INTERNATIONAL COUNCIL FOR
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ANALYSIS OF THE COD SAMPLES COLLECTED IN THE NORTH SEA DURING THE 1991 INTERNATIONAL STOMACH SAMPLING PROJECT

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ABSTRACT

Over 10,000 stomachs of North Sea cod (Gadus morhua) have been sampled and analysed within the framework of the 1991 ICES Stomach Sampling Project, in order to enhance and update the existing data on predation used in MSVPA.
The average weight of the stomach contents (empty stomachs included) (W) is determined per sizeclass (L) on a quarterly and annual basis. The relationship ($W=18{,}29 \times 10^{-5} \times L^{3.01}$, $r^2= 0.99$) found in 1991 is comparable to the one established in 1981.
At least 75% of the weight percentage of the food of cod of all sizes consists of fish and crustaceans. The remainder is formed by smaller quantities (in terms of weight) of molluscs and polychaetes.
There is a marked change-over from a crustacean to a fish diet: the weight percentage of fish in the diet of cod gradually increases with length in all four quarters (up to over 90% of the total weight of the stomach contents).
Compared to 1981 the amount of commercially important fish preyed upon by cod in the North Sea has increased. Sandeel, Norway pout, whiting and herring and dab are the main prey items. Predation on crustaceans has decreased since 1981, as has predation on young cod. Within the crustaceans, Caridea are eaten in relatively large proportions.

INTRODUCTION

In 1981, the first large scale International Stomach Sampling Project under auspices of the International Council for the Exploration of the Sea (ICES) was undertaken. This project was directed primarily at the evaluation of the impact of predator-prey interactions on population dynamics of commercially exploited species in the North Sea (Daan, 1981). Information resulting from this study has been used extensively for assessment studies by means of Multi Species Virtual Population Analysis (MSVPA; Anon.,1989). However, since considerable changes took place in some of the major fish stocks in the North Sea since 1981, the need for new information on the food composition and total consumption of the most important species grew over the years.

In 1988, ICES recommended that a repetition of the 1981 International Stomach Sampling Project should be executed in the North Sea in 1991, in order to update and enhance the quality of the data used in multispecies assessment routines (Anon., 1989). Participating countries in the 1991 project were (in alphabetic order): Denmark, England, France, Germany, Norway, The Netherlands, Scotland and Sweden. J.R.G. Hislop (Scotland, UK) was appointed project coordinator (Anon, 1991).

The same five main predator species as in 1981, representing the most important piscivorous predators (cod, whiting, haddock, mackerel and saithe), were selected for sampling. In addition, pelagic 0-group gadoids and secondary predators (eg. scad, rays and gurnards) were also sampled in 1991. To maintain consistency within the analysis of stomachs of a predator species, it was agreed that each country was assigned responsibility for the processing of one particular predator species. The Netherlands were made responsible for cod and H.J.L. Heessen was appointed species coordinator. The analyses were carried out under his supervision.

This paper reports the results of the analysis of all cod samples collected in the North Sea in 1991. As far as 0-group cod is concerned, only data for demersal fish are included in this analysis. The data for pelagic 0-group will be presented elsewhere. Interpretation of the collected data by means of MSVPA is beyond the scope of this report.

METHODS

Stomachs were collected and analysed in accordance with the guidelines outlined in the manual for the stomach sampling project (Anon, 1990). Sampling was stratified by quarter, predefined sizeclasses and ICES statistical rectangle.

Sampling at Sea
Most of the stomach samples were taken by research vessels during the quarterly International Bottom Trawl Survey (IBTS) of the North Sea. In addition, material was collected on board commercial vessels. The total number of hauls by research vessels per ICES statistical rectangle in each quarter of 1991 is given in Figure 1.

The overall objective was to maintain the sampling levels of cod at those achieved in 1981. To achieve this end, a minimum number of stomachs was sampled per haul, per predefined cod sizeclass (Table 1). In the case of larger cod the target number was relatively high, because it was feared that these fish would be caught only infrequently and a large sample should be collected whenever the opportunity arose.

On board, distinction was made between fish with:

1. Everted stomachs (stomachs pushed inside out as a result of expansion of the swimbladder during the lift of the trawl),

2. Regurgitated stomachs (stomachs showing evidence of regurgitation),

3. Empty stomachs (stomachs without contents and also without signs of regurgitation).

4. Stomachs only containing skeletal remains.

5. Full stomachs (stomachs containing food items and not showing signs of regurgitation)

Stomachs of category 1 were excluded from any further analysis. When stomachs were sampled, sometimes individuals were found which obviously had been eating fish in the trawl. As this situation does not reflect natural feeding behaviour (Bromley and Last, 1990), it was decided that fresh fish in the mouth of the cod should be discarded. In practice, this meant that the decision to discard fish was taken by different people under different circumstances (and was, therefore, somewhat subjective). However, it was felt that allowing the field investigators to judge the situation was the best possible way to handle the problem. Only stomachs within categories 3, 4 and 5 were collected and preserved (either in 4% buffered formaldehyde solution, or by by deep freezing). The number of stomachs in category 2 was recorded to allow adjustment when calculating average stomach contents.

Stomach analysis
In most cases, especially when larger cod was concerned, it was possible to examine individual stomachs. Emphasis was placed on identification of prey items to the lowest possible taxonomic level. The (wet) weight, digestion stage and (if possible) the length of each prey item were determined.

Three different digestion states were identified:

1. State 0: undigested; prey items looking intact.
2. State 1: partially digested; prey items consisting of flesh and bones.
3. State 2: (almost) completely digested; prey items consisting of skeletal remains only.

Data processing

Sampled stomachs were treated as pooled samples during the processing of data. Although in this way information on variation between individuals is lost, the analysis of pooled samples requires less time and time was a limiting factor.

Auxiliary trawl survey information from the International Bottom Trawl Surveys was used to compute local abundance (N per hour fishing) per size class. Age length keys collected during these surveys were used to transform length class data to age groups.

Calculations

In order to determine the mean weight of the stomach contents per size class (or age group) the following mathematical model was used:

$$W_s = \frac{W_{tot}}{N_s} \times \frac{N_f + N_r}{N_f}$$

where W_S= mean weight of stomach contents in the sample,
W_{tot}= total weight of the stomach contents of the samples included in the size class (or age group),
N_S= Number of individuals sampled within the size class (or age group).
N_f = Number of stomachs containing food (including skeletal remains),
N_r = Number of fish with regurgitated stomachs.

In this formula the multiplication with (N_f+N_r/N_f) is used to include the number of stomachs which were derived from regurgitated cod in the total number of stomachs containing food. As, by definition, regurgitated stomachs were not empty, omitting them from the sample would give a bias. It was assumed that the mean stomach contents of the regurgitated ones, before they were regurgitated, was the same as the mean contents of the sampled stomachs with food.

Weighting Procedure

Since (maximum) sample size is independent of the number of fish caught per haul, a sample might not be representative for the quantitative consumption of cod in a certain area, when no allowance is made for differences in density between sample sites. The number of fish caught per haul is very likely to be related to the local abundance. Daan (1983) showed that use of the square root of N/hr as a weighting factor in stomach analysis results in less extreme values than other weighting factors (N/hr, sample size or equal weight). Therefore, in order to make up for possible inconsistencies between sample size and actual local abundance, the square root of N/hr has been applied as a weighting factor.

RESULTS

Sampling intensity

Figure 2 shows the boundaries of the ICES Roundfish Areas in the North Sea used in the 1991 Stomach Sampling Project. Altogether over 10,000 cod stomachs were sampled in the North Sea, Skagerrak and Kattegat (ICES Roundfish Area 1-9). Only stomachs collected in Roundfish Areas 1-7 , were used for further computation in this report. The total number of stomachs collected in these areas was 9,723. Good coverage was achieved in each quarter (Figure 3).

Table 2 shows the number of cod stomachs sampled per sizeclass, ICES Roundfish Area and quarter in 1991.The numbers collected in the second quarter are much higher than in any of the other quarters. Although part of this can be attributed for by the collection of demersal 0-group cod, there is no obvious explanation for the fact that also larger cod have been sampled more successfully in this quarter.

Empty Stomachs

The percentage of empty stomachs (Table 3) varies strongly per size class, quarter and Roundfish Area. Figure 4 shows that in all four quarters the mean percentage of empty stomachs in size classes 80 - 200 is close to 20%. In larger cod, the percentage of empty stomachs decreases. Only in the first quarter is a higher percentage (circa 15%) found for larger cod as well. It appears to be significantly higher when compared to quarter 2 and 3 (Table 4a). Table 4b shows that significant differences in the percentage of empty stomachs exist between the different ICES Roundfish Areas as well: the percentage of empty stomachs in Roundfish Area 1 is significantly higher than in Roundfish Areas 4 and 5. When different size classes are compared (Table 4c), the percentage of empty stomachs in size class 50 is significantly lower than in size classes 80 and 120 - 400. Also, the percentage of empty stomachs in size classes 150 - 300 is significantly higher compared to size classes 600 - 800.

Mean Stomach Contents Weight

Table 5 shows the mean stomach content weight per sizeclass, roundfish area and quarter in 1991. As the mean stomach content weights show great individual differences and the number of samples per sizeclass and Roundfish Area is also variable, the figures in this Table are difficult to compare. Therefore in Table 6 the Roundfish Areas have been combined and a weighted mean value per quarter and per sizeclass is provided.

In order to describe the relation between stomach contents weight and length, a mean length from survey data has been used. Table 7 shows these data. In this Table a relation between predator length and mean stomach contents weight is given. Also the feeding coefficient (ϕ) has been estimated, based on the assumption that stomach contents weights are linearly correlated with the length to the power 3 of cod (Daan, 1973). Only one value
of ϕ was found outside the 95% confidence limits.

Diet of different sized cod

In Figure 5a-d, the contributions of the major prey taxa to the food of cod in each size class and quarter are shown. This figure outlines major differences in the diet of cod between size classes and seasons.

Together, fish and crustaceans represent at least 75% of the total weight in every size class and quarter. There is a change-over from a crustacean to a fish diet: the weight percentage of fish in the diet of cod increases with length in all four quarters, making up

over 80% of the total weight of the stomach contents of the largest size classes. In smaller cod (< 25 cm) the major proportion of stomach contents is made up for by crustaceans. In middle sized cod crustacean prey are of moderate importance and in large cod relatively low numbers were found.
The smallest cod sampled in the first quarter appear to have been feeding on fish to a large extent. However, it should be noted that this sizeclass (100-120) was sampled rather poorly in this period (only 4 specimens). Therefore, not too much attention should be given to this deviation.
Table 8 and 9 provide a more detailed composition of the predominant prey taxa by quarter.

In Figure 6a-d, 3 groups of fish prey are distinguished (Gadidae, Clupeidae and Pleuronectoidei). Apparently cod mainly feed on gadidae in every season. Predation on clupeoids increases with size, although a peak in the first quarter can be noted for cod in sizeclasses 100 - 250. In the fourth quarter predation on clupeoids is almost negligible except for very large cod. The importance of flatfish gradually increases with length.

Size composition of fish prey
The length frequency distribution (in percent) of fish prey per predator size class and quarter is given in Table 10. Generally, prey size increases with predator size. In the first quarter no stepwise subdivision into major prey size groups can be made. A gradual shift from fish within size classes 30 - 50 mm (which are preyed upon by small cod) towards prey within size class 80 (which is preyed upon mainly by medium sized cod) towards fish within size classes 100 - 200 mm (predominantly preyed upon by medium sized and larger cod) appears to exist.

In the second quarter, however, a more obvious separation can be made. There seem to be three major prey size classes on which predation by cod of different size classes takes place. First, there is an obvious cluster of (fish) prey within the length range of 25 - 40 mm. This group is preyed upon by small cod (60 - 120 mm). A second group of prey with a size between 50 and 60 mm can be shown. It is mostly eaten by cod with a length between 200 - 500 mm. Larger cod largely prey on fish within size classes 120 - 200 mm.

In the third quarter, this stepwise division of prey becomes less obvious again. Although a peak can be found in predation on small fish (30 mm) by cod with a length between 70 and 100 mm, the transition to the second group is more gradual. Fish with a size of about 50 mm are almost exclusively preyed upon by cod within size class 150, while cod within size class 200 - 250 mm mostly feed on fish with a size between 70 and 120 mm. As in quarter 2, a large range of cod is preying upon fish with a size between 70 and 120 mm in the third quarter. Finally, very large cod seem to feed mainly upon fish with a size between 200 and 300 mmin

In the fourth quarter three groups can again be distinguished. One group of small fish (40 - 50 mm) which is eaten by cod in size classes 100 - 200 mm. A second group of prey has a length of about 80 mm and is preyed upon predominantly by cod with a length between 300 and 500 mm. The third group consists of larger fish (120 - 250 mm) and is a prey item for cod within size classes 600 - 1000 mm.

Diet of different age groups
Age/length keys from the trawl surveys were used to transform the data per sizeclass into estimates of the diet of each age group. The food composition (by major prey taxa) for different age groups of cod is given as weight percentage in Figure 7a-d. In the first quarter, data for 0-group cod could not be collected due to the absence of the new year class in this quarter. Again, there is an increase in fish prey at the expense of crustacean prey with length and age. In Figure 7, however, a more gradual change in diet is shown

compared to Figure 5, probably as a result of the smoothing effect of the conversion of length into age.

At first sight there seems to be little difference between the data of the four quarters. However, in the first half of the year 40% or less of the diet of one-year-old cod consists of fish. In the second half of the year this amount is much higher (up to over 60%). Also the amount of molluscs eaten in the first quarter by large cod is noteworthy. This is caused mainly by large numbers of cephalopods found in cod of 4 years old and more. In the second and third quarter large cod had eaten fewer molluscs and more crustaceans (N.B. in terms of weight percentage). In the fourth quarter more fish has been eaten by large cod.

Cod with an age of 2 or more seem to feed almost exclusively on fish and crustaceans, while younger cod feed on polychaete worms and molluscs as well (up to a weight percentage of about 10%). In the second quarter, consumption of molluscs by young cod appears to be higher than in the other quarters. In the first and fourth quarter polychaetes are mainly responsible for the 10% "others" group. Tables 11 and 12 show the weight percentage of (commercially important) fish and crustaceans by predator age group.

In general, different predator age groups appear to prey on different fish prey species. In the diet of 0,1 and 2 year old cod, mostly sandeels (*Ammodytidae*) are found (Table 11). Only in the fourth quarter Norway pout is also eaten by younger cod in appreciable numbers. Norway pout and also whiting appear more frequently in the food of 1 - 4 year old cod. Herring (*Clupea harengus*) is preyed upon by 3 years and older cod. Note that the percentage of herring eaten does not increase with age. Especially in the third and fourth quarter the weight percentage of herring eaten by 4, 5 and 6 year old cod is high. Finally, a main prey species is dab (*Limanda limanda*). Especially in the case of older cod (age group 3 and more) this appears to be a very important prey species. Only in the first quarter mackerel (*Scomber scomber*) seems to be an important food item.

0-group cod prey almost exclusively on Caridea in the second half of the year, when over 30 % of the stomach contents weight is composed by this group (Table 12). The same holds for 1-group cod in quarter 1. Other main prey taxa are Anomura and Brachyrhyncha which account for about 15% and 10%, respectively, in the total weight of food on an annual basis.

Predator size and prey size

Table 13 shows the length frequency distribution of fish prey per predator age group and quarter. Evidently, larger cod eat larger prey. In Table 7 the mean length per age group in each quarter (based on IBTS-data) is given. When this key is used in Table 13, a highly correlated relation between average prey size and predator size can be calculated:

$$\text{Length of fish prey} = 0.64 \times (\text{Length of predator})^{0.69} \qquad r^2 = 0.98$$

The relationship giving average prey size against mean predator size per quarter is shown in Figure 8. Predators seem to prefer fish prey of a certain length. It must be stated that the relationship in Figure 8 may be misleading because a mean length was used for prey items within a predator size class. In fact this extrapolation is somewhat doubtful. Table 10 and Table 13 show that some sizegroups of prey are preyed upon much heavier than others. For example, when cod with a length of 400 preys for 50% on whiting within size class 80 mm and for 50% on whiting within size class 120, the mean prey length would be 100 mm, while no prey of this length was eaten. In fact, the relationship

described can only serve as a tool to estimate prey size in a broad sense and should, therefore, be handled with care.

DISCUSSION AND CONCLUSIONS

The objective of maintaining sampling levels at those achieved in 1981 was almost attained; 10,000 stomachs were sampled, c.f. 11,000 in 1981. Taking into account the decrease in abundance of cod in this decade, the sampling itself can be considered quite succesfull.

Food and Feeding level

Differences in the food taxa exploited by predators of different sizes have been observed by several students of the diet of gadoids (e.g. Rae, 1967; Daan, 1973; Müller,1989; Mattson, 1990 and Hislop *et al.*, 1991). Bergstad (1991a) did not observe this phenomenon but, as Müller (1989) points out, when an individual prey species with a high nutrient content (*Cyprina islandica* in Bergstad's case) is sufficiently abundant to meet the needs of the predator population, predation on other prey might be influenced to a major degree.

When the data in Figure 5a-d (weight percentage per size class) are compared to the 1981 data found by Daan (1983) in Table 14, it is clear that the percentage of fish eaten in 1991 exceeds the percentage found in 1981 to a large extent. This preponderance of fish in the food holds for every season. Only in the case of smaller cod (L< 30 cm) in the second quarter was a lower percentage observed. Consequently, as about 90% of the diet of cod appears to consist of fish and crustaceans in both years and the total weights appear to be in the same order, the weight percentage of crustaceans is lower than in 1981 (Table 14). The same feature is of course observed in the weight percentages per age group (Figure 7a-d). The change-over from a crustacean to a fish diet seems to take place at a smaller size than in 1981.

Figure 9 shows the mean stomach contents weight per size class based on 1981 data (Daan,1983) and 1991 data. Some size classes were split in 1991 and have been combined to allow proper comparison. The two years agree rather well, although for some size classes in 1991 more food (in terms of weight) was found in the stomachs.

This trend is also expressed in the feeding coefficient, which shows a higher value for the different seasons in 1991 than in 1981 (Daan, 1983) (18.3 x 10-5 and 14.6 x 10-5 for the total North Sea, respectively). Still, on an annual basis there is no evidence that the regression coefficient (b) is significantly different from 3 (within the 95% confidence limits). For the individual quarters this is only the case in the fourth quarter (b = 3.26). The lowest feeding coefficient was found in the first quarter. This might be due to a reduced food intake during the spawning period (Arntz, 1974; Rae, 1967); the results presented in Figure 4 show that the mean percentage of empty stomachs in the first quarter in the range of mature cod exceeds the values for the other quarters. In addition, Table 4a shows a significant higher percentage of empty stomachs in the first quarter compared to the second and third quarter.

Some doubt exists on the assumption that the relative weights of the individual prey species found within the stomach reflect the actual (level of) predation of cod on each species. Animals with a soft exoskeleton or evertebrates without exoskeleton may be digested at a faster rate than, for instance, fish. This could cause underestimates of the true proportions of these taxa in the diet (Nordeide, 1992; Mattson, 1990). On the other hand, when prey items are found and a digestion rate is fixed at a value based on digestion of fish, the number of fast digestible animals actually found can be used as a minimum in quantitative evaluations on predation of that individual species. Other students of the food of North Sea Gadoids (Jones,1974; Hislop *et al.* ,1983) found that differences in the rate of elimination of different prey items were of minor importance when compared to differences caused by other factors (e.g. size of the predator, weight of the food in the stomach, the history of the fish (starved or not) and temperature).

Cannibalism

Only in the third quarter was cannibalism found to occur regularly. This contrasts with the results of the 1981 stomach sampling project, when cannibalism in cod (Daan,1989) appeared in such a high frequency, that a regulatory effect on population abundance due to cannibalism (Smith and Reay, 1991) was considered feasible. Due to the decline of the stock of large cod in the North Sea and in the numbers of juvenile cod produced each year, the importance of cod both as a predator and as a food item has probably declined since 1981 and, under the present circumstances, a significant influence of cannibalism on population regulation seems unlikely. However, the ultimate size (in quantitative terms) of the impact of predation by cod in 1991 can only be established when the results of this study will have been applied in MSVPA.

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Table 1. Number of stomachs to be collected per haul.

sizeclass (mm)	target number (per haul)
50 - 59	5
60 - 69	5
70 - 79	5
80 - 99	5
100 - 119	5
120 - 149	5
150 - 199	10
200 - 249	10
250 - 299	10
300 - 349	10
350 - 399	10
400 - 499	10
500 - 599	10
600 - 699	25
700 - 799	25
800 - 999	25
1000 - 1199	25
> 1200	25

Table 2. Number of stomachs sampled per sizeclass, ICES Roundfish Area and quarter in 1991.

Quarter 1

sizeclass	50			60			70			80			100			120			150			200			250		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1															1			2			1	1		4	1		13
RNF2															1			1		2	7				1		6
RNF3															2	2		3	4	2	13	3	2	8	1		3
RNF4																			1	1	2						1
RNF5																			1		2						
RNF6																4		17	8	1	48	10		70	1		24
RNF7																3	3	7	10	2	14		4	18	3		7
Total:															4	9	3	30	24	8	85	15	6	102	7		54

Quarter 2

sizeclass	50			60			70			80			100			120			150			200			250		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1															1			3	3	1	8	5	2	30	4	1	14
RNF2	1		7			1										1			9		39	15	1	125	2	1	61
RNF3																		1	1	6	18	4	4	30	2	1	15
RNF4																				1	15	1		25	2		14
RNF5																											2
RNF6	2		18	1		14			7									1	14	1	59	33	1	175	16		164
RNF7	1		11			3													8	1	32	4		43	5		27
Total:	4		36	1		18			7						1	1		5	35	10	171	62	8	428	31	3	297

Quarter 3

sizeclass	50			60			70			80			100			120			150			200			250		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	4		9	8	2	17	2	6	34	10	9	38	4	3	26	1	1	4	2			3	4	21	2	2	59
RNF2			1	1		6	15	3	25	14	2	71	11	3	61	1	1	25				3	1	23	6	6	74
RNF3		1	4	2	1	8		2	7	2		7			2							3	2	10	8	23	85
RNF4			3	2		6	1		9	1	1	10			1			1			1	2	7	31	2	4	25
RNF5																											
RNF6				3		11	8	1	17	6		34	1	1	38			9				1		4	4		32
RNF7				1		4	2		8	8		41	3	1	38	2		10			1	1		33	8	1	51
Total:	4	1	17	17	3	52	28	12	100	41	12	201	19	8	166	4	2	49	2		2	13	14	122	30	36	326

Quarter 4

sizeclass	50			60			70			80			100			120			150			200			250		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1						1	1	2	5	3	3	15	4	3	26	3	2	16	3		3	1		2	8	1	32
RNF2						1				2		9	5	3	11	4	6	27			12			2			8
RNF3												1						3						1			1
RNF4												2	1		1	2		3	1		1			1			
RNF5												1						1			6						
RNF6										1		2	9	1	114	7		41	16		228	4		68	1		20
RNF7									1	2	2	18	4	2	28	6	1	43	8		57	2		21	1		8
Total:						2	1	2	6	8	5	48	23	9	180	22	9	134	28		307	7		95	10	1	69
Total over 1991:	8	1	53	18	3	72	29	14	113	49	17	249	42	17	351	36	14	218	89	18	565	97	28	747	78	40	746

Table 2. (continued) Number of stomachs sampled per sizeclass, ICES Roundfish Area and quarter in 1991.

Quarter 1

sizeclass	300			350			400			500			600			700			800			1000			Total		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	10	3	53	7	5	53	18	16	55	12	6	106	11	5	60	5		23	7	1	41		1	3	72	37	415
RNF2	4	5	35	4	3	28	6	3	25	5	2	20	4		19	1		7	4	1	15	12		10	41	16	174
RNF3	1		6	7	2	17	4	1	13	8	1	23	1		7			1			1		1	5	31	9	102
RNF4	1		12	1	1	24	13		38	5		10	1		4			2			3			1	22	2	97
RNF5						2			2	1		6	1		9	2	1	12	1		3				7	1	36
RNF6	2		26	1		28	14		97	16		79	37	2	113	21	2	96	27	2	127	11		25	152	7	750
RNF7	1	1	12	4		20	1	3	18	2	1	16		1	6	2		11	2		22		1	11	28	16	162
Total:	19	9	144	24	11	172	56	23	248	49	10	260	55	8	218	31	3	152	41	4	212	23	3	55	353	88	1736

Quarter 2

sizeclass	300			350			400			500			600			700			800			1000			Total		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	8		46	14	16	100	21	31	156	13	26	122	12	26	63	3	1	34		6	27			9	83	110	613
RNF2	2	2	35	8	6	88	18	17	134	5	3	107	1	1	49			14			9	1		4	63	31	673
RNF3			5		1	9	1	7	26	2	5	10		4	8		1	2	3		4			3	10	32	131
RNF4	1		15	1		9	2		8			6			1			1			2				7	1	95
RNF5			3						4	1		12	1		24			9			4			1	2		59
RNF6	11		106	4		30	13	1	70	5	1	65	3		43	2	2	32			28			7	104	6	819
RNF7	4		10	4		44	2	1	52	1	3	41			10	2		9			13	1		3	32	5	298
Total:	26	2	220	31	23	280	57	57	450	27	38	363	17	31	197	7	4	101		9	87	2		27	301	185	2688

Quarter 3

sizeclass	300			350			400			500			600			700			800			1000			Total		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	1	7	45	3	3	29	5	15	77	4	16	49	5	11	39		2	14	1	1	13			3	55	82	477
RNF2	10	1	67		1	22	2	11	81	1	8	40		1	11		2	3	1		8			3	65	40	521
RNF3	3	14	71	1	4	13	1		10		2	7			1			2						2	20	49	229
RNF4	1	2	16		5	16	1	2	6		2	3						2			1				10	23	131
RNF5			1			6			4			1			18			10			7						47
RNF6	4	1	41	9		31			14	2		1			1			1			1				38	3	235
RNF7	5	3	27	1		14			34	3		26			12			5			3			1	34	5	308
Total:	24	28	268	14	13	131	9	28	226	10	28	127	5	12	82		4	37	2	1	33			9	222	202	1948

Quarter 4

sizeclass	300			350			400			500			600			700			800			1000			Total		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	19	2	98	8	9	79	2	4	80	4	4	76	2	1	65	1	2	45	3	1	16			2	62	34	561
RNF2	5	1	30	5	1	16	5	2	16		1	13			18			4			6			4	26	14	177
RNF3	3		16	2		4	1		3			2			2			1			1				6		35
RNF4			1						3			1													4		13
RNF5			2			5			2			2			2			1									22
RNF6	1		65	3		91			83			15			19			15			4				42	1	765
RNF7			13			7			4			1						4			2			3	23	5	210
Total:	28	3	225	18	10	202	8	6	191	4	5	110	2	1	106	1	2	70	3	1	29			9	163	54	1783
Total overall:	97	42	857	87	57	785	130	114	1115	90	81	860	79	52	603	39	13	360	46	15	361	25	3	100	1039	529	8155

Table 3. Percentage of empty, regurgitated and full stomachs, sampled per sizeclass, ICES Roundfish Area and quarter in 1991.

Quarter 1

sizeclass	50			60			70			80			100			120			150			200			250		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1															100			100			100	20		80	7		93
RNF2															100			100		22	78				14		86
RNF3															100	40		60	21	11	68	23	15	62	25		75
RNF4																			25	25	50						100
RNF5																			100			33		67			
RNF6																19		81	14	2	84	13		88	4		96
RNF7																23	23	54	38	8	54		18	82	30		70

Quarter 2

sizeclass	50			60			70			80			100			120			150			200			250		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1															100			100	25	8	67	14	5	81	21	5	74
RNF2	13		88			100										100			19		81	11	1	89	3	2	95
RNF3																		100	4	24	72	11	11	79	11	6	83
RNF4																				6	94	4		96	13		88
RNF5																											100
RNF6	10		90	7		93			100									100	19	1	80	16	0	84	9		91
RNF7	8		92			100													20	2	78	9		91	16		84

Quarter 3

sizeclass	50			60			70			80			100			120			150			200			250		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	31		69	30	7	63	5	14	81	18	16	67	12	9	79	17	17	67	100			11	14	75	3	3	94
RNF2			100	14		86	35	7	58	16	2	82	15	4	81	4	4	93				11	4	85	7	7	86
RNF3		20	80	18	9	73		22	78	22		78			100							20	13	67	7	20	73
RNF4			100	25		75	10		90	8	8	83			100			100			100	5	18	78	6	13	81
RNF5																											
RNF6				21		79	31	4	65	15		85	3	3	95			100				20		80	11		89
RNF7				20		80	20		80	16		84	7	2	90	17		83			100	3		97	13	2	85

Quarter 4

sizeclass	50			60			70			80			100			120			150			200			250		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1						100	13	25	63	14	14	71	12	9	79	14	10	76	50		50	33		67	20	2	78
RNF2						100				18		82	26	16	58	11	16	73			100			100			100
RNF3												100						100						100			100
RNF4												100	50		50	40		60	50		50			100			
RNF5												100						100			100						
RNF6										33		67	7	1	92	15		85	7		93	6		94	5		95
RNF7									100	9	9	82	12	6	82	12	2	86	12		88	9		91	11		89

Table 3. (continued) Percentage of empty, regurgitated and full stomachs, sampled per sizeclass, ICES Roundfish Area and quarter in 1991.

Quarter 1

sizeclass	300			350			400			500			600			700			800			1000			Total		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	15	5	80	11	8	82	20	18	62	10	5	85	14	7	79	18		82	14	2	84		25	75	14	7	79
RNF2	9	11	80	11	9	80	18	9	74	19	7	74	17		83	13		88	20	5	75	55		45	18	7	75
RNF3	14		86	27	8	65	22	6	72	25	3	72	13		88			100			100		17	83	22	6	72
RNF4	8		92	4	4	92	25		75	33		67	20		80			100			100			100	18	2	80
RNF5						100			100	14		86	10		90	13	7	80	25		75				16	2	82
RNF6	7		93	3		97	13		87	17		83	24	1	74	18	2	81	17	1	81	31		69	17	1	83
RNF7	7	7	86	17		83	5	14	82	11	5	84		14	86	15		85	8		92		8	92	14	8	79

sizeclass	300			350			400			500			600			700			800			1000			Total		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	15		85	11	12	77	10	15	75	8	16	76	12	26	62	8	3	89		18	82			100	10	14	76
RNF2	5	5	90	8	6	86	11	10	79	4	3	93	2	2	96			100			100	20		80	8	4	88
RNF3			100		10	90	3	21	76	12	29	59		33	67		33	67		43	57			100	6	18	76
RNF4	6		94	10		90	20		80			100						100			100				7	1	92
RNF5			100						100	8		92	4		96			100			100			100	3		97
RNF6	9		91	12		88	15	1	83	7	1	92	7		93	6	6	89			100			100	11	1	88
RNF7	29		71	8		92	4	2	95	2	7	91			100	18		82			100	25		75	10	1	89

sizeclass	300			350			400			500			600			700			800			1000			Total		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	2	13	85	9	9	83	5	15	79	6	23	71	9	20	71		13	88	7	7	87			100	9	13	78
RNF2	13	1	86		4	96	2	12	86	2	16	82		8	92		40	60	11		89			100	10	6	83
RNF3	3	16	81	6	22	72	9		91		22	78			100			100						100	7	16	77
RNF4	5	11	84		24	76	11	22	67		40	60						100			100				6	14	80
RNF5			100			100			100			100			100			100			100						100
RNF6	9	2	89	23		78			100	67		33			100			100			100				14	1	85
RNF7	14	9	77	7		93			100	10		90			100			100			100			100	10	1	89

sizeclass	300			350			400			500			600			700			800			1000			Total		
category	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full	empty	regur.	full
RNF1	16	2	82	8	9	82	2	5	93	5	5	90	3	1	96	2	4	94	15	5	80			100	9	5	85
RNF2	14	3	83	23	5	73	22	9	70		7	93			100			100			100			100	12	6	82
RNF3	16		84	33		67	25		75			100			100			100			100				15		85
RNF4			100						100			100													24		76
RNF5			100			100			100			100			100			100									100
RNF6	2		98	3		97			100			100			100			100			100				5	0	95
RNF7			100			100			100			100						100			100			100	10	2	88

Table 4a. Student's-T tests on percentage of empty stomachs per quarterly period.
(Paired observations, Ho: $\mu 0=\mu 1$)

	Qrt. 1	Qrt. 2	Qrt. 3
Qrt. 2	0.002		
Qrt. 3	0.010	0.363	
Qrt. 4	0.111	0.303	0.432

Underlined values show significant differences ($p< 0.05$)

Table 4b. Student's-T tests on percentage of empty stomachs per Roundfish Area.
(Paired observations, Ho: $\mu 0=\mu 1$)

	RNF1	RNF2	RNF3	RNF4	RNF5	RNF6
RNF2	0.617					
RNF3	0.066	0.129				
RNF4	0.016	0.084	0.777			
RNF5	<0.001	0.145	0.237	0.460		
RNF6	0.442	0.886	0.167	0.089	0.095	
RNF7	0.083	0.367	0.431	0.370	0.183	0.318

Underlined values show significant differences ($p< 0.05$)

Table 4c. Student's-T tests on percentage of empty stomachs per sizeclass.
(Paired observations, Ho: $\mu 0=\mu 1$) Underlined values show significant differences ($p< 0.05$)

	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800
60	0.034															
70	0.188	0.569														
80	0.019	0.358	0.072													
100	0.182	0.862	0.551	0.724												
120	0.029	0.106	0.028	0.136	0.064											
150	0.037	0.094	0.109	0.077	0.126	0.388										
200	0.020	0.142	0.162	0.137	0.396	0.756	0.117									
250	0.015	0.094	0.103	0.283	0.396	0.478	0.120	0.672								
300	0.002	0.068	0.042	0.250	0.304	0.266	0.101	0.482	0.567							
350	0.019	0.101	0.089	0.187	0.329	0.392	0.168	0.577	0.959	0.748						
400	0.034	0.105	0.114	0.330	0.145	0.433	0.180	0.761	0.947	0.738	0.879					
500	0.059	0.138	0.100	0.121	0.359	0.674	0.208	0.889	0.811	0.640	0.734	0.852				
600	0.075	0.598	0.851	0.437	0.690	0.132	0.031	0.034	0.223	0.191	0.167	0.131	0.076			
700	0.250	0.322	0.672	0.201	0.500	0.089	0.025	0.048	0.046	0.040	0.119	0.191	0.082	0.623		
800	0.143	0.314	0.513	0.330	0.383	0.085	0.024	0.043	0.173	0.123	0.162	0.176	0.123	0.626	0.880	
1000	0.402	0.963	0.726	0.565	0.869	0.008	0.103	0.261	0.315	0.274	0.259	0.273	0.220	0.963	0.800	0.850

Table 5. Mean stomach contents weight (per sizeclass, ICES Roundfish Area and quarter in 1991) (g).
(Maxima underlined).

Quarter 1																	
sizeclass	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
RNF1					0.21	0.82	0.16	1.05	2.21	1.97	3.96	8.59	34.09	72.99	56.27	110.69	99.18
RNF2					0.20	0.08	1.11	0.00	1.15	4.60	12.69	14.21	31.27	83.41	26.66	39.45	56.96
RNF3					0.16	0.33	0.68	1.43	0.84	6.34	3.84	6.67	14.31	26.25	15.11	573.56	274.61
RNF4					0.00	0.00	0.44	0.00	0.30	7.22	6.92	14.52	27.33	44.22	150.15	291.62	214.41
RNF5					0.00	0.00	0.00	1.08	0.00	0.00	20.37	12.59	18.93	42.72	70.75	58.66	0.00
RNF6					0.00	0.33	0.83	1.86	3.27	11.59	9.37	28.08	33.62	46.14	77.36	73.09	92.77
RNF7					0.00	0.40	0.50	2.02	0.88	3.90	8.85	15.19	38.86	74.36	48.44	66.46	322.91

Quarter 2																	
sizeclass	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
RNF1					0.39	0.29	0.17	1.85	2.31	5.31	11.19	20.26	40.34	76.13	88.80	195.10	235.75
RNF2	0.05	0.02				0.00	0.65	1.64	2.07	3.58	10.29	16.58	47.21	76.22	230.30	395.94	243.01
RNF3						0.01	0.98	1.30	2.72	1.58	11.32	15.96	42.69	109.54	72.10	180.78	482.60
RNF4							0.45	1.46	1.94	11.18	24.91	15.54	28.92	42.45	243.50	138.25	
RNF5									0.90	2.50		16.14	19.21		51.00	250.44	390.01
RNF6	0.03	0.07	0.12				0.82	2.41	4.13	6.26	12.96	17.83	32.79	61.36	82.08	170.69	376.89
RNF7	0.05	0.03				0.09	0.48	1.06	2.80	2.80	13.67	28.00	36.22	96.71	130.64	301.84	102.85

Quarter 3																	
sizeclass	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
RNF1	0.03	0.03	0.07	0.09	0.20	0.13	0.00	2.35	3.81	5.57	8.25	15.57	27.17	48.04	118.14	85.41	189.46
RNF2	0.02	0.02	0.05	0.07	0.19	0.38		2.94	3.27	4.43	7.80	20.74	35.03	49.46	141.69	182.47	221.42
RNF3	0.02	0.02	0.04	0.05	0.17			2.31	3.93	4.42	6.63	17.65	72.12	45.16	63.84		146.34
RNF4	0.14	0.07	0.06	0.13	0.08	0.09	1.31	1.93	2.76	3.62	13.99	38.33	55.69		137.10	46.58	
RNF5										1.80	2.98	7.29	29.86	129.18	58.48	127.55	
RNF6		0.05	0.04	0.10	0.23	0.27		1.33	1.97	7.47	5.29	8.89	0.51	14.59	72.43	21.70	
RNF7		0.05	0.03	0.05	0.10	0.22	9.40	2.16	4.24	4.02	6.98	17.81	24.69	84.44	99.28	72.50	353.62

Quarter 4																	
sizeclass	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
RNF1		0.07	0.01	0.07	0.20	0.53	1.68	0.14	1.41	4.69	6.60	14.14	19.75	44.00	71.55	158.66	789.80
RNF2		0.04		0.12	0.10	0.15	0.64	1.98	3.30	6.81	8.46	16.92	12.78	60.79	133.39	150.50	
RNF3				0.08		0.27		0.30	1.05	3.21	6.19	37.25	13.67		217.98	2.51	
RNF4				0.06	0.01	0.30	0.35	2.46		0.66		18.77	32.02				
RNF5				0.05		0.10	0.67			16.10	13.22	13.19	166.88	85.00	105.72		
RNF6				0.04	0.31	0.26	1.01	1.39	3.53	6.42	11.24	15.49	36.74	53.78	72.60	54.37	
RNF7			0.09	0.07	0.09	0.15	0.36	0.70	1.24	3.59	4.61	17.56	40.88		217.11	120.22	469.13

Table 6. Weighted mean stomach contents weight (g) per sizeclass and quarter.

sizeclass (mm)	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Total Year
50 - 59		0.01	0.01		0.01
60 - 69		0.01	0.01	0.06	0.06
70 - 79			0.03	0.04	0.25
80 - 99			0.05	0.08	0.20
100 - 119	0.18		0.13	0.23	0.32
120 - 149	0.37	0.05	0.12	0.29	0.31
150 - 199	0.73	0.34		0.84	0.69
200 - 249	1.79	0.94	1.65	1.49	1.50
250 - 299	2.18	1.59	2.42	2.50	3.74
300 - 349	4.94	1.68	3.93	5.35	6.09
350 - 399	7.28	5.93	4.76	8.46	8.04
400 - 499	17.08	11.61	9.16	15.17	16.08
500 - 599	31.16	20.83	13.13	25.97	27.81
600 - 699	56.11	26.42	9.40	51.26	45.41
700 - 799	69.90	61.93	68.13	94.09	80.05
800 - 999	84.29	152.85	35.76	194.24	115.63
> 1000	132.43	211.91	112.36	413.71	187.28

Table 7. Double logarithmic regression analysis of mean stomach contents weight (g) against mean predator length (mm) per quarter in 1991. RNF's 1 - 7 combined.

	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Total Year	
Sizeclass (mm)	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight
50 - 59			5.00	0.04	5.00	0.05			5.00	0.05
60 - 69			6.00	0.09	6.00	0.03	6.00	0.05	6.00	0.06
70 - 79			7.00	0.12	7.00	0.05	7.00	0.04	7.00	0.07
80 - 99					8.42	0.08	8.70	0.08	8.45	0.08
100 - 119	10.56	0.19	11.00	0.39	10.37	0.18	10.60	0.19	10.44	0.23
120 - 149	13.52	0.37	13.25	0.16	12.37	0.27	13.33	0.29	13.23	0.25
150 - 199	16.78	0.72	17.76	0.65	18.50	2.68	16.60	0.84	16.69	0.64
200 - 249	21.42	1.80	21.92	1.81	23.03	2.24	20.70	1.31	21.57	1.79
250 - 299	27.19	1.89	26.68	3.02	27.21	3.37	27.69	2.44	27.08	2.68
300 - 349	32.16	4.13	32.05	5.33	31.55	5.04	32.08	5.09	31.94	4.90
350 - 399	36.89	7.28	37.20	12.66	36.55	7.31	36.83	7.89	36.89	8.79
400 - 499	44.06	15.66	44.22	18.95	44.85	17.53	44.02	16.50	44.23	17.16
500 - 599	53.90	30.65	54.47	38.44	54.05	32.21	53.34	29.55	54.03	32.71
600 - 699	62.09	62.20	61.76	74.74	63.18	57.56	62.31	54.47	62.15	62.24
700 - 799	71.81	59.54	72.55	113.63	71.54	108.85	72.29	109.00	72.14	97.76
800 - 999	86.71	103.99	86.49	225.80	85.36	105.36	85.24	183.92	86.31	154.77
> 1000	113.44	130.67	102.73	260.53	105.00	216.57	112.70	535.52	112.96	285.82
n =	13		16		17		16		17	
r2 =	0.992		0.987		0.993		0.996		0.989	
b =	2.9853		2.9994		3.0314		3.2608		3.0147	
Sb =	0.117		0.130		0.091		0.076		0.055	
b(95%) =	2.728 - 3.243		2.721 - 3.278		2.837 - 3.225		3.098 - 3.424		2.897 - 3.132	
a =	16.09 E(-5)		22.73 E(-5)		17.39 E(-5)		7.70 E(-5)		18.29 E(-5)	
ø =	15.41 E(-5)		22.69 E(-5)		19.02 E(-5)		16.42 E(-5)		19.07 E(-5)	

Table 8. Weight percentage of fish prey in the food of cod by size class and quarter.

Quarter 1

Species	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Gadus morhua												0.29	0.14	2.34		1.09	0.47
Melanogrammus aeglefinus												2.37	4.45	3.38	1.86	3.82	2.23
Merlangius merlangus								0.43		4.88	9.73	27.39	25.28	26.03	20.72	26.19	24.77
Trisopterus esmarki									8.76	11.55	21.45	5.23	22.48	7.77	5.90	2.37	
Clupea harengus											6.93	5.16	9.01	12.60	17.55	15.64	13.06
Sprattus sprattus							12.14	7.65			0.34	6.94		0.21	0.99	0.02	0.49
Ammodytidae							11.74	11.90	4.90	1.67	5.17	2.98	0.26	0.04	0.24	0.39	0.05
Pleuronectes platessa															0.77	0.03	3.91
Solea solea												1.05	0.48	0.35	2.17	0.45	2.54
Limanda limanda									0.74	0.09	0.90	6.62	5.30	6.80	12.65	8.26	25.11
Scomber scomber														23.41	11.12	13.38	
Other fish					65.49	19.55	11.87	25.82	37.08	32.93	21.27	19.02	17.18	9.06	10.07	9.46	16.28
Total %					65.49	19.55	35.75	45.80	51.48	51.12	65.79	77.05	84.58	91.99	84.04	81.10	88.91
Total weight stomach contents					0.76	15.54	84.24	221.4	115.3	710.4	1507	5121	9961	17727	11074	26829	10584

Quarter 2

Species	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Gadus morhua										0.38		0.21	0.54		1.06	10.42	
Melanogrammus aeglefinus								0.07			0.06	1.64	2.62	1.77	6.19	9.06	9.05
Merlangius merlangus								0.02			1.24	10.07	8.06	7.68	8.40	5.33	18.72
Trisopterus esmarki										14.03	19.08	14.17	17.95	4.72	4.66	2.13	5.23
Clupea harengus										1.16	2.97	0.29	10.27	27.08	15.38	12.31	14.69
Sprattus sprattus									0.16	0.38		0.27	1.49	0.17	0.08	0.25	0.49
Ammodytidae	6.77	6.23					9.25	10.06	9.87	11.18	10.55	10.70	6.80	2.67	3.21	1.01	0.13
Pleuronectes platessa																4.03	
Solea solea									1.60		0.08	0.46	0.49	0.70	3.04	0.52	5.71
Limanda limanda							0.87	0.10	0.30	1.03	1.72	2.91	10.98	14.29	10.79	14.88	15.32
Scomber scomber																	1.55
Other fish	47.38	47.51	62.08		100	9.38	4.43	11.70	17.38	17.85	26.73	17.37	22.77	19.02	29.55	16.36	12.36
Total %	54.15	53.74	62.08		100	9.38	14.55	21.95	29.31	46.01	62.43	58.09	81.97	78.10	82.36	76.30	83.25
Weight stomach contents	1.6	1.71	0.84		0.39	0.96	140.4	901.4	999.6	1322	4228	10707	16491	18386	12954	21903	7816

Quarter 3

Species	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Gadus morhua		1.16	0.45	0.06		2.59		9.55	7.68	8.88	3.47	2.84	1.57	0.73	0.11	0.11	1.52
Melanogrammus aeglefinus								0.09	2.30	4.06	6.12	3.00	6.64	5.83		0.75	5.66
Merlangius merlangus		4.21	0.45						2.83	4.09	8.00	3.53	1.55	12.57	6.26	5.72	
Trisopterus esmarki					0.92	2.75		8.03	15.41	8.36	15.19	22.26	22.82	10.01	16.71	4.68	3.17
Clupea harengus										0.61		13.26	17.04	22.96	41.22	47.33	7.90
Sprattus sprattus										1.63		0.28		5.08	0.64		
Ammodytidae								32.24	30.64	23.08	11.35	6.99	4.65	4.84	3.89	0.12	
Pleuronectes platessa										0.01							
Solea solea													0.08				3.84
Limanda limanda				0.43				0.66	0.02	0.01		0.47	12.31	8.46	3.14	9.31	9.22
Scomber scomber																0.10	
Other fish	1.99	3.43	1.09	18.85	22.72	18.82	4.76	13.34	5.31	9.34	9.76	23.60	11.61	9.07	7.85	13.25	37.76
Total %	1.99	8.80	1.99	19.34	23.64	24.16	4.76	63.91	64.19	60.07	53.89	76.23	78.27	79.55	79.82	81.37	69.07
Weight stomach contents	1.1	2.16	7	20.32	34.74	14.85	10.72	333.8	1321	1613	1155	4610	5315	5698	4463	3793	1949

Quarter 4

Species	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Gadus morhua							0.06			2.01	0.72	0.64	2.03	1.63	5.91	1.80	0.44
Melanogrammus aeglefinus									4.71	11.53	15.69	15.44	8.78	9.05	9.60	6.39	5.31
Merlangius merlangus									0.76	0.96	2.34	16.03	16.70	7.43	13.00	19.27	4.68
Trisopterus esmarki									11.17	15.20	7.63	14.97	7.77	9.26	12.01	9.26	0.66
Clupea harengus												1.50	0.01	2.50	2.39	0.15	39.66
Sprattus sprattus								3.65		1.20	9.65	0.11		0.28	0.29	0.03	0.31
Ammodytidae								3.81	3.57	1.94	2.38	2.20	0.87	0.29	0.05	0.62	
Pleuronectes platessa															2.11	5.42	11.86
Solea solea													0.75		0.59	0.10	
Limanda limanda					0.46	0.30				1.01	0.57	0.94	5.87	18.24	20.04	24.54	20.59
Scomber scomber															5.31	8.91	
Other fish			1.95	4.13	11.14	11.53	17.61	18.58	12.73	22.72	12.10	13.29	18.86	14.37	8.04	16.97	9.21
Total %			1.95	4.13	11.60	11.83	17.67	26.04	32.94	56.57	51.08	65.12	61.64	63.05	79.34	93.46	92.72
Weight stomach contents		0.1	0.48	9.68	55.86	79.75	401.5	195.2	273.3	1471	2012	3812	4137	6373	8720	7541	6426

Total year

Species	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Gadus morhua		0.63	0.38	0.04		0.35	0.04	1.93	3.74	3.48	0.61	0.79	0.75	1.16	1.77	4.52	0.40
Melanogrammus aeglefinus								0.06	1.60	4.60	4.37	4.22	4.43	3.81	4.96	5.86	5.21
Merlangius merlangus		2.29	0.38					0.07	1.46	2.24	3.80	13.42	12.87	14.98	12.89	16.42	16.38
Trisopterus esmarki					0.35	0.37		1.62	9.01	12.23	16.39	13.95	18.75	7.07	8.20	3.29	1.92
Clupea harengus										0.49	2.58	3.97	9.74	18.01	16.08	14.48	19.54
Sprattus sprattus							1.61	1.46	0.06	0.96	2.24	1.66	0.68	0.78	0.47	0.10	0.41
Ammodytidae	4.01	2.68					3.59	14.05	19.15	10.95	7.90	7.03	3.98	1.64	1.67	0.63	0.06
Pleuronectes platessa										0.00					0.72	2.16	4.39
Solea solea									0.59		0.04	0.42	0.46	0.40	1.84	0.40	2.95
Limanda limanda				0.29	0.28	0.22	0.19	0.19	0.15	0.57	1.10	2.92	9.01	11.37	12.59	12.78	20.01
Scomber scomber														8.61	4.55	7.10	0.45
Other fish	28.89	22.33	7.30	14.10	16.35	13.61	13.73	14.74	11.86	18.66	20.30	18.26	19.12	13.56	16.11	13.16	15.00
Total %	32.90	27.94	8.05	14.43	16.98	14.54	19.16	34.11	47.63	54.19	59.33	66.65	79.80	81.39	81.85	80.92	86.73
Weight stomach contents	2.7	3.97	8.32	30	91.75	111.1	636.9	1652	2709	5116	8902	24249	35904	48184	37211	60066	26776

Table 9. Weight percentage of crustacean prey in the food of cod by size class and quarter.

Quarter 1

Taxon	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Mysida					7.96	0.09	0.12			0.02						0.01	
Cumacea							0.03	0.03									
Gammaridea					0.88	0.22	0.03	0.02	0.28	0.05	0.05						
Hypeiidae							0.29										
Euphausiacea										0.01	0.55						
Caridea					5.31	59.34	44.20	20.14	21.16	7.77	3.35	1.36	2.03	1.25	0.80	0.10	0.01
Astacidea											5.26	0.88	2.30	0.95	1.97	1.58	3.32
Anomura					20.35	13.80	3.31	16.95	7.70	9.13	9.64	3.83	2.82	0.25	3.56	0.43	0.36
Oxyrhyncha								0.53	5.00	2.71	1.36	1.99	0.02	0.16	0.23	0.19	
Cancridea						1.59		0.73		1.71	0.28	0.35	0.45	0.45	0.81	0.42	0.06
Brachyrhyncha							4.21	0.67	5.92	3.22	5.20	5.60	5.32	2.61	4.13	1.22	1.98
Other crustaceans					0.01	0.74	0.79	3.38	1.55	0.90	0.41	0.18	0.22	0.20	0.16	0.01	0.00
Total %					34.51	75.78	52.98	42.45	41.61	25.52	26.10	14.19	13.16	5.87	11.66	3.96	5.73
Total weight					0.76	15.54	84.24	221.4	115.3	710.4	1507	5121	9961	16727	11074	26829	10584

Quarter 2

Taxon	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Mysida	2.03						1.02	0.18	0.01	0.01							
Cumacea																	
Gammaridea							1.49	0.21			0.03						
Hypeiidae	23.01	16.97	35.83				9.20	9.96	2.89	2.24	2.75	0.67	0.06	0.01			
Euphausiacea							0.05		0.01		0.57	0.95	0.05		0.01	0.03	
Caridea	4.96	21.62				80.21	10.16	7.56	3.47	1.06	0.94	0.61	0.86	0.22	0.19	0.14	
Astacidea								3.89		2.30	3.04	6.50	1.18	2.85	3.62	8.93	10.18
Anomura	2.71						20.23	24.80	31.62	26.12	10.85	6.25	3.24	1.44	3.61	0.57	0.01
Oxyrhyncha							6.19	2.30	4.61	2.80	2.83	1.75	0.48	0.08	0.02	0.02	0.19
Cancridea							3.82	0.65	1.51	2.32	2.16	3.76	3.41	7.30	4.60	5.76	0.78
Brachyrhyncha							15.29	14.59	11.46	7.64	5.53	9.36	3.80	3.66	3.66	3.19	1.94
Other crustaceans	13.14	6.61	2.09			9.37	3.42	1.02	0.95	1.26	0.32	0.07	0.13	0.01	0.02	0.02	
Total %	45.85	45.20	37.92			89.58	70.87	65.16	56.53	45.75	29.02	29.92	13.21	15.57	15.73	18.66	13.09
Total weight	1.6	1.71	0.84		0.39	0.96	140.4	901.4	999.6	1322	4228	10707	16491	18386	12954	21903	7816

Quarter 3

Taxon	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Mysida		0.53	0.07	2.20	1.01	0.19		0.02	0.02		0.04						
Cumacea				0.02		0.11											
Gammaridea		3.16	2.07	2.42	1.49	0.34		0.04	0.01	0.02	0.01	0.01					
Hypeiidae		1.05	0.51	10.51	24.68	22.31			0.02	0.09						0.01	
Euphausiacea	12.92	6.10	2.90	5.00	5.21	0.40		0.15	0.23	0.41	0.05	0.01	0.03		0.01		0.01
Caridea	49.11	39.74	61.69	37.48	27.18	34.36		4.86	2.77	1.66	2.97	0.67	0.11	0.42	1.00	0.75	
Astacidea								4.68	3.39	3.32	5.37	3.51	4.87	0.26	5.58	7.18	7.67
Anomura	15.90	2.10	3.75	1.78	4.00	11.13	95.24	11.96	8.66	11.27	7.24	4.45	1.87	1.78	0.44	0.06	1.45
Oxyrhyncha									0.05	0.06			0.01				
Cancridea			0.26	0.57	0.54	0.24		0.83	1.79	2.73	4.46	4.09	2.97	2.71	2.66	1.46	1.05
Brachyrhyncha		14.59	3.95	3.25	5.18	4.02		9.18	10.16	10.52	9.88	6.15	5.59	11.45	6.30	7.09	12.11
Other crustaceans	20.08	11.26	13.06	6.29	3.07	0.89		2.50	2.97	2.92	2.74	1.10	1.22		0.29	0.12	
Total %	98.01	78.53	88.26	69.52	72.36	73.99	95.24	34.22	30.07	33.00	32.76	19.99	16.67	16.27	16.28	16.67	22.29
Total weight	1.1	2.16	7	20.32	34.74	14.85	10.72	333.8	1321	1613	1155	4610	5315	5698	4463	3793	1949

Quarter 4

Taxon	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Mysida				0.18	1.07	0.20	0.15	0.05	0.21		0.02	0.03					
Cumacea				0.07		0.37	0.01										
Gammaridea		9.09	5.84	9.53	3.71	1.37	0.36			0.08							
Hypeiidae		9.09		0.63	0.74												
Euphausiacea				7.75	9.21	21.22	0.65	0.80	0.09	0.20	0.08	0.18	0.16	0.03	0.02	0.03	
Caridea		9.09	58.44	55.47	40.84	36.32	32.18	28.37	16.32	6.43	10.14	8.72	5.46	2.18	2.22	1.22	0.19
Astacidea							9.82			0.89	5.10	0.75	1.08	4.90	0.28	0.66	0.85
Anomura				7.51	11.24	9.09	15.63	20.45	16.13	15.01	5.95	7.44	3.25	3.55	3.20	0.36	
Oxyrhyncha						0.65	0.03	0.36		1.16	2.55	0.05	0.04	0.61	0.13		0.06
Cancridea						0.12	1.75		0.29	0.61	1.49	4.12	2.86	0.81	1.35	0.48	2.58
Brachyrhyncha				1.34	8.84	10.72	9.91	14.35	25.07	10.91	16.22	10.04	23.29	15.18	11.29	2.73	3.41
Other crustaceans		45.46	33.77	5.85	5.76	1.73	0.28		2.07	0.73	1.04	0.11	0.09	0.02		0.02	
Total %		72.73	98.05	88.33	81.41	81.79	70.77	64.38	60.18	36.02	42.59	31.44	36.23	27.28	18.49	5.50	7.09
Total weight		0.1	0.48	9.68	55.86	79.75	401.5	195.2	273.3	1471	2012	3812	4137	6373	8720	7541	6426

Total Year

Taxon	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
Mysida	1.20	0.29	0.06	1.55	1.10	0.18	0.34	0.11	0.03	0.01	0.01	0.00				0.00	
Cumacea				0.04		0.28	0.01	0.00									
Gammaridea		1.95	2.08	4.71	2.83	1.06	0.56	0.13	0.02	0.04	0.02	0.00					
Hypeiidae	13.64	8.11	4.05	7.32	9.80	2.98	2.07	5.44	1.08	0.61	1.31	0.30	0.03	0.00		0.00	
Euphausiacea	5.26	3.32	2.44	5.89	7.58	15.29	0.42	0.12	0.12	0.19	0.39	0.45	0.05	0.00	0.01	0.01	0.00
Caridea	22.95	31.16	55.27	43.28	35.20	39.66	28.37	11.16	5.18	3.72	3.69	2.05	1.60	0.87	0.94	0.30	0.05
Astacidea							6.19	3.07	1.65	1.90	4.18	3.84	2.03	2.14	2.58	4.50	5.05
Anomura	8.08	1.14	3.16	3.63	8.53	9.94	16.35	20.64	17.84	15.89	9.07	5.58	2.92	1.34	3.12	0.45	0.25
Oxyrhyncha						0.47	1.38	1.37	1.94	1.45	2.15	1.20	0.23	0.17	0.11	0.09	0.07
Cancridea			0.22	0.39	0.20	0.34	1.95	0.62	1.46	1.87	1.99	3.16	2.46	3.44	2.48	2.44	0.95
Brachyrhyncha		7.94	3.32	2.63	7.34	8.23	10.18	11.60	11.96	8.87	8.45	8.06	6.73	5.78	5.90	2.50	3.05
Other crustaceans	15.97	10.12	13.15	6.15	4.67	1.55	1.03	1.51	2.07	1.58	0.81	0.30	0.31	0.08	0.09	-0.02	0.00
Total %	67.10	64.03	83.74	75.59	77.25	79.97	68.85	55.77	43.36	36.12	32.08	24.95	16.36	13.84	15.23	10.32	9.41
Total weight	2.7	3.97	8.32	30	91.75	111.1	636.9	1652	2709	5116	8902	24249	35904	47184	37211	60066	26776

Table 10. Length frequency distribution (in percentage) of fish prey per predator size class and quarter. Modus underlined.

Quarter 1

sizeclass (mm)	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
<20										5.85							
20 - 24								1.51									
25 - 29										0.84	0.95			0.51			
30 - 34								11.52		2.75	0.06		0.02		0.23		
35 - 39								5.03		0.90	0.47	0.48					
40 - 49						29.77		12.32	8.04	3.77	3.44	0.79	4.00	0.94	1.41	0.09	
50 - 59						37.27	29.41	2.78	7.18	0.45	2.52	1.92	1.04	0.97	1.05	0.96	1.02
60 - 69						15.00		7.57		1.85	4.48	2.38	1.62	0.20	2.29	1.04	
70 - 79							11.99			4.16	9.71	1.34	0.91	1.79	2.40	1.03	1.88
80 - 99							2.33	10.11	29.38	9.84	14.91	11.04	7.62	8.19	8.71	8.62	8.32
100 - 119								2.54	5.34	18.66	14.06	14.01	13.10	12.66	9.45	14.02	10.73
120 - 149								3.01		6.97	18.03	31.68	28.23	20.15	18.73	20.33	29.92
150 - 199							2.89			4.16	3.37	7.29	18.77	15.06	21.75	13.93	30.13
200 - 249											0.47	0.88	5.80	12.20	9.78	14.91	6.53
250 - 299													1.69	3.36	2.33	4.67	3.77
300 - 349														4.57	0.59	3.40	2.07
350 - 399														0.14	1.17		
400 - 500																0.35	
Unknown					100.00	17.95	53.39	43.60	50.07	39.80	27.52	28.18	17.21	19.27	20.09	16.65	5.63

Quarter 2

sizeclass (mm)	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
<20		17.70				100.00	3.76	3.02	5.64			0.47	0.26				
20 - 24	42.86						1.34	4.02		3.67	0.63						
25 - 29							18.55	4.52	3.76	10.44	0.10	0.09	0.04				
30 - 34			45.38		100.00		15.32	1.01	0.56	0.85	0.42	0.14	0.23		0.12		
35 - 39			18.27				1.34	1.01	2.63			1.02	0.04	0.13			
40 - 49	14.29	8.85					4.57	17.09	4.14	2.54	3.66	3.96	7.96	0.27	1.49		
50 - 59							0.81	18.09	16.92	18.48	38.01	46.83	33.34	5.82	0.19	0.54	
60 - 69								2.51	8.08	9.73	8.06	4.93	1.07	3.62	0.83	13.08	
70 - 79								7.04	6.39	5.08	3.77	2.42	2.03	1.28	0.19	10.09	
80 - 99							1.88	1.51	9.59	5.36	5.13	6.33	3.43	8.12	2.89	2.19	1.45
100 - 119								2.01	2.82	5.92	3.14	4.33	4.54	6.22	5.59	4.58	6.12
120 - 149							1.88	1.01	3.57	9.17	4.82	7.50	18.00	24.34	23.64	14.94	28.42
150 - 199								0.50	1.69	3.81	3.46	4.42	11.33	20.40	28.59	23.26	25.16
200 - 249											1.47	0.74	2.69	12.28	16.86	11.68	12.79
250 - 299													0.41	2.37	0.87	5.16	7.39
300 - 349										0.28				0.09	0.68	0.27	1.45
350 - 399																0.38	
400 - 500															0.50	0.38	
Unknown	42.86	73.46	36.35				50.54	36.68	34.21	24.68	27.33	16.81	14.63	15.06	17.54	13.44	17.21

Quarter 3

sizeclass (mm)	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
<20				18.27	17.05	31.16			0.06								
20 - 24			61.11		0.92	13.26		0.48	0.08	0.29	0.38	0.22					
25 - 29		55.00						2.89	0.43	0.90	0.63	1.31	0.56	0.38			
30 - 34		15.00	22.22	23.08	55.30			3.57	0.77	0.41	0.38	1.83	0.43				
35 - 39				0.48	4.15	10.70		4.34	3.39	0.97	2.67	3.23	0.05	0.72	0.71	1.48	
40 - 49		15.00	5.56	3.85	4.15	18.14		3.34	3.98	3.89	1.49	6.45	1.18	1.40	0.78	0.73	
50 - 59							100.00	7.26	14.13	4.16	0.78	1.16	1.74	0.84			
60 - 69						1.63		19.27	28.89	14.85	13.50	6.93	8.25	4.47	4.67		
70 - 79								17.41	6.49	11.62	26.25	18.76	21.51	14.06	17.60	4.44	
80 - 99								12.46	6.38	5.38	12.35	23.11	21.09	21.68	21.90	12.54	
100 - 119								0.22	1.24	2.83	4.27	7.12	5.54	8.02	16.87	7.20	
120 - 149								0.84		0.90	3.93	7.46	7.85	8.78	17.85	15.50	16.31
150 - 199									0.41	0.68	1.37	5.79	9.81	5.39	7.08	13.10	36.74
200 - 249									0.10	0.11		1.54	0.95	1.60	2.70	21.89	8.17
250 - 299													0.74	1.31	4.85	17.71	24.48
300 - 349														0.30			
350 - 399																0.55	4.09
400 - 500																	4.09
Unknown	100.00	15.00	11.11	54.33	18.43	25.12		27.92	33.65	53.00	31.99	15.09	20.31	31.05	5.00	4.85	6.13

Quarter 4

sizeclass (mm)	50	60	70	80	100	120	150	200	250	300	350	400	500	600	700	800	1000
<20					4.90												
20 - 24						1.72	3.49				0.72	1.80		0.76			
25 - 29					4.90	14.50	12.87	1.74		1.85	0.72	5.57				0.06	
30 - 34				45.45	7.76	4.18	5.19	3.06	2.25	1.97	3.62	2.16		0.76	0.62		0.59
35 - 39					6.53	5.90	8.78	18.63	9.44	7.76	2.25	2.95	0.94	0.50	0.31		
40 - 49					28.98	41.28	35.93	47.90	17.64	18.40	18.62	6.81	5.42	4.98	2.06	0.98	
50 - 59							3.19	7.40	8.20	7.85	4.90	1.83	7.43	5.64	1.70	1.16	2.33
60 - 69							2.69		9.38	2.72	6.74	3.86	4.95	3.06	2.16	3.25	0.59
70 - 79								0.41	5.79	5.76	4.68	2.85	11.61	3.97	1.70	3.25	2.33
80 - 99								1.10	10.90	21.81	17.75	21.05	20.41	14.25	17.61	22.98	14.04
100 - 119									4.44	9.57	13.51	16.60	12.18	12.42	14.03	17.84	20.47
120 - 149										2.88	5.96	9.63	14.62	24.96	21.27	17.46	18.13
150 - 199										0.22	0.72	5.73	7.56	16.29	18.69	19.25	16.96
200 - 249												1.70	1.71	2.11	5.61	3.30	20.47
250 - 299													0.94	0.63	3.19	2.45	2.33
300 - 349																	0.59
350 - 399																0.73	
400 - 500																	
Unknown			100.00	54.55	46.94	32.43	27.84	19.77	31.97	19.21	19.84	17.45	12.24	9.68	11.05	7.29	1.17

Table 11. Weight percentage of fish prey per predator agegroup and quarter.

Quarter 1	agegroup						
Species	0	1	2	3	4	5	6+
Gadus morhua			0.27	0.79	1.17	0.98	0.78
Melanogrammus aeglefinus			1.69	3.27	3.18	3.37	3.03
Merlangius merlangus		0.35	18.53	25.06	24.63	25.20	25.35
Trisopterus esmarki		0.91	13.06	12.23	6.55	3.50	1.50
Clupea harengus		0.03	5.79	10.29	14.57	15.44	14.53
Sprattus sprattus		8.14	2.70	1.70	0.37	0.22	0.27
Ammodytidae		10.46	2.89	0.89	0.22	0.31	0.23
Pleuronectes platessa				0.10	0.23	0.38	1.80
Solea solea			0.48	0.76	0.88	0.84	1.45
Limanda limanda		0.06	3.87	6.86	8.80	9.81	15.97
Scomber scomber			1.44	8.19	15.31	13.03	7.40
Other fish		21.40	21.04	14.37	10.07	10.02	12.51
Total %		41.35	71.76	84.51	85.98	83.10	84.82
Mean length		18.38	37.14	51.92	70.00	81.70	96.64
Total weight all prey (g)		318.24	5114.3	19909	18242	10448	24037

Quarter 2	agegroup						
Species	0	1	2	3	4	5	6+
Gadus morhua		0.08	0.21	0.53	5.27	8.79	5.12
Melanogrammus aeglefinus	0.06	0.04	1.51	3.08	6.83	8.54	8.97
Merlangius merlangus	0.02	0.16	7.06	8.13	6.88	6.03	11.88
Trisopterus esmarki		3.87	14.02	9.97	4.39	2.70	3.70
Clupea harengus		0.39	8.30	16.33	14.71	12.90	13.55
Sprattus sprattus		0.13	0.47	0.60	0.26	0.24	0.36
Ammodytidae	8.57	10.20	8.25	4.88	2.40	1.36	0.65
Pleuronectes platessa				0.04	1.88	3.35	1.97
Solea solea		0.52	0.43	1.12	1.46	0.95	3.10
Limanda limanda	0.09	0.50	6.61	11.37	13.01	14.32	14.97
Scomber scomber						0.03	0.75
Other fish	21.37	15.14	20.68	22.43	21.87	18.09	14.81
Total %	30.11	31.03	67.54	78.48	78.96	77.30	79.83
Mean length	4.99	23.65	42.57	56.86	70.93	84.43	97.25
Total weight all prey (g)	0.044	2752	19641	34460	12149	9630.3	14749

Quarter 3	agegroup						
Species	0	1	2	3	4	5	6+
Gadus morhua	0.50	6.98	2.20	0.91	0.18	0.13	0.91
Melanogrammus aeglefinus		3.46	4.97	4.46	0.64	0.87	3.52
Merlangius merlangus	0.06	4.02	3.81	7.42	6.10	5.88	2.49
Trisopterus esmarki	0.80	13.16	20.81	15.32	10.99	4.81	3.83
Clupea harengus		1.54	14.96	25.78	42.95	46.74	25.06
Sprattus sprattus		0.57	0.62	2.25	0.46	0.12	
Ammodytidae	0.25	22.41	6.20	4.48	2.18	0.24	0.05
Pleuronectes platessa							
Solea solea			0.03	0.02			2.17
Limanda limanda	0.14	0.10	6.17	8.06	6.30	9.29	9.26
Scomber scomber					0.05	0.10	0.04
Other fish	17.88	9.89	15.31	10.38	10.63	13.14	27.09
Total %	19.63	62.13	75.08	79.08	80.48	81.32	74.42
Mean length	7.63	29.71	46.82	52.99	76.22	87.93	101.07
Total weight all prey (g)	38.82	4481	7900.2	8665.4	3954.5	826.24	2374.6

Quarter 4	agegroup						
Species	0	1	2	3	4	5	6+
Gadus morhua	0.04	1.08	2.34	3.57	3.85	1.34	0.75
Melanogrammus aeglefinus		13.49	10.66	8.79	8.31	6.02	5.56
Merlangius merlangus		6.59	13.68	13.41	14.79	9.75	7.29
Trisopterus esmarki	0.01	12.29	10.68	10.26	10.65	4.24	2.29
Clupea harengus		0.46	1.38	1.65	1.54	24.59	32.38
Sprattus sprattus	0.47	3.33	0.19	0.20	0.19	0.23	0.27
Ammodytidae	0.50	2.21	0.92	0.34	0.30	0.19	0.11
Pleuronectes platessa			0.40	1.91	3.14	9.07	10.62
Solea solea		0.03	0.36	0.38	0.34	0.08	0.03
Limanda limanda	0.04	0.97	10.07	18.30	21.57	21.71	21.26
Scomber scomber			1.01	3.94	6.10	3.11	1.60
Other fish	16.90	15.87	14.43	12.76	12.17	11.39	10.51
Total %	17.96	56.32	66.12	75.51	82.95	91.72	92.67
Mean length	15.85	34.55	51.93	65.79	75.25	91.35	102.26
Total weight all prey (g)	882.39	5508.9	7971.5	10038	6049.4	3064.6	8917.8

Total Year	agegroup						
Species	0	1	2	3	4	5	6+
Gadus morhua	0.08	0.82	0.79	1.07	2.79	4.16	2.06
Melanogrammus aeglefinus	0.04	6.04	3.23	3.67	4.83	5.70	5.13
Merlangius merlangus	0.04	3.17	8.62	12.62	15.50	14.69	17.01
Trisopterus esmarki	0.05	6.37	10.71	9.56	5.97	3.19	2.26
Clupea harengus	0.04	0.62	5.21	10.85	11.33	15.09	16.78
Sprattus sprattus	0.49	1.97	0.80	0.89	0.37	0.26	0.33
Ammodytidae	0.52	3.68	4.73	2.71	0.96	0.74	0.37
Pleuronectes platessa	0.04	0.34	0.27	0.43	1.24	2.71	3.38
Solea solea	0.04	0.47	0.53	0.91	0.99	0.79	1.66
Limanda limanda	0.08	0.86	5.85	9.86	11.22	12.84	15.91
Scomber scomber	0.04	0.34	0.57	2.89	7.93	6.12	4.11
Other fish	16.55	27.94	27.94	24.32	19.75	15.51	15.24
Total %	18.03	52.62	69.26	79.79	82.88	81.81	84.26
Total weight all prey (g)	921.25	13060	40627	73072	40395	23970	50078

Table 12. Weight percentage of different crustacean prey per predator agegroup and quarter.

Quarter 1

Taxon	agegroup 0	1	2	3	4	5	6+
Mysida		0.07					
Cumacea		0.03					
Gammaridea		0.06	0.02				
Hyperiidae		0.10					
Euphausiacea			0.15	0.01			
Caridea		30.70	3.27	1.51	0.82	0.34	0.10
Astacidea		0.02	2.12	1.63	1.52	1.69	2.36
Anomura		11.55	5.89	2.52	1.36	0.93	0.51
Oxyrhyncha		0.65	1.59	0.55	0.18	0.18	0.11
Cancridea		0.48	0.54	0.47	0.53	0.46	0.27
Brachyrhyncha		2.33	4.92	4.41	2.76	1.90	1.68
Other crustaceans		1.63	0.39	0.20	0.15	0.07	0.03
Total %		47.62	18.89	11.30	7.32	5.57	5.06
Total weight (g)		318.2	5114	19909	18242	10448	24037

Quarter 2

Taxon	agegroup 0	1	2	3	4	5	6+
Mysida	0.15	0.13					
Cumacea		0.00					
Gammaridea	0.18	0.16	0.01				
Hyperiidae	11.70	5.70	0.87	0.09	0.01		
Euphausiacea		0.04	0.45	0.11	0.03	0.03	0.02
Caridea	6.44	4.75	0.68	0.46	0.22	0.16	0.08
Astacidea	3.31	2.10	3.78	2.84	5.87	8.13	9.38
Anomura	21.12	26.06	6.35	2.97	1.97	0.99	0.39
Oxyrhyncha	1.96	3.37	1.40	0.36	0.07	0.03	0.10
Cancridea	0.55	1.53	4.01	5.07	5.33	5.51	3.32
Brachyrhyncha	12.42	11.75	6.23	4.21	3.48	3.24	2.60
Other crustaceans	1.08	1.14	0.17	0.06	0.02	0.00	0.00
Total %	58.91	56.73	23.95	16.17	17.00	18.09	15.89
Total weight (g)	0.044	2752	19641	34460	12149	9630	14749

Quarter 3

Taxon	agegroup 0	1	2	3	4	5	6+
Mysida	1.15	0.02					
Cumacea	0.02						
Gammaridea	1.67	0.01					
Hyperiidae	16.13	0.04					
Euphausiacea	4.07	0.23	0.02	0.01			
Caridea	35.05	2.38	0.54	0.49	0.85	0.74	0.33
Astacidea	0.04	3.82	3.86	3.16	6.15	7.02	7.46
Anomura	5.98	9.19	3.32	1.59	0.36	0.10	0.85
Oxyrhyncha	0.05	2.06	1.15	0.72	0.24	0.13	0.05
Cancridea	0.47	2.73	3.49	2.78	2.12	1.49	1.23
Brachyrhyncha	4.18	9.74	6.67	8.28	6.81	7.20	9.93
Other crustaceans	4.92	0.66	0.08	0.02	0.01	0.00	0.00
Total %	73.73	30.88	19.13	17.05	16.54	16.68	19.85
Total weight (g)	38.82	4481	7900	8665	3954	826.2	2375

Quarter 4

Taxon	agegroup 0	1	2	3	4	5	6+
Mysida	0.16	0.03	0.01				
Cumacea	0.05						
Gammaridea	0.52	0.02					
Hyperiidae	0.02						
Euphausiacea	3.09	0.15	0.11	0.05	0.02	0.01	0.01
Caridea	32.38	8.85	4.94	2.52	1.83	0.68	0.40
Astacidea	7.26	2.08	1.71	1.54	0.94	0.74	0.81
Anomura	15.42	9.63	4.36	2.78	2.15	0.40	0.11
Oxyrhyncha	0.14	1.13	0.20	0.21	0.13	0.05	0.05
Cancridea	1.31	2.02	2.41	1.30	0.96	1.85	2.20
Brachyrhyncha	10.53	13.79	15.92	12.36	8.43	3.93	3.40
Other crustaceans	0.52	0.33	0.06	0.02	0.02	0.00	0.00
Total %	71.40	38.03	29.72	20.78	14.48	7.66	6.98
Total weight (g)	882.4	5509	7972	10038	6049	3065	8918

Total Year

Taxon	agegroup 0	1	2	3	4	5	6+
Mysida	0.20	0.05	0.00	0.00	0.00	0.00	0.00
Cumacea	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Gammaridea	0.57	0.05	0.01	0.00	0.00	0.00	0.00
Hyperiidae	0.70	1.22	0.42	0.04	0.00	0.00	0.00
Euphausiacea	3.13	0.15	0.26	0.06	0.01	0.01	0.01
Caridea	32.49	6.30	1.81	1.03	0.79	0.32	0.16
Astacidea	6.96	2.63	3.18	2.37	3.19	4.34	4.39
Anomura	15.02	12.99	5.31	2.66	1.56	0.86	0.42
Oxyrhyncha	0.14	1.91	1.14	0.43	0.15	0.10	0.09
Cancridea	1.27	2.12	3.16	3.03	2.19	2.70	1.56
Brachyrhyncha	10.26	11.69	8.05	5.87	4.22	2.88	2.65
Other crustaceans	0.71	0.65	0.16	0.09	0.08	0.03	0.01
Total %	71.50	39.75	23.51	15.58	12.21	11.25	9.29
Total weight (g)	921.3	13060	40627	73072	40395	23970	50078

Table 13. Length frequency distribution of fish prey per predator age group and quarter. (Modus underlined)

Quarter 1

sizeclass	agegroup 0	1	2	3	4	5	6+
<20		0.08	1.04				
20 - 24		0.73					
25 - 29			0.50	0.14	0.16	0.04	
30 - 34		5.43	0.60	0.04	0.08	0.04	0.01
35 - 39		2.35	0.50	0.18			
40 - 49		7.79	2.94	2.13	1.18	0.49	0.11
50 - 59		14.44	2.07	1.39	1.01	0.98	0.99
60 - 69		4.22	2.84	1.85	1.22	1.15	0.55
70 - 79		4.46	4.71	1.79	1.68	1.43	1.53
80 - 99		7.87	12.80	9.34	8.44	8.56	8.46
100 - 119		1.78	14.23	13.05	12.09	12.71	12.11
120 - 149		1.54	20.21	26.58	20.80	20.83	25.19
150 - 199		1.14	5.98	13.81	17.24	16.90	22.61
200 - 249			1.14	5.38	11.32	12.84	10.35
250 - 299			0.20	1.39	3.17	3.95	4.09
300 - 349			0.10	0.82	2.51	2.78	2.61
350 - 399				0.12	0.40	0.25	0.05
400 - 500					0.08	0.21	0.15
Unknown		48.18	30.14	21.98	18.62	16.80	11.18
Total %	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Quarter 2

sizeclass	agegroup 0	1	2	3	4	5	6+
<20	0.95	5.34	0.33	0.23	0.06		
20 - 24	1.18	3.88	0.41				
25 - 29	1.18	9.71	0.65	0.06	0.02		
30 - 34	73.93	3.88	0.33	0.17	0.09	0.02	
35 - 39	9.00	1.94	0.57	0.28	0.06		
40 - 49	4.74	14.56	5.31	4.87	2.12	0.54	0.05
50 - 59	4.98	26.21	48.49	27.96	8.36	1.77	0.27
60 - 69	0.71	7.77	6.95	2.55	5.39	10.34	6.56
70 - 79	1.90	8.74	3.60	1.84	4.02	7.91	5.04
80 - 99	0.47	6.80	7.03	4.92	3.42	2.43	1.88
100 - 119	0.47	3.88	5.15	4.90	5.09	4.80	5.33
120 - 149	0.24	4.85	11.28	17.12	19.30	16.79	21.51
150 - 199	0.24	2.43	7.36	13.08	22.06	23.66	24.34
200 - 249			2.29	5.46	11.56	12.20	12.40
250 - 299			0.25	0.74	2.35	4.31	6.03
300 - 349				0.08	0.34	0.35	0.84
350 - 399					0.13	0.29	0.18
400 - 500				0.06	0.30	0.37	0.20
Unknown				15.68	15.35	14.22	15.36
Total %	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Quarter 3

sizeclass	agegroup 0	1	2	3	4	5	6+
<20	18.78	0.02					
20 - 24	4.69	0.22	0.15	0.02			
25 - 29		0.85	0.92	0.45	0.09	0.02	—
30 - 34	32.39	0.87	1.05	0.28	0.07		
35 - 39	3.29	2.59	1.88	0.73	1.03	1.43	0.95
40 - 49	6.10	3.72	3.76	1.61	1.01	0.79	0.46
50 - 59		8.45	1.47	1.02	0.15	0.06	
60 - 69	0.47	21.09	8.27	5.96	3.39	0.33	
70 - 79		11.58	19.82	17.30	13.46	5.14	2.83
80 - 99		7.73	20.60	21.37	19.02	13.21	7.99
100 - 119		2.20	6.19	8.21	12.67	7.26	4.59
120 - 149		1.02	7.07	9.60	15.92	15.01	15.80
150 - 199		0.74	6.42	7.16	8.88	12.54	21.70
200 - 249		0.13	1.14	1.82	8.47	20.40	16.89
250 - 299			0.34	1.72	8.33	16.52	20.18
300 - 349			0.02	0.14	0.02	0.02	
350 - 399				0.02	0.17	0.52	1.83
400 - 500							1.48
Unknown	34.27	38.79	20.90	22.59	7.34	6.76	5.30
Total %	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Quarter 4

sizeclass	agegroup 0	1	2	3	4	5	6+
<20	0.12						
20 - 24	2.69	0.54	0.77	0.21	0.11		
25 - 29	11.23	1.97	1.95	0.05	0.02	0.03	0.01
30 - 34	4.88	2.49	0.99	0.42	0.36	0.34	0.42
35 - 39	9.77	5.41	1.53	0.45	0.19	0.03	
40 - 49	38.10	16.34	5.69	3.31	1.95	0.62	0.30
50 - 59	3.30	5.92	4.54	3.76	1.95	1.77	2.00
60 - 69	1.95	4.73	3.96	3.20	2.75	1.87	1.35
70 - 79		4.97	6.11	4.66	2.67	2.67	2.59
80 - 99	0.12	19.24	19.25	18.49	19.59	18.23	16.59
100 - 119		11.47	13.94	14.01	15.53	18.71	19.63
120 - 149		4.90	15.22	19.92	20.04	18.15	18.00
150 - 199		1.46	9.49	15.76	18.64	18.11	17.63
200 - 249		0.34	2.17	3.44	4.15	11.64	15.44
250 - 299			0.80	1.91	2.54	2.46	2.38
300 - 349						0.28	0.41
350 - 399				0.13	0.32	0.31	0.21
400 - 500							
Unknown	27.84	20.19	13.59	10.28	9.20	4.77	3.04
Total %	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 14. Comparison between weight percentages of major prey taxa in the 1981 and 1991 Stomach Sampling Project.

Weight percentage of major prey taxa after Daan (1983) per quarter in 1981.

Quarter	I			II			III			IV		
Agegroup	Fish	Crust.	Rest	Fish	Crust.	Rest	Fish	Crust.	Rest	Fish	Crust.	Rest
0							26.36	66.82	6.82	24.25	69.60	6.15
1	30.01	46.11	23.88	45.06	39.30	15.64	51.49	40.47	8.04	33.56	50.97	15.47
2	50.11	30.12	19.77	51.43	35.67	12.90	58.18	33.72	8.10	39.43	48.31	12.26
3	67.93	18.08	13.99	56.56	36.75	6.69	62.83	28.41	8.76	58.36	26.01	15.63
4	83.80	10.02	6.18	55.81	39.72	4.47	69.80	19.13	11.07	69.79	11.43	18.78
5	87.86	8.35	3.79	56.08	39.50	4.42	72.56	16.82	10.62	70.95	9.89	19.16
6+	91.04	6.54	2.42	61.61	32.31	6.08	85.85	12.49	1.66	87.66	6.75	5.59

Weight percentage of major prey taxa per quarter in 1991.

Quarter	I			II			III			IV		
Agegroup	Fish	Crust.	Rest	Fish	Crust.	Rest	Fish	Crust.	Rest	Fish	Crust.	Rest
0				30.11	58.91	10.98	19.63	73.73	6.64	17.96	71.40	10.64
1	41.35	47.62	11.03	31.03	56.73	12.24	62.13	30.88	6.99	56.32	38.03	5.65
2	71.76	18.89	9.35	67.54	23.95	8.51	75.08	19.13	5.79	66.12	29.72	4.16
3	84.51	11.30	4.19	78.48	16.17	5.35	79.08	17.05	3.87	75.51	20.78	3.71
4	85.98	7.32	6.70	78.96	17.00	4.04	80.48	16.54	2.98	82.95	14.48	2.57
5	83.10	5.57	11.33	77.30	18.09	4.61	81.32	16.68	2.00	91.72	7.66	0.62
6+	84.82	5.06	10.12	79.83	15.89	4.28	74.42	19.85	5.73	92.67	6.98	0.35

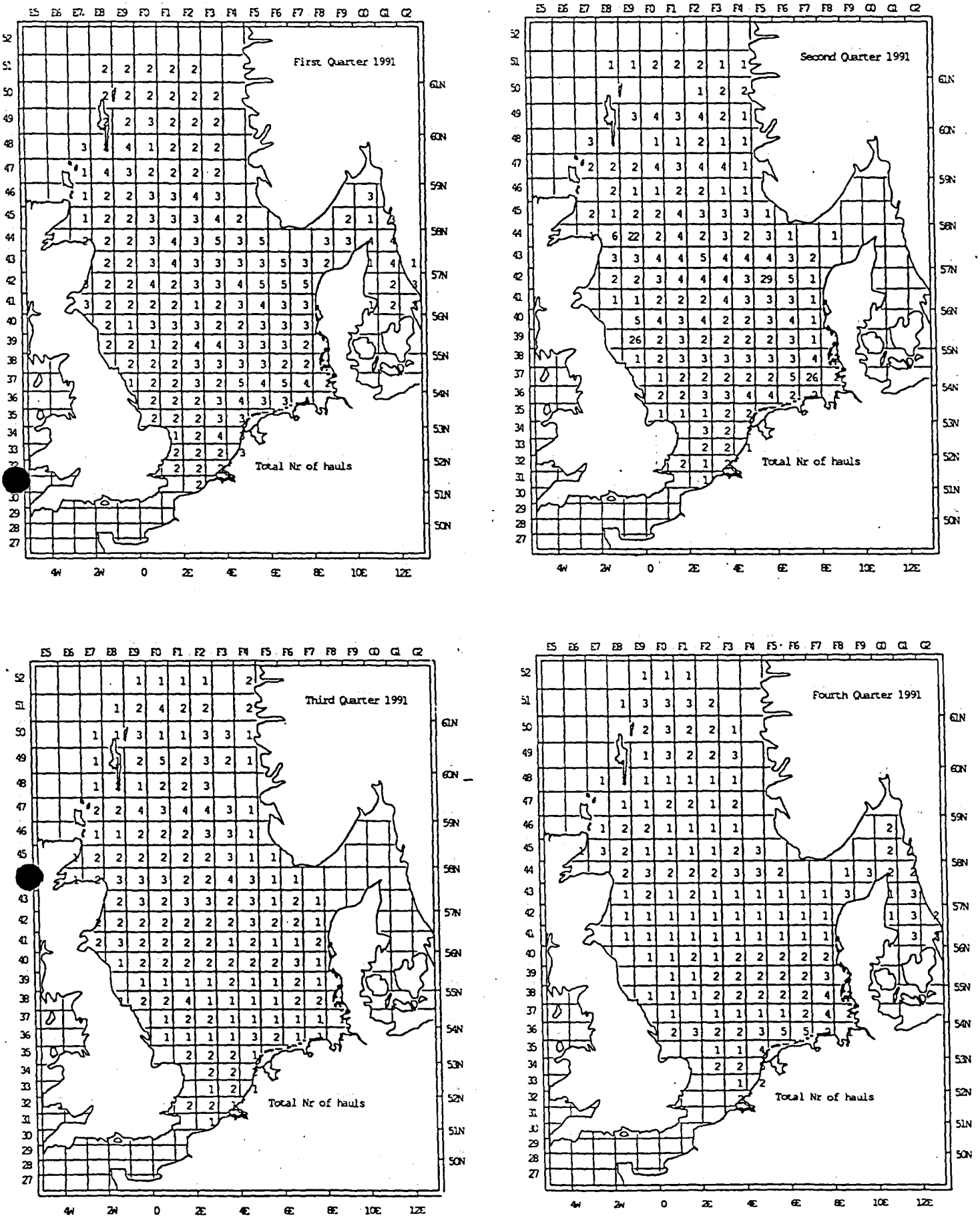

Figure 1. Total number of hauls per ICES statistical rectangle and quarter Research vessels only.

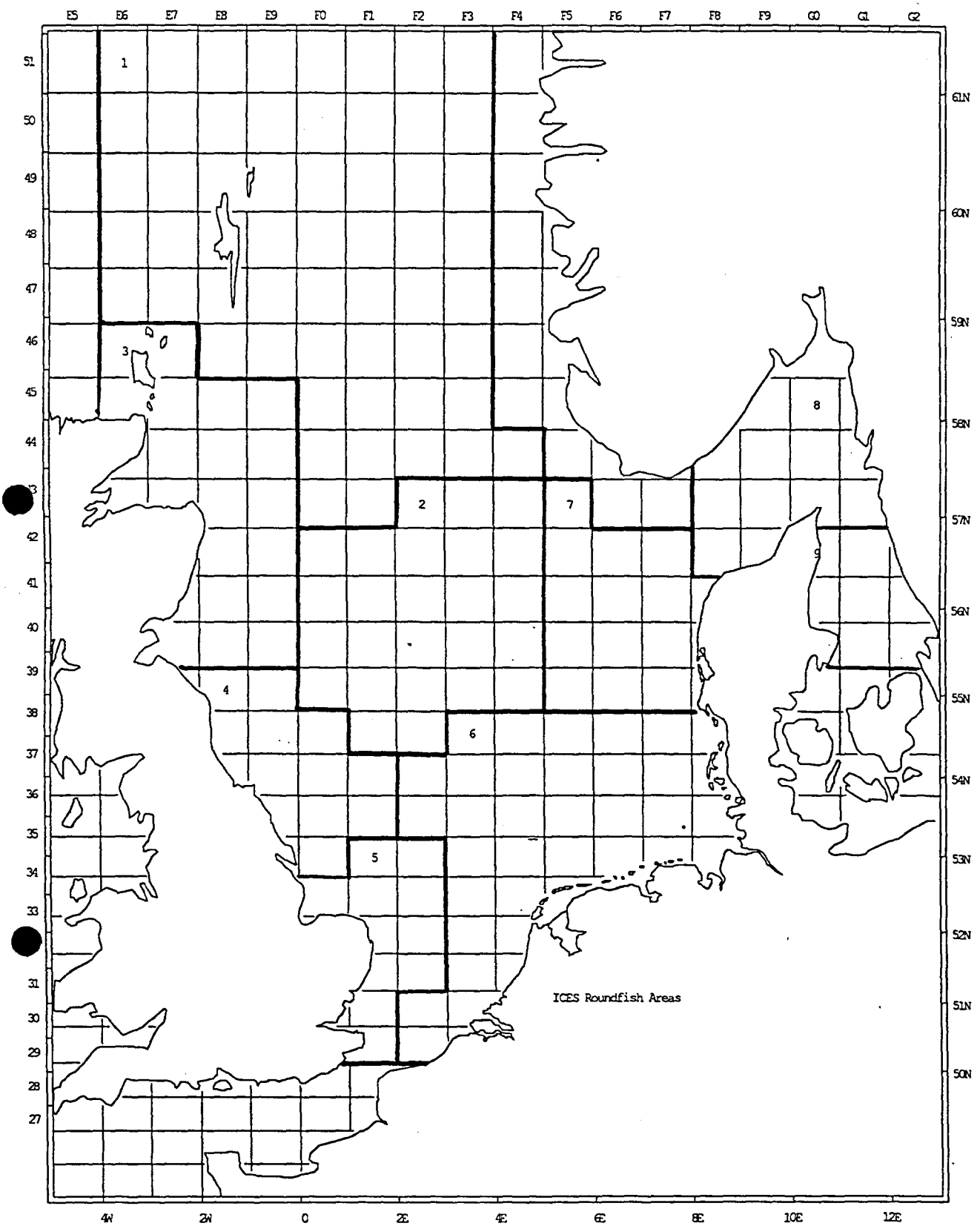

Figure 2. ICES Roundfish Areas

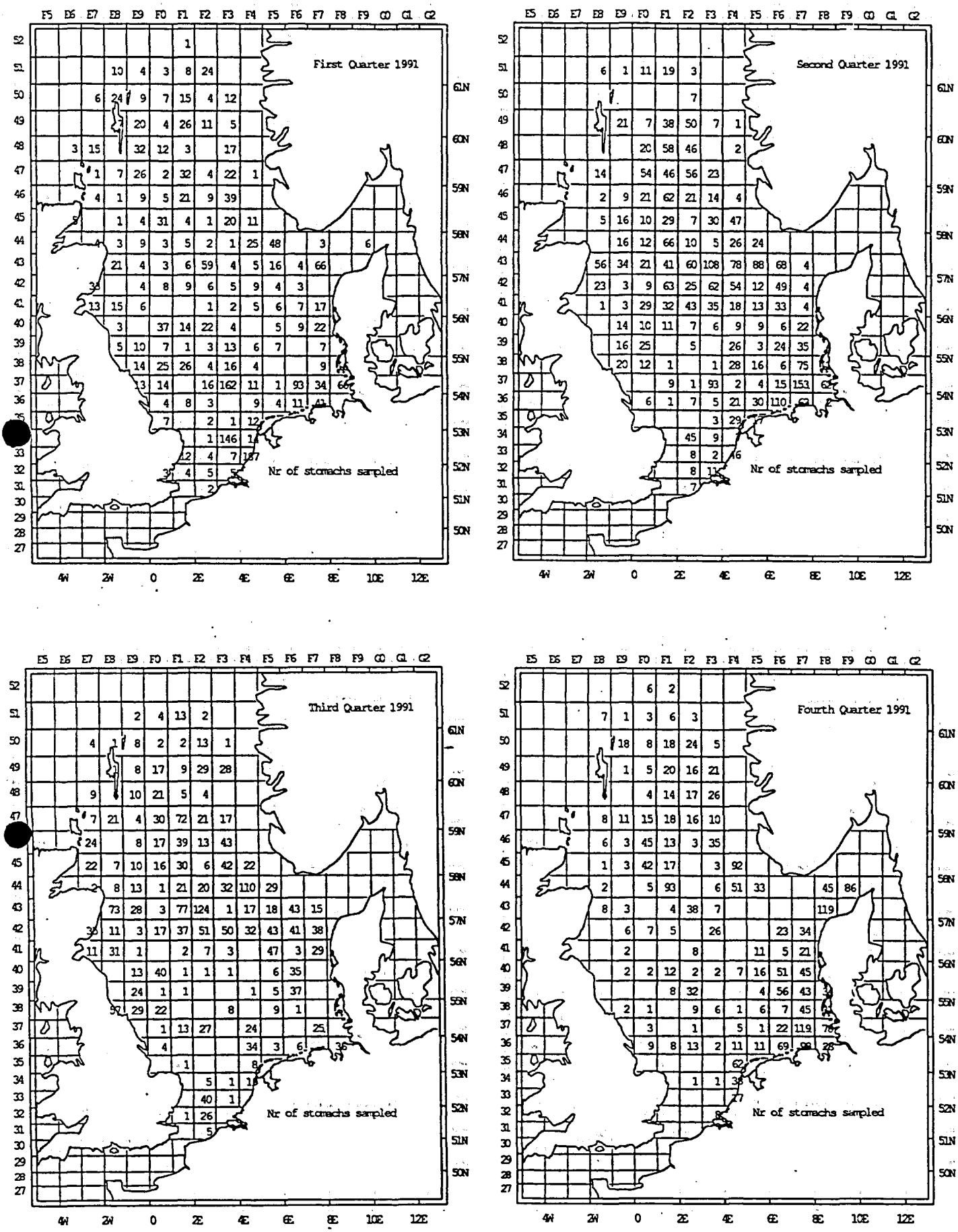

Figure 3. Total number of cod stomachs sampled per ICES statistical rectangle and quarter in 1991.

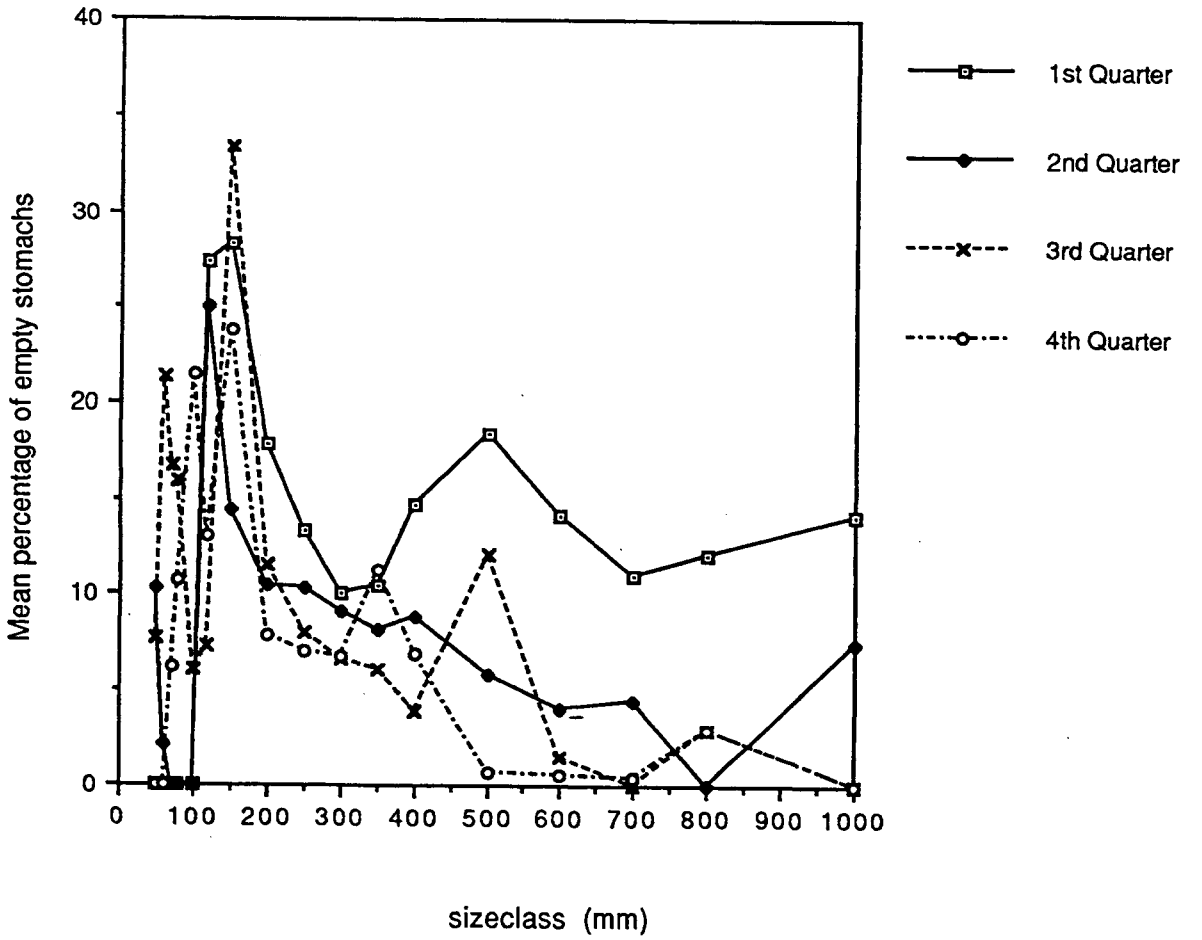

Figure 4. Mean percentage of empty stomachs per sizeclass and quarter.

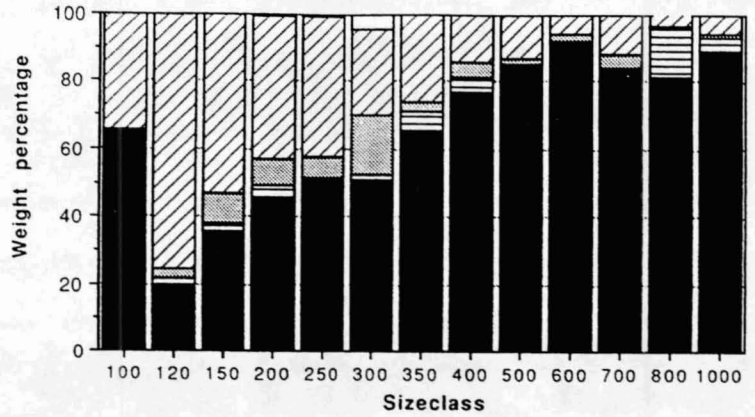

Figure 5a. First quarter data.

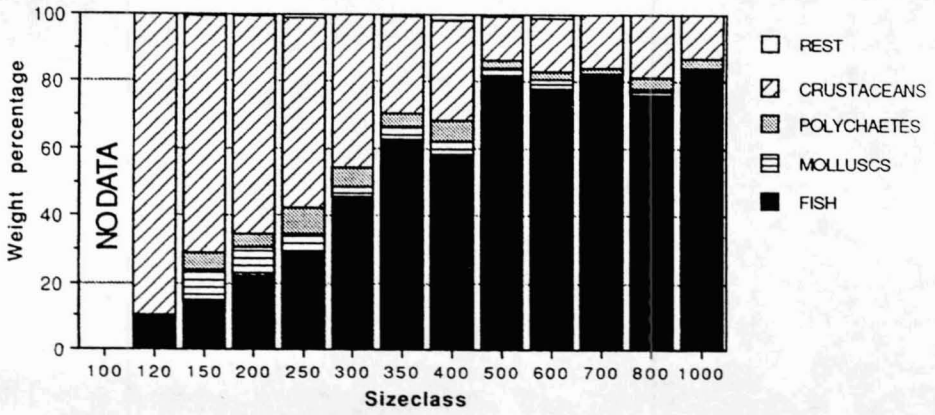

Figure 5b. Second quarter data.

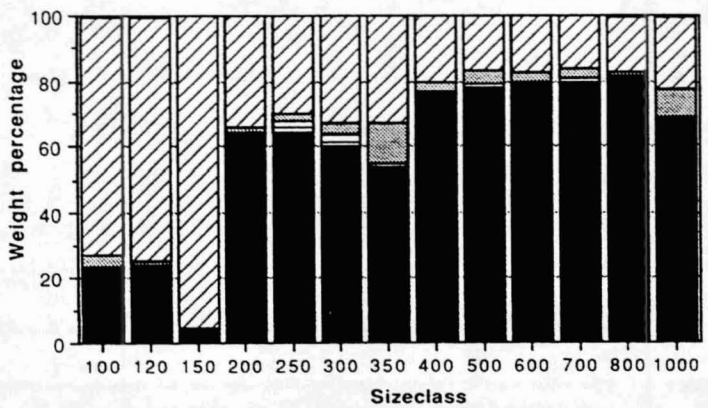

Figure 5c. Third quarter data.

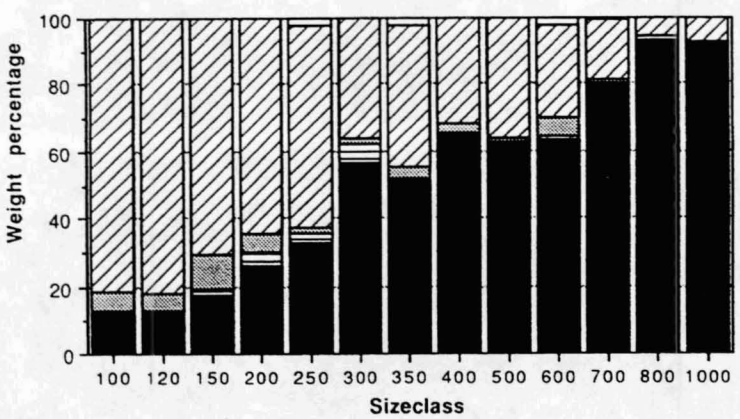

Figure 5d. Fourth quarter data.

Figure 5a-d. Weight percentage of major prey taxa per predator size class and quarter in 1991.

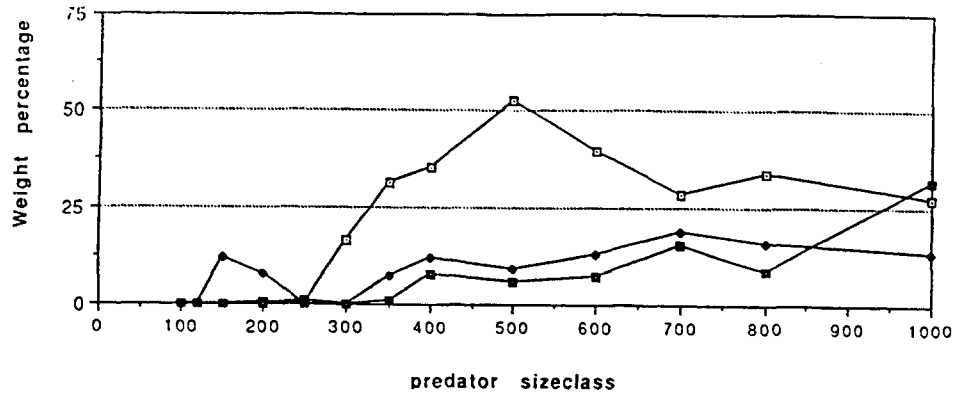

Figure 6a. First quarter data.

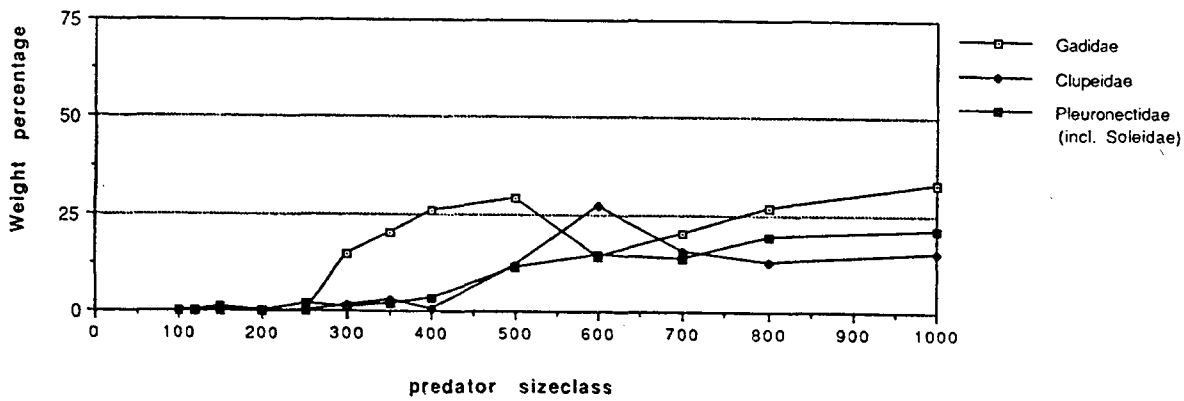

Figure 6b. Second quarter data.

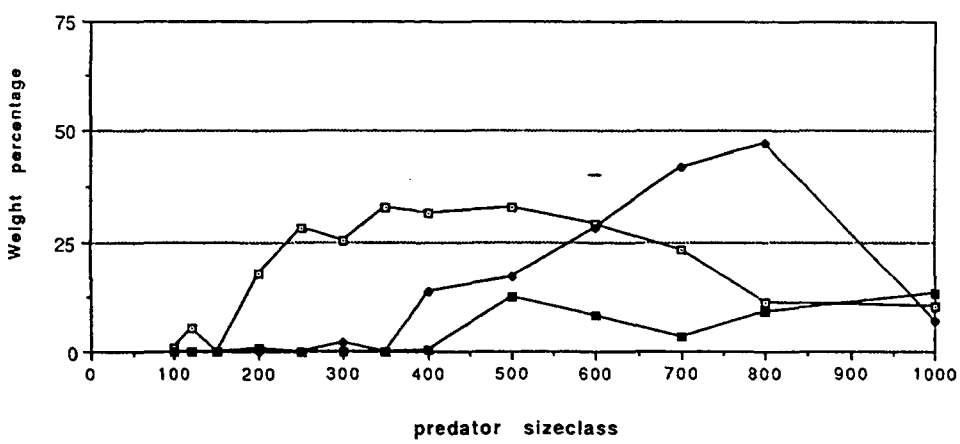

Figure 6c. Third quarter data.

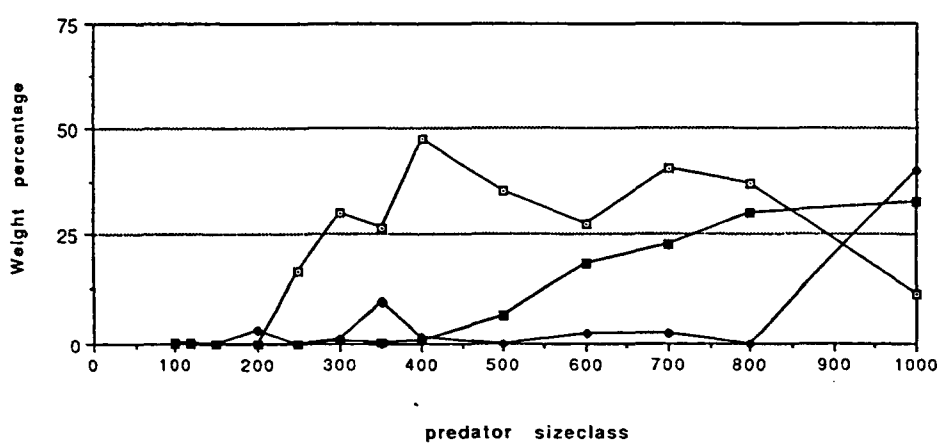

Figure 6d. Fourth quarter data.

Figure 6a-d. Major groups of fish prey per predator size class and quarter in 1991.

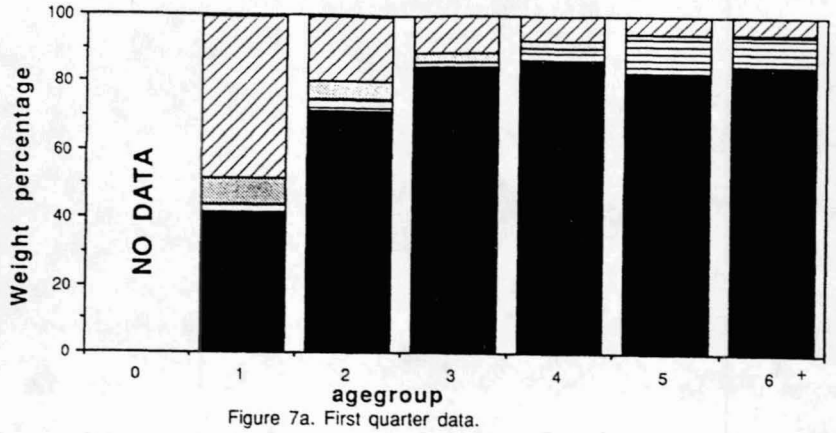

Figure 7a. First quarter data.

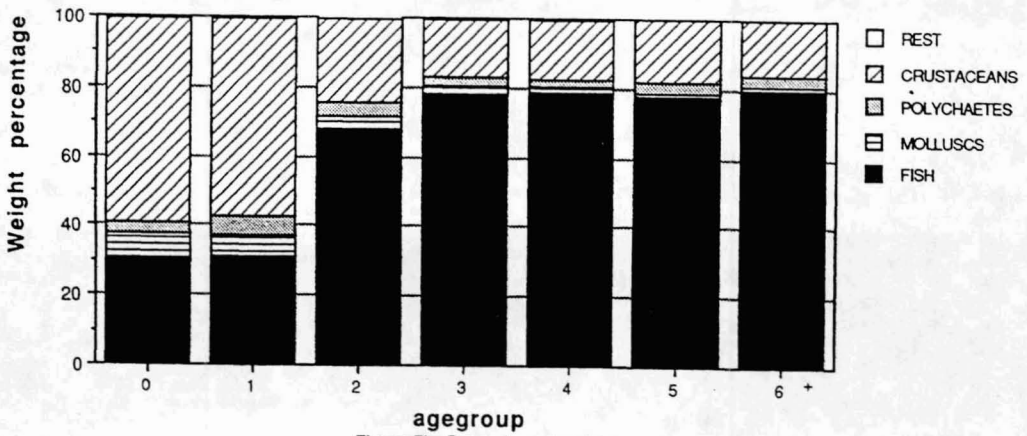

Figure 7b. Second quarter data.

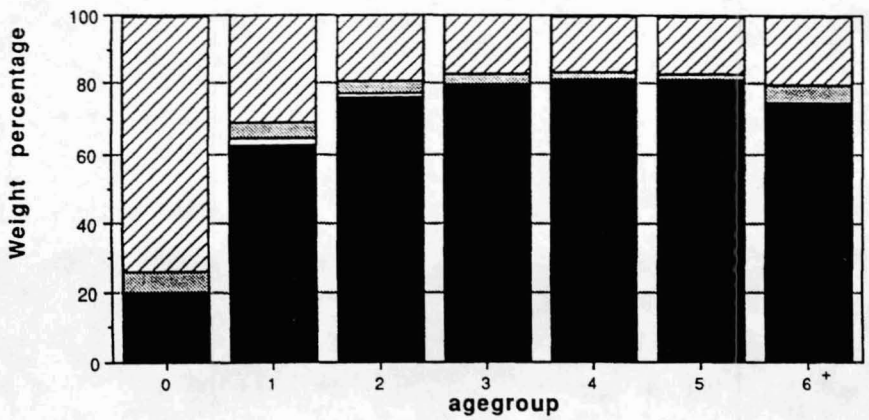

Figure 7c. Third quarter data.

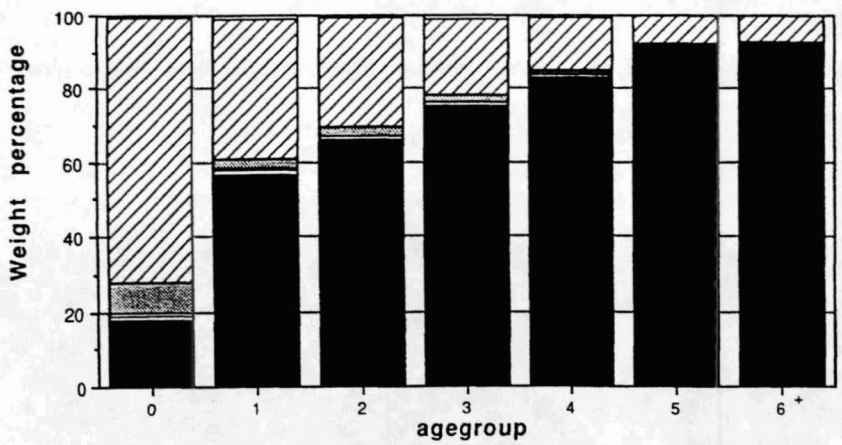

Figure 7d. Fourth quarter data.

Figure 7a-d. Weight percentage of major prey taxa per predator age group and quarter in 1991.

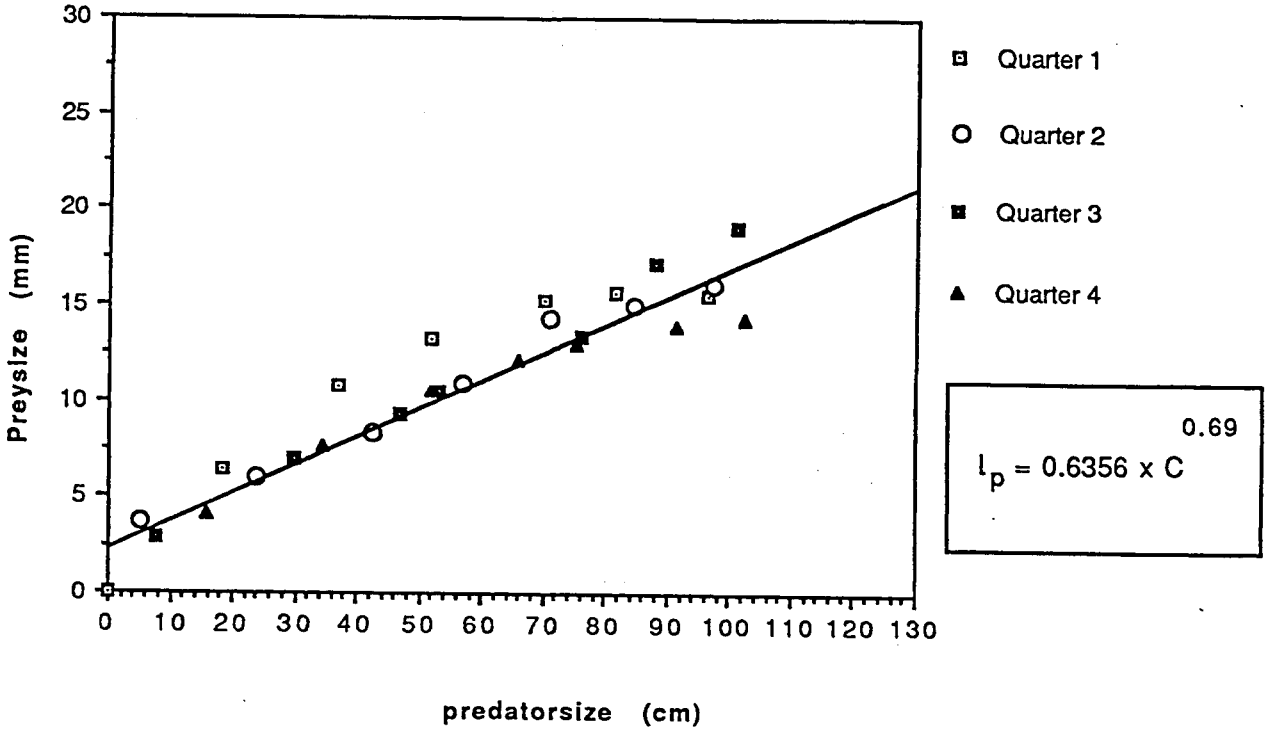

Figure 8. Average (fish-)prey length (l_p) against mean predator size (C) per quarter.

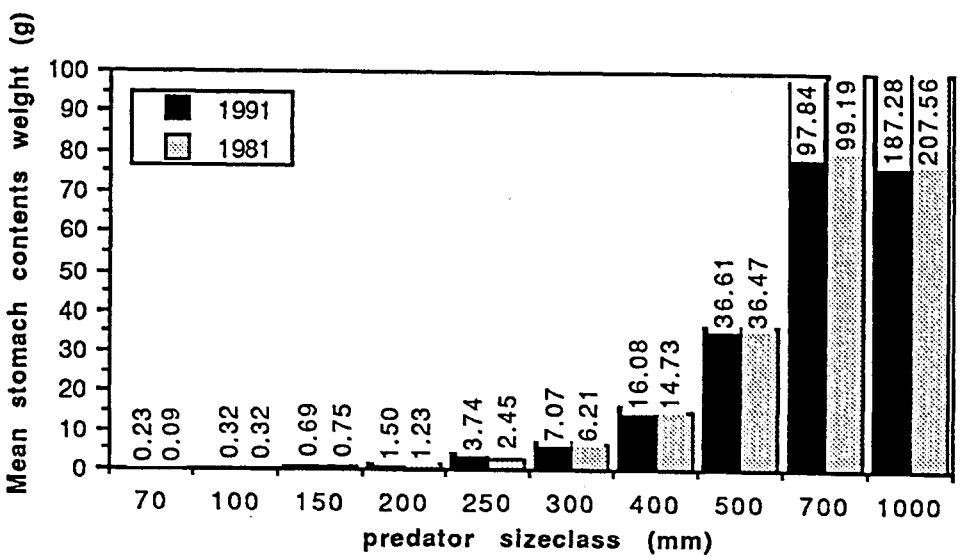

Figure 9. Mean stomach contents weight (g) based on 1981 data and 1991 data.