

UNIVERSITY OF WASHINGTON  
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*College of Fisheries*  
*Fisheries Research Institute*

ERRATUM

FRI-UW 7735, ADF&G-OCS, Fish Food Habits Analysis

Myoxocephalus polyacanthocephalus, great sculpin, was mistakenly identified as M. quadricornis. All reference to the latter species should instead read M. polyacanthocephalus.

FRI-UW-7735  
October 1977

Fisheries Research Institute  
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University of Washington  
Seattle, Washington 98195

ADF&G-OCS FISH FOOD HABITS ANALYSIS

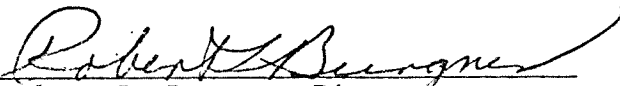
by

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Final Report  
March 1977 - October 1977  
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Robert L. Burgner, Director  
Fisheries Research Institute

## Introduction

Fisheries Research Institute (FRI) was contracted in March 1977 by the Alaska Department of Fish and Game (ADF&G) to examine, identify, and quantify the contents of approximately 500 stomachs from marine and estuarine fishes collected by ADF&G as a part of National Oceanic and Atmospheric Administration's OCSEAP studies in southern Cook Inlet and in Ugak and Alitak bays on Kodiak Island, Alaska. This report summarizes the condition, abundance, biomass, and composition of prey organisms in the stomach contents of these fishes. Where sample size permitted, comparisons between prey spectra from Cook Inlet and Kodiak Island fishes are presented.

## Materials and Methods

### Stomach Collection

Fish stomach samples originated principally from otter trawl collections but included some specimens from beach seine collections. The otter trawl was a 400-mesh Eastern-style net. The beach seine was 47.3 m (155 ft) long and 3.7 m (12 ft) deep at the bag with 6.4-mm (1/4 inch, stretch measure) mesh at the bag section.

Station and trawl transect locations as well as catch compositions and catch per unit effort (numbers of fish and kilograms of fish per 20-min. haul for trawls) were identified in Blackburn (1976a,b,c,d).

### Stomach Analysis

In the laboratory, the stomach samples were removed from the preservative or 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 processed. Processing

involved taking a total (damp) weight (to nearest 0.1 g) and removing the contents from the stomach and weighing the empty stomach, which gave a total contents weight (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 individual stomach contents were then sorted and identified as far as practical, using a zoom binocular dissecting microscope, and the sorted organisms were counted and a total (damp) weight of each taxon obtained (to nearest 0.01 g). If a sorted taxon was represented by too many individuals to count, the number was estimated using a random grid counting procedure.

All stomach analysis data were recorded directly on NOAA/EDS format No. 100 computer forms.

#### Data Analysis

All data were processed using FORTRAN computer programs specifically written for the NOAA/EDS format record types, including statistical analyses of stomach content data; calculation of Shannon-Weiner ( $H'$ ) diversity indices\* using both numbers and biomass; and generation and plotting of IRI (see next section) values.

#### Trophic Diagrams

In the presentation of the food habit data, a modification of Pinkas, et al. (1971), "Index of Relative Importance" (IRI) has been utilized to rank the importance of prey organisms. The IRI values for food items are

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\*Shannon-Weiner diversity indices are comparable between species only when the mean digestion factors are not significantly different.

displayed graphically where justified by sample size ( $n \geq 10$ ). These three-axis graphs illustrate frequency of occurrence (that proportion of stomachs containing a specific prey organism) plotted on the horizontal axis, and percentage of total abundance and percentage of total biomass plotted for each prey item above and below the horizontal axis, respectively (Fig. 1). Prey taxa of differing stages of digestion (e.g., partly digested shrimp, "Natantia--unidentified", as opposed to family, "Pandalidae", or species, "Pandalus borealis") are graphed separately.

All prey groups, including those assigned to a broad phylogenetic level (family, order, class) because of advanced digestion, have been arranged from left to right by decreasing frequency of occurrence. Items of taxa with less than 5% frequency of occurrence or 1% of total abundance or biomass were not graphed. Prey items that occurred in more than 5% of the stomachs appear on the graph, but if either the abundance or the biomass of a particular item was less than 1% of the total, a bar was not drawn. Hence, if a prey taxon appears on the graph but no bars extend above or below the horizontal axis, that particular taxon was present in more than 5% of the stomachs but contributed less than 1% to abundance (above) and biomass (below).

The IRI value was computed as follows.  $IRI = \% \text{ frequency of occurrence}_i [ \% \text{ numerical composition}_i + \% \text{ gravimetric composition}_i ]$ , 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 contribution of general prey taxa (e.g., all shrimp, including "Unidentified Natantia" and those identified to family and species, added together) have been discussed as a percentage of the total combined IRI (areas) of the

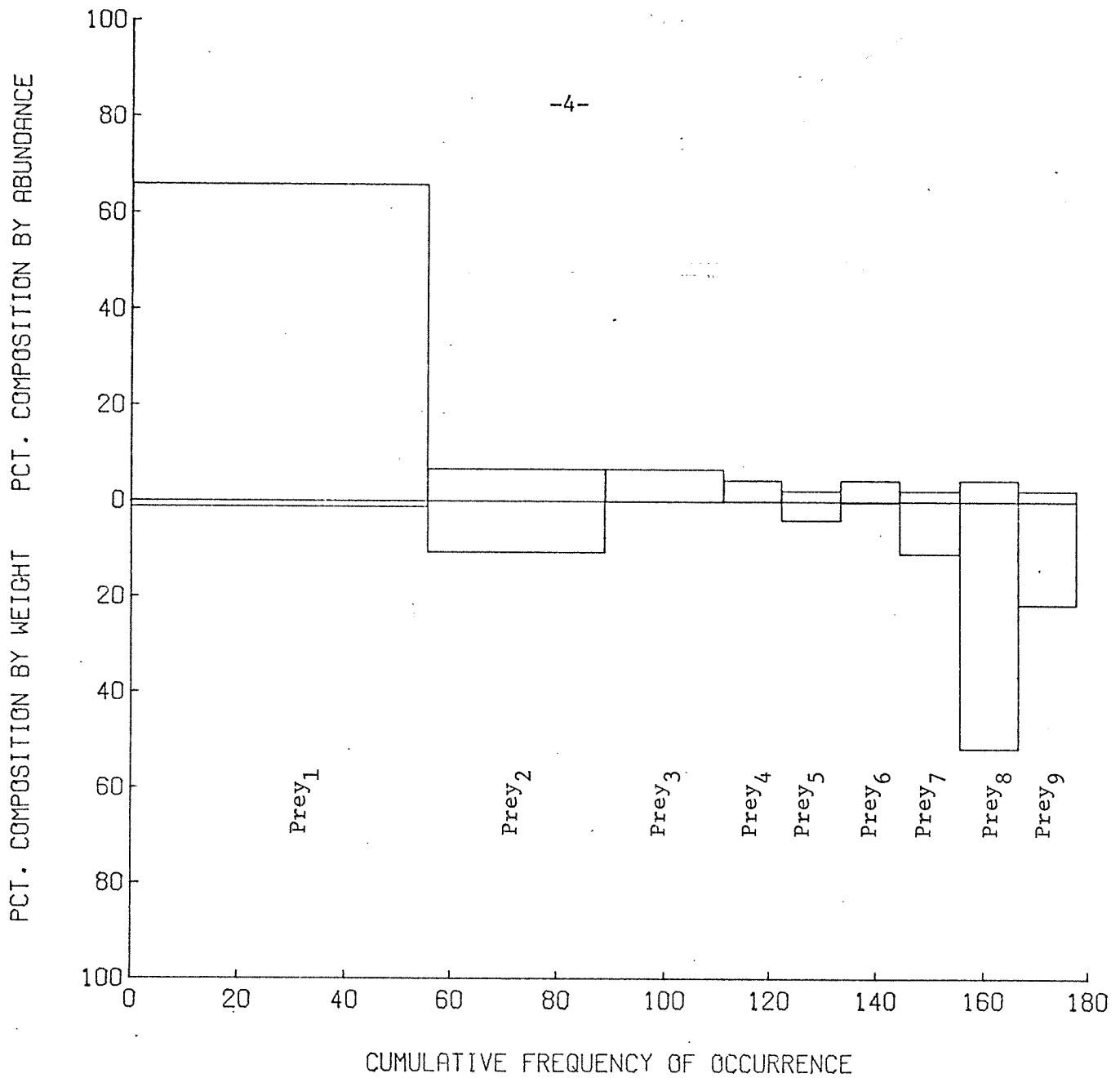


Fig. 1. Example IRI (Index of Relative Importance) diagram.

Table 1. Example computation of IRI values and percentages of total IRI from data illustrated in Fig. 1.

Prey category	% Freq. occur.	% num. compos.	% grav. compos.	IRI value	% Total IRI
1	55.6	65.9	1.2	3729.5	65.8
2	33.3	6.7	10.7	583.7	10.3
3	22.2	6.7	0.1	152.5	2.7
4	11.1	4.6	0	50.5	0.9
5	11.1	2.3	3.8	67.9	1.2
6	11.1	4.6	0.1	51.8	0.9
7	11.1	2.3	10.9	146.3	2.6
8	11.1	4.6	51.7	624.6	11.0
9	11.1	2.3	21.5	264.4	4.7

different prey taxa. Table 1 illustrates an example of the IRI values and percentages of total IRI generated from the data illustrated in Fig. 1.

The IRI values essentially represent a single index of prey importance incorporating normalized values for (1) the frequency (%) in which a particular prey taxon is represented in the food habits of a sample of fish--i.e., its occurrence in the diet of a population at any one time; (2) the numerical composition (%) which that prey taxon represents of the total number of prey items consumed; and (3) the composition (%) by biomass represented by that prey taxon over the total consumed (identifiable organism) biomass. Thus, numerically rare but high biomass taxa (e.g., prey<sub>8</sub>, Fig. 1); infrequently occurring but abundant or high biomass (when eaten) taxa; and numerically abundant or frequently occurring taxa (but which contribute little in the way of trophic input, e.g., prey<sub>1</sub>, Fig. 1) do not overpower the more representative prey organisms.

### Results and Discussion

#### Condition of Stomachs

Of the 313 stomach samples processed in the FRI laboratory, 74 (24%) had to be completely discarded because of extensive deterioration due to improper preservation at the time of collection. These samples originated from lower Cook Inlet. The samples from Kodiak Island, however, appeared to be in much better condition. Of those stomachs with obvious deterioration, most were very full of food organisms; empty stomachs did not undergo extensive deterioration. Accordingly, the data obtained from the lower Cook Inlet samples that were processed undoubtedly were biased by partial deterioration. Therefore, in interpreting the food habit data of Cook Inlet fishes, it should be realized that the percentage of empty stomachs, percentage of unidentifiable material, digestion factor, and

stomach contents weight values will provide impressions of lower feeding activity and ration size and higher digestive rates than actually occurred. Appendix Table 1 lists the stomach samples that were discarded.

#### Food Items

All food items identified from the stomach contents and their percentage frequencies of occurrence are listed in Table 2. On the basis of percent occurrence in the two sampling areas, the dominant prey taxon was caridean shrimp, principally the pandalid species Pandalus borealis and P. goniurus and crangonid species. Fishes were the second most important prey taxon, with the capelin (Mallotus villosus) and the prickleback (Lumpenus medius) being the commoner identifiable species.

Although the predator species composition varied in the samples from Kodiak Island and lower Cook Inlet, there appear to exist significant differences in the epibenthic and benthic prey resources of demersal fish assemblages in the two regions. Notable examples of these differences include: (1) More polychaete annelids in the lower Cook Inlet stomachs than in the Kodiak Island stomachs; (2) no gastropods in Kodiak Island stomach samples; (3) percentage occurrence of mysids in predator diets is higher in lower Cook Inlet than in Kodiak Island; (4) percentage of gammarid amphipods in predator diets is higher in lower Cook Inlet than in Kodiak Island; (5) similar utilization of caridean shrimps in both regions but with different occurrences of some species--e.g., P. borealis is absent in the stomachs of Kodiak Island predators; and (6) the importance of fishes in the food habits of Kodiak Island predators, as compared with the near lack of fishes in the stomachs of lower Cook Inlet fishes.

Table 2. Percent frequency of food items in stomachs of demersal fishes from Kodiak Island and lower Cook Inlet, Alaska, collected during ADF&G-OCS studies, June 1976 - March 1977.

Food item	Frequency of occurrence (Subtotals in parentheses)		
	Kodiak Island	Lower Cook Inlet	Overall
Algae			
Ulotrichales	0.4	...	0.2
<i>Ulva</i> sp.	1.6	...	0.9
Unidentified	0.4 (2.4)	0.6 (0.6)	0.5 (1.6)
Vascular plants			
<i>Zostera marina</i>	0.4	...	0.2
Hydroids, hydrozoans, medusae			
Cnidaria	0.4	...	0.2
Worms			
Trematoda (parasitic)	4.3	...	2.6
Nematoda (parasitic)	9.7	9.7	9.7
Polychaeta	0.8	10.3	4.5
Maldanidae	0.4	...	0.2
Terebellidae	... (1.2)	1.2 (11.5)	0.5 (5.2)
Snails			
Gastropoda	...	0.6	0.2
<i>Puncturella multistriata</i>	...	1.8	0.7
<i>Natica clausa</i>	...	0.6 (3.0)	0.2 (1.1)
Clams			
Bivalvia	2.7	4.2	3.3
<i>Nuculana</i> spp.	1.6	...	0.9
<i>N. fossa</i>	0.4	...	0.2
Veneroida	0.4	...	0.2
Mactridae	...	0.6	0.2
<i>Spisula</i> spp.	...	0.6	0.2
Veneridae	1.2 (6.3)	3.0 (8.4)	1.9 (6.9)
Crustaceans			
Crustacea	1.2	2.4	1.7
(Barnacles) Cirripedia	0.4	...	0.2
(Mysids) Mysidacea	2.3	14.5	7.1
(Isopods) Cymothoidae	0.4	...	0.2
Bopyridae	0.4 (0.8)	...	0.2 (0.4)
(Amphipods) Gammaridea	0.8	10.3	4.5
Caprellidea	0.4 (1.2)	... (10.3)	0.2 (4.7)
(Euphausiids) Euphausiacea	7.8	1.2	5.2
Decapoda	1.2	1.2	1.2
(Shrimp) Decapoda-Caridea	9.3	11.5	10.2
Hippolytidae	1.9	1.8	1.9
<i>Eualus biunguis</i>	0.4	...	0.2
<i>Heptacarpus</i> spp.	0.4	...	0.2
Pandalidae	3.5	1.8	2.8
<i>Pandalus</i> spp.	1.6	...	0.9
<i>P. borealis</i>	3.5	...	2.1

Table 2. Percent frequency of food items in stomachs of demersal fishes from Kodiak Island and lower Cook Inlet, Alaska, collected during ADF&G-OCS studies, June 1976 - March 1977, cont'd

Food item	Frequency of occurrence (Subtotals in parentheses)		
	Kodiak Island	Lower Cook Inlet	Overall
<i>P. goniurus</i>	3.1	5.5	4.0
<i>Pandalopsis</i> spp.	0.8	...	0.5
Crangonidae	1.2	6.1	3.1
<i>Crangon</i> spp.	3.1	4.2	3.5
<i>C. communis</i>	0.4	...	0.2
<i>Argis</i> spp.	0.8	...	0.5
<i>A. dentata</i>	1.2 (31.2)	... (30.9)	0.7 (30.8)
(Crabs) Lithodidae	0.4	...	0.2
<i>Paralithodes</i> spp.	0.4	...	0.2
Decapoda-Brachyura	...	0.6	0.2
Oxyrhyncha	...	0.6	0.2
<i>Pugettia gracilis</i>	0.4 (1.2)	... (1.2)	0.2 (1.0)
Brittlestars Ophiuroidea	0.4	...	0.2
Sea cucumbers Holothuroidea	1.2	0.6	0.9
Fishes Osteichthys	14.7	2.4	9.9
<i>Clupea harengus pallasii</i>	0.8	...	0.5
Osmeridae	1.9	...	1.2
<i>Mallotus villosus</i>	1.9	...	1.2
Zoarcidae	0.8	0.6	0.7
<i>Lycodes brevipes</i>	0.4	...	0.2
Cottidae	0.4	...	0.2
<i>Hemilepidotus jordani</i>	0.4	...	0.2
Stichaeidae	0.4	...	0.2
<i>Lumpenus</i> spp.	1.9	...	1.2
<i>L. medius</i>	1.6	...	0.9
Pleuronectidae	0.4	...	0.2
<i>Hippoglossoides elassodon</i>	0.4 (26.0)	... (3.0)	0.2 (16.8)
Rocks	1.2	1.2	1.2
	100%	100%	100%

### Food Habits

Fourteen predator species--two gadoids (codfishes), four cottids (sculpins), and eight pleuronectids (right-eyed flounders)--were examined for stomach contents (Table 3).

Gadus macrocephalus, Pacific cod. Stomachs of Pacific cod were typically quite full of food items and over 50% of these were usually identifiable. The combined prey spectrum (Fig. 2) indicated a generally benthophagous feeding behavior based on epibenthic macrocrustacea and fishes. Euphausiids accounted for 44.7% of the total IRI; shrimps (principally Pandalus goniurus but also P. borealis and several Crangon spp.), 26.6%; and fishes (including Clupea harengus pallasii, Hemilepidotus jordani, Hippoglossoides, and Lumpenus medius, and species of osmerids, zoarcids, stichaeids, and pleuronectids), 17.5%.

When the data were separated into collections from Kodiak Island and lower Cook Inlet, euphausiids were seen to dominate the IRIs at Ugak Bay on Kodiak, with fishes and shrimp providing the remaining prey items. The prey spectrum of lower Cook Inlet cod was composed almost entirely of shrimp, and mysids made up most of the remaining prey (Table 4).

Theragra chalcogramma, walleye pollock. As with Pacific cod, stomachs from the walleye pollock averaged 75% full with close to 75% of the contents identifiable. They also appeared to be benthophagous, feeding principally upon epibenthic crustacea--mysids, shrimp, and euphausiids--and fish (Fig. 3), although the biomass diversity ( $H'_{\text{biomass}} = 2.13$ ) was half that of Pacific cod ( $H'_{\text{biomass}} = 4.36$ ). Mysids dominated the total prey IRI with 71.6%, shrimp (Pandalus goniurus, Eualus biunguis, Heptacarpus sp., and Crangon sp.) composed 9.2%, and fish (identifiable only as cottids) composed 6.8%. The nematodes included in the prey spectra were parasitic and should not be considered as food items.

Table 3. Predator species and sample size; stomach fullness and contents digestion; prey abundance and biomass; and diversity of demersal fishes from Kodiak Island and lower Cook Inlet, Alaska, collected during ADF&G-OCS studies, June 1976 - March 1977.

Species	Sample size		% empty stomachs	Fullness factor $\bar{X} \pm S.D.$	Digestion factor $\bar{X} \pm S.D.$	Prey abund. $\bar{X} \pm S.D.$	Prey biomass $\bar{X} \pm S.D.$ (grams)	Shannon-Weiner Diversity Index H'	
	Cook Inlet	Kodiak						Abundance	Biomass
<i>Gadus macrocephalus</i> Pacific cod	12	15	0	5.2±1.1	4.8±0.7	52.7±76.2	23.9±27.7	2.84	4.36
<i>Theragra chalcogramma</i> walleye pollock	10	11	0	5.0±1.6	4.7±1.2	23.4±31.9	13.8±38.8	2.72	2.13
<i>Gymnocanthus</i> sp. sculpin	0	16	43	2.7±1.9	2.6±2.0	1.9±3.1	1.6±2.6	2.85	2.19
<i>Hemilepidotus jordani</i> yellow Irish lord	0	9	22	5.0±2.3	4.3±1.9	3.0±2.3	8.6±6.9	3.19	2.44
<i>Myoxocephalus</i> sp. sculpin	0	3	0	3.0±1.0	5.0±0	1.3±0.6	6.2±3.1	2.00	1.88
<i>Myoxocephalus quadricornis</i> , fourhorn sculpin	0	9	22	3.0±1.5	4.2±1.9	2.7±2.1	5.3±6.2	3.74	2.90
<i>Atheresthes stomias</i> arrowtooth flounder	6	7	30	3.4±2.1	3.5±2.1	3.4±4.5	2.7±6.1	2.53	2.05
<i>Hippoglossoides elassodon</i> , flathead sole	3	13	18	3.9±2.1	4.1±1.9	18.7±42.2	2.0±3.0	1.39	2.84
<i>Isopsetta isolepis</i> butter sole	6	6	41	2.7±2.0	2.5±1.9	3.1±7.4	0.7±1.3	2.42	2.59
<i>Lepidopsetta bilineata</i> rock sole	19	5	29	2.6±1.5	3.2±2.1	6.5±11.2	0.5±0.8	3.11	3.45
<i>Limanda aspera</i> yellowfin sole	5	60	36	2.3±1.5	3.3±2.2	3.9±18.6	1.5±4.4	2.76	3.41

Table 3. Predator species and sample size; stomach fullness and contents digestion; prey abundance and biomass; and diversity of demersal fishes from Kodiak Island and lower Cook Inlet, Alaska, collected during ADF&G-OCS studies, June 1976 - March 1977, cont'd

Species	Sample size		% empty stomachs	Fullness factor $\bar{x} \pm$ S.D.	Digestion factor $\bar{x} \pm$ S.D.	Prey abund. $\bar{x} \pm$ S.D.	Prey biomass $\bar{x} \pm$ S.D. (grams)	Shannon-Weiner Diversity Index H'	
	Cook Inlet	Kodiak						Abundance	Biomass
<i>Microstomus pacificus</i>	17	0	5	3.8±1.5	4.1±1.4	6.5±5.7	0.1±0.1	2.56	2.52
<i>Platichthys stellatus</i>	3	1	75	1.3±0.5	1.8±1.5	1.5±3.0	0.1±0.1	1.46	1.07
<i>Pleuronectes quadritu-</i> <i>berculatus</i> , Alaska plaice	3	0	0	2.0±0	4.0±2.0	5.0±6.9	0.1±0.1	1.75	1.54
Total stomach sample	84	155							

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

8791030401 - GADUS MACROCEPHALUS  
PACIFIC COD

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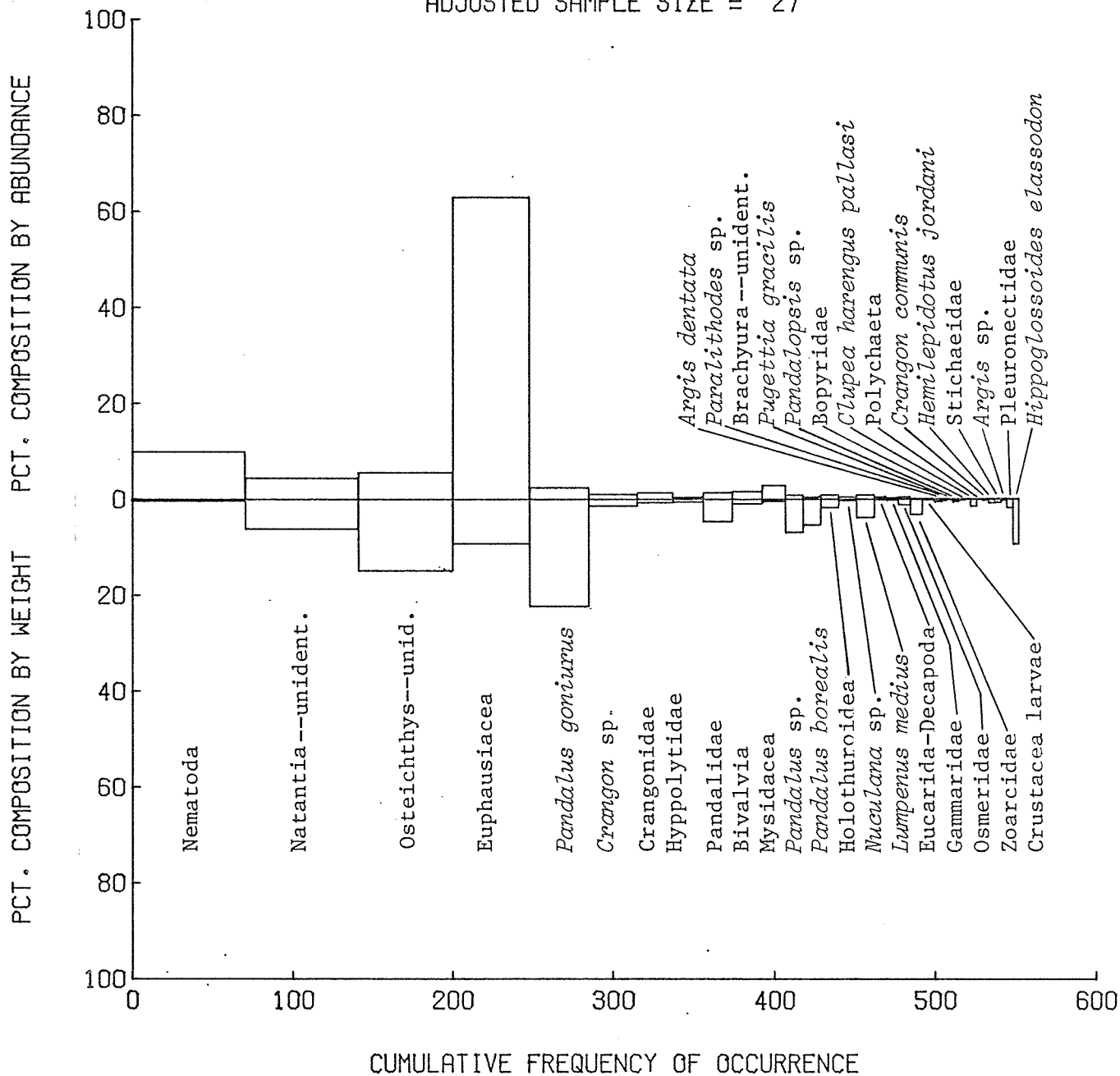


Fig. 2. Composite IRI diagram for prey organisms of Pacific cod, Gadus macrocephalus.

Table 4. Percent IRI composition for dominant prey taxa in stomachs of Pacific cod from Kodiak Island and Lower Cook Inlet.

Taxon	Ugak Bay, Kodiak July 1976 n=15	Lower Cook Inlet September 1976 n=12
Euphausiacea	65.33	0.13
Osteichthys	17.66	0.0
Natantia	15.35	91.71
Bivalvia	1.01	0.0
Holothuroidea	0.51	0.0
Reptantia	0.10	0.28
Mysidacea	0.0	6.17
Polychaeta	0.0	0.14
Amphipoda	0.0	1.43

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

8791030701 - THERAGRA CHALCOGRAMMA  
WALLEYE POLLOCK  
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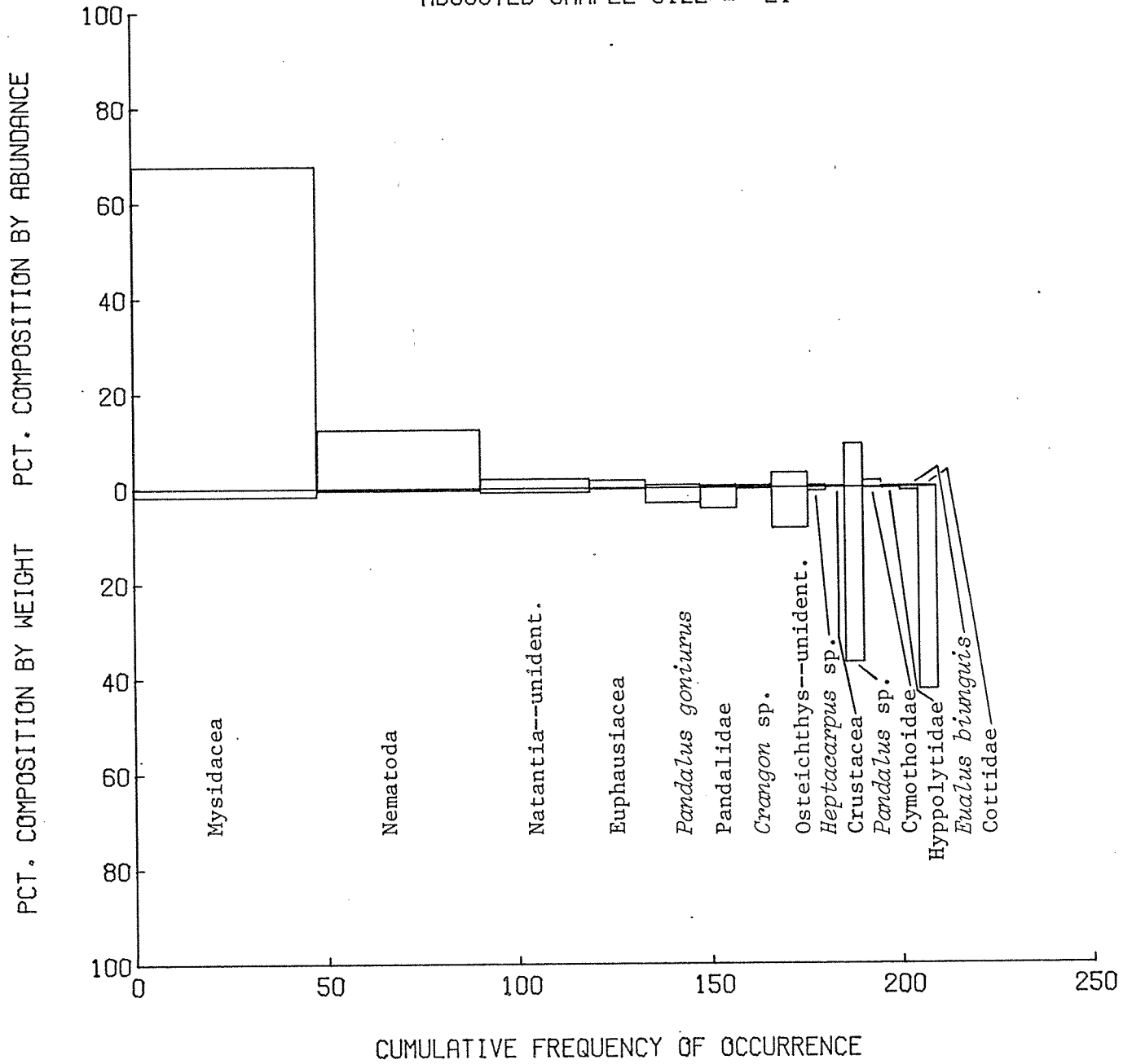


Fig. 3. Composite IRI spectrum for prey organisms of walleye pollock, Theragra chalcogramma.

While shrimp and fish were the more important prey organisms around Kodiak Island, mysids were much more important to the diet of walleye pollock in lower Cook Inlet and shrimp proportionally less so (Table 5).

Gymnocanthus sp., sculpin. These cottids originated from August and September 1976 collections in Ugak Bay. Because of a high percentage of empty stomachs (43%), the resulting sample size did not permit a quantitative representation of the prey spectrum. Fishes, Mallotus villosus and Lumpenus sp., formed the greatest percentage of the total IRI with lesser contributions by euphausiids and mysids.

Hemilepidotus jordani, yellow Irish lord. Of the nine specimens of H. jordani collected in Ugak Bay in August 1976, the stomachs of two (22%) were completely empty. Shrimp was the major prey item; Pandalus borealis and P. goniurus provided 64.5% and 21.7% of the total IRI, respectively.

Myoxocephalus sp., sculpin. We examined the stomachs of three unidentified cottids of the genus Myoxocephalus captured in Ugak Bay in August and September 1976. IRI values were equally shared by the shrimp P. borealis and two fishes, Mallotus villosus and Lumpenus medius, but the low sample size does not allow quantitative generalizations.

Myoxocephalus quadricornis, fourhorn sculpin. Of the nine specimens of M. quadricornis identified from the August 1977 collections at Ugak Bay, seven had identifiable stomach contents, a sample size too small to allow quantitative evaluation. Fishes (principally Lumpenus sp. and M. villosus) composed the highest percentage of the total IRI; shrimp (Argis dentata, Crangon sp., Hyppolytidae, and Pandalidae) were second in importance, followed by euphausiids.

Table 5. Percent IRI composition for dominant prey taxa in stomachs of walleye pollock from Kodiak Island and lower Cook Inlet.

Taxon	Ugak Bay, Kodiak I., 7-9/76 Alitak Bay, Kodiak I., 3/77 (n=11)	Lower Cook Inlet, 9/76 (n=10)
Natantia	47.97%	9.07%
Osteichthys	24.79	0
Mysidacea	5.67	90.85
Euphausiacea	2.38	0.08
Isopoda	2.36	0

Atheresthes stomias, arrowtooth flounder. Seven A. stomias stomach samples originated from Ugak Bay collections in July and September 1976; and six samples were collected in lower Cook Inlet in September 1976. The stomachs of 30% of the combined samples were empty, creating a low sample size.

Mysids were the prevalent prey organisms for arrowtooth flounder, accounting for 65.8% of the total IRI; fish (Mallotus villosus, Osmeridae, and Zoarcidae) composed most of the remaining IRI percentage.

Hippoglossoides elassodon, flathead sole. Most of the H. elassodon stomach samples originated from the August 1977 collections at Ugak Bay. Of the 16 samples, three (18%) were empty. Samples with food items averaged nearly half full and usually over half of the prey were identifiable.

Flathead sole fed almost exclusively upon epibenthic crustaceans. Mysids constituted the main prey organism, especially on the basis of percent numerical composition--72.5% of the total IRI (Fig. 4), producing a low diversity diet, numerically ( $H'_{abundance} = 1.39$ ). Shrimp (predominately Pandalus goniurus and P. borealis) composed 14.0% and fish (Clupea harengus pallasi and Lumpenus sp.) 8.5% of the total IRI.

Isopsetta isolepis, butter sole. The stomachs of six butter sole were taken from September 1976 collections both at Ugak Bay and lower Cook Inlet; five (41%) of these were empty. The reduced sample size did not permit quantitative interpretations, but crustaceans (shrimp and mysids), bivalves (Veneridae, Nuculana sp.) gastropods, fish, and polychaetes were the major food items. The polychaetes, bivalves, and gastropods appeared to be more important in the diet of Ugak Bay flathead sole, whereas fish and shrimp were more important in lower Cook Inlet.

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

8857040601 - HIPPOGLOSSOIDES ELASSODON

FLATHEAD SOLE

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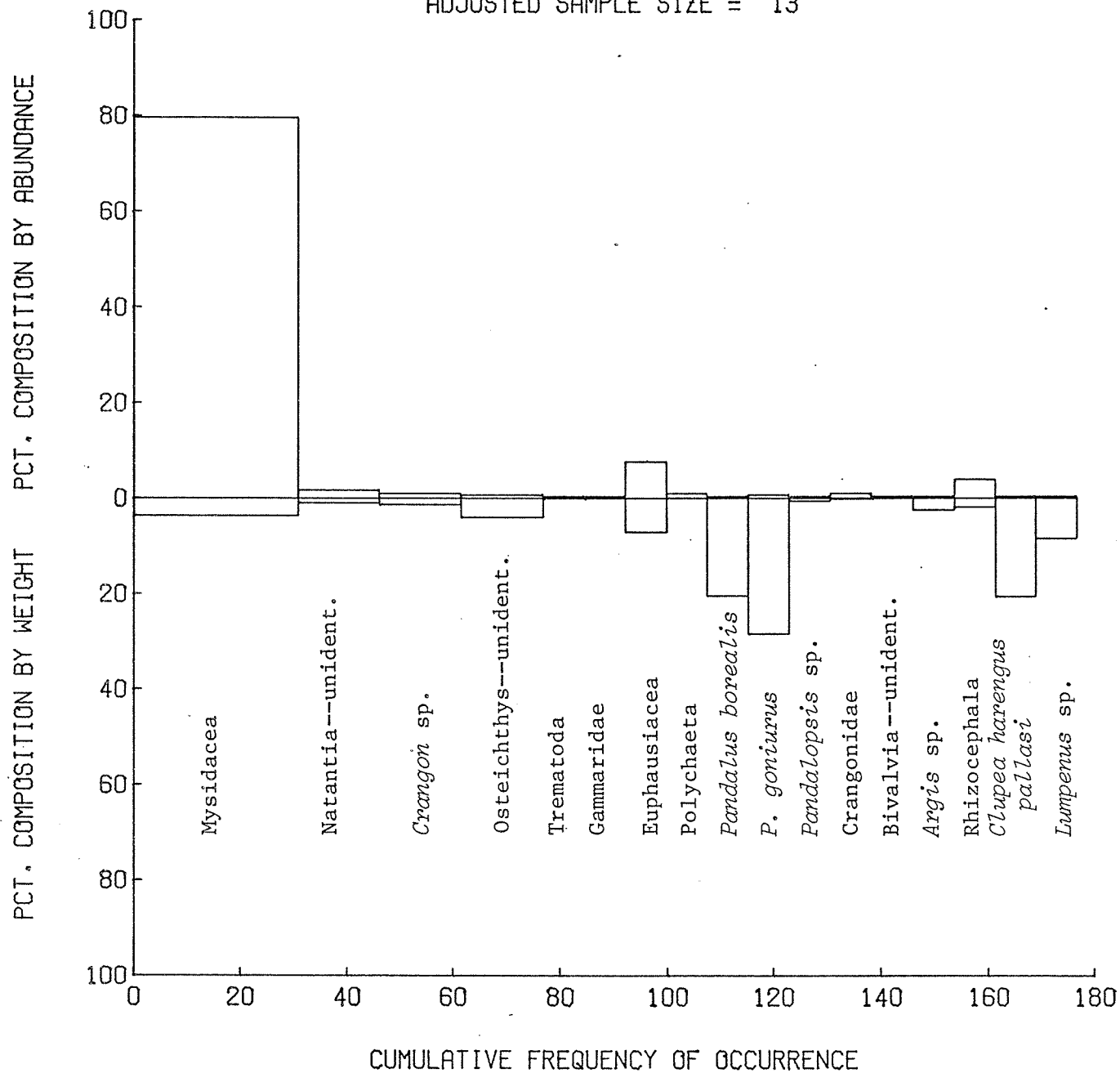


Fig. 4. Composite IRI spectrum for prey organisms of flathead sole, Hippoglossoides ellassodon.

Lepidopsetta bilineata, rock sole. Rock sole were captured mainly in lower Cook Inlet (September), although five stomach samples were retained from the Ugak Bay collections in September 1976. A high percentage (29%) of these were empty and the remainder averaged less than 25% full; typically, less than 50% of the contents were identifiable.

These rock sole were benthophagous; polychaete annelids (Terebellidae) and gastropods (Puncturella multistriata and Natica clausa) were the more important prey organisms, constituting 89.8% and 33.0% of the total IRI, respectively (Fig. 5). Bivalves (Veneridae, Nuculana fossa, Spisula sp., 14.2% of total IRI), mysids (6.1%), and shrimp (Crangon sp., 4.6%) were the secondary food items.

Despite the low sample size for Ugak Bay, there appears to be a basic difference in prey composition for rock sole collected there and in lower Cook Inlet in that the polychaete annelids were prominent only in the lower Cook Inlet samples.

Limanda aspera, yellowfin sole. Large numbers of stomach samples were taken from yellowfin sole collected at Ugak Bay in June through September 1976; only five samples were retained from the lower Cook Inlet collections, in September 1976. Over 36% of these stomachs were empty. Those with food items were seldom over 25% full, nor were more than half the organisms identifiable.

Both benthic and epibenthic organisms were important prey, according to the IRI prey spectrum (Fig. 6). Fishes (Lycodes brevipes and Osmeridae), polychaete annelids (including Maldanidae), and shrimp (Crangon sp. and Pandalidae) were the most important prey, with 35.7%, 23.8%, and 22.8% of the total IRI, respectively. The trematodes within the stomachs were probably parasites and it is likely that the algae, Ulva sp., were consumed incidentally with food organisms.

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

8857040801 - LEPIDOPSETTA BILINEATA  
ROCK SOLE

ADJUSTED SAMPLE SIZE = 17

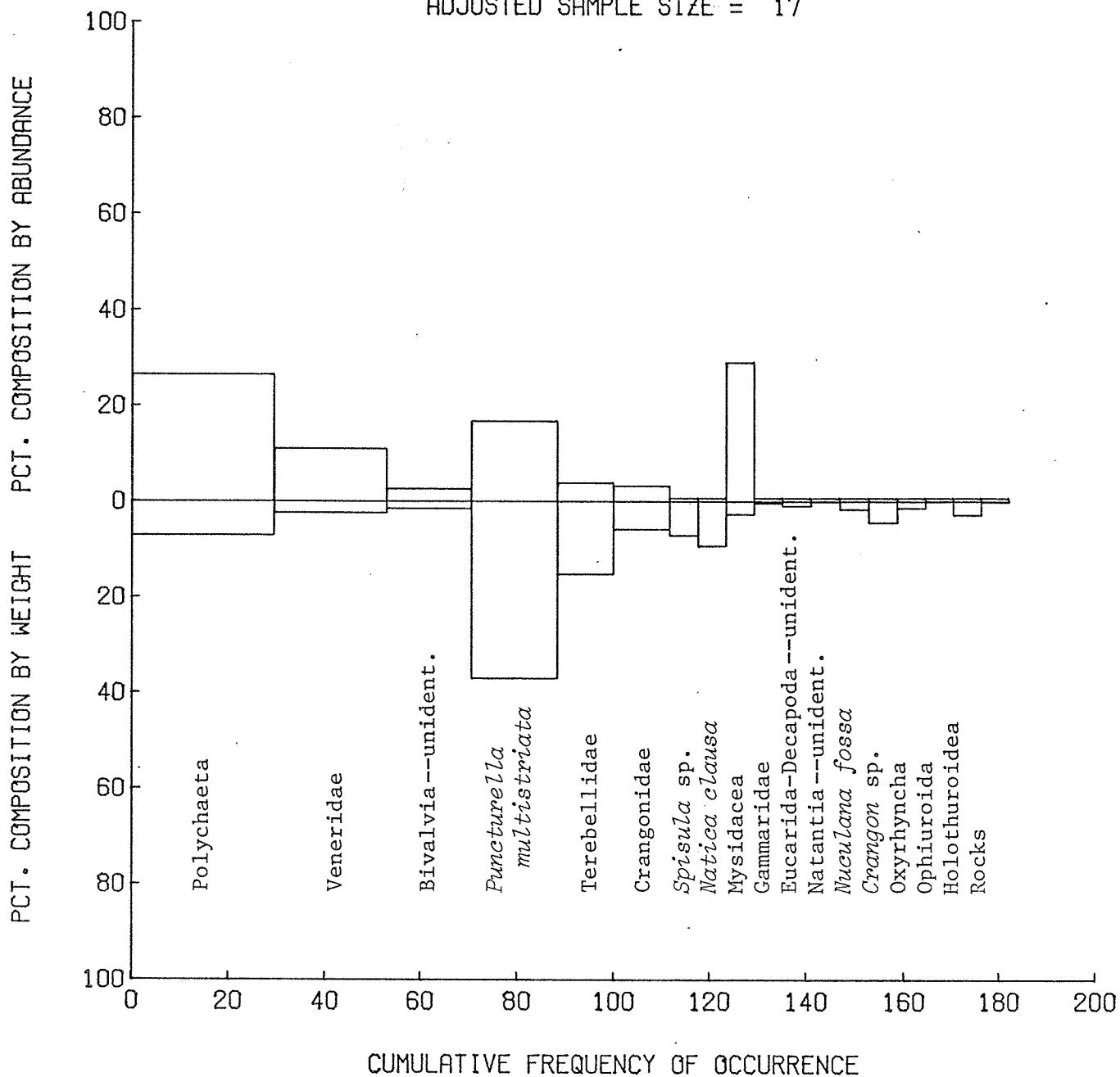


Fig. 5. Composite IRI spectrum for prey organisms of rock sole, Lepidopsetta bilineata.

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

8857040901 - LIMANDA ASPERA  
YELLOWFIN SOLE  
ADJUSTED SAMPLE SIZE = 41

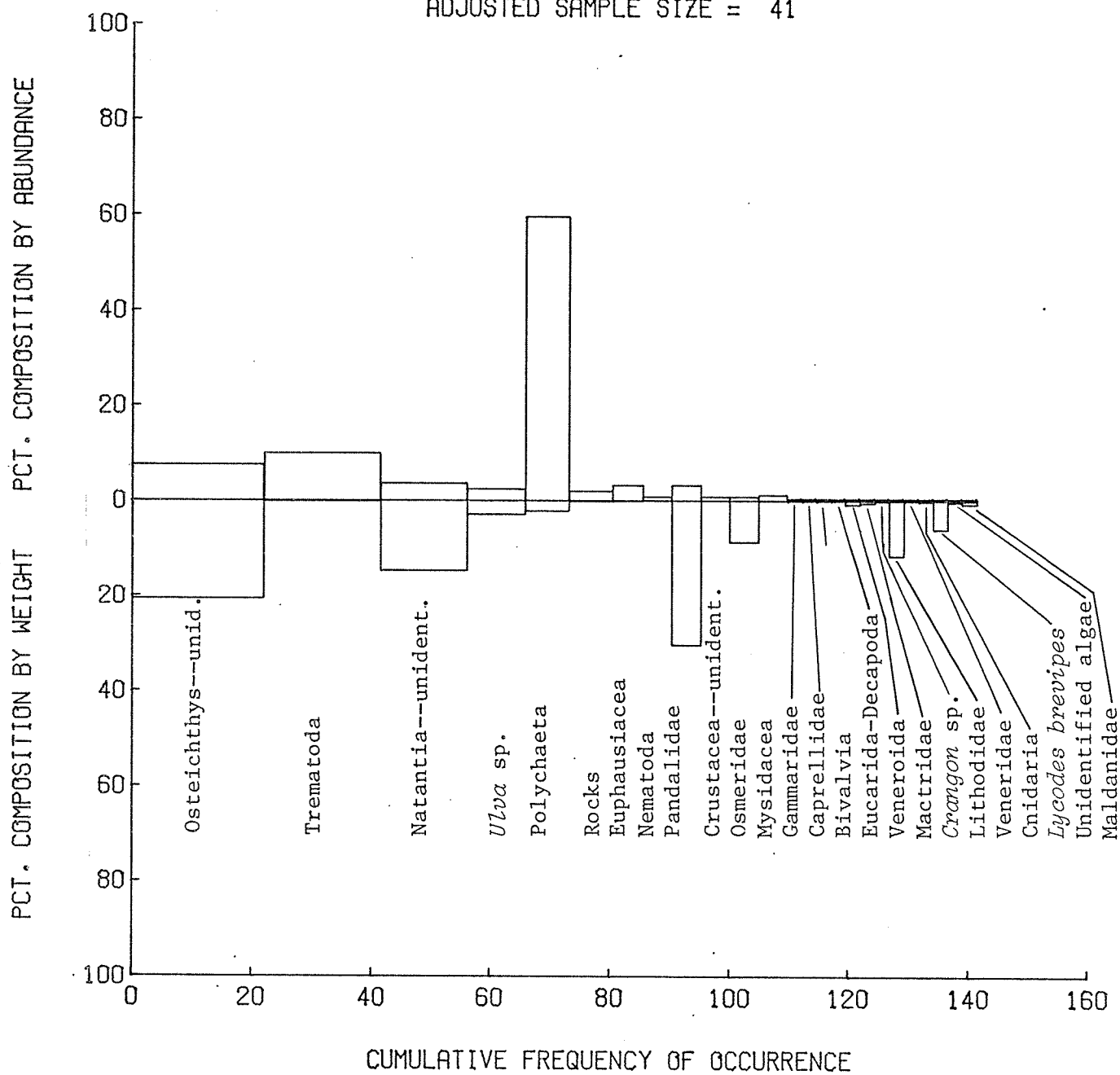


Fig. 6. Composite IRI spectrum for prey organisms of yellowfin sole, Limanda aspera.

Microstomus pacificus, Dover sole. Dover sole specimens were collected only during the September 1976 lower Cook Inlet cruise. Five of the 17 stomachs collected were empty but the remaining stomachs averaged close to 50% full with 50-75% of the organisms considered identifiable.

Gammarid amphipods completely dominated the IRI prey spectrum (Fig. 7), making up 86.1% of the total IRI. Polychaete annelids and shrimp (Cragonidae) were secondary prey, with 7.1% and 6.2% of the total IRI, respectively.

#### Discussion

Faulty preservation of almost 25% of the stomach samples collected in the course of ADF&G's OCS studies in lower Cook Inlet and Kodiak Island unfortunately reduced the sample sizes of many species below the point where their food habits could be quantitatively described or regional differences reliably detected. In addition, a naturally high incidence of empty stomachs, notably in the pleuronectids, reduced sample sizes to below that permitting quantitative interpretation. It is suggested that, in future studies in which predator food habits are an important objective, at least twice the number of samples desired be obtained of dominant predators found at a station.

Given the results from the remaining analyses, we can gain a broad view of the trophic position of the demersal fishes in the two regions of the western Gulf of Alaska (Table 6). Seven of the 12 fish studied were facultative planktivores--i.e., predators feeding principally upon epibenthic crustaceans such as shrimp, mysids, euphausiids, and amphipods. These would also prey (secondarily) upon benthic organisms--gastropods, bivalves, and polychaetes--or epibenthic fishes. Four species, mostly sculpins, were considered facultative piscivores by their reliance upon

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

8857041201 - MICROSTOMUS PACIFICUS  
DOVER SOLE  
ADJUSTED SAMPLE SIZE = 16

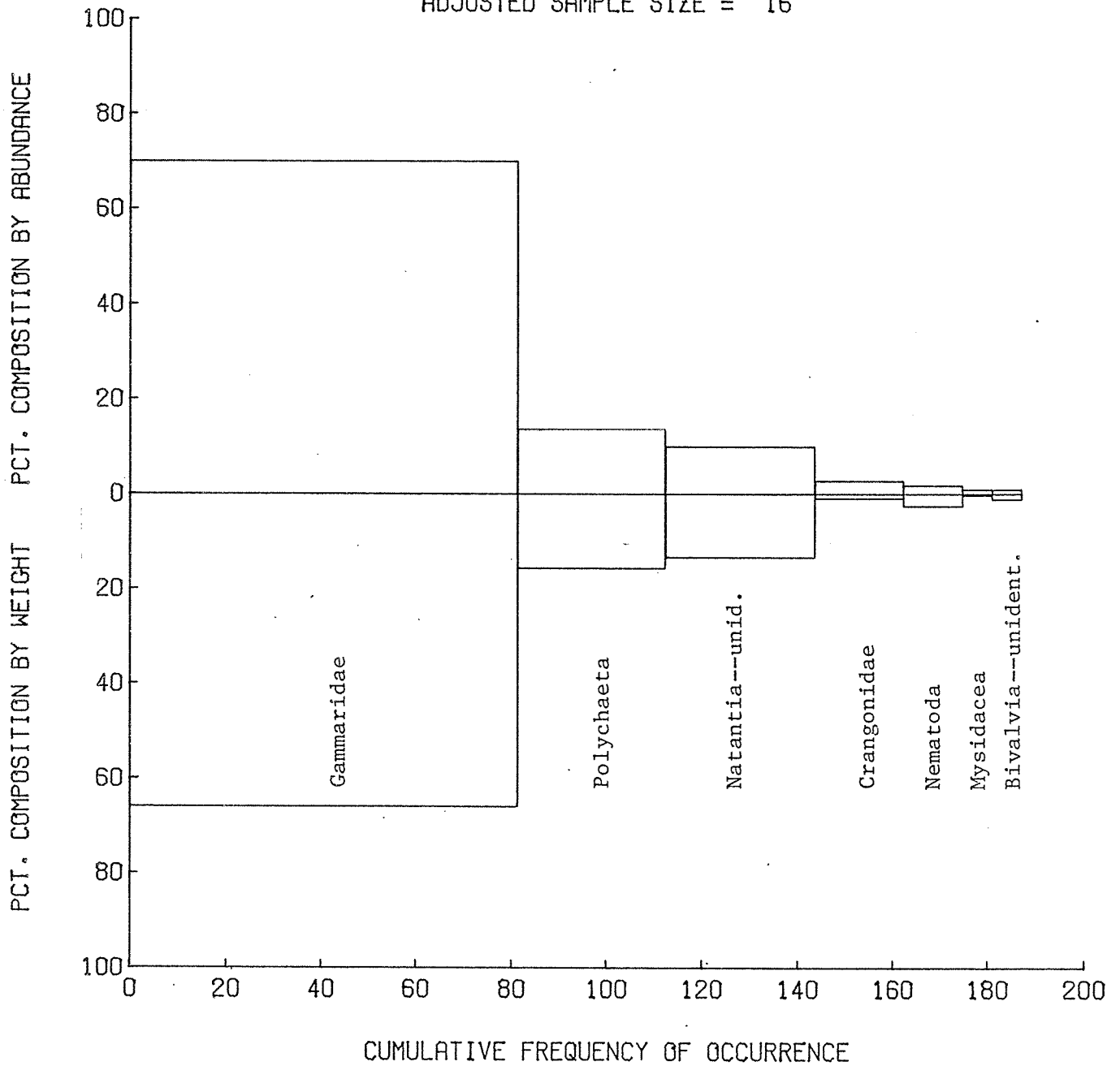


Fig. 7. Composite IRI spectrum for prey organisms of Dover sole, Microstomus pacificus.

Table 6. Feeding classifications of 12 species of demersal fish predators from Kodiak Island and lower Cook Inlet collected during ADF&G-OCS studies, June 1976 - March 1977.

Predator species	Classification	Feeding realm	Prey organisms in general order of importance
<i>Gadus macrocephalus</i>	Facultative planktivore	Epibenthic Benthic	Shrimp
<i>Theragra chalcogramma</i>			Mysids
<i>Hemilepidotus jordani</i>			Euphausiids
<i>Atheresthes stomias</i>			Amphipods
<i>Hippoglossoides elassodon</i>			Fishes
<i>Isopsetta isolepis</i>			Polychaetes
<i>Microstomus pacificus</i>			Bivalves Gastropods
<i>Lepidopsetta bilineata</i>	Facultative benthivore	Benthic Epibenthic	Polychaetes Gastropods Bivalves Mysids Shrimp
<i>Gymnocanthus</i> sp.	Facultative piscivore	Epibenthic Benthic	Fishes
<i>Myoxocephalus</i> sp.			Shrimp
<i>M. quadricornis</i>			Polychaetes
<i>Limanda aspera</i>			Euphausiids Mysids

epibenthic fishes but with supplemental predation upon epibenthic crustaceans or benthic organisms. Only one species, the rock sole, was described as a facultative benthivore, preying mainly upon truly benthic prey and only secondarily upon epibenthic crustaceans or fishes. There was no indication that any of these predator species, at least as adults, could be considered an obligate planktivore, obligate benthivore, or obligate piscivore.

If these data truly represent trophic interactions of the demersal fish assemblages in the Kodiak Island and lower Cook Inlet regions, it is apparent that prey resources available to these predators were distinctly different in the two regions. Lower Cook Inlet fishes appear to have exploited more benthic (especially soft-bottom) organisms--polychaetes, gastropods, bivalves--whereas fishes of the Kodiak Island embayments seem to have relied more upon smaller demersal fishes. Both assemblages, however, were surprisingly similar in their prominent exploitation of epibenthic crustaceans--caridean shrimp, mysids (more prevalent in lower Cook Inlet samples), euphausiids (more prevalent in Kodiak Island samples), and amphipods.

#### Acknowledgements

This work was performed under contract No. 11-41-3-406-380 with the State of Alaska, Department of Fish and Game. Mr. James Blackburn of ADF&G Kodiak Island office, project leader for the OCS Cook Inlet and Kodiak Island studies, was instrumental in arranging the study. Mr. Mark Hunter, graduate student in the College of Fisheries at University of Washington, performed the analysis of the stomach contents.

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Appendix Table 1. Lower Cook Inlet stomach samples discarded due to improper preservation.

Collection date	Site No.	Time, GMT	Species	Length range, mm	No.
9/3/76	718	0218	<i>Hippoglossoides elassodon</i>	250-255	2
			<i>Lepidopsetta bilineata</i>	215-328	5
9/3/76	A28	1748	<i>L. bilineata</i>	230	1
			<i>Limanda aspera</i>	250-280	2
			<i>Pleuronectes quadrituberculatus</i>	220-350	4
9/3/76	AM1	2120	<i>H. elassodon</i>	242-288	4
			<i>Isopsetta isolepis</i>	220-240	2
			<i>L. bilineata</i>	380-400	2
9/4/76	230	2315	<i>Platichthys stellatus</i>	462-500	4
9/4/76	595	2145	<i>Gadus macrocephalus</i>	250	1
			<i>I. soplepis</i>	200-220	2
			<i>L. bilineata</i>	310	1
			<i>L. aspera</i>	260-290	3
9/4/76	*	*	<i>L. bilineata</i>	320	1
9/5/76	V75	0257	<i>H. elassodon</i>	176-195	5
			<i>L. aspera</i>	162-218	5
			<i>P. stellatus</i>	325	1
			<i>Theragra chalcogramma</i>	88-230	10
9/5/76	S36	2012	<i>H. elassodon</i>	255	1
			<i>I. isolepis</i>	210-298	3
			<i>L. bilineata</i>	315	1
9/5/76	X37	1737	<i>I. isolepis</i>	220-300	4
			<i>L. bilineata</i>	247-405	6
			<i>P. stellatus</i>	470-505	2
9/5/76	P67	2245	<i>G. macrocephalus</i>	260-270	2
					74

\*No data recorded on tag.