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Analysis of the grey gurnard *(Eutrigla gurnardus)* samples collected during the 1991 International Stomach Sampling Project

by

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(Eutrigla gurnardus)

ABSTRACT

During the ICES Stomach Sampling Project 1991, 11 700 grey gurnard stomachs from the North Sea have been examined.

Significant seasonal differences in the proportion of empty stomachs were observed, which may be related to migration. The average weights of the stomach contents were related to size. The estimated feeding coefficient of grey gurnard was slightly lower than for North Sea cod. (Gadus morhua)

Fish and crustaceans together accounted for at least 85% of the weight of the stomach contents in all length classes in all quarters. A general pattern of an increasing contribution of fish prey and a decreasing contribution of crustacean prey with increasing predator size was apparent in all seasons. Such a shift appears to be a general pattern in many predatory fish species, although the size at which they shift may be very different. In grey gurnard, the size at which this occurs appears to be relatively small (ca 20 cm).

Grey gurnard feeds mainly on juvenile fish (0- and 1-group), a large proportion of which consists of commercially exploited species. An attempt has been made to estimate the annual food consumption by the North Sea population. The estimated annual consumption is about 700 000 tonnes of fish, which would imply that this species consumes roughly the same amount as estimated for the whiting population in 1981 and considerably more than the haddock population. (Merlangius merlangus) (Melanogrammus aeglefinus)

1. INTRODUCTION

In 1981, ICES has undertaken a major stomach sampling project in the North Sea to provide quantitative information on predator-prey interactions between commercially exploited species for use in Multispecies Virtual Population Analyses (Daan, 1983a, 1989). In 1988 ICES endorsed a recommendation of the Multispecies Assessment Working Group (MSAWG) that the project should be repeated in 1991 following largely the same guidelines and at a similar scale to extend the basis for multispecies assessment (Anon., 1989).

The ICES International Stomach Sampling Project 1991 was directed primarily at estimates of the food composition of five main predators (cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), saithe (*Pollachius virens*) and mackerel (*Scomber scombrus*)) and will allow a comparison of the relative impact of different components of the ecosystem on the recruitment of these target species. In addition, a research project to evaluate the impact of various by-catch species on the survival of juveniles of the important exploited species during the first year of life (before the age of recruitment) has been granted by the EEC ("FAR"-programme).

The stomach samples have been collected by research vessels of France, England, Germany, Scotland, Denmark, Norway, Sweden and the Netherlands. The countries participating in the "FAR"-contract have collected stomachs of by-catch species and, in addition, England, Norway and Sweden have voluntarily provided a significant amount of material. The total number of sampled stomachs of by-catch predators collected during the entire year 1991 was over 25 000 including a wide variety of species. In order of numerical sampling strength, grey gurnard (*Eutrigla gurnardus*), rays (Rajidae), scad (*Trachurus trachurus*) and long rough dab (*Hippoglossoides platessoides*) were the most important species. Because the unexpectedly large numbers of by-catch species sampled priority has been given to rays and grey gurnard (Anon., 1992b).

This paper presents the the results of the analysis of the grey gurnard samples taken during the project.

2. MATERIALS AND METHODS

2.1. Stomach sampling

Grey gurnard stomachs were sampled in the North Sea throughout 1991 by research vessels of different countries during the ICES quarterly International Bottom Trawl Surveys which commenced that year (Anon., 1992a). The stomachs were collected and administrated according to the Stomach Sampling Manual (Anon., 1991), i.e. stratified by area (ICES statistical rectangle), season (quarterly period), predator length class (70-79, 80-99, 100-119, 120-149, 150-199, 200-249, 250-299, 300-349 and 350-399 mm) and classified as containing food, regurgitated, everted, containing only skeletal remains and empty. The sampling target was 10 stomachs per length class per haul.

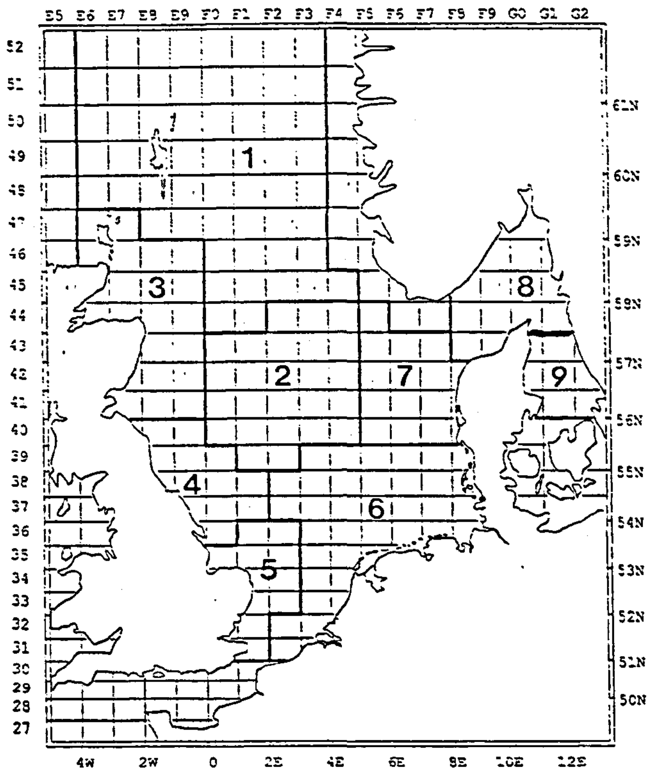
Fish with everted stomachs were discarded and only the non-regurgitated stomachs were preserved, either in 4% buffered formalin or blast-frozen, for examination in the laboratory. The sampling procedures applied on board of different research vessels and the subjective assesments of individual scientists may have influenced the numbers of stomachs recorded as regurgitated. It has yet to be evaluated what effects such differences have on estimates of mean stomach contents and fractions empty.

2.2. Stomach analysis

The stomachs (or stomach contents) collected within a size stratum from each haul were generally pooled in a jar for preservation and therefore it was impossible to examine individual stomachs. Identification of prey items has been done to the lowest possible taxonomic level (for a list of references used in the analysis see Appendix I). This level depends on prey type and its condition. Three digestion stages were defined: stage 0 (intact prey), stage 1 (partial digested prey) and stage 2 (skeletal material).

After identification, the prey items were classified according to length classes and for each length class of each prey type the total wet weight and number of individuals has been recorded.

Figure 1. Boundaries of ICES Roundfish Areas (RFA).



2.3. Data processing

The information collected has been punched in a database, originally developed at the Netherlands Institute for Fisheries Research (RIVO) to analyse stomach data (1981-1987) and recently modified to cope with the changes that have been introduced in the 1991 programme (Anon., 1992b). Auxiliary information from the International Bottom Trawl Surveys was used to compute catch rates (numbers per hour fishing per statistical rectangle, i.e. an estimate of the local abundance) and length compositions. The procedures of the data processing include (Hislop et al., 1991):

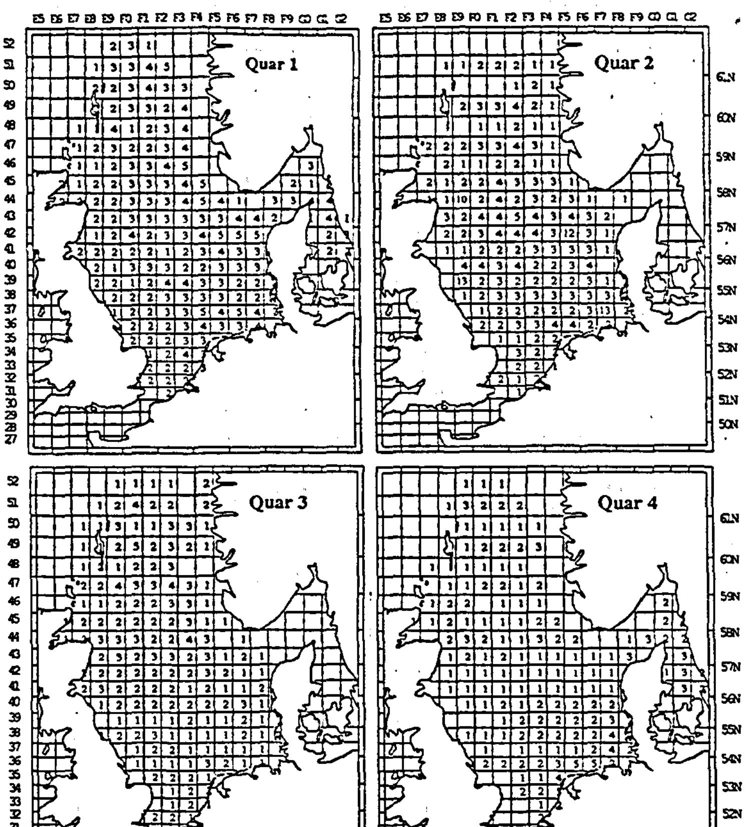
- sorting and combining samples by size class and statistical rectangle;
- sorting and combining the sample information by length class and Roundfish area (cf fig. 1), using the average catch rate of the predator size class by statistical rectangle as a weighting factor;
- calculating mean stomach contents by predator length class by Roundfish area;
- summing the information by Roundfish area over the total North Sea.

The method of calculating the mean weight of the stomach contents in a sample from an individual haul (W_S) is:

$$W_S = \frac{W_{tot}}{(F+R+E)} \cdot \frac{(F+R)}{F}$$

where W_{tot} is the total weight of the stomach contents of all prey observed, F is the number of stomachs containing food and/or skeletal remains, R is the number of regurgitated stomachs and E is the number of empty stomachs. The value of the mean stomach contents per length class has thus been corrected for regurgitation and fish with empty stomachs are included in the calculations.

Figure 2. Number of valid hauls by statistical rectangle and quarter.



Daan (1983b) has shown that, in order to reduce the effect of accidentally high catches, the square root of the average number per fishing hour (N/hr) per length class appears to be an appropriate weighting factor. This factor has been applied throughout the analysis presented in this paper.

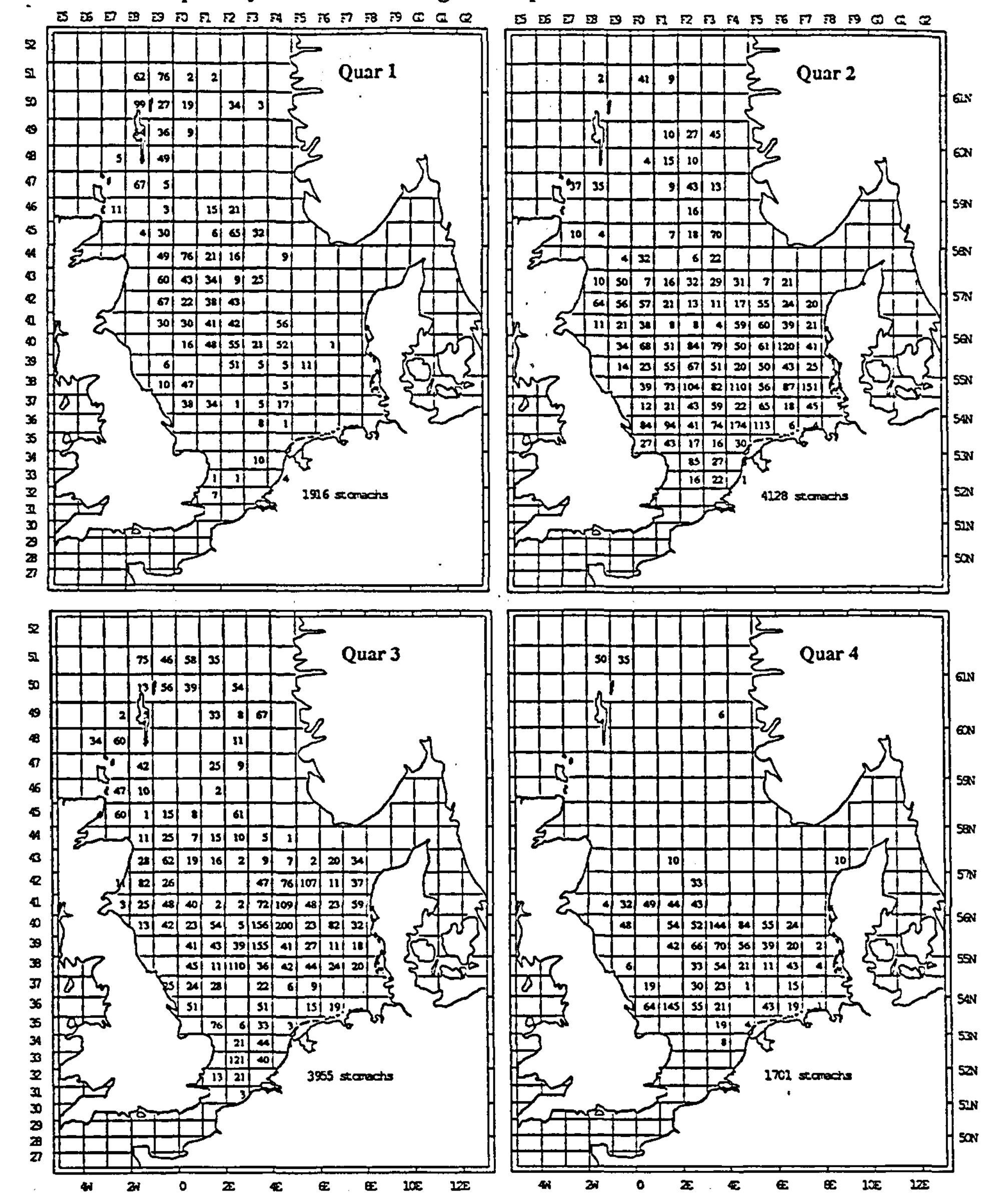
2.4. Statistical methods

A covariance analysis (ANCOVA) of the numbers of empty stomachs has been carried out by fitting a GLIM (General Linear Interactive Modelling) model (Baker & Nelder, 1978) with a binominal error distribution and a logit link function:

$$\text{logit } Ne = Q + R + L + QR + QL + RL + \varepsilon$$

where Ne is the number of empty stomachs, Q represents quarters, R represents roundfish area and L represents predator length class. QR, QL and RL are the interactions between the variables and ε is an error term with a binominal distribution. The logit link function is analogous to a logit transformation of proportions of empty stomachs.

Figure 3. Number of stomachs sampled by statistical rectangle and quarter.



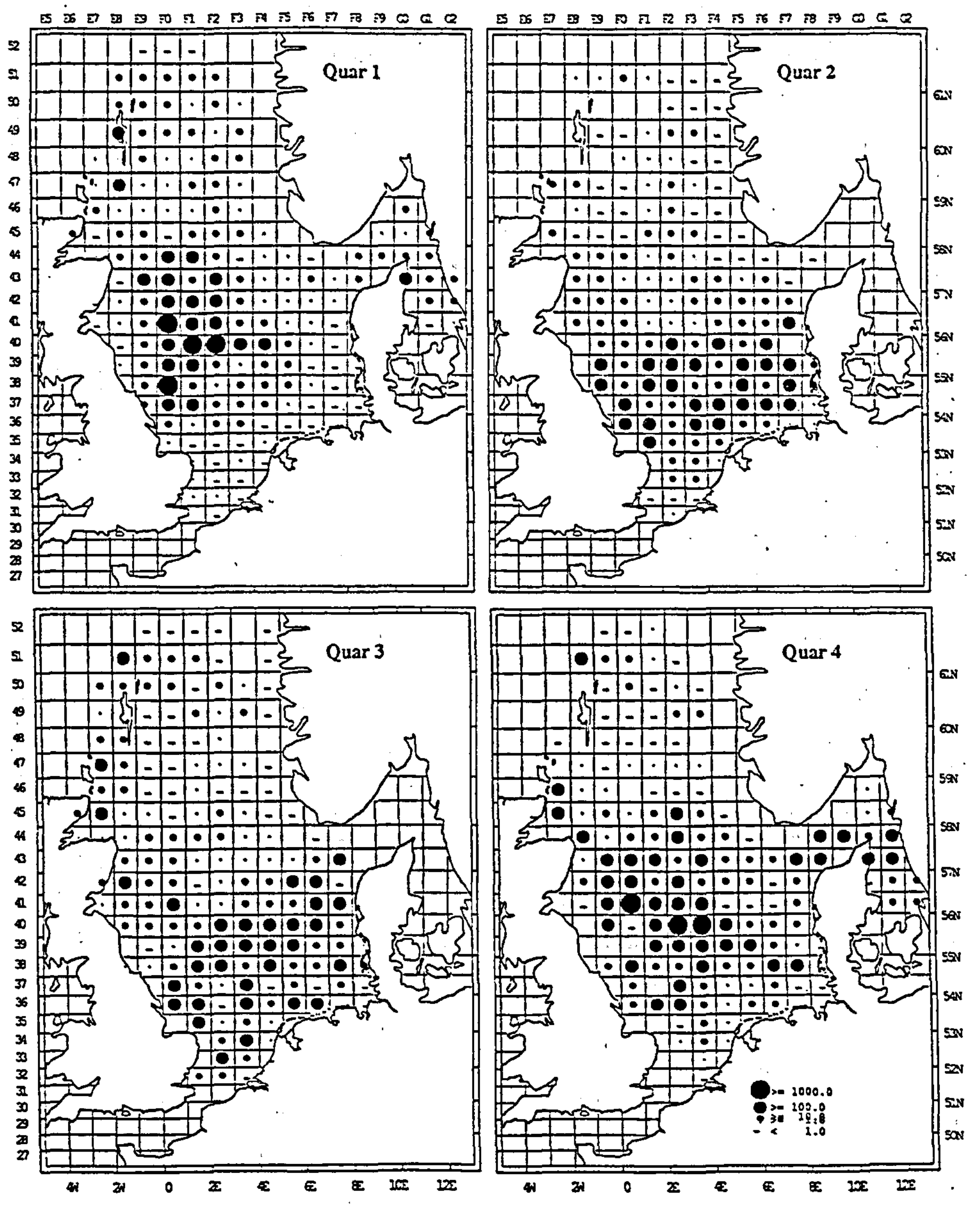
3. RESULTS

3.1. Sampling intensity

Table 1 shows the numbers of valid hauls taken by research vessels and the numbers of squares fished during 1991 by Roundfish area (fig 1) and quarter. The analysis presented in this paper deals only with seven areas (RFA 1 to 7).

The number of valid hauls in each statistical regtangle in each quarter is given in Figure 2, indicating that coverage of the North Sea was adequate in all seasons. However, the numbers of stomachs collected per statistical rectangle in each quarter vary considerably and there are clear gaps (fig. 3). However, these gaps are not due to lack of sampling effort but to low catch rates (fig. 4). Apparently, the distribution of grey gurnard shifts significantly between seasons.

Figure 4. Catch rates of grey gurnards (n per hr) by statistical rectangle and quarter. (data from International Bottom Trawl Surveys, 1991).



The numbers of stomachs from each length class sampled per roundfish area per quarter are given in Table 2. Table 3 gives the numbers of stomachs classified as containing only skeletal remains. Because of the very low numbers recorded, these stomachs have not been given further attention and are treated together with full stomachs. The numbers and percentages of stomachs classified as full, regurgitated or empty in each quarter are given in Table 4 and 5 for each roundfish area and for each length class, respectively.

3.2. Regurgitation

The percentages of stomachs classified as regurgitated per ICES statistical rectangle during the second quarter are given in Figure 5B, while 5A indicates the different research vessels involved in sampling during that period. It is remarkable that, when Cirolana (1) and Scotia (5) are involved, the percentages of regurgitated stomachs are much higher compared to other countries. This suggests that there have been significant differences in classification.

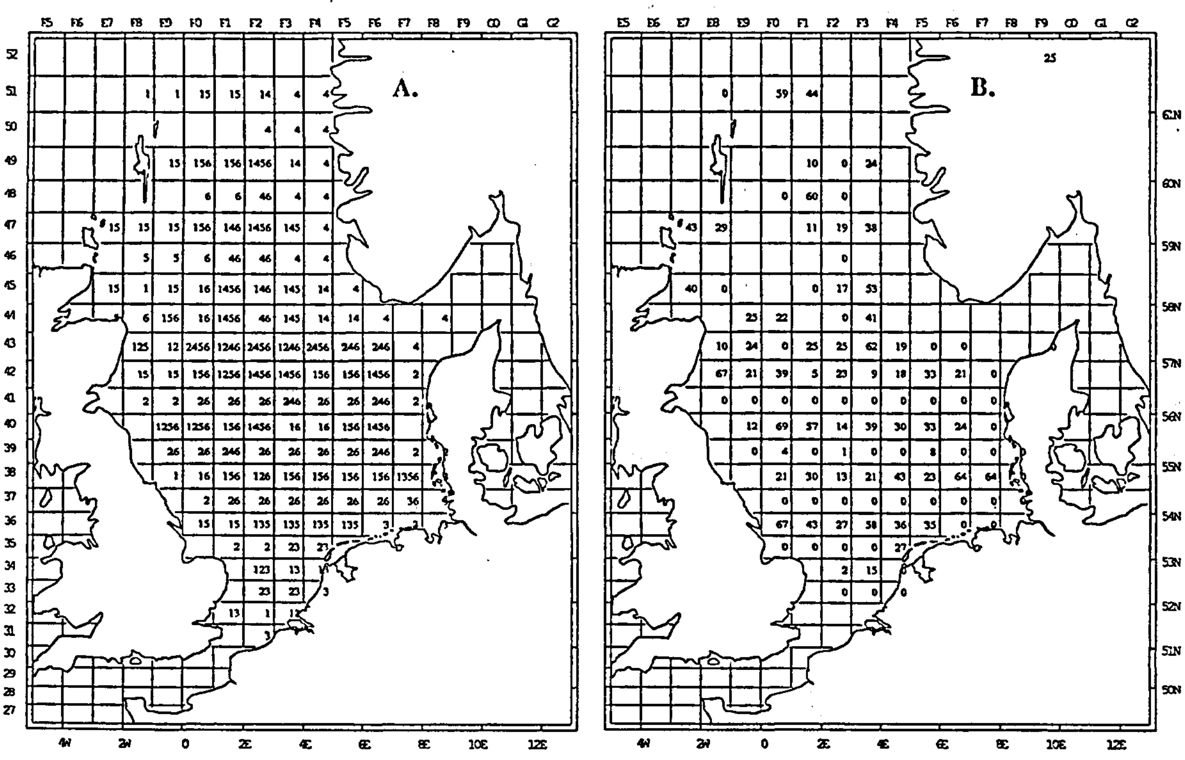
3.3. Empty stomachs

Regression analysis (Sokal & Rohlf, 1981a, 1981b) of the empty stomachs data shows that there are statistically significant differences between seasons and also between roundfish areas, while length classes do not contribute significantly to the model (Table 6). Information in the data-set was insufficient to fit the interaction terms QL (quarters and length classes) and R.L (areas and length classes), so the full model is:

$$\text{logit Ne} = Q + R + L + QR + \varepsilon.$$

The model explains 80 % of the variance. The significant interaction between seasons and areas indicates that in different seasons the distributions of the proportion of empty stomachs over the areas vary.

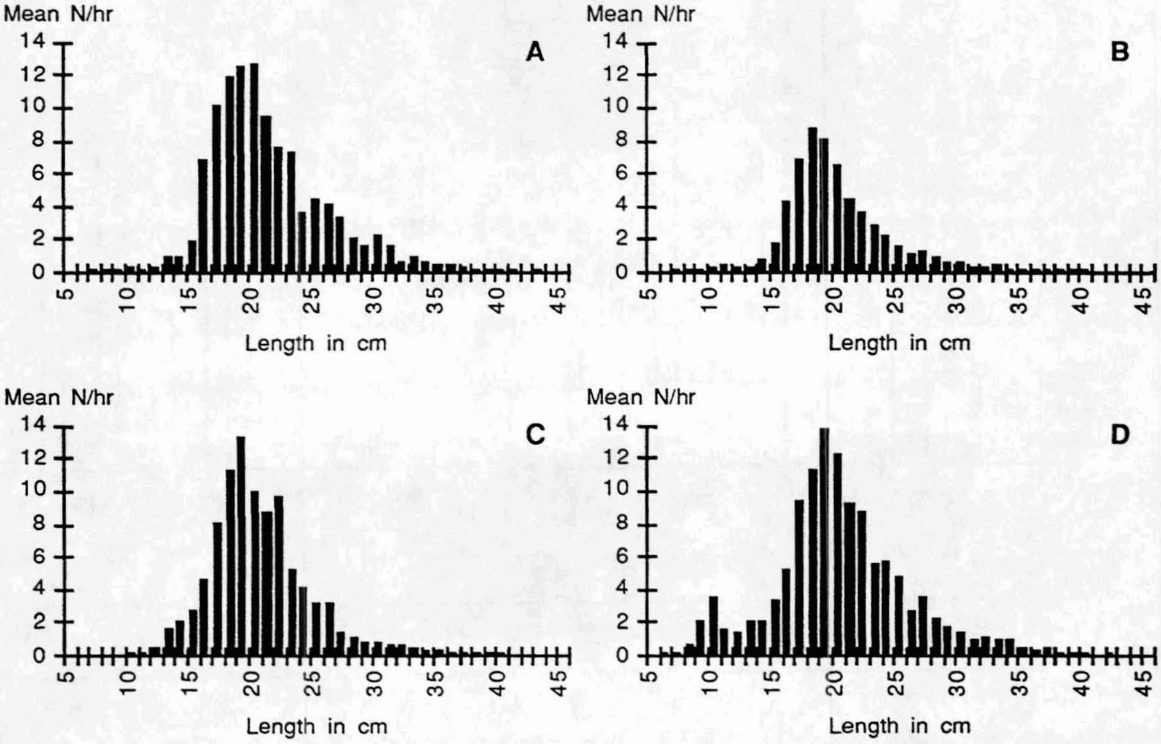
Figure 5. Example of differences in reported regurgitation rates by different countries during the second quarter of 1991.
A. Squares fished by: 1 Cirolana; 2 Tridens; 3 Isis; 4 J. Hjort; 5 Scotia; 6 W. Herwig.
B. Percentage of grey gurnard stomachs classified as regurgitated by statistical square.



3.4. Average stomach content weight

Because there were no otolith readings of grey gurnard available to determine age-size distributions, calculations of stomach contents by age group have not been possible. Table 7 gives the mean weight of stomach contents by length class, roundfish area and quarter. These data, together with length distribution data (fig. 6), have been used to calculate the mean lengths with the corresponding mean stomach content weights per length class and quarter averaged over the total North Sea (Table 8). Double logarithmic regression analysis of mean stomach contents weight versus predator length indicated a decreasing trend in the estimated regression coefficients, but the confidence limits are large and the value of 3, which corresponds to a proportional relationship between stomach content weight and fish weight, lies within the calculated 95% confidence intervals during all seasons except for quarter 4. Assuming the model $W=\phi.L^3$, where W and L represent stomach content weight and length, respectively, the feeding coefficient (ϕ) can be estimated.

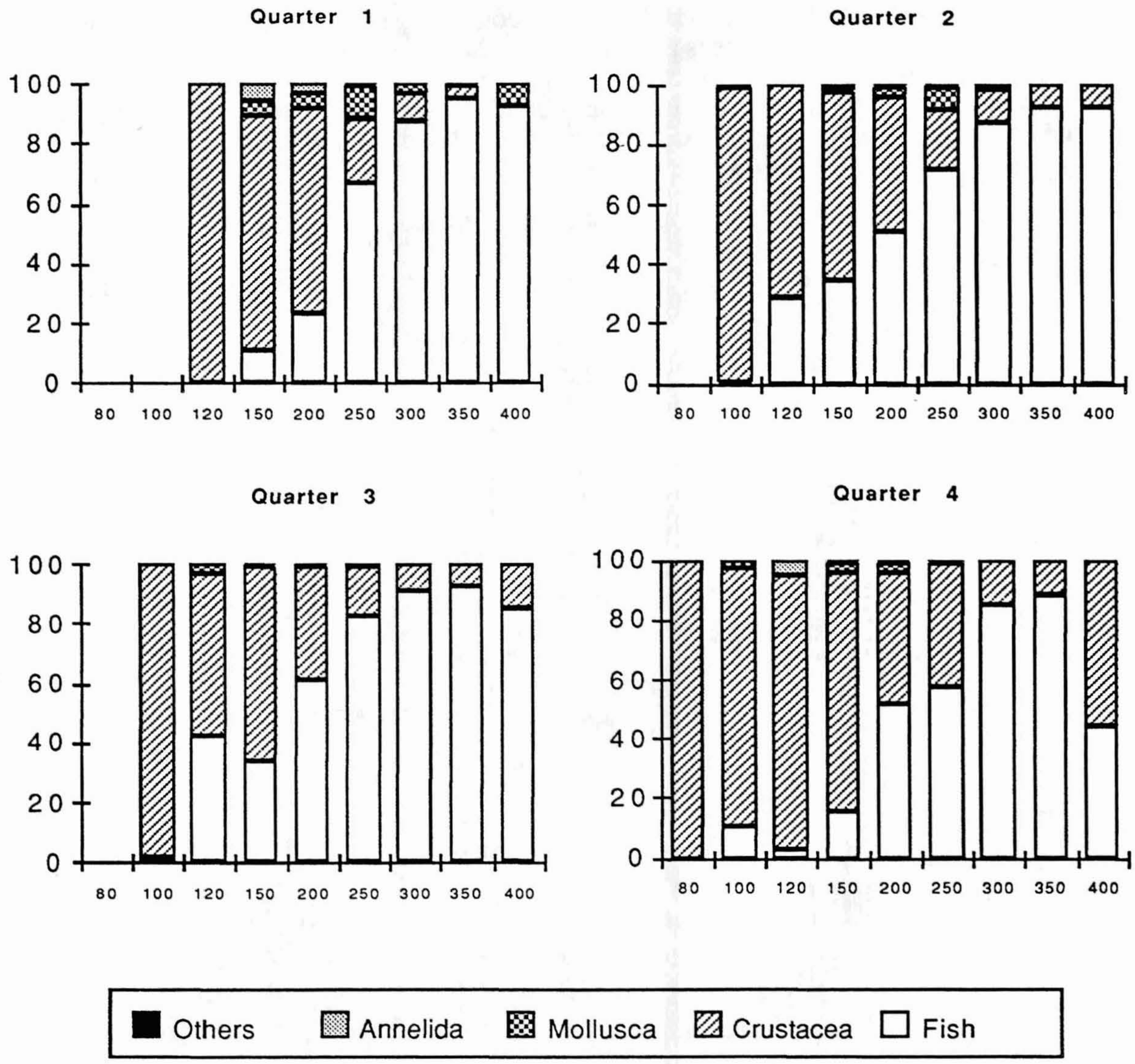
Figure 6. Length distributions of grey gurnard in the North Sea in mean numbers per hour fishing per cm-class and quarter (data from the IBTS, 1991).
A: quarter 1, nr of hauls = 465; B: quarter 2, nr of hauls = 368;
C: quarter 3, nr of hauls = 294; D: quarter 4, nr of hauls = 248 .



3.5. Diet of grey gurnard of different sizes

In Appendix II a complete list is given of taxonomic prey categories identified from grey gurnard stomachs during this project. Table 9 presents the percentages by weight of the major prey taxa by length class and quarter. These data have been visualized in figure 7. Fish (Gnathostomata), crustaceans, molluscs and annelids represent almost the total weight of food in all length classes and every quarter. In fact, fish and crustaceans together account always for at least 85% of the weight of the stomach contents. Annelids and molluscs contribute up to about 12% to the diet of gurnards in the size range of 20 - 30 cm during the first quarter and only to about 3% in the third quarter. Among the molluscs, squids (Cephalopoda) are the most important component followed by bivalves.

Figure 7. Weight percentages of major prey taxa by length class and quarter.

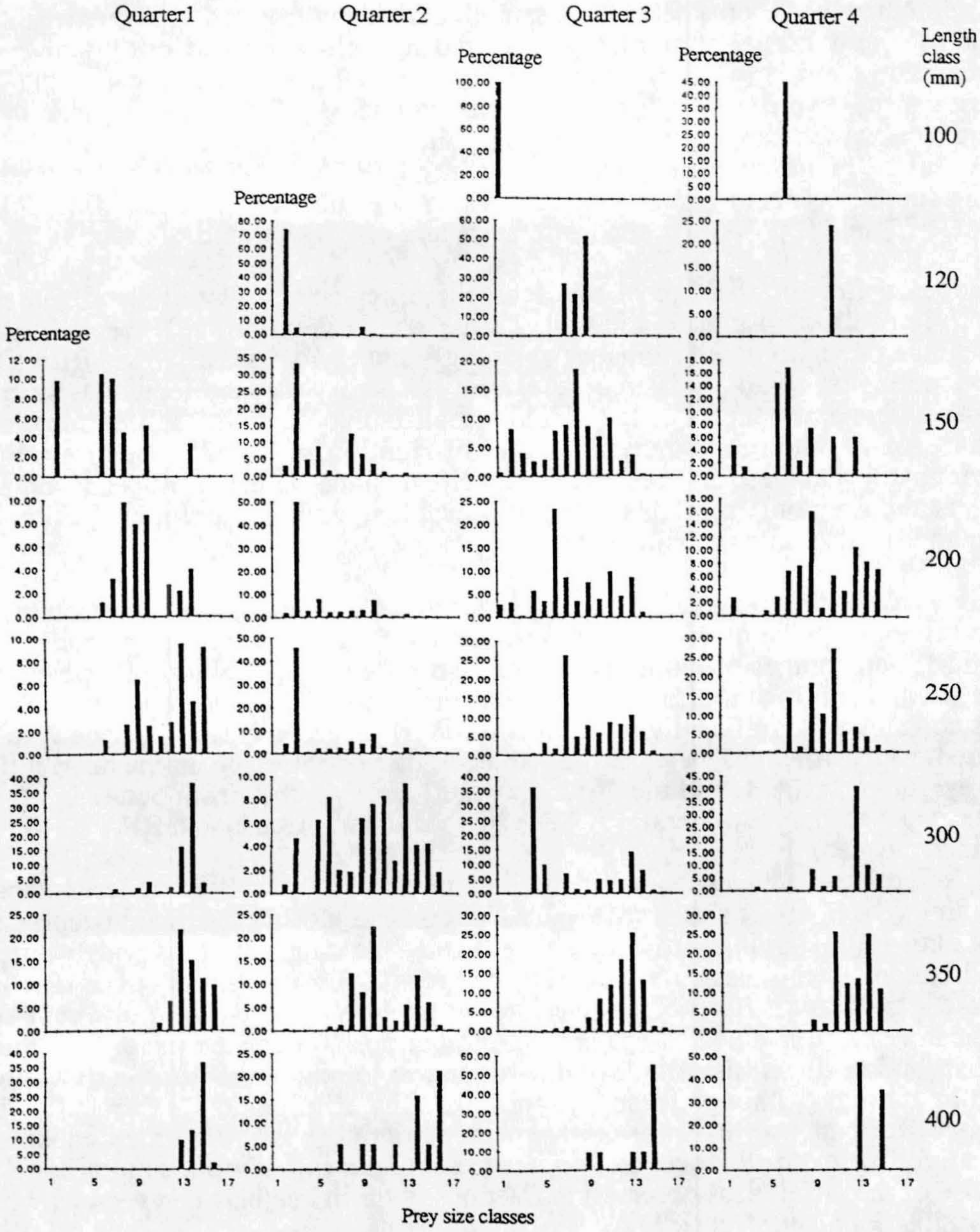


Weight percentages of commercially important fish prey are given in more detail in table 10. The group 'other fish' includes identified fish that are not classified as commercially important and fish not identified to species level. For example, a fish identified to the family level Pleuronectidae has been put into this class, even though it may have been a plaice (*Pleuronectes platessa*) as well as a scaldfish (*Arnoglossus laterna*).

Disregarding species which were always below 2% in all size classes, 6 commercially important fish species appear to be regularly eaten: sprat (*Sprattus sprattus*), cod, Norway pout (*Trisopteris esmarkii*), whiting, sandeels (Ammodytidae) and dab (*Limanda limanda*). Of these, sprat and dab are of less importance in the diet compared to the other four species.

Sandeels contribute the largest weight percentage in nearly all size classes. While the contribution of sandeels decreases with increasing length, Norway pout and whiting exhibit the opposite trend. Cod merely show a fluctuating pattern.
Crustacean prey have been split by taxonomic order in table 11. Using the same criterion of 2% for defining important groups, there are nine important crustacean taxa. Weight percentages of Mysidacea, Cumacea and shrimps (Caridea) decrease while Anomura, Cancridea and crabs (Brachyrhyncha) increase with increasing length. For Hyperiidae and Euphausiacea there appears to be a preference of grey gurnards in the range of 150-250 mm. Predation on *Nephrops norvegicus* (Astacidea) is confined to the larger size classes.

Figure 8. Length frequency distribution of fish prey (percentage by numbers) by predator length class and quarter. Prey with size classified as 'unknown' are excluded. Class 1 = 8-10 mm; class 17 = 200-250 mm (cf. table 12).



3.6. Size composition of fish prey

Table 12 gives the percentage contribution in terms of numbers of fish prey in each size class to the total numbers of fish prey by predator length class and quarter. The prey size class 'unknown' represents prey fish that could not be measured because digestion stage was too advanced. In figure 8 the data, disregarding the 'unknown' category, are classified in length frequency distributions. It shows a good example of the general rule that, although each length class eats a wide range of prey sizes, bigger fish tend to eat larger prey (e.g.: cf for whiting Hislop et al., 1991; for cod Kikkert, 1993). The prey distributions of the different predator length classes in the last and first quarter show a broadly similar pattern, but in the second quarter the contribution of small prey fish (10-15 mm) in the diet of grey gurnard of 120-250 mm suddenly increases remarkably. In the third quarter this group becomes less obvious.

4. DISCUSSION AND CONCLUSIONS

Although there has been a decreasing sampling intensity from the first quarter to the last one (table 1). the numbers of stomachs collected in the second and third quarter were large compared to the first (table 2). Therefore, the seasonal differences (fig. 3, table 2) appear to be less caused by differences in overall sampling intensity (fig. 2, table 1) than by changes in abundance, which can be quite significant (fig. 4). The distibution patterns of catch rates show that the highest densities shift from the north (RFA 2 and 4) in the first quarter to south during summer. This migration pattern has also been noted by Daan et al. (1990) and Knijn et al. (1993) and appears to be a consistent feature of grey gurnard.

Based on a first impression of the data, there appears to have been a real problem in classifying full, regurgitated and empty stomachs in grey gurnards, because the recorded percentage of regurgitated stomachs is strongly linked to research vessel (fig 5). Although gear handling on board of different research vessels may play a role, it does seem likely that the subjective assessments of individual scientists may have influenced the classification. Because of the 'non-randomness' of the distribution of recorded regurgitation rates, it appears likely that these differences have an effect on the estimates of mean stomach contents weights and fractions empty. Although this problem requires careful evaluation in future, it has not been taken into account at this stage.

Seasons have a significant effect on the proportions of empty stomachs (table 6) and higher fractions appear to be more common in autumn and winter than in spring and summer (table 4 and 5). Percentages of empty stomachs also differed significantly between areas, while there was no significant effect of lengh classes. Only the interaction between seasons and areas contributed significantly to the GLIM model. To get a clearer overview, the data from different roundfish areas were pooled (table 13), taking into account the distribution patterns of grey gurnard (fig. 4) and the different watermasses in the North Sea (RFA 5 + 6 + 7 are influenced by Channel water, RFA 1 + 3 by the Atlantic Ocean and RFA 2 + 4 represent an intermediate area).

It has sometimes been suggested in the literature that feeding may be less intensive during spawning (Daan, 1973; Kikkert, 1993). Since spawning of grey gurnard occurs mainly from April until July (Hardings & Nichols, 1987) and spawning activity is widely spread over all roundfish areas with particular emphasis on areas 2, 3 and 4 (Daan et al., 1990), it follows that the significant differences in the fraction of empty stomachs in different seasons and areas can not be explained by spawning. Another possibly related factor is migration. From the distribution charts (fig. 4), grey gurnards appear to migrate south in early spring and back north in autumn. Although these seasonal patterns of migration and fractions empty bear some correspondence, it is not clear whether migration is the primary causal factor or a derivative like the differences in temperature regime. In addition, caution is required here because of the differences observed in fractions regurgitated between vessels, which may be responsible for an artefact.

The relationship between calculated mean length and corresponding mean stomach content weight (table 8) confirms the general observation that the average weight of food in the stomach increases exponentially with fish length (cf. Hislop et al., 1991). Although exceptions do occur in the smallest and largest length classes, these deviations are probably caused by the small number of samples in these classes.
The observations by Daan (1973, 1983) and Kikkert (1993) for cod that there is a simple functional relationship between the weight of the stomach contents and the third power of the length, appear to be valid also for grey gurnard (table 8). The estimated average annual value of 0.00011 of the feeding coefficient is slightly smaller compared to the values for cod of 0.00015 (Daan, 1983) and 0.00018 (Kikkert, 1993). The estimated quarterly values of the feeding coefficient suggest a seasonal trend, with values during spring and summer being ca. 25% higher than during autumn and winter. This phenomenon is probably related to the seasonal differences in fractions empty.

Fish and crustaceans together account for at least 85% of the weight of the stomach contents of all length classes in all quarters (table 9, fig. 7). A general pattern of increasing contribution of fish prey and a decreasing contribution of crustacean prey with increasing predator size is apparent in all seasons, with a few exceptions due to poor sampling in some length classes. The size at which grey gurnards switch from crustaceans to fish (ca 25 cm) appears to be rather small compared to whiting (Hislop et al., 1991) and cod (Daan, 1973).
Sandeels and Norway pout represent an important food resource for five commercially exploited predator fish species (cod, haddock, mackerel, saithe and whiting) (Hislop et al., 1991). Because these two prey species are, together with whiting, also the predominant fish prey in the diet of grey gurnard (table 10), there is scope for some competition. However,the size range of the fish prey (fig. 8) indicates that this species feeds to a very large extent on 0-group, whereas the predation by the other predators mentioned concerns mainly 1-group and older. Figure 8 also indicates that, although larger fish eat in general larger prey, when 0-group fish become available in the second quarter, grey gurnard up to a length of 30 cm eats large amounts of very small fish (10-15 mm).
In contrast with cod (Daan, 1989) and whiting (Hislop et al., 1991), there has only been one single observation of cannibalism in the grey gurnard stomachs collected.

To derive a rough estimate of daily rations in grey gurnard, the feeding model developed by Daan (1973) for North Sea cod has been used. In his study, digestion time in cod of 20 cm was estimated at 1.2 days. Because such information is not available for grey gurnards, these parameter values have been applied for calculations of daily rations (table 14) and quantitative estimates of food consumption by the grey gurnard population (table 15). Grey gurnard lengths (L) were converted to weights (W) by means of $W=0.0062*L^{3.1003}$ (Coull et al., 1989). Further assumptions are:
- The daily ration is twice the mean amount of food in the stomach, divided by the stomach depletion time:

$$\Phi_L = \frac{2.w_L}{D_L} \quad [1]$$

where Φ_L is the daily ration of a fish at length L, w_L is mean weight of the stomach contents at length L, and D_L is digestion time in days at length L.
- The digestion time can be expressed as:

$$D_L = \delta.L \quad [2]$$

where δ is the digestion coefficient.
- The mean weight of the stomach contents can be expressed as:

$$w_L = \phi.L^3 \quad [3]$$

where ϕ is the feeding coefficient.

Substituting [2] and [3] in [1] gives:

$$\Phi_L = \frac{2.\phi}{\delta} . L^2 \qquad [4]$$

Daily rations have been calculated for 8 selected grey gurnard lengths by means of equation [4] (Table 14). These rations are approximately 30% smaller than the cod values calculated by Daan (1973), because of the lower feeding coefficents.

Apart from a likely bias caused by using values of digestion time and length-weight conversion for cod, the results of this exercise have to be considered with caution, because the assumptions made represent a considerable simplification of the digestion problem. Nevertheless, the estimated daily rations are probably indicative of the order of magnitude.

Following methods developed by Sparholt (1987), Daan et al. (1990) have estimated the average total biomass of grey gurnard in the North Sea over the years 1977-1986 at 205800 tonnes. By converting the length frequency distributions to biomass fractions of the total population and multiplying these fractions with daily rations and the observed fractions of fish in the total food, a tentative evaluation can be made of the fish consumption of the grey gurnard population in the North Sea (table 15). According to the available information grey gurnard consumes over 700 000 tonnes of fish annually. Comparing these values with results from MSVPA (Anon., 1987), this species appears to consume roughly the same amount as estimated for whiting in 1981 (730 000 tonnes) and considerably more than the haddock population (130 000 tonnes).

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Table 1. Number of hauls and statistical rectangles fished during the ICES 1991 Stomach Sampling Project in each roundfish sampling area (RFA) and quarter (research vessel data only).

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
Total nr valid hauls	463		368		294		284	
Area	Hauls	Squares	Hauls	Squares	Hauls	Squares	Hauls	Squares
RFA 1	126	44	75	34	99	46	55	39
RFA 2	72	25	77	25	54	25	33	25
RFA 3	34	20	33	15	40	20	22	15
RFA 4	21	12	30	9	17	11	7	6
RFA 5	19	10	14	7	10	7	7	4
RFA 6	100	34	88	35	46	34	76	33
RFA 7	49	13	42	12	18	12	17	13
North Sea proper (1-7)	421	7	359	7	284	7	217	7
RFA 8 & 9	41	17	1	1	-	-	31	15
outside RFA	1	1	8	8	10	8	-	-

Table 2. Number of stomachs sampled by length class, area and quarter.

Length class (mm)	80	100	120	150	200	250	300	350	400	Total
Quarter 1										
RFA 1			15	230	250	148	103	36	7	789
RFA 2			3	188	189	130	103	33	5	651
RFA 3				120	89	33	14	3		259
RFA 4				32	36	34	24	8	1	135
RFA 5				1	7	1				9
RFA 6			1	33	16	12	4	5	1	72
RFA 7				1						1
Total			19	605	587	358	248	85	14	1916
Quarter 2										
RFA 1				149	185	53	15	2	2	406
RFA 2			4	360	297	99	51	20	2	833
RFA 3		31	11	102	89	27	7			267
RFA 4				130	126	33	7	4		300
RFA 5		2	4	98	116	71	20	12		323
RFA 6		10	31	649	502	182	100	53	3	1530
RFA 7			1	194	209	45	14	6		469
Total		43	51	1682	1524	510	214	97	7	4128
Quarter 3										
RFA 1				202	253	170	105	39	1	770
RFA 2				230	315	227	115	45	5	937
RFA 3		5	7	179	160	68	32	7		458
RFA 4			5	110	100	54	9	2		280
RFA 5				60	138	21	16	2		237
RFA 6		14	8	275	291	94	57	54	2	795
RFA 7		1		166	192	89	22	8		478
Total		20	20	1222	1449	723	356	157	8	3955
Quarter 4										
RFA 1				18	19	19	25	10		91
RFA 2			4	176	159	124	110	39	9	621
RFA 3				11	12	11	2			36
RFA 4			2	59	37	38	1			137
RFA 5		4	5	43	81	60	7			200
RFA 6	16	84	38	140	156	73	19	10	1	537
RFA 7	1	17	19	18	21	1	2			79
Total	17	105	68	465	485	326	166	59	10	1701
Annual total										
RFA 1	0	0	15	599	707	390	248	87	10	2056
RFA 2	0	0	11	954	960	580	379	137	21	3042
RFA 3	0	36	18	412	350	139	55	10	0	1020
RFA 4	0	0	7	331	299	159	41	14	1	852
RFA 5	0	6	9	202	342	153	43	14	0	769
RFA 6	16	108	78	1097	965	361	180	122	7	2934
RFA 7	1	18	20	379	422	135	38	14	0	1027
Total	17	168	158	3974	4045	1917	984	398	39	11700

Table 3. Number of stomachs with only skeletal remains in each area by quarter.

Roundfish area	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
RFA 1		4			4
RFA 2				2	2
RFA 3					0
RFA 4					0
RFA 5					0
RFA 6	1	2			3
RFA 7		2			2
Total	1	8	0	2	11

Table 4. Numbers and percentages of stomachs classified as full, regurgitated, or empty by area and quarter.

Area	Full		Reg		Empty		Total	Full		Reg		Empty		Total
	N	%	N	%	N	%	N	N	%	N	%	N	%	N
	Quarter 1							Quarter 2						
RFA 1	356	45	164	21	269	34	789	223	55	120	30	59	15	402
RFA 2	268	41	169	26	214	33	651	556	67	210	25	67	8	833
RFA 3	84	32	76	29	99	38	259	150	56	89	33	28	10	267
RFA 4	41	30	3	2	91	67	135	161	54	91	30	48	16	300
RFA 5	6	67			3	33	9	233	72	53	16	37	11	323
RFA 6	33	46			38	53	71	850	56	406	27	272	18	1528
RFA 7	1	100					1	323	69	72	15	72	15	467
Total	789	41	412	22	714	37	1915	2496	60	1041	25	583	14	4120
	Quarter 3							Quarter 4						
RFA 1	420	55	320	42	30	4	770	21	23	68	75	2	2	91
RFA 2	559	60	283	30	95	10	937	164	26	153	25	302	49	619
RFA 3	303	66	132	29	23	5	458	16	44	4	11	16	44	36
RFA 4	177	63	56	20	47	17	280	46	34	64	47	27	20	137
RFA 5	73	31	147	62	17	7	237	92	46	103	19	5	3	200
RFA 6	556	70	185	23	54	7	795	396	74	18	3	123	23	537
RFA 7	334	70	63	13	81	17	478	36	46	21	27	22	28	79
Total	2422	61	1186	30	347	9	3955	771	45	431	25	497	29	1699

Table 5. Numbers and percentages of stomachs classified as full, regurgitated, or empty by length class and quarter.

Size class (mm)	Full		Reg		Empty		Total	Full		Reg		Empty		Total
	N	%	N	%	N	%	N	N	%	N	%	N	%	N
	Quarter 1							Quarter 2						
80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	19	44	21	49	3	7	43
120	15	79	4	21	0	0	19	38	75	11	22	2	4	51
150	227	38	146	24	232	38	605	895	53	519	31	266	16	1680
200	250	43	121	21	216	37	587	921	61	394	26	206	14	1521
250	141	39	69	19	148	41	358	355	70	80	16	72	14	507
300	101	41	55	22	92	37	248	184	86	10	5	20	9	214
350	44	52	14	17	26	31	84	77	79	6	6	14	14	97
400	11	79	3	21	0	0	14	7	100	0	0	0	0	7
Total	789	41	412	22	714	37	1915	2496	61	1041	25	583	14	4120
	Quarter 3							Quarter 4						
80	-	-	-	-	-	-	-	14	82	0	0	3	18	17
100	16	80	3	15	1	5	20	82	78	3	3	20	19	105
120	16	80	0	0	4	20	20	51	75	1	1	16	24	68
150	750	61	367	30	105	9	1222	190	41	135	29	140	30	465
200	854	59	469	32	126	9	1449	234	48	121	25	130	27	485
250	461	64	202	28	60	8	723	121	37	109	33	96	29	326
300	219	62	99	28	38	11	356	51	31	54	33	61	37	166
350	101	64	45	29	11	7	157	23	40	8	14	26	46	57
400	5	63	1	13	2	25	8	5	50	0	0	5	50	10
Total	2422	61	1186	30	347	9	3955	771	45	431	25	497	29	1699

Table 6. ANCOVA results of the proportion empty stomachs (Ne) as a function of quarters (Q), Roundfish Sampling Area's (R) and predator length classes (L) according to the GLIM model: logit Ne = Q + R + L + QR. The model employs a binominal error and a logit link function. QR is the interaction term between the 2 variables.

	SS	df	MS	F	P
Q	851.2	3	283.73	112.57	<0.01
R	131.1	6	21.85	8.67	<0.01
L	26.8	8	3.35	1.33	n.s.
QR	347.2	18	19.29	7.65	<0.01
QL	-	-	-		
RL	-	-	-		
error	332.7	132	2.52		
total	1689.0	167			

Table 7. Mean weight (g) of contents per length class, area and quarter.

Length class (mm)	80	100	120	150	200	250	300	350	400
Quarter 1									
RFA 1			0.60	0.24	0.61	1.00	2.41	2.44	8.78
RFA 2			0.05	0.10	0.27	1.14	3.07	6.08	22.01
RFA 3				0.35	0.23	0.62	0.53	11.07	
RFA 4				0.09	0.07	0.87	1.10	1.88	25.53
RFA 5				0.16	0.16	0.04			
RFA 6			0.01	0.05	0.33	0.11	4.84	2.29	24.51
RFA 7				1.24					
Quarter 2									
RFA 1				0.30	0.52	1.39	1.56	2.39	24.90
RFA 2			0.49	0.50	0.88	2.23	3.60	9.22	6.36
RFA 3		0.23	0.33	0.77	0.99	1.22	10.28		
RFA 4				0.20	0.78	1.38	2.96	7.35	
RFA 5		0.05	0.24	0.55	0.89	2.72	2.42	7.18	
RFA 6		0.22	0.15	0.49	0.91	1.63	5.33	6.90	27.73
RFA 7			0.04	0.22	0.85	1.84	5.91	8.80	
Quarter 3									
RFA 1				0.70	1.28	3.03	3.81	5.17	0.00
RFA 2				0.35	0.67	1.44	3.59	5.62	8.35
RFA 3		0.05	0.23	0.66	1.20	2.33	3.99	7.44	
RFA 4			0.09	0.31	0.74	1.10	3.29	1.63	
RFA 5				0.37	0.50	2.25	1.67	0.00	
RFA 6		0.13	0.30	0.43	1.11	2.10	4.46	7.28	0.13
RFA 7		0.12		0.34	0.8	1.73	2.03	4.98	
Quarter 4									
RFA 1				0.76	0.83	0.92	3.94	7.77	
RFA 2			0.09	0.08	0.55	0.63	1.14	1.83	1.15
RFA 3				0.07	0.16	0.14	0.89		
RFA 4			0.04	0.09	0.28	0.32	1.93		
RFA 5		0.47	0.09	0.31	1.92	2.59	5.05		
RFA 6	0.20	0.28	0.62	0.44	0.70	1.59	3.38	1.48	8.70
RFA 7	0.03	0.11	0.11	0.09	0.14	0.00	1.70		

Table 8. Mean lengths (L) in cm and mean stomach contents weights (W) in g by length class and quarter, and parameters double logarithmic regression analysis. (Log W = Log a + b Log L; b 95% = 95% confidence interval of b; feeding coefficient (ϕ) assuming $W = \phi*L^3$).

	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Total year	
Length class (mm)	L	W	L	W	L	W	L	W	L	W
80	8.33		8.59		9.00		8.64	0.16	8.61	0.16
100	10.44		10.55	0.21	10.86	0.08	10.32	0.25	10.37	0.22
120	13.27	0.32	13.28	0.18	13.40	0.24	13.12	0.42	13.25	0.28
150	17.61	0.15	17.58	0.43	17.69	0.45	17.62	0.20	17.63	0.32
200	21.51	0.30	21.48	0.85	21.59	0.94	21.60	0.59	21.56	0.66
250	26.51	0.97	26.65	1.82	26.28	2.02	26.57	0.80	26.5	1.33
300	31.43	2.49	31.64	4.20	31.62	3.56	31.84	1.87	31.63	2.88
350	36.39	4.05	36.04	7.45	36.10	5.72	36.45	2.30	36.32	4.85
400	41.79	19.59	40.75	20.81	40.33	4.22	41.18	1.78	41.33	13.58
n		7		8		8		9		9
r		0.90		0.97		0.99		0.92		0.95
b		3.77		3.42		3.20		1.67		2.65
S(b)		0.82		0.37		0.22		0.27		0.32
b 95%		1.66 - 5.88		2.52 - 4.33		2.66 - 3.74		1.03 - 2.31		1.89 - 3.41
a		$0.62*10^{-5}$		$3.39*10^{-5}$		$4.79*10^{-5}$		$407*10^{-5}$		$31.6*10^{-5}$
ϕ		$7.3*10^{-5}$		$12.4*10^{-5}$		$9.0*10^{-5}$		$7.5*10^{-5}$		$11.2*10^{-5}$

Table 9. Percentage by weight of major prey taxa by length class and quarter.

Length class (mm)	80	100	120	150	200	250	300	350	400
				Quarter 1					
Annelida				5.91	3.18	0.63	0.01		
Gastropoda				0.71	0.21	0.08			
Bivalvia				4.40		0.15	0.02		
Scaphopoda						0.05			
Cephalopoda				0.23	4.40	10.66	3.21	0.56	7.57
Crustacea			100.00	77.66	68.97	21.20	9.41	4.48	0.04
Echiura					0.01				
Echinodermata				0.15		0.04			
Gnathostomata				10.86	23.15	67.19	87.35	94.96	92.39
Unknown				0.09	0.09				
				Quarter 2					
Annelida			0.15	1.77	1.18	0.82	0.02	0.20	
Gastropoda					0.01		0.01		
Bivalvia		0.96		0.03		0.57		0.26	
Cephalopoda				1.19	2.75	6.97	1.53		
Crustacea		98.12	71.14	62.95	45.13	19.85	10.60	7.42	7.32
Echinodermata					0.01	0.01	0.02		
Gnathostomata		0.91	28.71	34.06	50.92	71.79	87.82	92.13	92.68
				Quarter 3					
Annelida				0.41	0.12	0.43	0.08		
Bivalvia			2.88	0.50	0.72	0.39	0.02	0.17	
Cephalopoda				0.80	0.02	0.11		0.23	
Crustacea		97.68	54.41	64.65	38.15	16.79	9.29	7.10	14.38
Gnathostomata		2.32	42.71	33.64	60.98	82.29	90.61	92.50	85.62
				Quarter 4					
Annelida		0.13	4.87	0.74	0.68	0.56	0.01		
Bivalvia		2.20		0.34	0.09	0.33			
Cephalopoda				2.85	3.52				
Crustacea	100.00	87.53	91.88	81.06	44.17	41.37	15.31	11.36	55.34
Ectoprocta						0.03			
Gnathostomata		10.14	3.25	15.01	51.53	57.71	84.68	88.64	44.66

Table 10. Proportion of different commercial important fish prey expressed as % of total fish weight observed by length class and quarter.

Length class (mm)	80	100	120	150	200	250	300	350	400
				Quarter 1					
Gadus morhua						13.92			
Melanogrammus aeglefinus						3.62			
Trisopterus esmarki				1.29	43.02	11.53	65.15	30.88	23.2
Merlangius merlangus						3.18	2.97	31.97	64.76
Ammodytidae				40.88	21.81	37.89	13.03	12.62	
Scomber scomber								0.29	
Limanda limanda					0.78				
Other fish				57.83	34.38	29.86	18.86	24.24	12.05
				Quarter 2					
Sprattus sprattus						0.28	3.25		
Clupea harengus				0.03	0.02			4.30	
Gadus morhua					1.63	0.67	6.74	0.36	
Melanogrammus aeglefinus						0.33	0.59		
Trisopterus esmarki				2.14	3.00	5.10	2.77	7.46	36.88
Merlangius merlangus				1.26	2.87	1.91	10.19	14.19	26.56
Ammodytidae			32.53	33.35	41.83	50.98	28.89	27.04	1.48
Limanda limanda				2.58	1.77	0.14	1.14		
Pleuronectes platessa						0.06			
Other fish		100.00	67.47	60.63	48.88	40.53	46.44	46.66	35.08
				Quarter 3					
Sprattus sprattus					3.95	5.55		0.35	
Gadus morhua				0.42	3.18	5.43	3.26	16.18	
Melanogrammus aeglefinus					0.20	0.77	1.24	4.12	
Trisopterus esmarki				2.85	9.23	10.67	17.57	7.55	
Merlangius merlangus				1.66	3.71	7.62	3.77	18.96	
Ammodytidae			37.91	63.23	48.44	43.77	46.26	43.36	92.43
Scomber scomber							2.12		
Limanda limanda				1.87	0.25	0.11	0.20		
Other fish		100.00	62.09	29.96	31.04	26.08	25.58	9.48	7.57
				Quarter 4					
Sprattus sprattus					0.83		0.18		
Gadus morhua						13.69	5.93	4.23	
Melanogrammus aeglefinus					10.19		5.83		
Trisopterus esmarki							8.82	2.54	
Merlangius merlangus		0.30			7.47	5.70	29.15	14.88	96.91
Ammodytidae			84.31	33.91	58.22	18.35	21.33	36.94	
Limanda limanda				1.53	0.89	0.16			
Other fish		99.70	15.69	64.56	22.39	62.10	28.77	41.41	3.09
				Annual total					
Sprattus sprattus					2.14	2.69	0.84	0.11	
Clupea harengus				0.01	0.01			1.38	
Gadus morhua				0.21	2.04	6.89	3.53	5.69	
Melanogrammus aeglefinus					1.86	1.11	1.36	1.30	
Trisopterus esmarki				2.32	7.99	8.33	26.84	12.90	25.50
Merlangius merlangus		0.29		1.33	3.92	5.29	8.74	20.29	49.38
Ammodytidae			40.82	48.81	46.83	41.34	28.46	29.62	6.47
Scomber scomber							0.66	0.07	
Limanda limanda				2.04	0.79	0.10	0.35		
Pleuronectes platessa						0.01			
Other fish		99.71	59.18	45.27	34.43	34.23	29.23	28.66	18.65

Table 11. Proportions of different crustacean taxa expressed as % of total crustacean weight observed by length class and quarter.

Length class (mm)	80	100	120	150	200	250	300	350	400
Quarter 1									
Leptostraca				0.26					
Mysidacea			5.13	4.62	1.48	0.14			100.00
Cumacea				0.31	0.10				
Valvifera					0.04				
Gammaridea			6.18	1.39	1.12	0.47			
Hyperiidea					0.58				
Euphausiacea				0.31	0.13	0.42			
Caridea			87.76	88.53	86.52	80.57	37.19	72.99	
Anomura				0.53	5.87	12.41	25.93	10.04	
Cancridea				0.04			15.83		
Brachyrhyncha				3.13	2.87	5.05	19.87	16.96	
Other Crustacea			0.93	0.89	1.29	0.94	1.17		
Quarter 2									
Mysidacea		13.76	18.68	16.35	12.41	9.22	2.74	1.21	
Cumacea		20.97	11.13	1.43	0.84	0.05	0.09		
Valvifera					0.02				
Gammaridea		3.93	3.78	2.65	0.51	0.91			
Hyperiidea		3.13	20.78	31.52	32.46	46.55	18.68	7.55	
Euphausiacea				2.62	2.13	2.17	3.49		
Caridea		42.80	19.85	39.95	43.76	33.15	57.26	6.20	
Astacidea							0.75		52.60
Anomura					0.09	0.05	2.83	31.00	
Cancridea							6.89	22.64	
Brachyrhyncha		5.57		0.48	4.34	3.93	6.23	30.73	
Other Crustacea		9.82	25.78	5.00	3.43	3.98	1.04	0.67	47.40
Quarter 3									
Calanoida				0.02	0.05				
Leptostraca				0.03					
Mysidacea		14.53		3.05	3.15	2.03		0.14	
Cumacea		0.55	18.01	3.12	2.10	0.30			
Anthuridea				0.02					
Valvifera						0.12			
Oniscoidea				0.22			0.32		
Gammaridea				0.56	0.10	0.48	0.32		
Hyperiidea				7.07	10.35	8.46	7.32	0.85	
Euphausiacea			1.53	6.68	9.15	28.05	11.63	23.80	
Caridea		66.06	27.97	50.41	47.65	25.01	29.60	7.61	1.04
Astacidea					0.03				
Anomura				0.29	1.57	3.99	16.36	10.56	
Oxystomata					0.03	0.95			
Cancridea		0.74		0.22	0.34	4.11		9.01	
Brachyrhyncha		18.12	37.27	18.76	13.74	20.61	30.68	47.46	98.96
Other Crustacea			15.22	9.56	11.74	5.90	3.77	0.56	
Quarter 4									
Leptostraca		0.13							
Mysidacea		8.19		1.63	0.66	0.75			
Cumacea	15.50	4.90	7.78	8.12	3.46	0.97			
Gammaridea			0.14	1.34	0.18	0.12	0.33		
Hyperiidea		0.01							
Euphausiacea		1.05		3.03	2.92	2.13		0.09	
Caridea	84.50	81.09	67.70	61.18	60.49	26.08	15.48	21.57	
Anomura		0.06		1.57	1.58	2.88	4.51		
Cancridea				0.30	0.23	0.56			
Brachyrhyncha		3.94	22.50	20.65	29.61	66.16	79.69	78.35	100.00
Other Crustacea		0.63	1.88	2.18	0.86	0.36			

Table 11. (Continued).

Length class (mm)	80	100	120	150	200	250	300	350	400
				Annual total					
Calanoida				0.01	0.02				
Leptostraca		0.09		0.05					
Mysidacea		9.93	4.11	7.10	4.86	2.79	0.69	0.45	0.49
Cumacea	15.50	8.61	8.70	2.97	1.59	0.38	0.02		
Anthuridea				0.01					
Valvifera					0.01	0.04			
Oniscoidea				0.09			0.08		
Gammaridea		0.97	1.50	1.42	0.43	0.47	0.16		
Hyperiidea		0.78	3.92	12.53	12.54	12.35	6.64	2.83	
Euphausiacea		0.73	0.18	4.05	4.41	10.14	3.96	7.59	
Caridea	84.50	70.79	56.39	53.89	56.58	37.75	35.56	20.02	0.21
Astacidea					0.01		0.19		23.13
Anomura		0.04		0.42	2.04	4.50	12.99	15.44	
Oxystomata					0.01	0.31			
Cancridea		0.04		0.14	0.16	1.48	5.98	10.54	
Brachyrhyncha		5.16	17.39	11.39	11.75	26.82	32.15	42.72	55.32
Other Crustacea		2.86	7.81	5.92	5.59	3.00	1.58	0.41	20.85

Table 12. Percentage contribution by numbers of fish prey by size class to the total number of fish prey by each length class and quarter.

Length class (mm)	80	100	120	150	200	250	300	350	400
Prey size class				Quarter 1					
10 - 12				9.79					
....									
25 - 30				10.50	1.20	1.23	0.16		
30 - 35				10.02	3.20		1.44		
35 - 40				4.53	9.75	2.57			
40 - 50					7.88	6.42	1.81		
50 - 60				5.25	8.68	2.43	3.82		
60 - 70						1.54	0.51	1.57	
70 - 80					2.67	2.71	2.13	6.28	
80 - 100					2.14	9.45	15.99	21.64	10.11
100 - 120				3.34	4.01	4.48	38.06	14.98	13.49
120 - 150						9.10	3.53	11.08	37.08
150 - 200								9.75	2.24
Unknown				56.56	60.48	60.07	32.56	34.69	37.08
				Quarter 2					
10 - 12			73.99	2.99	1.86	4.39	0.75	0.40	
12 - 15			4.84	33.17	49.73	45.65	4.67		
15 - 20				4.74	2.65	0.47			
20 - 25				8.73	7.56	2.27	6.23		
25 - 30				1.50	2.12	1.96	8.21	0.81	
30 - 35				0.25	2.25	2.43	1.99	1.07	5.27
35 - 40				12.47	2.65	5.25	1.83	12.24	
40 - 50			5.85	6.48	2.92	4.23	6.39	8.11	5.27
50 - 60			1.01	3.49	7.29	8.61	7.62	22.37	5.27
60 - 70				1.25	1.06	2.43	8.32	2.77	
70 - 80				0.25	0.27	0.86	2.79	2.02	5.27
80 - 100				1.00	1.19	2.66	9.39	5.52	
100 - 120					0.27	0.70	4.13	11.79	15.79
120 - 150					0.13	0.47	4.24	5.99	5.27
150 - 200						0.70	1.83	1.15	21.05
200 - 250								0.22	
Unknown		100.00	14.31	23.69	18.04	16.91	31.62	25.53	36.84

Table 12. ctd

Length class (mm)	80	100	120	150	200	250	300	350	400
Prey size class				Quarter 3					
8 - 10		100.00		0.71	2.74	0.30			
10 - 12				8.13	3.06	0.07			
12 - 15				3.89	0.32	0.07			
15 - 20				2.47	5.64	0.52	36.14		
20 - 25				2.83	3.38	3.35	9.97	0.53	
25 - 30				7.77	23.19	1.71	0.22	0.80	
30 - 35			26.98	8.83	8.53	26.21	6.85	1.38	
35 - 40			21.63	18.37	3.38	4.91	1.61	0.80	
40 - 50			51.39	8.48	7.41	7.97	1.25	3.61	9.09
50 - 60				6.71	3.86	5.96	4.99	8.56	9.09
60 - 70				9.89	9.66	8.79	4.55	12.17	
70 - 80				2.47	4.51	8.34	4.84	18.72	
80 - 100				3.53	8.53	10.65	14.30	25.55	9.09
100 - 120				0.35	0.97	6.25	7.95	13.43	9.09
120 - 150						1.12	1.10	1.38	54.55
150 - 200							0.29	1.02	
Unknown				15.55	14.81	13.78	5.94	12.05	9.09
				Quarter 4					
10 - 12				4.65	2.74				
12 - 15				1.40	0.14				
15 - 20							1.66		
20 - 25				0.47	0.82	0.27			
25 - 30				14.42	2.88	0.55			
30 - 35		44.94		16.74	6.85	14.34	1.66		
35 - 40				2.33	7.67	1.56			
40 - 50				7.44	16.03	18.19	8.46	2.77	
50 - 60					1.23	10.27	1.95	1.84	
60 - 70			23.91	6.05	6.16	26.95	5.82	25.44	
70 - 80					3.84	5.50	0.37	12.17	
80 - 100				6.05	10.55	6.69	41.09	13.36	47.07
100 - 120					8.36	4.17	10.35	24.89	
120 - 150					7.12	1.97	6.48	10.60	35.30
150 - 200						0.37			
200 - 250								0.35	
Unknown		55.06	76.09	40.47	25.62	9.17	22.16	8.57	17.63

Table 13. Percentage empty stomachs in different regions by quarter. The areas are pooled using a weighting factor corresponding to the relative survey areas.

Region	Quarter 1	Quarter 2	Quarter 3	Quarter 4
RFA 1 + 3	35	13	4	14
RFA 2 + 4	39	10	12	44
RFA 5 + 6 + 7	41	16	10	18

Table 14. Estimated daily rations and coefficients as a function of size. Weight is calculated as $0.0062 \times L^{3.1003}$, the daily ration as $(2 \times 0.00011 \times L^2)/0.06$ and the daily coefficient as (daily ration x weight)/100.

predator length (cm)	predator weight (g)	daily ration (g)	daily coefficient (%)
7	2.58	0.18	6.98
12	13.65	0.53	3.85
17	40.47	1.06	2.62
22	90.01	1.77	1.97
27	169.84	2.67	1.57
32	287.61	3.75	1.30
37	451.12	5.02	1.11
42	668.27	6.47	0.97

Table 15. Calculation of the annual food consumption of the grey gurnard population in the North Sea. The length frequency percentages are calculated from the quarterly distributions of Figure 6. For calculating weight contributions and consumed food, data from Tables 8, 9 and 14 have been used.

Length class (cm)	Length frequency (%)	Weight contribution (%)	Biomass (tonnes)	Daily consumption (tonnes)	Annual consumption ('000 tonnes)	Annual fish consumption ('000 tonnes)
5 - 9	1.97	0.07	135	9.4	3	0
10 - 14	6.60	1.17	2416	93.0	34	5
15 - 19	48.57	25.43	52333	1371.1	500	144
20 - 24	28.97	33.73	69425	1367.7	499	258
25 - 29	9.52	20.92	43048	675.9	247	181
30 - 34	3.40	12.65	26035	338.5	124	109
35 - 39	0.87	5.08	10449	116.0	42	39
40 - 44	0.11	0.95	1957	19.0	7	6
Total	100%	100%	*205800	3990.6	1457	742

*) The value of the total population biomass (average 1977-1986) is from Daan et al. (1990).

APPENDIX I

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APPENDIX II

PREY LIST

List of identified taxonomic groups of prey found in the stomachs of grey gurnard (*Eutrigla gurnardus*), collected during the ICES 1991 North Sea Stomach Sampling Project. Names follow standard used in the NODC (National Oceanographic Data Center) code list.

(Sub)Phylum	Class	Order	Suborder	Family	Species
Annelida	**Polychaeta**	Phyllodocida		Aphroditidae	*Aphrodite aculeata*
				Polynoidae	
				Nereidae	*Nereis* sp.
				Nephtyidae	*Nephtys* sp.
		Terebellida		Pectinariidae	*Pectinaria* sp.
Mollusca	**Gastropoda**	Archaeogastropoda			
	Bivalvia	Heterodonta		Astartidae	*Astarte* sp.
				Solenidae	*Ensis* sp.
	Scaphopoda	Dentalioida		Dentaliidae	*Dentalium* sp.
					Dentalium entale
	Cephalopoda	Sepiidea		Sepiolidae	*Sepiola* sp.
				Sepiidae	*Sepia* sp.
		Teuthidea		Loliginidae	*Loligo* sp.
					Allotheutis sp.
Crustacea	**Copepoda**	Calanoida			
		Harpacticoida			
	Malacostraca	Leptostraca			
		Nebaliacea		Nebalidae	*Nebalia* sp.
		Mysidacea		Mysidae	*Mysis* sp.
				Lophogastridae	*Lophogaster typicus*
		Cumacea		Pseudocumidae	*Pseudocuma longicornis*
		Isopoda	Anthuridea	Anthuridae	*Anthura* sp.
			Valvifera	Arcturidae	*Astacilla* sp.
			Oniscoidea	Ligiidae	*Ligia* sp.
		Amphipoda	Gammaridea	Gammaridae	
			Hyperiidea	Hyperiidae	
		Euphausiacea		Euphausiidae	*Euphausia* sp.
		Decapoda	Natantia	Hippolytidae	*Spirontocaris* sp.
					Spirontocaris liljeborgii
					Spirontocaris spinosus
				Processidae	*Processa* sp.
					Processa canaliculata
				Pandalidae	*Pandalus* sp.
					Pandalus borealis
					Pandalus montagui
					Pandalus brevirostris
					Pandalus propinquis
				Crangonidae	*Crangon* sp.
					Crangon crangon
					Crangon allmanni
					Pontophilus sp.
					Pontophilus bispinosus
					Pontophilus trispinosus
					Pontophilus spinosus
					Pontophilus norvegicus
					Pontophilus sculptus
			Reptantia	Nephropidae	*Nephrops norvegicus*
			Anomura	Callianassidae	*Callianassa* sp.
					Upogebia sp.
				Paguridae	*Pagurus bernhardus*
				Galatheidae	*Munida rugosa*
					Galathea sp.
					Galathea intermedia
					Galathea dispersa
			Brachyura	Leucosiidae	*Ebalia* sp.
				Corystidae	*Corystes cassivelanus*
				Atelecyclidae	*Atelecyclus rondatus*
				Portunidae	*Macropipus holsatus*
				Pinnotheridae	*Pinnotherus pisum*
Echiura				Echiuridae	*Echiurus* sp.
Ectoprocta					
Echinodermata	**Stelleroidea**	Ophiurida		Ophiuridae	*Ophiura* sp.
	Echinoidea	Cidaroida		Cidaridae	*Cidarius cidarius*

			Echinidae	*Echinus* sp.

Gnathostomata	**Chondrichthyes**	Rajiformes	Rajidae	*Raja* sp.
				Raja clavata
	Osteichthyes	Clupeiformes	Clupeidae	*Sprattus sprattus*
				Clupea harengus
		Argentiniformes	Agentinidae	*Argentina sphyraena*
		Gadiformes	Gadidae	*Gadus morhua*
				Melanogrammus aeglefinus
				Rhinonemus cimbrus
				Trisopterus sp.
				Trisopterus minutus
				Trisopterus luscus
				Trisopterus esmarki
				Merlangius merlangus
				Micromesistius poutassou
				Ciliata sp.
		Syngnathiformes	Syngnathidae	*Syngnathus typhle*
		Scorpaeniformes	Triglidae	*Eutrigla gurnardus*
			Agonidae	*Agonus cataphractus*
		Perciformes	Carangidae	*Trachurus trachurus*
			Pholididae	*Pholis gunnellus*
			Anarhichadidae	*Anarhichas lupus*
			Blenniidae	*Blennius* sp.
			Ammodytidae	*Hyperoplus lanceolatus*
			Callionymidae	*Callionymus* sp.
				Callionymus lyra
				Callionymus maculatus
				Callionymus reticulatus
			Gobiidae	*Pomatoschistus* sp.
				Crystallogobius sp.
				Crystallogobius linearis
				Aphia minuta
			Scombridae	*Scomber scombrus*
		Pleuronectiformes	Bothidae	*Arnoglossus laterna*
			Pleuronectidae	*Hippoglossoides platessoides*
				Limanda limanda
				Glyptocephalus cynoglossus
				Pleuronectes platessa
			Soleidae	*Buglossidium luteum*
				Solea solea
