	27.2	52.3	2.6	4.2	5.9	1	2	1	5	4	5
Gammarid amphipods	18.6	23.3	23.1	29.1	21.1	5.4	37.4	62.6	41.6	31.1	61.0	36.0	2	1	2	2	1	1
Barnacles	1.3	--	0.2	5.2	2.7	--	4.6	--	0.4	7.0	15.5	--	3	--	4	3	2	--
Harpacticoid copepods	--	0.5	--	5.4	0.1	0.1	--	4.4	--	51.0	1.5	9.7	--	3	--	1	6	3
Polychaetes	8.9	13.5	6.1	19.8	24.1	9.7	1.1	1.5	3.9	4.9	11.3	4.6	5	4	3	4	3	7
Hermit crabs	--	--	5.3	1.6	3.9	60.2	--	--	0.4	0.0	0.2	27.8	--	--	5	17	12	2

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831022402 - OLIGOCOTTUS RIMENSIS
SADDLEBACK SCULPIN
ADJUSTED SAMPLE SIZE = 75



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	56.00	38.14	55.04	5218.5	74.16
HARPACTICOIDA	32.00	31.27	1.03	1033.7	14.69
SPHAEROMATIDAE	22.67	14.43	16.57	702.7	9.99
POLYCHAETA	4.00	1.03	1.44	9.9	.14
CIRRIPEDIA	4.00	2.75	.98	14.9	.21
FLABELLIFERA	2.67	1.03	1.44	6.6	.09
ISOPODA	1.33	.34	1.92	3.0	.04
CHLOROPHYTA	1.33	.34	7.68	10.7	.15
ARGULIDEA	1.33	4.12	.02	5.5	.08
NATANTIA	1.33	.34	2.64	4.0	.06
COTTIDAE	1.33	.34	6.96	9.7	.14

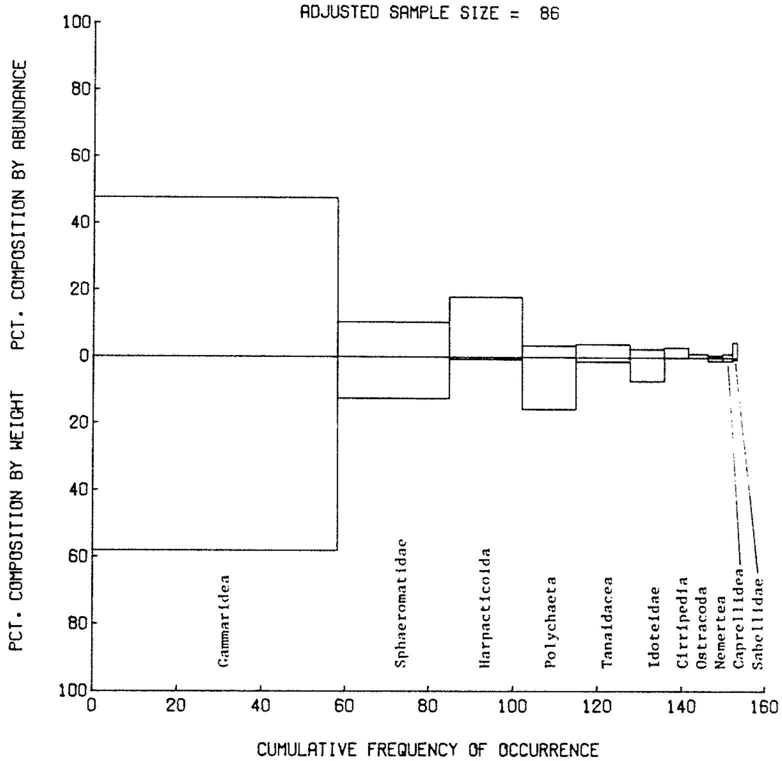
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.27	.34	.58
SHANNON-WEINER DIVERSITY	2.50	2.35	1.18
EVENNESS INDEX	.54	.51	.25

App. Fig. 9w. IRI prey spectrum of saddleback sculpin along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831022403 - OLIGOCOTTUS SNYDERI
FLUFFY SCULPIN
ADJUSTED SAMPLE SIZE = 86

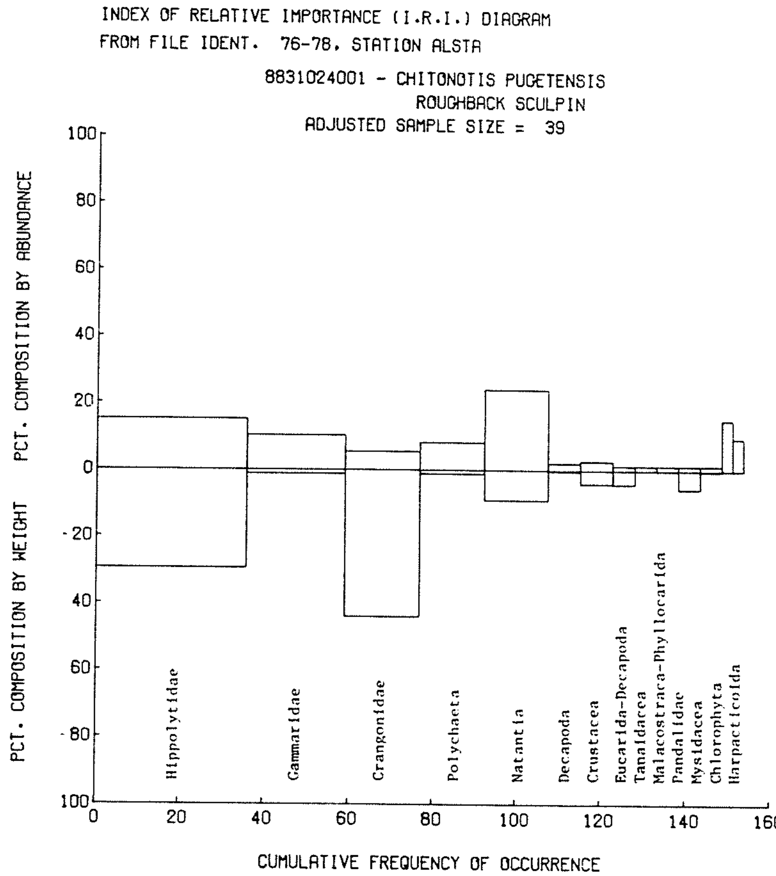


PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	58.14	47.58	58.10	6143.7	81.64
SPHAEROMATIDAE	26.74	10.39	12.51	612.6	8.14
HARPACTICOIDA	17.44	18.01	.76	327.5	4.35
POLYCHAETA	12.79	3.46	15.64	244.3	3.25
TANAIDACEA	12.79	3.93	1.34	67.3	.89
IDOTEIDAE	8.14	2.54	7.14	78.8	1.05
CIRRIPEDIA	5.81	3.00	.14	18.3	.24
OSTRACODA	4.65	1.15	.03	5.5	.07
NEMERTEA	3.49	.69	1.00	5.9	.08
CAPRELLIDEA	2.33	1.15	1.00	5.0	.07
SABELLIDAE	1.16	4.62	.75	6.2	.08

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.28	.38	.68
SHANNON-WEINER DIVERSITY	2.61	1.99	1.09
EVENNESS INDEX	.60	.46	.25

App. Fig. 9x. IRI prey spectrum of fluffy sculpin along the Strait of Juan de Fuca, 1976-78.



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
HIPPOLYTIDAE	35.90	15.07	29.50	1600.0	44.01
GAMMARIDAE	23.08	10.27	1.27	266.5	7.33
CRANGONIDAE	17.95	5.48	44.14	890.6	24.50
POLYCHAETA	15.38	8.22	1.23	145.4	4.00
NATANTIA	15.38	23.97	9.13	509.2	14.01
DECAPODA	7.69	2.05	.43	19.1	.53
CRUSTACEA	7.69	2.74	4.08	52.4	1.44
EUCARIDA-DECAPODA	5.13	1.37	4.19	28.5	.78
TANAIDACEA	5.13	1.37	.00	7.0	.19
MALACOSTRACA PHYLLOCARIDA	5.13	1.37	.05	7.3	.20
PANDALIDAE	5.13	1.37	5.62	35.9	.99
MYSIDACEA	5.13	1.37	.32	8.7	.24
CHLOROPHYTA	2.56	15.07	.00	38.6	1.06
HARPACTICOIDA	2.56	9.59	.00	24.6	.68

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.13	.30	.28
SHANNON-WEINER DIVERSITY	3.23	2.20	2.31
EVENNESS INDEX	.83	.56	.59

App. Fig. 9y. IRI prey spectrum of roughback sculpin along the Strait of Juan de Fuca, 1976-78.

Sturgeon Poacher, *Agonus acipenserinus*

Winter beach seine collections at Beckett Point and West Beach furnished the greatest number of sturgeon poachers for stomach analysis. The overall prey spectrum (App. Fig. 9z) was divided among cumaceans (36.3% of total IRI), gammarid amphipods (29.6%), and harpacticoid copepods (22.9%) as primary prey organisms, and crangonid shrimp (including *Crangon alaskensis* and *C. stylirostris*) as secondary prey.

Tubenose Poacher, *Pallasina barbata*

Beach seine collections at Twin Rivers and Morse Creek provided over half of the tubenose poacher stomach samples. These small poachers appeared to be highly selective toward mysids, regardless of the source of the samples (App. Fig. 9aa).

Ribbon Snailfish, *Liparis cyclopus*

Both beach seine and tidepool collections produced some specimens of *L. cyclopus*, mostly from Jamestown and Twin Rivers. Over 94% of the total IRI was contributed by gammarid amphipods. Sphaeromatid isopods (*Gnorimosphaeroma oregonensis* and *Exosphaeroma amplicauda*) and mysids provided the remaining 6% (App. Fig. 9bb).

Tidepool Snailfish, *Liparis florae*

The most common snailfish in the intertidal collections, tidepool snailfish were regularly collected at Morse Creek, Observatory Point, and Slip Point. As in the case of the ribbon snailfish, gammarid amphipods contributed over 94% of the total IRI. Idoteid isopods (including *Synidotea* sp., *Idotea wosnesenski*, and *Pentidotea montereyensis*) and harpacticoid copepods were also common prey items (App. Fig. 9cc). Prey composition of tidepool snailfish at the three sites differed slightly in 1977 (App. Table 9o). The primary prey taxon was gammarid amphipods at all three sites and the secondary prey were idoteid isopods, except at Observatory Point where harpacticoid copepods were more important.

Shiner Perch, *Cymatogaster aggregata*

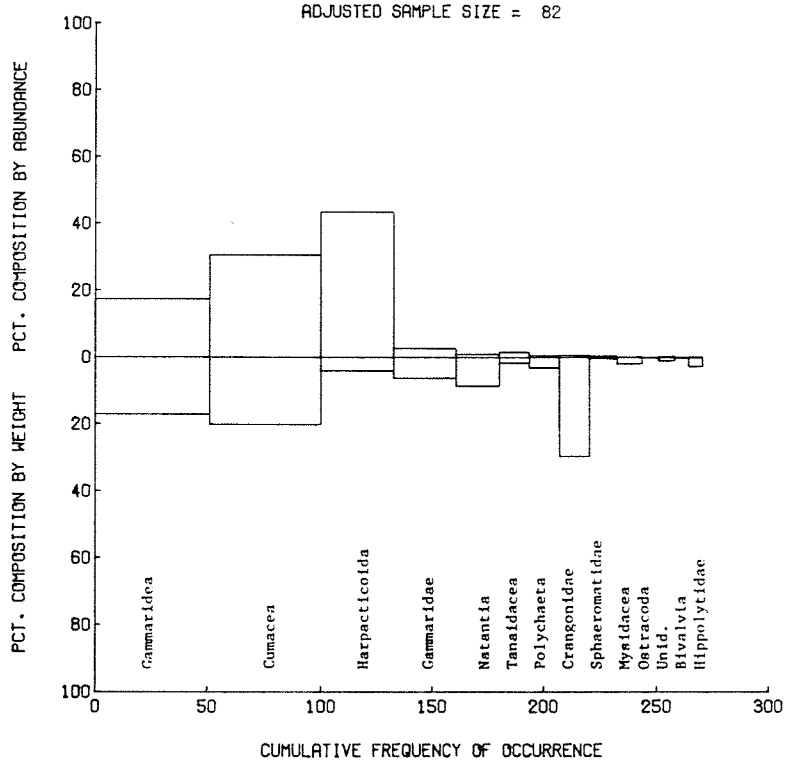
Shiner perch appeared to be one of the principal schooling nearshore fishes characterizing the eastern sites, especially Beckett Point and Jamestown. The diverse IRI prey spectrum was composed of gammarid amphipods (47% of total IRI), cumaceans, harpacticoid copepods, tanaids, sphaeromatid isopods (including *Gnorimosphaeroma oregonensis* and *Exosphaeroma amplicauda*), algae, and calanoid copepods (App. Fig. 9dd).

Striped Seaperch, *Embiotoca lateralis*

Beach seine collections at Beckett Point, Twin Rivers, and Morse Creek provided the majority of the striped seaperch stomach samples. Over 90% of the striped seapearch prey spectrum was made up of gammarid amphipods, supplemented by sphaeromatid (*Gnorimosphaeroma oregonensis*) and idoteid (*Synidotea nodulosa*) isopods.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831080802 - AGONUS ACIPENSERINUS
STURGEON POACHER
ADJUSTED SAMPLE SIZE = 82



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	51.22	17.33	17.15	1765.9	25.91
CUMACEA	48.78	30.48	20.19	2471.6	36.27
HARPACTICOIDA	32.93	43.31	4.13	1562.2	22.93
GAMMARIDAE	28.05	2.68	6.27	251.3	3.69
NATANTIA	19.51	.92	8.68	187.4	2.75
TANAIDACEA	13.41	1.53	1.74	43.8	.64
POLYCHAETA	13.41	.62	3.10	50.0	.73
CRANGONIDAE	13.41	.68	29.58	406.0	5.96
SPHAEROMATIDAE	12.20	.49	.41	11.0	.16
MYSIDACEA	10.98	.30	1.88	23.9	.35
OSTRACODA	7.32	.09	.08	1.2	.02
UNIDENTIFIED	7.32	.33	.93	9.2	.13
BIVALVIA	6.10	.15	.19	2.0	.03
HIPPOLYTIDAE	6.10	.21	2.64	17.4	.26

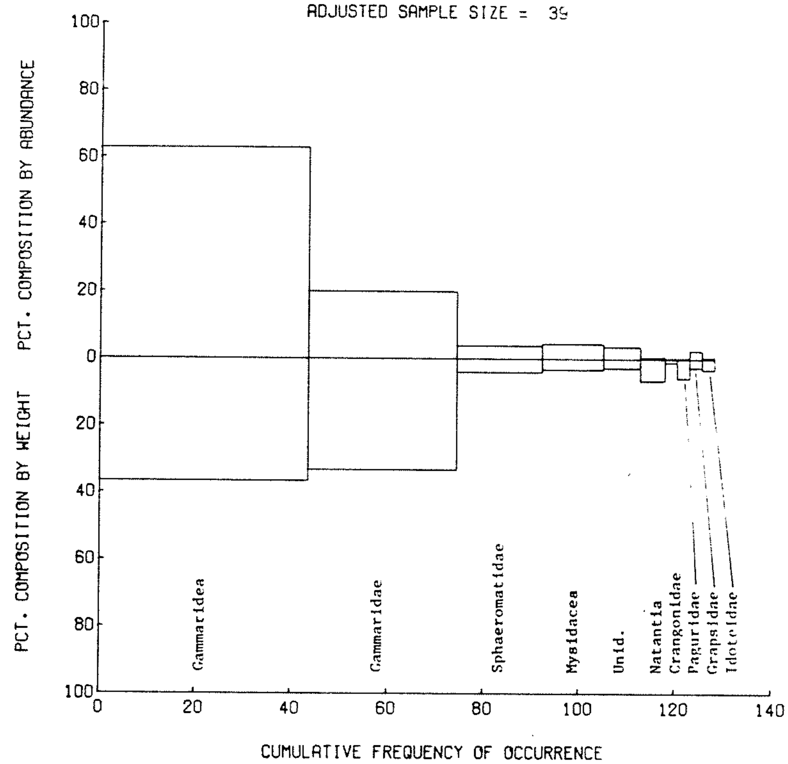
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM.	GRAV.	PERCENT TOTAL IRI
PERCENT DOMINANCE INDEX	.31	.17	.26
SHANNON-WEINER DIVERSITY	2.09	3.02	2.29
EVENNESS INDEX	.44	.64	.48

App. Fig. 9z. IRI prey spectrum of sturgeon poacher along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831090806 - LIPARIS CYCLOPUS
RIBBON SNAILFISH
ADJUSTED SAMPLE SIZE = 39



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	43.59	62.78	36.65	4334.1	68.29
GAMMARIDAE	30.77	20.00	33.29	1639.6	25.83
SPHAEROMATIDAE	17.95	3.89	4.05	142.5	2.25
MYSIDACEA	12.82	4.44	3.25	98.6	1.55
UNIDENTIFIED	7.69	3.61	2.78	49.2	.77
NATANTIA	5.13	.56	6.54	36.4	.57
CRANGONIDAE	2.56	.28	1.04	3.4	.05
PAGURIDAE	2.56	.28	5.73	15.4	.24
GRAPSIDAE	2.56	2.50	2.61	13.1	.21
IDOTEIDAE	2.56	.56	3.18	9.6	.15

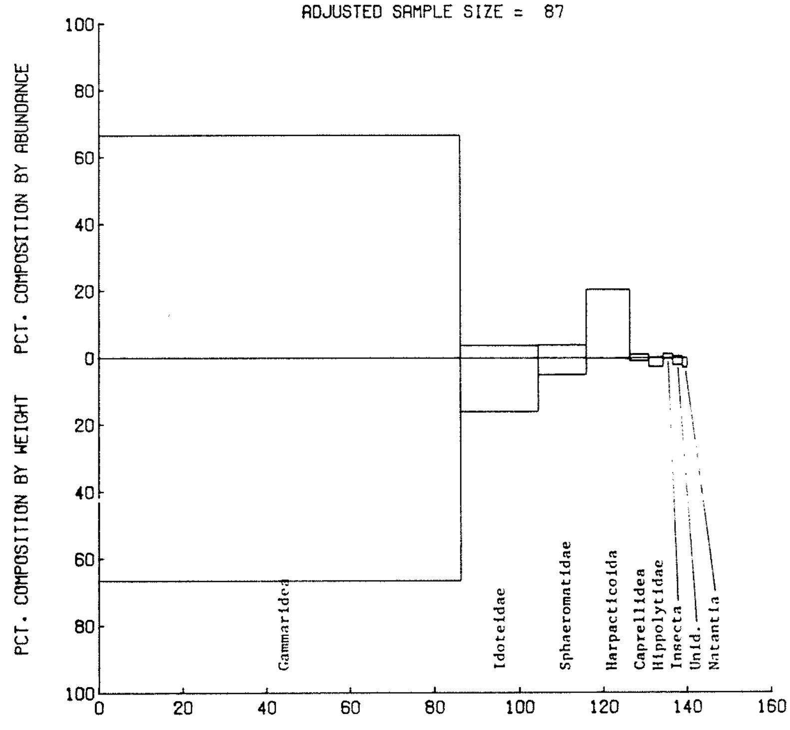
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.44	.26	.53
SHANNON-WEINER DIVERSITY	1.80	2.48	1.26
EVENNESS INDEX	.47	.65	.33

App. Fig. 9bb. IRI prey spectrum of ribbon snailfish along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8831090810 - LIPARIS FLORAE
TIDEPOOL SNAILFISH
ADJUSTED SAMPLE SIZE = 87



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	86.21	66.50	66.55	11469.1	94.08
IDOTEIDAE	18.39	3.72	16.04	363.5	2.98
SPHAEROMATIDAE	11.49	3.85	5.05	102.3	.84
HARPACTICOIDA	10.34	20.41	.29	214.1	1.76
CAPRELLIDEA	4.60	1.09	.91	9.2	.08
HIPPOLYTIDAE	3.45	.19	2.73	10.1	.08
INSECTA	2.30	1.22	.30	3.5	.03
UNIDENTIFIED	2.30	.58	2.15	6.3	.05
NATANTIA	1.15	.06	2.90	3.4	.03

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.49	.47	.89
SHANNON-WEINER DIVERSITY	1.65	1.79	.43
EVENNESS INDEX	.35	.38	.09

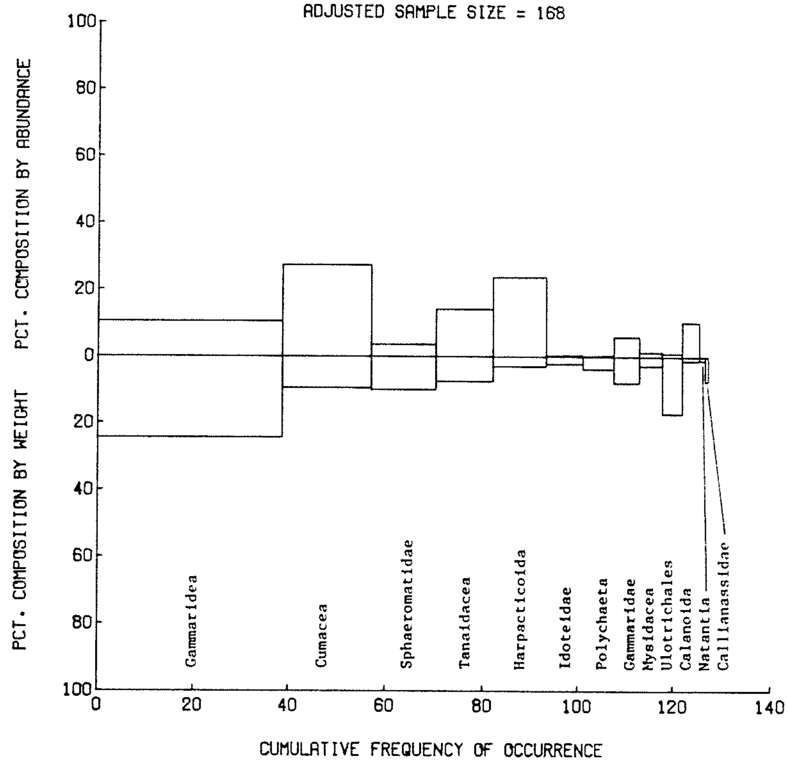
App. Fig. 9cc. IRI prey spectrum of tidepool snailfish along the Strait of Juan de Fuca, 1976-78.

App. Table 9o. IRI comparison of principal prey organisms of tidepool snailfish at Morse Creek (MC, n=11), Slip Point (SP, n=31), and Observatory Point (OP, n=18) tidepools in 1977.

Prey	Freq.occur. %			Numer.comp. %			Grav.comp. %			Total IRI %			IRI rank		
	MC	SP	OP	MC	SP	OP	MC	SP	OP	MC	SP	OP	MC	SP	OP
Gammarid amphipods	90.9	83.9	83.3	66.7	85.1	28.1	62.4	72.5	51.8	86.0	95.6	71.0	1	1	1
Idoteid isopods	36.4	19.4	11.1	3.7	8.2	0.7	31.2	16.4	3.6	9.3	3.4	0.5	2	2	5
Insects	18.2	--	5.6	12.0	--	0.2	5.0	--	0.2	2.3	--	0.0	3	--	9
Harpacticoid copepods	18.2	--	33.3	16.4	--	65.6	0.3	--	2.3	2.2	--	24.2	4	--	2
Sphaeromatid isopods	--	9.7	16.7	--	1.8	4.1	--	2.6	8.2	--	0.3	2.2	--	3	3

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8835600201 - CYMATOGASTER AGGREGATA
SHINER PERCH
ADJUSTED SAMPLE SIZE = 168



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	38.69	10.49	24.43	1351.1	44.51
CUMACEA	18.45	27.31	9.50	679.3	22.38
SPHAEROMATIDAE	13.10	3.61	10.07	179.1	5.90
TANAIDACEA	11.90	14.09	7.45	256.4	8.45
HARPACTICOIDA	11.31	23.70	2.99	301.9	9.95
IDOTEIDAE	7.74	.45	2.18	20.3	.67
POLYCHAETA	6.55	.32	3.75	26.6	.88
GAMMARIDAE	5.36	5.96	7.88	74.2	2.44
MYSIDACEA	4.76	1.35	2.77	19.6	.65
ULOTRICHALES	4.17	.97	17.19	75.7	2.49
CALANOIDA	3.57	10.25	1.24	41.0	1.35
NATANTIA	1.19	.05	1.14	1.4	.05
CALLIANASSIDAE	.60	.03	7.46	4.5	.15

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.18	.13		.27
SHANNON-WEINER DIVERSITY	2.85	3.34		2.42
EVENNESS INDEX	.58	.68		.49

App. Fig. 9dd. IRI prey spectrum of shiner perch along the Strait of Juan de Fuca, 1976-78.

Pile Perch, Rhacochilus vacca

Twenty-nine pile perch were collected by beach seine at Jamestown and townet at Beckett Point; however, over 50% of the stomachs were empty. Gastropods made up 32.1% of the total IRI; followed by pagurid crabs (Pagurus beringanus, P. granosimanus, P. hirsutiusculus), 22.6%; gammarid amphipods, 13.6%; brachyuran crabs, 11.5%; sphaeromatid isopods, 2.6%; valviferan isopods, 5.9%; and tanaids, 2.8%.

Redtail Surfperch, Amphisticus rhodoterus

Redtail surfperch occurred abundantly in beach seine collections at Twin Rivers and infrequently at Morse Creek and Kydaka Beach. Over 70% of the prey spectrum was gammarid amphipods. Mysids (including Neomysis awatschensis), sphaeromatid isopods (including Gnorimosphaeroma oregonensis and Exosphaeroma sp.), flabelliferan isopods, idoteid isopods (including Idotea resecata and I. wosnesenski), and polychaetes were secondary prey (App. Fig. 9ee). The principal differences between diet compositions in 1976 and 1977 were primarily a result of differing contributions made by secondary prey, the three isopod taxa and mysids (App. Table 9p). This is illustrated over seven of the eight quarters' samples at Twin Rivers (App. Table 9g). Gammarid amphipods were the primary prey taxon in all but the October 1976 collection when flabelliferan isopods predominated. Mysids, fish, and polychaetes were the typical secondary prey in 1976 but sphaeromatid isopods consistently ranked second through 1977, followed by mysids and the other isopods.

High Cockscomb, Anoplarchus purpurescens

The most ubiquitous prickleback among the intertidal collections, A. purpurescens was a predominant member of the intertidal assemblage at Slip Point, Observatory Point, Twin Rivers, and Morse Creek. Nemertean worms, gammarid amphipods, and polychaete annelids predominated in the overall prey spectrum (App.Fig. 9ff).

Black Prickleback, Xiphister atropurpureus

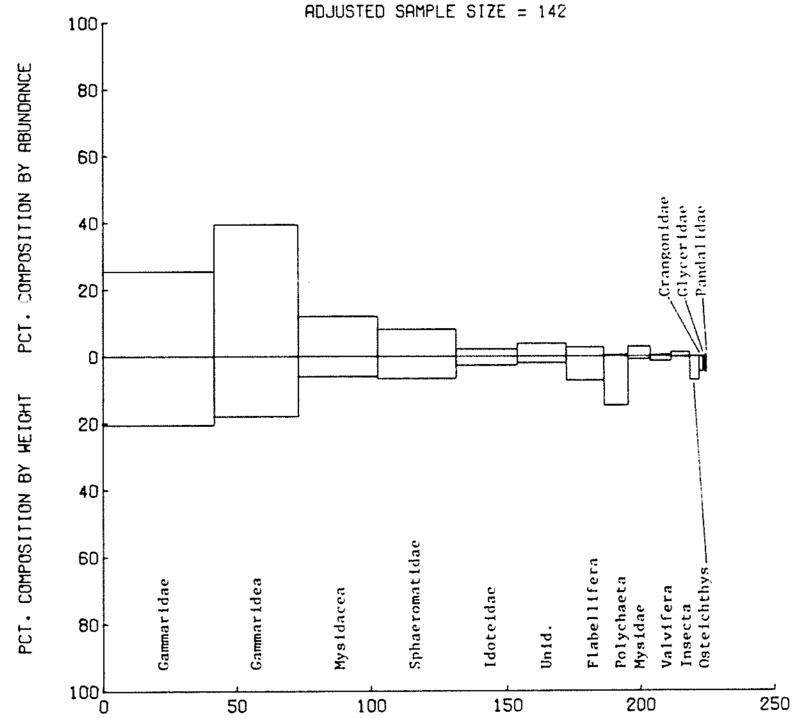
Slip Point and Observatory Point intertidal collections provided the largest sample sizes of black prickleback. Almost three-quarters of the total IRI (App. Fig. 9gg) were gammarid amphipods. Sabellarid and polychaete worms and several algae were also important.

Rock Prickleback, Xiphister mucosus

Although not as prevalent in intertidal collections as X. atropurpureus, the rock prickleback occurred at six of the seven intertidal sites and were common at Slip Point and Twin Rivers. Numerically, the IRI prey spectrum of X. mucosus (App. Fig. 9hh) was more diverse than that of X. atropurpureus. Gammarid amphipods were the predominant prey organism but composed less than half of the total IRI. Instead, algae made a greater contribution, Rhodophyta, Chlorophyta, Phaeophyta, Ultrichales, Bangiales, and Gigartinacea combining for 44.8% of the total IRI.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8835600701 - AMPHISTICUS RHODOTERUS
REDTAIL SURFPERCH
ADJUSTED SAMPLE SIZE = 142



CUMULATIVE FREQUENCY OF OCCURRENCE

PREY ITEM	FREQ. OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDAE	41.55	25.43	20.60	1912.2	36.18
GAMMARIDEA	31.69	39.47	17.99	1820.9	34.45
MYSIDACEA	29.58	12.00	6.09	535.2	10.12
SPHAEROMATIDAE	28.87	8.12	6.64	426.3	8.06
IDOTEIDAE	22.54	2.15	2.73	109.9	2.08
UNIDENTIFIED	18.31	3.81	2.03	106.9	2.02
FLABELLIFERA	14.08	2.70	7.24	139.9	2.65
POLYCHAETA	9.15	.42	14.74	138.8	2.63
MYSIDAE	8.45	2.87	.92	32.0	.61
VALVIFERA	7.75	.38	1.46	14.3	.27
INSECTA	7.04	1.21	.17	9.7	.18
OSTEICHTHYS	3.52	.08	7.11	25.3	.48
CRANGONIDAE	1.41	.03	4.60	6.5	.12
GLYCERIDAE	.70	.01	1.45	1.0	.02
PANDALIDAE	.70	.30	4.93	3.7	.07

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.25	.12	.27
SHANNON-WEINER DIVERSITY	2.55	3.41	2.35
EVENNESS INDEX	.56	.74	.51

App. Fig. 9ee. IRI prey spectrum of redtail surfperch along the Strait of Juan de Fuca, 1976-78.

App. Table 9p. IRI comparison of principal prey organisms of redtail surfperch in 1976 (n=78) and 1977 (n=64).

Prey	Freq.occur.%		Numer.comp.%		Grav.comp.%		Total IRI %		IRI rank	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Gammarid amphipods	75.6	70.3	54.7	73.8	29.4	60.0	77.6	79.1	1	1
Mysids	25.6	34.4	21.1	4.1	5.5	7.5	8.3	3.4	2	3
Flabelliferan isopods	24.4	--	5.7	--	10.3	--	4.8	--	3	--
Polychaetes	11.5	6.3	0.6	0.2	18.7	5.6	2.7	0.3	4	6
Sphaeromatid isopods	10.3	51.6	1.2	14.1	1.3	19.2	0.3	14.5	10	2
Idoteid isopods	11.5	35.9	0.9	3.2	2.3	3.7	0.5	2.1	8	4

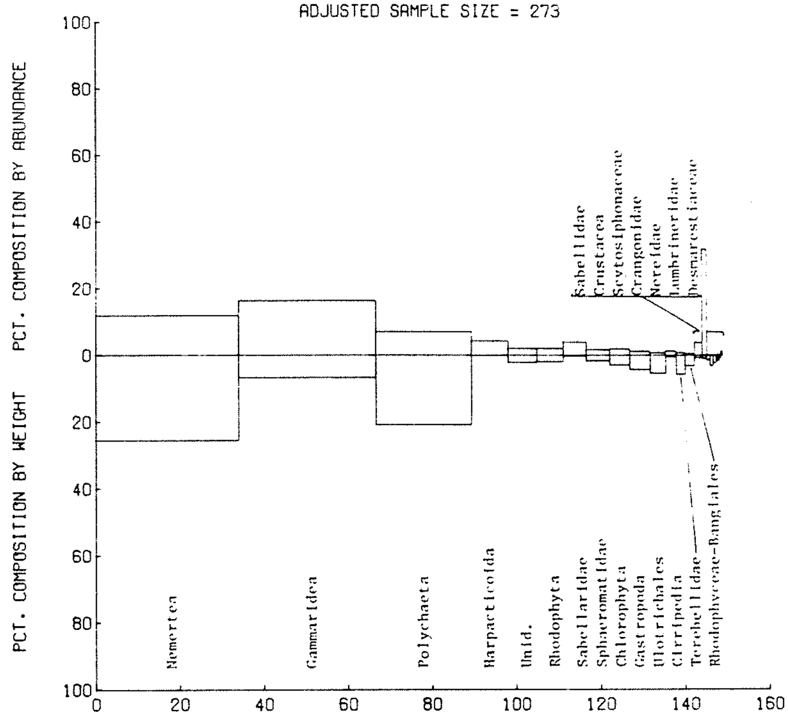
App. Table 9g. IRI comparison of principal prey organisms of redtail surfperch captured at Twin Rivers in August 1976 (n=10), October 1976 (n=20), January 1977 (n=43), May 1977 (n=12), August 1977 (n=10), October 1977 (n=13), and January 1978 (n=16).

Prey	Frequency occurrence, %							Numerical composition, %						
	8/76	10/76	1/77	5/77	8/77	10/77	1/78	8/76	10/76	1/77	5/77	8/77	10/77	1/78
Gammarid amphipods	90.0	80.0	74.9	91.7	50.0	84.6	87.5	71.3	25.8	44.7	81.7	75.3	54.1	62.8
Mysids	90.0	5.0	46.5	50.0	10.0	46.2	25.0	24.0	6.0	44.7	1.3	1.3	7.7	6.6
Flabelliferan isopods	30.0	60.0	7.0	8.3	--	--	--	0.3	30.3	2.3	0.1	--	--	--
Fish	10.0	15.0	--	--	--	--	--	0.1	0.8	--	--	--	--	--
Polychaetes	--	--	11.6	8.3	10.0	7.7	6.3	--	--	1.5	0.1	1.3	0.6	0.6
Sphaeromatid isopods	--	--	18.6	83.3	40.0	46.2	75.0	--	--	4.3	11.8	16.9	18.5	22.1
Idoteid isopods	--	--	20.9	83.3	20.0	15.4	37.5	--	--	3.3	3.9	2.6	0.9	1.6
Insects	--	--	--	50.0	--	23.1	6.3	--	--	--	0.9	--	18.2	0.1

Prey	Gravimetric composition, %							Total IRI %							IRI rank						
	8/76	10/76	1/77	5/77	8/77	10/77	1/78	8/76	10/76	1/77	5/77	8/77	10/77	1/78	8/76	10/76	1/77	5/77	8/77	10/77	1/78
Gammarid amphipods	81.2	11.6	20.6	73.3	86.8	48.8	51.3	78.2	30.9	69.9	80.3	86.6	69.2	72.1	1	2	1	1	1	1	1
Mysids	14.3	1.6	7.3	1.6	0.7	3.2	12.4	19.7	0.4	16.6	0.8	0.2	4.0	3.4	2	5	2	4	4	3	3
Flabelliferan isopods	0.2	36.0	0.5	0.2	--	--	--	0.1	41.1	0.3	0.0	--	--	--	5	1	7	6	--	--	--
Fish	0.1	35.8	--	--	--	--	--	0.0	5.7	--	--	--	--	--	6	3	--	--	--	--	--
Polychaetes	--	--	41.1	0.0	0.7	0.5	11.5	--	--	7.1	0.0	0.2	0.1	0.5	--	--	3	9	5	6	5
Sphaeromatid isopods	--	--	3.0	18.5	11.1	43.0	16.2	--	--	2.0	14.2	12.0	22.6	20.8	--	--	5	2	2	2	2
Idoteid isopods	--	--	5.6	4.6	0.7	2.3	3.2	--	--	2.7	4.0	0.7	0.4	1.3	--	--	4	3	3	5	4
Insects	--	--	--	0.9	--	2.2	0.0	--	--	--	0.6	--	3.8	0.0	--	--	--	5	--	4	7

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8842120402 - ANOPLARCHUS PURPURESCENS
HIGH COCKSCOMB
ADJUSTED SAMPLE SIZE = 273



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
NEMERTEA	34.07	11.87	25.50	1272.9	43.11
GAMMARIDEA	32.60	16.28	6.72	749.5	25.38
POLYCHAETA	22.71	6.47	20.86	631.9	21.40
HARPACTICOIDA	8.79	4.19	.08	37.6	1.27
UNIDENTIFIED	6.96	1.99	2.19	29.1	.98
RHODOPHYTA	6.23	1.99	2.02	25.0	.85
SABELLARIDAE	5.49	3.91	.26	22.9	.78
SPHAEROMATIDAE	5.49	1.63	1.75	18.6	.63
CHLOROPHYTA	4.76	1.85	3.03	23.2	.79
GASTROPODA	4.76	1.14	4.36	26.2	.89
ULOTRICHALES	3.66	.71	5.49	22.7	.77
CIRRIPEDIA	2.56	1.21	.54	4.5	.15
TEREBELLIDAE	2.20	.71	5.82	14.3	.49
RHODOPHYCEAE-BANGIALES	2.20	.43	3.23	8.0	.27
SABELLIDAE	1.83	3.77	.81	8.4	.28
CRUSTACEA	1.10	31.77	1.03	36.0	1.22
SCYTOSIPHONACEAE	.73	.14	1.49	1.2	.04
CRANGONIDAE	.73	.14	3.23	2.5	.08
NEREIDAE	.73	.14	2.33	1.8	.06
LUMBRINERIDAE	.37	.07	1.41	.5	.02
DESMARESTIACEAE	.37	.14	1.72	.7	.02
NATANTIA	.37	.07	1.03	.4	.01
STYLOMMATOPHORA-BASOMMATOPHORA	.37	1.14	.14	.5	.02

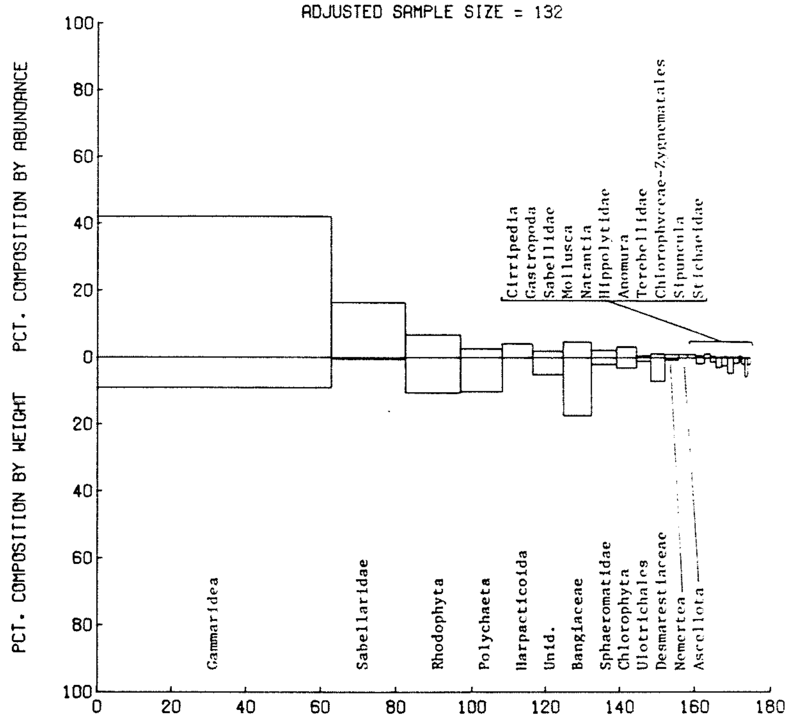
PREY TAXA WITH FREQ. OCCUR. LESS THAN .5 AND NUMERICAL AND GRAVIMETRIC COMPOSITIONS WITH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM.	GRAV.	PERCENT TOTAL IRI
PERCENT DOMINANCE INDEX	.15	.13	.30
SHANNON-WEINER DIVERSITY	3.63	3.83	2.24
EVENNESS INDEX	.62	.66	.38

App. Fig. 9ff. IRI prey spectrum of high cockscomb along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8842121401 - XIPHISTER ATROPURPUREUS
BLACK PRICKLEBACK
ADJUSTED SAMPLE SIZE = 132

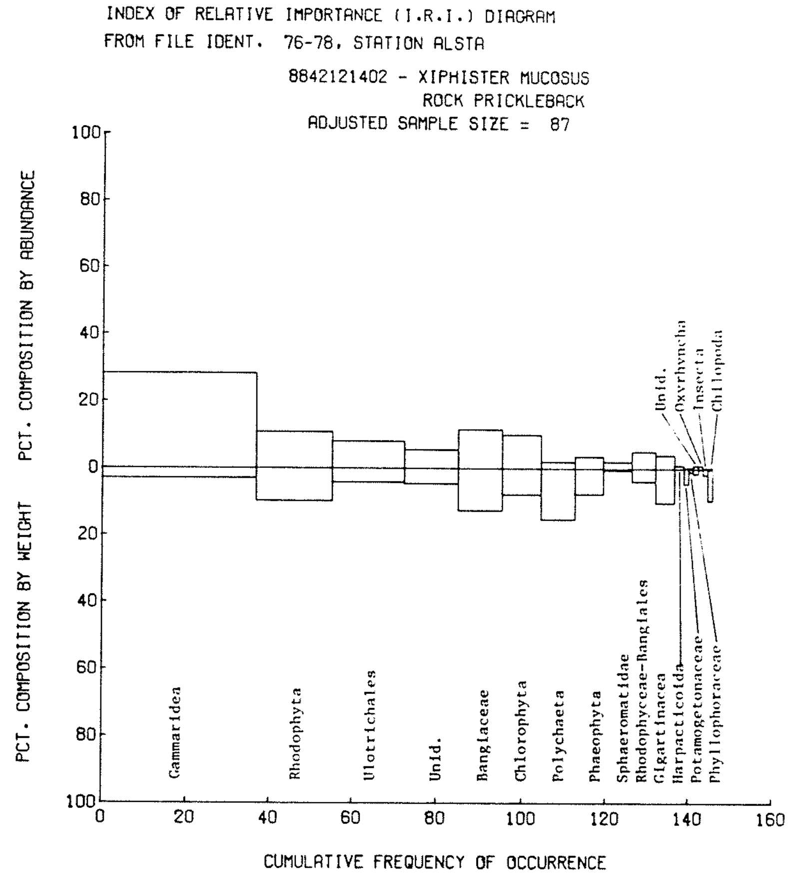


PREY ITEM	FREQ. OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	62.88	42.01	9.04	3209.8	73.39
SABELLARIDAE	19.70	16.32	.66	334.6	7.65
RHODOPHYTA	14.39	6.74	10.60	249.5	5.70
POLYCHAETA	11.36	2.63	10.20	145.8	3.33
HARPACTICOIDA	8.33	4.11	.01	34.4	.79
UNIDENTIFIED	8.33	1.94	5.10	58.7	1.34
BANGIACEAE	7.58	4.68	17.31	166.6	3.81
SPHAEROMATIDAE	6.82	2.17	2.07	28.9	.66
CHLOROPHYTA	5.30	3.20	3.10	33.4	.76
ULOTRICHALES	3.79	.57	1.10	6.3	.15
DESMARESTIACEAE	3.79	1.14	7.08	31.1	.71
NEMERTEA	3.79	1.03	.70	6.5	.15
ASELLOTA	2.27	1.03	.05	2.5	.06
CIRRIPEDIA	2.27	1.03	.00	2.3	.05
GASTROPODA	2.27	.57	1.83	5.5	.12
SABELLIDAE	1.52	1.14	.04	1.8	.04
MOLLUSCA	1.52	.46	1.31	2.7	.06
NATANTIA	1.52	.23	2.92	4.8	.11
HIPPOLYTIDAE	1.52	.34	2.41	4.2	.10
ANOMURA	1.52	.23	4.67	7.4	.17
TEREBELLIDAE	1.52	.23	1.69	2.9	.07
CHLOROPHYCEAE-ZYGNEMATALES	.76	.57	1.03	1.2	.03
SIPUNCULA	.76	.11	1.88	1.5	.03
STICHAEIDAE	.76	.11	5.74	4.4	.10
PHOLIDIDAE	.76	.11	2.06	1.6	.04

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.22	.08	.55
SHANNON-WEINER DIVERSITY	3.36	4.24	1.67
EVENNESS INDEX	.60	.76	.30

App. Fig. 9gg. IRI prey spectrum of black prickleback along the Strait of Juan de Fuca, 1976-78.



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	36.78	26.21	3.09	1151.3	43.01
RHODOPHYTA	18.39	10.83	9.78	379.1	14.16
ULOTRICHALES	17.24	8.06	4.19	211.2	7.89
UNIDENTIFIED	12.64	5.54	4.60	128.2	4.79
BANGIACEAE	10.34	11.59	12.60	250.2	9.35
CHLOROPHYTA	9.20	10.08	7.83	164.6	6.15
POLYCHAETA	8.05	2.02	15.22	138.7	5.18
PHAEOPHYTA	6.90	3.53	7.69	77.3	2.89
SPHAEROMATIDAE	6.90	2.02	.52	17.5	.65
RHODOPHYCEAE-BANGIALES	5.75	5.04	3.85	51.1	1.91
GIGARTINACEA	4.60	4.03	10.24	65.6	2.45
HARPACTICOIDA	2.30	1.01	.00	2.3	.09
POTAMOGETONACEAE	1.15	.25	4.54	5.5	.21
PHYLLOPHORACEAE	1.15	.25	1.01	1.4	.05
UNIDENTIFIED	1.15	1.01	1.56	2.9	.11
OXRHYNCHA	1.15	1.01	.00	1.2	.04
INSECTA	1.15	.25	1.77	2.3	.09
CHILOPODA	1.15	.25	9.56	11.3	.42

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.13	.09	.23
SHANNON-WEINER DIVERSITY	3.55	3.74	2.79
EVENNESS INDEX	.73	.77	.58

App. Fig. 9hh. IRI prey spectrum of rock prickleback along the Strait of Juan de Fuca, 1976-78.

Penpoint Gunnel, Apodichthys flavidus

Appearing frequently in both beach seine and tidepool collections, penpoint gunnel were most numerous at Twin Rivers and Beckett Point. Epibenthic Crustacea--gammarid amphipods, harpacticoid copepods, mysids, and valviferan isopods (Idotea sp.)--were the most important prey in the spectrum (App. Fig. 9ii), composing 88% of the total IRI. Benthic polychaete and nemertean worms composed 7.4%.

Crescent Gunnel, Pholis laeta

Twin Rivers, Morse Creek, and North Beach intertidal collections and Twin Rivers beach seine collections all contained crescent gunnel. Except for dipteran insects, all the major prey organisms were epibenthic crustaceans. Gammarid amphipods composed over 80% of the IRI; isopods (including sphaeromatid, idoteid, and valviferan species), 7.4%; munnid crabs, 3.4%; and harpacticoid copepods, 2.7% (App. Fig. 9jj).

Saddleback Gunnel, Pholis ornata

Compared to its congener, the saddleback gunnel was not as widely distributed. The largest samples came from Beckett Point and Twin Rivers beach seine collections. Gammarid amphipods were important to the diet of P. ornata (75% of the total IRI); secondary prey were sabellid worms, mysids, and juvenile hippolytid shrimp (App. Fig. 9kk). A juvenile Parophrys vetulus was found in the stomach of one saddleback gunnel, but though it constituted 60.1% of the total prey biomass, it was too rare a food item to be important.

Pacific Sand Lance, Ammodytes hexapterus

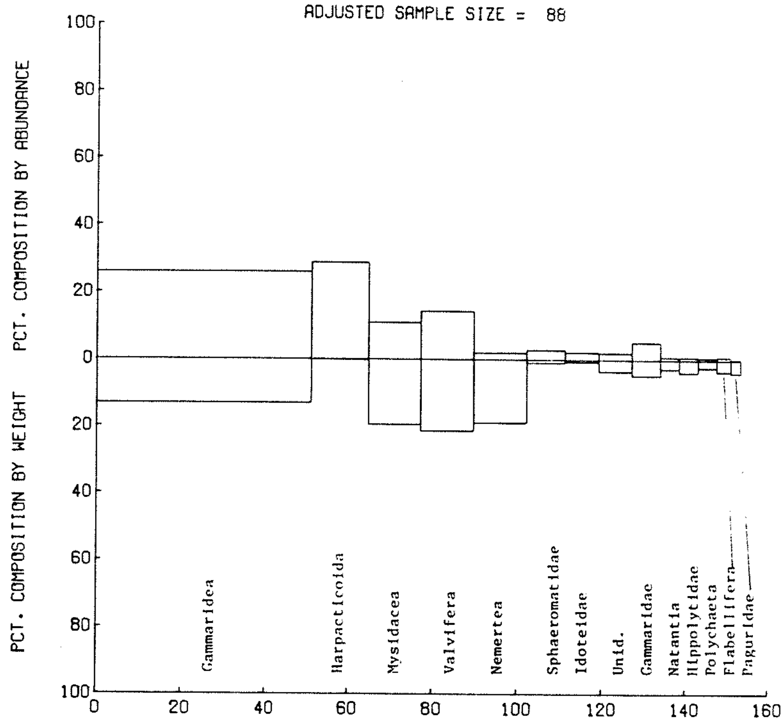
Although Pacific sand lance larvae were often captured in abundance, large juveniles and adults were infrequently collected. Both beach seine and townet collections at Dungeness Spit and Kydaka Beach yielded adequate samples for analysis at various times. Pacific sand lance were extremely selective planktivores, preying upon calanoid copepods (App. Fig. 9-ll) even more than did Pacific herring. One juvenile Pacific sand lance provided 2.6% of the total IRI, principally because it supplied 62.7% of the total prey biomass in one adult.

Rock Sole, Lepidopsetta bilineata

Beach seine collections at Beckett Point, especially in winter, contributed the most rock sole stomach samples. Rock sole were benthic feeders, preying principally on polychaete annelids (75% of the total IRI) (App. Fig. 9mm). Epibenthic gammarid amphipods (12.6%) and tanaids supplemented the diet. An interesting uniformity in rock sole prey composition between seasons and years was indicated by the Beckett Point samples for May 1976 and January and May 1977 (App. Table 9r); only minor prey organisms changed in relative importance.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8842130101 - APODICHTHYS FLAVIDUS
PENPOINT GUNNEL
ADJUSTED SAMPLE SIZE = 88



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	51.14	25.96	13.22	2003.7	53.60
HARPACTICOIDA	13.64	28.75	.23	395.2	10.57
MYSIDACEA	12.50	10.96	19.54	381.3	10.20
VALVIFERA	12.50	14.33	21.38	446.4	11.94
NEMERTEA	12.50	2.02	18.92	261.7	7.00
SPHAEROMATIDAE	9.09	2.88	.98	35.1	.94
IDOTEIDAE	7.95	2.21	.73	23.4	.63
UNIDENTIFIED	7.95	2.02	3.55	44.3	1.19
GAMMARIDAE	6.82	5.19	4.75	67.8	1.81
NATANTIA	4.55	.87	2.71	16.2	.43
HIPPOLYTIDAE	4.55	.87	3.78	21.1	.56
POLYCHAETA	4.55	.67	2.31	13.6	.36
FLABELLIFERA	3.41	.87	3.44	14.7	.39
PAGURIDAE	2.27	.19	3.96	9.4	.25

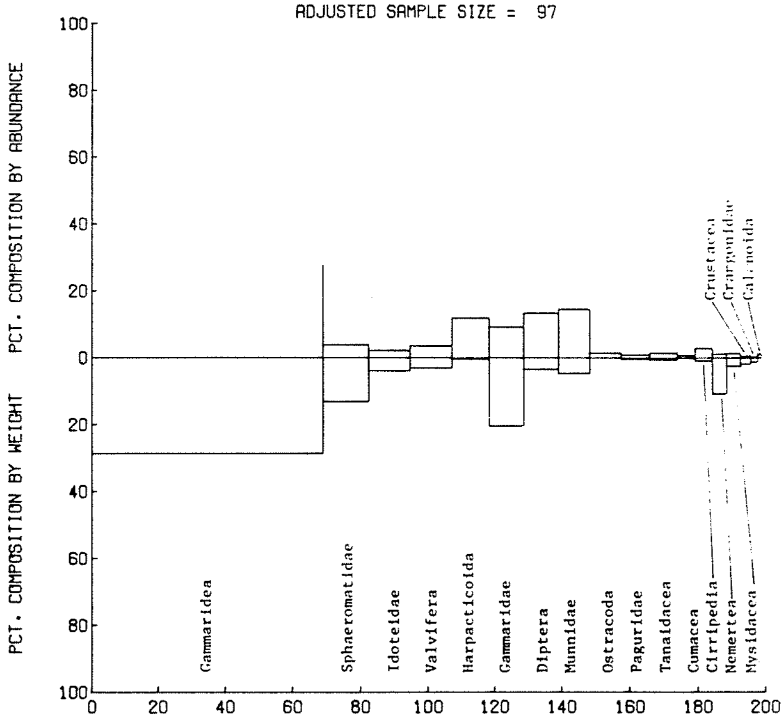
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM. COMP.	GRAV. COMP.	PERCENT TOTAL IRI
PERCENT DOMINANCE INDEX	.19	.15	.33
SHANNON-WEINER DIVERSITY	2.92	3.14	2.26
EVENNESS INDEX	.64	.68	.49

App. Fig. 9ii. IRI prey spectrum of penpoint gunnel along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8842130205 - PHOLIS LAETA
CRESCENT GUNNEL
ADJUSTED SAMPLE SIZE = 97



CUMULATIVE FREQUENCY OF OCCURRENCE

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	69.07	27.45	28.68	3876.6	74.36
SPHAEROMATIDAE	13.40	3.78	13.11	226.5	4.34
IDOTEIDAE	12.37	2.15	3.96	75.6	1.45
VALVIFERA	12.37	3.56	3.11	82.5	1.58
HARPACTICOIDA	11.34	11.87	.41	139.3	2.67
GAMMARIDAE	10.31	9.20	20.40	305.1	5.85
DIPTERA	10.31	13.28	3.49	172.9	3.32
MUNNIDAE	9.28	14.47	4.76	178.4	3.42
OSTRACODA	9.28	1.41	.05	13.6	.26
PAGURIDAE	8.25	.89	.52	11.6	.22
TANAIDACEA	8.25	1.41	.69	17.3	.33
CUMACEA	5.15	.67	.14	4.2	.08
CIRRIPEDIA	5.15	2.82	.98	19.6	.38
NEMERTEA	4.12	1.04	10.78	48.7	.93
MYSIDACEA	4.12	1.26	2.56	15.7	.30
CRUSTACEA	3.09	.52	1.89	7.4	.14
CRANGONIDAE	2.06	.30	1.28	3.2	.06
CALANOIDA	1.03	1.11	.01	1.2	.02

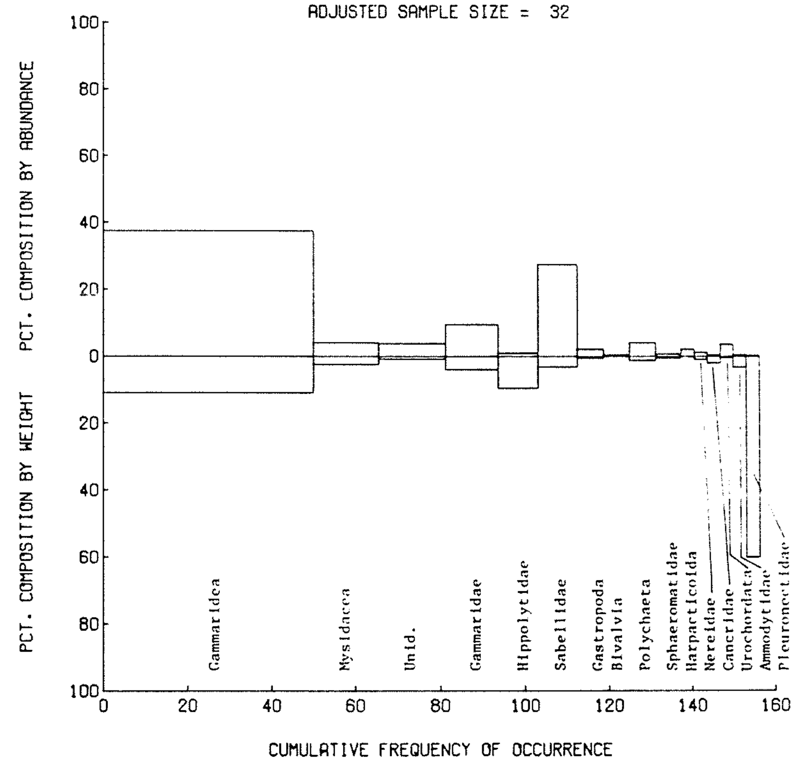
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.14	.16	.56
SHANNON-WEINER DIVERSITY	3.40	3.21	1.65
EVENNESS INDEX	.69	.66	.34

App. Fig. 9jj. IRI prey spectrum of crescent gunnel along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8842130206 - PHOLIS ORNATA
SADDLEBACK GUNNEL
ADJUSTED SAMPLE SIZE = 32



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
GAMMARIDEA	50.00	37.47	10.94	2420.4	70.20
MYSIDACEA	15.63	4.06	2.46	101.9	2.95
UNIDENTIFIED	15.63	3.82	.80	72.2	2.09
GAMMARIDAE	12.50	9.55	4.00	169.3	4.91
HIPPOLYTIDAE	9.38	.95	9.53	98.3	2.85
SABELLIDAE	9.38	27.45	3.23	287.6	8.34
GASTROPODA	6.25	2.15	.54	16.8	.49
BIVALVIA	6.25	.48	.04	3.2	.09
POLYCHAETA	6.25	4.06	1.28	33.3	.97
SPHAEROMATIDAE	6.25	.72	.51	7.7	.22
HARPACTICOIDA	3.13	2.15	.00	6.7	.19
NEREIDAE	3.13	1.19	.93	6.6	.19
CANCRIDAE	3.13	.48	1.98	7.7	.22
UROCHORDATA	3.13	3.58	.32	12.2	.35
AMMODYTIDAE	3.13	.48	3.26	11.7	.34
PLEURONECTIDAE	3.13	.24	60.09	188.5	5.47

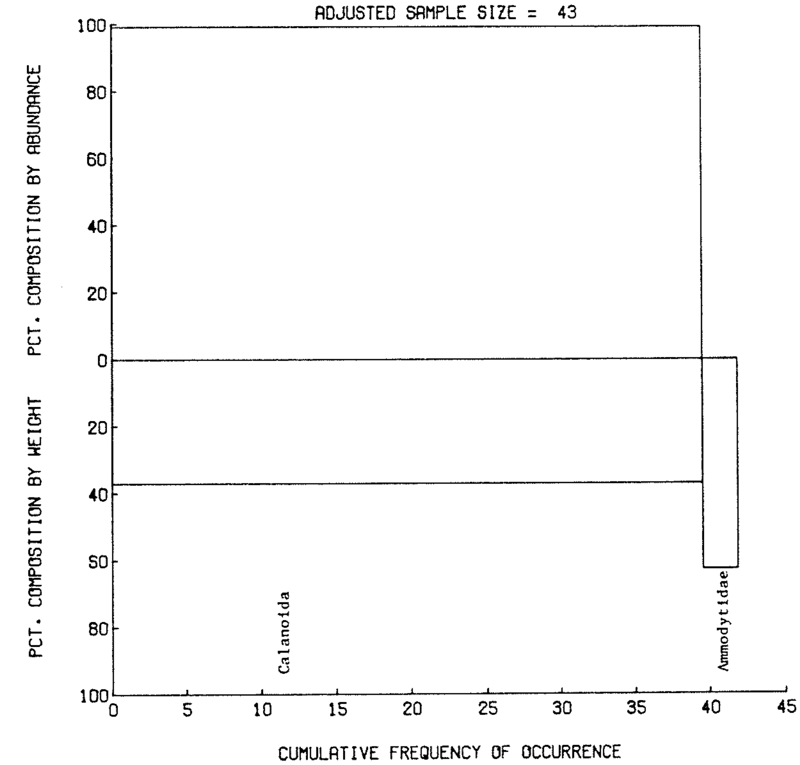
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.23	.39	.51
SHANNON-WEINER DIVERSITY	2.75	2.18	1.77
EVENNESS INDEX	.65	.51	.42

App. Fig. 9kk. IRI prey spectrum of saddleback gunnel along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8845010101 - AMMODYTES HEXAPTERUS
PACIFIC SAND LANCE
ADJUSTED SAMPLE SIZE = 43



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
CALANOIDA	39.53	99.21	37.06	5387.6	97.32
AMMODYTIDAE	2.33	.02	62.69	145.8	2.63

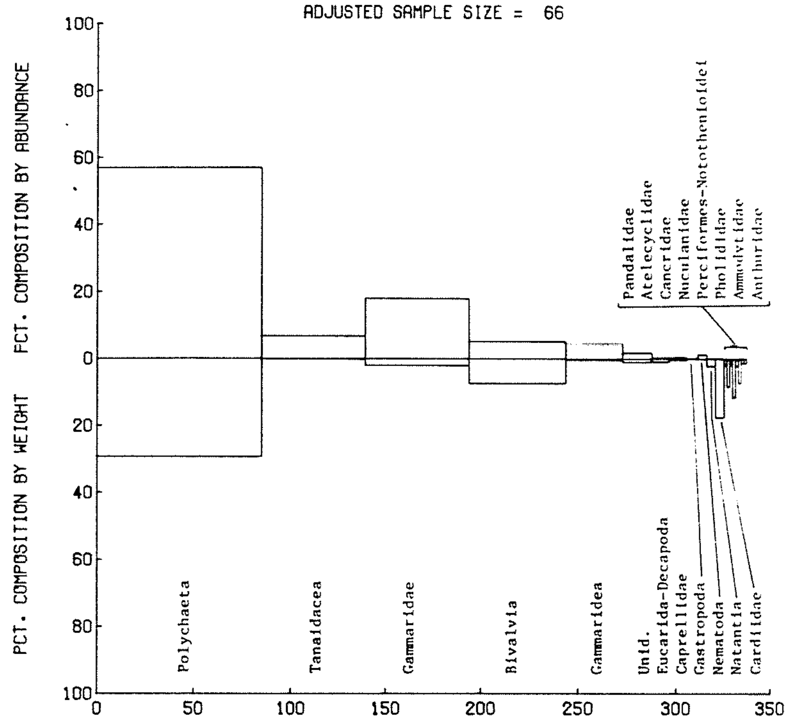
PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

	NUM. COMP.	GRAV. COMP.	PERCENT TOTAL IRI
PERCENT DOMINANCE INDEX	.98	.53	.95
SHANNON-WEINER DIVERSITY	.08	.98	.18
EVENNESS INDEX	.03	.35	.06

App. Fig. 9-11. IRI prey spectrum of Pacific sand lance along the Strait of Juan de Fuca, 1976-78.

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8857040801 - LEPIDOPSETTA BILINEATA
ROCK SOLE
ADJUSTED SAMPLE SIZE = 66



PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
POLYCHAETA	84.85	56.91	29.36	7319.5	74.84
TANAIDACEA	54.55	6.68	.20	375.0	3.83
GAMMARIDAE	54.55	17.94	2.06	1091.2	11.16
BIVALVIA	50.00	5.11	7.37	624.1	6.38
GAMMARIDEA	28.79	4.41	.41	138.8	1.42
UNIDENTIFIED	15.15	1.80	1.01	42.6	.44
EUCARIDA-DECAPODA	9.09	.46	.94	12.7	.13
CAPRELLIDAE	9.09	.46	.35	7.4	.08
GASTROPODA	6.06	.23	.01	1.5	.02
NEMATODA	4.55	1.28	.00	5.8	.06
NATANTIA	4.55	.23	2.15	10.8	.11
CARDIIDAE	4.55	.23	17.49	80.6	.82
PANDALIDAE	1.52	.12	1.77	2.9	.03
ATELECYCLIDAE	1.52	.06	8.31	12.7	.13
CANCRIDAE	1.52	.12	1.67	2.7	.03
NUCULANIDAE	1.52	.06	11.51	17.5	.18
PERCIFORMES-NOTOTHENIOIDEI	1.52	.06	2.14	3.3	.03
PHOLIDIDAE	1.52	.12	7.18	11.1	.11
AMMODYTIDAE	1.52	.17	1.42	2.4	.02
ANTHURIDAE	1.52	.12	1.30	2.1	.02

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.37	.15	.58
SHANNON-WEINER DIVERSITY	2.28	3.36	1.39
EVENNESS INDEX	.42	.62	.26

App. Fig. 9mm. IRI prey spectrum of rock sole along the Strait of Juan de Fuca, 1976-78.

App. Table 9r. IRI comparison of principal prey organisms of rock sole at Beckett Point from beach seine collections in May 1976 (n=20), January 1977 (n=18), and May 1977 (n=14).

Prey	Freq.occur. %			Numer.comp. %			Grav.comp. %			Total IRI %			IRI rank		
	May 76	Jan 77	May 77	May 76	Jan 77	May 77	May 76	Jan 77	May 77	May 76	Jan 77	May 77	May 76	Jan 77	May 77
Polychaetes	100.0	94.4	92.9	69.3	34.1	61.9	26.5	59.4	87.2	75.8	49.6	81.6	1	1	1
Gammarid amphipods	95.0	94.4	85.7	9.5	51.7	13.6	1.3	32.8	4.0	8.2	44.8	8.9	2	2	2
Bivalves	80.0	44.4	35.7	4.4	4.1	6.8	7.7	3.5	3.9	7.7	2.0	2.3	3	4	4
Tanaids	55.0	61.1	64.3	3.3	7.7	16.6	0.0	2.8	2.2	1.5	3.6	7.1	4	3	3

English Sole, Parophrys vetulus

Juvenile English sole were the most widely and evenly distributed species across the eight beach seine sites. The overall prey spectrum (App. Fig. 9nn) was equally divided among benthic glycerid and gonaid polychaetes, bivalves (including Clinocardium nuttalli), epibenthic gammarid amphipods, cumaceans, harpacticoids, tanaids, and mysids (including Archaeomysis grebnitzki). Prey composition across both years was consistent (App. Table 9s); the two major prey taxa, polychaetes and gammarid amphipods, showed no dramatic differences. The secondary prey organisms usually switched among the lower ranks, especially mysids and bivalves. Seasonal changes in feeding selectivity or prey availability may be seen in the August 1976, October 1976, and January 1977 collections (App. Table 9t). Gammarid amphipods definitely were not as important in fall and winter as in summer, although the summer sample size is too low to be representative.

Starry Flounder, Platichthys stellatus

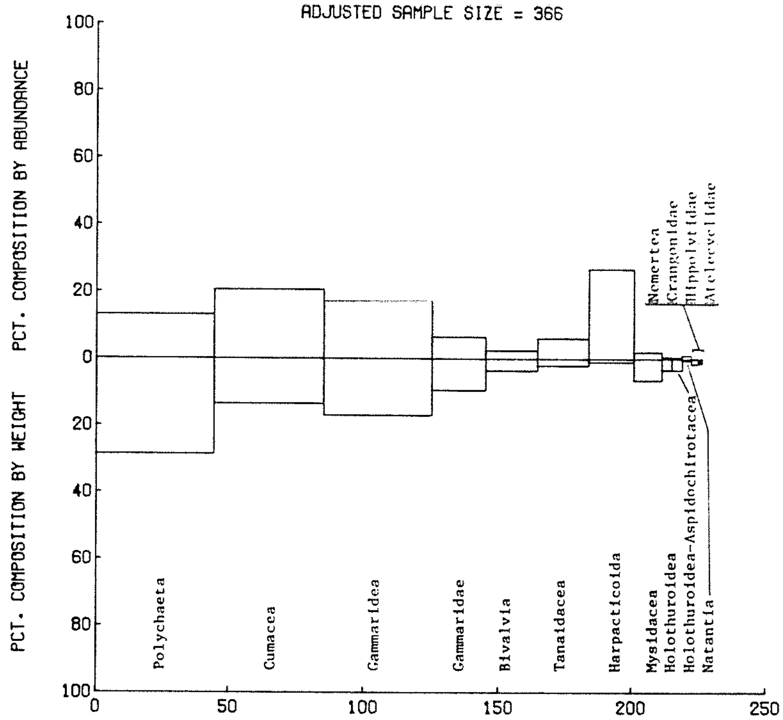
Although not as numerous as English sole, starry flounder occurred in all but the Dungeness Spit beach seine collections; juveniles and adults occurred in approximately equal proportions. The overall prey spectrum (App. Fig. 9oo) was quite similar to that of the rock sole (App. Fig. 9mm); polychaete annelids, gammarid amphipods, and tanaids supplied the greatest proportions of the total IRI. Polychaete annelids and gammarid amphipods maintained the same ranks between both years (App. Table 9u), but their respective trophic contributions differed because of the occurrence of rocks in stomachs collected in 1976 and of tanaids in 1977.

Sand Sole, Psettichthys melanostictus

Juvenile sand sole were almost as abundant as English sole but were by and large confined to the four western beach seine sites. The overall prey spectrum (App. Fig. 9pp) showed a radical difference from the other flatfish by the predominance of epibenthic mysids (primarily Neomysis awatschensis but also including N. rayi and Archaeomysis grebnitzki, accounting for 88.9% of the total IRI) and the absence of polychaetes. Other epibenthic crustaceans, such as gammarid amphipods, cumaceans, and shrimp (including Crangon stylirostris and Pandalus danae), were the secondary prey. Fish (including juvenile Clupea harengus pallasi, Ammodytes hexapterus, Liparis florae, and Psettichthys melanostictus) accounted for 31.4% of the total prey biomass but were not common or abundant enough to provide a high (1.5%) proportion of the total IRI. There was no difference in prey composition between 1976-77 and 1977-78 other than a slight increase in the importance of gammarid amphipods in 1977-78 (App. Table 9v). Sand sole selected similar prey at the four sites where they were most common, as illustrated in the overall predominance of epibenthic mysids and gammarid amphipods (App. Table 9w).

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8857041301 - PAROPHRYS VETULUS
ENGLISH SOLE
ADJUSTED SAMPLE SIZE = 366



PREY ITEM	FREQ. OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
POLYCHAETA	44.54	13.08	28.68	1860.0	32.02
CUMACEA	40.71	20.53	13.51	1385.7	23.86
GAMMARIDEA	39.89	17.08	17.03	1360.6	23.42
GAMMARIDAE	19.95	6.46	9.44	317.1	5.46
BIVALVIA	19.40	2.45	3.60	117.4	2.02
TANAIDACEA	19.40	6.10	2.05	158.2	2.72
HARPACTICOIDA	16.94	26.79	1.00	470.8	8.10
MYSIDACEA	10.38	1.99	6.46	87.7	1.51
HOLOTHUROIDEA	3.83	.59	3.31	14.9	.26
HOLOTHUROIDEA ASPIDOCHIROTACEA	3.83	.47	3.37	14.7	.25
NATANTIA	3.28	1.09	.38	4.8	.08
NEMERTEA	2.46	.13	1.57	4.2	.07
CRANGONIDAE	1.09	.03	1.39	1.5	.03
HIPPOLYTIDAE	.27	.02	1.44	.4	.01
ATELECYCLIDAE	.27	.02	1.07	.3	.01

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.17	.15	.23
SHANNON-WEINER DIVERSITY	2.99	3.42	2.47
EVENNESS INDEX	.54	.61	.44

App. Fig. 9nn. IRI prey spectrum of English sole along the Strait of Juan de Fuca, 1976-78.

App. Table 9s. IRI comparison of principal prey organisms of juvenile English sole in 1976 (n=123) and 1977 (n=243).

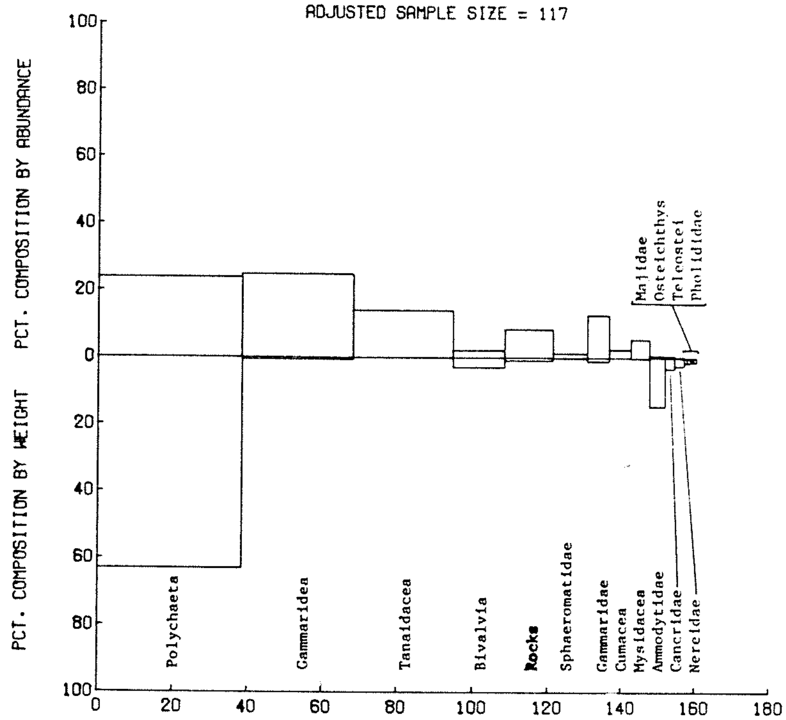
Prey	Freq. occur., % 1976	Freq. occur., % 1977	Numer. comp., % 1976	Numer. comp., % 1977	Grav. comp., % 1976	Grav. comp., % 1977	Total IRI % 1976	Total IRI % 1977	IRI rank 1976	IRI rank 1977
Polychaetes	58.5	38.3	20.7	10.9	31.1	27.3	37.3	20.3	2	3
Gammarid amphipods	60.2	60.1	29.3	21.9	25.7	27.0	40.6	40.8	1	1
Cumaceans	34.2	44.0	14.2	22.3	5.0	18.5	8.1	25.0	3	2
Mysids	22.8	4.5	7.4.	0.5	15.8	1.0	6.5	0.1	4	9
Tanaids	28.5	14.8	9.5	5.1	2.0	2.1	4.0	1.5	5	6
Bivalves	12.2	23.1	0.7	3.0	0.4	5.5	0.2	2.7	8	5
Harpacticoid copepods	13.0	18.9	8.4	32.0	0.1	1.5	1.4	8.8	7	4

App. Table 9t. IRI comparison of principal prey organisms of juvenile English sole at Twin Rivers in August 1976 (n=5), October 1976 (n=11), and January 1977 (n=20).

Prey	Freq.occur., %			Numer.comp., %			Grav.comp., %			Total IRI, %			IRI rank		
	Aug 76	Oct 76	Jan 77	Aug 76	Oct 76	Jan 77	Aug 76	Oct 76	Jan 77	Aug 76	Oct 76	Jan 77	Aug 76	Oct 77	Jan 77
Gammarid amphipods	60.0	27.3	35.0	70.4	4.3	4.0	38.3	2.7	1.2	64.9	2.4	2.0	1	5	4
Polychaetes	60.0	81.2	55.0	7.5	26.6	64.4	39.0	30.6	45.5	27.4	59.8	66.9	2	1	1
Mysids	20.0	18.2	50.0	8.3	21.6	17.3	6.7	32.8	21.6	2.9	12.6	21.5	3	3	2
Sea cucumbers	--	36.4	25.0	--	14.3	7.6	--	31.0	21.0	--	21.0	7.9	--	2	3

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8857041401 - PLATICHTHYS STELLATUS
STARRY FLOUNDER
ADJUSTED SAMPLE SIZE = 117



STOMACH ANALYSIS
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PAGE 3

SPECIES: 8857041401-PLATICHTHYS STELLATUS STARRY FLOUNDER

INDEX OF RELATIVE IMPORTANCE (I.R.I.) TABLE
USING FILEID= 76-78, STATION= ALSTA FOR PLOT

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
POLYCHAETA	38.46	23.81	63.16	3344.9	68.06
GAMMARIDEA	29.91	24.82	.70	763.3	15.53
TANAIDACEA	26.50	13.99	.16	374.8	7.63
BIVALVIA	13.68	2.14	2.97	69.9	1.42
ROCKS	12.82	8.46	.90	120.0	2.44
SPHAEROMATIDAE	9.40	1.24	.20	13.5	.27
GAMMARIDAE	5.98	12.71	1.13	82.8	1.68
CUMACEA	5.98	2.48	.03	15.0	.31
MYSIDACEA	5.13	5.49	.19	29.1	.59
AMMODYTIDAE	4.27	.68	14.54	65.0	1.32
CANCRIDAE	2.56	.53	3.29	9.8	.20
NEREIDAE	2.56	.26	2.45	7.0	.14
MAJIDAE	.85	.11	1.54	1.4	.03
OSTEICHTHYS	.85	.04	1.56	1.4	.03
TELEOSTEI	.85	.04	1.16	1.0	.02
PHOLIDIDAE	.85	.04	1.35	1.2	.02

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.17	.42	.49
SHANNON-WEINER DIVERSITY	3.06	2.21	1.65
EVENNESS INDEX	.56	.41	.30

App. Fig. 9oo. IRI prey spectrum of starry flounder along the Strait of Juan de Fuca, 1976-78.

App. Table 9u. IRI comparison of principal prey organisms of starry flounder in 1976 (n=27) and 1977 (n=90).

Prey	Freq. occur., % 1976	Freq. occur., % 1977	Numer. comp., % 1976	Numer. comp., % 1977	Grav. comp., % 1976	Grav. comp., % 1977	Total IRI % 1976	Total IRI % 1977	IRI rank 1976	IRI rank 1977
Polychaete annelids	63.0	32.2	28.4	21.0	71.3	58.3	75.9	49.7	1	1
Gammarid amphipods	25.9	38.9	33.3	40.1	3.0	1.1	11.4	31.2	2	2
Rocks	33.3	7.8	20.1	1.3	1.9	0.3	8.9	0.2	3	9
Mysids	7.4	4.4	11.4	1.8	0.3	0.1	1.1	0.2	4	10
Bivalves	22.2	11.1	1.2	2.7	2.5	3.2	1.0	1.3	5	5
Tanaids	14.8	30.0	1.3	21.8	0.0	0.2	0.2	12.9	7	3

App. Table 9v. IRI comparison of principal prey organisms of sand sole in 1976 (n=122) and 1977 (n=186).

Prey	Freq. occur., % 1976	Freq. occur., % 1977	Numer. comp., % 1976	Numer. comp., % 1977	Grav. comp., % 1976	Grav. comp., % 1977	Total IRI % 1976	Total IRI % 1977	IRI rank 1976	IRI rank 1977
Mysids	71.3	64.5	71.5	60.3	56.4	36.9	88.0	75.5	1	1
Gammarid amphipods	40.2	53.2	14.1	24.7	5.2	7.1	7.5	20.4	2	2
Fish	12.3	10.8	0.6	1.0	18.6	20.4	2.3	2.8	3	3

INDEX OF RELATIVE IMPORTANCE (I.R.I.) DIAGRAM
FROM FILE IDENT. 76-78, STATION ALSTA

8857041701 - PSETTICHTHYS MELANOSTICTUS
SAND SOLE
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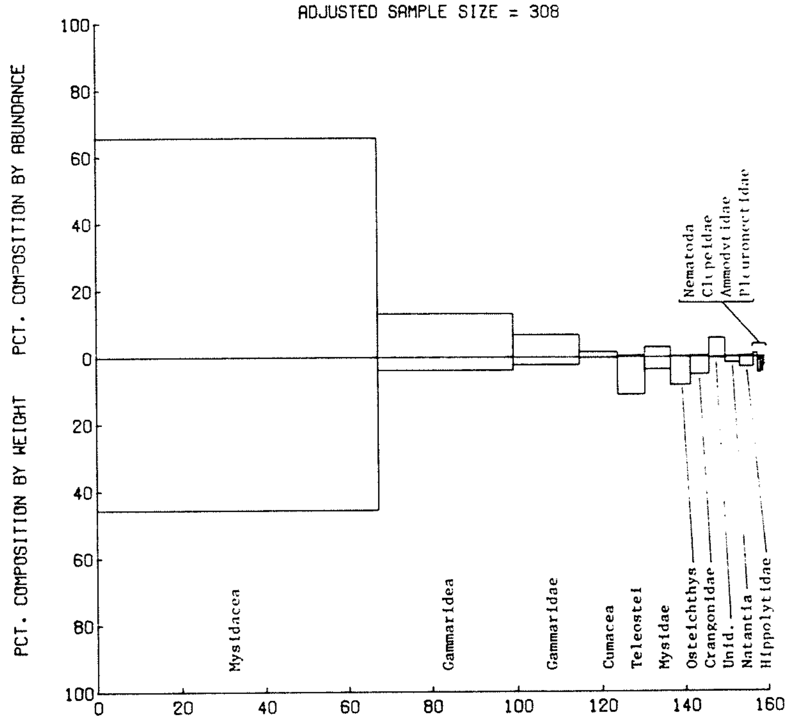

CUMULATIVE FREQUENCY OF OCCURRENCE

PREY ITEM	FREQ OCCUR	NUM. COMP.	GRAV. COMP.	PREY I.R.I.	PERCENT TOTAL IRI
MYSIDACEA	67.21	65.61	45.68	7479.5	88.85
GAMMARIDEA	32.14	13.01	3.91	543.9	6.46
GAMMARIDAE	15.58	6.66	2.34	140.3	1.67
CUMACEA	9.09	1.54	.18	15.7	.19
TELEOSTEI	6.49	.50	11.19	76.0	.90
MYSIDAE	6.17	2.95	3.76	41.4	.49
OSTEICHTHYS	4.87	.27	8.40	42.2	.50
CRANGONIDAE	4.55	.41	5.21	25.6	.30
UNIDENTIFIED	3.90	5.60	.27	22.9	.27
NATANTIA	3.57	.22	1.73	7.0	.08
HIPPOLYTIDAE	3.25	.36	2.99	10.9	.13
NEMATODA	.97	1.04	.01	1.0	.01
CLUPEIDAE	.65	.03	4.79	3.1	.04
AMMODYTIDAE	.65	.06	4.38	2.9	.03
PLEURONECTIDAE	.32	.01	2.65	.9	.01

PREY TAXA WITH FREQ. OCCUR. LESS THAN 5 AND NUMERICAL AND GRAVIMETRIC COMPOSITION BOTH LESS THAN 1 ARE EXCLUDED FROM THE TABLE AND PLOT (BUT NOT FROM CALCULATION OF DIVERSITY INDICES)

PERCENT DOMINANCE INDEX	.46	.24	.79
SHANNON-WEINER DIVERSITY	1.90	2.91	.75
EVENNESS INDEX	.37	.56	.14

App. Fig. 9pp. IRI prey spectrum of sand sole along the Strait of Juan de Fuca, 1976-78.

App. Table 9w. IRI comparison of principal prey organisms of sand sole at Dungeness Spit (DS, n=61), Morse Creek (MC, n=69), Twin Rivers (TR, n=92), and Kydaka Beach (KB, n=64) in 1976-78.

Prey	Freq.occur., % DS	MC	TR	KB	Numer. comp., % DS	MC	TR	KB	Grav. comp., % DS	MC	TR	KB
Mysids	52.5	62.3	91.3	73.0	68.0	41.6	88.3	36.3	37.1	20.9	69.8	21.7
Gammarid amphipods	16.4	61.0	38.0	58.0	23.9	21.9	8.7	51.3	11.5	8.0	4.2	9.5
Shrimp	8.2	15.0	7.0	4.7	1.3	3.0	0.3	0.2	16.4	22.6	5.3	5.6
Cumaceans	6.6	7.3	--	26.6	1.4	0.5	--	7.2	0.1	0.1	--	0.9
Fish	5.0	8.7	12.0	20.0	0.5	1.2	0.5	1.3	12.0	46.6	13.4	40.0

Prey	Total IRI, % DS	MC	TR	KB	IRI rank DS	MC	TR	KB
Mysids	86.1	64.9	97.4	53.8	1	1	1	1
Gammarid amphipods	9.7	25.7	1.7	32.8	2	2	2	2
Shrimp	2.6	3.7	0.2	0.2	3	3	4	10
Cumaceans	0.2	0.1	--	4.1	8	11	--	5
Fish	0.6	1.6	0.6	8.0	6	4	3	3