Annotated Bibliography of Demersal Fish Feeding with Emphasis on Selected Studies from the Scotian Shelf and Grand Banks of the Northwestern Atlantic

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Annotated bibliography of demersal fish feeding with emphasis on selected studies from the Scotian Shelf and Grand Banks of the northwestern Atlantic

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Abstract

Methven, David A. 1999. Annotated bibliography of demersal fish feeding with emphasis on selected studies from the Scotian Shelf and Grand Banks of the northwestern Atlantic. Can. Tech. Rep. Fish. Aquat. Sci. 2267: iv + 106 p.

This document summarizes selected studies on the feeding ecology of demersal fishes from the Nova Scotian and Grand Banks regions of the northwestern Atlantic. Some studies from the eastern Atlantic and from Iceland are also included. The following information, if available, is recorded for each study; purpose, predator, predator size, dominant prey, pre size, location and time of study, how prey were quantified, number of predator stomachs examined, depth, bottom type, and calorific content of prey. Text describing the contribution of the dominant prey of each predator is also included and is summarized with respect to sources of variation known to influence prey selection. This includes: variation in the diet with respect to predator size, time of sampling, and sampling location. Eighty-nine studies are summarized. This feeding ecology of four species of Gadidae (Atlantic cod *Gadus morhua*; haddock *Melanogrammus aeglefinus,* pollock *Pollachius virens*; silver hake *Merluccius bilinearis*), three species of Pleuronectidae (American plaice *Hippoglossoides platessoides*; yellowtail *Pleuronectes ferrugineus* [=*Limanda ferruginea*]; winter flounder *Pleuronectes americanus* [*Pesudopleuronectes americans*]), redfish *Sebastes* sp., wolffish *Anarhichas lupus*, and eelpout *Macrozoaraces americanus* are outlined from these selected studies.

Résumé

Methven, David A. 1999. Annotated bibliography of demersal fish feeding with emphasis on selected studies from the Scotian Shelf and Grand Banks of the northwestern Atlantic. Can. Tech. Rep. Fish. Aquat. Sci. 2267: iv + 106 p.

Ce document présente un résumé d`études portant sur l`alimentation des poissons démersaux de la plate-forme néo-écossaise et des Grands Bancs du nord-ouest de l`Atlantique, ainsi que quelques études provenant des regions de l`est de l`Atlantique et de l`Icelande. Quatre-vinght neuf études sont incluse. Pour chaque étude, nous présentons les données suivantes, si elles étaient disponibles: le but du projet de recherche, les prédateurs étudiés, leurs taille, les proies importantes, les tailles des proies, l`endroit et la période où l`étude à eu lieu, la procédure utilisée pour quantifier le montant de proies, le nombre d`estomachs de prédateurs étudiés, la profondeure, le type de substrat, et la valeure calorifique des proies. Une description de la contribution de la proie principale de chaque prédateur, ainsi qu`un résumé des sources de variabilité influençant la sélection des proies, sont aussi inclus. La variation des contenus stomacaux par rapport à la taille du prédateur, ainsi que les temps et les endroits où les échantillonages ont eu lieu, sont addressées comme sources de variabilité. Ce document présente un résumé de l`alimentation de quatre espèces de la familles Gadidae (Morue franche *Gadus morhua*; aiglefin *Melanogrammus aeglefinus*; goberge *Pollachius virens*; merlu argenté *Merluccius bilinearis*), trois espèces de la famille Pleuronectidae (plie *Hippoglossoides platessoides*; limande à queue jaune *Pleuronectes ferrugineus* [=*Limanda ferruginea*]; plie rouge Pleuronectes americanus [=*Pseudopleuronectes americanus*]), le sébaste *Sebastes* sp., le loup d`atlantique *Anarhichas lupus*, et la loquette d`Amérique *Macrozoaraces americanus*.

Objectives

(i) identify publications that contain information on the feeding ecology of demersal fish species (age 0+; commercial and non-commercial) from the north western Atlantic with emphasis on the Grand Banks of Newfoundland and the Nova Scotian Shelf;

(ii) review selected publications, identify the taxonomic groups and prey species, and where possible the size classes of prey that comprise the most important food of demersal fish;

(iii) prepare an annotated bibliography of all pertinent publications with a brief summary;

Organization and approach

This report summarizes 89 papers from the primary (53) and secondary (33) scientific literature that describe the diet and feeding ecology of demersal fish that occur on the Grand Bank, Scotian Shelf, and nearby waters.

Individual studies are summarized in an annotated bibliography. The results are combined to gain an overview of the diet and feeding ecology of several of the best studied, most common, and commercially important species (4 gadids, 3 pleuronectids, redfish, wolffish, and eelpout) that occur on the Scotian Shelf and Grand Bank.

The feeding ecology of many small and unmanaged species within the Cottidae, Lumpenidae, Pholidae, etc. from the Grand Banks and Scotian Shelf likely have not been examined. Consequently, studies that describe the diet from neighbouring regions such as the Gulf of St. Lawrence, Gulf of Maine, Georges Bank, Bay of Fundy, and eastern Atlantic were included. Studies that describe the diet of demersal feeding fishes from inshore areas of Atlantic Canada were also included. Inshore studies often examine fewer stomachs than studies conducted offshore at sea. Hence, if there is a tradeoff between number of stomachs examined and level of taxonomic identification of the prey, then studies conducted inshore may provide complete descriptions of the diet. This document does not include all known studies on the feeding ecology of demersal fishes in the Canadian Atlantic but does include information on as many different predator species as possible.

For each study in the bibliography the important taxonomic groups and species are identified. The diet is described with respect to sources of variation that generally influence the diet. This includes variation in the diet with respect to size of predator, time and location of sampling. **Each study is identified with a reference number.** The **reference number** is located on the first line of the box included with each individual study in the bibliography section of this review. Individual papers are in alphabetical order by the first author. The first paper in the bibliography section is by Albert (1993). Its reference number is (1). This number is used to identify papers applicable to a specific predator and specific region, be it the Scotian Shelf, Grand Bank, etc. Reference numbers are used to summarize papers by sampling location (Table 1) and predator (Table 2).

Table 1. Distribution of studies by region.

Region	Study
Iceland - Greenland	62,63
eastern Atlantic	1,2,13,18,22,23,29,50-52,58,59,70
Newfoundland and Labrador Shelf	3,5,9,12,20,24-28,30,32,33,40-46,55,56,57,64-66,69,77-79,88,89
Gulf of St. Lawrence	30,31,33,67,68,73,74,84
Scotian Shelf	6,8,10,15,30,31,34,35,36,37,48,49,53,54,72,73,75,76,81,83,85
Bay of Fundy	47,75,80,86
Gulf of Maine - Georges Bank	4,6,7,8,10,11,14,15,16,17,19,21,34,35,36,37,38,39,53,54,60,61
	71,81,82,87

Table 2. Distribution of studies by predator.

Gadidae		**Reference number**
Fourbeard rockling	*Enchelyopus cimbrius*	1,6,36,50,80
Haddock	*Melanogrammus aeglefinus*	2,6,23,31,34,36,48,52,53,62,80,87
Atlantic cod	*Gadus morhua*	6,15,18,20,21,22,29,31,32,34,36,40,41,42,
		43,44,45,46,47,51,53,55,57,62,67,70,79,80,84
Silver hake	*Merluccius bilinearis*	6,7,10,14,15,34,36,53,71,76,79,80,81,82,83,85
Pollock	*Pollachius virens*	6,14,34,36,75,80
Red hake	*Urophycis chuss*	6,21,34,36,81,82,83
White hake	*Urophycis tenuis*	6,34,36,64,79,80
Spotted hake	*Urophycis regius*	6,34,36
Longfin hake	*Phycis chesteri*	36
Offshore hake	*Merluccius albidus*	36
Cusk	*Brosme brosme*	36
Pleuornectidae		
Plaice	*Hippoglossoides platessiodes*	6,20,25,32,34,37,38,47,49,56,59,61,62,65,68,80,89
Yellowtail	*Pleuronectes ferrugineus*	6,11,17,21,34,35,37,38,39,49,66
Winter flounder	*Pleuronectes americanus*	19,21,24,28,37,38,47,49,73,80,86
Atlantic halibut	*Hippoglossus hippoglossus*	30
Witch	*Glyptocephalus cynoglossus*	34,37,47,50
Greenland halibut	*Reinhardtius hippoglossoides*	5,9,20,69,79
Bothidae		
Windowpane	*Scophthalmus aquosus*	21,37
Summer flounder	*Paralichthys dentatus*	37
Gulf stream flounder	*Citharichthys arctifrons*	37
Four spot flounder	*Paralichthys oblongus*	34,37
Other species		
Checker eelpout	*Lycodes vahlii*	1
Wolffish	*Anarhichas* sp.	3,26,62,78
Ocean pout	*Macrozoarces americanus*	4,21,27,34,36,38,47,80
Dogfish	*Squalus acanthias*	8
Lumpfish	*Cyclopterus lumpus*	12
Tautog	*Tautoga onitis*	60
Cunner	*Tautogolabrus adspersus*	60
Anglerfish	*Lophius piscatorius*	13
Redfish	*Sebastes* sp.	14,32,33,34,62,74,79,88
Longhorn sculpin	*Myoxocephalus octodecemspinosus*	21,34,38,80
Winter skate	*Raja ocellata*	54
Little skate	*Raja erinacea*	21,34,38,54,80
Thorny skate	*Raja radiata*	54,63,77,79,80
Smooth skate	*Raja senta*	54
Butterfish	*Peprilus triacanthus*	34
Scup	*Stenotomus chrysops*	34
Marlin spike	*Nezumia bairdi*	36
Longnose grenadier	*Coelorhynchus carmininatus*	36
Fawn cusk eel	*Lepophidium cerinum*	36
Sand lance	*Ammodytes* sp.	72

Species summaries describing diet composition and feeding ecology

Individual species accounts that follow summarize the diet of four species of Gadidae (Atlantic cod *Gadus morhua*; haddock *Melanogrammus aeglefinus*; pollock *Pollachius virens*; silver hake *Merluccius bilinearis*), three species of Pleuronectidae (American plaice *Hippoglossoides platessoides*; yellowtail *Pleuronectes ferrugineus*; winter flounder *Pleuronectes americanus*), redfish *Sebastes* sp., wolffish *Anarhichas lupus*, and eelpout, *Macrozoaraces americanus*. The feeding ecology of these species was examined because they are relatively well studied and most are commercially important in the Canadian Atlantic.

Atlantic cod *Gadus morhua*

Cod are visual feeders that respond to prey movement and therefore feed most often on nektonic, epibenthic, and shallow infaunal prey (Lilly 1987, Macdonald and Green 1987). True infaunal components in the diet are sometimes present but are usually rare (Klemetsen 1982). The extra time required to search for and handle infauna prey makes them suboptimal (Macdonald and Green 1987). Cod feed on many taxa but relatively few (usually 5-15) make up the majority of the diet (Tyler 1972, Klemetsen 1982, Lilly 1987). Cod prey primarily on crustaceans and fish (Table 3). These two prey categories were always ranked first or second in the diet although with increasing size the order of the rankings can change.

Table 3. Proportion of crustacean and fish prey (by percent weight or volume) in the diet of cod (3 cm to >100 cm) from the east and west Atlantic.

Prey\Study	6	20	21	31	36	40	42	44	45	57	67
Polychaetes	0.4	0.1	1	0.5	1.3	0.6	2.4	0	0.5	0.2	3.1
Crustaceans	81.6	10	40.3	16	20.7	23.3	14.2	41.8	29.1	12.4	32.3
Mollusca	0.1	0.1	0	7.5	7.6	0.4	9.6	1.4	4.1	1.2	10.8
Echinoderms	0	0	1.9	0.7	1.2	0	0	0	0	0.9	3.2
Fish	16	87.2	14.6	71.5	64	69.2	71.8	54.4	59.6	84.8	39.8

Cod <9 cm fed primarily on planktonic food which made up a progressively smaller proportion of the diet as predator size increased (Bowman 1981, Hop et al. 1994, Lomond et al. 1998). The dominant food of cod 9-20 cm was benthic prey (Gammaridea, Caprellidae, Cumacea; Bowman 1981, Lomond et al. 1998). Crustacea accounted for the greatest proportion of the diet of small cod (Bowman 1981). With increasing size the proportion of crustacea often decreased with a corresponding increase in fish prey. This observation is not limited to cod <20 cm (Bowman 1981) but is repeatedly made for much larger cod in reviews by Daan (1973), Palsson (1983), Lilly (1987), and Kikkert (1993).This is also a common observation for many of the papers examined in this study (Powles 1958, Waiwood et al. 1980, Turuk and Postolaky 1980, Palsson 1983, Durbin et al. 1983, among others) although Santos and Falk-Petersen (1985) and Gerasimova et al. (1991) report that capelin *Mallotus villosus* (rather than a crustacean diet) can be more important at small predator sizes. Crustaceans and fish are always the most important components in the diet (Klemetsen 1982) although the rank order with fish usually being more important at large predator sizes is not always true (Santos and Falk-Petersen 1985 [study 70], Gerasimova et al. 1991 [study 20]). Palsson (1983) noted that investigations on the feeding habits of cod from the northwest Atlantic (Langton and Bowman 1980), around Newfoundland (Minet and Perodou 1978), the North Sea (Daan 1973) and from Icelandic waters (Palsson 1983) have demonstrated a considerable degree of similarity with fish (usually pelagic species) yielding c. 2/3 of the diet and crustacea c. 1/3 whereas benthic prey do not exceed 1/10 of the diet by weight. These ratios are usually size dependent and most likely apply to cod of adult sizes. Powles (1958) showed that the diet becomes increasingly benthic with greater predator size. At sizes of 70-100 cm Powles (1958) reported that half of the cods' diet was of benthic origin.

Lilly (1987) has summarized the diet of cod in the Newfoundland area. At small predator sizes, mysids, euphausids, amphipods, and shrimp were important. Medium sized cod feed on larger crustaceans and pelagic fish with larger cod feeding on larger fish including pleuronectids. The occurrence of flatfish in stomachs of cod <70 cm is very low but this increases steadily for cod between 70-99 cm (Lilly 1987). Median prey size generally increases with predator size however Lilly (1987) indicates that prey size is not the only factor that influences prey selection. Availability (and abundance) of prey is also important. Methven and Piatt (1989) reported that cod (c. 62-66 cm) feeding near the coast of Newfoundland took invertebrates, primarily shrimp and euphausids in late May and early June prior to the inshore arrival of spawning capelin. When capelin arrive nearshore in mid to late June they are highly aggregated for the purposes of spawning and are usually an abundant prey. Cod switched from feeding on invertebrates to feeding on capelin when capelin were most abundant. When capelin departed the coastal zone in August cod predation on invertebrates increased once again. Hence availability and abundance of capelin during summer has an important bearing on the stomach contents of cod.

Diets of cod can differ greatly over short distances. This again suggests that availability of prey is important in structuring the composition of the diet. Diets of juvenile cod were significantly different between sampling locations in the coastal zone (<10 m depth) of southern Norway (Hop et al. 1994, Fjosne and Gjosaeter 1996). Diets were also different at 3 coastal fjord sampling locations in northern Norway (Klemetsen 1982). In their study Klemetsen (1982) noted that differences in prey composition in stomachs of cod taken from two locations in the same fjord were likely due to differences in the faunal composition between the inner and outer sections of the fjord (i.e., availability of prey). Lilly and Rice (1983) show that cod caught in the same tow of a research trawl often differ considerably in their prey composition. Much of variation may be related to spatial variation in prey over the distance traversed by the trawl, c. 3 km (Lilly and Rice 1983).

Annual variation in the diet of cod collected at the same time (autumn) and from the same region (NAFO Divisions 2J, 3K) is generally consistent from year to year for some prey groups, especially shrimp and crabs which contributed approximately the same proportions each year (Lilly 1987). The quantity of shrimp and crabs in cod stomachs expressed as partial fullness indices also showed little variation from year to year but more recent research has indicated that the proportions of shrimp, crabs, and hyperiids can vary from year to year due primarily to the changing quantity of capelin in the diet (Lilly 1991). Variability in the annual composition of the diet is introduced when fish, primarily small migrating pelagic fish such as capelin, herring, and Arctic cod are considered. Palsson (1983) states "that the most remarkable feature in the feeding of cod is its general preference for fish prey, particularly pelagic species. As a consequence, the feeding of cod is apparently closely linked to the migration periods and routes of these species" which coupled with variability in their annual abundance can potentially introduce annual variation in the proportion of fish in the cods diet.

The high abundance of capelin in cod stomachs is well documented for the Newfoundland region (see studies by Lilly in Literature Cited, Minet and Perodou 1978) where capelin is considered a key prey in the food web, not only for cod but also for other fish, whales, and seabirds (Akenhead et al. 1982, Carscadden 1984, Brown and Nettleship 1984). Capelin are generally most important in the diet of Newfoundland cod at 40-69 cm (Lilly and Rice 1983, Lilly 1987) although predation on capelin often occurs at much larger (to 134 cm) and smaller (17 cm) sizes (Minet and Perodou 1978, Lilly 1987, Gerasimova et al. 1991). Predation on capelin varies both spatially and temporally (Lilly 1987). Predation on capelin occurs primarily in summer and autumn off southern Labrador and northeastern Newfoundland and year round on the northern Grand Bank where there is much less seasonal variation reported in cod predation on capelin (Lilly 1987). Capelin is usually estimated to comprise about 30% of the cod's annual diet (Minet and Perodou 1978, see also Lilly 1987).

Important crustacean prey in the diet of cod from the Newfoundland region include relatively large, usually active and conspicuous epibenthic, semipelagic or pelagic species such as *Pandalus borealis* and *P. montagui*, the crabs *Chionoecetes opilio* and *Hyas araneus*, and the euphausids *Thysanoessa* sp. and *Meganyctiphanes*. Large crabs such as *Chionoecetes opilio* are taken throughout the size range of 20 to 94 cm however *C. opilio* is most abundant in cod between 60-94 cm (Lilly 1987). Gammaridea exhibit the opposite trend, are most abundant in cod <30 cm and are rare in large cod. The abundance of euphausids in cod stomachs decreases with increasing predator size. *Pandalus borealis* and Hyperiidae commonly occur throughout the 20-94 cm size range reported by Lilly (1987).

Konstantinov et al. (1985) reported that cod on the Flemish Cap, east of the Grand Bank have a diet that is very different from cod taken at other locations on the Newfoundland Shelf and that the diet appears to be based on pelagic invertebrates, primarily shrimp and amphipods (*Pandalus*, *Themisto*). Pelagic amphipods were important in some years, shrimp in other years, and young redfish were important in still other years. These observations from the Flemish Cap and those by Lilly (1987) who recorded high numbers of small prey (euphausids for example) in the stomachs of large cod support the hypothesis that abundance (availability) of prey is important in prey selection by cod and hence in the composition of the diet. Other studies on feeding ecology from the Flemish Cap or that contain additional references include Lilly (1985, 1987a), Casas and Paz (1996), and Parsons et al. (1998).

There appear to be relatively few studies that describe the diet of Scotian Shelf cod. In this review these include: Kohler and Fitzgerald (1969), Langton and Bowman (1980) and Maurer (1975). Other studies on cod predation were conducted in the Gulf of St. Lawrence (Powles 1958, Waiwood et al. 1980) and the Bay of Fundy (Macdonald and Green 1986). The diet of cod on the Nova Scotia Banks and neighboring regions appears similar to the Newfoundland diet. Individual species may be different but the niche occupied by important fish prey is similar. For example pelagic species such as herring, silver hake and sand lance, common in cod stomachs from the Scotian Shelf (Kohler and Fitzgerald 1969, Maurer 1975) appear to substitute for capelin and sand lance which are the most common fish prey of cod in Newfoundland waters. Maurer (1975) described the diet of Scotian Shelf cod as consisting primarily of fish (sand lance, herring, and gadids) and crustaceans (*Meganyctiphanes, Hyas*, and *Pandalus*).

Comparison of the Scotian Shelf diet with diets from the Gulf of Maine and Gulf of St. Lawrence indicates that crustaceans and fish overwhelm the contributions of Polychaeta, Mollusca, and Echinodermata (Table 4).

Table 4. Composition of the diet (as percent weight or volume) of Atlantic cod from the central Scotian Shelf (Div. 4W; Kohler and Fitzgerald 1969), southern Scotian Shelf (4X; Langton and Bowman 1980), Gulf of Maine (Langton and Bowman 1980) and the southern Gulf of St. Lawrence (Div. 4T; Waiwood et al. 1980, Powles 1958). (#) identifies each individual study in this report.

Study (#) Div.	(31) Div. 4W	(31) Div. 4W	(36) Div. 4X	(36) Gulf of Maine	(67) Div 4T	(84) Div. 4T
Prey	(<50 fath.)	(50+ fath.)				
Polychaeta	Trace	1	0.8	0.3	3.1	1.3
Crustacea	5	27	27.6	26.1	32.3	52.6
Mollusca	8	7	0.6	0.7	10.9	5.5
Echinodermata	Trace	1	3.6	0.4	3.2	4.9
Pisces	84	59	60.6	69.5	39.9	24.1

Tyler (1972) noted for the fish community in Passamaquoddy Bay, Bay of Fundy that there was a narrowing of the diet of the principal prey in winter compared to summer. The median number of principal prey in summer was 4 and in winter 3 suggesting a narrowing of the diet. This was observed for the fish community as a whole which included plaice, longhorn sculpin, and haddock among others. The diet in summer consisted of 5, 6, and 5 principal prey respectively for plaice, longhorn sculpin, and haddock. This was reduced to 3, 4, and 3 principal prey respectively in winter (Tyler 1972). Cod 15-40 cm however had 3 principal prey in summer and winter. Principal prey were epifauna or nekton and included *Meganyctiphanes*, *Clupea*, and *Pandalus* in summer and *Meganyctiphanes*, *Mysis*, and *Pandalus* in winter. This narrowing of the winter diet (not observed for cod) may be linked to a reduction or stoppage in feeding during winter - spring when water temperatures are usually at their coldest and when many species of fish spawn.

Haddock *Melanogrammus aeglefinus*

Haddock are benthic feeders that are noted for the diversity of organisms they prey on (Wigley and Theroux 1965). Haddock have the most diversified diet of any member of the Gadidae examined in this study. The most important prey categories include epi- and infauna polychaetes, crustaceans, echinoderms, and fish (Kohler and Fitzgerald 1969, Langton and Bowman 1980). The main prey of

haddock are small (bivalves <5 mm; polychaetes <15 mm, ophiuroids <3 mm disc diameter) and slow moving (Wigley and Theroux 1965, Kohler and Fitzgerald 1969, Mattson 1992) compared to prey of other gadids (e.g., cod, hakes, pollock). This is due to the haddocks collective method of feeding in the benthos which is not aimed at selecting specific individual benthic prey (Mattson 1992). The diet typically includes a broad spectrum of prey from four (Annelida, Arthropoda, Echinodermata, Chordata) of the five phyla commonly listed in most studies of fish predation. Haddock are considered to be a facultative consumer of fish (Palsson 1983) suggesting that if fish are available they may be included in the diet. Molluscs usually account for <10% of the total diet by weight (Wigley and Theroux 1965, Kohler and Fitzgerald 1969, Langton and Bowman 1980, Bowman 1981, Mattson 1992) as summarized in Table 5.

Table 5. Composition of the diet (as percent weight or volume) of haddock (2-76 cm) from the east and west Atlantic.

Prey\Study	6	31	36	52	87
Polychaetes	13.6	14.5	17.6	23	14.9
Crustaceans	62.3	12	16.2	47	28.8
Mollusca	0.1	7.5	3.1	8.1	3.9
Echinoderms	1.2	23.5	29.9	21	6.1
Fish	5	29	14.6	0.1	13.6

Haddock 10-19 cm were noticeably different in the composition of their diet (Jiang and Jorgensen 1996) than larger haddock. This is shortly after or during the time when haddock abruptly switch from a predominantly pelagic diet of copepods and pteropods to benthic prey that includes ophiuroids and polychaetes (Mahon and Neilson 1987). Bowman (1981) also reported a size related difference in the composition of the diet near the time of settlement or shortly thereafter. Haddock <8 cm fed primarily on pelagic organisms (copepods, euphausids) whereas haddock >8 cm fed on benthic amphipods, decapods, and polychaetes. In general, small haddock (<19 cm) take more crustacea and polychaetes (Bowman 1981, Jiang and Jorgensen 1996). Larger haddock continue to feed on crustacea and polychaetes but will also take echinoderms (Ophiuroidea) and fish (sand lance, redfish, capelin) (Wigley and Theroux 1965, Kohler and Fitzgerald 1969, Palsson 1983, Jiang and Jorgensen 1996).

Increased predation on fish results in reduced predation on benthic invertebrates. Annual variation in the overall diet of haddock was due in large part to seasonal and year to year fluctuations in the occurrence of capelin around Iceland (Palsson 1983). Fish (in addition to crustaceans) also contributed to the high seasonal variation in the diet of haddock off the coast of Massachusetts. Fish prey were most abundant in the diet in April-May a time of year when large mature haddock are spawning and reduce their feeding (Wigley and Theroux 1965). Despite the presence of fish in the diet of larger haddock Palsson (1983) still considered the overall diet of haddock to consist primarily of benthic invertebrates during all seasons.

No studies were found reporting on the diet of haddock from Newfoundland other than that of Templeman (1965). Templeman reported that haddock were feeding on capelin and capelin eggs when capelin were spawning on the southeast shoal of the Grand Bank. Newfoundland represents the northern limit of the haddocks range in the western Atlantic (Scott and Scott 1988). Besides the studies by Bowman and by Langton which sample only the western portion of the Scotian Shelf there are only two studies that describe the diet of haddock on the Scotian Shelf (Kohler and Fitzgerald 1969, Mahon and Neilson 1987). Mahon and Neilson (1987) focused their study on the diet of 0-group haddock during the time of settlement. They reported a shift from pelagic copepods and amphipods to more benthic prey that included ophiuroids, polychaetes, amphipods, cumaceans, and euphausids. Changes in the diet during the months after settlement were minor relative to those associated with settlement. *Leptocheirus* and *Unciola* were the only prey identified to genera (Mahon and Neilson 1987). The diet of cod is the focus of study by Kohler and Fitzgerald (1969) although haddock in the Gulf of St. Lawrence and Scotian Shelf are discussed as a basis for comparison with cod. Crustaceans were the most important dietary items of small haddock. With increasing size annelid worms and echinoderms (brittle stars, sea urchins, sand dollars)

were more evident in the diet of haddock relative to cod. In the Bay of Fundy (Passamaquoddy Bay) haddock (25-40 cm) were members of both the summer and winter fish communities where the principal prey were infauna (*Nephtys, Lumbrineris*) and epifauna (*Lumpenus*, a benthic fish) during winter and infauna (*Leptocheirus, Aphrodite, Lumbrineris, Praxillella, Yoldia*) during summer (Tyler 1972). The number of principal prey was reduced from five in summer to three in winter (Tyler 1972).

Pollock *Pollachius virens*

Pollock prey predominantly on a pelagic food base (Dexter 1969) with the diet consisting mostly of crustaceans and secondarily of fish. Annelids, molluscs, and echinoderms typically account for a very small proportion of the diet (Table 6).

Table 6. Composition of the diet of pollock (as percent weight or volume) from the western Atlantic.

Prey\Study	6	14	36	75
Polychaetes	0.7	0	0.1	0.5
Crustaceans	68.2	78.2	50.8	95
Mollusca	0	0	0.4	0.5
Echinoderms	0	0	0	0
Fish	0	21.1	47	2*

* the proportion of fish can be higher depending on location

Euphausids and copepods combined accounted for 91.1% of the diet with squid (6.3%) accounting for most of the remaining diet of pollock in the Gulf of Maine (Dexter 1969). Pollock preyed upon fish (47.0%) and crustaceans (50.8%) in the region from the mid Atlantic Bight to southern Nova Scotia (Langton and Bowman 1980). Euphausids are probably the single most important prey of pollock. Euphausids accounted for 35.5% (primarily *M. norvegica* [26.5%]) of the diet reported by Langton and Bowman (1980), 55.8% of the diet by Bowman (1981) for pollock <20 cm and c. 80-90% of the diet for pollock >27 cm from the Bay of Fundy although the proportion of euphausids in the diet was dependent on location (Steele 1963). Pandalid shrimp (2.5%) and *Dichelopandalus* (0.5%) were the next most important crustacean prey that were identified (Langton and Bowman 1980). Important secondary prey from the Bay of Fundy included amphipods (primarily Gammaridea: *Orchomenella minuta, Calliopius laeviusculus, Pontogeneia inermis*) and decapods (*Cragon septemspinosus*) but these were only important in pollock <26 cm (Steele 1963).

The proportion of crustaceans in the diet may decrease with increasing size of pollock but this appears to be very flexible, possibly depending on availability of prey. Fish were not an important dietary item of pollock in the Bay of Fundy but were important prey in pollock >61 cm from the Scotian Shelf and Laurentian Channel (Steele 1963). Either fish or euphausids could be the dominant prey at sizes <61 cm in the Scotian Shelf and Laurentian Channel regions. The species identification of the fish prey suggests that pollock are feeding in the water column and away from the bottom. Important fish prey included silver hake, sand lance, and *Myctophum affine* (a mesopelagic species) on the Scotian Shelf and Laurentian Channel. Important fish prey in the Bay of Fundy included herring, sand lance, and Atlantic silverside (Steele 1963). All of these fish prey are know to be to some extent pelagic or mesopelagic species (Scott and Scott 1988). Consequently the diet of pollock appears to be quite restricted relative to the diets of Atlantic cod and haddock.

Silver hake *Merluccius bilinearis*

Silver hake are pelagic and opportunistic feeders that exhibit a clear size dependent shift in their diet from crustaceans at small sizes to almost 100% fish (or squid) at sizes greater than c. 40-45 cm (Dexter 1969, Vinogradov 1972, Swan and Clay 1979, Durban et al. 1983, Clay et al. 1984). Silver hake feed at night usually from dusk to midnight when they are off the bottom. Silver hake are located on or immediately above the bottom during the day when they are reported not to be feeding (Bowman and

Bowman 1980). Forty-one of 59 prey taxa identified in the stomachs by Vinogradov (1972) were considered to be pelagic or bathypelagic with the remainder being benthic or usually associated with the bottom. Silver hake do not generally prey on molluscs (excluding squid and cephalopods), polychaetes or echinoderms as summarized in Table 7.

Table 7. Diet composition of silver hake (as percent weight or volume) from the northwest Atlantic.

Prey\Study	6	7	14	36	71	82	85
Polychaetes	0.3	0	0	0.2	0.03	1.1	0
Crustaceans	89	96.7	7.3	25	9.4	27.1	20.3
Mollusca	0	0.4	1.5	2.2	0	7.5	23.5
Echinoderms	0	0	0	0	0	0	2.2
Fish	8.5	2.8	90.3	70.9	90.5	64.5	48.5

Euphausids (primarily *M. norvegica* and *Thysanoessa* sp.) are the most important prey of silver hake <40 cm (Vinogradov 1972, Langton and Bowman 1980, Bowman 1981) although Bowman and Bowman (1980) reported that the dominant prey of silver hake between 21-40 cm from Georges Bank were *Crangon septemspinosa, Dichelopandalus leptocerus*, and *Monoculodes intermedius*. The two main prey of silver hake between 25-30 cm in Passamaquoddy Bay (Bay of Fundy) during summer were *M. norvegica* and *Pandalus* which were described as nektonic and epipelagic respectively (Tyler 1972). Echinoderms were not reported as an important prey of silver hake in any of the studies examined herein and Langton and Bowman (1980) report that the only molluscs of any importance were either cephalopods (2.2% by weight) or *Loligo* squid (1.5%). Polychaetes were also of very minor importance in the diet representing 0.3% of the total weight of the diet of hake <20 cm (Bowman 1981), 1.1% of the diet for hake with a mean length of 27.5 cm (Langton and Bowman 1980) and 0.03% of the diet in hake between c. 25-50 cm (Schaefer 1960).

An important component of the silver hake diet is the high incidence of cannibalism which accounted for 22.7-33.7% (Schaefer 1960), 8.6-68.7% (Vinogradov 1977) and 79.6% (Waldron 1992, but usually 30-40%) of the total diet. The incidence of cannibalism just like the incidence or predation on other fish species increases with increasing predator length (Swan and Clay 1979). Additional fish species that are important in the diet include Gadidae, yellowtail (Bowman and Bowman 1980), herring, sand lance (Dexter 1969), mackerel, alewife (Langton and Bowman 1980), lanternfish (Maurer 1975), and red hake (Schaefer 1960).

American plaice *Hippoglossoides platessoides*

Plaice are bottom feeders that have a large mouth, relative to other flounders (Scott and Scott 1988) and are capable of taking a wide variety of prey types (Langton and Watling 1990) as indicated in Table 8. Echinoderms (sea urchins, brittle stars, and sand dollars) are important prey at adult sizes but fish in some locations contribute more to the total weight of the diet (Ntiba and Harding 1993). Plaice progress through two feeding stanzas, exploiting supra benthic fauna (e.g. mysids) when small (c. <21 cm) and larger epifauna of a sedentary (e.g. *Actinauge longicornis*) or slow-moving nature (e.g. *Pagurus* sp.) when mature (Martell and McClelland 1992). Pitt (1976) suggested that plaice are daytime feeders as indicated by differences in diel catch and feeding rates (Beamish 1966).

Table 8. Diet composition (as percent weight or volume) of plaice from the east and western Atlantic.

Prey\Study	6	20	25	37	56	59	61	65
Polychaetes	72.1	2.8	0	4.4	9.3	25.1	0.5	3.7
Crustaceans	21.1	12	3.3	16	10.2	48.3	11.5	32.4
Mollusca	0	0	2.3	7.7	16.4	5	5.9	0.7
Echinoderms	0	21.6	63.1	65.4	53.2	4	82.1	23.3
Fish	0	61	25	1	2.2	12	0	37.1

At small sizes plaice prey extensively on crustaceans but unlike small Gadidae, polychaetes are an important component of the diet. Plaice <7 cm fed on polychaetes (72.1%; primarily Capitellidae and Sabellidae) and crustaceans (21.1%; primarily amphipods and mysids) (Bowman 1981) from the mid Atlantic Bight to the western Scotian Shelf. In the North Sea small c. 5-30 cm long rough dab (= plaice) also take crustaceans (48%) and polychaetes (25%) but with increasing predator size (>30 cm) fish rapidly became an important component of the diet (Ntiba and Harding 1993). Polychaetes (37.9%; primarily *Melinna cristata* [7%]) and crustaceans (18.7% primarily *Mysis mixta*) were also the most important phyla taken by plaice that averaged 18 cm in Sheepscot Bay, Maine (Langton and Watling 1990). Langton and Watling (1990) compared the diet of inshore plaice with plaice collected offshore and reported that larger plaice offshore fed mostly on echinoderms, primarily brittle stars. These studies indicate that two phyla (Arthropoda [crustaceans] and Annelida [polychaetes]) are consistently important in the diet of small plaice.

With increasing predator size there is a shift from polychaetes and crustaceans at sizes less than c. 30 cm to primarily an echinoderm diet with secondary emphasis on fish. The reported shift in the diet at c. 30 cm (Powles 1965, Ntiba and Harding 1993) agrees well with the observations of Gerasimova et al. (1991) who summarized the diet of plaice from the southern Grand Bank (NAFO Div. 3N, 3O) as containing *Ophiura*, euphausids, and amphipods at sizes <29 cm and primarily fish (capelin, sand lance) at >29 cm. The shift in diet composition (at 20-35 cm) is also noted by Minet (1973) who reported that crustaceans and polychaetes become less important with increasing predator size while the occurrence of fish, ascidians (St. Pierre Bank only), and larger crustaceans (Brachyuran crabs) increased with predator size. Consequently the diet of larger plaice (c. >30 cm) consists primarily of echinoderms and fish, the relative importance of which varies with sampling location.

In the Newfoundland region the diet of plaice is very similar for studies conducted on the Grand Bank (Pitt 1973, Zamarro 1992) and inshore along the coast of Newfoundland (Keats 1991) but shows some differences in secondary prey with studies from St. Pierre Bank (Minet 1973) and the Flemish Cap (Konstantinov et al. 1985). On the northern and southern Grand Bank echinoderms and fish were the most important prey of plaice between 10-69 cm that were collected year round (Pitt 1973). The dominant echinoderms were *Ophiura*, sand dollars, and sea urchins. These typically occurred in more stomachs (27-44% occurrence) than capelin and sand lance, the most important fish prey (9-29% occurrence) but accounted for only 8-32% of the diet by weight compared to fish prey which comprised 51-85% of the diet by weight. Echinoderms (brittle stars, sea urchins) and fish (capelin, sand lance) were also the most important prey of plaice (40-55 cm) collected year round on the southern Grand Bank by Zamarro (1992). The diet expressed as stomach fullness (a weight based index) indicated that sand lance (3.1 stomach fullness) were more than twice as important as brittle stars (1.24 stomach fullness), the dominant echinoderm in the diet. The final study conducted on plaice on the northern and southern Grand Bank was conducted by Gerasimova et al. (1991). At large sizes (>30 cm) fish (capelin and sand lance) were once again the most important prey. Secondary prey included echinoderms (primarily *Ophiura*) although crustaceans (amphipods and especially euphausids) were usually the most important secondary prey on the southern portion of the Grand Bank (NAFO Div. 3N, 3O). On the northern portion of the Grand Bank (3L) euphausids and amphipods were very rare in the diet of plaice of any size. Capelin and sand lance were the most important primary prey at sizes >24 cm but echinoderms (*Ophiura*) dominated the diet of plaice <24 cm. On the Flemish Cap located east of the Grand Bank, echinoderms (sea urchins, sand dollars, Ophiuroidea) occurred in 100% of the stomachs examined. Molluscs (<15% occurrence) and polychaetes (<13% occurrence) were the most important secondary prey but fish were very rare (Konstantinov et al. 1985) in contrast with the studies by Pitt (1973) and Zamarro (1992) on the Grand Bank. Large plaice (42-73 cm) from the coast of Newfoundland fed primarily on sea urchins (62% by weight). Fish (primarily capelin) were of secondary importance (12.9%) (Keats 1991). Thus the two main prey categories (echinoderms and fish) agree with Pitt (1973) and Zamarro (1992) but with the rank order reversed. On St. Pierre Bank (NAFO Div. 3Ps) and off Cape Breton (4Vn) Minet (1973) reported that plaice fed primarily on echinoderms (brittle stars, sea urchins and sand dollars in order of importance) with, as on the Flemish Cap (Konstantinov et al. 1985) molluscs being the next most important prey. Important molluscs included *Yoldia* sp., *Chlamys islandicus*, *Clinocardium ciliatum*, *Serripes groelandicus*, and the genera *Astarte*, *Tellina*, *Macoma*, and *Spisula* (Minet 1973).

The only study of the diet of plaice from the Scotian Shelf (Sable Island Bank) is that of Martell and McClelland (1992). Fish were not an important component of the diet for any size of plaice on the

Scotian Shelf in February or in June. The dominant prey of small (< 31 cm) plaice were crustaceans (primarily Gammaridea, Mysidacea, Copepoda), *Terebellida* polychaetes, and at 26-30 cm bivalve and gastropod molluscs. Crustaceans were still important in the diet at sizes >31 cm but there was an increased presence of stomachs containing Echinoidea especially in February. Crustaceans are the dominant prey in June with polychaetes (*Phyllodocida*, *Capitellida*, *Spionida*, and *Terebellida*) being of secondary importance over all sizes of plaice.

There appears to be a nearly consistent absence of fish in the diet of plaice south of the Grand Bank in the Gulf of St. Lawrence (Powles 1965), on the Scotian Shelf (Martell and McClelland 1992), in Georges Bank - Gulf of Maine region (Langton and Bowman 1981, Packer 1994) and in the Bay of Fundy (Macdonald and Green 1986). Consequently the diet appears to differ substantially with that from the Newfoundland region. The diet of plaice from the Gulf of St. Lawrence appears to be the most characteristic of the Newfoundland diet with individuals <30 cm feeding primarily on crustaceans (mysids, amphipods), small polychaetes, and small echinoderms (primarily *Ophiura* sp.) (Powles 1965). Larger plaice in the southern Gulf of St. Lawrence took echinoderms (*Ophiopholis aculeata, E. parma, S. droebachiensis*) with molluscs as secondary prey (*Yoldia myalis, Nuculana tenuisulcata, Clinocardium ciliatum, and Serripes groenlandicus*). Once again, as on the Scotian Shelf (Martell and McClelland 1992) fish prey were not important in the diet of plaice from the Gulf of St. Lawrence (<5% occurrence). In Passamaquoddy Bay, (Bay of Fundy) Macdonald and Green (1986) reported plaice to be mollusc, annelid, and arthropod feeders throughout the year. Important prey included *N. incisa, S. scutata, L. pinguis, Eteone rubrocincta, C. bigelowi, Amphipholis squamata,* and ampharetids. Langton and Bowman (1981) reported that echinoderms (45.9-90.7%; Echinoidea [7.1-72.2% weight], Ophiuroidea [11.9-38.8% weight]) were the dominant prey of plaice (mean lengths 25-32 cm) on Georges Bank, western Scotian Shelf, and Gulf of Maine. Secondary prey were crustaceans which accounted for 7.0-30.2% of the diet. Pandalidae and Paguridae were the most important crustaceans. Fish accounted for <2.5% of the diet by weight in all regions (Langton and Bowman 1981). In the Gulf of Maine brittle stars (primarily *O. sarsi*) occurred in >65% of the stomachs and accounted for >80% of the diet by weight (Packer et al. 1994). Secondary prey consisted of crustacea (*M. norvegica* [8.4% weight], *Pandalus borealis* [3.0%]) and molluscs (<5.5%, *Yoldia thraciaeformis* [3.0%]). The one exception to plaice predation on fish south of Newfoundland appears to be Langton and Watling (1990) who examined the stomach contents of several fishes including plaice from Sheepscot Bay, Maine. Polychaetes (37.9%; primarily *Melinna cristata* [7%]) were the most important prey taxon closely followed by fish (33.16%; primarily herring [12.06%]), and epibenthic crustaceans (18.74%; primarily sand shrimp [13.87%] and the mysid *Mysis mixta* [10.4%]).

Yellowtail *Limanda ferruginea* (=*Pleuronectes ferrugineus*)

Yellowtail flounder are crustacean and polychaete predators that forage primarily on benthic prey at the sediment surface during the day (Hacunda 1981, Langton 1983). Fish prey are often absent or are a minor component of the diet (Libey and Cole 1979, Hacunda 1981, Langton 1983).Yellowtail progress through two feeding stanzas, exploiting small epi- or infauna when small and larger infauna (polychaetes and tabaceous amphipods) as they mature (Martell and McClelland 1992). Crustacea (primarily amphipods) and polychaeta are the dominant prey throughout the demersal juvenile and adult stages and Langton (1983) reports a trend of increasing biomass of polychaetes in the diet with increasing predator size accompanied with a decrease in amphipod biomass. Yellowtail has a flexible diet in that the dominant prey vary among sampling locations (Collie 1987). The percentage of empty stomachs is highest in winter (Pitt 1976, Martell and McClelland 1992) when water temperature is coldest prior to spawning in spring (Langton 1983, Scott and Scott 1988). Low feeding intensity is apparently characteristic of flatfishes during the spawning period (Efanov and Vinogradov 1973).

This review contains 11 studies that report on the diet of yellowtail flounder. All but two of these were conducted in the vicinity of Georges Bank and the Gulf of Maine. Pitt (1976) examined feeding of yellowtail on the Grand Bank and Martell and McClelland (1992) did likewise on Sable Island Bank. A comparison of the stomach contents from the northern (3L) and southern (3N) Grand Bank indicated very little difference in the occurrence of food items (Pitt 1976). The diet consisted primarily of polychaetes (38.4%) and amphipods (29.3%; *Haploops* and *Caprella* were the only taxa identified). Polychaetes were not identified to species but free-living, burrowing, and tube-building forms were all present. Very few

stomachs contained mollusca and fish prey, although fish (1.2% occurrence, 7.5% by weight) and molluscs (bivalves; 5.2% occurrence, 0.8% weight) were occasionally important at some sizes (Pitt 1976).

The diet of yellowtail flounder on the Scotian Shelf was not quantified as percent weight or volume but polychaetes (83 species identified) and crustaceans (68 species) were the most important prey (Martell and McClelland 1992). Relatively few studies discuss size related differences in the diet of yellowtail however Martell and McClelland (1992) noted that flounder <30 cm took small epifauna (primarily cumaceans and some species of amphipods) during summer and winter. Large yellowtail consumed "suprabenthic" fauna (cumaceans and mysids) in winter and infaunal polychaetes (surface deposit feeders, e.g., *Spiophanes bombyx*; burrowers, e.g., *Ophelina acuminata* and epifaunal polychaetes, e.g., *Phyllodoce* sp.) during summer (Martell and McClelland 1992).

Arthropoda and Annelida were consistently the dominant phyla in the diet of yellowtail from the Gulf of Maine and Georges Bank. Crustaceans, primarily amphipods and polychaetes were the most important prey within these phyla which together accounted for >55% of the diet (Table 9). Molluscs, echinoderms, and fish together accounted for <10% of the diet in any one study and were generally not important prey.

Table 9. Diet composition of yellowtail flounder (as percent weight or volume).

Prey\Study	6	21	35	37	38	39	66
Polychaetes	3	10.5	48.9	42	41.5	24.9	53.8
Crustaceans	94.4	48.5	20.7	37.2	31.5	66.1	31.4
Mollusca	0	5.2	0	1.9	2.8	6.3	1.1
Echinoderms	0	0	0	2.8	0	2.5	2.9
Fish	0	0	0	0.8	7.3	0	2.6

The most important polychaetes and crustaceans in the diet of large juvenile and adult yellowtail from Gulf of Maine region are listed in order of importance in Table 10.

Table 10. Rank order of importance of polychaetes and crustaceans in the diet of yellowtail from the New England - Gulf of Maine region. The spelling of the genus and species names appear as in the original study. p = polychaete, e = euphausiid, m = mysid, a = amphipod, s = shrimp.

Study 17	Study 21	Study 35	Study 37	Study 38
Nephthys ingens (p)	*Nephtys* sp. (p)	*Spiophanes bombyx* (p)	*Eunice* sp. (p)	*Ophelia acuminata* (p)
Arabella opalina (p)			*Polydora* sp. (p)	*Lumbrineris fragilis* (p)
Nereis pelagica (p)	*Unciola* sp. (a)	*Unciola* sp. (a)	*Nereis* sp. (p)	*Ampharete arctica* (p)
Clymenella torquata (p)	*Leptocheirus pinguis* (a)	*Leptocheirus pinguis* (a)	*Lumbrineris* sp. (p)	
	Mysis mixta (m)	*Byblis serrata* (a)	*Nephtys* sp (p)	*Unciola inermis* (a)
M. damnonensis (a)		*Crangon septemspinosa* (s)		
Ampelisca spinipes (a)		*D. leptocerus* (s)		
Thysanopoda acutifrons (e)				

Winter flounder *Pseudopleuronectes americanus* (=*Pleuronectes americanus*)

Winter flounder are visual predators that prey heavily on polychaetes and characteristically feed during daylight on in- and epifauna (Olla et al. 1969, Tyler 1972, Macdonald and Green 1986, Keats 1990). Winter flounder are generalists (140 prey species identified, Martell and McClelland 1992) and are largely unselective taking whatever benthic prey of suitable size is available (Keats 1990, Langton and Watling 1990). They often feed by nipping off siphons of molluscs (Frame 1974, Macdonald and Green 1986). Winter flounder have a small mouth gape and seem to select prey by size taking mainly the larger prey (Keats 1990). The diet is seldom described in terms of predator size suggesting that the diet is similar across predator sizes or that only weak size related trends exist. The diet is more diverse inshore than offshore (Gulf of Maine; Langton and Watling 1990) where in coastal Newfoundland, the Bay of

Fundy and coast of Maine the diet often contains large quantities of algae (Kennedy and Steele 1971, Wells et al. 1973, Hacunda 1981, Keats 1990). The winter flounder may be a functional omnivore as Wells et al. (1973) considered it unlikely that feeding on algae was solely for the benefit of the prey that were entangled on it. The seasonal cycle of feeding activity is highest in summer, decreases in autumn as large flounder start to mature, is essentially stopped over winter, and is initiated again in late winter or early spring (Kennedy and Steele 1971, Martell and McClelland 1992).

This review includes 11 studies that describe the diet of winter flounder from the western Atlantic. Eight of these were conducted inshore, four at depths <15 m (Kennedy and Steele 1971, Wells et al. 1973, Frame 1974, Keats 1990), four at depths from 30-100 m (Tyler 1972, Hacunda 1981, Macdonald and Green 1986, Langton and Watling 1990) with three studies conducted offshore, one primarily in the Gulf of Maine-Georges Bank region (Langton and Bowman 1981), and two from the Scotian Shelf-Gulf of St. Lawrence region (Scott 1976, Martell and McClelland 1992).

The diet of winter flounder reported by Scott (1976), and by Martell and McClelland (1992) was quantified as percent occurrence, not as weight or volume. Four prey types were important in the Gulf of St. Lawrence: fish , polychaetes, crustaceans, and lamellibranchs (none of which were identified further). The occurrence of stomachs containing these prey was highly variable and depended somewhat on predator size. These four prey categories were also the most important for winter flounder from the Scotian Shelf. Fish prey do not appear to be important in the diet of winter flounder south of the Scotian Shelf (i.e. offshore on Georges Bank and in the Gulf of Maine - Langton and Bowman 1981; or in other southern coastal habitats, Tyler 1972, Hacunda 1981, Macdonald and Green 1986, Langton and Watling 1990; but see Frame 1974).

Sampling on the Scotian Shelf was conducted in February and June (Martell and McClelland 1992). Only the June stomachs contained prey. Important prey as judged by percent occurrence were polychaetes, primarily the families Phyllodocida (*Eteone longa, Phyllodoce mucosa*), Capitellida, Spionida, Cirratulida, Terebellida (*Pectinaria granulata, Ampharete* sp.) and Sabellida (*Potamilla reniformis*), bivalve and gastropod (*Retusa obtusa*) molluscs, Cumacea , Gammaridea, Caprellidea, and Ascidacea. The occurrence of stomachs containing polychaetes generally increased with predator size.

The final study conducted offshore was by Langton and Bowman (1981) who sampled flounder from the mid Atlantic Bight to the western Scotian Shelf. The diet is quantified as percent weight and is compared to diets from the neighboring Gulf of Maine and Georges Bank (Table 11 below, modified from Langton and Bowman 1981, Table 8, p. 12).

Table 11. Diet of offshore winter flounder from Georges Bank, Gulf of Maine, and western Scotian Shelf (as percent weight or volume).

	Georges Bank	Gulf of Maine	western Scotian Shelf
Cindaria	30.4	0.4	17.4
Annelida	15.1	60.5	55.8
Arthropoda	3.9	1.9	9
Mollusca	20.4	4.8	4.3
Echinodermata	0.5	0.1	0.7
Pisces	0.1	0.5	0.2

Annelida on the western Scotian Shelf and Gulf of Maine were the most important prey of winter flounder. Terebellidae accounted for 37.6% of the winter flounders diet from western Nova Scotia. Important species included: *Thelepus cincinnatus* (32.2%), *Nicomache lumbricalis* (3.9%), *Pherusa* (2.2%) and *Chone infundibuliformis* (1.1%). Cnidaria were prey of secondary importance and accounted for 17.4% of the western Nova Scotia diet. Cnidaria were also present in stomachs of winter flounder collected in June from Sable Island Bank but their importance was not quantified as percent weight or volume (Martell and McClelland 1992). Cnidaria were the most important food of winter flounder on Georges Bank (Table 11) and Langton and Bowman (1981) considered Cnidaria to be a normal prey of flounder given that it occurred in significant amounts (maximum of 53% of the diet) in four of five broad regions sampled.

Both MacPhee (1969) and Frame (1974) have shown that the food of winter flounder reflects the environmental conditions under which the fish live and that this may explain some of the variation in its diet (Langton and Bowman 1981). The diet of winter flounder from four inshore areas is summarized below in Table 12. The only study not recording polychaetes in the diet of winter flounder is study 24 (Keats 1990). Keats (1990) collected winter flounder in 5-15 m of water in a sea urchin dominated hard substratum typical of the open Atlantic coast of Newfoundland, i.e. not typical of the softer sediments favored by many polychaetes.

Table 12. Diet composition (percent weight) of winter flounder from four inshore areas.

Prey\Study	21	24	28	38
Polychaetes	18.3	0	17.2	33.1
Crustaceans	32.5	0	1.2	22.2
Mollusca	6.1	14.4	6.8	3.4
Echinoderms	0.5	16.2	2.3	0.1
Fish	0	11.7	44.7*	0.7
Algae	12.6	29.1	12.6	
Cnidaria			1.8	14.5

* 29.4 of 44.7 is fish eggs.

This supports the observations made above that winter flounder are generalists and are largely unselective predators that will feed on whatever prey of a suitable size is most abundant and available.

Redfish *Sebastes* sp.

Redfish are pelagic predators that rise off the bottom at night to feed on a relatively narrow prey base consisting of planktonic invertebrates, primarily copepods, pandalid shrimp, amphipods, euphausids (Steele 1957, Yanulov 1962, Dexter 1969, Palsson 1983, Konstantinov et al. 1985), and occasionally on pelagic fish (Steele 1957, Lambert 1960). None of the prey are considered to be truly benthic (Lambert 1960, Turuk and Postolaky 1980) although Steele (1957) reports that pelagic species (21 of 32 species) make up >90% of the diet by volume. These same prey are important throughout the year (Dexter 1969, Konstantinov et al. 1985) and seasonal variation in food content is considered to be insignificant (Palsson 1983). Redfish generally occur along the edge and upper slope of the continental shelf, i.e. in deeper water than many continental shelf fishes (Scott and Scott 1988). The overall composition of the diet could be determined from three studies and is summarized in Table 13 below.

Table 13. Diet composition (percent weight) of redfish, *Sebastes* sp.

Prey\Study	14	33	74
Polychaetes	0	0	0
Crustaceans	97.8	72	87
Mollusca	0.5	1.2	0
Echinoderms	0	0	10
Fish	1.3	25.4	0

The composition of the crustacean portion of the diet varied among studies. On the Flemish Cap (NAFO Div. 3M) planktonic copepods (39-59% occurrence), amphipods (22-28% occurrence), and euphausids (9-14% occurrence) were the dominant prey (Konstantinov et al. 1985). In the Gulf of Maine the diet consisted of euphausids and copepods (57.4% volume), decapod shrimp (28.1%) and hyperid amphipods (9.6%) (Dexter 1969). Euphausids occurred in 16-92% of the redfish from all around Newfoundland and accounted for 2-90% of the diet (by volume) depending on sampling location (Lambert 1963). Euphausids were identified as *Meganyctiphanes norvegica, Thysanoessa inermis,* and *T. raschii.* Amphipods were primarily pelagic species (*Themisto libellula, T. gaudichaudi*) with gammarid amphipods occurring in <3% of the stomachs (Lambert 1963). These same euphausids (in addition to *T.*

longicaudata) and amphipods were important in the in the diet of redfish from the Gulf of St. Lawrence (Steele 1957) and in the waters from Nova Scotia to Labrador (Yanulov 1962).

Larger redfish feed more on fish prey (lancet and lantern fish) than smaller redfish on southwest and northern edges of Grand Bank. These are mesopelagic species and accounted for 26-49% of the diet by volume (Lambert 1960). Large calonoida (*C. finmarchicus, C. hyperboreus, Parachaeta*) were the dominant food of small (<15 cm) redfish in late winter. Euphausids were not an important prey at this size (Palsson 1983). Euphausids, copepods, and amphipods (some of which were gammarids) were the most important components in the diet of redfish <30 cm. Fish prey accounted for c. 40% of the diet in redfish between 41-45 cm (Yanulov 1962).

With increasing depth in the Gulf of St. Lawrence there was a change in the diet with euphausids being more common at shallow depths and fish prey becoming increasingly important at deeper depths. Euphausids comprised >85% of the diet (by volume) at depths of 102-110 fm. This decreased to 55% at 118-122 fm and to <5% at 148-150 fm. No euphausids were taken at depths of 174-176 fm (Steele 1957). Important fish in the diet with increasing depth were herring and *Paralepis rissoi kroyeri*. This depth related diet contrasts with the observations of Yanulov (1962) who observed the same food items occurring at approximately the same proportions in the diet at depth intervals of <300, 301-400 and >400 m when the diet was examined over a large spatial (Scotian Shelf to Labrador) and temporal (five years) extent.

Atlantic Wolffish *Anarhichas lupus*

The wolffish is a benthic and visual feeder that selects individual prey items (Keats et al. 1986) consisting primarily of molluscs, crustaceans, and echinoderms (Table 14). Stomachs frequently contained sand, silt, and stones (Albikovskaya 1982). Typical prey are relatively robust and often stationary (Palsson 1983) although fish prey do occur in wolffish of large size (Templeman 1982). Palsson (1983) considered large wolffish to be occasional consumers of fish. The diet is typically varied and appears to be influenced by availability of prey at different sampling locations.

Table 14. Diet composition (percent weight) of wolffish, *Anarhichas lupus*.

Prey\Study	26	78
Polychaetes	4.4	0.1
Crustaceans	11.8	22.9
Mollusca	76.3	35.6
Echinoderms	5.5	23.3
Fish	0	0

The diet composition of wolffish from western Greenland to the Scotian Shelf consisted of whelks (22%; not identified), scallops (12%; *Chlamys islandicus*), crabs (12%), hermit crabs (11%), and brittlestars (16%) (Templeman 1982). The diet of *Anarhichas lupus* from much of the same area sampled by Templeman (1982) included Ophiurae, bivalve molluscs, gastropods, and crabs as the most important prey (Albikovskaya 1982). Redfish, cod, and skate were the most important vertebrates reported by Albikovskaya (1982). Redfish represented 12% of the vertebrate food (15%) recorded by Templeman (1982).

Off Iceland, benthic food (primarily Ophiuroiidea) were the dominant prey (Palsson 1983). Ophiurae also occurred in more stomachs of wolffish in NAFO Div. 2K, 3K, 3L, and 3M than any other prey (Albikovskaya 1982).

In coastal Newfoundland the diet consisted primarily of sea urchins (76%) which occurred in 96% of the stomachs (Keats et al. 1986). Wolffish fed largely on urchins >20 mm in diameter. Smaller urchins were generally unavailable to wolffish because they often occurred in cryptic microhabitats among coralline algae, in crevices among horse mussels and rocks (Keats et al. 1986). Keats et al. (1986) suggested that wolffish would not likely select a small difficult to get sea urchin when larger more accessible urchins were available. Secondary prey in coastal Newfoundland included the horse mussel

(9.5%, *Modiolus modious*), blue mussel (1.6%, *Mytilus edulis*), and *Hyas araneus* and *Pagurus* sp. crabs (4.4%).

Ocean pout *Macrozoarces americanus*

Ocean pout are benthic predators that feed primarily on infauna and some epifauna (Tyler 1972). Stomachs typically contain large amounts of inorganic bottom sediment, sand, rocks, and gravel (Langton and Bowman 1980, Hacunda 1981, Buzulutskaya 1983) consistent with the observations of Keats et al. (1987) who reports that ocean pout take in large quantities of loose bottom material, sort it in the buccal cavity and eject most of the inorganic portion. This method of feeding is consistent with Macdonald and Green (1986) who report ocean pout to be non-visual feeders. The diet consists primarily of echinoderms and secondarily of molluscs and crustaceans (Table 15). Fish prey can (but rarely do) occur in the diet. Fish prey were important in only one study. Fish appeared to be already dead or weakened prior to being taken as prey (Keats et al. 1987).

Table 15. Diet composition (percent weight) of ocean pout.

Prey\Study	21	27	36	38
Polychaetes	1.4	0	3.3	9.24
Crustaceans	13.6	0.2	11.1	3.4
Mollusca	9.8	0.2	4	69.1
Echinoderms	20.6	68.7	70.7	2.7
Fish	0	27.9	0.1	0

Echinarachnius parma and *S. droebachiensis* were the most important prey (by weight) of ocean pout sampled by Langton and Bowman (1980), Hacunda (1981), and Keats et al. (1987) where they represented 20-70% of the diet. *Echinarachnius parma* (10.8%) was relatively unimportant in the study by Buzulutskaya (1983) where it ranked behind *Cancer borealis* 59.7% and gammarid amphipods (14.0%; not identified to species). Echinoderms only accounted for 2.67% of the diet in Langton and Watling (1990) where bivalves (69.1%; *Nucula* and *Sphenia*) were the most important component of the diet. Ocean pout sampled by Tyler (1972) and by Macdonald and Green (1986) were taken at the same silt-clay sampling sites in Passamaquoddy Bay approximately 14 years apart. The size of ocean pout and some of the dominant prey were generally similar for the two studies (Tyler: 20-65 cm; Macdonald and Green: 26-58) but contrasted in part with prey from the studies above. Principal summer time prey in the study by Tyler (1972) included *Pandalus, Aphrodite, Praxillella, Yoldia, Arctica, Nuculana, Ophiura, Musculus,* and *Venericardia.* Macdonald and Green (1986) listed *Sternaspis scutata, C. alba, Yoldia sapotilla*, and *Nucula* sp. as being the most important prey taken in July, August, and October.

The diet composition of ocean pout appears to be size dependent with the smallest individuals (26-40 cm) reported to only be feeding on Gammaridea (Buzulutskaya 1983). Gammarids (not identified to species) decreased in dietary importance with increasing predator size and represented only 15% of the diet at 51-55 cm. The biomass due to crabs (*Cancer* sp.) in the diet increased with predator size (Buzulutskaya 1983).

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Annotated bibliography:

Albert, O.T. 1993. Distribution, population structure and diet of silvery pout (*Gadiculus argenteus thori* J. Schmidt), poor cod (*Trisopterus minutus minutus* (L.)), four-bearded rockling (*Rhinonemus cimbrius* (L.)) and Vahl's eelpout (*Lycodes vahlii gracilis* Reinhardt) in the Norwegian deep. Sarsia 78:141-154.

Reference (#)	Albert 1993 (1)
Purpose of study	describes the population structure, distribution, and diet
Predators	*Rhinonemus cimbrius* (known in the western Atlantic as *Enchelyopus*
	cimbrius, the fourbeard rockling); *Lycodes vahlii gracilis*, Vahl's eelpout
Predator size	
Dominant prey	*E. cimbrius*: polychaetes, cumaceans, gammarid amphipods, decapods
	L. vahlii: ophiuroids, bivalves, cumaceans, polychaetes
Prey size	
Location	Norwegian Deep, south coast of Norway
Time of year	Feb-Apr, Jul-Aug, Oct-Nov, 1984-1987
How prey quantified	percent weight, percent frequency of occurrence
Number of stomachs	*R. cimbrius*: n=48; *L. vahlii gracilis*: n=8
Depth	*R. cimbrius*: 140-320 m; *L. vahlii gracilis*: 205 m
Bottom type	
Prey energetics	

Enchelyopus cimbrius: Polychaetes, cumaceans, gammarid amphipods, and decapods were all important in the diet and accounted for 95% of the total weight of the stomach contents that could be identified. Each of these prey groups were found in more than 40% of the stomachs examined. The diet consists of infauna and epifauna and closely resembles the diet from other locations in the North Sea.

Lycodes vahlii: The diet consisted mostly of infauna and epifauna and included ophiurids, bivalves, cumaceans (occurred in all stomachs examined), polychaetes, ostracods, and isocods.

Albert, O.T. 1995. Diel changes in food and feeding of small gadoids on a coastal bank. ICES J. Mar. Sci. 52:873-885.

Reference (#)	Albert 1995 (2)
Purpose of study	describes diel variation in food and feeding behaviour
Predators	*Melanogrammus aeglefinus* haddock; Norway pout, and poor-cod are
	discussed in this paper but not in this review
Predator size	haddock: <26 cm
Dominant prey	polychaetes and isopods
Prey size	
Location	coastal bank off southwest Norway
Time of year	July, 1991
How prey quantified	percent weight, percent frequency of occurrence
Number of stomachs	n=413
Depth	140 m
Bottom type	
Prey energetics	

The diet of haddock <15 cm on a coastal bank off southern Norway consisted largely of benthic invertebrates and included copepods and amphipods whereas 16-26 cm haddock were taking isopods, polychaetes, ophiurids, as well as benthopelagic decapods. For haddock 16-26 cm the relative contribution of the small isopod *Arcturella dilatata* decreased with predator length while that of the larger isopod *Cirolana borealis* and of decapods increased. Over all size classes, polychaetes represented 10.9% by weight of the diet with Ampharetidae being the single most important family (3.4%). The two isopods,

Cirolana borealis and *Arcturella dilatata* represented 10.2% and 23.8% of the diet respectively. Other important contributors to the diet included Decapoda (4.0%) and Ophiurida (3.9%).

The diel variation in the stomach contents of haddock showed a bimodal pattern with a primary peak in the evening and a secondary peak in the morning. The first feeding period was estimated to occur from 01:45 to 04:42 hr. The second feeding period occurred between 08:00-20:57 hr. The proportion of fish that had recently eaten was >60% in the evening.

Albikovskaya, L.K. 1982. Characteristics of feeding of three species of wolffishes in the northwest Atlantic. NAFO SCR Doc. 82/VI/69. Serial No. N562. 9 pp.

Reference (#)	Albikovskaya 1982 (3)
Purpose of study	describes diet
Predators	*Anarhichas lupus* (Atlantic wolffish); *A. minor* (spotted wolffish); *A. latifrons*
	is a synonym for *Anarhichas denticulatus* (northern or broadhead wolfish)
Predator size	
Dominant prey	brittlestars
Prey size	no information provided
Location	NAFO Divisions 2J, 3K, 3L, 3M
Time of year	1977-1981, month not indicated
How prey quantified	stomach fullness index, percent occurrence
Number of stomachs	n=5,059
Depth	
Bottom type	
Prey energetics	

Ophiurae occurred in more stomachs than any other prey. The most important stomach contents for each predator were: ***A. lupus*** - bivalve molluscs, Gastropoda, crabs; ***A. minor*** - crabs and worms; ***A. latifrons*** - also feeds heavily on benthic invertebrates but contains a more pelagic prey such as ctenophora and medusas relative to the other wolffish. Sand, silt, and stones, indicative of benthic feeding occurred wolffish stomachs.

Buzulutskaya, 1983. Feeding of ocean pout (*Macrozoarces americanus*) in the northwest Atlantic. NAFO SCR Doc. 83/IX/76. Serial No. N742. 9 pp.

Reference (#)	Buzulutskaya 1983 (4)
Purpose of study	describes diet
Predator	*Macrozoarces americanus* ocean pout
Predator size	26-70 cm
Dominant prey	*Cancer* crabs, Gammaridae
Prey size	
Location	Georges Bank, Nantucket shoals
Time of year	May-July 1971
How prey quantified	percent weight
Number of stomachs	n=105
Depth	40-80 m
Bottom type	
Prey energetics	

Decapoda (*Cancer borealis*; 76% weight) was the single most important prey of ocean pout off the Nantucket Shoals whereas Echinodermata (*Echinarachnius parma*: 43.7%) and gammarid amphipods (not identified) were the important prey on Georges Bank (36.3%). All prey were considered to be benthic. Sand and pebbles were also found in the stomachs. The only other prey listed include: Pelecypoda (0.5-8.5%; *Nucula, Yoldia, Cardium [Cerastoderma] pinnulatum*), and Nematoda (11-24%).

Gammaridea were listed as the only prey of ocean pout between 26-40 cm. Gammarids decrease in importance with increasing size and accounted for 15.9% of the prey in ocean pout 51-55 cm long. Crabs became more important with increasing length such that at 46-50 cm they accounted for 78% of the prey.

Bowering, W.R. and G.R. Lilly. 1992. Greenland halibut (*Reinhardtius hippoglossoides*) off southern Labrador and northeastern Newfoundland (northwest Atlantic) feed primarily on capelin (*Mallotus villosus*). Neth. J. Sea. Res. 29:211-222.

Reference (#)	Bowering and Lilly 1992 (5)
Purpose of study	describes diet and estimates annual consumption of capelin by cod
Predator	*Reinhardtius hippoglossoides* Greenland turbot
Predator size	10 to > 84 cm
Dominant prey	<20 cm: small crustaceans and cephalopods; 20-69 cm: primarily capelin;
	>69 cm: a variety of demersal fish (redfish and greenland halibut)
Prey size	
Location	northeast Newfoundland Shelf (includes Hamilton Bank, Belle Isle Bank,
	and Funk Island Bank)
Time of year	autumn, 1981, 1982, 1984
How prey quantified	percent weight
Number of stomachs	n=10,309
Depth	100-1000 m (continental shelf and upper slope)
Bottom type	
Prey energetics	

There was a strong degree of similarity among years in the percentage of stomachs which were empty (42-48%), the average fullness (1.41-1.44), the prey consumption and the relative importance of individual prey taxa. Fish were the major prey, contributing about 62-71% of the diet by number, c. 96% of the total prey weight and 91-94% of the total fullness index. The dominant fish prey was capelin (*M. villosus*) which occurred in only 19-23% of the stomachs but contributed to 39-46% of the total prey weight. Secondary fish prey which were much less important were arctic cod (*Boreogadus saida*), redfish (*Sebastes* sp.), Greenland halibut, and Atlantic cod (*G. morhua*). Secondary prey occurred in small numbers but were moderately important in terms of weight.

Other than fish prey, Crustacea were the only other taxa of any importance in the diet. Crustacea occurred in <26.4% of the stomachs and accounted for <2% of the stomach weight in any given year. Crustaceans identified to species included the northern shrimp (*Pandalus borealis*) but hyperiid and gammarid amphipods which were present in relatively high numbers (but contributed little to total weight) were not identified to species.

Variation in diet due to depth: Predators were grouped into four depth categories: <400 m, 401-600, 601-800, and 801-1000 m. Greenland halibut sampled on the slope were larger than those on the shelf. The frequency of empty stomachs increased with depth and the average stomach fullness declined with depth. Capelin was the dominant prey to depths of 600 m. Hyperiids, northern shrimp, Arctic cod, and Greenland halibut were preyed upon primarily on the shelf whereas cephalopods, macrourids, and redfish were preyed upon mainly on the slope.

Variation in diet due to predator length: Predation on fish was related to size of predator. There was an abrupt change at about 65-69 cm from feeding on capelin to feeding on other fish prey. The observations in this study agree with reports elsewhere that small Greenland halibut tend to feed on plankton and that larger halibut feed almost entirely in the water column and predominantly on fish. Small individuals (<20 cm) feed primarily on small crustaceans (mainly hyperid amphipods) and cephalopods (some of which were identified as *Gonatus* sp.). Medium sized halibut (20-69 cm) feed primarily on capelin (10-18 cm). Large halibut (>69 cm) feed on a variety of demersal fish larger than capelin.

Bowman, R.E. 1981. Food of 10 species of northwest Atlantic juvenile groundfish. Fish. Bull. U.S. 79:200-206.

Reference (#)	Bowman, 1981 (6)
Purpose of study	identifies types of food taken and examines change in prey with predator length
Predators	*Gadus morhua* Atlantic cod; *Melanogrammus aeglefinus* haddock;
	Merluccius bilinearis silver hake; *Pollachius virens* pollock; *Urophycis*
	chuss red hake; *U. tenuis* white hake; *U. regius* spotted hake;
	Enchelyopus cimbrius fourbeard rockling; *Hippoglossoides platessoides*
	American plaice; *Limanda ferruginea* yellowtail flounder
Predator size	3-20 cm
Dominant prey	Crustacea
Prey size	
Location	mid Atlantic Bight; south New England; Georges Bank; Gulf of Maine;
	southern Scotian Shelf
Time of year	spring and fall
How prey quantified	percent weight
Number of stomachs	cod: n=107; haddock: n=2159; silver hake: n=440; pollock: n=22;
	red hake: n=229; white hake: n=23; spotted hake: n=16; rockling: n=3;
	plaice: n=10; yellowtail: n=56
Depth	
Bottom type	
Prey energetics	

Crustacea represented the largest portion of the diet of juvenile **cod** (81.6% weight). Dominant prey within Crustacea were: amphipods (22.5%) with Gammaridea (6.5%) and Caprellidae (12.9%) being most important. Euphausiacea (18.0%; mostly *Meganyctiphanes norvegica*), Mysidacea (12.9%; mostly *Neomysis americana* [3.7%]) and Decapoda (11.2%; mainly *Crangon septemspinosa*) were also important. Fish (none identified to species) made up 16% of the diet, Polychaeta (0.4%), Mollusca (0.1%) and Chaetognatha (trace) were less important. The predominant food of cod >9 cm was benthic organisms (Gammaridae, Caprellidae, Cumacea) which made up >50% of the diet. Plankton was the dominant food of cod <9 cm and made up a progressively smaller proportion of the diet as the size of fish increased.

Small crustaceans accounted for 62.3% of the **haddock** diet. Amphipod crustaceans were the single most important food (27.6%) with Corophiidae (primarily *Unicola* sp.) being the single most common amphipod identified (5.0%). Other amphipod groups frequently found were in order of importance: Caprellidae (mainly *Aeginina longicornis*), Ampeliscidae, Aoridae, Hyperiidae, Gammaridae and Pontogeneiidae. Euphausiacea (chiefly *Meganyctiphanes norvegica*) accounted for 13% of the diet. *Crangon septemspinosa* (2.6%) made up the largest portion of the decapod prey. Crustaceans of lesser dietary importance to haddock were: Mysidacea (1.5%), Isopods (0.7%), Cumacea (0.7%), and Copepoda (0.6%). The largest contributor to the identified polychaete prey (13.6%) were the nereidiform worms with *Eunice* sp. (c. 5%) being the most common. Fish made up 5% of the diet with silver hake comprising 2.2% of this prey group. Echinodermata (1.2%), Chaetognatha (0.2%), and Mollusca (0.1%) were not important prey. Haddock >8 cm fed heavily on the benthos (amphipods, decapods, polychaetes). Pelagic organisms (copepods, euphausiids) were the dominant food of haddock <8 cm.

Crustacea (89.0%) were the most important prey of **silver hake** with euphausiids (44.4%; *M. norvegica* [22.8%]; *Thysanoessa* sp. [2.0%]) being the single most important food. Decapods (30.4%) included *Crangon septemspinosa* (21.5%) and pandalid shrimp (7.9%; primarily *Dichelopandalus leptocerus* [3.8%]). Amphipods (6.6%; mostly Ampeliscidae [1.9%] and Tironidae [0.6%]), mysids (2.6%; all were *N. americana*), cumaceans (0.1%) and copepods (0.1%) were relatively unimportant. Small fish and fish larvae accounted for 8.5% of the diet. *Crangon septemspinosa* and bottom living amphipods were found in the stomachs of the smallest silver hake (3 cm). However benthic prey did not increase in importance in the diet of larger silver hake. The primary prey of all silver hake collected was *M. norvegica*.

Crustaceans (68.2%), primarily euphausiacea (*M. norvegica* [40.9%]; *Thysanoessa* sp. [2.3%]) made up 55.8% of the crustaceans found in the stomachs of **pollock**. Amphipods (1.5%; primarily *Byblis*

serrata [1.3%]), decapod larvae (0.3%), isopods (1.2%), calanoid copepods (0.2%), polychaetes (0.7%), and fish (0.7%) were relatively unimportant.

Crustaceans (90.1%) accounted for most of the diet of the juvenile **red hake**. The single most important crustacean prey was *C. septemspinosa* (40.6%). Amphipod prey included: Oedicerotidae (5.9%), Corophiidae (2.3%; mainly *Unciola* sp. [1.9%]), and Gammaridea (7.1%). Euphausiids (6.4%; *M. norvegica* [1.6%]) and Mysids (3.6%) were the only other crustacean prey of importance to juvenile red hake. Other taxon were relatively unimportant: copepods (1.3%), cumaceans (0.5%), isopods (0.1%), polychaeta (2.4%), pisces (1.9%), chaetognatha (0.3%), and mollusca (0.2%).

White hake preyed almost exclusively on crustaceans (94.9%) with C. *septemspinosa* (57.9%) being the single most important prey. Amphipods (15.4%) included: Corphiidae (4.6%; *L. pinguis*), Aoridae (2.0%), Hyperiidae (0.5%), Pontogeneiidae (0.4%), Ampeliscidae (0.3%), and Caprellidae (0.2%). Polychaete worms made up 2.9% of the diet. Planktonic organisms were not found in any of the stomachs.

Spotted hake also fed primarily on crustacea (85.9%) with amphipods (all identified as Gammaridea) accounting for 77.1% of the diet. Calanoid copepods accounted for 7.0% of the diet. By 5 cm approximately half of the diet was of benthic origin.

Gammarid amphipods (33.3%) and small quantities of hermit crabs were the only items identified from the single **rockling** stomach examined with food present.

Polychaeta (72.1%) was the primary prey of **American plaice**. Only two families of polychaetes were identified: Capitellidae (10.6%) and Sabellidae (2.9%). Crustacea (21.1%; amphipods [17.3%], mysids [3.8%]) and Mollusca (trace; Dentalidae) made up the rest of the diet.

Crustacea (94.4%) were the dominant prey of juvenile **yellowtail flounder**. Amphipods (38.8%) were the most important crustacea with the families Gammaridea (5.2%) and Caprellidae (0.5%) being the most important. Mysidacea (33.4%; primarily *Erythrops* sp. [9.9%]), cumaceans (10.2%), decapods (primarily *Crangon septemspinosa* [3.4%] and hermit crabs [0.3%]), and isopods (1.0%) made up the remainder of the crustacean prey. Polychaetea (3.0%; primarily *Phyllodoce* sp. from the family Nerediformia [2.1%]) were the only other important prey.

Bowman, R.E. and E.W. Bowman. 1980. Diurnal variation in the feeding intensity and catchability of silver hake (*Merluccius bilinearis*). Can. J. Fish. Aquat. Sci. 37:1565-1572.

Reference (#)	Bowman and Bowman 1980 (7)
Purpose of study	describes feeding behavior and prey types
Predator	*Merluccius bilinearis* silver hake
Predator size	21-40 cm
Dominant prey	crustaceans, decapods, and amphipods
Prey size	
Location	Georges Bank
Time of year	Sept. 1978
How prey quantified	percent weight
Number of stomachs	n=498
Depth	
Bottom type	
Prey energetics	

Silver hake feed at night from just after dark to pre-dawn but mostly between dusk and midnight. Silver hake are located on or immediately above the bottom during the day and off bottom at night. A variety of free swimming crustaceans make up the largest part of the diet. These include *Crangon septemspinosa, Dichelopandalus leptocerus,* and *Monoculodes intermedius*. Crustaceans made up 96.7% of the diet, the above species being the most important and contributing 28.0%, 10.1%, and 9.9% to the diet by weight respectively. Other prey groups were Pisces (2.8%; silver hake, Gadidae, yellowtail), Cephalopoda (0.4%), and Chaetognatha (0.1%).

Bowman, R., R. Eppi and M. Grosslein. 1984. Diet and composition of spiny dogfish in the northwest Atlantic. ICES CM 1984/G:27 16 pp.

Reference (#)	Bowman et al. 1984 (8)
Purpose of study	describes diet
Predator	*Squalus acanthias* spiny dogfish
Predator size	<31 cm to >100 cm
Dominant prey	fish: pelagic and demersal
Prey size	
Location	continental shelf waters from Cape Hatteras to the southern Scotian Shelf
Time of year	1963-1983, time of year not directly stated but includes spring and autumn
How prey quantified	percent weight, volume, number of prey/stomach, frequency of occurrence
Number of stomachs	n=10,167 (5,441 empty)
Depth	
Bottom type	
Prey energetics	

Juvenile and small-sized fishes, demersal and pelagic, made up the majority of the diet of dogfish off the northeastern United States from 1963-1983. Bowman et al. (1984) make a cautionary note that some of the food items in the stomachs of sharks may have been ingested when dogfish took other prey (i.e. secondary ingestion). This possibly accounts for many of the parasites (Trematoda, Cestoda, Nematoda), ophiuroides, and amphipods which are suggested to have originated from the stomachs of prey fish.

Important fish in the diet include several species of herrings, mackerel, sand lance, cod, haddock, silver, red, and white hakes. Squid (mostly *Loligo* and *Illex*) were also important.

Dogfish <60 cm TL fed primarily on ctenophores, euphausids, decapod shrimp, small fish, and squid. Dogfish >60 cm preyed intensively on a wide variety of fish species (herrings, mackerel, gadids, pleuronectids [=yellowtail and summer flounder]), and squid. Large dogfish also tended to take a greater proportion of crabs, such as *Cancer irroratus* than the smaller dogfish.

Although fish and squid were consistently identified as the principal prey throughout the entire period (1963-1983) the species composition of the prey varied widely throughout the period. For example, little or no mackerel were taken from 1973-1978 whereas mackerel made up 23% (weight) of the stomach contents in 1969-1972. Sand lance was identified as prey only after 1976. Bivalves (mostly identified as scallop viscera) made up >10% (weight) of the diet in spring 1978 and the spring and summer of 1979 and 1980. Some of these differences seem to be related with known changes in abundance and availability of prey. For example, starting in 1978 sea scallop viscera (*Placopecten magellanicus*) began showing up in the stomachs of dogfish. It is documented (p. 6 of Bowman et al. 1984) that fishes can feed on the viscera of scallops discarded from commercial fishing vessels. Annual catches of sea scallops increased in the late 1970s and early 1980s, a trend similar to that observed for the incidence of viscera in the diet of dogfish. The stomach content data also shows a similar pattern within years with c. 2/3 of scallop landings occurring in April-September with the highest percentages of viscera in stomachs of dogfish occurring in spring and summer.

Feeding intensity was highest in autumn (compared to spring) with 1.8 times as much food occurring in dogfish >40 cm collected in autumn.

Chumakov, A.K. and S.G. Podrazhanskaya. 1983. Feeding of Greenland halibut in the northwest Atlantic. NAFO SCR Doc. 83/IX/79. Serial No. N745. 22 pp.

Reference (#)	Chumakov and Podrazhanskaya 1983 (9)
Purpose of study	investigates seasonal feeding
Predator	*Reinhardtius hippoglossoides* Greenland halibut
Predator size	21-99 cm
Dominant prey	fish, squid, and crustaceans
Prey size	
Location	mostly from Labrador and Newfoundland, NAFO Divisions 2G, 2H, 2J, and 3K.
Time of year	throughout the year
How prey quantified	percent occurrence and percent weight
Number of stomachs	n=76,693 total, n=12,150 from Newfoundland
Depth	c. 270-1020 m
Bottom type	
Prey energetics	

Prey of Greenland halibut are primarily bathypelagic except for the occasional echinoderm, polychaete, crustacea, and sponge. In the southern portion of the sampling area (southern Labrador and Newfoundland) small halibut feed mainly on fish (81.8%; cod [22.1%], Greenland halibut [14.1%], eelpout [10.0%]) and crustaceans primarily shrimp *Pandalus borealis* (6.0%). In the northern portion of the sampling area where it is reported that most of the larger mature halibut are located, important prey included large redfish and grenadier. Feeding intensity is highest from July to November at depths of 600-700 m.

Clay, D., L. Currie and B. Swan. 1984. Food and feeding of silver hake (*Merluccius bilinearis* Mitchill), on the Scotian Shelf with special reference to cannibalism. NAFO SCR Doc. 84/VI/86. Serial No. N876. 25 pp.

Reference (#)	Clay et al. 1984 (10)
Purpose of study	describes diet at low population biomass
Predators	*Merluccius bilinearis* silver hake
Predator size	10 to 50+ cm
Dominant prey	>40 cm: fish and squid; <30 cm: euphausiids and shrimp
Prey size	
Location	most stomachs from the Scotian Shelf, some from Georges Bank
Time of year	1976-1980; Oct-Dec, Apr, Jun, May-Dec
How prey quantified	stomach fullness index, frequency of occurrence, average food volume
Number of stomachs	n=3,779
Depth	
Bottom type	
Prey energetics	

The stomach contents by predator length and month do not show clear seasonal relationships, possibly due to not all months being represented and several months having a small number of samples. It does appear that in spring and early summer euphausiids are important food of hake <40 cm and that small fish and squid become increasingly more important in October to December. Crustaceans (not identified to species) are an important prey in stomachs throughout the year. Squid were commonly found in the stomachs of larger hake (<40 cm) and may have had higher levels of occurrence than normal due to the high levels of squid abundance on the Scotian Shelf in the late 1970's. The seasonal pattern of squid appearance in the diet is closely related to the movement of squid into and out of the area in early fall.

Hake appear to be opportunistic feeders taking whatever is present in the water column at the time. Amphipods, although occasionally found in the stomachs do not appear to be important and maybe present in the stomach only due to chance.

Much of the same data in this study were also examined by Swan and Clay in 1979. This study includes two new data sources (n=2,068 additional stomachs from NAFO subdivision 4VW).

Collie, J.S. 1987. Food selection by yellowtail flounder (*Limanda ferruginea*) on Georges Bank. Can. J. Fish. Aquat. Sci. 44:357-367.

Reference (#)	Collie 1987 (11)
Purpose of study	to determine prey selection and size selection in the same study
Predator	*Limanda ferruginea* yellowtail flounder
Predator size	most between 26-35 cm; age 3
Dominant prey	polychaetes (*Lumbrineris* sp. and *Nephtys* sp.)
	amphipods (*Unciola* sp.), and decapods (*Crangon septemspinosa*)
Prey size	amphipods 5-8 mm; polychaetes 10-30 mm; size of prey is often given in mg.
Location	Georges Bank
Time of year	quarterly from August 1982 to May 1983
How prey quantified	number, weight
Number of stomachs	n=594
Depth	three sampling stations, 84, 69, and 60 m
Bottom type	one sampling site is locally known as the "mud patch" (69 m)
Prey energetics	

The diet of yellowtail flounder is flexible in that the dominant prey vary among sampling locations. The preferred prey size was 13 mg. In general yellowtail flounder neglected small 2-5 mm amphipods in favour of those between 5-8 mm. This observation was independent of season. Yellowtail took only the intermediate sizes of the sand dollar *E. parma*, (5-12 mm) even though these sizes were rare in the benthos. For the sabellid polychaete (*Chone infundibuliformis*) which feeds with tentacles above the surface of the substrate the fish stomach and grab sample length frequency distributions were very similar with most *C. infundibuliformis* being between 10-35 mm. The only vertebrate prey taken were larvae of the cusk, *Brosme brosme* an eel- like gadid. Although very important at one site sampled in August cusk larvae were generally a minor prey of yellowtail flounder.

Collins, M.A.J. 1976. The lumpfish (*Cyclopterus lumpus* L.) in Newfoundland waters. Can. Field. Nat. 90:64-67.

Reference (#)	Collins 1976 (12)
Purpose of study	describes various aspects of the biology including feeding
Predator	*Cyclopterus lumpus* lumpfish
Predator size	
Dominant prey	summer: nothing in stomachs; winter (offshore) pelagic prey
Prey size	
Location	Conception Bay, Newfoundland
Time of year	summer
How prey quantified	as a list in order of importance
Number of stomachs	
Depth	
Bottom type	
Prey energetics	

Mature lumpfish during summer had no food in their stomachs when sampled in Conception Bay, Newfoundland. Lumpfish taken off St. John's and in the Gulf of St. Lawrence in winter were taking pelagic prey: coelenterates (*Aurelia aurita, Cyanea capillata*), ctenophores (*Pleurobrachia pileus*), chaetognaths (*Sigitta elegans*), annelids (*Nereis pelagica*), crustaceans (*Hyperia sp., Meganyctiphanes norvegica, Parathemisto guadichaudi, Thysanoessa* sp.) and fish larvae.

Crozier, W.W. 1985. Observations on the food and feeding of the angler-fish *Lophius piscatorius* L., in the northern Irish Sea. J. Fish. Biol. 27:655-665.

Reference (#)	Crozier 1985 (13)
Purpose of study	describes diet and aspects of the life history
Predator	*Lophius piscatorius* angler fish
Predator size	range = 9-129 cm; three size classes in analyses: <26, 26-60, >60 cm
Dominant prey	fish and *Nephrops*
Prey size	
Location	Irish Sea
Time of year	May 1983 to April 1984
How prey quantified	percent weight, percent number, and percent occurrence
Number of stomachs	n=1,621
Depth	50-100 m
Bottom type	
Prey energetics	

The angler-fish *Lophius piscatorius* occurs in the eastern Atlantic. Its counterpart in the western Atlantic is *Lophius americanius* which is similar in many respects. Fish and unidentified fish remains were the dominant prey and accounted for 87.6% (weight) of the diet with demersal fish (Gadidae, Pleuronectidae) being the most important taxa. Crustacea accounted for 11.1% of the diet with *Nephrops* accounting for 10.2% of this. Mollusca (primarily squid *Loligo forbesi*, and lesser octopus *Eledone cirrhosa*) accounted for 1.2% of the diet. Fish were the dominant prey regardless of predator size class.

Dexter, R.W. 1969. Studies on the food habits of whiting, redfish and pollock in the Gulf of Maine. J. Mar. Biol. Ass. India 11:288-294.

Reference (#)	Dexter 1969 (14)
Purpose of study	determine stomach contents
Predators	*Merluccius bilinearis* silver hake; *Sebastes* redfish; *Pollachius virens* pollock
Predator size	
Dominant prey	*M. bilinearis:* fish; *Sebastes* : euphausids, copepods, shrimp;
	P. virens: euphausids, copepods, fish
Prey size	
Location	Gulf of Maine
Time of year	summer, 1959 to 1961
How prey quantified	percent number, percent volume
Number of stomachs	*M. bilinearis* : n=23,295; *Sebastes* : n=460; *P. virens* : n=472
Depth	
Bottom type	
Prey energetics	

Silver hake: Herring (13.8% volume), sand lance (53.3%), fish remains (9.7%), and squid (9.6%) were the dominant prey in stomachs of redfish from the Gulf of Maine during summer. Invertebrates other than squid and euphausids (5.6%) formed <1% of the diet. The stomach contents varied from year to year but fish were always the most important component of the diet. In one instance euphausids accounted for as high as 30.5% (volume) of the diet. Silver hake <12 inches fed almost entirely on euphausids and occasionally on other crustaceans. Hake from 12-18 inches fed largely but not entirely on euphausids while hake >18 inches fed mostly on fish.

Redfish: Most of the redfish were collected at considerable depths and had their stomachs empty or everted by the time they reached the surface. Little quantitative data were obtained. Those with food in their stomachs fed on euphausids and copepods (57.4%), decapod shrimp (28.1%), and hyperid amphipods (9.6%). These prey were the most important prey in each year of the study.

Pollock: Like redfish, pollock also relied on a predominately pelagic food base. Dominant prey included euphausids and copepods (91.1%), squid (6.3%), and fish remains (8.1%). Again the proportions

changed from year to year but euphausids and copepods were the dominant prey in both years examined. The percent volume of invertebrate prey in redfish and pollock stomachs always exceeded that of fish prey. This was always the reverse for silver hake.

Durbin, E.G., A.G. Durbin, R.W. Langton and R.E. Bowman. 1983. Stomach contents of silver hake *Merluccius bilinearis* and Atlantic cod, *Gadus morhua* and estimation of their daily rations. Fish. Bull. U.S. 81:437-454.

Reference (#)	Durbin et al. 1983 (15)
Purpose of study	determines feeding habits and daily ration
Predators	*Merluccius bilinearis* silver hake; *Gadus morhua* Atlantic cod
Predator size	*M. bilinearis:* mean = 20.3 cm; *G. morhua:* mean = 53.2 cm
Dominant prey	fish and "other" prey categories most important
Prey size	
Location	offshore waters from Cape Hatteras to western Nova Scotia.
Time of year	spring and autumn, 1973-1976
How prey quantified	prey weight expressed as percentage body weight of the predator
Number of stomachs	*M. bilinearis*, n=2,714; *G. morhua*, n=1,697
Depth	*M. bilinearis*, means = 82.6-88.4 m; *G. morhua*, means = 90.3-104.8 m
Bottom type	
Prey energetics	

There are two prey categories: "other" and fish. Prey in each of these categories are not described further. In **silver hake** the "other" prey category was important up to a predator size of c. 40 cm. Hake >40 cm fed almost exclusively on fish. The mean weight of fish prey exceeded that of "other prey" in all silver hake size classes >30 cm during spring and >20 cm during autumn. Hake >20 cm contained 66.2% and 77.3% fish prey as a percentage of body weight during spring and fall respectively. Hake <20 cm contained 18.7% and 8.5% fish prey in spring and fall respectively.

Cod in all size classes fed on "other prey" to a significant degree. Fish prey was absent from the diet of cod <30 cm during spring but was observed in all size classes during fall. Fish prey constituted a significant proportion of the diet of cod >60 cm during spring and >30 cm during fall but the mean weight of fish prey did not exceed that of other prey except in cod >70 cm (spring) or > 50 cm (fall). Fish prey constituted 0% and 32.1% of the stomach contents of cod <30 cm and 37.4% and 55.1% of the stomach contents of cod >30 cm in spring and fall respectively.

Edwards, R.L. and R.E. Bowman. 1979. Food consumed by continental shelf fishes. From: Predator-prey systems in fisheries management. Sport Fishing Institute. pp. 387-406.

(16) This paper provides an overview of the main prey types taken by continental shelf fishes in the Gulf of Maine. Prey are not usually identified to species but are listed as polychaeta, crustacea (pelagic, benthic), fish, echinodermata, pelecopoda, gastropoda, and squid. Over 20 common continental shelf predatory fishes are listed. There is no break down by size or by sampling location.

Efanov, V.N. and V.I. Vinogradov. 1973. Feeding patterns of yellowtail flounder in two New England stocks. ICNAF Res. Doc. 73/32. Serial No. 2965. 3 pp.

Reference (#)	Efanov and Vinogradov 1973 (17)
Purpose of study	describes feeding intensity and diet
Predator	*Limanda ferruginea* yellowtail flounder
Predator size	
Dominant prey	Georges Bank: 3 primary species; southern New England: 12 primary
	species. One species contributed to the bulk of food in both locations:
	Microdeutopus damnonensis, an amphipod
Prey size	
Location	Georges Bank and southern New England
Time of year	June, 1971
How prey quantified	percent weight, stomach fullness index
Number of stomachs	Georges Bank: n=141; southern New England: n=524
Depth	
Bottom type	
Prey energetics	

Polychaetes and amphipods were the most important prey of yellowtail flounder on Georges Bank. The index of relative stomach filling indicates the polychaetes *Nephthys ingens* (2.0 ppt) and *Arabella opalina* (0.3 ppt) and the amphipod *Microdeutopus damnonensis* (6.5 ppt) were the most important species. The values given above are out of 14.4 ppt (=parts per thousand) which represents the absolute index of stomach filling for Georges Bank. Thus 2.0 for *N. ingens* out of a total of 14.4 = 13.8% of the total diet. Polychaetes and amphipods were the only prey found in the stomachs of Georges Bank yellowtail.

The diet was much more diverse in southern New England where polychaetes and amphipods were still the most important taxa but where many more species were identified. These include the polychaetes: *Nereis pelagica* (0.2 ppt), *Nephthys ingens* (0.4 ppt), *Arabella opalina* (0.4 ppt), and *Clymenella torquata* (0.1 ppt). Important amphipods were: Gammaridea (0.3 ppt, unidentified), *Ampelisca spinipes* (0.1 ppt), and *Microdeutopus damnonensis* (6.5 ppt). Isopods (not identified) represented 0.1 ppt of the diet. The only euphausiid identified was *Thysanopoda acutifrons* (0.2 ppt). Two decapods (*Crangon septemspinosus* and *Cancer borealis*) each represented 0.1 ppt of the absolute index of filling for yellowtail flounder from southern New England (9.0 ppt). Thus even though some of these numbers are very small, they do represent a substantial proportion of the diet. For example, *M. damnonensis* represents 6.5/9.0=72.2% of the diet from southern New England.

Feeding intensity was low for both locations. Low feeding intensity is characteristic of flatfish during the spawning period.

Fjosne, K., and J. Gjosaeter. 1996. Dietary composition and the potential of food competition between 0-group cod (*Gadus morhua* L.) and some other fish species in the littoral zone. ICES J. Mar. Sci. 53:757-770.

Reference (#)	Fjosne and Gjosaeter 1996 (18)
Purpose of study	determines dietary composition and potential for competition
Predators	*Gadus morhua* Atlantic cod; *Merlangius merlangus* whiting;
	Ctenolabrus rupestris wrasse; *Gobius niger* black goby
Predator size (range cm)	*Gadus morhua* (7.6-20.3 cm); *Merlangius merlangus* (6.3-19.2 cm);
	Ctenolabrus rupestris (4.7-15.0 cm); *Gobius niger* (7.2-13.5 cm)
Dominant prey	*G. morhua*: fish (gobies), crabs (megalopas, *Carcinus, Macropipus*);
	M. merlangus: fish (gobies), crabs (megalopas, *Carcinus*), copepods;
	C. rupestris: crabs, gastropods, and some bivalves
	G. niger: crabs (*Carcinus,* not megalopas stage), gammarids
Prey size	
Location	3 sites on the Norwegian Skagerrak coast
Time of year	August and October, 1991
How prey quantified	number, percent volume, percent occurrence
Number of stomachs	*Gadus morhua* (n=206); *Merlangius merlangus* (n=200)
	Ctenolabrus rupestris (n=147); *Gobius niger* (n=87)
Depth	all samples from <8 m, all sampling done with a beach seine
Bottom type	*Zostera*, macroalgae, sand, stones, and rock
Prey energetics	

This study was conducted in very shallow water and of the four predators, only *G. morhua* is discussed here. 0-group cod were generalists and in addition to taking fish and crabs also took calanoid copepods (primarily *C. finmarchicus*), gammarids, shrimps or prawns (mostly *Leander* sp.). Most active benthic, hyperbenthic, and pelagic prey were taken. Hyperbenthic and pelagic fish (primarily gobies) were the most important prey by volume (36.3-57.0%) however crabs, the second most important prey at two sites (13.6-21.2%) were replaced by pelagic copepods (31.5%; primarily *C. finmarchicus*) at the third site where they made up 73% of the total prey. The diet was significantly different between locations. The diet was also significantly different in August and October samples collected at the same sampling location though this may be due to cod being larger in October than in August due to growth over the August to October period.

Frame, D.W. 1974. Feeding habits of young winter flounder (*Pseudopleuronectes americanus*): prey availability and diversity. Trans. Am. Fish. Soc. 103:261-269.

Reference (#)	Frame, 1974 (19)
Purpose of study	describes feeding habits
Predator	*Pseudopleuronectes americanus* winter flounder
Predator size	length of predator not provided, age is given as 1+
Dominant prey	polychaetes, bivalves, gastropods, crustaceans
Prey size	
Location	Weweantic River Estuary, Wareham, Massachusetts
Time of year	April, July, August, 1968; January, March, June, October 1969.
How prey quantified	mean percent volume
Number of stomachs	n=176
Depth	three sampling sites: A transect <3 m; B transect <3 m ; C transect <3.5 m
Bottom type	A transect: fine sand-shell, mud, coarse gravel-shell; B transect: mud-silt,
	shell fragments, coarse sand-cobble; C: transect mud-silt.
Prey energetics	

The principal prey included polychaetes, bivalves, gastropods, and planktonic crustaceans. Planktonic copepods were most numerous in spring, bivalves, amphipods, and polychaetes were more numerous in summer and fall. The most numerous molluscs were: *Laevicardium mortoni*, *Nucula proxima*, *Tellina agilis*, and *Tetusa canaliculata*. Bivalve siphons were also encountered in the stomachs taken in midsummer.

Flounders appeared to feed more selectively in spring. Flounders fed primarily on planktonic copepods in spring and shifted to benthic invertebrates in summer and fall. In the Weweantic estuary flounder seem to prefer molluscs and amphipods to polychaetes. Molluscs "preserve" better than annelid worms or other soft-bodied invertebrates, they were easier to identify and therefore may have appeared more numerous than they actually were.

Gerasimova, O.V., L.K. Albikovskaya and S.P. Melnikov. 1991. Preliminary results from feeding analysis for abundant commercial fishes on the Newfoundland Bank in April-May 1991. NAFO SCR Doc. 91/125. Serial No. N2018. 20 pp.

Reference (#)	Gerasimova et al. 1991 (20)
Purpose of study	describes diet with respect to predator size
Predators	*Gadus morhua* Atlantic cod; *Reinhardtius hippoglossoides* Greenland
	halibut; *Hippoglossoides platessoides* American plaice
Predator size	*G. morhua*: 11 size classes from 9-134 cm; *R. hippoglossoides*: five size
	classes from 18-47 cm; *H. platessoides*: six size classes from 12-47 cm
Dominant prey	primarily fish, crustaceans sometimes important at smaller predator size
Prey size	
Location	Grand Bank and Flemish Cap, eastern Newfoundland
Time of year	April-May, 1991
How prey quantified	frequency of occurrence and precent weight
Number of stomachs	*G. morhua*: n=649; *R. hippoglossoides*: n=742; *H. platessoides*: n=149
Depth	
Bottom type	
Prey energetics	

Important information in Gerasimova et al. (1991) is contained in the many Tables that relate prey to predator size. The data for **cod** in the table immediately below (% weight) indicate polychaetes, molluscs, and echinoderms form a minor portion of the diet. Crustaceans and fish are the dominant prey. Crustaceans are important in the diet of small cod. With increasing size fish became increasingly important prey. Therefore with increasing predator size the number of prey taxon decreased as fish became prominent in the diet. Surprisingly, cod <17 cm were taking capelin as their most important prey in NAFO Div. 3NO (65% by weight). Such a high proportion of capelin in the diet was not observed until cod were <27 cm in NAFO Div. 3L. Fish, primarily capelin and sand lance were the most important component of the diet of all the cod <27 cm in NAFO Div. 3L. Capelin and sandlance were also important in the diet of cod from 3NO but cannibalism was also very high in these cod as indicated in the table that follows.

Prey of cod (as percent weight) from the Grand Bank and Flemish Cap (from Gerasimova et al. 1991)

NAFO Div.	Length of cod (cm)	No. of stomachs with food	Polychaetes	Ophiura	Molluscs	Caprella	Cumacea	Amphipods	Hyperids	Euphausids	Shrimp	Crabs: H. araneus	Crabs: C. opilio	Capelin	Sand lance	Plaice	Cod
3NO	9 to 17	20	2.1				4.4	13		0.8		8.3		65			
3NO	18 to 26	127	2.2	1.1			16	8.4	2.3	2.8	4.8	6.4	4.7	26	13		
3NO	27 to 35	40	1.5	0.1			1.7	0.4	0.2	0.5	4.1	27	13	25	6.1	4.2	
3NO	36 to 44	30	1.3	1.9			0.3	0.4		0.1	9.7	26	9.6	18	11	2.7	
3NO	45 to 53	16	0.1				0.5	0.4		0.5	3.1	3.8	5.1	37	11		38
3NO	54 to 62	6	1.9						35		1.6		28				
3NO	90 to 98	5								0.1			64		10		25
3NO	99 to 107	10									0.1		1.8	3.2	8.9	2.5	73
3NO	108 to 116	10		0.5								0.5	3.4	58	4.1		29
3NO	117 to 125	7		0.6									21	16	23	1.4	17
3NO	126 to 134	4												61	33		6.1
3L	18 to 26	38	7.1		4.5	1.5	11	13	1.1	2.1	4.7	11		32			
3L	27 to 35	66	3.1		0.8	0.2	5.1	3.6	3.9	0.1	2.6	2.6	3.8	60	5.1	0.5	
3L	36 to 44	75	0.3		0.9		0.8	1.3	1.1		1.7	1.5	2.2	51	31	0.8	
3L	45 to 53	47	0.1		0.3			0.4	1.1		2.6	1.2	1.1	85	2.8		
3L	54 to 62	46	0.3		0.8			0.3	0.1		2.3	0.1	5.5	57	23	0.1	
3L	63 to 71	38			0.6			0.3			0.8	1.7	1.9	79	9.3		
3L	72 to 80	31			0.1						1.9	1.1	16	45	17	1.3	
3L	81 to 89	25						0.2			1.1	0.7	2.5	34	37		
3L	90 to 98	8						0.5			0.7		11	20		0.8	

Greenland halibut <18 cm in 3NO and in 3L fed on crustaceans and fish (Table immediately below). Once again, capelin were the most important fish prey. Crustaceans consisted of euphausids, hyperids, amphipods, and shrimp. Squid were the only mollusc and were not an important component of the diet (<5% by weight). Data from Gerasimova et al. (1991).

NAFO Division	Length (cm)	No. of stomach	Euphausids	Hyperids	Amphipods	Shrimp	Squid	Capelin
3NO	18 to 23	6						100
3NO	24 to 29	28	0.4	0.2		0.3		99
3NO	30 to 35	28	0.2			0.2		95
3NO	36 to 41	27				0.3		99
3NO	42 to 47	14						88
3L	24 to 29	9						100
3L	30 to 35	25			3.4		0.2	95
3L	36 to 41	34			2.3	6.4	1.1	90
3L	42 to 47	15				2.1	3.4	67

The table below summarizes the diet of **plaice** in 3NO and 3L in April-May. Polychaetes were not an important prey and represented <5% of the diet for any size class. Ophiura, euphausids, and amphipods were important for plaice <29 cm. Invertebrates were not identified to a lower level. At sizes >29 cm fish (capelin and sand lance) were always the most important component of the diet.

NAFO Division	Length (cm)	No. of stomachs with foo	Polychaetes	Ophiura	Euphausids	Amphipods	Crabs	Capelin	Sand lance
3NO	12 to 17	25		12	62	18			8.1
3NO	18 to 23	31		0.3	14	2.1	0.2	52	25
3NO	24 to 29	24	4.4	4.3	21	2.9		31	32
3NO	30 to 35	16	0.3	1.6	0.2			19	75
3NO	36 to 41	5		3.4	0.1	0.2	0.1	70	26
3NO	42 to 47	5		6.1		0.2	0.4	20	54
3L	18 to 23	4		94					
3L	24 to 29	12	1.3	39				23	36
3L	30 to 35	9	1.3	7.5		0.2		59	32
3L	36 to 41	14				0.1	0.9	49	50
3L	42 to 47	4					16	52	32

Hacunda, J.S. 1981. Trophic relationships among demersal fishes in a coastal area of the Gulf of Maine. Fish. Bull. U.S. 79:775-788.

Reference (#)	Hacunda 1981 (21)
Purpose of study	examines feeding relationships in a coastal area
Predators	*Myoxocephalus octodecemspinosus* longhorn sculpin;
	Pseudopleuronectes americanus winter flounder; *Scophthalmus*
	aquosus windowpane flounder; *Limanda ferruginea* yellowtail flounder;
	Raja erinacea little skate; *Gadus morhua* Atlantic cod; *Urophycis*
	chuss red hake; *Macrozoarces americanus* ocean pout
Predator size (mean)	longhorn sculpin, 21.1 cm; winter flounder, 24.0 cm; windowpane, 27.3 cm;
	yellowtail flounder, 30.9 cm; little skate, 39.6 cm; ocean pout, 34.3 cm;
	cod, 22.5 cm; red hake 25.6 cm
Dominant prey	crustaceans comprised the dominant prey despite the dominance of molluscs
	and polychaetes in grab samples
Prey size	summarized below
Location	John's Bay, coast of Maine
Time of year	monthly samples from April 1978 to April 1979
How prey quantified	percent weight, percent number, percent frequency of occurrence
Number of stomachs	longhorn sculpin, n=299; winter flounder, n=201; windowpane, n=37;
	yellowtail flounder, n=60; little skate, n=33; ocean pout, n=46; cod, n=75;
	red hake, n=30
Depth	c. 30 m
Bottom type	
Prey energetics	

Longhorn sculpin: Crustaceans accounted for 58.4% (by weight) and were the most important component of the diet. Amphipods (25.66%; *Unciola* sp. [10.58%] and *Leptocheirus pinguis* [10.21%]) and decapods (27.67%; *Crangon septemspinosa* [10.05%] and *Cancer irroratus* [8.15%]) were the most important crustacean taxon. Fish (25.19%; *Clupea harengus* [11.04%] and other pisces [14.14%]) were the second most important major prey taxa. Porifera, Polychaeta, and Mollusca formed a minor portion of the diet.

Winter flounder: Crustaceans accounted for 32.5% of the diet. The amphipods (25.74%) *Unciola* sp. (10.17%), *Leptocheirus pinguis* (9.18%), and *Aeginella longicornis* (2.86%) were the dominant species taken. Polychaetes (18.26%) were the next major taxon of importance with *Melinna cristata* (2.16%), *Lumbrineris fragilis* (2.79%), and *Pherusa affinis* (5.03%) being the most important. Algae made up 12.7% of the diet. Prey of minor importance included: cumaceans, isopods, decapods, and molluscs although one bivalve (*Cerastoderma pinnulatum*) accounted for 4.2% of the diet by weight.

Windowpane flounder: Crustaceans made up 79.3% of the diet by weight with a single species, a mysid *Mysis mixta* accounting for 72.4% of the total diet. Herring (20.3%; *Clupea harengus*) made up most of the remaining diet.

Yellowtail flounder: Crustaceans (48.5%) made up most of the diet with amphipods (33.58%), mysids (12.51%), and decapods (1.59%) being the most important. Important amphipods were *Unciola* sp. (28.66%) and *Leptocheirus pinguis* (1.73%). *Mysis mixta* (12.19%) was the most important mysid. After crustacea, polychaetes (10.2%; *Nephtys* sp. [2.64%]) and molluscs (5.2%; bivalves, *Cerastoderma pinnulatum* [3.41%] and *Nucula proxima* [1.46%]) were the most important prey taxon taken.

Ocean pout: Echinoderms were the most important prey in terms of percent weight (20.63%) with the sea urchin *S. drobachiensis* (1.78%) and sand dollar *Echinarachnius parma* (18.03%) accounting for most of the echinoderm prey. Crustaceans (13.65%), with the amphipods (10.29%) *Unciola* sp. (8.0%) *Leptocheirus pinguis* (1.15%) were more important in the diet than the dominant Mollusca (9.87%; bivalves, *Placopecten magellanicus* [4.57%], *Cerastoderma pinnulatum* [3.85%]). A large amount of bottom sediment and organic material (c. 54%) was found in the stomachs.

Little skate: Crustaceans were the most important prey (66.89%) with decapods (50.71%; *Crangon septemspinosa* [18.51%] and *Cancer irroratus* [22.68%]) and amphipods (*Unciola* sp. [1.37%]

Leptocheirus pinguis [5.01%], *Anonyx sarsi* [2.38%], *Monoculodes* sp. [2.42%]) being the most important taxa. Polychaetes, none of which were identified to species, accounted for 10.14% of the diet.

Atlantic cod: Crustaceans (40.27%) were the most important prey group with amphipods (16.89%; *Unciola* sp. [11.16%], *Leptocheirus pinguis* [2.44%]) and decapods (*Crangon septemspinosa* [9.06%] and *Cancer irroratus* [6.07%]) being the most important. Fish, none of which were identified to species were the next most important prey group and accounted for 14.61% (weight) of the diet. Nematoda, Polychaeta, Mollusca, and Echinodermata were of little importance.

Red hake: Crustaceans accounted for 72.4% of the diet. Amphipods (31.87%; *Leptocheirus pinguis* [13.89%], *Unciola* sp. [6.71%], *Ampelisca agassizi* [2.48%]) and decapods (36.90%; *Crangon septemspinosa* [28.67]) were the most important crustaceans. The mean size of crustacean prey taken is summarized below (from Hacunda 1981) and is related to mouth size of the predator. The predator with the smallest mouth size, winter flounder took the smallest crustacean prey.

Predator (mean length ± s.d.) TL	mean crustacean prey length	upper jaw length (as % TL)
longhorn sculpin (19.5±3.7) cm	11.1±5.3 mm	15.1+0.69
Atlantic cod (23.3±3.8) cm	9.0±3.9 mm	11.7+0.75
winter flounder (22.3±3.4) cm	6.8±3.0 mm	4.9+0.32
yellowtail flounder (25.3±5.3) cm	10.8±4.9 mm	5.0+0.39
windowpane flounder (27.4±3.9) cm	14.4±2.6 mm	9.2+0.44

Hacunda (1981) suggested that demersal predators choose either infaunal, epifaunal, or nektonic organisms and that the proportion of the prey types in the diet is a reflection of preferred foraging strata (in a microhabitat sense). At one extreme is windowpane, a predator feeding primarily on nektonic prey while other predators are strongly dependent on bottom dwelling prey (e.g., yellowtail flounder).

Hop, H., J. Gjosaeter and D.S. Danielssen. 1994. Dietary composition of sympatric juvenile cod, *Gadus morhua* L., and juvenile whiting *Merlangius merlangus* L. in a fjord of southern Norway. Aqua. Fish. Manag. 25(Supp. 1):49-64.

Reference (#)	Hop et al. 1994 (22)
Purpose of study	investigates dietary composition and overlap between two gadids
Predators	*Gadus morhua* Atlantic cod; *Merlangius merlangus* whiting
Predator size	*G. morhua* (35-225 mm) ages 0 and 1; *M. merlangus* (55-145 mm) age 0
Dominant prey	*G. morhua:* (age 0) bivalves, cladocerans, copepods
	G. morhua : (age 1) polychaetes, shrimp, fish
	M. merlangus: (age 0) cladocerans, copepods, decapods, amphipods, fish
Prey size	
Location	three sites, Skagerrak, south coast of Norway
Time of year	two collections; July and August 1987
How prey quantified	mean number of each prey species per stomach as percentage
Number of stomachs	*G. morhua* : n=239; *M. merlangus* : n=72
Depth	< 3 m
Bottom type	
Prey energetics	

Only *G. morhua* is discussed here. *Merlangius merlangus* does not occur in the western Atlantic. Dietary composition of 0-group cod varied significantly between July and August. In July cod took copepods and copepod nauplii (43.2% by number), bivalves (19.5% primarily *Mytilus edulis*), cladocerans (13.7%), and gastropods (6.9%), whereas in August cladocerans (37.2%) and fish (14.6%) became relatively more important. Diets of age 0 and age 1 cod differed significantly. Age 1 cod took more decapods (28.5%), primarily shrimp (17.7%) in addition to fish (27.2%, primarily gobiids), and polychaetes (20.8%) indicating a switch to a predominantly epibenthic diet. Dietary composition of *G. morhua* varied significantly between three sampling sites on the south coast of Norway.

Jiang, W. and T. Jorgensen. 1996. The diet of haddock (*Melanogrammus aeglefinus* L.) in the Barents Sea during the period 1984-1991. ICES J. Mar. Sci. 53:11-21.

Reference (#)	Jiang and Jorgensen 1996 (23)
Purpose of study	describes diet at different temporal scales and due to predator size
Predator	*Melanogrammus aeglefinus* haddock
Predator size	five size classes: 10-19, 20-29, 30-39, 40-49, >50 cm
Dominant prey	Crustacea and Echinodermata
Prey size	
Location	Barents Sea
Time of year	collections were taken at 3 month intervals
How prey quantified	percent weight
Number of stomachs	n=9,531
Depth	
Bottom type	
Prey energetics	

Prey were seldom identified at levels lower than the five following major prey categories: Annelida, Mollusca, Crustacea, Echinodermata, and Pisces. Prey not belonging to these groups were classified as miscellaneous. The three most important prey categories were Crustacea, Echinodermata, and fishes which accounted for >80% of the diet (by weight). Important crustaceans included euphausids, amphipods, hyperids, and *Pandalus borealis*. Ophiuroidea were the most commonly occurring echinoderms and made up c. 38% of the diet. The most common fish prey were, redfish (*Sebastes* sp.), capelin (*Mallotus villosus*), and sandeels (=sandlance, *Ammodytes* sp.).

In general, Crustacea and Annelida were most important in the third quarter of the year, fish in the second quarter and echinoderms and molluscs in the fourth quarter. Haddock 10-19 cm did not conform to this pattern. Ordination analyses showed that differences in diet occurred most noticeably between 10-19 cm fish and larger individuals. Small haddock took more Crustacea-Annelida and less Echinodermata than larger (>20 cm) haddock. There was little change in the diet of haddock >20 cm.

Keats, D.W. 1990. The food of winter flounder *Pseudopleuronectes americanus* in a sea urchin dominated community in eastern Newfoundland. Mar. Ecol. Prog. Ser. 60:13-22.

Reference (#)	Keats 1990 (24)
Purpose of study	describes diet
Predator	*Pseudopleuronectes americanus* winter flounder
Predator size	c. 20-49 cm, mean = 36.3 cm
Dominant prey	fleshy algae, and the sea anemone, *Metridium senile*
Prey size	
Location	Conception Bay, Newfoundland
Time of year	19 June - 17 August, 1983
How prey quantified	stomach fullness index based on weight
Number of stomachs	n=63
Depth	5-15 m
Bottom type	sea urchin dominated hard substratum, bedrock, boulders
Prey energetics	

Fleshy algae (95% of which was *Desmarestia aculeata*, and *D. viridis*) and the sea anemone *Metridium senile* were the only significant soft bodied prey that were identifiable. These taxa made up 29% and 17% respectively of the identifiable food material. Hydroids (mainly *Obelis* sp.), chitons (*Tonicella marmorea, T. rubra*), sea urchins, and capelin eggs comprised from 7 to 12% of the diet. Hydroids and capelin eggs occurred in few fish (5 and 2 respectively). *Acmaea testudinalis* and brittle stars (*Ophiopholus*

aculeata) contributed 2.6 and 3.8% of the diet respectively. All other prey items were present at low weights and occurred in only a few fish.

Winter flounder in this study have a mouth gape of <16 mm which restricts the prey biomass available. This study concludes that winter flounder are largely unselective predators and that they feed on whatever prey of a suitable size is most abundant and available. Winter flounder, however, seem to select prey by size, taking mainly the larger prey within the size range that they can consume.

Keats, D.W. 1991. American plaice, *Hippoglossoides platessoides* (Fabricius), predation on green sea urchins, *Strongylocentrotus droebachiensis* (O.F. Muller), in eastern Newfoundland. J. Fish. Biol. 38:67-72.

Reference (#)	Keats 1991 (25)
Purpose of study	describes diet
Predator	*Hippoglossoides platessoides* American plaice
Predator size	42 to 73 cm
Dominant prey	sea urchins, fish eggs
Prey size	sea urchins: 5-45 mm test diameter
Location	off northern tip of Bell Island in Conception Bay, Newfoundland
Time of year	July, 1984
How prey quantified	frequency of occurrence, percent weight
Number of stomachs	n=29
Depth	10-15 m
Bottom type	sand and bedrock
Prey energetics	

Green sea urchins *Strongylocentrotus droebachiensis,* comprised 62% of the diet by weight and occurred in 71% of the stomachs that contained food. Capelin *M. villosus*, was the second most important food item (12.9% weight, occurring in 32.1% of the stomachs). Sand dollars (*Echinarachnius parma*) were a very minor portion of the diet (1.1% weight) even though they were very abundant on the sandy bottom. The size frequency of the green sea urchins from the fish stomachs shows that plaice feed on all available sizes of urchins except those <5 mm. The peak sea urchin test diameter was at 25-30 mm.

Keats, D.W., D.H. Steele and G.R. South. 1986. Atlantic wolffish (*Anarhichas lupus* L.: Pisces: Anarhichidae) predation on green sea urchins (*Strongylocentrotus droebachiensis* (O.F. Mull.; Echinodermata: Echinoidea) in eastern Newfoundland. Can. J. Zool. 64:1920-1925.

Reference (#)	Keats et al. 1986 (26)
Purpose of study	describes diet
Predator	*Anarhichas lupus* Atlantic wolffish
Predator size (mean)	mean length = 79.7 cm; s.e.= 1.35
Dominant prey	*Strongylocentrotus droebachiensis,* green sea urchin
Prey size	*S. droebachiensis* : 5-60 mm (mode is 30-35 mm)
Location	along the coast of the Avalon Peninsula, eastern Newfoundland
Time of year	April to September
How prey quantified	weight as percentage, frequency of occurrence
Number of stomachs	n=90
Depth	5-15 m
Bottom type	sea urchin dominated hard substratum typical of the open Newfoundland coast
Prey energetics	

Strongylocentrotus droebachiensis comprised 76% of the wolffish diet by weight and were present in 96% of the stomachs that contained food. Wolffish fed largely on sea urchins >20 mm diameter. The observed size selectivity was likely due to two factors. Wolffish select their prey visually and feed on

urchins individually. It is energetically more profitable to feed on larger urchins. It is therefore unlikely that wolffish would choose a small urchin if larger ones were available. Secondly, smaller urchins generally occur in cryptic microhabit among coralline algae, in crevices, among horse mussels, and under rocks. The horse mussel (*Modiolus modiolus*) represented 9.5% of the diet and occurred in 14/90 = 15.5% of the wolffish stomachs. Blue mussels (*Mytilus edulis*) occurred in 21/90 = 23.3% of the stomachs and represented 1.6% of the total diet. Crabs (*Hyas araneus, Pagurus* sp.) represented 4.4% of the diet.

Keats, D.W., D.H. Steele and G.R. South. 1987. Ocean pout (*Macrozoarces americanus* (Bloch and Schneider) (Pisces: Zoarcidae)) predation on green sea urchins (*Strongylocentrotus droebachiensis* (O.F. Mull.) (Echinodermata: Echinoidea)) in eastern Newfoundland. Can. J. Zool. 65:1515-1521.

Reference (#)	Keats, Steele and South 1987 (27)
Purpose of study	describes diet
Predator	*Macrozoarces americanus* ocean pout
Predator size (mean)	mean = 65.7 cm, s.e. = 0.87
Dominant prey	*Strongylocentrotus droebachiensis,* fish, *Ophiopholus aculeata*
Prey size	*S. droebachiensis* : 5-35 mm diameter
Location	along the coast of the Avalon Peninsula, eastern Newfoundland
Time of year	March to October, December?
How prey quantified	percent wet weight; frequency of occurrence
Number of stomachs	n=151
Depth	5-15 m
Bottom type	sea urchin dominated hard substratum typical of the open Newfoundland coast
Prey energetics	

Strongylocentrotus droebachiensis was the dominant prey of ocean pout in coastal Newfoundland. It occurred in 70% of stomachs and accounted for 62% weight of the diet. The billfish (*Scombersox saurus*) ranked second, accounted for 9.2% by weight of the diet and occurred in 8.3% of the stomachs. These pelagic fish do not appear to be a regular component of the diet of demersal ocean pout. Keats et al. (1987) note that there were large numbers of billfish in the area and that they were dying presumably as a result of decreasing temperature in December. The third most abundant prey was *Ophiopholus aculeata.* It occurred in 22% of the stomachs and represented 7% of the diet. *Ophiopholus aculeata* are apparently only available if ocean pout turn over stones or *Lithothamnion* rhodoliths. The high frequency of occurrence of intact *O. aculeata* indicates that ocean pout probably feed mainly in patches of loose bottom material where small to medium sized sea urchins (<15 mm) also tend to aggregate. Ocean pout probably take large quantities of bottom material into their mouths, sort it in the buccal cavity, and eject most of the inorganic portion. Ocean pout take sea urchins mostly between 5-15 mm test diameter, a size that was not commonly observed on the sea bed.

Kennedy, V.S. and D.H. Steele. 1971. The winter flounder (*Pseudopleuronectes americanus*) in Long Pond, Conception Bay, Newfoundland. J. Fish. Res. Board Can. 28:1153-1165.

Reference (#)	Kennedy and Steele 1971 (28)
Purpose of study	describes aspects of the life history, including feeding
Predator	*Pseudopleuronectes americanus* winter flounder
Predator size	three length classes: 8-19, 20-31, 32-46 cm
Dominant prey	small flounder: polychaetes, fish eggs; large flounder: fish
Prey size	
Location	Long Pond, Conception Bay, Newfoundland
Time of year	monthly collections from Nov 1962 to Oct 1963
How prey quantified	percent occurrence, percent volume
Number of stomachs	c. 486
Depth	<7 m
Bottom type	soft bottom
Prey energetics	

The seasonal cycle of feeding activity was highest in summer, decreased in autumn, essentially stopped over winter, and was initiated again in March. Polychaetes, plant material, and molluscs were the most common food types taken throughout the year. Capelin eggs and fish remains were found only during a few months of the year (May-July) but were taken in great quantities. Polychaetes (primarily *Nereis pelagica* and *Nereis virens* accounted for 7.8% of the annual diet) were most common in the diet in spring when they generally occurred in >50% of the stomachs examined. Plant material was observed in the diet from March to November when it on average occurred in 25% of the stomachs examined. Molluscs, primarily pelecypoda (*Mya arenaria, Macoma balthica*) occurred in stomachs throughout the feeding cycle (March-November) but were not recorded in winter when feeding ceased. These two species accounted for 5.6% of the annual diet.

Klemetsen, A. 1982. Food and feeding habits of cod from the Balsfjord, northern Norway during a one-year period. J. Cons. int Explor. Mer 40:101-111.

Reference (#)	Klemetsen 1982 (29)
Purpose of study	describes diet
Predator	*Gadus morhua* Atlantic cod
Predator size	18.5 to 74 cm; few were <25 and >65 cm.
Dominant prey	*Pandalus borealis* prawn; *Thysanoessa* sp. krill; *Mallotus villosus*
	capelin; *Clupea harangus* herring
Prey size	
Location	three sites in Balsfjord, northern Norway, c. 70°N
Time of year	sampling conducted at 1-2 month intervals for one year
How prey quantified	frequency of occurrence, stomach fullness (estimated visually for each prey)
Number of stomachs	n=1,089
Depth	Svartnes c. 185 m; Ramfjordnes and Tenes c. 100-125 m
Bottom type	sampling was confined to the soft-bottom deepwater areas
Prey energetics	

Seventy-two taxa were recorded in the diet of cod from Balsfjord, northern Norway. Principal prey were considered to be prey that occurred in ≥5% of the stomachs from any station. Of these 11 made up the principal prey: deep water prawn *Pandalus borealis* (25.3-46.8% occurrence), capelin *Mallotus villosus* (8.9-49.1% occurrence), small krill *Thysanoessa* sp. (13.5-29.8% occurrence) were the most important. The other principal prey included: polychaetes *Nephtys* sp. (3.2-15.3%), mysids *Erythrops* sp. (6.3-12.6%) and *Michteimysis mixta* (4.1-15.8%), amphipods *Arrhis phyllonyx* (0-11.0%), *Halirages fulvocinctus* (1.4-8.1%), and *Rhachotropis macropus* (0.4-9.0%), krill *Meganyctiphanes norvegica* (1.8-21.6%), and herring *Clupea harengus* (2.3-14.7%). Krill was probably the only prey taken in midwater.

The relative importance of the three most important prey *P. borealis*, capelin, and krill differed at the three sampling sites in the fjord. *Pandalus borealis* was the dominant prey at the Tennes sampling site, capelin and *P. borealis* at Svartnes, and small krill (*Thysanoessa* sp., *M. norvegica*), herring, and *Nephtys* sp. were important at Ramfjordnes. *Pandalus borealis* was important in the stomachs of cod at Tennes throughout the year with *Thysanoessa* sp. also occurring in stomachs throughout the year but being much less important. Capelin *and P. borealis* were important in stomachs throughout the year at Svartnes. Considerable seasonality was observed at the Ramfjordnes sampling site with *P. borealis* and *Thysanoessa* sp. being important in March-April; *Thysanoessa* sp. in May-June; *P. borealis, Thysanoessa* sp., herring, and *Nephtys* sp. being the important prey in August-September and with *P. borealis, Thysanoessa* sp. and capelin being important prey in November to February. The general lack of seasonal trends in stomach filling shows that the extreme light regime at this latitude probably has little effect on the food intake of cod. Thus during the two months of polar darkness cod had as much food in their stomachs as at other times of the year. It is suggested that possible receptors on barbels and pelvic fins are involved in prey location during dark periods. Temperatures should not influence the feeding of deepwater cod in Balsfjord because the seasonal variation in temperature is small at depths <100 m.

All comprehensive studies of the food of cod have shown that a wide variety of prey is taken (50-150 taxa) but that comparatively few species (usually <15) are important in the diet. Usually active and conspicuous epibenthic, semipelagic, or pelagic species dominate the food of cod. Crustaceans and fish are almost always important components of the diet. True infaunal components of the diet are rare.

Kohler, A.C. 1967. Size at maturity, spawning season and food of Atlantic halibut. J. Fish. Res. Board Canada 24:53-66.

Reference (#)	Kohler 1967 (30)
Purpose of study	describes diet
Predator	*Hippoglossus hippoglossus* Atlantic halibut
Predator size	maximun size = 260 cm
Dominant prey	depends on size of predator, (summarized below)
Prey size	
Location	Gulf of St. Lawrence, Scotian Shelf, Grand Banks
Time of year	primarily March to May, 1959-1963
How prey quantified	percent occurrence
Number of stomachs	Scotian Shelf: n=807; Gulf of St. Lawrence: n=157; Grand Banks: n=185
Depth	
Bottom type	
Prey energetics	

Prey were not identified to species or were quantified as percent volume or weight. Data appear to be summarized as percent occurrence. Halibut <30 cm contained invertebrates, primarily annelids and crustaceans in their stomachs. Halibut between 30-80 cm contained invertebrates and fish whereas halibut >80 cm fed almost exclusively on fish.

Kohler, A.C. and D.N. Fitzgerald. 1969. Comparisons of food of cod and haddock in the Gulf of St. Lawrence and on the Nova Scotia Banks. J. Fish. Res. Board Canada 26:1273-1287.

Reference (#)	Kohler and Fitzgerald 1969 (31)
Purpose of study	describes diet by length of predator, season, and depth
Predators	*Gadus morhua* Atlantic cod; *Melanogrammus aeglefinus* haddock
Predator size	4 size catagories: <30, 30-49, 50-69, >70 cm
Dominant prey	*G. morhua* : crustaceans changing to fish with increasing predator size
	M. aeglefinus: benthic speceis, annelid worms, molluscs, echinoderms
Prey size	
Location	Scotian Shelf: Emerald, Western, and Banquereau Banks
	Gulf of St. Lawrence: region between Sydney Bite and Orphan Bank
Time of year	Jan-Apr, May-Aug, Sep-Dec
How prey quantified	displacment volumes visually estimated,
Number of stomachs	*G. morhua* : n=20,340; *M. aeglefinus* : n=4,710
Depth	two depth ranges compared: <91 m, >91 m
Bottom type	
Prey energetics	

The variables about which cod and haddock diet are explained include: **location** (Gulf of St. Lawrence [4T], Sydney Bight [4Vn], Banquereau [4Vs], Western Bank [4W]), **depth** (<91 m, >91 m), **season** (Jan-Apr, May-Aug, Sep-Dec), and **size of predator** (<30, 30-49, 50-69, >70 cm for both cod and haddock). The data matrix is not complete. It was not possible to collect all sizes of cod and haddock at all locations, depths, and seasons.

In all four areas examined **small cod** (<30 cm) in shallow and deep water fed primarily on crustaceans with euphausids, pandalid shrimp, and amphipods. Fish in the Gulf of St. Lawrence and on Western Bank and annelids in the Sydney Bight area were of secondary importance. Cod between 30-49 cm in all four areas fed primarily on crustaceans and fish with all other prey categories (annelids, echinoderms, molluscs) being of minor importance. Fish and crustaceans were important in both shallow and deep water. At 50-69 cm fish were the dominant prey of cod in all regions except possibly Banquereau [4Vs] where crustaceans appear to be equally important. Cod >70 cm fed overwhelmingly on fish. Exceptions occurred in shallow water where molluscs and echinoderms were occasionally important.

Gulf of St. Lawrence: (summarized from Fig. 3 of Kohler and Fitzgerald 1969)

Cod <30 cm in the Gulf of St. Lawrence fed primarily on crustaceans (primarily euphausids) independent of season and depth. All other prey were of very minor importance. Cod between 30-49 cm also fed primarily on crustaceans (euphausids) however fish, molluscs, and annelids were, depending on season, of secondary importance. Cod between 50-69 cm were feeding on fish in deep and shallow water at all three times of the year. Fish were the most important prey in January-April and decreased in importance in May-August and September-December when crustaceans (in both deep and shallow water) and molluscs (primarily in shallow water) became increasingly important. Cod > 70 cm fed overwhelming on fish independent of season and water depth.

Sydney Bight [4Vn]: (summarized from Fig. 4 of Kohler and Fitzgerald 1969)

The seasonal diet of **cod** in the Sydney Bight area was investigated for two seasons: January-April and May-August. Cod <30 cm in January-April fed on crustaceans and annelids. Crustaceans were still the dominant prey in May-August but annelids, larval ascidians, ctenophores, and sagitta were also important. At 30-49 cm the diet is more diverse with fish, crustaceans, and other prey (larval ascidians, ctenophores, and sagitta) being important in both shallow and deep water. 50-69 cm cod were feeding on three prey groups in shallow and deep water in both January-April and May-August: fish, crustaceans, and

echinoderms. Cod >70 cm fed predominantly on fish especially in deep water in both January-April and May-August. In shallow water molluscs and echinoderms were the dominant prey in January-April. Shallow water cod were feeding on fish, molluscs, and echinoderms all of which were approximately of equal importance.

Western Bank [4W]: (summarized from Fig. 5 of Kohler and Fitzgerald 1969)

Cod stomachs were only examined from Western Bank in January-April and May-August. Cod <30 cm were feeding heavily on crustaceans from January to August; - fish and annelids were minor components of the diet. Fish were about as important as crustaceans in cod between 30-49 cm during the period January-August however fish tended to be more important in shallow water and crustaceans more important in deeper water. Fish and crustaceans were again important prey for cod of 50-69 cm. An important seasonal difference was the high abundance of molluscs (species not stated) in stomachs from cod taken in shallow water in May-August. Molluscs were not important in this size of cod from January-April. Cod >70 cm fed overwhelmingly on fish (primarily sand lance) from January-August in both shallow and deep water. It is difficult to determine within each broad prey category the specific types of prey that were being taken by cod. Figure 7 (in Kohler and Fitzgerald 1969) indicates in Division 4W (Emerald Bank) that the crustaceans that were important were: euphausids, pandalids, amphipods with decapods being of much lesser importance.

In the Western and Emerald Bank regions (4W) 80% of the stomach contents of **cod** and of **haddock** could be classified under the headings of fish, crustaceans, annelids, molluscs, and echinoderms. The most important items in small cod and haddock were crustaceans (euphausids, amphipods, pandalids). Fish became increasingly important as food for larger predators but was taken more often by cod than by haddock. Cod in general fed more on pelagic crustaceans and fish than did haddock. Haddock fed more on bottom animals such as annelid worms and echinoderms than did cod. For example many more euphausids were taken by cod than by haddock. Crustaceans taken by both species included crabs and pandalids. Polychaete worms, brittle stars, sea urchins, and sand dollars were the main items that were common in the diet of haddock but of little importance in the diet of cod. This indicates that haddock tended to feed more on bottom fauna than did cod. The benthic forms of annelid worms, molluscs, and echinoderms made up >40% of the total diet of haddock and <10% of the diet of cod.

It appears that when there is an abundance of pelagic prey (particularly fish) as well as benthic prey in an area where both cod and haddock are abundant there is less likelihood of competition between these predators for the same food. Cod would tend to feed on the pelagic, more active prey, whereas haddock would concentrate mainly on the slower moving or sedentary organisms.

Konstantinov, K.G., T.N. Turuk, and N.A. Plekhanova. 1985. Food links of some fishes and invertebrates on Flemish Cap. NAFO Sci. Coun. Studies, 8:39-48.

Reference (#)	Konstantinov et al. 1985 (32)
Purpose of study	determines relationships between food resources and dominant predators
Predators	*Gadus morhua* Atlantic cod; *Sebastes mentella* redfish;
	Hippoglossoides platessoides American plaice
Predator size	juvenile cod: <21, 21-30, 31-40 cm; adult cod: 36-50, 51-71, >71 cm;
	no size classes for redfish or plaice
Dominant prey	cod <40 cm: amphipods and copepods; adult cod: amphipods, shrimp, fish;
	redfish: copepods, amphipods, euphausids; plaice: echinoderms
Prey size	
Location	Flemish Cap, Newfoundland
Time of year	Jan-Sep (+Dec) for cod; year-round for redfish; Mar-Sep (+Dec) for plaice
How prey quantified	stomach fullness, percent occurrence
Number of stomachs	cod, n=10,882; redfish, n=10,391; plaice, n=2,083
Depth	five 50 m depth classes from 100 m to 350 m
Bottom type	
Prey energetics	

Cod: The composition of food types in the stomachs of cod from the Flemish Cap is diverse and differs from the feeding spectrum of cod in other parts of the Newfoundland Shelf. The diet of young cod consisted of amphipods (*Themisto* sp. up to 100% occurrence), gammarids, and copepods (max. 50% occurrence). Young cod of all sizes fed on these organisms from February to August at depths of 100-350 m. *Themisto* was fed on most frequently in June-August, gammarids in winter-spring and copepods in February-March. *Calinus finmarchicus* were only common in the stomachs of cod <30 cm. The occurrence of euphausids, polychaetes, bottom crustaceans, and small fish in stomachs of young cod was low. Feeding intensity of juvenile cod was highest in spring.

Adult cod fed on amphipods (*Themisto* sp. 22-51% occurrence), shrimp (primarily *Pandalus borealis*, 17-39% occurrence), fish (young redfish, cod, myctophids, 0-31% occurrence) and some planktonic organisms (copepods, sagittae, ctenophores, maximum of 12% occurrence). *Themisto* sp., the most common food item, was found in stomachs mainly during the summer over all depth ranges. Unlike pelagic amphipods (*Themisto* sp.) bottom amphipods (gammarids) were seldom found in the stomachs of cod. Shrimp were the second most important prey. Their occurrence increased with depth but decreased in cod >72 cm. Feeding was more intense in summer and autumn than in spring.

Year to year variability in the diet was high. The most frequently occurring food components were amphipods in 1980 and 1982, shrimp in 1979 and 1980, and young redfish in 1979 and 1981. In years when the frequency of occurrence of redfish was low cod fed intensively on amphipods.

Redfish: The main food items were planktonic invertebrates, copepods (39-59% occurrence), amphipods (22-28%), and euphausids (9-14%) which occurred throughout the year but were most important in summer. Shrimp were less important but occurred frequently in stomachs from redfish collected in April-May and December. Feeding was most intense in summer.

Plaice: Echinoderms were found in c. 100% of the plaice stomachs examined and consisted mostly of sea urchins, sand dollars, and Ophiuroidae (brittle stars). The diet was not quantified at a lower level. Molluscs (1-15% occurrence) and polychaetes (1-13%) were observed occasionally, but planktonic organisms and fish were rare. Highest feeding intensity occurred in summer.

Lambert, D.G. 1960. The food of the redfish *Sebastes marinus* (L.) in the Newfoundland area. J. Fish. Res. Board Can. 17:235-243.

Reference (#)	Lambert 1960 (33)
Purpose of study	describes diet
Predator	*Sebastes marinus* redfish
Predator size	c. 26-40 cm in Trinity Bay
Dominant prey	amphipods, fish, euphausids
Prey size	
Location	Gulf of St. Lawrence, southwest and northern Grand Bank, Hamilton Inlet
	Bank, Hermitage Bay and south coast of Newfoundland, Trinity Bay
Time of year	
How prey quantified	precent occurrence, percent volume
Number of stomachs	n=2,669 of which 627 (23%) contained food
Depth	110-713 m
Bottom type	
Prey energetics	

Redfish fed primarily on pelagic prey. Most of the organisms in stomachs of redfish were pelagic and dissociated from the bottom. None could be regarded as completely benthic. Larger redfish tend to feed more on fish. The importance of crustacea in their diet diminished with increasing predator size. The diet differed among the five areas sampled. Fish (primarily lancet fish, *Paralepis coregonoides borealis* and lanternfishes *Myctophum punctatum* and *Benthosema glaciale*) were the only major prey of redfish from the southwest and northern edges of the Grand Bank and from Hamilton Bank where they accounted for 26-49% (volume) of the diet. Euphausids (primarily *Meganyctiphanes norvegica*, *Thysanoessa inermis*, and *T. raschii*) occurred in stomachs of redfish (16-92% occurrence) from all sampling locations and accounted for 2-90% (volume) of the diet. Amphipods were primarily pelagic species, (primarily *Themisto libellula* and *T. gaudichaudi*) and accounted for >90% of all the amphipods identified. Gammarid amphipods occurred in

<3% of the stomachs examined. Amphipods accounted for 60 and 47% of the diet in Trinity Bay and the northern Grand Bank-Hamilton Bank area respectively. Shrimp were all identified as a single species *Pandalus borealis*. Shrimp formed 46 and 17% of the redfish diets in the Gulf of St. Lawrence and Trinity Bay respectively. Shrimp were not present in redfish from the Grand Bank or Hamilton Bank.

Langton, R.W. 1982. Diet overlap between Atlantic cod, *Gadus morhua*, silver hake, *Merluccius bilinearis* and fifteen other northwest Atlantic finfish. Fish. Bull. U.S. 80:745-759.

Reference (#)	Langton 1982 (34)
Purpose of study	determines diet overlap between demersal fishes
Predators	*Gadus morhua* Atlantic cod; *Raja erinacea* little skate; *Sebastes*
	marinus redfish; *Myoxocephalus octodecemspinosus* longhorn sculpin;
	Peprilus triacanthus butterfish; *Urophycis tenuis* white hake;
	Hippoglossoides platessoides American plaice;
	Urophycis chuss red hake; *Urophycis regia* spotted hake;
	Stenotomus chrysops scup; *Limanda ferruginea* yellowtail flounder;
	Pollachius virens pollock; *Melanogrammus aeglefinus* haddock;
	Glyptocephalus cynoglossus witch flounder; Paralichthys oblongus
	fourspot flounder; Macrozoarces americanus ocean pout
Predator size	maximum size class is 125 mm
Dominant prey	see below
Prey size	
Location	continental shelf, Cape Hatteras to Nova Scotia
Time of year	
How prey quantified	percent weight expressed as a percentage similarity index between 2 species
Number of stomachs	
Depth	
Bottom type	
Prey energetics	

This study does not report extensive lists of prey but compares pairs of predators to determine at what size overlap (as percent similarity) in the diets is highest. The dominant prey at the size of maximum diet overlap are reported.

Atlantic cod - Little skate: Show relatively little similarity in diet. Diet overlap was highest (48%) at sizes of 11-15 cm where these predators shared a preference for amphipods such as *Unciola*. Medium values of overlap exist between these two predators between 15-45 cm which is generally attributed to the presence of a variety of crustaceans in the diets. For larger cod the overlap values with little skate are extremely low, primarily because of a shift in the diet of cod from crustaceans to fish.

Atlantic cod - Redfish: Show low levels of diet overlap. Highest overlap (49%) occurred between redfish 16-20 cm and 6-10 cm cod which was primarily the result of predation on pandalid shrimp, *Dichelopandalus leptocerus*.

Atlantic cod - Longhorn sculpin: Show low to medium diet overlap values throughout much of the size range of both species. The peak value of diet overlap was 38% (sizes not indicated) and was the result of the pandalid shrimp, *Dichelopandalus leptocerus* being common between predators.

Atlantic cod - Scup: Diet overlap was low. The low values represent a broad array of prey, primarily crustaceans that constitutes the forage base of these two predators.

Atlantic cod - White hake: The diet of hake shifts from crustaceans (euphausiids, shrimp, mysids) at sizes <50 cm to primarily fish for larger hake. This parallels change in the cod's diet. Low levels of diet overlap occurred between small white hake and large cod and vice versa. The greatest overlap (40-50%) occurred between 21-25 cm cod and larger sizes of hake (36-85 cm). The author states that this high overlap maybe artificial due to the high proportion of unidentified fish in the diets of both predators.

Atlantic cod - Red hake: Have low to intermediate overlap in the diet. Lowest values occur between small hake and large cod. Small hake feed on crustaceans, large cod have shifted from crustaceans

to fish. Diet overlap remains at intermediate values for large cod and hake even though both predators at large sizes feed on fish.

Atlantic cod - Spotted hake: Have diets which overlap at low to intermediate levels. The cluster of intermediate values occurring between 11-25 cm cod and 11-30 cm spotted hake is the result of predation on crustaceans such as *Meganyctiphanes, Dichelopandalus, Crangon*, and *Unicola*. The intermediate overlap values between 31-35 cm spotted hake and cod are due to fish predation.

Atlantic cod - Pollock: Show low to intermediate levels of diet overlap over all sizes of both predators. For smaller pollock, the euphausiid *Meganyctiphanes norvegica* and the shrimp *Pasiphera multidentata* were major components of the diet while cod relied on a much broader variety of prey. For larger individuals of both species unidentified species of fish were important.

Atlantic cod - Fourspot flounder: Show low to intermediate levels of diet overlap due primarily to predation on crustaceans. The single most important crustacean prey was the pandalid shrimp *Dichelopandalus leptocerus* which makes up from 17-30% of the diet of 21-30 cm flounder and 3-40% of the diet of 6-45 cm cod.

Silver hake - Little skate: Highest dietary overlap (44%) occurred between small silver hake (<15 cm) and skate of 11-45 cm. This degree of overlap can be attributed to the crustaceans in each of the predators' diets with the sand shrimp *Crangon septemspinosa* being of particular importance.

Silver hake - Redfish: High levels of dietary overlap occur between 16-20 cm silver hake and 11-45 cm redfish. Highest overlap (75%) is for 31-35 cm redfish and these smaller silver hake. Most of the overlap is due to predation on *Meganyctiphanes norvegica* which accounted for 60% and 63% of the diet of these 16-20 cm silver hake and 31-35 cm redfish respectively. For silver hake >35 cm there was little if any diet overlap. Large silver hake prey heavily on fish while redfish are predominantly crustacean predators.

Silver hake - Longhorn sculpin: Intermediate diet overlap was observed between (6-15 cm) and most of the size classes of longhorn sculpins. This overlap was due to reliance on crustaceans that include: *Crangon septemspinosa, Dichelopandalus leptocerus,* and *Neomysis americana.*

Silver hake - Scup: Both species prey on crustaceans but have few prey species in common.

Silver hake - Butterfish: The diets overlap at very low levels (<17%), butterfish being more planktonic in its predatory habits than silver hake.

Silver hake - Atlantic cod: All of the high values of dietary overlap (>60%) are the result of unidentified fish remains forcing up the computed overlap values. Smaller fish share crustacean prey (euphausiids) while the larger fish both prey on a number of different species of fish.

Silver hake - White hake: The diet of small silver hake has little in common with larger white hake and vice versa due to a size dependent change in diet for both predators. When small they both rely on crustaceans such as euphausiids and then gradually shift to fish with increasing size.

Silver hake - Red hake: The diet overlap ranges from zero to 56%. The general pattern is increasing overlap with increasing predator size up to 26-30 cm. The peak overlap occurs between 26-30 cm silver hake and 41-45 cm red hake and can be explained by predation on fish, *Dichelopandalus leptocerus,* and other invertebrates.

Silver hake - Spotted hake: These species have intermediate to high overlap in their diets. Peak values of 60-70% occur between 11-20 cm silver hake and 16-25 cm spotted hake as a result of reliance by both predators on *Dichelopandalus leptocerus, Meganyctiphanes norvegica,* and *Crangon septemspinosa.*

Silver hake - Pollock: High diet overlap values exist between silver hake (16-20 cm) and pollock (16-65 cm) due to predation on *Meganyctiphanes norvegica* and unidentified fish.

Silver hake - Haddock: These species show little similarity in their diets and consequently have low dietary overlap indices. Highest values occur between smallest individuals which reflects dependence on crustacean prey.

Silver hake - American plaice: Low dietary overlap is characteristic between these species. The diets, especially of larger individuals is quite specific, fish for silver hake and echinoderms for plaice.

Silver hake - Ocean pout: The diets are "mutually exclusive". The only prey that they share in common are amphipods.

Silver hake - Witch flounder: These species share few prey in common and have low levels of dietary overlap. The only exception is a high peak (66-67%) between 16-20 cm silver hake and 11-20 cm witch flounder. A single prey species, *Meganyctiphanes norvegica* is responsible for it alone accounts for >63% of each predators' diet.

Silver hake - Yellowtail flounder: These species show low levels of dietary overlap. Overlap is highest (39%) at smallest sizes (6-10 cm) where these predators took *Crangon septemspinosa* and *Neomysis americana.*

Silver hake - Fourspot flounder: These species have low to intermediate overlap in their diets. The highest value (54%) occurs between 6-10 cm silver hake and 16-20 cm flounder due to predation on crustaceans, primarily *Dichelopandalus leptocerus, Crangon septemspinosa,* and *Neomysis americana.*

Langton, R.W. 1983. Food habits of yellowtail flounder, *Limanda ferruginea* (Storer), from off the northeastern United States. Fish. Bull. U.S. 81:15-22

Reference (#)	Langton 1983 (35)
Purpose of study	describes stomach contents and evaluates factors influencing quantity
	and composition of the diet
Predator	*Limanda ferruginea* yellowtail flounder
Predator size	4-55 cm, 70% between 26-40 cm, mean = 29.4 cm
Dominant prey	small flounder: amphipods are main prey, large flounder: polychates
Prey size	
Location	from Cape Hatteras to southern Nova Scotia
Time of year	March to May; September to November
How prey quantified	percentage wet weight
Number of stomachs	n=1,018
Depth	max. depth is 220 m, most (68%) fish were taken at 38-73 m
Bottom type	
Prey energetics	

Polychaetes accounted for 43% of the stomach contents. The following families of polychaetes were the most important: Spionidae (13.27%), Lumbrinereidae (1.90%), Sabellidae (1.42%), and Nephtyidae (1.19%). *Spiophanes bombyx* was the most important polychaete making up 9.68% of the weight of the total stomach contents. Crustaceans (18.0%) were second to polychaetes in importance with amphipods (13.65%) being most important. *Unciola* sp. (4.41%), *Leptocheirus pinguis* (2.25%), and *Byblis serrata* (1.72%) were important amphipod prey. Other gammarids (1.92%), ampeliscids (1.56%) and corophiids (0.3%) made up most of the remaining amphipod prey. Only two other crustaceans were important: the shrimps *Crangon septemspinosa* (1.89%) and *Dichelopandalus leptocerus* (0.94%).

Variation in diet due to predator size: Amphipods were the most important prey of small yellowtail flounder although stomachs of every size class of fish contained amphipods. Polychaetes comprise a greater percentage of the stomach contents of the larger fish but also occur in stomachs from most every size class. This is summarized below from data in Table 1 of Langton (1983). The data are summarized as a percentage of the total weight of the stomach contents within each size class.

Size class (cm)	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55
Polychaetes	22.56	11.9	13.64	38.71	31.36	48.91	46.36	47.91	40.28	0.33
Amphipods	16.25	12.84	27.62	20.84	23.94	10.77	9.5	5.19	4.6	0

Variation in diet due to geographic area: Composition of the diet was similar in southern New England and Georges Bank with polychaetes and amphipods accounting for 50-70% of the total weight of the stomach contents in both areas. Polychaetes were the most important in both regions with *Spiophanes bombyx* being the single most important species identified. However, S. *bombyx* was three times more important as prey on Georges Bank compared to southern New England. The diversity of polychaete prey was very similar between regions with 27 families and 6 genera occurring in southern New England and 24 families and 6 genera occurring on Georges Bank. Six genera were common to both regions but only the genera *Spiophanes* contributed >1% of the total stomach contents weight.

Amphipods made up almost twice the percentage of the weight of stomach contents in southern New England than on Georges Bank (18.87% vs. 10.23%). The same species were important in both areas

however there was a greater reliance on *Unciola* sp. and *Leptocheirus pinguis* in southern New England than on Georges Bank. Crustaceans such as *C. septemspinosa* and *D. leptocerus* played a minor role in the diet as did all other arthropod groups except the amphipods. The only other category of stomach contents that differed substantially between areas was the quantity of sand in the stomachs. This is suggested to be due to heavy predation on *S. bombyx* on Georges bank, since this polychaete is reported to prefer a fine sand substrate.

Temporal variation in the diet: At the temporal scale of years polychaetes were always the most important prey in the stomachs of yellowtail flounder and accounted for between 36-44% of the annual diet. This was followed by amphipods which accounted for between 10 to 33% of the annual diet. Collections of stomachs were made at two times of the year (March to May and September to November).

There were no drastic shifts in diet between spring and autumn. Polychaetes were always more important in the spring (49%) than autumn (35%) and the same was true for amphipods (19% vs. 13%). A cautionary note added by Langton is that seasonal and annual patterns in diet may simply reflect the higher percentages of unidentified animal remains and sand in the stomachs collected in autumn. In all years stomachs collected on spring cruises contained a greater mean weight of prey than stomachs from autumn. Although the mean length of fish in the spring was only slightly larger (30.0 vs. 28.8 cm).

Diel variability in stomach contents indicated that weight of prey items in stomachs peaked in the afternoon to early evening period. This difference in feeding pattern was significant as were seasonal (spring, autumn) differences. Polychaetes were less important at night than during any of the other three time periods (dawn, day, and dusk). Conversely, crustaceans, and amphipods in particular were more important at night. The greatest percentage of empty stomachs (46%) were taken from fish collected at night compared to the day when only 19% were empty.

Variation in the diet due to sex of predator: Females were slightly larger than males (34.4$\pm$6.3 vs 31.8$\pm$5.3 cm) and contained a larger mean quantity of prey (0.57$\pm$1.37 vs 0.32$\pm$0.76 g). Females also had a lower percentage of empty stomachs than males (29% vs. 36%). There is no mention of the diet differing between sexes.

Variation in the diet due to temperature and depth: Temperature over the 12°C range in which flounders were caught had no apparent effect on diet composition. Certain prey were more prevalent in the stomachs at differing depths. The polychaete *S. bombyx* accounted for 26.6% of the diet in the 74-110 m depth zone and only 9.3% and 2.9% in the next lowest and highest depth zones respectively. *Spiophanes* did not occur in stomachs collected outside 38-146 m. *Crangon septemspinosa* also predominated in only one depth group, 39.6% of the diet at 147-183 m, although it did occur in stomachs at depths <147 m.

Langton (1983) concludes that predator size was of little importance in the diet composition of yellowtail flounder excepting that amphipods were somewhat more important in smaller flounder and polychaetes somewhat more important in larger fish. Data on feeding periodicity may be interpreted to suggest that yellowtail flounder are day time feeders with a peak food consumption in the afternoon to early evening hours, however it is quite likely that fish are feeding throughout the day. Yellowtail flounder feed more intensively in the spring prior to spawning than in the autumn.

Langton, R.W. and R.E. Bowman. 1980. Food of fifteen northwest Atlantic gadiform fishes. NOAA Technical Rep. NMFS SSRF-740, 23 pp.

Reference (#)	Langton and Bowman 1980 (36)
Purpose of study	describes diet
Predators	*Gadus morhua* Atlantic cod; *Melanogrammus aeglefinus* haddock;
	Merluccius bilinearis silver hake; *Pollachius virens* pollock;
	Urophycis chuss red hake; *Urophycis tenuis* white hake;
	Urophycis regius spotted hake; *Phycis chesteri* longfin hake;
	Merluccius albidus offshore hake; *Enchelyopus cimbrius* fourbeard
	rockling; *Brosme brosme* cusk; *Nezumia bairdi* marlin spike;
	Coelorhynchus carmininatus longnose grenadier; *Lepophidium cerinum*
	fawn cusk eel; *Macrozoarces americanus* ocean pout
Predator size (mean)	*G. morhua*, 54.7 cm; *M. aeglefinus*, 45.6 cm; *M. bilinearis*, 27.5 cm;
	P. virens, 46.8 cm; *U. chuss*, 30.3 cm; *U. tenuis*, 46.4; *U. regius*, 18.4 cm;
	P. chesteri, 23.6 cm; *M. albidus*, 32.2 cm; *E. cimbrius*, 24.2 cm
	C. carmininatus, 19.3 cm ; *L. cerinum*, 22.3 cm; *M. americanus* 46.0 cm
Dominant prey	summarized below
Prey size	
Location	mid Atlantic Bight; south New England; Georges Bank; Gulf of Maine;
	southern Scotian Shelf
Time of year	September to November; March to May
How prey quantified	percent wet weight
Number of stomachs	n=11-2,152 (depends on species); only five species with < 100 stomachs
	examined; (grenadier, marlin-spike, rockling, cusk, offshore hake)
Depth	
Bottom type	
Prey energetics	

The diets described here represent the overall diet of each predator. Some regional differences occur in the diets of some predators.

Atlantic cod: Cod preyed upon fish (64.0%), crustaceans (20.7%), mollusca (7.6%), polychaetes (1.3%), and echinoderms (1.2%). Important fish in the diet included herring (16.7%), Gadidae (3.7%), mackerel (3.1%), and redfish (2.6%). Decapods (16.6%) were the most important crustaceans. Crabs (*Cancer borealis*, and *C. irroratus*) represented 4.7% of the diet. Pandalid shrimp (2.9% mostly *Dichelopandalis leptocerus*[1.3%]) and toad crabs (Majidae 2.1%) were the next most important crustaceans. The most important molluscs were scallops, *Placopecten magellanicus* (2.9%) and *Pectin* (1.2%). Scallops were only important on Georges Bank and may represent the remains of scallops discarded by fishermen.

Pollock: Pollock preyed upon fish (47.0%) and crustaceans (50.8%). Annelids, molluscs, and echinoderms contributed only 1% of the total diet. The most important fish were clupeids (19.2%) with herring accounting for 14.3% of the diet. Other fish included: gadids (1.4%), redfish (1.5%), eels (5.7%), and lanternfish (2.0%). Euphausiids made up the majority of the crustacea (35.5%) with *M. norvegica* being the single most important species (26.5%). Pandalid shrimp (2.5%) of the genera *Pandalus* (1.8%) and *Dichelopandalus* (0.5%) were of secondary importance.

Silver hake: Fish (70.9%) accounted for the majority of the diet. The most important species were: mackerel (18.9%), clupeids (14.6%, primarily herring [10.4%] and alewife [4.2%]), Gadidae (7.1%, primarily silver hake [3.4%]), butterfish (1.5%), and lanternfish (1.1%). A large portion of the fish diet (30.1%) was not identified due to a high degree of digestion. Crustaceans formed the remaining bulk of the diet (25.0%) with euphausiids (12.6%, primarily *M. norvegica* [7.4%]) being the most important crustacean prey taxon. The only molluscs of any importance were cephalopods (2.2%) such as the squid *Loligo* (1.5%).

White hake: Fish (78.2%) and crustacea (17.3%) were the important prey taxa of white hake. Important fish taxa included: clupeids (12.5%, primarily herring [4.8%]), gadids (10.7%, silver hake [3.0%], red hake [0.8%], cod [0.5%]), mackerel (7.3%), argentine (8.9%), and wrymouth (0.8%). Of the crustacea (17.3%) four species of pandalid shrimp (9.1%) were the most important: *Pandalus borealis*

(2.2%), *Dichelopandalus leptocerus* (0.8%), *P. montagui* (0.5%), and *P. propinquis* (<0.1%). Euphausiids (4.3%), primarily *Meganyctiphanes* (2.1%) and *Thysanoessa inermis* (0.3%) were also of some importance. The only other category that contributed to the diet to any degree was cephalopods (2.1%).

Cusk: Fish (71.5%) none of which could be identified to a lower taxa were the most important prey. Crustaceans (20.4%) in the diet consisted of the toad crab (1.7%) and several species of pandalid shrimp (4.1%). The brittle star *Ophiopholus aculeata* (6.7%) was the only echinoderm preyed upon.

Red hake: Crustaceans (54.1%), fish (25.3%), molluscs (6.3%), and polychaetes (2.9%) were the important prey taxon of red hake. Important crustaceans included the Pandalidae (12.1%, primarily *Dichelopandalus* [7.1%]), the galatheid crab (*Munida* 10.2%), Cancridae (5.3%, primarily *C. irroratus* [2.1%]) and a variety of amphipods (7.4%). Several identified species each contributing <1% of the diet included: clupeids, Atlantic mackerel, gadids, Gulf Stream flounder, and winter flounder. Most molluscs were not identified below the class level.

Spotted hake: Crustaceans (47.5%), fish (34.2%), and molluscs (11.5%) were the most important taxa. Crustaceans included the galatheid crabs *Munida iris* (8.8%), *M. valida* (4.5%) and remains of *Munida* (3.1%). Other crustaceans included amphipods (7.3%, especially Hyperiidae [4.4%]), *Cancer irroratus* (4.2%), *Crangon* (3.9%), pandalid shrimp *Dichelopandalus* (3.7%), and isopods (2.0%). Gadidae (4.3%), cusk-eel (4.4%, Ophidiidae), lanternfish (3.0%), red hake (2.1%), mackerel (3.3%), Gulf Stream flounder (1.8%), and yellowtail flounder (0.5%) were the important fish taxon identified. Two genera of squid (*Loligo* [4.2%] and *Rossia* [0.4%]) in addition to unidentified cephalopods accounted for the mollusc portion of the diet.

Haddock: In this study the haddock was a benthic feeder, the important prey groups being echinoderms (29.9%, primarily Ophiuroidea [21.6%]), polychaetes (17.6%), crustaceans (16.2%), and fish (14.6%). Two species of brittle stars were the most important echinoderms, *Ophiura* (6.2%) and *Ophiopholis* (5.5%). Polychaetes in the stomachs of haddock were *Aphrodita, Cistenidae, Chone infundibulinformis, Sabella,* and *Nephtys* (all <0.5%). The single most important polychaete was *Ammotrypane aulogaster* (3.8%). Amphipods (6.4%, primarily gammaridean amphipods [4.2%]) were the largest component of the crustacean prey. Other crustaceans included euphausiids (2.6%, *M. norvegica* [1.8%]) and pandalid shrimp (1.4%). The entire fish component was due to herring eggs (benthic eggs) . Sand and rocks made up 8.7% of the stomach contents by weight.

Longfin hake: Crustacea made up 97.6% of the diet which was largely due to *Meganyctiphanes norvegica* (55.9%). *Pandalus* shrimp accounted for 8.6% of the diet.

Fourbeard rockling: Crustacea (57.4%) in the diet consisted mostly of *Crangon septemspinosa* (40.7%) and *Dichelopandalus leptocerus* (9.6%). Euphausiids and amphipods contributed little to the diet (c. 1%). Polychaetes accounted for 12.5% of the diet with *Ammotrypane* (3.3%) being the only identifiable genus.

Marlin-spike: Crustaceans (47.3%) and polychaetes (27.5%) were the two most important prey groups. Polychaetes could not be identified below class level. Crustaceans included: hippolytid shrimp (*Eualus pusiolus* 26.0%), *Neomysis americana* (4.0%), isopods (0.6%), and euphausiids (<0.1%).

Longnose grenadier: The only identifiable prey included polychaetes and decapod shrimp. As with the marlin-spike only a small number of stomachs were examined.

Fawn cusk-eel: 109 stomachs were examined and were found to contain crustaceans (28.8%) of which the isopod *Cirolina* (12.6%) was the most important. Polychaetes (9.9%) and parasitic nematodes (29.4%) were also important prey.

Ocean pout: Ocean pout preyed upon echinoderms (70.7%, primarily *Echinarachnius parma* [56.3%], Ophiuroids [5.3%]), crustaceans (11.1%, primarily Cancridae [2.9%]), and polychaetes (3.3%, primarily Aphrodita [3.0%]).

Langton, R.W. and R.E. Bowman. 1981. Food of eight northwest Atlantic pleuronectiform fishes. NOAA Technical Report NMFS SSRF-749. 16 pp.

Reference (#)	Langton and Bowman 1981 (37)
Purpose of study	describes prey of pleuronectiform fishes
Predators	*Citharichthys arctifrons* Gulf stream flounder; *Paralichthys dentatus*
	summer flounder; *P. oblongus* fourspot flounder; *Scophthalmus*
	aquosus windowpane flounder; *Glyptocephalus cynoglossus* witch
	flounder; *Hippoglossoides platessoides* American plaice; *Limanda*
	ferruginea yellowtail flounder; *Pseudopleuronectes americanus*
	winter flounder
Predator size	summarized below
Dominant prey	summarized below
Prey size	
Location	mid-Atlantic, southern New England, Georges Bank, Gulf of Maine,
	western Nova Scotia
Time of year	spring and autumn
How prey quantified	percent weight
Number of stomachs	
Depth	
Bottom type	
Prey energetics	

Gulf Stream flounder (mean length = 10 cm). Annelids (51.2%) and arthropods (42.2%) were the most important prey. Annelids included: *Nephtys incisa* (11%), *Aphrodita hastata* (3.3%), *Ninoe nigripes* (2.3%), *Nicomache lumbricalis* (1.4%), and *Onuphis* sp. (1.4%). The major prey groups within the arthropods were amphipods (24.2%) where the most important species were: *Leptocheirus pinguis* (4.9%), *Erichthonius rubricornis* (4.4%), *Casco bigelowi* (3.0%), *Unciola irrorata* (2.4%), *Ampelisca agassizi* (1.5%), and *Ampelisca macrocephala* (1.8%). The Euphausiacea that were identified included: *Meganyctiphanes norvegica* (1.9%) and *Thysanoessa inermis* (0.8%). Other taxa within Arthropoda included: *Crangon septemspinosa* (1.4%), the genus *Diastylis* (2.1% Cumacea), and the pandalid shrimp *Dichelopandalus leptocerus* (2.0%).

Summer flounder (mean length = 38.1 cm). Fish (47.8%) and squid (51.0%) were the dominant prey in the 8 stomachs examined that contained food. *Merluccius bilinearis* (26.1%) and *Stenotomus chryops* (21.2%) were the two important fish identified. *Loligo* (43.6%) was the important genus of squid identified.

Fourspot flounder (mean length = 26 cm). Three major taxa were important: arthropods (40.7%), fish (28.5%), and molluscs (19.4%). Important arthropods included: pandalid shrimp (15.8%, *Dichelopandalus leptocerus* [10.6%, *Pandalus* sp. [1.0%]), *Cancer irroratus* (5.0%), *C. borealis* (0.8%), *Crangon septemspinosa* (4.2%), and *Meganyctiphanes norvegica* (3.7%). Important fish included: silver hake (*M. bilinearis* (21.0%) and unidentified gadids (1.6%). Important Mollusca (19.4%) included the class Cephalopoda (19.3%) which included *Loligo* (2.4%), *Illex illecebrosus* (1.8%), *Rossia* (1.4%), and *Heteroteuthis tenera* (<0.1%).

Windowpane (mean length = 26 cm). 90% of the diet was arthropods with three groups accounting for most of the diet, Mysidacea (41.8%, *Neomysis americana* [41.0%]), Pandalidae (22.4%, *Dichelopandalus leptocerus* [20.4%]), and Crangonidae (*Crangon septemspinosa* 18.4%). The fish component of the diet (6.4%) consisted mostly of sand lance (3.4%). The only other animals of any importance included *Loligo* (1.1%) and the sand dollar (*Echinarachnius parma*, 1.2%).

Witch founder (mean length = 44 cm). Annelids accounted for 72.8% of the diet most of which (38.5%) could not be identified below the level of phylum. The other 32.6% of the annelids were divided among 51 genera of polychaetes. The most important species were: *Scalibregma inflatum* (3.1%), *Lumprineris fragilis* (3.1%), *Sternapsis* (2.8%), *Notomastus latericius* (1.5%), and *Onuphis eremita* (1.4%). The remaining quarter of the diet was divided among echinoderms (7.8%), arthropods (6.8%), and molluscs (3.2%). Among the echinoderms, holothuroideans of the order Dentrochirotida (5.7%) were the most important and included three dominant genera: *Thyone* (3.6%), *Steroderma* (0.6%), and *Pentamera* (0.4%). Genera identified within the arthropods included: *Gammarus annulatus* (0.3%), *Tmetonyx* (0.2%), *Ampelisca* (0.1%), *Unciola* (0.1%),

Casco bigelowi ((0.1%), *Maera* (0.1%), and *Leptocheirus pinguis* (0.1%). Two squid of the genus *Loligo* accounted for 2.2% of the Mollusca (3.2%) diet.

American plaice (mean length = 28 cm). Plaice preyed primarily upon echinoderms (65.4%). Important species included: the sand dollar, *Echinarachnius parma* (38.1%), sea urchin, *S. droebachiensis* (1.3%) and the genus *Ophiura* (12.3%, *O. sarsi* [5.6%], *O. robusta* [<0.1%]). Pagurids (6.2%, *Pagurus acdianus* [6.0%], *P. pubescens* [0.1%]) and pandalid shrimp (4.8%, *Dichelopandalus leptocerus* [1.4%], *Pandalus borealis* [0.5%], *P. montagui* [0.2%]) were the two major families of crustaceans that contributed to the arthropods which made up 16.0% of the diet. The presence of euphausids (2.0%) in the diet was due almost entirely to *Meganyctiphanes norvegica* (1.9%). Other crustacean genera that were identified included *Crangon* (4.5%), *Spirontocaris* (0.1%), *Pasiphaea* (0.2%), and *Balanus* (0.1%). Important molluscs (7.7%) included *Chamys islandica* (1.3%) and *Yoldia* (3.6%, *Y. sapotilla*, and *Y. thraciaeformis*). Annelids (4.4%) included *Melinna cristata* (0.3%), *Nephtys* (0.3%), and *Lumbrineris* (0.2%).

Yellowtail flounder (mean length = 30 cm). Annelids (42.0%) and arthropods (37.2%) were the most important prey. Over half of the annelids could not be identified below the level of phylum. Those genera that could be identified included: *Eunice* (4.1%), *Polydora* (1.6%), *Nereis* (1.5%), *Lumbrineris* (1.0%), and *Nephtys* (1.0%) all of which contributed >1.0%. Amphipods (31.4%) were the most important arthropod group. Three suborders were identified: Gammaridae (7.6%), Caprellidae (0.5%), and Hyperidea (0.1%). The following families were identified within the Gammaridae: Corophiidae (5.0%), Ampeliscidae (2.2%), Haustoridae (0.1), Lysianassidae (<0.1%), and Oedicerotidae (<0.1%). Other important prey included *Cancer* (2.1%, *C. irroratus* [0.3%] and *C. borealis* [<0.1%]), and *Echinarachnius parma* (1.6%).

Winter flounder (mean length = 35 cm). Annelids accounted for 26.6% of the diet. The remains were almost exclusively polychaete worms with the following species being the most important: *Thelepus cincinnatus* (6.8%), *Nicomache lumbricalis* (0.8%), Ampharete (0.8%), *Ophioglycera gigantea* (0.6%), *Pherusa* (0.5%), *Nereis* (0.4%), *Nephtys* (0.3%), *Ninoe* (0.2%), *Lumbrineris* (0.2%), *Chone infundibuliformis* (0.2%), *Nicolea* (0.1%), and *Scalibregma inflatum* (0.1%). Two classes of coelenterates were also important in the stomach contents of winter flounder, Anthozoa (22.2%) and Hydrozoa (4.1%). Most of the molluscs (15.7%) were recorded as unidentified bivalves (14.7%). Arthropods contributed 5.4% of the diet with Amphipoda being the most important (3.1%). All of the species listed below contributed <1% of the diet: *Aeginina longicornis, Gammarus annulatus, Leptocheirus pinguis*, and *Pontogeneia inermis*.

Langton and Bowman (1981) compare the diets of witch, American plaice, yellowtail, and winter flounder from the southern portion of the Scotian Shelf with the Gulf of Maine, Georges Bank, southern New England and Middle Atlantic Bite. There are some similarities among the different sampling locations (for example witch flounder at the level of phylum where Annelida usually accounted for the dominant proportion of the diet) but in many cases the actual identified species composition differs among locations. Read Langton and Bowman (1981) pages 8-11 to determine the extent of variation in the diet due to sampling location.

The over all diets of these eight pleuronectids are summarized in the table immediately below. This information comes from Table 1 of Langton and Bowman (1981).

	Gulf stream flounder	Summer flounder	Fourspot flounder	Windowpane flounder	Witch flounder	American plaice	Yellowtail plaice	Winter flounder
CINDARIA	**0.1**		**T**	**T**	**1.7**	**0.2**	**2.9**	**26.3**
Hydrozoa			T	T	T	0.1	T	4.1
Anthozoa	T				1.7	0.1	2.9	22.2
other Cindaria	0.1				T			
ANNELIDA	**51.2**		**0.3**	**T**	**72.8**	**4.4**	**42.1**	**26.6**
Nephthyidae	24.9				3.1	0.3	1.2	0.3
Maldanidae	3.6				0.8	T	0.4	0.9
Lumbreneridae	3.6				7.6	0.2	1.2	0.4
Ampharetidae	0.8				1.6	0.4	0.2	0.8
Terebellidae	1.5				0.6	T	0.1	8.5
Sabellidae	2.7				1.1	0.6	0.8	1.4
other Annelida	14.1		0.3	T	58.2	2.9	38.3	14.3
ARTHROPODA	**42.2**	**1.2**	**40.7**	**86.8**	**6.8**	**16.1**	**37.2**	**5.4**
Cumacea	2.1			T	0.1	T	0.4	
Amphipoda	24.2		0.8	2.1	2.9	0.4	31.4	3.1
Mysidacea	0.8		0.2	41.8	T	0.1	0.2	
Euphausiacea	4.4		3.7	0.2	0.9	2.1	T	
Pandalidae	2.1	0.1	15.8	22.4	0.2	4.8	0.8	
Crangonidae	2.4		4.9	18.4	0.1	0.4	0.6	0.1
Axiidae	T				T		T	T
Paguridae	T			0.1	T	6.2	0.2	
Majidae	T		T				T	0.1
Cancridae	1.6	1.1	8.8	0.1	0.3		2.1	0.7
other Decapoda	0.4	T	3.2	1.1	0.7	0.5	0.5	0.1
other Arthropoda	4.3		3.3	0.7	1.6	1.6	1.1	1.1
MOLLUSCA	**0.9**	**51.1**	**19.4**	**1.2**	**3.2**	**7.7**	**1.9**	**15.7**
Gastropoda				T	T	0.3	0.5	0.3
Bivalvia	0.6		T	0.1	0.4	7.1	1.2	15.3
Cephalopodae	0.2	51.1	19.3	1.1	2.7	0.1		T
other Mollusca	0.1		0.1		0.1	0.2	0.2	0.1
ECHINODERMATA	**1.4**			**1.2**	**7.8**	**65.4**	**2.8**	**1.1**
Holothuroidea					7.6		0.9	0.6
Echinoidea				1.2		42.6	1.9	0.1
Ophuroidea	1.4				0.2	22.8	T	0.1
other Echinodermata	T					T	T	0.2
Pisces	**2.7**	**47.8**	**28.5**	**6.4**	**0.6**	**1.1**	**0.8**	**0.1**
Gadidae		26.1	22.6			T		
Cottidae	2.6		T	0.2		0.1	0.5	
Bothidae			1.6	0.3				
other Pisces	0.1	21.7	4.3	5.9	0.6	0.9	0.3	0.1
other groups	1.1		0.5	1.2	1.4	0.7	3.9	3.8
animal remains	0.3		10.4	3.1	5.4	2.8	5.9	16.1
sand or rock	0.1		0.2	0.2	0.3	1.8	2.6	5.1
number of stomachs	**387**	**44**	**1096**	**716**	**1165**	**1186**	**2645**	**768**
percentage of empty stomachs	**38.5**	**81.8**	**41.6**	**46.2**	**9.2**	**40.5**	**21.6**	**26.8**
mean weight per stomach	**0.04**	**4.8**	**0.5**	**1.1**	**0.8**	**1.1**	**0.5**	**1.1**
mean predator length	**10**	**38.1**	**26**	**26**	**44**	**28**	**30**	**35**
number of sampling locations	**69**	**14**	**98**	**90**	**201**	**187**	**200**	**95**

Langton, R.W. and L. Watling. 1990. The fish-benthos connection: a defination of prey groups in the Gulf of Maine. pp 424-438 *In* Trophic relationships in the marine environment (M. Barnes and R.N. Gibson, eds). Proc. 24th Europ. Mar. Biol. Symp. Published by Aberdeen University Press.

Reference (#)	Langton and Watling 1990 (38)
Purpose of study	establishs prey groupings for dominant predators and trophic links
Predators	*Myoxocephalus octodecempinosus* longhorn sculpin; *Raja erinacea* little skate;
	Pseudopleuronectes americanus winter flounder; *Limanda ferruginea*
	yellowtail flounder; *Hippoglossoides platessoides* American plaice;
	Macrozoarces americanus ocean pout
Predator size (mean)	*M. octodecempinosus* (18 cm); *R. erinacea* (37 cm); *P. americanus* (18 cm);
	L. ferruginea (23 cm); *H. platessoides* (18 cm); *M. americanus* (34 cm)
Dominant prey	*M. octodecempinosus:* fish, epibenthic crustaceans; *R. erinacea* : fish,
	epibenthic crustaceans, polychaetes; *P. americanus* : polychaetes, infaunal
	crustaceans; *L. ferruginea* : polychaetes, infaunal crustaceans;
	H. platessoides : polychaetes, fish; *M. americanus* : bivalves
Prey size	
Location	Sheepscot Bay, coast of Maine, USA
Time of year	25 days from June 1987 to November 1988
How prey quantified	percent weight
Number of stomachs	*M. octodecempinosus* (n=468); *R. erinacea* (n=149); *P. americanus* (n=306);
	L. ferruginea (n=52); *H. platessoides* (n=173); *M. americanus* (n=61)
Depth	judged to be < 100 m from contours on map
Bottom type	
Prey energetics	see Brey et al . (1988), Steimle and Terranov (1988)

Myoxocephalus octodecemspinosus primarily took epibenthic and infaunal crustaceans with *Mysis stenlepis* being the single most important prey (13.56%) by weight although infaunal aorid amphipods (*Unciola inermis*) were the most frequent dietary component (29.7% occurrence). While fish (primarily herring *Clupea harangus* and wrymouth *Cryptacanthodes maculatus*) accounted for a high proportion of the diet when quantified as percent weight they occurred in only a small proportion of the stomachs (3.21% and 0.43% respectively). *M. octodecemspinosus* is strongly dependent on most of the same functional groups of prey in both inshore and offshore regions of the Gulf of Maine. The functional prey groups were remarkably constant over time (1978-1979 vs. 1987-1988) with epibenthic crustaceans, fish, and infaunal crustaceans being the primary prey categories.

Atlantic herring contributed most (25% by weight) to the diet of ***Raja erinacea***. Crustacean prey included: epifaunal pandalid shrimp, brachyurans (*Cancer* sp.), sand shrimp (*Crangon septemspinosa*), lobster (*Homarus americanus*) and the infaunal mud shrimp (*Axius serratus*). Infaunal amphipods weighed very little but occurred in >30% of the stomachs. *Raja erinacea* maintained the same functional prey groups in both inshore and offshore locations and over time (1978-1979 vs. 1987-1988) with the exception that fish (herring) were more important in the diet from 1987-1988.

Pseudopleuronectes americanus took polychaetes (33% by weight) and infaunal crustaceans which together accounted for >70% by weight of the stomach contents. Polychaetes occurred in 35.29% of the stomachs however many polychaetes could not be identified to species. Members of the Ampharetidae (*Ampharete arctica, Melinna cristata*) and Lumbrinereidae (*Ninoe nigripes, Lumbrineris fragilis*) accounted for 11.23% by weight of the diet. Cindarians were also important (14.49% weight) but occurred in few stomachs. The tube-dwelling anemone, *Cerianthus* sp. (9.62% by weight) was the one genus identified. *Pseudopleuronectes americanus* has a slightly more diverse diet inshore than offshore but several studies have shown that this species is cosmopolitan in its diet preferences.

Polychaetes (41.55%) and infaunal crustaceans (30.48%) together accounted for >70% (by weight) of the stomach contents of ***L. ferruginea***. Again, many species of polychaetes could not be identified but three species accounted for most of the diet: *Ophelia acuminata* (4.5%), *Lumbrineris fragilis*

(4.22%), and *Ampharete arctica* (2.98%). Only *Unicola inermis* (25.07% weight, 48.08 percent occurrence) was of any importance among the infaunal crustaceans. Herring, *C. harengus* contributed 7.34% by weight to the diet. *Limanda ferruginea* shows a strong dependence on polychaetes and infaunal crustaceans both coastal and offshore although predation on herring is higher at the present time.

Fish (33.16%), polychaetes (37.89%), and epibenthic crustaceans (18.74%) were the dominant prey of ***H. platessoides***. Herring (12.06%) and unidentified fish (21.10%) accounted for most of the fish prey. The single most important polychaete was *Melinna cristata* (7%). In terms of frequency of occurrence fish prey were less significant than polychaetes (26.59%), sand shrimp (13.87%), and the mysid *Mysis mixta* (10.4%). The inshore diet contrasts with other studies conducted offshore which together show that the diet of *H. platessoides* varies substantially. The single most important functional group of prey offshore is echinoderms (primarily brittle stars). This may to some extent reflect a predator size-diet shift for this species. *H. platessoides* in Langton and Watling (1990) averaged 18 cm TL while the mean size offshore (from another study) was 28 cm.

Macrozoarces americanus preyed extensively on bivalves with >69% by weight of the stomach contents consisting of bivalves of two genera: *Nucula* and *Sphenia* which together accounted for 50% of the total weight. Infaunal crustaceans (2.96%) including isopods and amphipods were preyed upon more frequently than weights of stomach contents would indicate. A complete geographic shift in the diet was noted for *M. americanus* in studies conducted offshore where the single most important functional prey group was echinoderms. This difference was not due to size of predator because the inshore and offshore populations have similar mean lengths (34 cm). From a functional perspective, it may also be true that bivalves and echinoderms are indistinguishable by *M. americanus* . Both the bivalve and ophiuroid prey live in the top few centimeters of soft muddy sediment and are similar sized calcareous prey.

Libey, G.S. and C.F. Cole. 1979. Food habits of yellowtail flounder, *Limanda ferruginea* (Storer). J. Fish. Biol. 15:371-374.

Reference (#)	Libey and Cole 1979 (39)
Purpose of study	describes seasonal food habits by sex and age
Predator	*Limanda ferruginea* yellowtail flounder
Predator size	
Dominant prey	cumaceans (spring), amphipods, polychaetes, and cumaceans in all other seasons
Prey size	
Location	off Cape Ann, Massachusetts
Time of year	Apr-May, Jun-Aug, Sep-Nov, Dec-Jan
How prey quantified	frequency of occurrence, average number, percent volume
Number of stomachs	n=231
Depth	
Bottom type	
Prey energetics	

Eleven prey taxon were established: **Polychaeta** - all individuals were in the sub-class Sedentaria and further identification was not possible due to the mutilated condition. Various types of mud and sand worm tubes also occurred in the stomachs. **Cumacea** - were abundant and identifiable, *Eudorella emarginata* was the most common species. **Isopoda** - were common, well preserved with *Idotea balthica* being the most common. **Amphipoda** - occurred frequently in stomachs but further identification was not done. **Caridea** - shrimps were rare in stomachs and badly decomposed, one specimen was identified as *Crangon septemspinosus*. **Brachyura** - small crabs were rare. **Gastropoda** - shelled gastropods were rare. **Bivalvia** - *Thyasira gouldi* was the most common, occasionally a small razor clam (*Ensis directus*) and bay scallop (*Aequipecten irradians*) were taken. **Echinoidea** - sea urchins (*S. droebachiensis*) and sand dollars (*Echinarachinius parma*) were observed, neither was common. **Organic detritus** - includes plant material, unidentified animal matter was included. Eel grass (*Zostera marina*) leaves, small sticks and twigs were the most frequently observed items. **Inorganic debris** - included fine sand and occasionally pebbles.

Seasonal variation in the diet: Cumaceans (53.5% by volume) were the most important food item (by volume, frequency, and number) in spring and were the most numerous prey in all seasons. During

summer, feeding shifted to amphipods (23.2%) and polychaetes (39.2%) but cumaceans remained the most frequent category. Cumaceans (44.7%) and amphipods (19.8%) were most important in autumn. Cumaceans, amphipods, and polychaetes (24.5-34.5%) were of approximately equal importance in winter. Organic detritus was found in nearly every stomach that had food and was important in all seasons. Maximum volume (48.9%) occurred in summer. The seasonal diet (from Libey and Cole 1979) is summarized below as percent volume.

	Spring	Summer	Autumn	Winter
Polychaeta	12.1	39.2	16	32.5
Cumacea	53.6	12.7	44.7	34.5
Isopoda	4.2	12.2	1.7	1.2
Amphipoda	23.6	23.2	19.8	24.5
Caridea	1.4	0	0	2.8
Brachyura	0.4	0.8	2	1.2
Gastropoda	0	0.8	Trace	Trace
Bivalva	4.2	3.9	13.3	3.2
Echinoidea	0.6	7.2	2.3	0.2
Organic detritus	38	48.9	30.3	36.9
Inorganic debris	5	14.3	9.6	5

Variation due to other sources: No differences in food habits were observed between males and females. Food habits did not vary with age of predator (ages I to IX). Older fish generally consumed the same food as younger fish but in greater quantities.

The frequent occurrence of plant detritus, sand, and pebbles in the stomachs was indicative of feeding in contact with the bottom. The occurrence of polychaete worm tubes, anterior portions of marine worms, sand dollars, small clams, and sand-burrowing animals such as sedentary polychaetes and cumaceans suggested that yellowtail ingest the upper layers of the substrate to acquire food. The highest percentage of empty stomachs coincided with the spawning season.

Lilly, G.R. 1987. Interactions between Atlantic cod (*Gadus morhua*) and capelin (*Mallotus villosus*) off Labrador and eastern Newfoundland: a review. Can. Tech. Rpt. Fish. Aquat. Sci. No. 1567. 37 pp.

Reference (#)	Lilly 1987 (40)
Purpose of study	review information on the trophic interactions between cod and capelin
	in the Newfoundland-Labrador area.
Predator	*Gadus morhua* Atlantic cod
Predator size	c. 9-100 cm
Dominant prey	*Mallotus villosus* capelin
Prey size	mostly adult capelin, 12-19 cm
Location	northeast Newfoundland and Labrador shelf
Time of year	mostly spring, summer, and autumn
How prey quantified	precent occurrence, percent weight, stomach fullness index
Number of stomachs	several thousands
Depth	review covers inshore and offshore depths
Bottom type	
Prey energetics	

The general feeding pattern of cod appears to be well established with a wide variety of prey being taken. Major prey were crustaceans and fish. Small cod tend to feed on small crustaceans (mysids, euphausids, amphipods, small shrimp) medium size cod feed on larger crustaceans and small fish (especially pelagic fish), and large cod feed on crabs and medium sized fish such as pleuronectids. There is the tendency for the median prey size to increase with increasing predator size but prey size is not the only

factor influencing prey selection. Records of high numbers of small prey (euphausids for example) found in stomachs of large cod support the hypothesis that abundance (and availability) of prey is important in prey selection.

Cod predation on capelin occurs primarily in summer and autumn off southern Labrador and northeast Newfoundland but occurs throughout the year on the northern Grand Bank. In offshore areas cod prey on a wide size range of capelin (c. 8-18 cm) but in inshore areas during the capelin spawning season (June-July) cod primarily take mature capelin (c. 14-18 cm). Capelin appear most often in cod of 40-69 cm. During the capelin inshore spawning season the cod stomach fullness index is almost entirely due to capelin. In August as the abundance of capelin in the nearshore declines cod switch to other prey (squid and crustaceans).

Lilly (1987) reports that the food of cod in NAFO Divisions 2J and 3K during autumn 1982 and 1985 is predominantly fish (66.65-71.81% by weight) and crustacean (23.20-23.42%) prey. Dominant fish prey included capelin (*Mallotus villosus*; 15.95-36.17% weight), Arctic cod (*Boreogadus saida*; 0.25-5.47% weight), and redfish (*Sebastes* sp.; 2.15-3.42% weight). Important crustacea included Hyperiidae (1.73-12.14% weight), *Pandalus borealis* (2.95-4.80% weight), and the crab *Chionoecetes opilio* (2.17-8.34% weight). This is similar to stomachs from cod collected on the northern Grand Bank in May-June 1979 when fish (capelin [15.0%], sandlance [28.0%]) and crustaceans (Reptantia crabs [27.0%], euphausids [9.1%]) were also the dominant prey.

Lilly, G.R. and J.R. Botta. 1984. Food of Atlantic cod (*Gadus morhua* L.) near Bonavista, Newfoundland in 1983. NAFO SCR Doc. 84/VI/51. Serial No. N838. 8 pp.

Reference (#)	Lilly and Botta 1984 (41)
Purpose of study	describes diet of cod feeding inshore
Predator	*Gadus morhua* Atlantic cod
Predator size	median size = 53-67 depends on sampling equipment (range 40-115 cm)
Dominant prey	*Mallotus villosus*, capelin with a switch to invertebrates in July
Prey size	
Location	Bonavista Bonavista Bay, Newfoundland
Time of year	June to October
How prey quantified	stomach fullness index
Number of stomachs	n=722
Depth	shallow sampling 27-64 m; deep water (gillnet) sampling: 302-348 m
Bottom type	
Prey energetics	

Cod caught in the inshore trap fishery fed almost exclusively on capelin (*Mallotus villosus*) in late June and July. After July cod fed on benthic invertebrates primarily *Pandalus* shrimps (*P. borealis, P. montagui*) and crabs (*Chionocoetes opilio, Hyas araneus, H. coarctatus*). Feeding intensity was highest in early to mid summer when capelin were abundant inshore. Partial stomach fullness indices for invertebrates did not exceed 0.1. This compares with capelin and other fish prey where fullness indices reached a maximum of 5.19.

Lilly, G.R. and S. Meron. 1986. Propeller clam (*Cyrtodaria siliqua*) from stomachs of Atlantic cod (*Gadus morhua*) on the southern Grand Bank (NAFO Div. 3NO): natural prey or an instance of net feeding. ICES CM. 1986/G:36.13 p.

Reference (#)	Lilly and Meron 1986 (42)
Purpose of study	examines prey spectrum in spring
Predator	*Gadus morhua* Atlantic cod
Predator size	range: 15-138 cm; mean: 57 cm in 1984, 63 cm in 1985
Dominant prey	fish and crustaceans
Prey size	*Cyrodaria siliqua*, 2-8 cm
Location	southern Grand Bank (NAFO Divisions 3N, 3O)
Time of year	spring, 1984, 1985
How prey quantified	percent occurrence, percent weight, stomach fullness index
Number of stomachs	n=2,209
Depth	<366 m
Bottom type	
Prey energetics	

The dominant prey of cod in the springs of 1984 and 1985 on the southern Grand Bank were fish (69.4-74.2% weight; primarily sand lance, *Ammodytes* sp.[50.5-55.9%] and capelin *M. villosus* [4.4-8.1%]), crustaceans (10.3-18.1%; primarily toad crabs, *Hyas araneus* [6.7-8.0]) and bivalve molluscs (8.6-10.7%), primarily the propeller clam, *Cyrtodaria siliqua* (7.2% weight in 1985). Invertebrates were of much lesser importance included: euphausids (max. 2.4% weight), gammarid amphipods (max. 0.5%), shrimp (max. 0.2%) and polychaetes (max. 3.3%) with the sea mouse, Aphroditidae being the most important (3.0% weight).

An interesting finding of this paper is the high incidence of propeller clams which were most abundant (in number and weight) in very large cod, 99-107 cm. The maximum number was 41 occurring in an 86 cm cod with the median being 5. The size range of propeller clams taken by large cod (>81 cm) was 2-8 cm. The median size of propeller clams increased from 40 mm in 81-89 cm cod to 69 mm in cod >125 cm. In some instances only siphons were found in stomachs. All *C. siliqua* shells were articulated and unbroken. The state of digestion varied from very fresh to entirely digested. Cod with propeller clams in their stomachs were taken over a broad expanse of the southern Grand Bank with 69% being taken in water 68-79 m deep. Lilly (1986) suggests the presence of propeller clams in stomachs of cod may be a natural prey or due to net feeding.

Lilly, G.R. and D.R. Osborne. 1984. Predation of Atlantic cod (*Gadus morhua*) on short-finned squid (*Illex illecebrosus*) off eastern Newfoundland and in the north eastern Gulf of St. Lawrence. NAFO SCR. Doc. 84/IX/108. Serial No. N905. 16 pp.

Reference (#)	Lilly and Osborne 1984 (43)
Purpose of study	selected observations that describe prey in summer and autumn
Predator	*Gadus morhua* Atlantic cod
Predator size	c. 39-104 cm
Dominant prey	*Mallotus villosus* capelin; *Illex illecebrosus* squid; *Ammodytes* sp. sandlance
Prey size	
Locations	Trinity Bay (inshore Newfoundland); eastern Newfoundland
	offshore from Avalon Penninsula; northern Gulf of St. Lawrence.
Time of year	Trinity Bay: Jun-Aug 1980, Oct-Nov 1968; off Avalon: Oct 1979,
	Oct-Dec 1982, Oct-Nov 1983; Gulf of St. Lawrence: Sep-Oct 1979,
How prey quantified	percent occurrence; percent weight; stomach fullness index
Number of stomachs	Trinity Bay: n=1,348; off Avalon: n=668;
Depth	Trinity Bay: 40-102 m but mostly between 70-90 m
Bottom type	
Prey energetics	

Mallotus villosus, *I. illecebrosus*, and to a lesser extent *Ammodytes* sp. were the dominant prey of cod in the selected observations presented in this study. The dominant prey of cod in the shallow water commercial fishery in Trinity Bay during summer was capelin which accounted for nearly 100% of the total stomach fullness index in June and July. Squid was more important than capelin for several days in August, but stomach fullness values for squid in August never reached the very high values observed for capelin in June and July.

Squid was the major prey of cod caught in bottom trawls off eastern Newfoundland in October 1979. Squid only occurred in 26% of the stomachs but accounted for 53% of the diet by weight. The only other prey listed were for trawling stations off southeastern Newfoundland: unidentified mollusca (0.9%), polychaetea (1.61%), amphipoda (1.5%), euphausiacea (0.9%), *Pandalus montagui* (8.0%), *Hyas araneus* (2.0%), echinodermata (1.9%). These data (% weight) indicate other prey were of only minor importance. *Illex illecebrosus* was taken by cod between 39-104 cm. Highest predation occurred at predator sizes of 80-90 cm. The mean size of *I. illecebrosus* taken by cod was 22.9 cm (range 20.9-25.4 cm).

The prey of cod in the eastern and northeastern Gulf of St. Lawrence was not quantified but squid were collected at bottom trawling sampling sites throughout the area.

Lilly, G.R. and J.C. Rice. 1983. Food of Atlantic cod (*Gadus morhua*) on the northern Grand Bank in spring. NAFO SCR Doc. 83/IX/87. Serial No. N753. 35 pp.

Reference (#)	Lilly and Rice 1983 (44)
Purpose of study	describes prey when cod-capelin interaction is thought to be strong in spring
Predator	*Gadus morhua* Atlantic cod
Predator size	20-100+ cm
Dominant prey	fish: *Mallotus villosus* (capelin), *Ammodytes* sp. (sand lance)
	crustaceans: crabs, euphausiids, shrimp, amphipods
Prey size	
Location	northern Grand Bank
Time of year	16 May to 4 June 1979
How prey quantified	percent occurrence, percent weight, stomach fullness index
Number of stomachs	n=1,771
Depth	
Bottom type	
Prey energetics	

This study was conducted during a two week period in late May and early June. During this time cod preyed on a wide variety of organisms, relatively few of which contributed significantly to the stomach contents by weight. Major prey were fish and crustaceans. Capelin (15%) and sand lance (28%) accounted for 43% of the diet by weight. The most important crustaceans were crabs ([27%], *Chionocoetes opillo, Hyas araneus*), *euphausiids* ([9.1%], primarily *Thysanoessa raschii*), shrimp (primarily *Pandalus montagui*), and gammarid and hyperiid amphipods (3.0%).

Feeding was heaviest in the north central portion of the Grand Bank and along the eastern slope of the bank. The contribution of capelin to the cod's diet was highest in the areas north of the Virgin Rocks. Sand lance were a major component of the diet in the eastern portion of the Grand Bank and along the south eastern slope. Sand lance also made a substantial contribution to cod diets in the central portion of the Grand Bank and along the southeastern slope where predation on capelin was also heavy. Feeding on crabs and euphausiids was wide spread with the stomach fullness index being highest in the north western and central areas of the bank. Feeding on euphausiids was highest near the northwestern edge of the plateau of the Grand Bank.

Food of cod was related to length. Euphausiids were taken most intensively by small cod, sand lance and capelin by 40-69 cm cod, crabs by 60-79 cm cod and flatfish by the largest cod, >80 cm. However each major prey category was preyed upon by the complete size range of cod and there were no abrupt changes in the diet with increasing predator length.

Cod on the northern Grand Bank fed on a wide variety of prey but 5 species contributed to the bulk of the diet (sand lance, capelin, queen crab, toad crab, and an euphausiid, *Thysanoessa raschii*) comprised 66% of the stomach contents by weight and 68% of the stomach fullness index. For cod to feed on many

taxa but concentrate on a few particularly in the colder regions of its distribution is well documented and reviewed by Klemetsen (1982). Lilly and Rice (1987) conclude that "it is clear that cod show no strong preference for any of the prey types examined. Individual fish commonly consumed mixed diets, and cod in close proximity to each other often consumed quite different prey."

Lilly, G.R., M.A. Almeida and W.H. Lear. 1984. Food of Atlantic cod (*Gadus morhua*) from southern Labrador and eastern Newfoundland (Div. 2J, 3K, and 3L) in winter. NAFO SCR. Doc. 84/VI/88. Serial No. N878. 9 pp.

Reference (#)	Lilly et al. 1984 (45)
Purpose of study	examines spatial variability in diet
Predator	*Gadus morhua* Atlantic cod
Predator size	
Dominant prey	capelin and shrimp, *P. borealis*
Prey size	capelin: 9-18 cm; *P. borealis* : 4-28 mm
Location	southern Labrador to northern Grand Bank
Time of year	February to April
How prey quantified	percent weight, stomach fullness index
Number of stomachs	n=1,500
Depth	c. 250-429 m, most cod from 300-360 m
Bottom type	
Prey energetics	

Major prey of cod off southern Labrador and on the northern portion of the Grand Bank in winter were fish and crustaceans. Polychaetes and cephalopods occurred frequently but were seldom important. 18 species of fish were identified, capelin being the most important on Belle Isle Bank (15.5% weight), off Cape Bonavista (40.2%) and on the northeast slope of the Grand Bank (12.5%). Capelin were not recorded from the stomachs of cod from Hamilton Bank or from Funk Island Bank. Myctophidae, Pleuronectidae, and *Gadus morhua* were other fish taxa that were important.

11 species of crustaceans were identified but only *Pandalus borealis* was common. It was rare on Hamilton Bank but occurred in most collections elsewhere and was particularly important on Belle Isle Bank (20.5% weight). *Pandalus borealis* represented 4.2%, 21.9%, 3.7%, and 5.3% of the total diet by weight on Hamilton Bank, Funk Island Bank, off Cape Bonavista, and on the northeast slope of the Grand Bank respectively. The only other crustacean of importance that was identified to species was *Chionoecetes opilio* which represented 0.2%, 0.8%, 5.3%, and 0.8% of the diet (weight) for cod collected on Belle Isle Bank, Funk Island Bank, off Cape Bonavista, and on the northeast slope of the Grand Bank respectively. Hyperid amphipods (not identified further) occurred in most collections, were preyed upon most intensively on Belle Isle Bank and represented 4.4%, 6.9%, 28.7%, 3.3%, and 1.5% of the diet on Hamilton Bank, Belle Isle Bank, Funk Island Bank, off Cape Bonavista and on the northeast slope of the Grand Bank respectively. Polychaetes represented <1% of the diet on any of the banks discussed above. Molluscs were only important as cephalopods and then only on certain banks were they represented a maximum of 7.2-7.8% of the diet (Belle Isle Bank, Funk Island Bank).

Lomond, T.M., D.C. Schneider and D.A. Methven. 1998. The transition from pelagic to benthic prey of 0-1 group cod. Fish. Bull. U.S. 96:908-911.

Reference (#)	Lomond et al. 1998 (46)
Purpose of study	quantifies the rate at which the shift from pelagic to benthic prey occurs
Predator	*Gadus morhua* Atlantic cod
Predator size	40-190 mm SL
Dominant prey	<100 mm: copepods, amphipods; >100 mm: isopods, *Crangon,*
	white hake, invertebrate eggs and polychaetes.
Prey size	approximated using standard formula for each major prey type
Location	single site at Bellevue, Trinity Bay, Newfoundland
Time of year	July to December 1989; August to October 1991.
How prey quantified	displacement volume,
Number of stomachs	n=98
Depth	< 2 m
Bottom type	
Prey energetics	

This study determines the size that juvenile cod make the transition from pelagic to benthic feeders. This occurs at standard lengths of 60-100 mm in coastal waters of Newfoundland when settled juvenile cod switch from copepod (calanoida and harpacticoida) to a more diverse benthic diet of isopods (*Jaera marina*), *Crangon septemspinsoa*, fish (white hake, *Urophycis hake*) invertebrate eggs and polychaetes. The diet of cod 40-59.9 mm was 98% pelagic prey, that of cod 60-100 mm was 39% pelagic prey, and the diet of cod >100 mm was 13% pelagic prey.

Macdonald, J.S. and R.H. Green. 1986. Food resource utilization by five species of benthic feeding fish in Passamaquoddy Bay, New Brunswick. Can. J. Fish. Aquat. Sci. 43:1534-1546.

Reference (#)	Macdonald and Green 1986 (47)
Purpose of study	uses multivariate analyses to explore the effect of temporal and spatial changes
	of the macrobenthos on food utilization and partitioning by demersal fish
Predators	*Gadus morhua* Atlantic cod; *Macrozoarces americanus* eelpout;
	Pseudopleuronectes americanus winter flounder; *Hippoglossides*
	platessoides plaice; *Glyptocephalus cynoglossus* witch flounder
Predator size	*G. morhua* 15-93 cm; *M. americanus* 26-58 cm; *P. americanus*
	25-40 cm; *H. platessoides* 22-30 cm, *G. cynoglossus* 26-60 cm
Dominant prey	*G. morhua* : amphipods, mysids, euphausiids; *M. americanus* :
	amphipods, molluscs, annelids; *P. americanus* : annelids, arthropods;
	H. platessoides : molluscs, annelids, arthropods; *G. cynoglossus*
	arthropods, annelids, molluscs
Prey size	size measured for three dominant prey in grab samples: *Yolida*
	sapotilla, Leptocherius pinguis, Casco bigelowi
Location	2 inshore sites: (A) Passamaquoddy Bay (Bay of Fundy),
	(B) just outside Passamaquoddy Bay.
Time of year	Jul, Aug, Oct, Dec, Jan, Apr, Jun
How prey quantified	weight and number of each prey species per stomach
Number of stomachs	*G. morhua* n=54; *M. americanus* n=74; *P. americanus* n=99;
	H. platessoides n=119, *G. cynoglossus* n=49
Depth	(A) 55 m, (B) 80 m
Bottom type	(A) sand, silt, and clay; (B) silt and clay; determined by grab sampling.
	Site A has stronger currents than site B
Prey energetics	

Predators fed selectively on the available food resource. Predators did not feed on all the benthic species that were present in the sediments and did not consume prey in the same proportion as the estimated availability (e.g., annelids: *Harmothoe imbricata, Nephtys incisa,* and *Tharynx acutus* were underutilized at most sites and times by most predators).

Winter flounder fed on large numbers of annelids at site B and arthropods at site A: *Praxillella praetermissa, Harmothoe imbricata, Eteone trilineata, Diastylis quadrispinosa, Leptocheirus pinguis, Casco bigelowi,* and *L. pinguis, Eteone rubrocincta, C. bigelowi.* Despite the large quantities at site B, molluscs were only consumed by winter flounder at site A and then only *Yoldia sapotilla* with consumption being heaviest in summer and early autumn.

Cod and **plaice** consumed fewer prey items during the year and showed less seasonal variation in food consumption habits than the other predators. Cod fed on arthropods at most site-time combinations. Cod took amphipods *L. pinguis* and *Unicola* sp. at site A and mysids and the euphausid *Meganyctiphanes norvegica* at site B. Mysids and euphausids are not well sampled by a benthic grab but both types of amphipods were more abundant at site A. *Unicola* sp. were consumed in the largest quantities when they were least abundant in the sediment, during spring. Annelids and molluscs were consumed in larger numbers in summer than in winter.

Plaice are mollusc, annelid, and arthropod feeders throughout the year. Arthropod predation was heaviest at site A where plaice utilized *N. incisa, S. scutata, L. pinguis, Eteone rubrocincta, C. bigelowi, Ampphipholis squamata,* and ampharetids in relative quantities that reflect benthic abundance at most times and sites.

Ocean pout take arthropods (*L. pinguis, C. bigelowi, Unicola* sp.) in April and June and are mollusc, and annelid predators (*S. scutata, C. alba, Y. sapotilla, Nucula* sp.) in July, August, and October.

Witch flounder fed on arthropods *C. bigelowi, Hippomedon* sp., and *L. pinguis* and the annelids *S. scutata, Ampharetidae,* and *Ninoe nigripes* at most times of the year that reflect benthic abundance. *Yoldia sapotilla* is the only mollusc consumed in large numbers and was taken more often in summer.

Cod and most pleuronectids are visual feeders that respond to prey movement and therefore feed on epibenthic and shallow infaunal items. Cod and winter flounder eat infaunal material, the cod by digging and the flounder by nipping off siphons or crushing shells of molluscs. The extra time required to search for and handle molluscs makes them suboptimal prey for cod, winter flounder, and possibly witch flounder. Plaice have larger mouths which may allow them to consume more molluscs and other calcareous prey than other pleuronectids. Shelled molluscs and to a lesser extent chitonous prey are evacuated at a slower rate by most predators and therefore appear to be eaten in greater numbers than they actually are. The mean sediment depths of several benthic invertebrates are shown in Fig. 7 of Macdonald and Green (1986). The Eckman Grab penetrates to a maximum depth of 10 cm. The mean in sediment depth distributions of amphipods, *S. Scutata*, Ampharetidae, *Y. sapotilla*, cumaceans, Maldanidae, Owenidae, *Nucula* sp., *Lumbrineridae, A. Pelagica*, Molluscs and Nemertea were all <5 cm.

Changes in the size of prey can be responsible for what is observed in the stomach contents. For example *Leptocheirus pinguis* is more heavily utilized by fishes when it is largest (October to April). *Yolida sapotilla* is more heavily utilized by winter and witch flounders when it is largest in summer. Similarly for *C. bigelowi* when it is largest in summer and more heavily utilized by plaice and winter flounder.

Demersal fish in many locations consume fewer polychaetes and more amphipods than would be expected from benthic samples. Predators respond in a variety of ways to differences in distribution, escape response, degree of concealment, and size of prey species.

Mahon, R. and J.D. Neilson. 1987. Diet changes in Scotian Shelf haddock during the pelagic and demersal phases of the first year of life.
Mar. Ecol. Prog. Ser. 37:123-130.

Reference (#)	Mahon and Neilson 1987 (48)
Purpose of study	describes diet and determines if transition to benthic prey is gradual or abrupt
Predator	*Melanogrammus aeglefinus* haddock
Predator size	3-18 cm, individuals considered to be <1 year old
Dominant prey	pelagic haddock: copepods and amphipods; demersal haddock:
	ophiuroids, polychaetes, amphipods, cumaceans, euphausids
Prey size	
Location	southern Scotian Shelf and Bay of Fundy
Time of year	Jun, Aug, Sep, Oct, Jan, Apr-May
How prey quantified	precent contribution by number of prey, precent frequency of occurrence
Number of stomachs	n=480
Depth	
Bottom type	
Prey energetics	

Aggregation of major prey by habitat type showed that the shift from planktonic to demersal feeding was abrupt and involved substantial changes in diet. Copepods and pteropods became increasingly insignificant components of the diet where as ophiuroids and polychaetes became major components upon and shortly after settlement. Amphipods remained relatively important throughout the first year of life but there was a shift from the planktonic hyperiideans to benthic species (e.g. *Leptocheirus* sp., *Unciola* sp.). After juvenile haddock became demersal, there was a continued change in diet through the first year of life, though less marked than the change that accompanied transition. Thus there is a shift from pelagic copepods and amphipods to more benthic prey that include ophiuroids, polychaetes, amphipods, cumaceans, and euphausids. With increasing size the most evident trends are an increasing contribution of ophiroid and a decreasing contribution of copepods. The only prey that were identified to the level of genera in this study were *Leptocheirus* sp. and *Unciola* sp.

Martell, D.J. and G. McClelland. 1992. Prey spectra of pleuronectids (*Hippoglossoides platessoides*, *Pleuronectes ferrugineus*, *Pleuronectes americanus*) from Sable Island Bank. Can. Tech. Rep. Fish. Aquat. Sci. No. 1895. 20 pp.

Reference (#)	Martell and McClelland 1992 (49)
Purpose of study	describes diet as part of a larger study of larval sealworm
	transmission to demersal fish
Predators	*Hippoglossoides platessoides* American plaice; *Pleuronectes*
	ferrugineus (=*Limanda ferruginea*) yellowtail; *Pleuronectes americanus*
	(=*Pseudopleuronectes americanus)* winter flounder
Predator size	Most predators were between 15-40 cm. Size modes: *H. platessoides*,
	16-30 cm Feb, 21-25 cm Jun; *P. ferrugineus*, 21-25 cm Feb,
	31-35 cm Jun; *P. americanus*, 26-30 cm Feb, 26-30 cm Jun.
Dominant prey	*H. platessoides*: crustaceans, molluscs, echinoderms, Anthozoans
	P. ferrugineus: polychaetes, crustaceans, one species of tunicate
	P. americanus: polychaetes, crustaceans, one species of tunicate
Prey size	
Location	1870 km^2 area on Sable Island Bank, Scotian Shelf.
Time of year	February and June 1989
How prey quantified	number of prey per stomach
Number of stomachs	*H. platessoides*, n=183 Feb, n=154 Jun; *P. ferrugineus*, n=169 Feb,
	n=141 Jun; *P. americanus*, n=47 Feb, n=130 Jun
Depth	
Bottom type	sand and gravel
Prey energetics	

This study provides good lists of the prey of three important pleuronectid predators from the central Scotian Shelf. One hundred prey were taken by **American plaice** (52% were crustaceans, 29% were polychaetes) but only 18 qualified as principle prey. The most frequently taken crustaceans were: cumaceans, hyperiid and gammaridean amphipods, mysids, and pagurids. Anthozoans, molluscs, and echinoderms were also common prey. 64% of the February stomachs and 14% of the June stomachs were empty.

Yellowtail fed primarily on polychaetes (83 species that included: phyllodocids, polynoids, spionids, orbiniids, cirratulids, ampharetids), crustaceans (68 species that included: cumacens and gammaridean amphipods as the predominant prey taxa), and one species of tunicate (*Molgula* sp.). 51% (February) and 6% (June) of the stomachs were empty. Similar to plaice, yellowtail consumed fewer species and lesser quantities of prey in February than in June.

Winter flounder took 140 species of prey. Sixty seven (48%) were polychaetes (phyllodocids, spionids, terebellids) and 52 (37%) were crustaceans (cumaceans, gammaridean, and caprellid amphipods) and one species of tunicate (*Molgula* sp.). Forty species (29%) were considered principal prey but only one species of prey occurred in $\geq$ 50% of the stomachs that contained food. Stomachs of all fish sampled in February were empty (but some food was observed in the intestine) but 96% of the fish collected in June had food in their stomachs. Yellowtail and winter flounder had diets more typical of generalists whereas plaice appeared to specialize on crustaceans.

Prey were assigned to three functional classifications of guilds: infauna, epifauna, and suprabenthic fauna. The diets of **plaice** showed variation with fish length only during summer but trends in prey guild exploitation were apparent from the diets of February and June specimens. Diets of small plaice (<21 cm) were composed of suprabenthic (e.g., mysids) and epibenthic crustaceans (e.g., tubaceous amphipods). Suprafauna were again prominent in the diets of plaice 21-30 cm although mysids declined for larger plaice in this length stratum. In winter, large plaice (>31 cm) usually took epibenthic prey of a sedentary (e.g., *Actinauge longicornis*) or slow-moving (e.g., *Parurus* sp.) nature but, like the smaller fish, frequently preyed upon suprafauna, such as hyperiids, during summer. Plaice appear to progress through two feeding stanzas, exploiting suprafauna when small and larger epifauna as they matured.

Small **yellowtail flounder** (< 30 cm) took epifauna (primarily cumaceans and amphipods) during winter and summer. In winter tubaceous amphipods (corophids, aorids) were common prey, although consumption of most of these crustaceans declined in larger fish. Increased fish length was accompanied by greater predation of epifauna (echinoderms) and infauna (polychaetes and amphipods). Large yellowtail consume suprabenthic fauna (e.g., *Mysis mixta, Crangon septemspinosa*). Large yellowtail exploited cumaceans and mysids in winter but in summer fed mainly on in infaunal polychaetes (particularly surface deposit-feeders, e.g., *Spiophanes bombyx*), burrowers (e.g., *Ophelina acuminata*), epifaunal polychaetes (e.g., *Phyllodoce* sp.), tunicates (*Molgula* sp.), and tubaceous amphipods. Yellowtail of Sable Island Bank seemed to progress through two feeding stanzas, exploiting small epifauna or infauna when small and larger infauna (polychaetes and tabaceous amphipods) as they matured.

Winter flounder primarily exploited epifauna, including cumaceans. Small surface deposit-feeding polychaetes (e.g., *Ampharete lindstroemi*), nesting (e.g., *Metopa bruzelli*) and free-swimming amphipods (e.g., *Pontogeneia inermis*) were also ingested but were replaced by tubaceous amphipods in the diets of larger fish. Polychaetes consumed by larger winter flounder were mobile epifauna carnivores (e.g., *Phyllodoce* sp.). Larger winter flounder also took ectoprocts and associated tubaceous amphipods (e.g., *Erichthonius rubricornis, Ischyroceros anguipes*) and clinging caprellids (*Aeginina longicornis*). Generally, feeding stanzas of winter flounder of Sable Island Bank changed from exploitation of small, exposed infauna and epifauna by younger fish to consumption of larger epifauna by mature fish.

Mattson, S. 1981. The food of *Galeus melastomus, Gadiculus argenteus thori, Trisopterus esmarkii, Rhinonemus cimbrius*, and *Glyptocephalus cynoglossus* (Pisces) caught during the day with shrimp trawl in a west-Norwegian fjord. Sarsia 66:109-127.

Reference (#)	Mattson 1981 (50)
Purpose of study	describes changes in diet with increasing predator length
Predator	*Rhinonemus cimbrius* (known in the western Atlantic as *Enchelyopus*
	cimbrius, the fourbeard rockling); *Glyptocephalus cynoglossus*
	witch flounder; plus several species endemic to the eastern Atlantic
Predator size	*R. cimbrius* : 7-30 cm; *G. cynoglossus* : 3-33 cm
Dominant prey	*R. cimbrius* : decapod crustaceans, polychaetes, fish, bivalves;
	G. cynoglossus : decapod crustaceans, polychaetes
Prey size	
Location	Raunefjorden, 15 km SW of Bergen, Norway
Time of year	12 times between September 1975 and July 1976
How prey quantified	percent frequency of occurrence, mean number, and weight per fish
Number of stomachs	*R. cimbrius* : n=329; *G. cynoglossus* : n=355
Depth	220-240 m
Bottom type	clay-mud with some sand
Prey energetics	

Enchelyopus cimbrius: Prey consisted mostly of decapod, mysidaceans, amphipod and cumaceans crustaceans, polychaetes, fish, and bivalves. The most important species by weight was a decapod crustacean, *Calocaris macandrea*. The polychaetes were dominated by polynoids, opheliids, spionids, and maldanids. Fish were almost exclusively gobiids.

Glyptocephalus cynoglossus: The main food types were crustaceans, polychaetes, and to a much lesser extent bivalves. Crustaceans were mostly decapods (*Calocaris macandrea* was the most important), amphipods, mysidaceans, and cumaceans. Polychaetes were dominated by spionids, nephtyids, opheliids, maldanids, and lumbrinerids. The food in Raunefjorden was dominated by taxa which were also dominant in other areas but the decapod *Calocaris macandrea* and the mysid *Lophogaster typicus* were more important in Raunefjorden as food than they usually are.

Mattson, S. 1990. Food and feeding habits of fish species over a soft sublittoral bottom in the northeast Atlantic. 1. cod (*Gadus morhua* L.) (Gadidae). Sarsia 75:247-260.

Reference (#)	Mattson 1990 (51)
Purpose of study	describes diet, prey type, and time of feeding
Predator	*Gadus morhua* Atlantic cod
Predator size	6-75 cm
Dominant prey	changes with size, below
Prey size	
Location	Gullmarsfjorden, west coast of Sweden
Time of year	Nov 1979, Jan, Mar, May, Jul, Sep 1980
How prey quantified	percent number, percent weight, percent frequency of occurrence
Number of stomachs	n=599, of which 569 contained food
Depth	55-75 m
Bottom type	clay-mud with some sand
Prey energetics	

The cod's food spectrum included prey of a wide size interval and ranged from a "low pelagic" prey to endobenthic species. With increasing predator size the feeding habitat widened vertically. Concurrently the mean feeding level lowered and the food dominance changed from medium-sized hyperbenthic prey to large epibenthic and endobenthic prey. The cod is reported to be very discriminatory regarding the nutritional content of its food.

The diet consisted primarily of polychaetes (22% by weight; 18% Errantia and 4.2% Sedentaria), crustaceans (32%; of which decapods [28%] were the most important), and fish (41%). The table immediately below (from p. 257, Mattson 1990) shows how the diet (in terms of the habitat occupied by the prey) changes with increasing predator size.

Habitat\Predator size	5 to 10	10 to 15	15 to 20	20 to 30	30 to 40	40 to 50	50 to 75
near bottom pelagic	0.40%	1.70%	2.30%	1.40%	2.90%	7.20%	6.20%
hyperbenthos	76%	57%	41%	40%	47%	9%	27%
epi- and endobenthos	24%	42%	57%	58%	50%	84%	67%

This indicates that with increasing size (up to 50-75 cm) cod tend to increase their feeding habitat in both directions, taking more endobenthic prey as well as more pelagic prey off the bottom. Prey in the near bottom hyperbenthic layer still remain a very important component of the cod's diet. The next table (from p. 256, Mattson 1990) ranks the top 10 prey with respect to size of cod and classifies these prey according to habitat type.

			5 to 10 cm	10 to 15 cm	15 to 20 cm	20 to 30 cm	30 to 40 cm	40 to 50 cm	50 to 75 cm
Family	**Genera**	**Habitat**							
Mysidacea	Erythrops	H-EP	1	1	2	2	5		8
Gammaridea	Dyopedos p.	H	2	4	6	9			
Gammaridea	Ericthonius	EP, T	3	2	1	4	4		
Gammaridea	Dyopedos m.	H	4	3	5				
Gammaridea	Paramphilochoides	EP	5	5	10				
Cumacea	Eudorella	EN,H	6		9	5	3		
Cumacea	Leucon	EN, H	7	6	3	1	1	4	1
Brachyura	Macropipus	EP	8	7	7	3	2	1	5
Gammaridea	Monoculodes	EN, H	9						
Polychaeta (Errantia)	Gattyana	EP	10	8	8	10	9		
Gammaridea	Haploops	EP-EN, T, H		9	4	6			
Euphausiidea	Thysanoessa	P		10					
Polychaeta (Errantia)	Ophryotrocha	EP-EN				7			
Fish	Pomatoschistus	EP				8	8	8	
Polychaeta (Errantia)	Aphrodita	EP-EN					6	5	2
Polychaeta (Sedentaria)	Melinna	EN, T					7	3	6
Anomura	Pagurus	EP					10		9
Ophiuroidea	Amphiura f.	EP-EN						2	4
Gammaridea	Maera	EN						6	
Ophiuroidea	Amphiura ch.	EP-EN						7	10
Fish	Sprattus	P						9	
Polychaeta (Errantia)	Nephtys	EN						10	7
Polychaeta (Sedentaria)	Terebellides	EN, T							3

P=pelagic; H=hyperbenthic; EP=epibenthic; EN=endobenthic; T=tubicolous

Mattson, S. 1992. Food and feeding habits of fish over a soft sublittoral bottom in the northeast Atlantic. 3. Haddock (*Melanogrammus aeglefinus* (L.)) (Gadidae). Sarsia. 77:33-45.

Reference (#)	Mattson 1992 (52)
Purpose of study	describes diet
Predator	*Melanogrammus aeglefinus* haddock
Predator size	13-43 cm
Dominant prey	echinoderms especially ophiuroids
Prey size	information provided on some prey, see below
Location	Gullmarsfjorden, west coast of Sweden
Time of year	Nov 1979, Jan, Mar, May, Jul, Sep 1980
How prey quantified	percent number, percent weight, percent frequency of occurrence
Number of stomachs	n=208
Depth	55-75 m
Bottom type	clay-mud with some sand
Prey energetics	

Haddock are reported to feed primarily on small to medium sized endobenthos and secondarily on ophiuroids. The stomach is reported to be adapted to an exceptional degree for "powerful grinding" of the prey. This grinding process is reported to make a higher feeding rate possible and this compensates for the

low nutritional value of the food. The combination of its special feeding method and digestive grinding process makes the haddock more specialized for utilization of the small to medium-sized endobenthos than any other littoral teleost in the northeast Atlantic.

The diet (as percent weight) consists of Mollusca (8.1%, primarily bivalves [7.8%] with *Abra nitida* and *Thyasira sarsi* being the most frequently occurring species), Polychaeta (23%; Errantia [5.8%], Sedentaria [17%]), Crustacea (47%, with Cumacea [40%], gammarid amphipods [3.2%], and decapods [3.1%] being the most important), and Echinodermata (21%, with Ophiuroidae [20%] being the most important).

Most of the bivalves (*Nucula tenuis, Modiolus modiolus,* and *Abra nitida*) were <5 mm in length. Most of the Errantia and Sedentaria polychaetes were <10-15 mm in length. Two of the four Ophiuroidea (*Ophiura albida, O. affinis*) had disc diameters <3 mm whereas the other two more common species (*Amphiura filiformis, A. chiajea*) were present as arms only. The first two species were considered epibenthic whereas both *Amphuria* species were considered epibenthic and endobenthic. The main prey species of haddock are small and slow moving compared to other teleosts of similar size. The small prey size is reported to be due to the haddock's collective method of feeding which is aimed at the entire endobenthos. Mattson (1992) states that other bottom-feeding fishes generally select one prey at a time and therefore select larger prey. Owing to the pronounced subterminal position of the mouth the haddock is poorly adapted for pelagic feeding.

Maurer, R. 1975. A preliminary description of some important feeding relationships. ICNAF Res. Doc. 75/IX/130. Serial No. 3681. 15 pp.

Reference (#)	Maurer 1975 (53)
Purpose of study	to indicate the inter-specific trophic relations among selected predators by
	analysis of their food habits
Predators	15 predators of which three are primary: *Gadus morhua* Atlantic cod;
	Melanogrammus aeglefinus haddock; *Merluccius bilinearis* silver hake
Predator size	
Dominant prey	identifed below
Prey size	
Location	mid Atlantic Bite to southern Scotian Shelf
Time of year	throughout the year, 1969-1972
How prey quantified	weight
Number of stomachs	n=18,500 stomachs for all species combined
Depth	
Bottom type	
Prey energetics	

In general silver hake and cod are described as mixed feeders although their diets are predominantly fish. The silver hake stomach contents consist of 96% fish and crustaceans. The diet of cod is 80% fish and crustaceans. A diverse invertebrate fauna characterizes the diet of haddock which consists of 35% echinoderms, and lesser amounts of crustaceans and polychaetes.

Georges Bank: Cod fed primarily on fish (12% weight, yellowtail, sculpins, gadids) and fish eggs (14%). While 80% of the diet of silver hake consisted of fish. Only lanternfish and silver hake were identifiable.

Polychaetes (24%) and crustaceans (23%0 were the chief food items of haddock. Important polychaetes included terebellid, sabellid, and nereid forms. The crustacean component of the diet consisted of gammarid amphipods and krill shrimp (*Meganyctiphanes*).

Gulf of Maine: Fish were the most important component of the diet of cod which consisted of 27% herring with lesser amounts of redfish, mackerel, and gadids. Crustaceans accounted for 23% of the cod diet, primarily the deep-sea red crab (*Geryon*).

Silver hake also fed heavily on herring (28%) which was followed in importance by mackerel and alewifes. Crustaceans, a minor component of the silver hake diet included *Meganyctiphanes*, glass shrimp (*Pasiphaea*), and Pandalidae.

Echinoderms dominated the diet of haddock (53%). Important echinoderms included brittle stars (*Ophiura*), sea urchins (Echinoidea), and sea cucumbers (*Thyone*).

Scotian Shelf: The cods diet consisted mainly of fish, sand lance (12%), herring, and gadids. Crustaceans taken by cod included *Meganyctiphanes*, toad crabs (*Hyas*), and pandalid shrimp.

The diet of silver hake was dominated by two taxon. Gadid fish accounted for >50% of the diet. *Meganyctiphanes* made up an additional 28% of the diet.

Echinoderms, primarily brittle stars (*Ophiopholis, Ophiura*), sea urchins (*Strongylocentrotus*) and sea cucumbers (*Psolus*) were important in the diet of haddock.

McEachran, J.D., D.F. Boesch and J.A. Musick. 1976. Food division within two sympatric species pairs of skates (Pisces: Rajidae). Mar. Biol. 35:301-317.

Reference (#)	McEachran et al. 1976 (54)
Purpose of study	compares food habits among 4 species of skates
Predators	*Raja erinacea* and *R. ocellata* (one sympatric species pair)
	R. radiata and *R. senta* (a second sympatric species pair)
Predator size	*R. erinacea* (9-64 cm); *R. ocellata* (12-114 cm); R. radiata (12-108 cm);
	R. senta (12-65 cm)
Dominant prey	*R. erinacea:* decapod crustaceans, amphipods; *R. ocellata* : amphipods,
	polychaetes; *R. radiata:* polychaetes, decapods;
	R. senta : decapods, euphausids
Prey size	
Location	mid Atlantic Bite, Georges Bank, Gulf of Maine, Scotian Shelf
Time of year	Mar-Apr, Jul-Aug, Oct-Nov, and Mar-Apr.
How prey quantified	number, displacement volume; index of relative importance
Number of stomachs	*R. erinacea* (n=785); *R. ocellata* (n=441); *R. radiata* (n=313); *R. senta* (n=107)
Depth	27-366 m
Bottom type	
Prey energetics	

Raja species are euryphagous, feeding particularly on nektobenthic and motile epibenthic animals and active infauna. *Raja ocellata* fed on infauna relative to *R. erinacea* which fed on epifauna. The diet of *R. senta* was very restricted and consisted almost entirely of epifauna. *Raja radiata* had a very diversified diet feeding on both epi- and infauna. The virtual absence of large common potential prey such as ophiuroids, echinods, and burrowing anemones suggests they are unattractive to foraging *Raja*. The diets can be summarized as follows:

R. erinacea: decapods - 31% by number; 55% by volume
amphipods - 51% by number; volume not indicated
polychaetes - second largest volume (not quantified)

Isopods, bivalves, and fishes were of minor importance. The diet of *R. erinacea* was size dependent. Specimens <41 cm took significantly fewer decapods and more amphipods than those >41 cm. There were no significant differences in "higher" taxonomic composition of diets among the different regions.

R. ocellata: amphipods - 64% by number; 7% by volume
polychaetes - 13% by number; 22% by volume

Fishes, decapods, isopods, and bivalves were also important in the diet. Fishes contributed more to the volume of prey than other taxa, but were found in relatively few stomachs. There was no indication of

seasonal or diel periodicity in feeding intensity. Large volumes of prey were encountered during all seasons. There was no significant change in the diet with increasing predator size.

R. radiata:	polychaetes	- 31% by number; 23% by volume
	decapods	- 19% by number; 21% by volume
	fishes	- 3% by number; 50% by volume

Fishes occurred in only 25% of the *R. radiata* stomachs examined. *Raja radiata* took a large variety of fishes, but no one species was dominant. There was no indication of either seasonal or diel feeding periodicity. Diets were significantly different between all but the Georges Bank and Scotian Shelf samples where the decapods *Hyas* sp. and *Eualus pusiolus* were the dominant prey.

R. senta:	decapods	- 13% by number; 50% by volume
	euphausids	- 24% by number; 50% by volume

Amphipods and mysids were of slightly less importance. Fishes and polychaetes contributed little to the diet. Although there was no (statistically) significant change in food habits with predator size plots showed that amphipods and mysids were relatively more important to smaller predators and that decapods were more important to larger specimens. Diets varied significantly between Georges Bank and the Gulf of Maine but not between the Gulf of Maine and the Scotian Shelf. *Meganytiphanes norvegica* was rare in the Georges Bank stomachs but was abundant in the other samples.

Methven, D.A. and J.F. Piatt. 1989. Seasonal and annual variation in the diet of Atlantic cod (*Gadus morhua*) in relation to the abundance of capelin (*Mallotus villosus*) off eastern Newfoundland. J. Cons. int. Explor. Mer 45:223-225.

Reference (#)	Methven and Piatt 1989 (55)
Purpose of study	abundance of prey in study area compared to abundance in predator stomachs
Predator	*Gadus morhua* Atlantic cod
Predator size	66 cm ± 8 (s.d.) in 1983; 62 cm ± 8 in 1984
Dominant prey	*Mallotus villosus* capelin
Prey size	
Location	Witless Bay, east coast of Newfoundland
Time of year	June, July, August, 1981-1984
How prey quantified	percent occurrence, mean number per collection
Number of stomachs	n=680
Depth	
Bottom type	
Prey energetics	

Capelin were the dominant prey of Atlantic cod from early to mid July in four consecutive years at Witless Bay, an inshore site off the eastern coast of Newfoundland. When the local abundance of capelin was high, the mean number of capelin in cod stomachs was high. When capelin abundance decreased the mean number of capelin in cod stomachs also decreased. Cod were taking capelin in proportion to their local availability. Cod stomachs were seldom empty when capelin were locally abundant. Other fishes taken by Atlantic cod included sandlance (*Ammodytes* sp.) , juvenile cod, redfish (*Sebastes* sp.), and unidentified flatfishes.

Shrimp (primarily *Pandalus*) and euphausiids were the next most abundant prey. These were often observed in stomachs throughout the summer but were most abundant from late May to early June and in August when capelin were less abundant. Occasional prey included mysids, gastropods, pelecyods, sea cucumbers, starfish, brittle stars, polychaetes, tunicates, sea anemones, and ctenophores. Squid were often important in late summer. Invertebrate prey were not identified to a lower taxonomic level. No other invertebrate prey were mentioned other than those indicated above.

Minet, J.P. 1973. Food and feeding of the American plaice (*Hippoglossoides platessoides* F.) on St. Pierre Bank and on Cape Breton Shelf. ICNAF Redbook 1973 Part III pp 59-70.

Reference (#)	Minet 1973 (56)
Purpose of study	describes diet and feeding habits
Predators	*Hippoglossoides platessoides* American plaice
Predator size	most between 25-45 cm, few <25 or >45
Dominant prey	depends on predator size and sampling location, summarized below
Prey size	
Location	St. Pierre Bank (3Ps) and off Cape Breton (4Vn)
Time of year	July 1971, November 1971, February 1972, May 1972
How prey quantified	frequency of occurrence and precent weight
Number of stomachs	n=564 from 3Ps and n=368 from 4Vn
Depth	
Bottom type	
Prey energetics	

More stomachs had echinoderms present than any other prey taxa. Brittle stars were the most common echinoderms (*Ophiura sarsi, O. robusta,* and *Ophiopholis aculeata*). Sea urchins were also important (mostly *S. droehbachensis* with some *Echinarachnius parma*). Few stomachs had the holoturian genera *Cucumaria* and *Thyone* present. The only sea star found was *Ctenodiscus crispatus*.

Molluscs were the second most important prey taxa due mainly to plecypods which were found in large numbers. These included: *Yoldia myalis* and *Y. thraciaeformis*. A few specimens of *Y. sapotilla* and *Nuculana tenuisulcata* were recorded. *Chlamys islandicus* was the most frequently occurring Filibranchia. As for the Eulamellibranchia, *Clinocardium ciliatum* and *Serripes groenlandicus* were the most important with lesser numbers *of Siliqua costota* and *Crytodaria siliqua* and the genera *Astarte, Tellina, Macoma,* and *Spisula* being recorded. Gastropods were rare and small in size. *Mararites cinerea, M. helicina,* and *M. groenlandica* accounted for two thirds of this group.

Crustaceans were the third most important taxon occurring in plaice stomachs. The amphipods *A. nugax*, *Euthemisto* sp., *Caprella* sp., *Stegocephalus* sp., *Amelisca* sp. and the euphausid *Meganyctiphanes norvegica* were the most important species.

Annelids were mainly represented by the polychaetes *Aphrodite aculeata*, *Nereis* sp., *Nephthys* sp., mainly *Onuphis conchilega* for Errantia; *Pectinaria granulata* and *Potamilla* sp. for Sedentaria and *Phascolosoma* sp. from the order sipunculids.

The most important fish prey included: sand lance (*Ammodytes* sp.), and small rock fish (*Sebastes* sp.). and witch flounder (*Glyptocephalus cynoglossus*)

Cindaria were represented by A*ntennularia* sp., *Pennatula borealis*, *Renilla reniformis,* and especially *Bolocera tuediae*, Lophophoroidae by *Membranipora monostachys* and *Hemithyris psittacea*, and Ascidians by the family Styellidae.

Variation in the diet due to sampling location (3Ps and 4Vn): Plaice off Cape Breton Island took no ascidians and less fish, cnidarians, and molluscs than plaice on St. Pierre Bank. Cape Breton Island plaice took more polychaetes (23.3%), crustaceans (38.8%, primarily amphipods and cumaceans) and echinoderms (94%, primarily brittle stars). Brittle stars were the most important food group on St. Pierre Bank where the diet is reported to be more diverse.

Variation in the diet due to size and sex of predator: The differences in the diet due to sex of predator are largely due to size because females reach greater lengths than male plaice. Brittle stars are taken in equally large quantities by small and large plaice due to a change in species of brittle stars taken. *Ophiura robusta* and small *Ophiopholis aculeata* were mostly taken by small plaice with *Ophiura sarsi* and larger *O. aculeata* being taken by larger plaice. As size increases there is a greater proportion of stomachs that have sea urchins present. The proportion of stomachs with Protobranchia molluscs decreases with size of predator. Small plaice take more *Yolida myalis. Yolida thraciaeformis* occur in larger plaice. The proportion of stomachs with *Chlamys islandicus* increases with size of predator. The percentage of stomachs containing crustaceans (primarily isopods, amphipods, euphausids, shrimp) also decrease with increasing size of predator. These small crustaceans are a "choice food" of small plaice (20-35 cm). Larger

crustaceans such as Brachyura crabs are taken in greater quantity by larger plaice (46-70 cm). Fish occur more frequently in stomachs of larger plaice. Occurrence of stomachs containing polychaetes (Errantia, Sedentaria) decreases as the size of plaice increases. The occurrence of stomachs containing ascidians (on St. Pierre Bank) increases with size of predator.

Seasonal variation in the diet: This is best summarized in the table that follows. This table was taken from p. 65 Minet (1973). The important species within the taxonomic groups outlined in this table below were identified earlier. The only taxon in common between the two regions which was taken in relatively large amounts is sand lance and Eulamellibranchia in the spring and Protobranchia in the autumn. Other than this variation in the diet was particular to each region. Seasonal fluctuations in the diet indicate that plaice feed on prey when they are abundant in the area and do not hesitate to leave the bottom if necessary to feed on sand lance, amphipods, and euphausids.

A reduction in feeding intensity was observed in the fall and especially during winter. This reduction is more marked on the Cape Breton Shelf than on St. Pierre Bank.

Prey	3Ps Jul	3Ps Nov	3Ps Feb	3Ps May	4Vn Jul	4Vn Nov	4Vn May
Cnidaria	0.2		2.2	1.5	*	0.1	4.5
Boloceridae	0.1		2.2	1.5	*	*	4.5
Others	0.1		*	*		0.1	
Annelida	9.7	5.4	12.6	0.7	16.2	13.4	4.5
Polychaeta Errantia	0.3	2	3.1	0.4	2.8	4.8	3
Polychaeta Sedentaria	8.5	3.4	9.5	0.3	13.3	7.5	0.7
Sipunculida	0.9				0.1	1.1	0.8
Lophophoroidae	0.2			*	*		*
Bryozoa	*			*	*		*
Branchiopoda	0.1						
Priapuloidea	0.1						
Mollusca	29.6	37.5	21.4	10.9	5.9	9.2	13.3
Polyplacophora	*			*			
Gasteropoda	0.3	2.6		0.5	0.2	0.9	4.3
Pelecyopoda Protobranchia	27.5	32.6	16.9		2.3	6.3	2.7
Filibranchia	0.7	*	*	0.5	1.1	1.1	0.6
Eulamellibranchia	0.5	2.3	4.5	9.9	2.2	0.9	5.7
not identifed	0.6				0.1		
Crustacea	8.1	24.7	16.4	10.9	8.3	2.8	4.1
Mysidacea		0.2		0.1	0.8		
Cumacea		0.4		*	0.5		0.7
Isopoda	0.7	1.1	*	1.5	0.2		
Amphipoda	4.9	0.7	12.3	1.7	2.5	0.2	0.4
Euphausiacea	0.6	20.7			2.6		1.4
Decopoda Macrura	0.8	0.1	3.5	*	0.8	1.3	1.4
Anomura	0.7		0.6	*	*	0.8	
Brachyura	0.2	0.3		7.6	0.2	0.2	0.1
not identified	0.1	1.2		*	0.7	0.3	
Echinodermata	39.6	20.2	40.3	61.8	62.3	65.4	71.3
Holoturidea		0.1		0.3	0.6		0.3
Asteroidea	*	*				0.1	52
Ophiuroidea	25.1	15.4	33.3	29.5	43.1	43.3	19
Echinoidea	14.6	4.7	7	32.1	18.6	22.1	
Ascidiacea	2.9	4.5	1.2	7.2			
Teleostei	4.7	2.6		4.3		1.7	1.1
Paralepididae	0.2						
Myctophidae	0.7						
Moridae						1.1	
Zoarcidae	0.9						
Ammodytidae		0.9		4.1			1.1
Scorpaenidae		0.7					
Pleuronectidae		0.5					
not identified	2.9	0.5		0.2		0.7	*
Pebbles and shell fragments	2.1	2.1	2.4	1.1	6.1	5.8	0.3
Vegetal fragments			2.4		*	0.1	*
Animal fragments not identified	2.7	2.9	0.9	1.6	1.1	1.5	0.9
TOTAL (%)	99.7	99.9	99.8	99.9	99.9	100	99.9
Number of stomachs with food	146	116	41	140	119	80	73

* trace

Minet, J.P. and J.B. Perodou. 1978. Predation of cod, *Gadus morhua*, on capelin, *Mallotus villosus*, off eastern Newfoundland and in the Gulf of St. Lawrence. ICNAF Res. Bull. No. 13. pp. 11-20.

Reference (#)	Minet and Perodou 1978 (57)
Purpose of study	defines main characteristics of predation on capelin
Predator	*Gadus morhua* Atlantic cod
Predator size	16-115 cm
Dominant prey	crustaceans, fish (capelin *Mallotus villosus*)
Prey size	
Location	southwest and west coast of Newfoundland (3Pn, 4R); northeast Gulf
	of St. Lawrence (4R, 4S); west coast of Newfoundland (4R) and off
	Labrador and east coast of Newfoundland (2J, 3K, 3L)
Time of year	3Pn and 4R: 17 Jan - 24 Feb 1975; 4R, 4S: 8 Jul - 7 Aug 1975;
	4R, 2J, 3K, 3L: 8 Jan - 27 Feb 1976
How prey quantified	percent weight, percent occurrence, fullness index (determined visually)
Number of stomachs	n=1,307
Depth	3Pn, 4R, 4S: 95-315 m; 2J, 3K, 3L: 130-445 m
Bottom type	
Prey energetics	

Fish occurred in 82% of the stomachs examined, crustaceans in 45%, and molluscs in 6%. Important fish (as percent occurrence) in the diet were: capelin (75%), redfish (15%), lantern fishes (8%), American plaice (2.3%), Greenland halibut (1.6%), cod (1.5%) and herring (1.2%). Important crustaceans were: *Parathemisto gaudichaudii* (38%), *Pandalus borealis* (38%), euphausids (15%; *Meganyctiphanes norvegica* and *Thysanoessa* sp.), *Anonyx nugax* (14%), shrimps (9%; *Pandalus montaugi*, *Sabinea sarsi*, *Spirontocaris* sp.) and crabs (9%; *Hyas* sp. *Chionocetes opilio*).

The proportion of the diet consisting of fish in winter (91% by weight) and summer (93% weight) in NAFO Divisions 3Pn, 4R and 4S was very similar with capelin being the single most important component (78% in summer and 59% in winter). There was also very little seasonal difference in the proportion of crustaceans in the diet (7% in summer and 6% in winter). In NAFO Division 3L (northern Grand Bank) fish formed the greatest part of the diet in both summer (94%) and winter (94%) due primarily to predation on capelin (90% in summer, 82% in winter). The rest of the diet consisted of other fish, squid, and crustaceans (3% in summer, 6% in winter). Off northeast Newfoundland (Division 3K) fish formed the greatest part of the diet in summer (74%) and in winter (53%) due mainly to predation on lanternfishes (59 and 24% respectively). Crustaceans formed 24% of the summer diet (11% amphipods, 11% *Pandalus borealis*). Off southern Labrador (Division 2J) the diet in summer consisted largely of crustaceans (73%) with fish (23%) as the second most important component. In winter this was reversed (72% fish, 23% crustaceans). Crustaceans in the summer diet consisted of crabs (41%) and *Pandalus borealis* (24%) whereas this group was represented in the winter diet by amphipods (13%) and *Pandalus borealis* (10%). Annelids, molluscs, and echinoderms were sometimes present but in very small quantities.

The diet of young cod (16-25 cm; present in only 2J, 3K, 3L) consisted mainly of small crustaceans (89%; *Parathemisto gaudichaudii* [36%], small shrimps [29%] and gammarids [17%]). Polychaetes (9%) and capelin (2%) formed the remainder of the diet. In cod >25 cm the diet was essentially composed of fish (72-99%) in both regions (2J, 3K, 3L and 3Pn, 4R, 4S) except in four cod (86-95 cm) in which the stomach contents consisted almost entirely of crabs (66%) and cephalopods (30%).

Moore, J.W. and I.A. Moore. 1976. The basis of food selection in flounders, *Platichthys flesus* (L.) in the Severn Estuary. J. Fish. Biol. 9:139-156.

Reference (#)	Moore and Moore 1976 (58)
Purpose of study	describes seasonal change in diet, compares diet with local availability of prey
Predator	*Platichthys flesus* flounder
Predator size	most from 6-35 cm, some < 6 cm, some > 20 cm
Dominant prey	predator < 6 cm: *Neomysis integer* regardless of month predator 6-35 cm: *Nereis diversiocolor* (Feb); *Gammarus salinus* (Feb-Apr); *N. integer,* and *Crangon vulgaris* (May-Nov)
Prey size	Depends on prey species taken and time of year. Size of prey taken is best summarized in Table 1 (p. 144) of Moore and Moore (1976).
Location	Severn Estuary, U.K.
Time of year	December 1973 to November 1974
How prey quantified	percent dry weight, percent numbers
Number of stomachs	15-20 fish collected every 2 weeks for c. 12 months
Depth	not indicated, fish from cooling intake of a power plant
Bottom type	fine sand, coarse gravel with rocks measuring up to 10 cm
Prey energetics	

Flounder between 6-35 cm taken from February to October fed predominantly on three species: *Gammarus salinus, Neomysis integer, and Praunus flexuosus.* It was concluded that *G. salinus* was consumed in roughly the same proportion as it occurred in the environment. It represented 40% of the stomach contents in April, this decreased to 5% in September and increased to 35% in October. The average length of *G. salinus* in stomachs was >1.2 cm however specimens collected from the local habitat were smaller, 0.5-1.0 cm. Much the same pattern was exhibited for *N. diversiocolor. Neomysis diversiocolor* represented 12% of the diet in February and this increased to 80% in August-September and declined to 20-25% in October. *Praunus flexuosus* occurred more frequently in the diet than in the environment. This was suggested to be due to it never concealing itself among seaweed and because it exhibited a limited escape response as shown in laboratory experiments.

Secondary prey, normally of little importance but that were occasionally taken in large quantities, included: *Crangon vulgaris, Corophium volutator, Eurydice pulchra,* and *Nereis diversicolor. Crangon vulgaris* was seldom taken even though this species was common in the environment. This was attributed in part due to size selection and to its unique escape reaction. It was the longest prey (up to 4 cm) taken by flounders. Flounders restricted themselves to small specimens of *C. vulgaris* presumably because of limitations of predator mouth size and because larger specimens could escape with little difficulty. In laboratory experiments large *C. vulgaris* were easily detected by flounders, however at the moment of contact *C. vulgaris* tried to escape with sharp turns traveling at least 15 cm away from the predator in one second. Escape under clear water conditions occurred in 55% of encounters. Escape approached 100% in turbid conditions. Water temperature (12-25°C) had no effect on capture of *C. vulgaris.*

Corophium volutator was seldom observed in the environment but accounted for 5-10% of the stomach contents in May-June. This species lives "in the bottom" and hence in the same habitat as flounders. Lab experiments demonstrated that flounders caught most prey when they occurred within a few cm of the substratum. *Corophium volutator* was seldom taken because large numbers of suitable non burrowing polychaetes were available hence there was no need to search for relatively inaccessible burrowing forms.

Nereis diversicolor in February represented 30-44% of the total stomach contents (by number). This is very high and is a departure from the normal feeding pattern due to the fact that at low temperatures, flounders are only able to catch sedentary prey reflecting the influence of low temperature on metabolic rate. Molluscs, present in the environment in small numbers were never taken. The only fish taken were eel elvers (*Anguilla anguilla*).

The closest this study comes to indicating which prey were most valuable is when stomach contents are expressed in terms of dry weight, instead of numbers of prey items (above). In terms of dry weight *C. vulgaris* formed by far (>70%) the most important component of the diet during April and from

August to October but at other times were of minor importance. *Nereis diversicolor* was the most important food early in the study (February-March) and represented 63.5% of the stomach contents. *Praunus flexuosus* occurred most abundantly in the stomachs from May to July and accounted for 48-63% of the diet. *Neomysis integer* ranked second at this time (24-38%), followed by *Gammarus salinus* (5-10%) and *Eurydice pulchra* (0-8%).

The diet of flounders <6 cm consisted entirely of *N. integer, G. salinus, and C. volutator*. In terms of dry weight *N. integer* accounted for 63% of the stomach contents, followed by *G. salinus* (25-31%) and *C. volutator* (4-6%). Both the average and maximum length of *N. integer* corresponded to those in the environment. Ingested *G. salinus* were usually larger than those present in the environment. *Corophium volutator* averaged 0.4 cm (range 0.3-0.6 cm) in both the stomach and environment. Such small prey was never taken by larger flounder but, as demonstrated in laboratory experiments, small flounders are highly efficient in detecting and ingesting organisms of this length.

This study conducted laboratory feeding experiments in which flounders appeared to use visual stimuli to find prey. Flounder normally moved across the bottom in short hops with pauses of variable length presumably searching for food. The exact moment of detection of prey was distinct and usually characterized by rapid eye movement, a quick alignment of the body with the prey and a dash with little hopping movement.

Moore and Moore (1976) observed that flounder generally took those prey of suitable length that were available to them. However feeding was also influenced by: (1) the spatial distribution of prey in the water column (prey were not detected if greater than 15 cm up in the water column. This observation was independent of water turbidity, (2) prey degree of concealment, i.e., prey within c. 3 cm of the bottom were generally taken over those borrowing in the sediment, (3) degree of motility and ability to escape predation, (4) hunting efficiency of fish, (5) conditioning for certain foods, and (6) the turbidity and water temperature, i.e. high turbidity and low temperature (<8°C) resulted in reduced prey capture of some organisms.

Ntiba, M.J. and D. Harding. 1993. The food and feeding habits of the long rough dab *Hippoglossoides platessoides* (Fabricius 1780) in the North Sea. Neth. J. Sea Res. 31:189-199.

Reference (#)	Ntiba and Harding 1993 (59)
Purpose of study	compares prey with other east and west Atlantic populations
Predator	*Hippoglossoides platessoides* long rough dab
Predator size	5 cm to >30 cm
Dominant prey	decapods, polychaetes, and ophiuroids
Prey size	for fish prey only; fish prey increase in length with increasing predator length
Location	North Sea
Time of year	monthly collections (except Apr, Sep, Oct) in 1987
How prey quantified	percent weight
Number of stomachs	n >522
Depth	
Bottom type	
Prey energetics	

The annual diet of the long rough dab (=plaice [*Hippoglossoides platessoides*] in the north west Atlantic) can be summarized as follows: crustaceans (48%), polychaetes (25%), fish (12%), molluscs (5%), and echinoderms (4%). Among the crustaceans the decapod genera *Crangon* and *Pandalus* were the most important. Polychaetes were not identified to a lower level. Among the fish prey, gobies and rocklings were the most important. Brittle stars, star fishes, and sea urchins were all represented in the echinoderm portion of the diet. Brittle stars (not identified to species) were the most important being present in three of the nine months sampled and accounted for a monthly average of 3.0% of the diet. Among the Mollusca the following genera were identified: *Tellina* sp., *Ensis* sp., and *Cardium* sp. *Tellina* was the most important but it did not represent >5.5% of the diet in any one month. Monthly variation in the diet may indicate that dab are feeding selectively but Ntiba and Harding (1993) state that it is logical to assume that the types of food eaten may be an indicator of prey availability.

Feeding intensity, as judged by the percentage of feeding fish was lowest in January (31%). It increased rapidly after peak spawning in April to levels of 90% in May to July. The proportion of feeding fish fell below 50% in August and further declined to <40% late in the year.

The long rough dab starts feeding early in the day and probably continues feeding until about 1800 hr. This observation is independent of predator size as the same pattern was observed for three size classes of dab (10-14, 15-19, and 20-24 cm).

At relatively large spatial scales (east central North Sea vs. west central North Sea) the diets of the long rough dab differed with fish (66% by weight) being most important in the east and crustacea (55%) being most important in the west. The proportion of echinoderms (9-10%), molluscs (2-5%) and polychaetes (18-19%) in the diet changed very little.

Olla, B.L., A.J. Bejda and A.D. Martin. 1975. Activity, movements and feeding behavior of the cunner, *Tautogolabrus adspersus* and comparison of food habits with young Tautog, *Toutoga onitis* off Long Island, New York. Fish. Bull. U.S. 73:895-900.

Reference (#)	Olla et al. 1975. (60)
Purpose of study	describes movements and feeding habits
Predators	*Tautogolabrus adspersus* cunner; *Toutoga onitis* tautog
Predator size	*T. adspersus*, 63-240 mm TL; *T. onitis*, 105-260 mm TL
Dominant prey	*T. adspersus: Mytilus edulis, Idotea baltica; T. onitis: Idotea baltica;*
Prey size	
Location	Long Island, New York
Time of year	May to October 1973
How prey quantified	percent volume
Number of stomachs	*T. adspersus*, n=64; *T. onitis*, n=39
Depth	2-10 m
Bottom type	
Prey energetics	

Two major food items, *Mytilus edulis* (24.8%) and *Idotea baltica* (44.8%) comprised the bulk of the food taken by cunner from May to October in 2-10 m off Long Island, New York. Young tautog fed almost entirely (81.7%) on *Mytilus edulis* which was the dominant prey throughout the May to October sampling period. There was a pronounced seasonal shift in the diet of cunner with *M. edulis* representing 57.1% of the diet in May-June but only 4.3% and 13.0% respectively in July-August and September-October. The diet was dominated by *Idotea baltica* in July-August (72.1%) and in September-October (61.7%). Fish were the second most important component of the cunners diet (13.6%). This was followed by brachyurans (8.7). Fish and brachyurans showed relatively little seasonality in the diet of cunner.

Packer, D.B., L. Watling and R.W. Langton. 1994. The population structure of the brittle star *Ophiura sarsi* Lutken in the Gulf of Maine and its trophic relationship to American plaice (*Hippoglossoides plattessoides* Fabricius) J. Exp. Mar. Biol. Ecol. 179:207-222.

Reference (#)	Packer et al. 1994 (61)
Purpose of study	describes population structure of a brittle star and its trophic relationship with a dominant predator
Predator	*Hippoglossoides plattessoides* American plaice
Predator size	most between 22-48 cm TL
Dominant prey	brittle stars, primarily *Ophiura sarsi*
Prey size	most brittle stars between 1-12 mm, maximun size is 28 mm
Location	22 km offshore in the Gulf of Maine
Time of year	Jul and Nov 1985, Jan, Apr, May, Jul, and Aug 1986.
How prey quantified	percent occurrence, percent weight
Number of stomachs	n=74, 18 (24.3%) were empty
Depth	148-156 m
Bottom type	poorly sorted silt-clay
Prey energetics	some references to caloric content of prey

Brittle stars, primarily *Ophiura sarsi* (but also *O. signata*) formed the bulk of the diet of American plaice throughout the year just offshore in the Gulf of Maine. Brittle stars and brittle star fragments occurred in >65% of the stomachs and accounted for >80% of the diet (by weight). The size (disk diameter) of ingested brittle stars indicated that plaice were primarily taking the smaller and more abundant brittle stars between 3-13 mm. This was true for all size classes of plaice. It is suggested that the high proportion of small relatively energy poor brittle stars in the diet reflects the greater availability or accessibility of this food type in the environment. The high proportion of brittle star fragments in the diet suggests this may be indicative of sublethal predation by arm cropping, however Packer et al. (1994) suggest that this form of predation is not important and that plaice are taking brittle stars in their entirety. The only other prey in stomachs of plaice was the bivalve *Yoldia thraciaeformis* (3% weight), gastropods (<1%), *Meganyctiphanes norvegica* (8.4%), *Pandalus borealis* (3.0%), and fragments of polychaetes (<0.5%). *Yoldia* were only taken by plaice >40 cm.

Palsson, O.K. 1983. The feeding habits of demersal fish species in Icelandic waters. Journal of the Marine Research Institute, Reykjavik. Rit Fiskideildar 7(1):1-60.

Reference (#)	Palsson 1983 (62)
Purpose of study	describes feeding habits of demersal fish
Predators	*Gadus morhua* Atlantic cod; *Melanogrammus aeglefinus* haddock; *Anarhichas lupus* catfish (or wolffish); *Sebastes marinus* redfish; *Hippoglossoides platessoides* plaice
Predator size	*G. morhua*: 10-110 cm; *M. aeglefinus*: 15-75 cm; *A. lupus*: 8-75 cm; *S. marinus*: 8-52 cm; *H. platessoides*: 8-45 cm;
Dominant prey	described below
Prey size	fish prey of *G. morhua* measured
Location	coastal waters of Iceland
Time of year	usually March, July, October-November
How prey quantified	percent weight, displacement volume
Number of stomachs	100s to 1000s, depends on predator
Depth	no information provided other than coastal waters of Iceland
Bottom type	
Prey energetics	

Despite the pronounced seasonal, regional, and year to year variations in diet, **cod** from Icelandic waters showed the same pattern of predation typical of cod off Newfoundland and Nova Scotia. The diet of cod <30 cm was predominantly a mixture of benthic prey, shrimp (primarily *P. borealis*) and euphausiacea, the contributions of which decreased in favour of fish (capelin, redfish, smaller cod, and *M. poutassou*) at 40-60 cm. An important feature of the feeding of cod is its general preference for pelagic fish prey. As a consequence the feeding of cod is apparently closely linked to the migration periods and spawning of these prey species (e.g., capelin).

Benthic prey groups were the principal food of **haddock**. Zooplanktonic prey was usually only important for the smaller haddock. As far a predation on other fish is concerned the larger haddock can be classified as facultative fish consumers. Seasonal and year to year variations in the prey depend on occurrence of capelin and other fish as prey for the larger haddock. Predation on capelin results in a decreased importance of benthic prey, particularly Echinodermata. In general benthic prey (polychaeta, ophiuroidea, echinodermata) were the important food of haddock in all seasons.

Benthic prey (particularly Ophiuroidea) provided the bulk of the food for **catfish** in all seasons. However this prey became less important and predator length increased. In the upper length range (c. >50 cm) a variety of other benthic prey (gastopods, *Eupagurus*, bivalvia, brachyura) were recorded in comparable amounts although somewhat variable with respect to seasonality. In October-November some nektonic species (not specified) became the predominant prey. In this season, the diet was highly variable. This might be related to reduced feeding activity of the catfish in early winter as the result of tooth exchange. Overall the diet is primarily benthic in nature. The catfish feeds upon relatively robust and stationary animals. The largest catfish might be classified as occasional fish consumers.

Zooplanktonic prey provide the bulk of the food of **redfish** in Icelandic waters. With the exception of the smallest redfish (c. < 15 cm) euphausiacea were of greatest importance in the diet. Large calonoida, (*C. finmarchicus, C. hyperboreus, Parachaeta*) were the predominant food of small redfish particularly in late winter. Sigitta were also commonly recorded in the diet of most length groups in late winter. Seasonal variations in the food composition of redfish however seem to be rather insignificant and mainly confined to a more pronounced occurrence of calanoida in late winter instead of euphausiacea.

The food of the long rough dab (i.e., this is *Hippoglossoides platessoides*, **plaice** of the northwestern Atlantic, NOT *Pleuronectes platessa* of the northeast Atlantic) is primarily of benthic origin with the most important prey (Ophiuroidea) showing limited seasonal variation in the diet. However other prey groups show considerable seasonal and year to year variation in the diet. These prey included Gammaridae and polychaetes which were occasionally abundant in small to medium plaice (< 30 cm). In the largest plaice (>35 cm) fish were occasionally taken.

Pedersen, A.S. 1995. Feeding habits of starry ray (*Raja radiata*) in west Greenland waters. ICES J. Mar. Sci. 52:43-53.

Reference (#)	Pedersen 1995 (63)
Purpose of study	describes food and feeding habits
Predator	*Raja radiata* starry ray
Predator size	8-49 cm
Dominant prey	<20 cm: diet was copepods, gammarids, mysids, polychaetes;
	>19 cm: shrimp and fish
Prey size	redfish and shrimp measured, see below
Location	shrimp fishing grounds off west Greenland
Time of year	Jun to Nov 1990; Aug to Nov 1991
How prey quantified	frequency of occurrence, percent weight and numbers
Number of stomachs	n=1,436
Depth	86-779 m
Bottom type	
Prey energetics	

Crustaceans, primarily copepods, gammarids, mysids, and shrimps (primarily *Pandalus borealis*) were the most important prey items (by number) of *Raja radiata* off west Greenland. Shrimp (*Pandalus*

Pitt, K.T. 1976. Food of yellowtail flounder on the Grand Bank and a comparison with American plaice. ICNAF Research Bulletin No. 12. pp. 23-27.

Reference (#)	Pitt 1976 (66)
Purpose of study	describes diet
Predator	*Limanda ferruginea* yellowtail flounder
Predator size	10-49 cm
Dominant prey	polychaetes and amphipods
Prey size	
Location	Grand Bank (NAFO Divisions: 3L, 3N)
Time of year	no information provided but maybe the same time of year (Mar-Feb, Apr-Jun,
	Jul, Oct-Nov) outlined in Pitt 1973 for American plaice
How prey quantified	percent occurrence, percent wet weight
Number of stomachs	c. 1100
Depth	<91 m
Bottom type	
Prey energetics	

A comparison of stomachs from Divisions 3L and 3N indicated very little difference between the occurrence of food items. Greater quantities of annelids were taken from Div. 3L than in 3N with an opposite pattern observed for crustaceans. Overall, as a proportion of the total (weight) of all the stomach contents polychaetes accounted for 38.4% and amphipods 29.3% of the diet. None of the polychaete species were identified to species but free-living, burrowing, and tube-building forms were all observed. Because of rapid digestion some difficulty was encountered in identifying the amphipods; however *Haploops* sp. and *Caprella* sp. were recognized. Echinoderms consisted almost exclusively of small brittle stars (*Ophiura sarsi, O. robusta*), sand dollars (*Echinarachnius parma*), and sea urchins (*S. droebachiensis*). Echinoderms represented 7% of the total weight of food and occurred in about 12% of the stomachs. Isopoda and mollusca occurred in 7.2% and 5.2% of the stomachs respectively but both represented a minor proportion of the total weight (2.8 and 0.8% respectively). 1.2% of stomachs contained fish, but fish represented 7.5% of the total weight of the stomach contents. Capelin (*M. villosus*) and sand lance (*Ammodytes americanus*) were the fish species present in approximately equal amounts.

Except for echinoderms, which were less common in smaller fish (<29 cm) there were no major differences in food taken by different size groups. The 10-19 cm group had fewer annelids and crustaceans. The number of fish examined at this size range may be too small (n=15) to give reliable results.

The percentage of empty stomachs was highest in January-March but this was not significantly different from the other time periods (April-June, July-September, October-December). Pitt (1976) reports that yellowtail are active at night and appear to fall into the "non-visual night-feeder category which feed on slow-moving invertebrates".

Powles, P.M. 1958. Studies of the reproduction and feeding of Atlantic cod (*Gadus collarias* L.) in the southwestern Gulf of St. Lawrence. J. Fish. Res. Board Can. 15:1383-1402.

Reference (#)	Powles 1958 (67)
Purpose of study	describes diet, maturity, and fecundity
Predator	*Gadus callarias* (=*G. morhua*) Atlantic cod
Predator size	five length classes: 11-30, 31-50, 51-70, 71-90, 91-120 cm
Dominant prey	<30 cm: pelagic mysids, euphausids, amphipods; fish and benthic invertebrates became important with increasing size of predator
Prey size	
Location	in vicinity of Chaleur Bay, southern Gulf of St. Lawrence
Time of year	May to September, 1955, 1956
How prey quantified	percent occurrence and percent volume
Number of stomachs	n=620
Depth	
Bottom type	
Prey energetics	

The diet with respect to size of predator is best summarized below (1955 upper, 1956 lower). The data (from Powles 1958) are expressed as percent occurrence. The percentages are therefore not additive.

Length	Annelids	Echinoderms	Crustaceans	Fish	Molluscs
11 to 30	4.3	4.3	91.6	8.6	6.1
31 to 50	15.5	7.1	83.9	17.2	22.7
51 to 70	21.7	20	76.3	39.4	30.2
71 to 90	3.5	17.8	75.1	57.1	17.8
11 to 30	10.4	1.5	96.5	8.9	2.2
31 to 50	21.2	10.6	89.3	29.7	15.9
51 to 70	28.8	7.9	81.4	52.2	35.3
71 to 90	37.1	8.7	69.2	61.2	45.1
91 to 120	16.6	8.3	75.1	66.6	33.3

With increasing size the occurrence of stomachs containing crustaceans decreases while fish and molluscs increase in importance. The most important crustaceans in the diet of cod <30 cm included the mysid *Mysis mixta*, and the euphausids *Meganyctiphanes norvegica*, *Thysanoessa raschii*, and *T. inermis*. The largest cod within the 11-30 cm size class took large numbers of decapods which accounted for 19.5% of the diet of 21-30 cm cod. Important decapods included *Pandalus montagui, Spirontocaris, Argis dentata,* and *Cragon.*

The percent volume of crustaceans decreased with increasing size of cod >30 cm. Mysids, decapods (hermit crab, *Pagurus acadianus*), and euphausids were the most important crustaceans in the diet of cod 51-70 cm and accounted for c. 40% of the diet. The mollusc component of the diet was most important for cod between 51-70 cm when it represented c. 20% of the total volume. The most common forms of molluscs (not quantified at the species level) were the whelk, *Buccinum undatum*, a pelecypod *Yoldia* sp., and the bank clam *Cytodaria siliqua.* Molluscs represented only c. 5% of the diet of cod <30 cm, 15% at 31-50 cm, 20% at 51-70 cm, and c. 15% at 71-100 cm. The next most important invertebrate groups were annelids and echinoderms which each accounted for c. 10% of the diet in cod of 31-50 cm. These two groups together also contributed approximately 20% of the diet for larger cod. The only species that is identified is the brittle star *Ophiopholis aculeata* which was found in large numbers (but not quantified) in the stomachs. A conservative estimate of 5% was estimated for coelenterates in the diet. Fish represented 25% of the diet in cod 31-50 cm, 32% from 51-70 cm and 69% in cod >71 cm and was volumetrically the most important prey of cod. Herring was the single most important fish prey taken.

Interestingly, once the different prey are identified as to their primary habitat, either pelagic or benthic, it is evident that the prey are primarily pelagic for cod from 11 to 100 cm. Even for the largest cod the pelagic benthic ratio is approximately 50/50 indicating cod in the southern Gulf of St. Lawrence rely predominantly on a pelagic food source throughout their life.

Length	P/B ratio %
11 to 20	92/8
21 to 30	81.8/18.2
31 to 50	68.1/31.9
51 to 70	62.6/37.4
71 to 100	49.6/50.4

Nearly all the prey showed similar abundances in the stomach contents of cod <30 cm collected in four different locations (Shippegan Gully, Miscou Island, Chaleur Bay, Bonaventure Island) in 1956. Teleosts varied from 34.7-44.9% of the diet at these four locations, crustacea 29.4-34.4% , echinoderms 0-5.3%, molluscs 6.9-14.7%, annelids 1.9-5.3%, and coelenterates 0-13.8%.

Monthly variation in the diet also remained relatively constant during the three months (June, July, and August) that cod were collected.

Powles, P.M. 1965. Life history and ecology of American plaice (*Hippoglossoides platessoides* F.) in the Magdalen Shallows. J. Fish. Res. Board Can. 22:565-598.

Reference (#)	Powles 1965 (68)
Purpose of study	biology (including feeding) is described
Predator	*Hippoglossoides platessoides* American plaice
Predator size	two size groups discussed: 11-30 cm, 31-70 cm
Dominant prey	< 30 cm: mysids, amphipods, small echinoderms, and annelids;
	31-70 cm: echinoderms and pelecypods
Prey size	
Location	southern Gulf of St. Lawrence (NAFO Div. 4T)
Time of year	May-Oct 1956, May-Jun 1960, Sep-Oct 1960, Jan-Feb 1961
How prey quantified	precent occurrence, percent volume
Number of stomachs	n=545
Depth	
Bottom type	
Prey energetics	

Plaice <30 cm feed mainly on mysids (33% occurrence), amphipods (25%), small echinoderms (c. 25%; mostly *Ophiura sarsi, O. robusta*), and annelids (20%; primarily small polychaete worms). Pelecypoda, Euphausiacea, Caprellidae, Cumacea, and Teleostei were all present but occurred in <10% of plaice stomachs. Large plaice took mainly echinoderms (50% occurrence) and pelecypods (25%). Amphipods and polychaetes occurred less frequently and volumetrically were less important than echinoderms and pelecypods. The most important echinoderms taken by large plaice were *Ophiopholis aculeata, Echinarachnius parma,* and *S. droebachiensis*. Pelecypods included *Yoldia myalis, Nuculana tenuisulcata, Clinocardium ciliatum,* and *Serripes groenlandicus*. Fish were present in <5% of the stomachs examined in the southern Gulf of St. Lawrence.

Seasonal changes in the diet: Feeding was reduced in winter when 93.1% of the stomachs examined were empty. Moderate feeding was observed in November and in April. These seasonal changes in feeding occurred among all sizes of plaice.

Rodriguez-Marin, E. and E. De Cardenas. 1979. Feeding of Greenland halibut (*Reinhardtius hippoglossoides*) in 3LMNO NAFO regulatory Area Divisions (Northwest Atlantic), 1991-94. NAFO SCR Doc. 97/37. Serial No. N2869. 10 pp.

Reference (#)	Rodriguez-Marin and De Cardenas 1979 (69)
Purpose of study	describes diet
Predators	*Reinhardtius hippoglossoides* Greenalnd halibut
Predator size	<30 cm to >90 cm
Dominant prey	<60 cm: primarily crustaceans and molluscs; >60 cm: fish and fish offal
Prey size	
Location	Flemish Pass and the slope of the Grand Bank (3L, 3M, 3NO)
Time of year	May 1992 - Dec 1994
How prey quantified	frequency of occurrence
Number of stomachs	n=18,527
Depth	< 800 m to >1200 m
Bottom type	
Prey energetics	

Approximately 60 cm appears to be a critical size for Greenland halibut when a change in diet composition is observed from primarily crustaceans and molluscs to fish and fish offal. This size related change in diet occurs in all fishing areas examined (3L, 3M, 3NO). Small halibut have a higher diversity of prey than larger halibut. The diet of Greenland halibut appears to be mostly pelagic or prey that are loosely associated with the bottom. Cephalopods were the most important prey in 3L and 3M at predator sizes <60 cm with cephalopods and fish being most important at <60 cm in Divisions 3NO. This difference between divisions is due to the consumption of capelin (*Mallotus villosus*) in Divisions 3NO. Fish offal is the second most important prey group in all divisions for halibut >60 cm. Decapod crustaceans made up the third most important prey group in 3LM for halibut <60 cm. Decapod crustaceans were the second most important taxa in of halibut <60 cm in division 3NO.

At depths <1000 m and for halibut <60 cm there is a significant change in the diet due to an increase in the consumption of cephalopods and a decline in fish prey with increasing depth. Decapod crustaceans are important at depths <800 m for all halibut size classes however their importance decreases as depth and length of predator increase. The only crustaceans identified to species include: *Acanthephyra pelagica, Pandalus borealis, Pasiphaea tarda, and Plesiopenaeus edwardsianus*. Amphipoda, Hyperiidae, Copepoda, brachyura, Bivalvia, and gastropods were present in <0.5% of stomachs examined. The importance of fish, fish offal, and molluscs (primarily cephalopods) is summarized below as frequency of occurrence for Greenland halibut <60 and >59 cm in the indicated NAFO Divisions.

	3L	3L	3M	3M	3NO	3NO
	<60 cm	>59 cm	<60 cm	>59 cm	<60 cm	>59 cm
Fish	35.8	51.5	35.1	62.4	55	62.3
Crustacea	20.4	3.5	8.6	0.9	22.8	3.7
Mollusca	41.2	8.6	50.2	7.1	20.6	10.7
Other	2.9	4.7	3.7	3.7	1.1	0.6
Offal	5.7	40.4	6.4	35.9	4.1	31.3

Santos, J.D. and S. Falk-Petersen. 1985. Seasonal changes in the stomach weight content of cod (*Gadus morhua*) from sub-arctic fjords. ICES C.M. 1985/G:25.

Reference (#)	Santos and Falk-Peterson 1985 (70)
Purpose of study	describes stomach contents
Predator	*Gadus morhua* Atlantic cod
Predator size	most cod were between 40-100 cm
Dominant prey	Balsfjord: *Mallotus villosus*, capelin; krill (species not identified)
	Ullsfjord: krill and shrimp (species not identified)
Prey size	
Location	Balsfjord and Ullsfjord, northern Norway, c. 70°N
Time of year	October 1982 to September 1983
How prey quantified	total number and wet weight of each prey species / stomach
Number of stomachs	Balsfjord: n=850; Ullsfjord: n=600
Depth	Balsfjord: depth > 200 m; Ullsfjord: depth > 150 m
Bottom type	all samples collected on soft bottom deep water areas
Prey energetics	includes references on calorfic content of prey

The findings of this study are very similar to those of Klemetsen (1982). This study adds information on how the diet of cod changes with respect to predator size. The switch from a primarily crustacean diet to a primarily fish diet occurs at c. 25-30 cm when the proportion of fish (primarily capelin, *Mallotus villosus*) increases from c. 30% by weight to c. 90% at 70-100 cm. In Ullsfjord just to the south of Balsfjord the proportion of crustaceans to fish in the diet is reversed with increasing predator size. Capelin and other fish is at its highest in the diet at predator lengths of 15-20 cm where fish represent approximately 40% of the diet by weight. This decreases to about 7% for cod between 70-100 cm. At 15-20 cm crustaceans account of 60% of the diet. This increases to c. 75% at 70-100 cm.

Schaefer, R.H. 1960. Growth and feeding habits of the whiting or silver hake in the New York Bight. New York Fish and Game Journal 7:85-98.

Reference (#)	Schaefer 1960 (71)
Purpose of study	describes aspects of the life history, including feeding
Predator	*Merluccius bilinearis* silver hake
Predator size	c. 25-50 cm
Dominant prey	amphipods, shrimp, and fish
Prey size	
Location	Long Branch Pier (New Jersey) and "Mud Hole" off the coast of N.J.
Time of year	Dec 1957 to Jan 1958, and Feb to May 1958
How prey quantified	frequency of occurrence, percent number and volume
Number of stomachs	n=338
Depth	
Bottom type	
Prey energetics	

Stomachs containing amphipods (29.2%), decapods (21.2%; primarily *Crangon septemspinosus*), and fish remains (24.0%) occurred more frequently than stomachs containing any other prey types at Long Branch Pier in December and January. Amphipods (2.44%) and *Crangon septemspinosus* (6.55%) only accounted for a small portion of the diet (as did all invertebrates combined) when expressed as percent volume. All invertebrates combined (Mysidacea [0.28%], Cumacea [0.02%], Isopoda [0.05%], Decapoda [6.63%], and Polychaeta [0.03%]) only represented 9.45% of the diet by volume with fish accounting for 90.45%. The most important fish were silver hake (22.7%), glut herring (26.59%; *Pomolobus aestivalis*), and silversides (23.37%; *Menidia menidia*).

Offshore in much deeper water, invertebrates were more important than they were inshore (27.8% volume) however most of the diet (72.2%) consisted of fish. *Crangon septemspinosus* (16.55%) and the squid *Loligo pealii* (10.05%) accounted for the bulk of the invertebrate diet. The three most important fish

species were silver hake (33.71%), glut herring (8.35%; *Pomolobus aestivalis*) and *Phycis chuss* (8.89%; = *Urophycis chuss*, red hake). All other fish prey accounted for <5% of the diet.

Scott, J.S. 1973. Food and inferred feeding behavior of northern sand lance (*Ammodytes dubius*) J. Fish. Res. Board. Can. 30:451-454.

Reference (#)	Scott 1973 (72)
Purpose of study	describes behavior and diet
Predator	*Ammodytes dubius* northern sand lance
Predator size	15-31 cm
Dominant prey	copepods, polychaete larvae, euphausiids
Prey size	
Location	Nova Scotia Banks
Time of year	May
How prey quantified	frequency of occurrence, percent volume
Number of stomachs	n=486
Depth	
Bottom type	
Prey energetics	

Sand lance is primarily a pelagic predator. It feeds on copepods (64.9%; mainly *Calanus finmarchicus*), euphausiids (13.9%; mainly *Meganyctiphanes norvegica*) and the larvae of polychaetes (14.9%).

Scott, J.S. 1976. Digenetic trematode parasites and food of winter flounder (*Pleuronectes americanus* (Walbaum 1792)) from the Scotian Shelf and Gulf of St. Lawrence. Tech. Rep. Dept. Enviro. Fish. Mar. Serv., Report No. 618. 9 pp.

Reference (#)	Scott 1976 (73)
Purpose of study	describes diet and parasite load
Predator	*Pleuronectes americanus* winter flounder
Predator size	four size classes: <25, 25-29, 30-34, >34 cm
Dominant prey	fish, polychaetes, and shrimp-like crustaceans
Prey size	
Location	southern Gulf of St. Lawrence (NAFO Div. 4T), Sable Island Bank (4W)
Time of year	summer
How prey quantified	percent frequency of occurrence
Number of stomachs	n=183
Depth	
Bottom type	
Prey energetics	

Stomachs containing fish remains (not identified), polychaetes, small shrimp-like crustaceans (mostly amphipods), and lamellibranchs occurred more frequently than stomachs containing gastropods, isopods, sand dollars, tubeworms, and crabs. Frequency of occurrence of stomachs containing fish was fairly uniform throughout the range of fish lengths examined and for both areas studied. Polychaetes and crustaceans maintained high levels throughout the fish length groups from the Gulf of St. Lawrence but showed lower levels (polychaetes: 8.3-36.4%; crustaceans: 16.7-54.4%) in the Sable Island Bank samples and a decreased occurrence with increasing predator length.

Occurrence of stomachs containing lamellibranchs in the Gulf of St. Lawrence decreased with fish length (93.7 to 10.0%) but showed little change (18.2-25.0%) in the Sable Island samples. Sand dollars were recorded from the Gulf of St. Lawrence fish (and not from the Sable Island Bank fish). Tubeworms, gastropods, and crabs were found in the Sable Island Bank samples but not from flounders from the Gulf of St. Lawrence. These data are summarized as percent occurrence in the table that follows.

Prey	Location	<25 cm	25 to 29 cm	30 to 34 cm	>34 cm
fish	4T	87.5	82	78.7	100
polychaetes	4T	87.5	10	95.7	100
crustaceans	4T	100	100	91.5	100
lamellibranch	4T	93.75	75	31.9	100
sand dollars	4T	25.5	25	12.8	0
tube worms	4T	0	0	0	0
gastropods	4T	0	0	0	0
isopods	4T	6.25	2.5	0	0
crabs	4T	0	0	0	0
fish	4W	0	72.7	96.4	100
polychaetes	4W	0	36.4	25	8.3
crustaceans	4W	50	54.5	50	16.7
lamellibranch	4W	0	18.2	25	25
sand dollars	4W	0	0	0	0
tube worms	4W	50	9.1	10.7	8.3
gastropods	4W	0	0	10.7	25
isopods	4W	0	0	0	0
crabs	4W	0	9.1	0	0

Steele, D.H. 1957. The Redfish (*Sebastes marinus* L.) in the western Gulf of St. Lawrence. J. Fish. Res. Board Can. 14:899-924.

Reference (#)	Steele 1957 (74)
Purpose of study	describes the life history, including feeding
Predators	*Sebastes marinus* redfish
Predator size	31-41 cm
Dominant prey	*Meganyctiphanes norvegica* euphausid
Prey size	
Location	area between the Saguenay River and Cape Gaspe, also the Fox River area; Gulf of St. Lawrence
Time of year	May-Jul and Aug-Sep 1953 and 1954
How prey quantified	percent occurrence, percent volume
Number of stomachs	Cape Gaspe: n=2,645; Fox River area: n=4,096
Depth	depth not stated
Bottom type	
Prey energetics	

Pelagic taxa (21 of 32 species) that made up over 90% (by volume) of the diet were the most common prey type in the stomachs of redfish of the Gulf of St. Lawrence. 87% and 95% of the stomachs examined in the Saguenay River-Cape Gaspe and Fox River areas respectively contained euphausids of four species: *Meganyctiphanes norvegica, Thysanoessa inermis, T. raschii*, and *T. longicaudata*. Euphausids made up > 85% of the diet (by volume) at depths of 102-110 fathoms. This decreased to 55% of the diet at 118-122 fathoms and to <5% at 148-150 fm. No euphausids were taken at depths between 174-176 fm. As euphausids decreased in importance with increasing depth, fish (primarily pelagic species such as herring [*Clupea harangus*] and *Paralepis rissoi kroyeri*) increased in importance. Several other species were present in the stomachs and many of these were also pelagic: *Sagitta elegans* (Chaetognatha), *Aglantha*

digitale (Coelenterata), *Pleurobrachia* sp. (Ctenophora), *Clione limacina,* and *Illex illecebrosa* (pelagic molluscs).

Isopoda (*Munnopsis typicus*), Mysidacea (*Boreomysis tridens, Amblyops abbreviata*), Decapoda (*Pasiphaea multidentata, Pandalus borealis, P. montagui, Pontophilus norvegicus*) and Amphipoda (*Anonyx nugax* [=Gammaridea], *Themisto gaudichaudi, T. abyssorum, Hyperia galba* [=Hyperiidae]) were also present in the stomachs of redfish but with the exception of *Themisto* species contributed very little to the volume of prey.

The diet, as percent volume can be summarized as approximately 70% euphausids, 7% copepods, 6% amphipods (primarily *Themisto*), 4% decapods, 10% fish with the remaining prey being ctenophores and medusae. Redfish feed off the bottom and their food consists almost entirely of deep-water pelagic species.

Steele, D.W. 1963. Pollock (*Pollachius virens* (L.)) in the Bay of Fundy. J. Fish. Res. Board Can. 20:1267-1314.

Reference (#)	Steele, 1963 (75)
Purpose of study	describes biology, including feeding
Predator	*Pollachius virens* pollock
Predator size	six size classes: 8-15, 17-26, 27-40, 41-60, 61-74, 75+ cm
Dominant prey	depends on size but generally fish and euphausids for large predators
Prey size	
Location	Bay of Fundy, Scotian Shelf, Laurentian Channel
Time of year	throughout the year in the Bay of Fundy; Apr, May, Jul - Scotian Shelf; Jan - Laurentian Channel
How prey quantified	percent volume
Number of stomachs	Bay of Fundy: n=1,052; Scotian Shelf and Laurentian Channel: n=344
Depth	
Bottom type	
Prey energetics	

Pollock rely on pelagic food. 0-1 group pollock occur close to shore in very shallow water where the young of the year contained mainly algae-inhabiting organisms (amphipods [c. 75% by volume], insects [c. 10%], and harpacticoid copepods [15-20%]). Many species of amphipods are listed however their importance is not quantified at the species level. Planktonic organisms were of less importance.

1-group pollock had a similar but more restricted diet and consumed more plankton (euphausids [c. 25%] and calanoid copepods [15-20%]). The offshore pollock in the Bay of Fundy are mainly planktonic feeders with euphausids (>75% by volume) especially *Meganyctiphanes norvegica* being by far the most important prey. Large pollock consumed relatively more fish (c. 20%). On the Scotian Shelf in July fish were the dominant prey (>50%) for pollock >41 cm.. On the Scotian Shelf in April-May euphausids (80-100%) and fish (20-90%) were the most important prey. Fish were more important in pollock >61 cm.; euphausids were more important in pollock <61 cm. Laurentian Channel pollock contain large quantities of fish, even at 27-40 cm where fish and euphausids were approximately equally important. The importance of fish increased at sizes >41 cm in the Laurentian Channel. The importance of euphausids decreased with increasing size such that pollock >75 cm only contained <15% euphausids in their diet.

Swan, B.K. and D. Clay. 1979. Feeding study on silver hake (*Merluccius bilinearis*) taken from the Scotian Shelf and INCAF subarea 5. ICNAF Res. Doc. 79/VI/49. Serial No. 5388.

Reference (#)	Swan and Clay 1979 (76)
Purpose of study	describes feeding during fall-winter
Predator	*Merluccius bilinearis* silver hake
Predator size	10-50+ cm; most between 10-19 cm
Dominant prey	crustaceans, fish
Prey size	summarized below
Location	Scotian Shelf and ICNAF subarea 5
Time of year	Oct-Dec 1976, Oct-Nov 1977, Apr 1978, Jun 1978, Oct-Nov 1978 (2 cruises), Oct-Dec 1978
How prey quantified	stomach fullness, volume, number, precent frequency of occurrence
Number of stomachs	n=1,711
Depth	< 100 m to > 400 m
Bottom type	
Prey energetics	

Silver hake were considered to be opportunists and feed on whatever is present at the time of feeding. Crustaceans and other fish made up most of the diet.

Variation in the diet due to depth: The high average volume of food in stomachs at shallower depths seems to indicate optimal feeding at depths <100 m. This obviously depends on the availability of food and it can be hypothesised that <100 m is an optimal depth for crustaceans and smaller fish which make up the majority of food.

Variation in the diet due to predator size: The percentage of fish that are multi-feeding (defined as the proportion of hake feeding on more than one item at a time) increases with length of predator. The proportion of multi feeders increased from 11.1% for hake 10-19 cm to 28.6% for hake >50 cm. The average number and percentage frequency of occurrence of shrimp, mysids, and euphausids per stomach decreases with increasing length of predator. None of these prey were identified to the species level. The percent frequency of occurrence of prey fish increases with length of predator. This is true for both hake (i.e. cannibalism) and other fishes (none of which were identified to species).

Variation in the diet by time of year: Stomach contents separated by length and by month do not show any clear relationships (some months are missing). It appears that during summer shrimp play an important role in the food of fish <40 cm and that small prey fish become important in October-December.

Templeman, W. 1982. Stomach contents of the thorny skate, *Raja radiata* from the northwest Atlantic. J. Northw. Atl. Fish. Sci. 3:123-126.

Reference (#)	Templeman 1982 (77)
Purpose of study	describes diet
Predator	*Raja radiata* thorny skate
Predator size	two size classes: 21-60 cm, 61-102 cm
Dominant prey	mostly fish, followed by decapods (spider and hermit crabs), cephalopods, and polychaetes
Prey size	
Location	west Greenland to Georges Bank, most from off eastern and southern Newfoundland
Time of year	1947-1967, any time of the year
How prey quantified	percent volume
Number of stomachs	n=446
Depth	two depth classifications: 17-200 m, 201-740 m
Bottom type	
Prey energetics	

Fish, including fish offal (17%) made up 74% of the stomach contents by volume. The most important fish prey were: redfish (*Sebastes* sp.) 18%, haddock (*Melanogrammus aeglefinus*) 14%, and sand lance (*Ammodytes* sp.) 12%. Invertebrate food constituted 25% of the stomach contents. The most numerous invertebrate taxa included: crabs (14%, primarily *Pagurus koryeri*, hermit crabs [not identified to species], *Chionoecetes opilio, Hyas araneus, Hyas coarctatus*), cephalopods (5%, primarily *Gonatus fabricii, Illex illecebrosus*), and polychaetes (4%, none identified to species). Spider crabs and hermit crabs were found in 17% and 30% of the stomachs respectively. This was followed by polychaetes (30%), shrimp (17%), and amphipods (12%). Sand lance and capelin occurred in 14% and 7% of the stomachs examined.

Variation in diet due to size of predator: The stomach contents of small skate (21-60 cm) consisted of higher percentages of crabs (22%), cephalopods (20%), polychaetes (11%), and amphipods (4%) than the larger (61-102 cm) skates (14, 3, 3, and 0.1% respectively). Fish prey were more important as food for the larger skates (78% by volume) than for smaller skates (35% by volume).

Variation in the diet due to depth: Fish made up 69% and 82% of the food volume in the depth range 17-200 m and 201-700 m respectively with haddock and sand lance being the most important food fishes at shallow depths and redfish and sand lance at greater depths. Cephalopods were the most important invertebrate food in deep water with crabs being most important in shallow water. Polychaetes occurred in 30% of the stomachs within each depth range.

Variation in the diet due to sampling location: Given that skates were collected from Greenland to Georges Bank it is not surprising that some prey were only recorded from stomachs collected in certain regions. *Gonatus fabricii* occurs only from the Grand Bank northward whereas haddock were most common on the southern Grand Bank, St. Pierre Bank, and southward to Georges Bank.

The observed presence of whelks, mostly without their shells and of some hermit crabs, also without their shells suggests skates can remove the soft parts of these prey without ingesting the shell. Templeman (1982) also suggested that much of the fish prey in skate stomachs came from commercial fishing vessels in the form of fish offal.

Templeman, W. 1984. Stomach contents of the Atlantic wolffish, *Anarhichas lumpus*, from the northwest Atlantic. NAFO SCR Doc. 84/VI/12. Serial No. N785. 6 pp.

Reference (#)	Templeman 1984 (78)
Purpose of study	describes diet
Predator	*Anarhichas lumpus* wolffish
Predator size	30-127 cm
Dominant prey	invertebrates (85%); fish (15%)
Prey size	
Location	west Greenland to Scotian Shelf
Time of year	
How prey quantified	percent volume
Number of stomachs	n=103 + 44 = 147; (44+32=74 contained food)
Depth	
Bottom type	
Prey energetics	

This paper summarizes stomach contents from wolffish from the northwest Atlantic with most stomachs being collected off eastern Newfoundland. Benthic invertebrates were the most important food with whelks (22%, species not identified), Icelandic scallops (12%, *Chlamys islandicus*), crabs (12%), hermit crabs (11%; primarily *Lithodes maia, Hyas coarctatus),* and brittlestars (16%) being the most important. Redfish (*Sebastes* sp.) made up 12% of the 15% vertebrate food.

Whelks occurred in 46% of the stomachs that contained food, scallops in 12%, sea urchins in 30%, hermit crabs in 20%, other crabs in 13%, brittle stars in 20%, and redfish in 9%.

Sea urchins and welk shells were often crushed and some whelks were recorded without their shells. Molluscs, especially whelks and Icelandic scallops increased and echinoderms usually decreased in importance from the smaller to larger fish. Fish were more plentiful as food in the larger than in the smaller wolffish.

Turuk, T.N. and A.I. Postolaky. 1980. Feeding and food relations of some fish species in the Labrador and Newfoundland areas. NAFO SCR Doc. 80/VI/70, Serial No. N118. 9 pp.

Reference (#)	Turuk and Postolaky 1980 (79)
Purpose of study	describes diet overlap in terms of broad prey type catagories (epipelagic etc.)
Predator	15 predators discussed below
Predator size	
Dominant prey	prey discussed in terms of prey habitat (e.g., pelagic, epipelagic, infauna, etc.)
Prey size	
Location	southern Labrador, eastern Newfoundland (NAFO Divs. 2J, 3K, 3L, 3N, 3O, 3M)
Time of year	May to August, 1978
How prey quantified	frequency of occurrence, stomach fullness, coefficient of food similarity
Number of stomachs	n=22,137 stomachs for all species combined
Depth	
Bottom type	
Prey energetics	

The diet is not quantified in this study. The diet is described in terms of the habitat that the dominant prey occupy. Few taxon are identified to species.

Atlantic cod: The food of cod during spring off Newfoundland and Labrador is diverse and consists of both demersal (shrimp, crab, Amphipoda) and pelagic crustacea (*Themisto*, euphausids) in addition to fish such as capelin, sand lance, and lanternfish which are known to be pelagic during some portion of their life.

Redfish: Redfish feed mainly on planktonic organisms. These include copopods, lanternfish, Amphipoda (Hyperidae, *Themisto*) in addition to euphausids. Not one of the redfishes prey can be considered to be purely benthic.

Pleuronectidae and **Anarhichadidae** (American plaice, witch flounder, yellowtail flounder, and northern, spotted and Atlantic wolffishes) were considered to be benthic feeders. Their stomach contents include polychaetes, isopods, molluscs, *Ophiura,* and hedgehog. Polychaetes and molluscs are the main components of the wolffish's food. Wolffish tend to feed on "more coarse bottom food" (*Ophiura* hedgehog, starfish).

Greenland halibut feed mainly off the bottom. The diet includes capelin, sandlance, *Themisto*, euphausids, and shrimp.

Rough head grenadier feed primarily on benthic food that includes: polychaetes, Mysidacea, Isopoda, Ophiura, and bottom shrimp, and squid.

Thorny skate feed on polychaetes, shrimp, Isopoda, crab, and to a lesser degree sand lance.

Blue whiting (= *Micromesistius poutassou*) feed on pelagic food including copepods and *Themisto*. [Blue whiting is an eastern Atlantic species that is seldom reported in the western Atlantic (Scott and Scott 1988). Blue whiting is similar to silver and offshore hakes (Scott and Scott 1988) which sometimes occur on the southern Grand Bank and along the south coast of Newfoundland.]

White hake feed on euphausids and squid.

Tyler, A.V. 1972. Food resource division among northern marine demersal fishes. J. Fish. Res. Bd. Canada 29:997-1003.

Reference (#)	Tyler 1972 (80)
Purpose of study	determines if feeding specializations were evident in demersal fishes
Predators	summarized in the following table
Predator size	summarized in the following table
Dominant prey	summarized in the following table
Prey size	
Location	Passamaquoddy Bay, Bay of Fundy
Time of year	monthly collections from March 1965 to June 1966
How prey quantified	wet weight
Number of stomachs	n=2,323, not broken down by species
Depth	38-55 m
Bottom type	sediments were entirely brown mud on a gentle sloping bottom
Prey energetics	

The dietary composition of each predator is not listed by Tyler (1971). The study focuses on the principle prey of each predator. Over 100 prey species were recorded in this study however each predator only took 3-4 principal prey and these made up 70-99% of the mass of food for each predator. Which species that a predator took as a principal prey depended on prey body size, whether the prey were considered nekton, epifauna or infauna, and whether prey had a hard test or shell. Pincipal prey were considered to be those species that occurred in >10% of the predators stomachs and at a mean quantity >1 g/kg fish on at least one date during the sampling period. This critera reduced the number of prey from >100 to 22 principal species that made up 70-99% of the stomach contents.

The principal prey of each predator are summarized below for the winter and summer fish communities in Passamaquoddy Bay. Predators are arranged so those with most similar diets were adjacent to one another. The median number of principal prey per predator species was four in summer and three in winter suggesting a narrowing of the diet in winter. Tyler (1972) noted that two feeding stanzas within a single species usually consumed prey with similar dwelling habits but of different (prey) body sizes over the size range of predators examined. The principal prey of each predator are summarized in the table immediately below (from Tyler 1972).

	Winter	American plaice (20-45 cm)	Pollock (15-30 cm)	Atlantic cod (15-40 cm)	Longhorn sculpin (15-35 cm)	Little skate (45-55 cm)	Thorny skate (40-65 cm)	Haddock (25-40 cm)	Winter skate (35-85 cm)	Thorny skate (15-39 cm)	Little skate (25-44 cm)		
Nekton	Meganyctiphanes		X	X		X				X			
Nekton	Mysis	X	X	X	X					X			
Epifauna	Pandalus			X	X	X							
Epifauna	Hyas				X	X	X						
Epifauna	Lumpenus					X			X				
Infauna	Aphrodite				X	X	X	X		X			
Infauna	Nephtys					X	X		X		X		
Infauna	Lumbrineris							X	X	X	x		
Infauna	Praxillella	X						X		X			
Infauna	Unciola										X		
Infauna	Yoldia	X											

	Summer	American plaice (20-45 cm)	Atlanticcod (15-45 cm)	Silver hake (15-30 cm)	White hake (28-45 cm)	Longhorn sculpin (15-35 cm)	White hake (15-27 cm)	Fourbeard rockling (15-30 cm	Thorny skate (40-65 cm)	Thorny skate (15-39 cm)	Winter flounder (20-40 cm)	Haddock (25-40 cm)	Ocean pout (20-65 cm)
Nekton	Meganyctiphanes	X	X	X	X	X	X	X		X			
Nekton	Mysis	X			X		X						
Nekton	Clupea	X	X			X							
Epifauna	Pandalus		X	X	X	X							X
Epifauna	Hyas					X							
Epifauna	Crangon				X								
Epifauna	Lumpenus				X				X				
Infauna	Leptocheirus					X	X					X	
Infauna	Maera						X	X					
Infauna	Unciola						X	X		X			
Infauna	Nephtys							X	X	X	X		
Infauna	Aphrodite					X			X	X		X	X
Infauna	Lumbrineris										X	X	
Infauna	Praxillella	X									X	X	X
Infauna	Yoldia	X										X	X
Infauna	Arctica												X
Infauna	Nuculana												X
Infauna	Ophiura												X
Infauna	Musculus												X
Infauna	Venericardia												X

Vinogradov, V.I. 1972. Studies of the food habits of silver and red hake in the northwest Atlantic area, 1965-67. ICNAF Res. Bull. No. 9. pp. 41-50.

Reference (#)	Vinogradov 1972 (81)
Purpose of study	investigates feeding patterns and competition between species
Predators	*Urophycis chuss* red hake; *Merluccius bilinearis* silver hake
Predator size	
Dominant prey	*M. bilinearis* : <40 cm, euphausiids; >40 cm, fish
	U. chuss: <40 cm, *Themisto compressa, Talorchestia longicornis*
	U. chuss: >50 cm, fish, squid, amphipods
Prey size	
Location	ICNAF Divisions 4W, 4X, 5Z, usually along the shelf edge
Time of year	throughout the year, 1965-1967
How prey quantified	frequency of occurrence
Number of stomachs	*Urophycis chuss* , n=5,486; *Merluccius bilinearis* , n=48,001; but of these
	only 16,597 (*M. bilinearis*) and 2,013 (*U. chuss*) contained food.
Depth	in deep water along the shelf edge.
Bottom type	
Prey energetics	

Of the 59 species of prey observed in the stomachs of ***M. bilinearis*** 41 were typically pelagic and bathypelagic species while 18 were benthic or usually associated with the bottom. 62% of all *M. bilinearis* stomachs contained euphausiids, the dominant species being *Meganyctiphanes norvegica* and *Thysanoessa inermis*. Immature *M. bilinearis* were < 28 cm and fed on euphausiids (70-90% occurrence). Euphausiids were still the most common prey item in stomachs of mature *M. bilinearis* up to 35-40 cm however fish were the main prey of *M. bilinearis* >40 cm. Euphausiids and fish were dominant prey regardless of the area sampled or time of year.

Fifty six species were found in the stomachs of **red hake**. Only 8 invertebrates and 8 fishes were considered to be pelagic and bathypelagic. The other 40 species were benthic or usually accocaited with the bottom. The main food of red hake were *Themisto compressa* and *Talorchestia longicornis*, two species of amphipoda that together occurred in 42% of the stomachs examined. Hake <25 cm fed mostly on amphipods. Hake between 26-40 cm still fed on amphipods but took a higher proportion of fish than hake <25 cm. Three prey taxon were important for the largest size group of red hake 51-55 cm: fish (57.2% occurrence), squid (14.3%), and amphipods (28.5%).

Vinogradov, V.I. 1977. Daily feeding rhythms and food rations of the silver hake, *Merluccius bilnearis*, and the red hake, *Urophycis chuss*, in the northwest Atlantic. J. Ichth. 17(4):600-610.

Reference (#)	Vinogradov 1977 (82)
Purpose of study	determines daily ration
Predators	*Merluccius bilinearis* silver hake; *Urophycis chuss* red hake
Predator size	*M. bilinearis:* means 26.5-34.5 cm ; *U. chuss:* means 30.8-34.9 cm
Dominant prey	*M. bilinearis: Thysanopoda acutifrons, M. bilinearis*
	U. chuss: Microdeutopus damnonenis, crabs, herring, *Dendrostoma alutaceum*
Prey size	
Location	"southwest part of the northwest Atlantic" (south of Nantucket)
Time of year	July, August, 1972, 1973
How prey quantified	stomach fullness index, percent weight
Number of stomachs	*M. bilinearis* : n=2,051; *U. chuss* : n=929
Depth	
Bottom type	
Prey energetics	calorific content of prey given in Tables 14 and 15 of Vinogradov (1977)

Sexually immature **silver hake** <30 cm long fed mainly on Amphipoda and shrimps with *Thysanopoda acutifrons* being the most important. Silver hake were also cannabilistic eating hake 20-50% its own length. The main components of the silver hake diet by weight in July 1971 were: *Illex illecebrosus* (22.1%), *Merluccius bilnearis (42.6%)*, and *Scomber scombrus* (15.7%). Fish represented 71.0% of the total silver hake diet. One year later (July, 1972) the composition of the diet was very different with the main prey being *Merluccius bilnearis (8.6%)*, Pandalidae (8.2%), *Thysanopoda acutifrons* (42.0%), Gammaridea (21.0%), and *Mysis stenolepis* (18.4%). The 1972 and 1973 August diets of silver hake were very similar with fish accounting for 87.0% and 88.5% of the diets respectively. Important prey of the diet in 1972 were *Merluccius bilnearis* (68.7%), *Scomber scombrus* (9.7%), *Poronotus tricanthus* (7.0%) and *Mysis stenolepis* (8.2%). Important prey in 1973 were *Merluccius bilnearis* (87.8%) and Polychaeta (4.5%).

The main prey (by weight) of **red hake** in July 1971 were *Microdeutopus damnonensis* (27.2%), Brachyura crabs (22.6%), and herring (22.6%). In August 1973 the most important prey were *Dendrostoma alutaceum* (28.8%), Brachyura crabs (20.1%), *Illex illecebrosus* (20.5%), and *Merluccius bilnearis* (18.1%). Calorific values of prey of silver and red hakes are summarized in Tables 14 and 15 of Vinogradov (1977).

Vinogradov, V.I. 1983. Food relationships between silver and red hakes and other fish species on Georges Bank and in adjacent waters. NAFO SCR Doc. 83/IX/80. Serial No. N746. 21 pp.

Reference (#)	Vinogradov 1983 (83)
Purpose of study	summarizes long term feeding and makes comparisons with other predators
Predators	*Merluccius bilinearis* silver hake; *Urophycis chuss* red hake
Predator size	
Dominant prey	identifed as broad taxon for each type of predator, see below
Prey size	
Location	mid Atlantic Bite to Sable Island
Time of year	throughout the year (?)
How prey quantified	index of stomach fullness, percent weight
Number of stomachs	silver hake: n=12,046; red hake: n=3,928
Depth	
Bottom type	
Prey energetics	

In addition to examining the stomachs of silver and red hake Vinogradov (1983) reports on the diets (described broadly) of other species commonly taken with the hakes. Vinogradov divides predatory fishes common on the fishing grounds of the northwest Atlantic into four borad groups according to their "life habits" and types of prey taken: consumers of plankton, consumers of nekton, consumers of benthos, and consumers of mixed food which is to some extent arbitrary. This division of predatory fishes is given below and is taken from Table 3 of Vinogradov (1983, p. 16).

All pelagic species of predators (except pollock) are closely related to a group of fishes which are primarily consumers of plankton or pelagic species of prey. The food of these species (<90% by weight) was composed of euphausids, mysids, hyperiids, larval decapods, pteropods, ctenophora, and salps. A second group of predators consumes mostly nektonic organisms (<60% weight) consisting of near-bottom species that for the silver hake include mackerel and shortfin squid. A third group of predators were primarily groundfish species that fed mainly on benthic crustacea (<55% weight). Predators not feeding on benthic crustacea were thorny skate (87% fish offal) and haddock (63% echinoderms). The fourth group of predators included gadids and pleuronectids whose diet was characterised as mixed and included nektonic organisms (fish, squid), benthic and nektobenthic (echinoderms, molluscs, ploychaetes, gammarids shrimp) organisms in addition to "macroplankton" (euphausids, mysids).

NOTES: For each species the numbers add up to c. 100 and indicate the approximate composition of the diet by weight of four main prey types: P = pelagic, B=benthos, NB=nektobenthos, N=nekton, T=trace of prey present. (This table from Vinogradov 1983).

		Crustacea (P)	Other (P)	Polychaetes (B-NB)	Crustacea (B-NB)	Mollusca (B-NB)	Echinoderms (B-NB)	Fish (N)	Squid (N)	Other (offal, detritus, unid)
Consumers of Plankton										
Blueback herring	*Alosa aestivalis*	78	22							
Alewife	*Alosa pseudoharengus*	56	37	T	7					
Atlantic herring	*Clupea harengus*	89	11		T					
Round herring	*Etrumeus sadina*	85	9		6					
Atantic argentine	*Argentina silus*	97	3							
Atlantic mackerel	*Scomber scomber*	84	14	T	2					
Butterfish	*Poronotus triacanthus*	46	53		1					
Redfish	*Sebastes* sp	100								
Consumers of Nekton										
Spiny dogfish	*Squalus acanthias*	4			T			78	18	
Silver hake		17		T	2	T		75	6	T
White hake	*Urophycis tenuis*	25		T	10	1	T	64	T	
Sea raven	*Hemitripterus americanus*				6			94		
American goosefish	*Lophius americanus*				T			62	38	
Consumers of benthos										
Little skate	*Raja erinacea*	7		22	60		T	11		T
Big skate	*Raja ocelata*			19	79			2		
Thorny skate	*Raja radiata*			3	5			5		87
Haddock	*Melanogrammus aeglefinus*	1		5	12	2	63	2	9	6
Ocean pout	*Macrozoarces americanus*			11	71	T	7	9		2
Longhorn sculpin	*Myoxocephalus octodecimspinosus*	3		9	84	4				
Yellowtail flounder	*Limanda ferruginea*	3		27	58	T	1		T	11
Winter flounder	*Pseudopleuronectes americanus*			45	55					
Consumers of mixed food										
Atlantic cod	*Gadus morhua*	8		2	38	6	4	26	15	1
Pollock	*Pollachius virens*	70						30		
Red hake	*Urophycis chuss*	6		2	44	6	1	26	7	8
American plaice	*Hippoglossoides platessoides*	T		6	6	10	22	40		16
Fourspot flounder	*Paralichtys oblongus*				74			26		

Silver hake and red hake are in different categories of consumers because nektonic organisms were predominant in the food of adult silver hake (<75% weight) while red hake consumed primarily bottom and near-bottom invertebrates in addition to 1/3 of its diet being fish. *M. norvegica* and *Crangon septemspinosus* were dominant prey to both young silver hake and red hake. The diets of these two species are summarized below. (This table from Vinogradov 1983).

	Silver hake (Georges Bank)	Red hake (Georges Bank)	Silver hake (south New England)	Red hake (south New England)
Percent weight				
pelagic prey, plankton	29	12	3	4
nekton	68	21	92	23
nektobenthos	2	42	5	17
benthos	1	25	T	56

T = trace

Waiwood, K.G., J. Majkowski and G. Keith. 1980. Food habits and consumption rates of cod from the southwestern Gulf of St. Lawrence (1979). CAFSAC Res. Doc. 80/37 17 pp.

Reference (#)	Waiwood et al. 1980 (84)
Purpose of study	determines composition of prey
Predator	*Gadus morhua* Atlantic cod
Predator size	three size classes: 35-55, 56-65, >65 cm
Dominant prey	invertebrates, primarily euphausids, and brachyuran crabs
Prey size	
Location	Shediac Valley, Ste- Marie sur-Mer and Miscou Bank in the southern Gulf of St. Lawrence
Time of year	May-Jul 1979
How prey quantified	percent weight
Number of stomachs	n=215
Depth	
Bottom type	
Prey energetics	

The percent weight of fish prey in the stomachs of cod increased with predator size from 13.5% in 3-4 year olds to 40.3% in age 11+ cod. Important fish prey included capelin (*Mallotus villosus*) and unidentified flatfishes (Pleuronectidae). As the percent weight of stomachs containing fish increased with predator size it decreased from 76.8% (age 3-4) to 31.7% (age 11+) for crustacea prey. Important crustaceans included: Amphipoda, Euphausiidae, and Decapoda (Carida and Brachyura). The percent weight of amphipods generally decreased with increasing predator size, decreased for Euphausiidae (69.0 to 5.0%), was uniform <5% for Carida, and increased for Brachyura (*Hyas araneus, Chionoecetes opilio*) from 3.9% (age 3-4) to 25.1% (age 11+). Molluscs (identified as Pelecypoda and Gastropoda) as percent weight were highest (10.6%) in cod of intermediate sizes (age 7). Annelids and echinoderms always represented <5% (weight) of the diet of any particular age class of cod. Invertebrate prey accounted for 60-90% of the cods diet.

Waldron, D.E. 1992. Diet of silver hake (*Merluccius bilinearis*) on the Scotian Shelf. J. Northw. Atl. Fish. Sci. 14:87-101.

Reference (#)	Waldron 1992 (85)
Purpose of study	describes the diet and determines the extent of cannibalism
Predator	*Merluccius bilinearis* silver hake
Predator size	diet partitioned by age (1-10+), not by size
Dominant prey	crustaceans, fish, and squid
Prey size	
Location	Scotian Shelf, but mostly along shelf edge
Time of year	spring, summer, and autumn, 1981-1986
How prey quantified	percent occurrence and percent weight
Number of stomachs	n=2,855
Depth	
Bottom type	
Prey energetics	

The main food categories of silver hake by occurrence are: fish (13.1%), crustaceans (43.5%), mollusca (2.9%), and echinoderms (0.4%). As percent weight the diet contained fish (48.5%), crustacea (20.3%), mollusca (23.5%), and echinoderms (2.2%). This overall diet was generally similar for male and female silver hake. With increasing size the proportion of fish prey increases in the diet as the proportion of crustacean prey decreases. Greater than 95% of the diet of age 0 silver hake consisted of crustaceans primarily euphausids (*Meganyctiphanes norvegica*) and Pasiphaeidae (individual species not identified). About 15-20% of the diet (by weight) consisted of fish at ages 1 and 2. This increased to >75% by age 7. The most important fish prey were the lantern fishes, a mesopelagic family of vertically migrating species as well as silver hake. Silver hake in the diet increased with increasing predator size and accounted for 79.6% of the diet (age 9) but usually represented 30-40% of the diet of hake greater than age 6. Molluscs, primarily *Loligo* and *Illex* were most important in the diet of age 4-8 hake and accounted for as much as 40% of the diet, usually 10-20%.

Wells, B., D.H. Steele and A.V. Tyler. 1973. Intertidal feeding of winter flounder (*Pseudopleuronectes americanus*) in the Bay of Fundy. J. Fish. Res. Board Can. 30:1374-1378.

Reference (#)	Wells et al. 1973 (86)
Purpose of study	compares prey from the intertidal and adjacent subtidal zone
Predator	*Pseudopleuronectes americanus* winter flounder
Predator size	23-43 cm
Dominant prey	algae and amphipods
Prey size	
Location	Brandy Cove, St. Andrews, Passamaquoddy Bay, Bay of Fundy
Time of year	
How prey quantified	frequency of occurrence, percent wet weight
Number of stomachs	n=84
Depth	c. 4.3-8.5 m; inter and subtidal, within the depth range of SCUBA divers
Bottom type	
Prey energetics	

Six species made up 70% of the diet of intertidal winter flounder. Three of these species were algae which together accounted for 40% of the stomach contents by weight (*Acrosiphonia arcta, Enteromorpha intestinalis, Cladophora sericea*). Other species included: *Gammarus oceanicus* (13.0% weight), the oligochaete *Peloscolex benedeni* (13.2%), *Nereis virens* (7.4%), *Gammarus lawrencianus* (3.3%), *Pilayella* (=*Pylaiella*) *littoralis* (3.3%), and *Amphithoe rubricata* (3.15). Seventy-nine percent of the stomachs contained chironomid larvae (*Cricotopus* sp.) which were entangled in clumps of seaweed.

Five species made up 70% of the diet of winter flounder caught in the subtidal zone. These included: *Pilayella littoralis* (algae), *Leptocheirus pinguis* (amphipod), *Enteromorpha intestinalis* (algae), *Peloscolex benedeni* (oligochaete), and *Mya arenaria* (bivalve). Three species of algae (*Pilayella littoralis*, *Enteromorpha intestinalis* and *Cladophora* sp.) made up 40% of the stomach contents. The percent weights of the other important species were: *Peloscolex benedeni* (8.9%), *Leptocheirus pinguis* (18.8%), and *Mya arenaria* (6.2%).

Wells et al. (1973) suggest that winter flounder are functional omnivores and that it is unlikely that flounder were feeding on the algae solely for the benefit of the chironomid larvae that were entangled in it.

Wigley, R.L. and R.B. Theriou. 1965. Seasonal food habits of highlands ground haddock. Trans. Am. Fish. Soc. 94:243-251

Reference (#)	Wigley and Theroux 1965 (87)
Purpose of study	describes seasonal diet
Predator	*Melanogrammus aeglefinus* haddock
Predator size	25-76.2 cm
Dominant prey	Mollusca and Echinodermata most important
Prey size	
Location	Highlands Ground, 15 miles NE of Provincetown, Massachusetts
Time of year	monthly (except July) from February 1958 to January 1959
How prey quantified	percent weight
Number of stomachs	n=941
Depth	100-120 m
Bottom type	predominantly sand and gravel
Prey energetics	

Variation in diet between sexes: There was no significant difference between sexes in stomach content weight. There were also no important differences between males and females in species preyed upon.

Variation in diet due to predator size: The amount of food in haddock stomachs increased from 0.59 g/stomach (20-29.9 cm haddock) to 5.42 g/stomach (60-69.9 cm). Surprisingly, the largest haddock (70-79.9 cm) had only 2.29 g/stomach. The authors state that this may be due to the small number of stomachs examined from haddock >70 cm. There were marked differences in diet composition in haddock between 29.6 to 68.2 cm. The diet is summarized in the table immediately below. In general the diet of larger haddock was composed of a much higher proportion of crustaceans and fish and a lower proportion of annelids and molluscs. The amount of echinoderms in large haddock was low compared to smaller haddock.

	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9
Crustacea	**18.4**	**21.9**	**36.6**	**42.7**
Amphipoda	10.2	7.6	2.6	35.7
Copepoda		<0.1		
Cumacea	6.9	0.6	0.3	
Decapoda	1.2	13.3	33.5	4.7
Isopoda		0.3	0.2	2.3
Euphausiacea		0.1		
Mollusca	**2.6**	**7.2**	**5.2**	**3.3**
Gastropoda		0.9	<0.1	0.7
Pelecypoda	2.6	6.2	5.2	2.6
Echinodermata	**16.5**	**18.2**	**9.5**	**3.1**
Asteroidea		1.1	0.3	
Echinoidea		9.1	2.6	
Holothurioidea			0.1	
Ophiuroidea	16.5	8.2	6.5	3.1
Annelida	**9.1**	**17.9**	**16.3**	**<0.1**
Nereidiformia	5.1	10.6	9.4	
Sabelliformia			0.1	
Scoleciformia		0.3	1.7	
Spioniformia	1.2	1.2	0.6	
Terebelliformia		0.2	0.5	
Unidentified	2.6	5.6	4	<0.1
Miscellaneous	**<0.1**	**3.3**	**0.1**	**3.5**
Coelenterata				3.5
Nematoda	<0.1	<0.1	<0.1	<0.1
Pycnogonida		<0.1		
Sipunculida		0.4	<0.1	
sand and stone		2.8	<0.1	<0.1
Pisces	**<0.1**	**1.6**	**13.8**	**28.2**
mucus	45.8	17.4	11.8	10.1
unidentified	7.7	12.5	6.8	9.2
number of stomachs	16	52	30	7

The three principal crustacean prey were: amphipods, cumaceans, and decapods. Amphipods and cumaceans are rather small sized animals and they decreased in quantity with increasing haddock size. Decapods are relatively large organisms and they increased in quantity as haddock size increased.

Variation in the diet due to month: There was a pronounced change in the weight of food in haddock stomachs with time of year at the monthly scale. This was due to a striking increase in feeding which took place during June when the mean stomach contents weight increases in all sizes of fish from 2.5g in May to 7 g in June. This increase was most noticeable in the largest haddock and may be related to sexual maturity and spawning activity. Large mature fish tend to slacken their feeding during the spawning season (March to May, peak in April) and then gorge themselves shortly afterward.

Fish and crustaceans exhibited the greatest seasonal variations in the diet. Fish were taken in largest quantities in April and May when they accounted for approximately 45.6% (weight) of the diet. During other months fish were absent or present in small quantities. Crustacea were preyed upon most heavily during the first half of the year when crustaceans averaged c. 30% (weight) of the diet. Very heavy predation took place on amphipods in June when large haddock were eating heavily after spawning. There was no seasonal cycle evident in the consumption of mollusc or miscellaneous prey. Annelids had a

relatively uniform occurrence in the diet throughout the year and ranged from 10.9% (May) to 22.5% (April) of the diet. Echinoderms represented 12-25% of the diet in winter and spring and their importance declined to 2-7% during summer. Echinoderms increased in importance once again in autumn and reached a maximum in January.

Prey were identified to a species level in some cases but their importance as species was not quantified. More than 100 different organisms were identified to species. Haddock typically select small organisms for food. Among the amphipods *Leptocheirus pinguis, Unicola irrorata,* and *U. inermis* were the most important. Juvenile decapods from *Cancer borealis, C. irroratus, Dichelopandalus leptocerus*, and *Hyas coarctatus* were important. The following cumaceans occurred regularly in the diet but only in small numbers: *Diastylis quadrispinosa, Eudorella hispida,* and *Petalosarsia declivis*. Two molluscs that occurred regularly in large quantities were *Cerastoderma pinnulatum* and *Nucula tenuis*. Molluscs of secondary importance included *Margarites*, *Astarte,* and *Nuculana*. *Ophiura sarsi* and *Echinarachnius parma* were the only echinoderms of importance in the diet. The important annelids were *Aphrodita hastata* and *Nephtys* (mainly *incisa*). Annelids of secondary importance were *Glycera* sp., *Lumbrineris fragilis, Goniada maculata*, and *Sternaspis scutata*.

Yanulov, K.P. 1962. Feeding habits of "beaked" redfish (*Sebastes mentella* Travin) in the Newfoundland-Labrador area. ICNAF Redbook 1962 Part III. pp 132-140.

Reference (#)	Yanulov 1962 (88)
Purpose of study	describes stomach contents
Predator	*Sebastes mentella* beaked redfish
Predator size	several size classes: <26 , 26-30, 31-35, 36-40, 41-45, >45 cm
Dominant prey	*Calanus* sp., *Themisto* sp., *Meganyctiphanes norvegica* , *Pandalus borealis*
Prey size	
Location	off Labrador, Newfoundland, and Nova Scotia
Time of year	August 1956 to December 1960
How prey quantified	percent frequency of occurrence
Number of stomachs	n=41,421 of which 12,542 (30%) contained food
Depth	several depth classes: <300 m, 301-400 m, >401 m
Bottom type	
Prey energetics	

The diet of redfish included about 40 pelagic and bathypelagic species. The dominant prey are: *Calanus finmarchicus, Themisto libellula, T. abyssorum, Meganyctiphanes norvegica, Thysanoessa inermis, T. raschii*, and *Pandalus borealis*. The dominant fish prey are: *Benthosema glaciale, Myctophm punctatum, Ceratoscopelus maderensis,* and *Paralepis coregonoides*. The prey are not quantified as percent volume or weight. In all the areas investigated two groups of organisms (Euphausiidae and bathypelagic fish) were the main prey of redfish.

Redfish < 30 cm feed primarily on euphausids, copepods, and gammarus species. Redfish between 41-45 cm have about 40% of their diet composed of fish. The composition of food in the stomachs remains "more or less constant" throughout the year. Feeding intensity changes among seasons and with location. Feeding intensity is highest in autumn and early winter in NAFO Divisions 2J, 3K, 3L, and 3M. This contrasts with the southern slope of the Grand Bank where feeding intensity was highest in April-June. Feeding intensity is related to spawning with feeding being lowest prior to and during spawning. Redfish feed most actively at night when they rise off the bottom.

The composition of the redfish diet does not depend on depth when the diet is broken down into three depth classes (<300, 301-400, >400 m). The same food items occur in roughly the same proportions in all depth classes.

Zamarro, J. 1992. Feeding behaviour of the American plaice (*Hippoglossoides platessoides*) on the southern Grand Bank of Newfoundland. Neth. J. Sea Res. 29:229-238.

Reference (#)	Zamarro 1992 (89)
Purpose of study	describes diel and annual feeding intensity, and predator prey relationships
Predators	*Hippoglossoides platessoides* American plaice
Predator size	40-55 cm
Dominant prey	1. *Ammodytes* sp. sand lance; 2. brittle stars (species not given); 3. *Mallotus villosus* capelin
Prey size	
Location	southern Grand Bank, (NAFO Div. 3N)
Time of year	July 1987 to December 1989
How prey quantified	stomach fullness, percent weight
Number of stomachs	n=7,032
Depth	51-328 m
Bottom type	
Prey energetics	information provided for fish at 7.1 kJ/g and brittle stars (1.7kJ/g)

Only two prey were important in the annual feeding cycle of plaice on the southern Grand Bank: sand lance and brittle stars. A third prey, capelin was only present in important quantities in April. Sand lance is consumed in larger amounts during spring and summer with brittle stars being more important during winter, although they are also taken during the rest of the year. The text table below (from Zamarro 1992) indicates how important these three prey are relative to other prey over the course of the year. The diet is summarized as an index of stomach fullness based on weight of the stomach contents.

sand lance	3.1	Mollusca	0.11
capelin	0.8	Crustacea [Decapoda]	0.01
other fishes	0.14	small Crustacea	0.01
brittle stars	1.24	polychaeta	0.01
sea urchins	0.05		

Other findings of this study include: 1) Daily feeding intensity shows maxima that are dependent on the type of prey. Sand lance is taken in largest amounts between 1800-2400 h; capelin and brittle stars were taken most intensively between 1200-1800 h. 2) Maximum feeding intensity occurs in April. Feeding intensity during summer is also high. Lowest feeding occurs in autumn and winter. Pitt (1973) estimated the energy content of sand lance as 7.1 kJ/g and Brawn et al. (1968) estimated the energy content of brittle stars as 1.7 kJ/g.

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