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FOOD AND FEEDING OF COD IN THE SKAGERRAK AND THE KATTEGAT IN 1991

by

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ABSTRACT

Within the international stomach sampling programme in the North Sea in 1991 Sweden made three surveys in the eastern North Sea, the Skagerrak and the Kattegat. Sampling of stomachs were made in all three areas although the latter two areas were not included in the international programme.

A number of species were sampled, but cod stomachs were first analysed, cod being the most important and interesting species with seperate stocks in the Baltic, the Kattegat and the Skagerrak. In this report results from the first quarter is presented.

The stomachs were analysed according to the procedures agreed in the international stomach sampling programme. The results are compared with results from the North Sea, the Baltic and previous investigations in the Skagerrak and the Kattegat.

INTRODUCTION

To extend the basis for multispecies assessment from what had been obtained largely in the stomach-sampling programme undertaken in the North Sea in 1981 (Daan, 1989) the Multi-species Assessment Working Group in 1988 recommended that another full-scale stomach sampling exercise should be executed in the North Sea in 1991. The recommendation was endorsed by ICES and the sampling successfully realized (Anon., 1992a).

The project greatly benefitted from the ICES Quarterly International Bottom Trawl Survey, which commenced in 1991 (Anon., 1992b). In that Sweden participated in the first three quarters and consequently also sampled stomachs from a number of fish species. The Swedish surveys covered the Kattegat, the Skagerrak and part of the eastern North Sea. Stomachs from the North Sea were partly exchanged according to the programme, but all stomachs from the Kattegat and the Skagerrak and some from the North Sea were analysed in Lysekil, Sweden.

The results from the Kattegat and the Skagerrak will not be included in the North Sea data base and therefore the basic results and some processed data from the first quarter of 1991 will be presented here, compared to other data.

MATERIAL AND METHODS

The stomach sampling was performed during the International Young Fish Survey in February 1991. The trawl used was a GOV -86 with a sprat extension and cod end (bar length 11 mm). The catch was measured and weighed and samples taken out for stomach analysis in accordance with recommendations from the ICES North Sea stomach sampling project 1991 (Anon., 1990). Everted stomachs were discarded but not replaced and regurgitated stomachs were noted. To preserve the stomachs individually we used tube gauze, which was tied between each stomach and samples from one haul thereby kept in one strip. The tube gauze strip containing the samples were put in 10 liter buckets with buffered 4% formalin. Later the stomachs were transferred to 96% denatured alcohol.

In total 336 cod were sampled in the Skagerrak, 653 in the Kattegat and 166 in The North Sea. Of those 87,5, 89,7 and 91 % respectively had stomach content.

The stomach content has, whenever possible, been identified to species level except for particularily difficult groups as gammarideans and ostracods. Often broader categories (family, order, class) had to be used depending on the state of digestion of the prey. For instance, bristleworms were usually categorized as *Polychaeta* since they often were found in a late digestion state and were very difficult to identify even to an order.

RESULTS

All food items found are listed in Table 1, 2 and 3 with weights and numbers, separated on cod size classes. In figure 1 a - c the percentage distribution (by weight) of prey groups are shown by cod size class. To get a reasonable number of cod in as many size classes as possible, cod <150 mm and >700 mm are joined to one size class respectively.

In figure 4 the mean weight of stomach content per cod size class is shown.

The main prey groups (by weight) are crustaceans, bristleworms, and fish in approximately the same proportions in the three areas, although the proportion of fish in the Skagerrak cod is slightly smaller and fish is there dominating only in the largest size class (Figure 1b).

There is a wide range of crustaceans represented (Figure 3 a - c). A significant difference between the areas is that in the Kattegat euphasians (krill) dominate (63% of the crustaceans, Figure 3c), where as in the Skagerrak and the North Sea crabs, mainly *Portunidae*, show a similar dominance. Of the commercial crustaceans, i.e. pandalids and *Nephrops* sp., the share is 7,34 % of total weight in the Skagerrak and 2,2 % in the Kattegatt. In Figure 3b the category "other" contains mostly *Pasiphea* sp.

In all three areas cod with a length <250 mm feed to more than 90% on invertebrates. Large cod (size classes over 500 mm) feed approximately to 30-75% on fish. Figures 2 a - c show the distribution (in percentage of weight) of the different groups of fish found in the stomachs related to size class in the North Sea, the Skagerrak and the Kattegat respectively. In the Kattegat large cod primarily had eaten herring, whiting and flatfish, where as cod

caught in the Skagerrak and the North Sea had fed on gadoids, and again mostly whiting. In the Skagerrak 52% of the fish consumed consisted of commercially important species such as whiting and haddock. In the Kattegatt 43 % was commercial fish and approx. 50 % of that was herring, where as whiting and haddock were the predominant commercial species in the North Sea. Cannibalism did not seem to be frequent (in the category "gadoids" (Table 1) cod can be hidden but this category is small compared to the others).

Significant amounts of molluscs had only been eaten in the Kattegat. Cod with a size of 20 - 40 cm had consumed rather high numbers of bivalves.

DISCUSSION

The material from the North Sea is small, but the main features of the food composition corresponds well with what is reported by e.g. Daan (1973, 1983). One exception is cannibalism, that was small in all three areas. As Daan (1973) points out cannibalism decreases with small yearclasses and the 1990 yearclass was small or average in all areas (Anon., 1992c).

Between the North Sea and the Skagerrak results the differences were rather small, less fish and more crustaceans in the Skagerrak material. In the Kattegat, however, there are striking differences, not so much in the total proportions of the main groups, but in the fact that krill seem to be extremely important at least this time of the year. Also the high occurence of herring in the stomachs is significant. This indicates that cod in the Kattegat should feed more pelagical than in other areas, which might seem logical in this very shallow area (average <20m). However, in February 1981 cod had eaten insignificant amounts of krill in the same area (only about 2% of total weight of crustaceans compared to our 63%), as presented by Börje et al. (1987).

Nephrops norvegicus is the most important target species of the trawl fishery in the Kattegat and a large of the Skagerrak. Much of the stomach sampling in the Kattegat and the Skagerrak was made on the *Nephrops* grounds, but the amount eaten by cod was rather small, 2% in the Kattegat and 3.5% in the Skagerrak, compared to 16 - 60% according to several reports from the Irish Sea, reviewed by Armstrong et al. (1991). Even considering the probable differences in cod size distribution (sampling from landings in the Irish Sea) the difference is large.

REFERENCES

Anon., 1992a. Progress report on the ICES 1991 North Sea stomach sampling project. ICES, Doc. C.M. 1992/G:12

Anon., 1992b. Report of the International Bottom Trawl Survey Working Group, Copenhagen, 13-17 January 1992. ICES, Doc. C.M. 1992/H:3

Anon., 1992c. Report of the Study Group on Demersal Stocks in Division IIIa. Copenhagen, 10 - 17 February 1992.

Armstrong, M.J., Smyth, D. and McCurdy, W., 1991. How much *Nephrops* is eaten by cod in the western Irish Sea? ICES, Doc. C.M. 1991/G:15

Börje, M., Fogelgren, J-E., Tengelin, B. and Ulmestrand, M., 1987. Födoval av torsk (Gadus morhua L.) i Skagerrak och Kattegatt under februari 1981. Meddelande från Havsfiskelaboratoriet, Nr 320. 13 pp.

Daan, N., 1983. Analysis of the cod samples collected during the 1981 stomach sampling project. ICES, Doc. C.M. 1983/G:61

Daan, N. (ed.), 1989. Data base report of the stomach sampling project 1981. ICES Coop. Res. Rep., 164, 144pp.

TABLES:

Table 1 : Primary data showing fooditems (weight and number) found in cod from the North Sea.

Table 2: Primary data showing fooditems (weight and number) found in cod from the Skagerrak.

Table 3: Primary data showing fooditems (weight and number) found in cod from the Kattegat.

Table 1

North Sea																														
Total samples	11		22		41		14		15		24		11		13		5		3		1		2		3		1		166		
No with food	10		19		37		14		15		21		9		12		5		3		1		1		3		1		151		
No empty	1		3		3		0		0		2		2		1		0		0		0		1		0		0		13		
No regurg.					1						1																		2		
Sizeclass	100		120		150		200		250		300		350		400		500		600		700		800		900		1000		Tot weig	% weigh	Tot no
Food items	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no			
INVERTEBRATES																															
Polychaeta	1,65	6	0,18	4	1,7	9	2,6	3	1	5			0,4	2	0	2	1,8	2											9,3	0,558	33
Aphrodite			0,1	1							0,2	1			8,3	3	4,6	1							59,1	5	0,8	1	73,1	4,375	12
Mollusca																													0,0	0,000	0
Buccinidae															15,6	1													15,6	0,934	1
Buccinum									0,1	1																			0,1	0,006	1
Allotheuthis sp											11,2	2																	11,2	0,670	2
Crustacea	0,1	6	0,2	3	0,1	1	0,1	1	0	1	0,2	5	0	1															0,5	0,030	18
Cumacea																													0,2	0,012	0
Diastylidae			0	1																									0,0	0,000	1
Mysida	0,15	2	0,05	1	0	1	0	1											0,1	1									0,3	0,018	6
Schistomysis ornata				1	0,05	2																							0,1	0,003	3
Isopoda																													0,0	0,000	0
Astacilla longicornis									1,7	10	0	1																	1,7	0,102	11
Cirolana borealis									0,5	3																			0,5	0,030	3
Amphipoda																													0,0	0,000	0
Gammaridea	0,4	21	0,35	33	0,28	6			0	1			0	2	0	1													1,0	0,062	64
Caprellidae			0	1																									0,0	0,000	1
Decapoda			0,2	6	0,3	7	0,4	5	0	1																			0,9	0,054	19
Caridea			0,05	1			0,5	1	1,7	6	0,9	4	0,2	1															3,4	0,201	13
Pandalidae			0,6	1	1	3			0,2	1	0,2	1			0,1	1													2,1	0,126	7
Pandalus montagui			1,6	3	6,3	9	3	4	1,3	1	2,5	5																	14,7	0,880	22
Pandalina brevirostris			0,2	2	1,1	10					0,6	4																	1,9	0,114	16
Processa sp							0,6	2	0,3	3	1,7	2			0,7	1													3,3	0,198	8
Crangonidae	0,1	3	0,48	6	1,28	19	0,7	4	0,5	5	0,3	2	1	3	0,5	2													4,9	0,291	44
Crangon sp			0,5	1																									0,5	0,030	1
Crangon crangon											0	1	0	1															0,0	0,000	2
Crangon allmani			0,6	1	2,1	29			0,5	2	1	2					0,2	1	1,3	3									5,7	0,341	38
Pontophilus spinosus					0,2	1	0,1	1																					0,3	0,018	2
Eulus pusiolus			0,1	1																									0,1	0,006	1
Reptantia																													0,0	0,000	0
Anomura																													0,0	0,000	0
Paguridae			0,4	1	1	2	1,4	5			3,6	4	2,3	3	0,4	1	12	1											21,1	1,263	17
Pagurus sp															5,7	1													5,7	0,341	1
Pagurus bernhardus									1,9	1	1	1	1,6	1											5,1	1			9,6	0,575	4
Pagurus prideaxi							0,5	1																					0,5	0,030	1
Anapagurus hyndmani							0,2	1																					0,2	0,012	1
Galathea sp			0	1	0,15	2	0,5	18			0,7	1			0,1	1													1,5	0,087	23
Munida sp											0,3	1																	0,3	0,018	1
Brachyura					0,7	4			0,6	2	4	3	1,2	1			3,4	1											9,9	0,593	11
Portunidae					0,1	1							2	1	4,6	1													6,7	0,401	3
Liocarcinus sp					1,4	4	1,3	2	5,6	2	2,2	2	0,6	1	5,3	1													16,4	0,982	12
Liocarcinus holsatus											7,1	1			29,4	7	3,7	1	34,9	12					45,2	6	6,9	1	127,2	7,614	28
Liocarcinus arcuatus																	0,4	1											0,4	0,024	1

Table 1

North Sea																														
Total samples	11		22		41		14		15		24		11		13		5		3		1		2		3		1		166		
No with food	10		19		37		14		15		21		9		12		5		3		1		1		3		1		151		
No empty	1		3		3		0		0		2		2		1		0		0		0		1		0		0		13		
No regurg.					1						1																		2		
Sizeclass	100		120		150		200		250		300		350		400		500		600		700		800		900		1000		Tot weig	% weig	Tot no
Food items	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no			
Eballa sp							0,3	2			0,3	1	0,4	1															1,0	0,060	4
Hyas coarctatus							1,2	1			5	5	12,6	8	2	1													20,8	1,245	15
Lithodes mala																									271	1			271,3	16,24	1
Ophiuroida					0,1	2							0,1	1															0,2	0,012	3
FISH																															
Clupeidae																													0,0	0,000	0
Clupea harengus													9,3	1	11,7	1	27,7	2							46,9	2	22,4	1	118,0	7,063	7
Gadidae									2	1	3	1																	5,0	0,299	2
Gadus morhua											6,9	1							14,4	1									21,3	1,275	2
Merlangius merlangus																	40,6	2	106	8	45,1	1			346	4			537,6	32,178	15
Melanogrammus aeglefinus													6,8	1									112	1	46,6	1			165,2	9,888	3
Trisopterus esmarckii													12,6	2															12,6	0,754	2
Trisopterus minutus											5	3																	5,0	0,299	3
Ammodytidae			0,2	1	1,8	4			1	2	0,7	1	4,5	2															8,2	0,491	10
Hyperoplus sp					0,5	1					3,5	1	3	1			4,1	4							42	22			53,1	3,178	29
Callionymidae																													0,0	0,000	0
Callionymus sp					2	4	0,5	1			13,5	6																	16,0	0,958	11
Gobidae																													0,0	0,000	0
Goby					0,53	3			0,2	1	0,2	1	0,7	1															1,6	0,098	6
Syngnathidae							0,4	1																					0,4	0,024	1
Pholididae																													0,0	0,000	0
Pholis gunnellus											1,2	1	2,3	1															3,5	0,209	2
Zoarcidae																													0,0	0,000	0
Zoarces viviparus											2,2	1																	2,2	0,132	1
Pleuronectiformes							0,1	4																					0,1	0,006	4
Pleuronectidae																							22,4	1					22,4	1,341	1
Limanda limanda																											39,1	1	39,1	2,340	1
Hippoglossoides sp											0,5	1																	0,5	0,030	1
Eggs																							9,6	1					9,6	0,575	1
Pisces							1,4	2			1,8	1			2	2													5,2	0,311	5
Total	2,4		5,8	70	22,7	124	15,8	60	19,1	49	81,5	67	61,6	36	86,4	27	98,5	16	156	25	45,1	1	144	3	863	42	69,2	4	1670,7		524

Table 2

Skagerrak																												
Total samples	11		39		91		54		10		12		13		43		24		25		8		5		1		336		
No with food	8		27		78		48		9		12		12		41		24		21		8		5		1		294		
No empty	3		12		13		6		1		0		1		2		0		4		0		0		0		42		
Sizeclass	100		120		150		200		250		300		350		400		500		600		700		800		900		Tot weig	% weig	Tot no
Food items	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no			
INVERTEBRATES																													
Polychaeta	0,3	1	8,4	16	11,7	34	16,6	18	2,2	2	0,3	1	0,6	1	1	1			4,7	3	0	1					45,75	1,008	78
Aphrodite			0,4	1			8,6	4	3	1			11,5	4	31,8	6	25	7	44,8	7			178	18			303,1	6,678	48
Polynoidae	0,4	1	0,2	1			2,3	1																			2,9	0,064	3
Molluscs			0,3	1	13,6	10	1,5	4	3,6	1			1,8	1													20,8	0,458	17
Bivalvia			0,3	1	0,2	2	0,55	2											2,2	1							3,25	0,072	6
Mactridae																									9,1	7	9,1	0,200	7
Gastropoda					1	2																					1	0,022	2
Buccinum													3,7	1	0,1	1	0,1	1									3,9	0,086	3
Turritella																			0,7	1							0,7	0,015	1
Priapulida																													
Pripulus																							6,2	1			6,2	0,137	1
Crustacea	0,1	1	0,45	11	4,9	8	1,4	8	0,1	1	0,1	1	0,2	1	2,2	3					10,4	0					19,85	0,437	34
Cumacea							0	1																					1
Diastylidae	0,03	1																									0,025	0,001	1
Erythrops elegans					0,05	1																					0,05	0,001	1
Isopoda																													0
Cirolana borealis															0,2	1											0,2	0,004	1
Amphipoda																													0
Gammaridea	0,04	6	0,1	2	0,3	4	0,35	8							0,1	2											0,89	0,020	22
Euphasiidae																			0,4	1							0,4	0,009	1
Meganyctiphanes norvegica			0,3	1	0,4	2					0,3	2			0,9	1	0,6	2	0,4	1			0,5	3			3,4	0,075	12
Decapoda					0,3	1									0,3	1			7,2	3							7,8	0,172	5
Caridea	0,02	1			5,6	7	1,5	5							1,2	2			2,9	2	0,8	3			0,7	1	12,715	0,280	21
Pasiphea sp			0,8	1	0,2	1	1,3	1									15,5	7			87,1	80					104,9	2,311	90
Pasiphea sivado							2,5	1																			2,5	0,055	1
Pasiphea multidentata					2,1	3	3,3	4							34,8	27	123	126	47	32	0,8	1	5,9	10			217,3	4,788	203
Pandalidae					0,5	2	3,1	8					1,1	1	0,8	1	1	1	1,2	3							7,7	0,170	16
Pandalus sp					1,3	2	1,3	1	6,8	7					4,1	3	4,4	5									17,9	0,394	18
Pandalus montagui			0,4	1	10,7	8	25	19	3,6	1	9,4	7	1,2	1	30,3	12	3,3	2			6,1	1					90	1,983	52
Pandalus borealis					5,2	5	4,5	3			8,5	2	1,1	1	26,7	13	5,3	2			12,5	2	1,1	1			64,9	1,430	29
Pandalina brevirostris					0,6	4	0,9	4	0,1	1	0,2	1			0,4	2	0,2	1									2,4	0,053	13
Processa sp							0,2	3																			0,2	0,004	3
Processa nouvell h	0,1	1	0,1	1	0,1	1																					0,3	0,007	3
Crangonidae	0,3	15			0,5	9	0,1	1									0,6	1			2,1	1					3,6	0,079	27
Crangon sp					0,1	1																					0,1	0,002	1
Crangon crangon																					2,5	1					2,5	0,055	1
Crangon allmani					0,3	1	2,3	3							0,8	1			0,5	1							3,9	0,086	6
Pontophilus sp					0,05	1															0,4	1					0,45	0,010	2
Eulus pusiolus							0,2	2																			0,2	0,004	2
Spirontocaris spinus													0,8	1													0,8	0,018	1
Reptantia																													0

Table 2

Skagerrak																														
Total samples	11		39		91		54		10		12		13		43		24		25		8		5		1		336			
No with food	8		27		78		48		9		12		12		41		24		21		8		5		1		294			
No empty	3		12		13		6		1		0		1		2		0		4		0		0		0		42			
Sizeclass	100		120		150		200		250		300		350		400		500		600		700		800		900		Tot weig	% weig	Tot no	
Food items	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no				
Nephropidae																													0	
Nephrops norvegica													11,1	1	6,4	3	11,2	1	70	6	59,4	5					158,1	3,483	16	
Anomura																													0	
Paguridae			0,5	1	0,3	1	1,9	3	0,1	1	3,7	1	0,7	1	0,6	1			12,3	3							20,1	0,443	12	
Pagurus bernhardus			0,4	3	1,7	6	15,5	12	9,9	1	4,2	3			17,9	5	11,9	2	98,1	17	3,3	2					162,9	3,589	51	
Calocaris sp					2,5	3			1,2	1					1	1											4,7	0,104	5	
Galatheid					0	3																					0	0,000	3	
Galathea sp							0,2	1					0,4	1													0,6	0,013	2	
Brachyura			0,35	6	2,2	14	2,6	5			3,6	4	1	1	29,4	12	24,4	7	20,6	7	22,3	4					106,45	2,345	60	
Portunidae					0,1	1					3,6	2	2	2	11,3	4									13,2	2	30,2	0,665	11	
Liocarcinus sp					0,2	5							4,2	2	10,2	3	11,8	5	23,1	7							49,5	1,091	22	
Liocarcinus holsatus					1	2	1,3	2	1,9	2	1,3	1	20,3	8	129	36	162	36	234	37	23,9	2	101	13			675,4	14,881	139	
Liocarcinus depurator					0,9	3			1,6	2			4,5	3	32,4	12	32,1	6	90,7	13	47,1	4	7,5	1			216,8	4,777	44	
Hyas coarctatus			0,8	9	0,1	2							1,1	1	1	1											3	0,066	13	
Corystes cassivelanum																			38,5	3							38,5	0,848	3	
Ophiurolda	0,02	1			0,1	1	0,5	5			1,2	2					0,4	1									2,22	0,049	10	
Ophiura sp					0,2	1	0,2	1							1,6	5			0,2	2							2,2	0,048	9	
Unid. material							5,2																				5,2	0,115	0	
Plantmaterial and algae					0,1		0,05						0,7														0,85	0,019	0	
FISH																														
Clupeidae																														
Clupea harengus																			56,8	1			123	1			179,3	3,950	2	
Gadidae									2,2	1							16,7	3			38,5	1					57,4	1,265	5	
Merlangius merlangus													32,1	2	17,6	1	60,6	3	70,5	3	127	2	370	7	19,2	1	696,5	15,345	19	
Melanogrammus aeglefinus																			66,1	1	104	2			49,4	1	219,6	4,838	4	
Trisopterus esmarckii													16,1	2	24,2	3	43,7	3	34,6	4							118,6	2,613	12	
Trisopterus minutus																			6,1	1							6,1	0,134	1	
Enchelyopus cimbria															53,1	2	9,2	1	40,5	2	59,4	1					162,2	3,574	6	
Callionymidae																														
Callionymus sp									11,9	3	2	1			2,7	2	0,2	1	57,5	2	73,9	4					148,2	3,265	13	
Gobidae																														
Goby			0,2	1																							0,2	0,004	1	
Gasterosteidae																														
Gasterosterus															0,5	1											0,5	0,011	1	
Stichaeidae																														
Lumpenus lampretiformes																	3,2	1	16,2	1							19,4	0,427	2	

Table 2

Skagerrak																														
Total samples	11		39		91		54		10		12		13		43		24		25		8		5		1		336			
No with food	8		27		78		48		9		12		12		41		24		21		8		5		1		294			
No empty	3		12		13		6		1		0		1		2		0		4		0		0		0		42			
Sizeclass	**100**		**120**		**150**		**200**		**250**		**300**		**350**		**400**		**500**		**600**		**700**		**800**		**900**		Tot wei	% weig	Tot no	
Food items	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no				
Zoarcidae																														
Lycodes sp											10,5	3	2	1	115	23	4,4	3	38,9	7	11,9	1					182,5	4,021	38	
Lycodes vahli									3,8	1																	3,8	0,084	1	
Pleuronectiformes													2,7	1					15,2	1	19,2	1					37,1	0,817	3	
Bothidae															13,5	1											13,5	0,297	1	
Pleuronectidae															0,5	1	2,3	2									2,8	0,062	3	
Hippoglossoides sp															0,8	1	15	2	30,5	3	46,4	1					92,7	2,042	7	
Glyptocephalus																	17,7	1	129	1							146,5	3,228	2	
Pisces							0,5	1							3,6	4					9,4	2					13,5	0,297	7	
Total	1,3	28	14	57	69,1	151	105	131	52	26	48,9	31	121	38	607	199	607	233	1261	177	768	123	792	55	91,6	12	4538,8		1261	

Table 3

Kattegat																														
Total samples	3		15		78		82		81		82		91		96		40		41		27		13		4		653			
No with food	3		14		68		70		71		72		83		90		39		38		24		10		4		586			
No empty	0		1		10		12		10		10		8		6		1		3		3		3		0		67			
Sizeclass	100		120		150		200		250		300		350		400		500		600		700		800		900		Tot weig	% weigh	Tot no	
Food items	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no				
INVERTEBRATES																														
Polychaeta			2,2	5	6,65	18	11,8	27	4,8	8	2,3	7	7	5	2,5	6	1,7	1					2,3	1			41,2	0,441	78	
Aphrodite					0,2	1	0,7	2	8	5	14	8	27	12	64,6	19	40,3	8	15,7	5	6,6	2	12,1	2			189,2	2,025	64	
Polynoidae					0,9	5	0,8	2																			1,7	0,018	7	
Phyllodocidae					0,03	1																					0,03	0,000	1	
Molluscs					0,2	1	0,7	1	18,5	3	1,3	1			2,6	1											23,3	0,249	7	
Bivalvia			0	2			40,1	12	131	23	132	23	213	33	34,7	7	0,1	1	4,3	2	0,3	1					555,81	5,948	104	
Gastropoda									1,7	1	0	1	0,5	1							1,8	1					4	0,043	4	
Buccinum															0,4	1	0,5	1									0,9	0,010	2	
Nuculana															0,2	1											0,2	0,002	1	
Turritella											1	2					2,8	4									3,8	0,041	6	
Loliginid									2,7	1							0,6	1									3,3	0,035	2	
Loligo sp													3,8	1													3,8	0,041	1	
Priapulida																														
Pripulus									2,4	1																	2,4	0,026	1	
Crustacea			0,1	1	1,4	10	0,4	8	0,2	2	0,6	1	2,1	9	0,1	1	1,2	1									6,1	0,065	33	
Cumacea					0	1																							1	
Diastylidae							0	1			0	1																	2	
Mysida									0,3	22																	0,3	0,003	22	
Mysidae					0,1	5																					0,1	0,001	5	
Schistomysis sp											0	1																	1	
Amphipoda																													0	
Gammaridea			0	1	0	4	0,1	19																			0,1	0,001	24	
Hyperiidae													0	1															1	
Caprellidae							0	2			0,05	10															0,05	0,001	12	
Phthisica marina					0	5	0	24	0	1																			30	
Euphasiidae					0,5	4	4,9	32	23,2	147	22,1	143	47,7	255	22,3	20	86,7	564	51,4	344	25,6	156					284,4	3,044	1665	
Meganyctiphanes norvegica					8,7	53	14,3	100	70,3	467	71	457	176	953	336	2031	455	2728	334	1510	379	2437	159	633	56,5	377	2059,6	22,042	11746	
Decapoda			0,3	2	0,4	4	1,3	4	0,6	4	2	2	0,5	2	0,9	4	0,21	1									6,21	0,066	23	
Caridea			0,3	2	0,7	4	0,4	4	1	3					1,1	3											3,5	0,037	16	
Pandalidae															0,3	1	3,4	1									3,7	0,040	2	
Pandalus montagui					2,2	1			0,7	1					3,8	2	2,3	1									9	0,096	5	
Pandalus borealis											1,4	1			4,2	1			0,9	1							6,5	0,070	3	
Pandalina breviostris					0,7	8	0,4	5			0,1	1									0,1	1					1,3	0,014	15	
Processa sp					0,05	1																					0,05	0,001	1	
Processa nouveli holthuisi			0,3	2	1,9	9	1,4	4	1,5	6	0,8	7	1	4	0,4	2	0,7	3			1	2					9	0,096	39	
Crangonidae	0,2	10	1	50	6,4	53	4	48	0,9	12	1	7	2,5	7	1,7	9	0,6	2	0,3	2							18,6	0,199	200	
Crangon sp									1,1	2					0,2	1											1,3	0,014	3	
Crangon crangon			0,05	1			0,1	1	0,8	2	1,7	6	0,1	1	0,8	1	1,7	2									5,25	0,056	14	
Crangon allmani			1,2	3	2,9	6	3,8	7	9,2	21	8,2	17	8,6	12	9,6	14	11,2	11	1	2	1,2	2					56,9	0,609	95	
Pontophilus sp	0,1	16	0,1	6	1	17							0,2	1													1,4	0,015	40	
Pontophilus spinosus											1,5	1															1,5	0,016	1	

Table 3

Kattegat																													
Total samples	3		15		78		82		81		82		91		96		40		41		27		13		4		653		
No with food	3		14		68		70		71		72		83		90		39		38		24		10		4		586		
No empty	0		1		10		12		10		10		8		6		1		3		3		3		0		67		
Sizeclass	100		120		150		200		250		300		350		400		500		600		700		800		900		Tot weig	% weigh	Tot no
Food items	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no			
Reptantia							0,3	1							1,3	1											1,6	0,017	2
Nephropidae																													0
Nephrops norvegica					2,2	1	2,5	1					5,7	2	37	4	52,3	4	41,6	2	42,6	3					183,9	1,968	17
Anomura																													0
Paguridae							0,7	1	3,4	4	3,7	2	4,6	5	3,7	4					1,7	2					17,8	0,190	18
Pagurus bernhardus							0,7	3	5,2	3			20,5	1							1,1	1					27,5	0,294	8
Calocaris sp							1,1	1							1,9	2	1,5	1									4,5	0,048	4
Brachyura					0,4	4	1	6	1,9	4	2,7	6	6	11	31,5	19	7,8	7			3,1	2					54,4	0,582	59
Portunidae											3,4	3	1,7	1			4	1	3,7	1			8,4	3			21,2	0,227	9
Liocarcinus sp	0,2	2	0,1	1					2,8	1			7,4	3	2,7	1					4	1					17,2	0,184	9
Liocarcinus holsatus											2,5	1	13,5	6	37,8	9	14	4			15,5	2					83,3	0,891	22
Liocarcinus depurator					0,5	3	4	4	3,4	2	16,9	10	50,9	14	172	50	145	29	116	15	134	21	90,8	11			733,5	7,850	159
Ebalia sp							0,5	1																			0,5	0,005	1
Majidae											0,4	2															0,4	0,004	2
Ophiuroida					1,23	12	0,6	9	1,1	8	1,2	9	3,8	30	8,8	15	0,2	1									16,93	0,181	84
Ophiura sp											0,2	1							0,7	2	0,5	2					1,4	0,015	5
Ophiopholis aculeata									0,4	2			2,5	8													2,9	0,031	10
Amphiura sp							1,2	6					0,2	3					3,7	9	0,7	5					5,8	0,062	23
Unid. material					0,7				0,5				1,9		0,5												3,6	0,039	0
Plantmaterial and algae											0,1				2,3												2,4	0,026	0
FISH																													
Myxinidae																													
Myxine																	10,4	1									10,4	0,111	1
Clupeidae							0,4	1	0,5	2			5,7	3	26,9	5	20,3	3	15,9	2	59,6	4	2	2			131,3	1,405	22
Clupea harengus											5,7	1	56,8	2	91,7	7	114	7	619	17	92	4	90	3			1068,4	11,434	41
Sprattus sprattus											19,7	3	2,5	1	44,2	4	25,6	2			5,8	1					97,8	1,047	11
Gadidae											3,1	1							79,6	2	31	2	23,9	2			137,6	1,473	7
Merlangius merlangus															294	8	298	9	139	5	20	1	45,8	2	44,8	2	841	9,000	27
Melanogrammus aeglefinus																			11,2	1							11,2	0,120	1
Pollachius sp																					34,3	1					34,3	0,367	1
Trisopterus esmarckii													0,8	1	40,8	3	30,6	2	20,9	1	16,8	2					109,9	1,176	9
Enchelyopus sp															31,4	1	22,3	2			71,2	1					124,9	1,337	4
Merluccius merluccius																							27,2	1			27,2	0,291	1
Callionymidae																													
Callionymus sp							2,4	6			94,6	33	165	43	216	67	72,5	15			20,9	8	3	1			574,2	6,145	173
Gobiidae																													
Goby					0,4	2	2,3	6	1,3	3	8,8	19	1,1	4	2,5	7	0,4	1	0,4	1							17,2	0,184	43
Aphia minuta									2,6	7	1,3	5	1,5	6	0,2	1											5,6	0,060	19

Table 3

Kattegat																													
Total samples	3		15		78		82		81		82		91		96		40		41		27		13		4		653		
No with food	3		14		68		70		71		72		83		90		39		38		24		10		4		586		
No empty	0		1		10		12		10		10		8		6		1		3		3		3		0		67		
Sizeclass	100		120		150		200		250		300		350		400		500		600		700		800		900		Tot weig	% weigh	Tot no
Food items	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no	weight	no			
Agonidae																													
Agonus																	10,1	1	5,4	1							15,5	0,166	2
Pholididae																													
Pholis gunnellus													3,5	1			16,8	1									20,3	0,217	2
Zoarcidae																													
Lycodes sp															35,8	5	7,2	1									43	0,460	6
Lycodes vahli													24,8	3													24,8	0,265	3
Pleuronectiformes															2	1	1,3	1	70,6	4	61,5	5	42,5	2	34,1	2	212	2,269	15
Bothidae																					22,6	2					22,6	0,242	2
Pleuronectidae											1,4	1	4	1	9,4	2	93	8	57,8	5	22,2	1					187,8	2,010	18
Limanda limanda															30,1	2	33,6	3	226	5	99,3	3	91,5	1			480	5,137	14
Hippoglossoides sp					0,9	1	1,3	1					0,7	1			27,3	2	62,7	4	15,2	2					108,1	1,157	11
Platichthys													13,6	1	6,5	1			105	1	123	1	152	1	50,7	1	450	4,816	6
Soleidae																													
Solea solea																			58,7	1							58,7	0,628	1
Eggs															5,6												5,6	0,060	0
Pisces							0,1	1	0,5	2	0,4	2	6,4	5	7,8	4	10,5	4	2,6	1	12,1	3	1	2			41,4	0,443	24
Total	0,5	28	5,65	76	41,3	234	104	351	303	770	427	796	895	1453	1629	2348	1628	3440	2047	1946	1326	2682	751	667	186	382	9344,1		15173

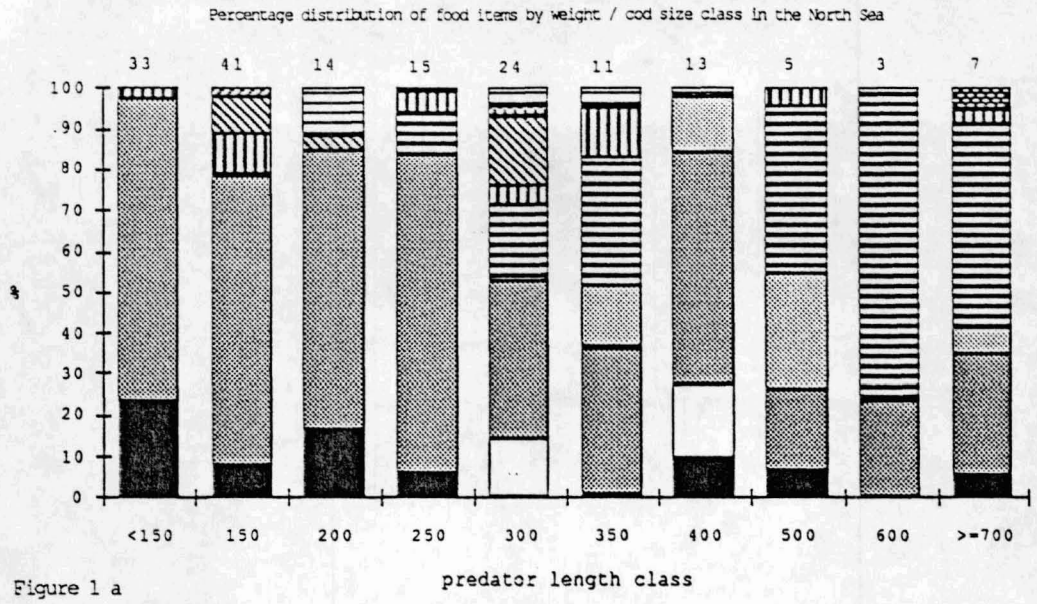

Figure 1 a

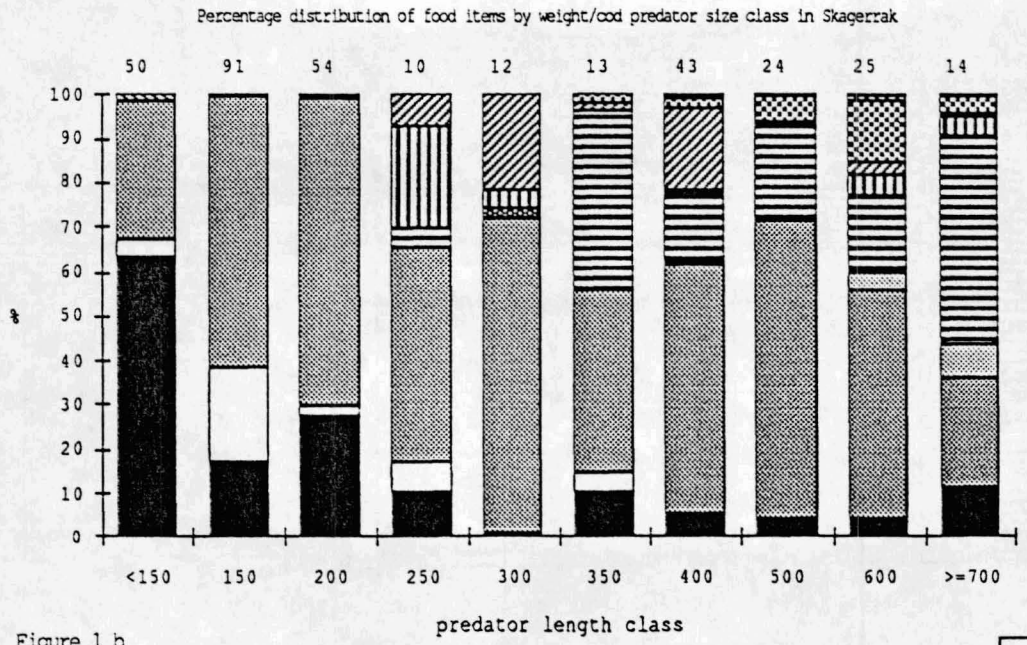

Figure 1 b

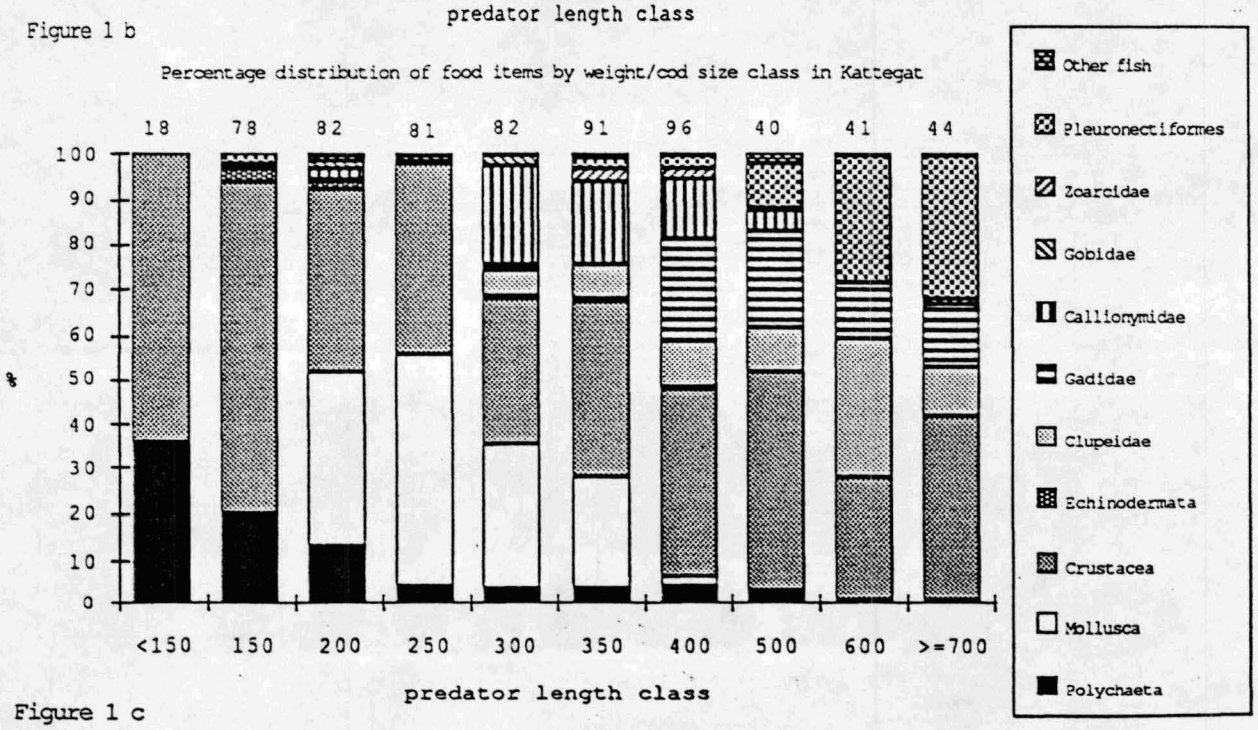

Figure 1 c

Percentage distribution fish prey by weight/cod size class in the North Sea

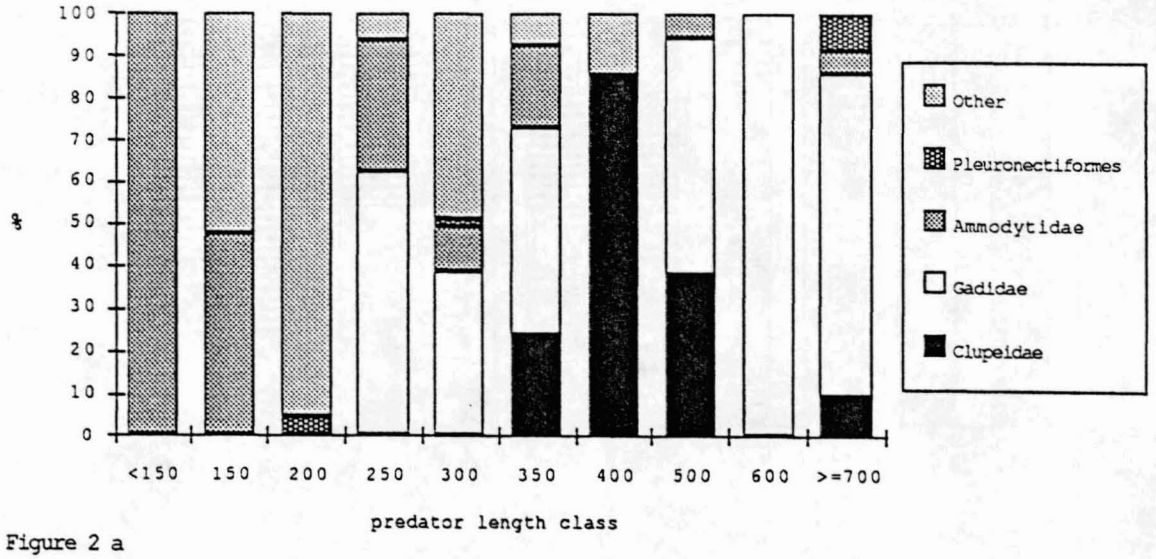

Figure 2 a

Percentage distribution of fish prey by weight/cod size class in Skagerrak

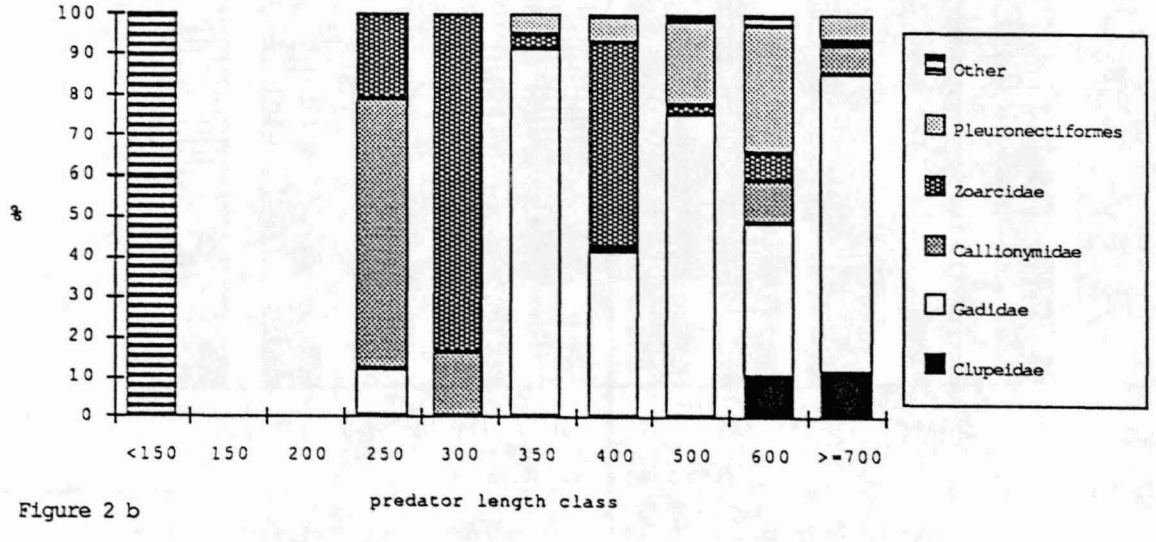

Figure 2 b

Percentage distribution of fish prey by weight/cod size class in Kattegat

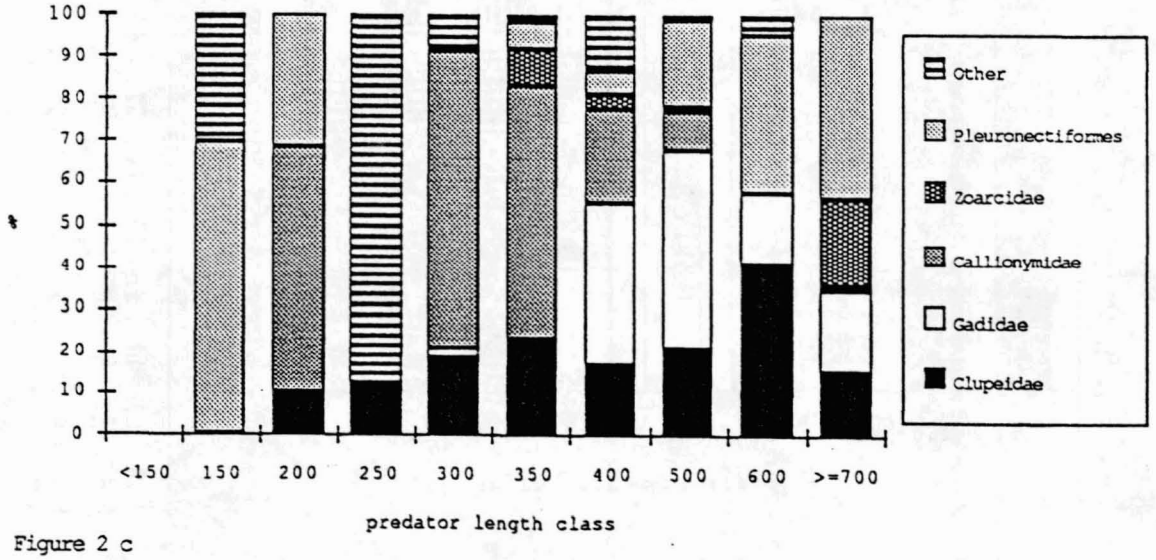

Figure 2 c

Percentage distribution of crustaceans by weight/ cod length class in the North Sea

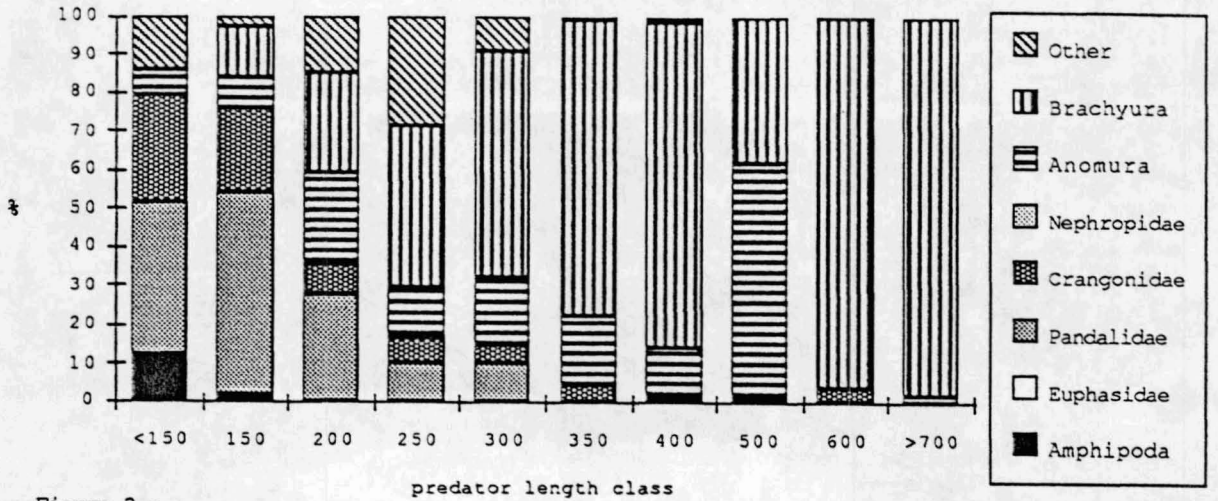

Figure 3 a

Percentage distribution of crustaceans by weight / cod size class in Skagerrak

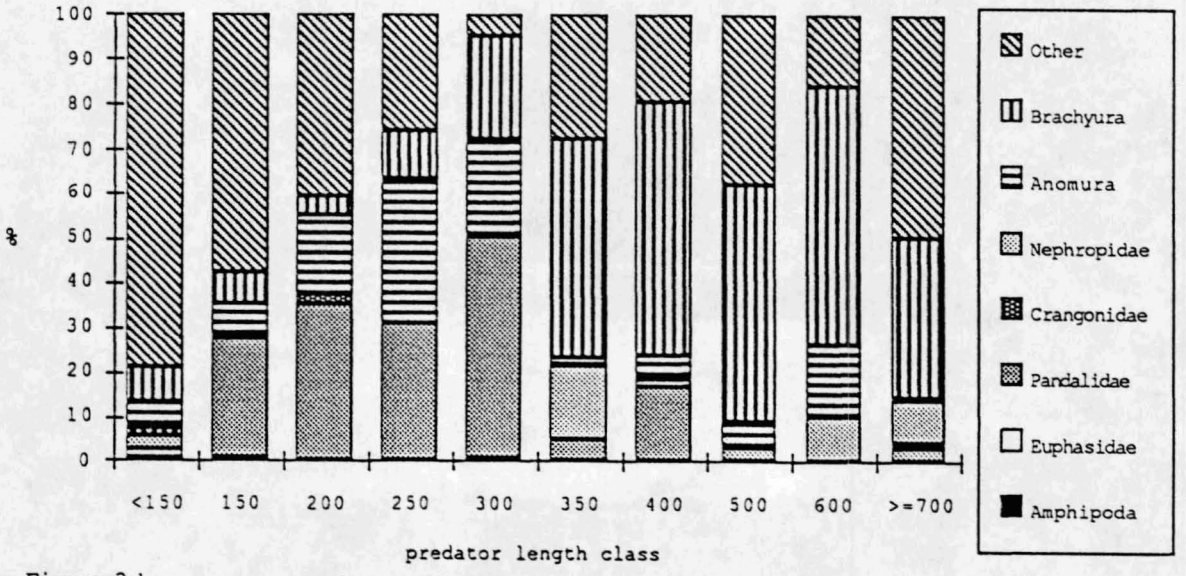

Figure 3 b

Percentage distribution of crustaceans by weight / cod size class in Kattegat

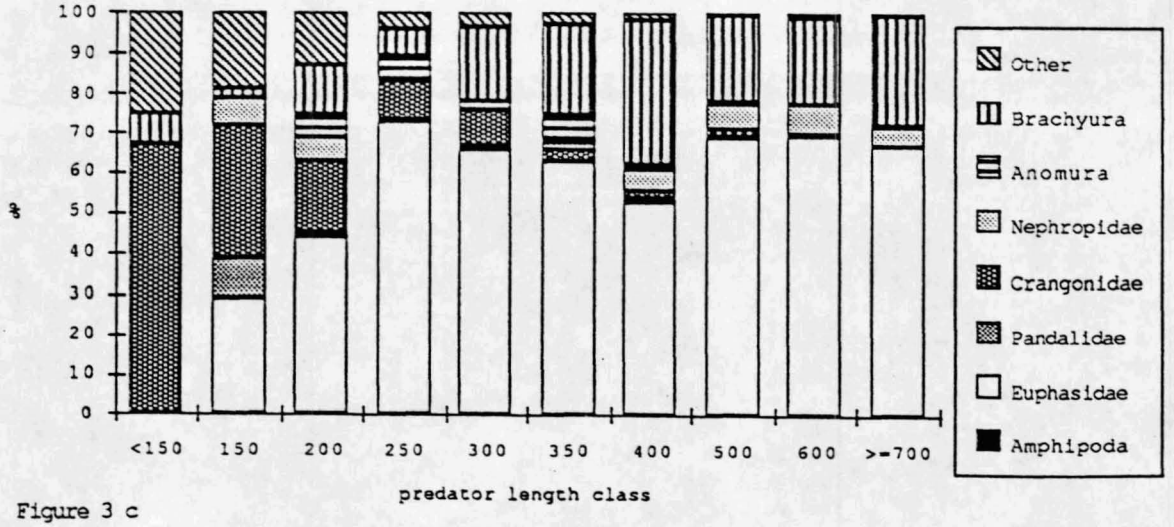

Figure 3 c

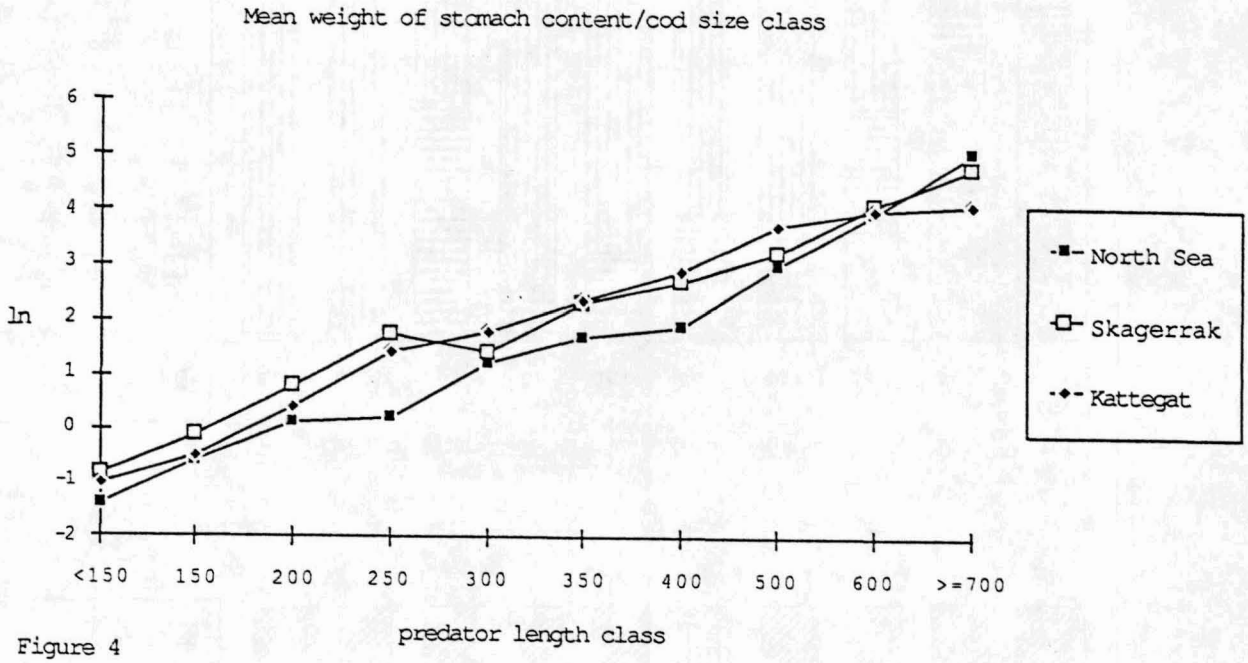
Mean weight of stomach content/cod size class
6
5
4
3
2
1
0
-1
-2
ln
<150
150
200
250
300
350
400
500
600
>=700
predator length class
North Sea
Skagerrak
Kattegat

Figure 4