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PROGRESS REPORT ON THE ICES 1991 NORTH SEA STOMACH SAMPLING PROJECT

IJmuiden, 23-28 April 1992

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1. TERMS OF REFERENCE

During the 79th Statutory Meeting at La Rochelle, ICES adopted the following resolution (C.Res. 1991/2:13):

The Planning Group on the Stomach Sampling Project in 1991 will meet in IJmuiden (Netherlands), from 23-28 April, 1992 to:
a) prepare a progress report on the 1991 Stomach Sampling Project;
b) resolve logistical problems that may have arisen during the sampling, analysis and computerisation of the data;
c) compile the auxiliary information on age/length keys, survey data etc. needed for preparing the stomach data for the MSVPA model.

2. PARTICIPATION

The meeting was held in IJmuiden from 23-28 April, 1992. It was attended by:

Peter Bromley	UK (England)
Niels Daan	Netherlands
Ton de Gee	Netherlands
Tomas Gröhsler	Germany
Henk Heessen	Netherlands
John Hislop (Chairman)	UK (Scotland)
Arjen Kikkert	Netherlands
Jan-René Larsen	Denmark
Sandy Robb	UK (Scotland)
Dankert Skagen	Norway
Axel Temming	Germany

Acknowledgements
The Group wishes to thank their hosts at the Netherlands Institute for Fisheries Research for ensuring that the meeting ran smoothly and for providing excellent technical and secretarial support. Special thanks are also due to those staff at the various national institutes who have spend many hours analysing stomachs and processing large amounts of data.

3. HEALTH WARNING

The Group wishes to stress that this Progress Report is intended to give a preliminary impression of the overall scale of the 1991 Stomach Sampling Project and the results that have been achieved to date. It should be noted that many of the numbers given in this report are provisional and there are discrepancies between several of the Tables and Figures relating to the numbers of fish sampled.

4. SAMPLING INTENSITY

4.1 Total sampling intensity

The numbers of stomachs of each species examined at sea in each quarter of 1991 are given in Table 4.1. It should be noted that these figures include stomachs which were classified as 'regurgitated' and not retained for analysis. Because many of the fish in the smaller size classes were preserved whole, definitive information on the numbers of stomachs kept for analysis will not be available until the completion of the project. In addition to these North Sea samples, stomachs were collected from the Skagerrak/Kattegat by Sweden in the first, second and third quarters.

4.2 Primary predators (cod, haddock, whiting, saithe, mackerel)

During the planning phase, it was agreed that the sampling levels for cod, whiting, saithe and mackerel should be maintained at, or above, those achieved in 1981 and that haddock sampling could be reduced (Anon., 1991). The 1981 figures are given, for comparison, in Table 4.1. Slightly fewer cod were examined in 1991, while there were moderate increases in the numbers of haddock, mackerel and saithe. In the case of whiting, the number of stomachs examined more than doubled.

Sampling effort in the four quarters of 1991 was highly satisfactory, and the project greatly benefitted from the ICES Quarterly International Bottom Trawl Survey, which commenced in that year (Anon., 1992a). There was a certain amount of 'patchiness' in the distribution of the samples (Figures 4.1-4.5) but this reflects the distribution of the fish.

Preliminary data on the size distributions of the primary predators sampled in 1991 are given in Table 4.2, with the 1981 data for comparison. In general, the size range of fish sampled was greater in 1991. This was mainly due to the fact that more importance was attached to sampling the smaller size classes (< 10 cm). Large fish were apparently much scarcer in the North Sea in 1991 and this is reflected in the stomach samples. In particular, far fewer large (> 70 cm) cod and saithe were sampled than in 1981.

4.3 Secondary predators

Additional predators were included in the project and at the planning stage it was decided that priority should be given to three (grey gurnards, rays and scad). Table 4.1 and Figures 4.6-4.13 show that these species/species groups were adequately sampled. Many of the other predator species were only sampled on an occasional basis (Table 4.1) but more than 2 500 long rough dabs were examined.

4.4 Pelagic 0-group gadoids

Pelagic 0-group gadoids were sampled in June in the northern North Sea (FRV 'Clupea', Scotland) and the southeastern North Sea (FRV 'Tridens', Netherlands), using the International Young Gadoid Pelagic Trawl (IYGPT; Figure 4.14). Intensive 24 h sampling at three depths (5m, 30m and bottom) was undertaken southeast of the Shetland Islands. Additional samples were also taken in the Moray Firth and west of the Orkney Islands. The southeastern area was sampled twice, at the beginning and end of June. Some additional samples of pelagic 0-group gadoids were collected in the north in July 1991 by FRV 'Johan Hjort' (Norway). The cod, haddock, whiting, saithe and Norway pout were preserved for stomach analysis at Lowestoft. Approximately 2 800 were from the northern North Sea and 900 were from the southeastern region.

5. PROGRESS IN EXCHANGE OF MATERIAL, SAMPLE ANALYSIS AND DATA PROCESSING

Considering the large numbers of nations and vessels that participated in the project, the exchange of material proceeded remarkably smoothly. Some problems arose with the redistribution of material collected by, and intended for, Denmark but these have been resolved and it is anticipated that by the end of May almost all samples should have reached their final destinations. There are still some scad residing in Norway, some mackerel samples in Denmark and some samples of pelagic 0-group gadoids collected by Norway, whose present whereabouts are unknown.

5.1. Cod

During 1991 the participating countries managed to sample over 10 000 cod stomachs. The start of the analysis of the collected material was slow because of lack of experience, but by now over 9 000 cod stomachs have been analysed. No problems have been encountered with either frozen samples or samples preserved in formalin. All data have been put into the computer.

Especially in the case of larger cod it was often possible to examine stomachs of individual fish. These samples showed that there was a great variety in both fullness and contents of individual stomachs. The first results indicate that smaller cod (60-80 cm) appeared to have more food in their stomachs (both fish and crustaceans) than the larger cod. The main fish prey items were dab, long rough dab, herring, sprat, whiting and Norway pout. Also a large number of 0-group gadoids has been observed.

The remaining cod stomachs have recently been exchanged and it is expected that these will have been analysed by the end of May.

5.2 Haddock

Of the approximately 20 000 stomachs collected during 1991, about 1 500 have been analysed since October 1991, when Tomas Gröhsler joined the project (Table 5.1), consisting of material sampled by the Netherlands in the first three quarters. Whenever possible, stomachs

were treated individually and all prey items were identified to the species level. No data have yet been computerised.
The preliminary impression from the material that has been analysed to date is that the food consists mainly of invertebrates (polychaetes and crustaceans).The commercially important prey items made up only a small part of the food spectrum.

5.3 Whiting

Table 5.1 gives the total number of whiting stomachs examined at sea and the numbers which have been analysed to date. Some 13 000 stomachs, representing nearly all of quarter 1 and most of quarter 2, have been processed, all as pooled samples. This means that around 28 000 stomachs have still to be analysed. It is hoped that these can be completed by March 1993. The stomach samples collected by Denmark have still to reach Aberdeen but these should be delivered in the near future. To date, the stomach content data have not been entered on the computer but analysis should proceed quickly once the data sets for quarters 1 and 2 are completed.

5.4 Mackerel.

A total of 6 990 stomachs has been sampled. By mid April 1991, 1 605 stomachs had been examined. The stomachs have been examined individually, and all prey items have been classified to the lowest possible taxonomic level, and to length class whenever possible. So far, no data have been computerized.
Most of the samples examined to date have been frozen. For formalin-fixed material, examination on an individual basis presents more problems, because it is difficult to assign the loose material often found on the bottom of the jar to the different stomachs in the sample.

5.5 Saithe

The number of stomachs that has been sampled and analysed is shown in table 5.1. All material has been exchanged. The analysis and processing is expected to be completed at the beginning of 1993.
The preliminary results suggest that, contrary to the observations in 1981, whiting and haddock were observed in relatively small quantities. In 1991, the principal fish prey were Norway pout and herring. The stomachs also contained large amounts of Mysids.

5.6 Rays

The number of stomachs that has been sampled and analysed is shown in table 5.1. None of the data have yet been computerised.
The analysis of the ray stomachs is difficult for two reasons:

1) Rays seem to feed at night. Most of the samples were collected during day time and the stomach contents were usually well digested.

2) The stomach contents were usually without any structure, suggesting that rays chew their prey.

As a consequence, a large fraction of the food is impossible to identify, and the average weight of the stomach contents may be biased.
Sandeels and Norway pout were the main fish prey items. The most abundant invertebrates found were crustaceans (mainly Crangon) and polychaetes.

5.7 Other by-catch species

Grey gurnard has been particularly well sampled in all quarters and a reliable evaluation of food consumption over the year should be possible. Sampling intensity has also been high for scad and long rough dab. For other species the numbers are smaller, but also greater sandeels, hake, red gurnards, tub gurnards and spurdogs have been well represented in the samples taken during some of the quarters.
Presently, about 9 000 stomachs have been analysed by the Netherlands Institute for Fisheries Research, the majority of which is made up by grey gurnard stomachs collected in the first two quarters of 1991. The resulting information has been entered in the available database and a start has been made with sorting and combining the results by computer.
Considering the sampling target of 2 500 stomachs per quarter, more than twice as many stomachs of by-catch species have been collected. Because of this sampling intensity, it is envisaged that it will not be possible to finish the analysis and processing of all samples before

early 1993. It will therefore be necessary to make an appropriate selection of the material to be worked up as a first priority.
It is not possible at this stage to provide specific results of stomach analysis of any of the by-catch species.

5.8 Pelagic 0-group Gadoids

The stomachs of 2 646 pelagic 0-group gadoids have been analysed (Table 5.1) and the results entered in a data base.

5.9 Samples from Skagerrak/Kattegat

It is hoped that all the stomachs collected from the Skagerrak and Kattegat will be analysed by the end of June. None of the data have yet been computerised.

6. COMPUTERISATION OF DATA

Apart from the cod and by-catch data analysed by the Netherlands and the pelagic 0-group gadoid stomachs analysed by England, there has been little progress so far in computerisation of the data. This will, however, become a problem in the near future and therefore the possibilities for the various institutes involved as well as the plans of the various species coordinators to resolve the exchange problems were discussed. The format for exchanging stomach content data, that was agreed in 1991 by the Planning Group (Anon., 1991), consists of a flat ASCII file with fixed record size, where each line represents an observation of a separate prey category in an individual stomach sample or an individual stomach. Each coordinator is therefore committed to provide the data accordingly. During a recent meeting in St John's of the Study Group on the Analysis of Feeding Data, the exchange of stomach content data on a North Atlantic-wide scale has been addressed for statistical evaluation of basic sampling procedures. At this meeting, the agreed format for the North Sea sampling programme was used as a starting point, but several revisions were introduced to allow for more flexibility in presentation of the available data from the various sources (Anon., 1992b). Apart from one minor point, this new format (cf table 6.1) fits the requirements for the North Sea programme entirely and therefore it was agreed to accept this format for future exchange.
The point that has to be resolved is that the new format allows for great flexibility in the reported size classes, whereas in the North Sea context the size classes have been strictly defined. This means that in preparing exchange tapes, the species coordinators must ensure that all the information follows strictly this definition because otherwise confusion may be created at subsequent steps in the analysis.
The situation within the various institutes involved in respect of computerisation can be summarised as follows:

-*The Netherlands*: The software package originally developed in IJmuiden for a VAX and used to analyse the 1981, 1985, 1986, and 1987 data has been modified to cope with the changes that have been introduced in the 1991 programme. The input, checking, exchange format and primary analysis parts are finalised, but more work has to be done on the multispecies part, where prey size classes have to be converted into age classes. Recently, a standard Pascal version has been produced for a SUN workstation under UNIX. Although it has not yet been completely tested, trial runs indicate that it works satisfactorily. It is intended to complete this version of the program within the next 6 months, but it is directly available for input of new data.
The VAX version has been modified to produce the new format (table 6.1) and also data that are made available in that format can be read in and checked or extended to incorporate additional information.
The survey data base in IJmuiden for the 4 quarters in 1991 is virtually complete and trawl list information, n-per-hour weighting factors, and age length keys can soon be made available to all participants.

- *Scotland*: A copy of the software package developed in IJmuiden is available on the VAX in Aberdeen and therefore there should not be any major problems in processing the whiting data. One problem, however, that may arise is that the array sizes become a limiting factor due to the unexpectedly large numbers of whiting stomachs sampled. These arrays cannot be readily increased because of internal VAX limitations and transfer to a SUN workstation in IJmuiden may be required.

- *Denmark*: The Danish institute operates a Hewlett Packard system under UNIX and therefore is interested in the source code of the UNIX version. In addition, they would like to modify the program for application on PC's under MS-DOS.

- *Norway*: There is another stomach sampling programme carried out in Norway and therefore it may be possible to use software developed for the Barents Sea to input data for the North Sea and create exchange files to be handled further by the IJmuiden laboratory. However, there are also SUN workstations available in the Bergen institute and it was agreed that IJmuiden would provide a copy of the UNIX version, which would allow complete compatibility. Norway would also be interested in a PC version of the input part.

- *Germany*: The German institute has only access to PC's and would therefore be interested in a PC-version if the Danish institute is able to modify the program. However, it should always be possible to provide data in exchange format by means of a dBase program, which could then be further be processed in close cooperation with the Netherlands institute.

- *England*: The Lowestoft institute has entered all stomach content data for the pelagic 0-group gadoids in a SAS data base, from which it is easy to create data in exchange format. Also, data in exchange format may be read in.

From this overview, it appears that the exchange of data is not expected to create major problems. In some cases, it may be necessary for the IJmuiden laboratory to act as an intermediate in combining stomach content data with the appropriate survey information or to do some of the final analyses. Since all data will be made available in exchange format, it will be relatively easy in the end to provide an integrated data base for further statistical evaluation.

7. PROBLEMS ENCOUNTERED IN THE INTERPRETATION OF THE MANUAL

The Stomach Sampling Manual (Anon., 1991) used for the 1991 Stomach Sampling Project was based on the original 1981 Manual, (Anon., 1981) with extensive revisions arising partly from the experience gained in the intervening years and partly from new project aims. The Group discussed their practical experiences with the Manual and identified a number of problems.

7.1 Predator size classes

On a few occasions stomachs have by mistake been sampled using broader predator size classes than those defined in the Manual: e.g. 40-59 cm instead of 40-49 and 50-59 cm. It was agreed that in some cases it might be possible to assign such stomachs to the correct size class by referring to the length composition of the trawl catch. However, if the samples were from size classes that had already been adequately sampled, they need not be analysed. It was agreed that it would be sensible to adopt the convention agreed during the recent meeting of the Study Group on the Analysis of Feeding Data (Anon., 1992b), whereby both the minimum and maximum size of the size class used should be recorded.

7.2 Sampling levels

The Group noted that the choice of sampling levels in 1991 was not based on statistical considerations, but on a somewhat arbitrary decision to maintain sampling at least at the level attained in 1981. The optimum sampling level will, presumably, depend on factors such as the spatial differences in prey composition and is likely to be different for different size classes within a species and also between species. Because some of the cod, haddock and mackerel material collected in 1991 are being analysed on an individual stomach basis, it should soon be possible to address this problem more rationally.

7.3 Regurgitated, empty and everted stomachs

This familiar problem was discussed at some length and it became clear that, although the subject had been covered rather extensively in the Manual, there was still some confusion over the identification of these stomachs and the way in which they should be treated and documented.

Most countries have tried to apply Robb's gall-bladder states (Anon., 1991) to discriminate between empty and regurgitated stomachs. Although specifically developed for use in whiting, the same system may be applicable to other gadoid species, but certainly not to Elasmobranchs. This was not stated clearly in the Manual.

It furthermore appeared that problems have arisen with the interpretation of the procedure on how to handle everted and empty stomachs. During Norwegian and Danish cruises, some everted stomachs may have been recorded as regurgitated, but is not possible as yet to evaluate the extent of this misunderstanding. More information is required.

Both the sampling procedures applied on board different research vessels and the subjective assessments of individual scientists may have influenced the numbers of stomachs recorded as regurgitated. This is illustrated in Figure 7.1, which shows the percentages of grey gurnard stomachs classified as regurgitated during a 'complementary' survey by two research vessels (Tridens and Cirolana) during the second quarter of 1991. There is a need to evaluate what effect such differences have on estimates of mean stomach contents weights and fractions empty.

7.4 Food eaten in the trawl

In the course of discussion it was established that procedures adopted to cope with the problem of food eaten in the trawl had been broadly similar between countries. On Dutch vessels, 'lively' prey were removed from the stomachs, as were very fresh prey when they mirrored the catch composition to any large extent. In the case of other countries, prey in the mouth or throat were always rejected, but there may have been differences in the treatment of fresh prey in the stomachs. The stomach analysts should be aware of these differences.

According to the Manual, fresh ('pristine') prey should be recorded as digestion stage 0. However, different criteria have to be applied for pristine conditions in frozen and in material preserved in formalin. In this respect the analysis would gain from further standardization of the method of preservation.

7.5 Sample documentation

During the stomach sampling projects a lot of time is spent in a proper administration of the samples collected: labels in the jar, on top of the jar and also the Sample Check Lists have to be filled in. It was agreed that in order to save time and avoid unnecessary confusion the number of categories mentioned on the Sample Check List could be reduced. For each predator size class the only strictly necessary columns would be number of stomachs regurgitated, number of stomachs in the jar and total number investigated.

Because of the need to link stomach sampling information with survey data, it is extremely important to use corresponding station numbers.

7.6 Treatment of frozen samples

The best method to thaw stomach samples appears to be with a microwave, which makes it unnecessary to thaw great amounts of stomachs at the same time.

7.7 NODC ten-digit coding system

The manual includes a list of 10-digit codes for recording prey species. In the case of fish, all the codes have been officially recognised by the NODC. However, many of the codes for invertebrates are 'unofficial' and were devised on an ad hoc basis during the 1981 and subsequent North Sea sampling projects. In order to avoid chaos when trying to merge data bases at a later stage, the species coordinators, when finding a prey species not listed in the Manual, should consult the current NODC catalogue. If the species is listed, then the official code should be used. If the species is not listed, it should be reported to the Netherlands Institute, which will issue an 'unofficial' code that can be used by all participants in the project.

7.8 Conclusions

It was agreed that the Manual had been a useful document, although there are still several points that some people find ambiguous and confusing. A new version will have to be prepared before any future large-scale stomach sampling exercise is undertaken, but the Group felt that it would be unnecessary to make a new edition in the immediate future.

8. TRAWL SURVEY DATA BASE

The data for most of the bottom trawl surveys carried out in 1991 as part of the International Bottom Trawl Survey were sent as exchange files to IJmuiden and are available in the IJmuiden data base (Table 8.1). Some data were still preliminary and not all the otoliths collected in 1991 had as yet been read.

9. PREY AGE LENGTH KEYS

Prey age length keys (ALK's) are necessary to convert numbers in the stomachs by length categories to numbers by age, which is what is needed as input to the Multispecies Virtual Population Analysis (MSVPA). To some extent, such ALK's can be obtained from the surveys in which the stomachs were collected. This raises several problems, however.

Due to the mesh size, the smallest prey fish are poorly sampled. This not only reduces the availability of the smaller fish, but may also bias the length at age distribution. In particular, this is a problem for sandeel. In addition, the pelagic prey species will be poorly sampled, since most of the sampling was done during bottom trawl surveys.

Tables 9a-e show the number of otoliths for each of the main prey species by length class and quarter which are available at present. Some survey data are still not included in the data base. The general impression is that for Norway pout and sprat, the coverage is fairly satisfactory. Sandeel is very poorly covered, except for the 3rd quarter in area 1. For the herring, the coverage seems to be quite good.

For the sandeels in particular, an additional problem is that they grow very rapidly during the 2nd quarter. In this situation, it would be desirable to apply separate ALK's for each month or even on a finer time scale (Anon., 1992c) For the areas where the commercial fishery takes place, it may be possible to make use of the ALK's used by the Industrial WG.

As noted above, the coverage is fairly satisfactory for most species. Nevertheless, there are some gaps and the bottom trawl survey ALK's need to be supplemented with data from other sources, including commercial fisheries and other surveys. It is also recommended that the stomach analysts take full advantage of every opportunity to collect otoliths from well-preserved prey in stomach samples. This is particularly important for sandeels.

10. INCORPORATING 0-GROUP FEEDING DATA IN MSVPA

The pelagic 0-group sampling was intended to estimate the amount of internal consumption amongst gadoids and investigate area, diel and depth effects. The findings should indicate the magnitude of internal consumption and whether there is a case to incorporate pelagic 0-groups in MSVPA. During the discussion it was pointed out that to be of use in MSVPA, consumption should be estimated for the 0-groups as a whole, including both pelagic and demersal phases. It was also felt that consumption should be estimated over a shorter time scale than by quarter-year, due to the rapid changes in growth and feeding in spring and summer. Whilst it would be difficult to quantify population size from the 1991 sampling programme over quarters 2-3, it would be possible to compare the diets and relative consumption of the demersal 0-groups collected by the demersal trawling gears and the pelagic members of the population taken by the IYGPT. Peter Bromley agreed to collate the data and cooperate with other workers interested in a more detailed study of feeding during the change from the pelagic to demersal pattern of behaviour in June-August. Indeed, there was some doubt as to the validity of distinguishing between pelagic and demersal feeding in the shallow areas of the southern North Sea, and there were doubts over the ability to quantify feeding in such areas, particularly close inshore where substantial numbers of 0-groups congregate.

It was felt that the sampling of the 0-groups in the fourth quarter, when most are demersal, should be reasonably quantitative and the 1991 feeding data could be used in MSVPA.

11. TREATMENT OF OTHER PREDATORS

An unexpectedly large number of predators was sampled in 1991 (Table 4.1). The Group agreed that priority should be given to rays, grey gurnards and scad. However, some truly demersal predators, such as anglerfish, might yield useful information on the time at which young gadoids start to live on the sea bed.

12. TIMETABLES

A considerable amount of work remains to be done before the data can be processed into a form suitable for MSVPA. The Group agreed that the following timetable should be strictly adhered to:

1 All prey ALK's must be submitted to the IJmuiden laboratory by September 1992;

2. Exchange files with stomach content data must be sent to the IJmuiden laboratory by 1 May, 1993;

3. Final processing to be completed by early August, 1993, in time for submission of the data to the Multispecies Assessment Working Group;

4. Species coordinators should submit individual reports to the 1993 Council Meeting.

During the meeting, it seemed that all species coordinators are currently identifying prey items in as much detail as possible. However, in order to meet these deadlines, it may become necessary to identify stomach contents in a rather less detailed manner. The Group prepared a set of guide-lines on the minimum level of identification that should be aimed for (Table 12.1). In defining these criteria, the Group recognised that, although the Multispecies Assessment Working Group is their main customer, the results of the Stomach Sampling Project are of considerable interest to other workers, such as the Study Group on the Ecosystem Effects of Fishing, and these groups are particularly interested in some of the other, non-commercial, species eaten by the predators. In this context, grouping prey into broad taxonomic categories such as 'molluscs' and 'crustaceans' is not very helpful. What is needed is an indication as to whether the prey are pelagic or demersal, epibenthic or part of the infauna etc. To achieve this aim, it will usually be necessary to identify prey at least to the level of Order or even Family. Fish and commercially important crustaceans as well as a selected group of other organisms (see Table 12.1) must always be identified to species level.

13. RECOMMENDATION

The Group recommends that the species coordinators of the 1991 Stomach Sampling Project meet again in IJmuiden for 6 days from 2-7 September 1993 to prepare the input data for MSVPA.

14. REFERENCES

Anonymous 1981 - Draft Manual for the Stomach Sampling Project, January 1981. Internal Report Netherlands Institute for Fishery Investigations.

Anonymous 1991 - Manual for the ICES North Sea Stomach Sampling Project in 1991. ICES C.M. 1991/G:3.

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

Anonymous 1992b - Report of the Study Group on the Analysis of Feeding Data. ICES C.M. 1992/G:4.

Anonymous 1992c - Report of the Industrial Fisheries Working Group. ICES C.M. 1992/Assess:9.

Figure 4.1-5 Preliminary estimates of the total number of stomachs of primary species examined at sea by quarter.

4.1 Cod
4.2 Haddock
4.3 Whiting
4.4 Mackerel
4.5 Saithe

Fig. 4.1

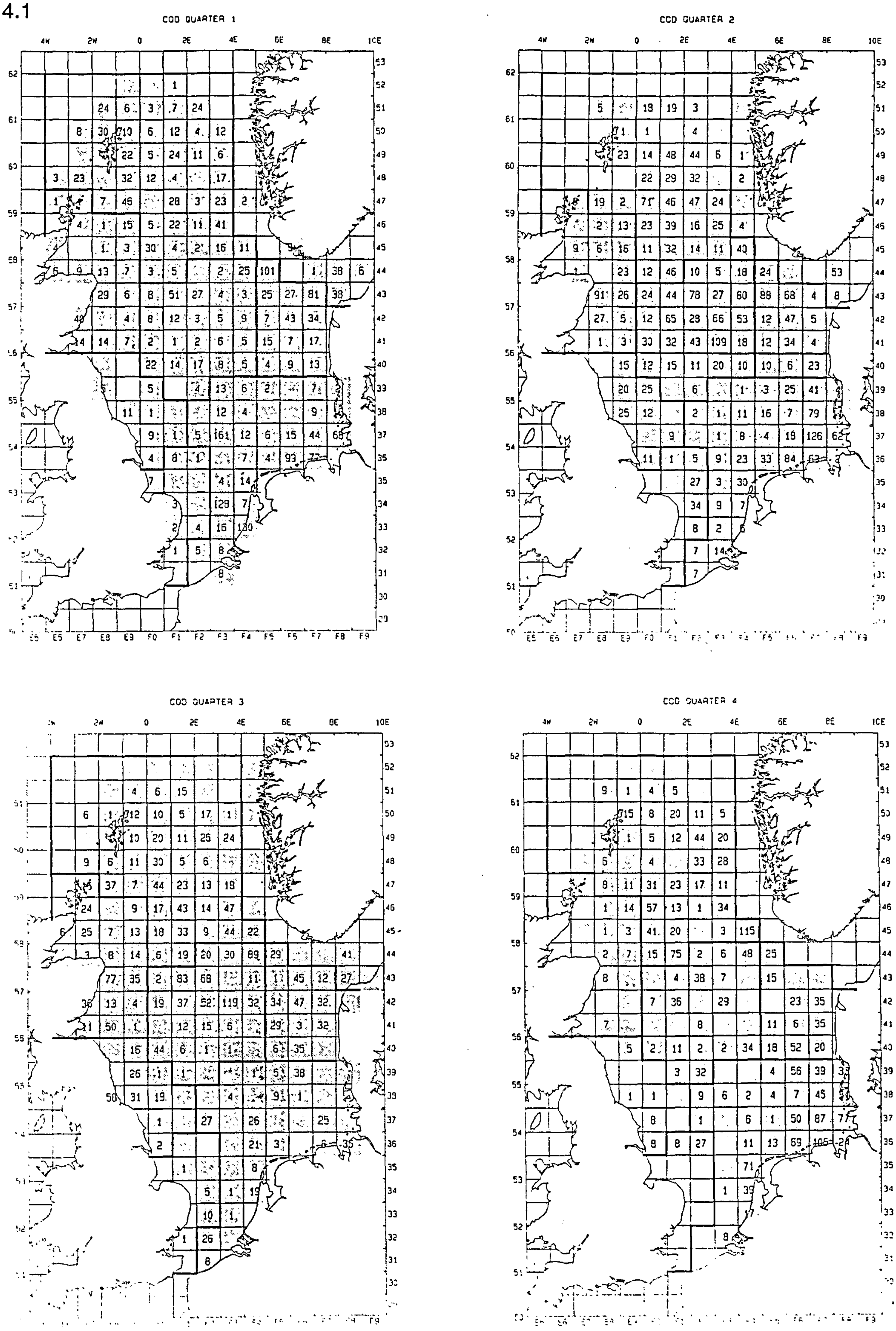


Fig. 4.2

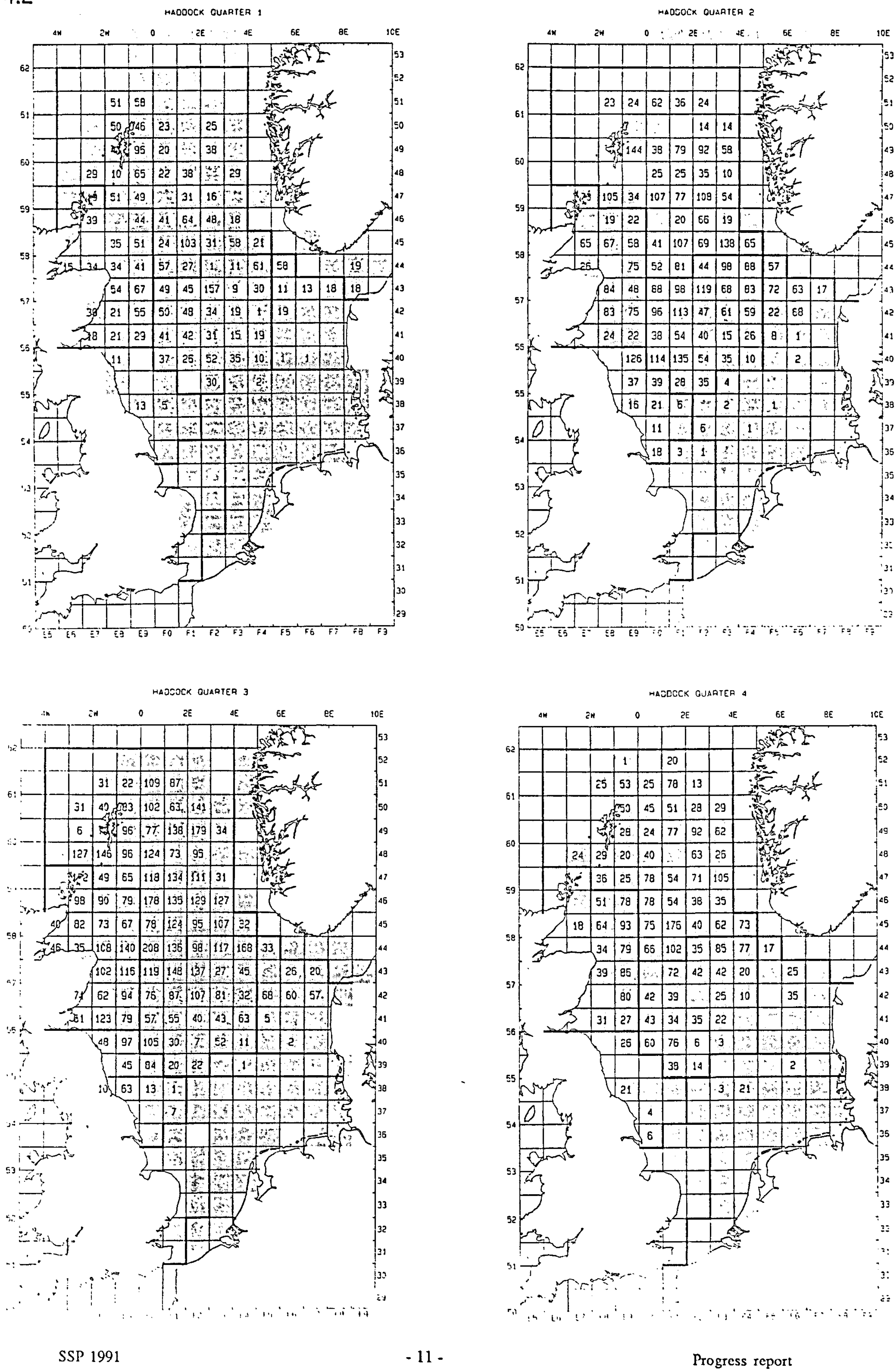
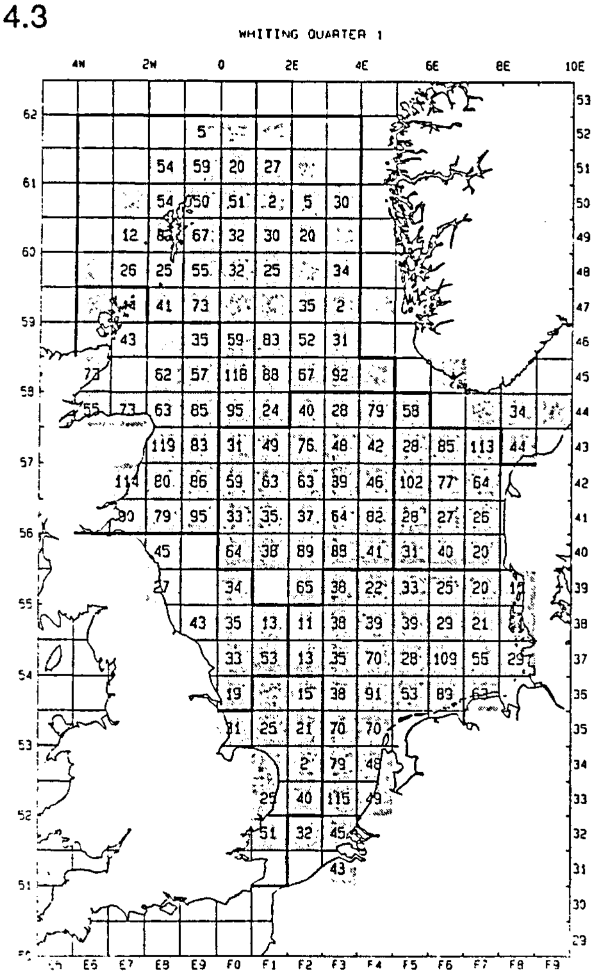

HADDOCK QUARTER 1
HADDOCK QUARTER 2
HADDOCK QUARTER 3
HADDOCK QUARTER 4

Fig. 4.3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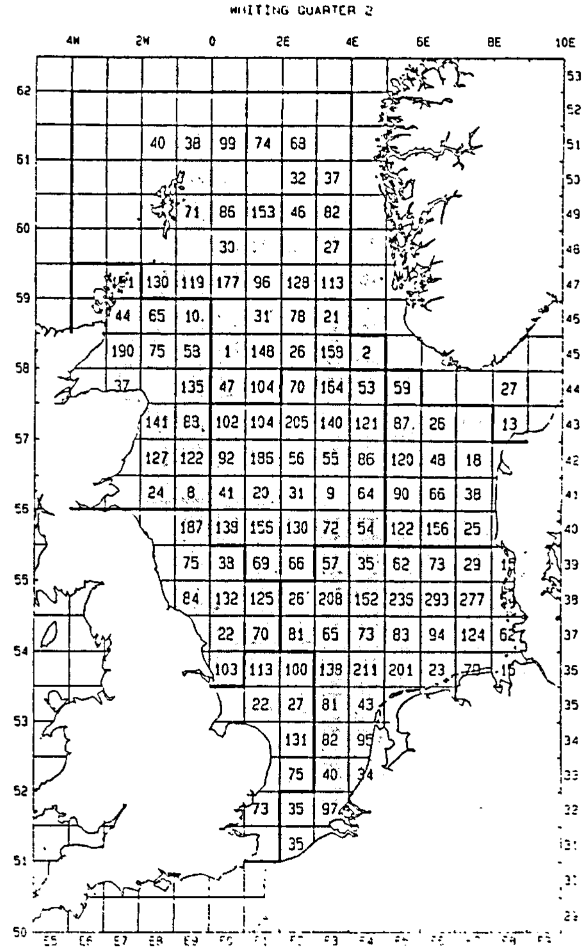
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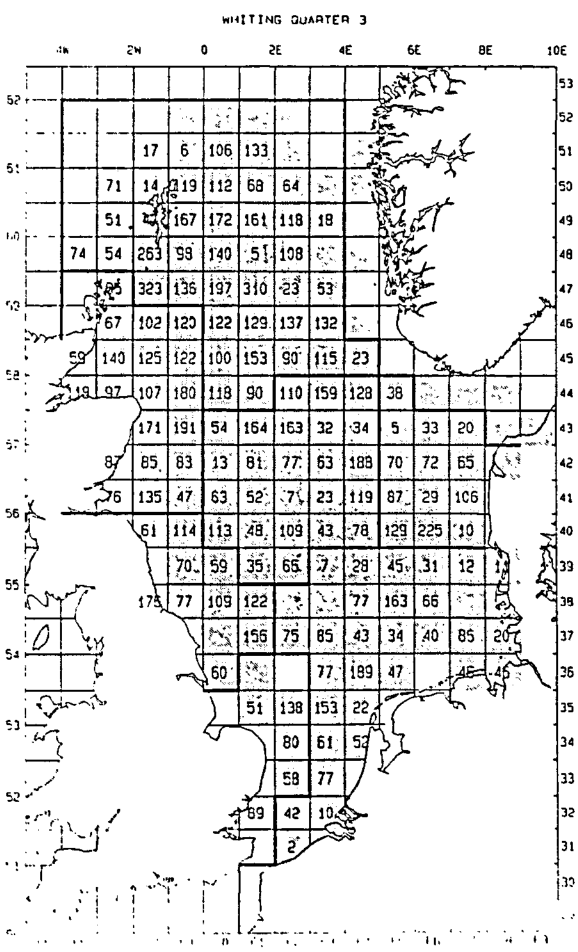
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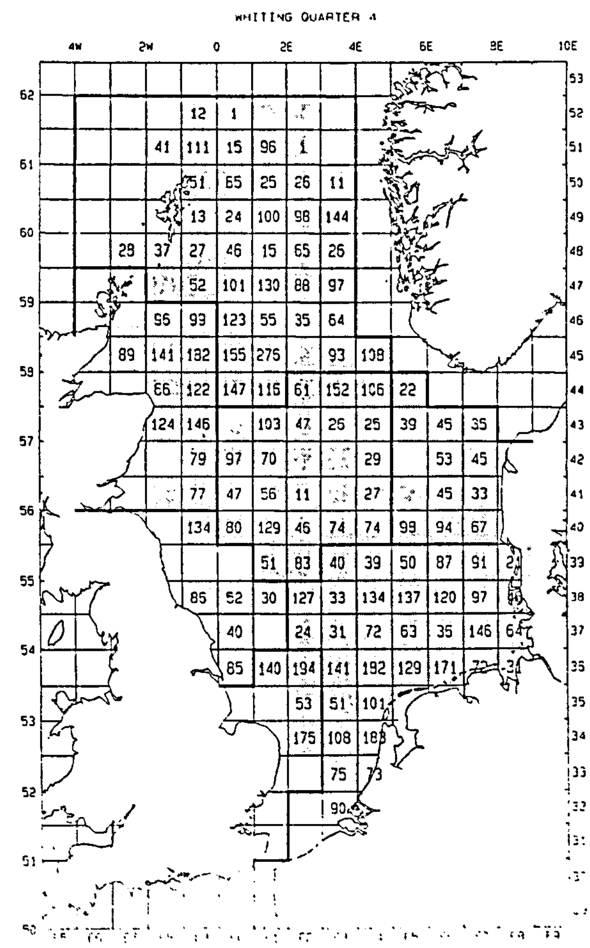
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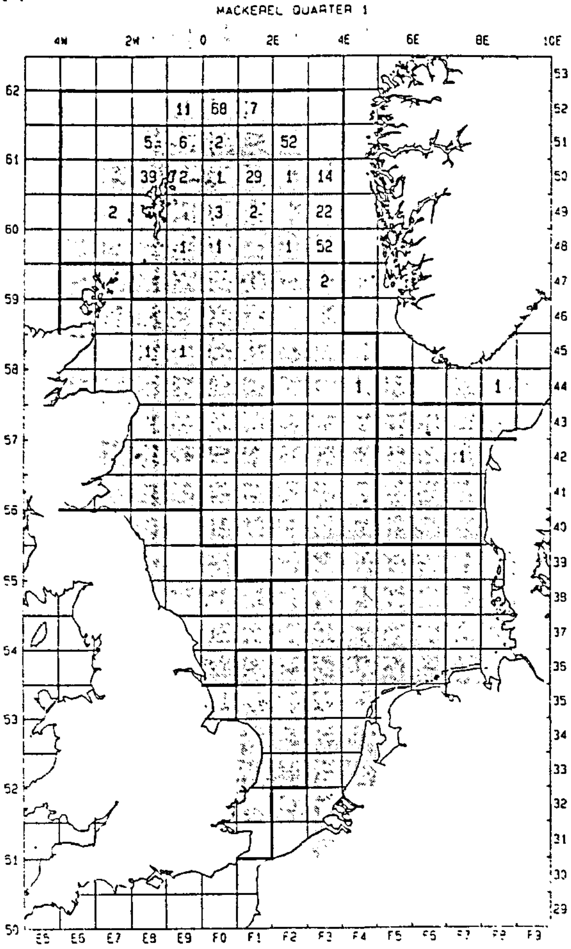
Fig. 4.4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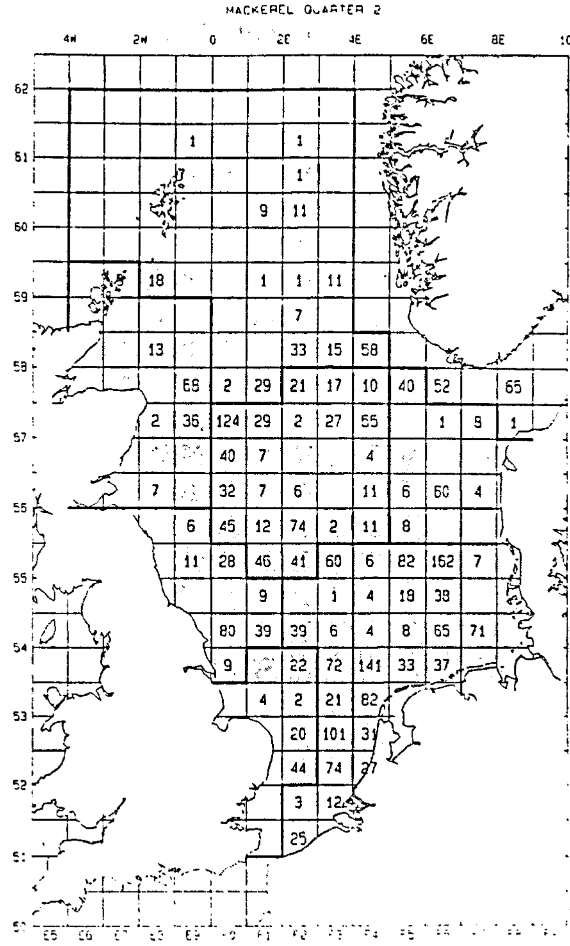
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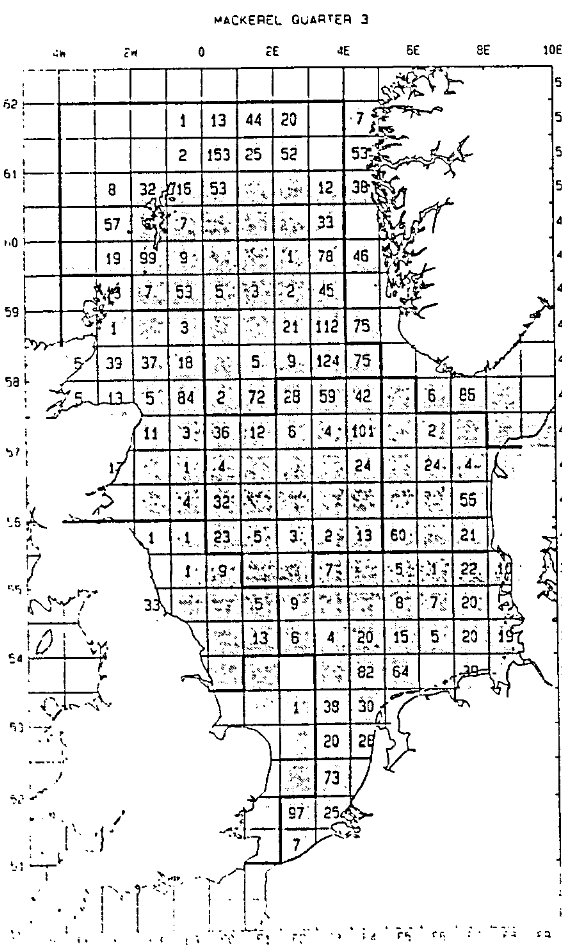
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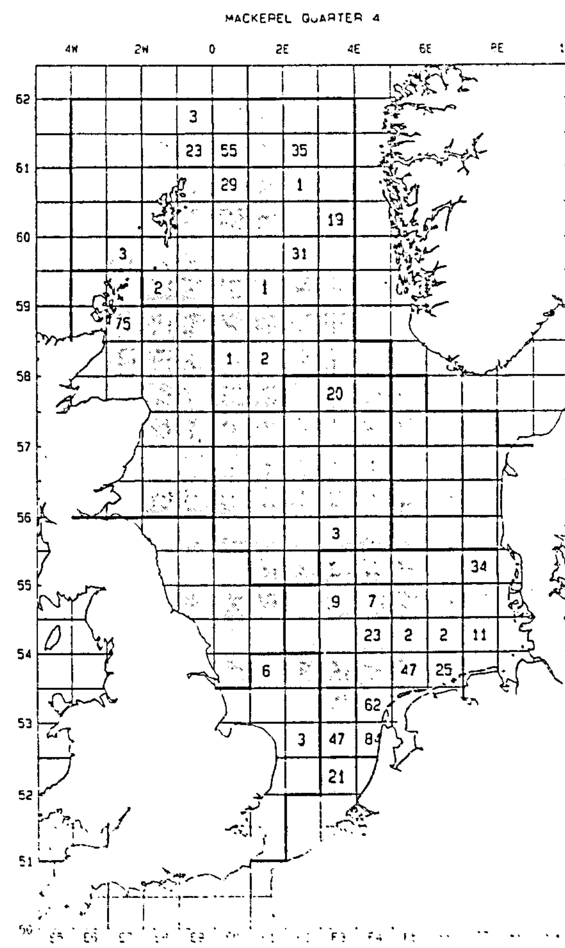
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Fig. 4.5

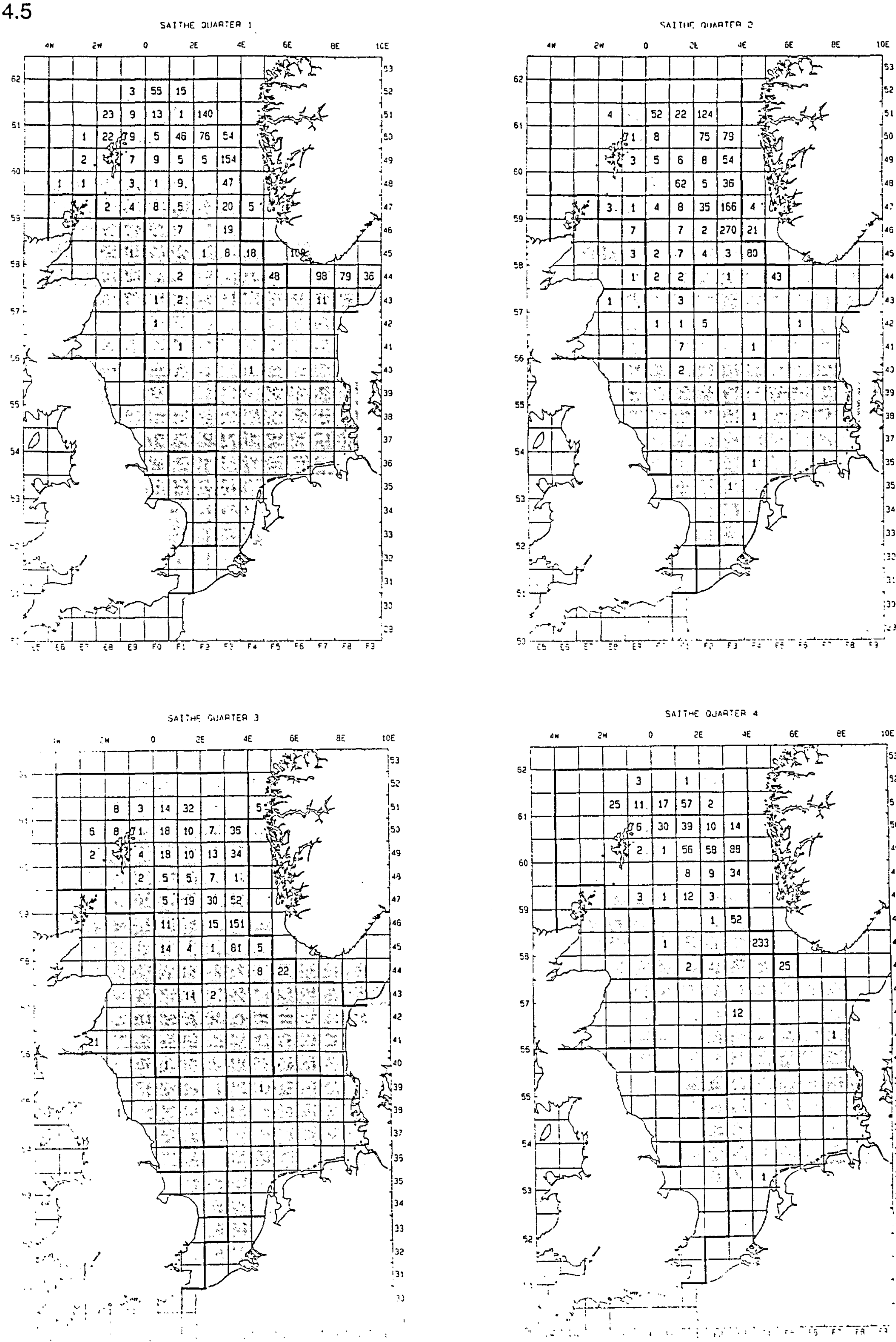
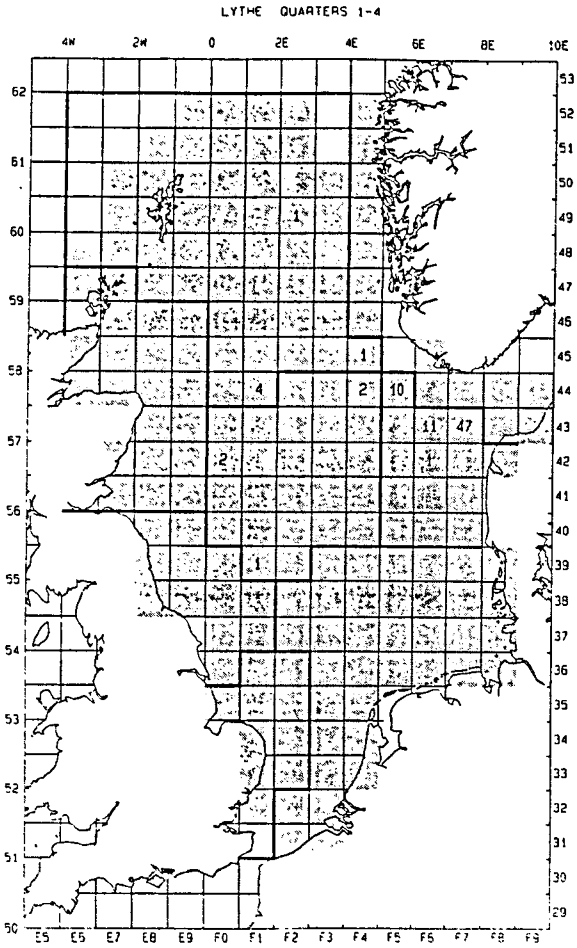
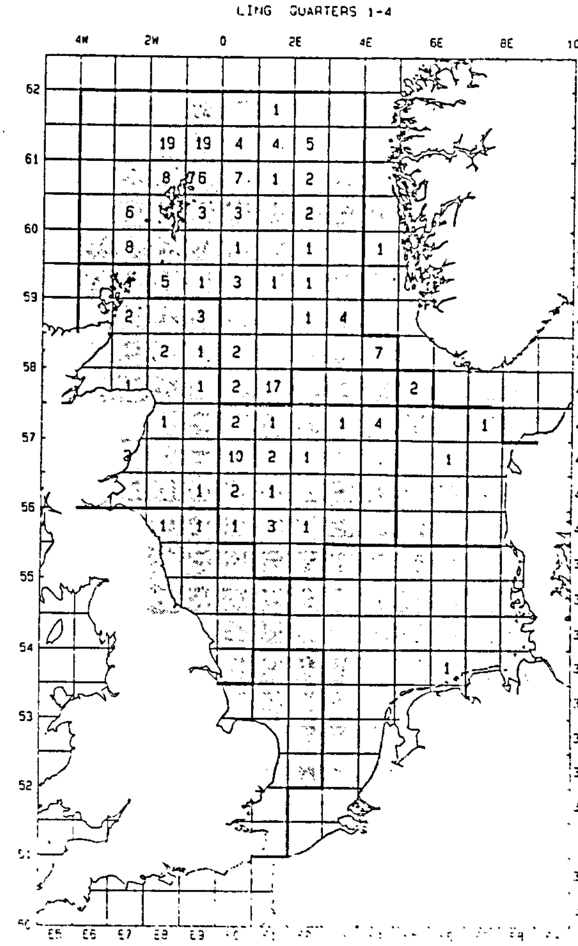

SAITHE QUARTER 1
SAITHE QUARTER 2
SAITHE QUARTER 3
SAITHE QUARTER 4

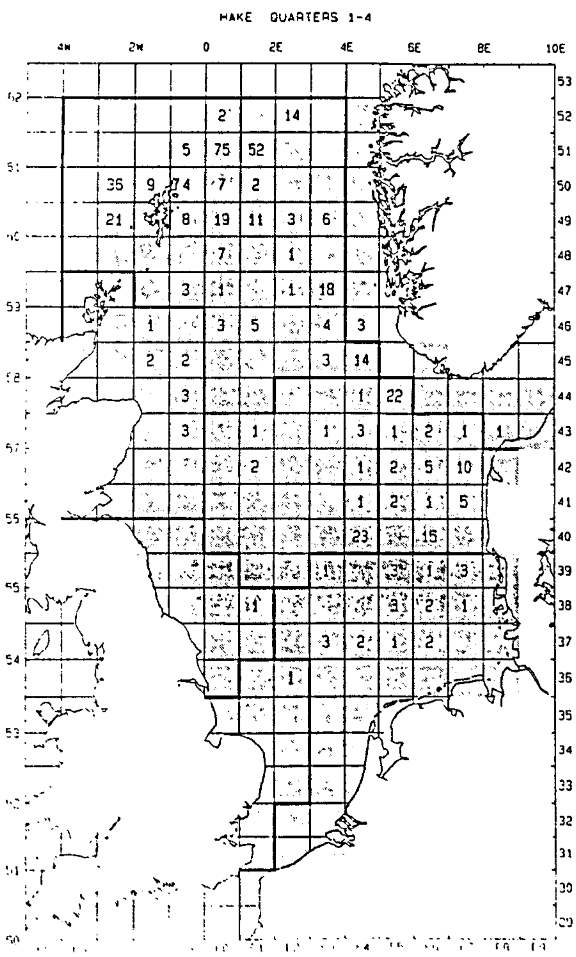
Figure 4.6-13 Preliminary estimates of the total number of stomachs of secondary species examined at sea by year.

4.6 Pollack, ling, hake and torsk
4.7 Bib, blue whiting, scad and grey gurnard
4.8 Red gurnard, tub gurnard, red mullet and Norway haddock
4.9 R. radiata, R. naevus, R. clavata and R. montagui
4.10 R. fullonica, R. batis, spurdog and lesser spotted dogfish
4.11 Tope, starry smooth hound, long rough dab and turbot
4.12 Brill, megrim, halibut and anglerfish
4.13 Anglerfish unidentified, catfish, greater sandeel and Raitt's sandeel

Fig. 4.6


LYTHE QUARTERS 1-4


LING QUARTERS 1-4


HAKE QUARTERS 1-4

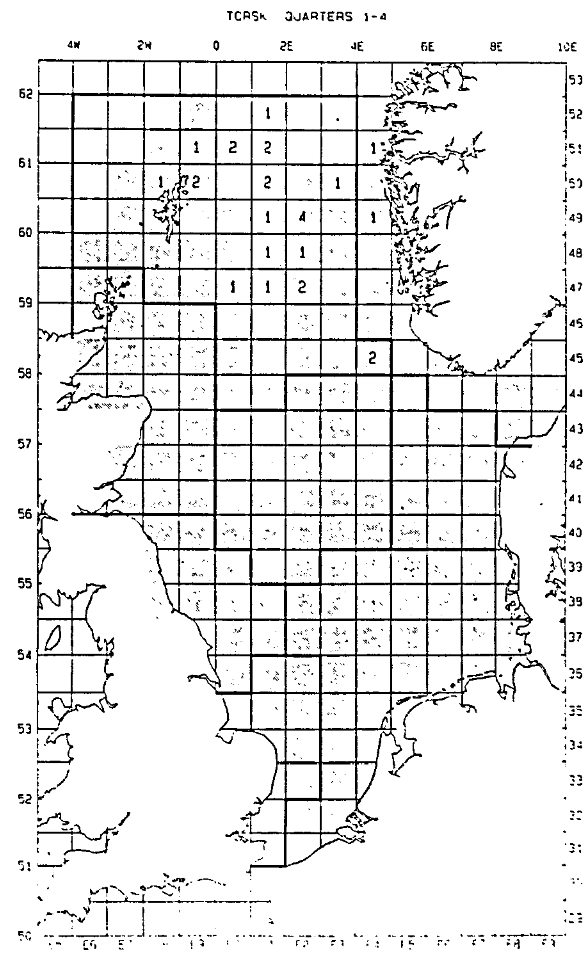
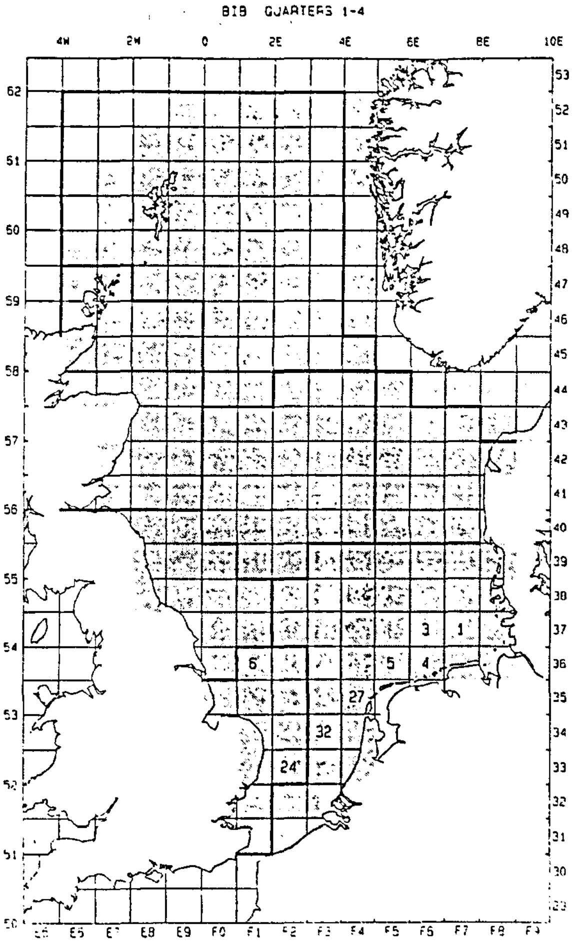
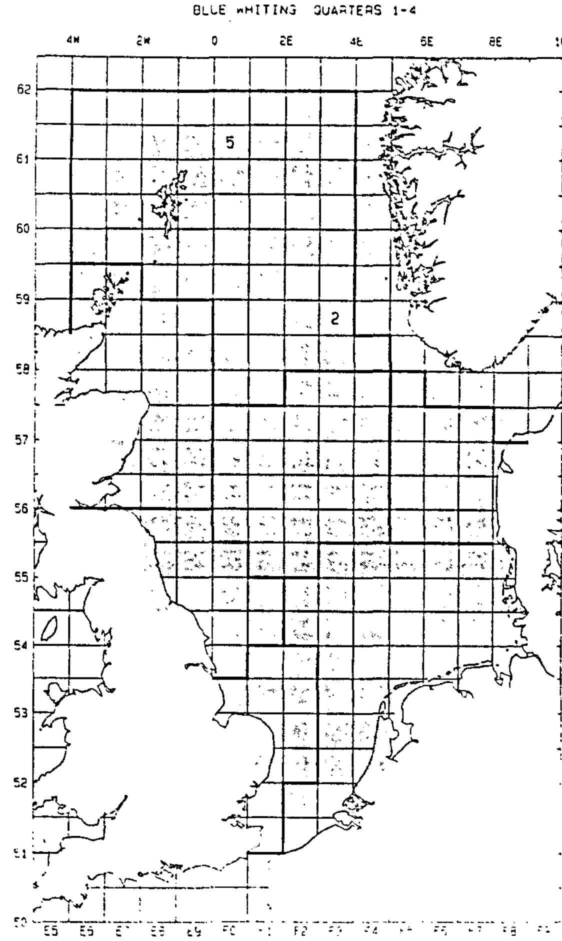
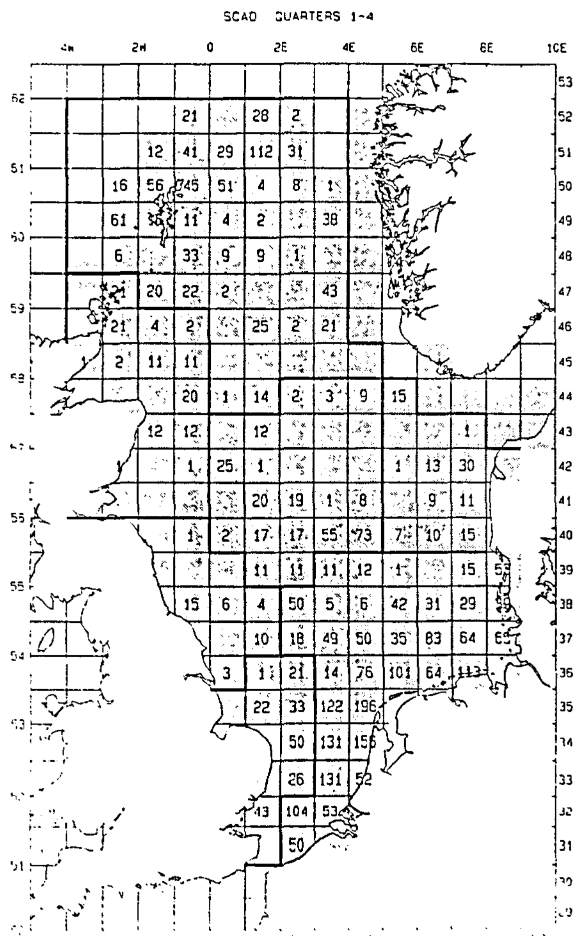

TORSK QUARTERS 1-4

Fig. 4.7


BIB QUARTERS 1-4


BLUE WHITING QUARTERS 1-4


SCAD QUARTERS 1-4

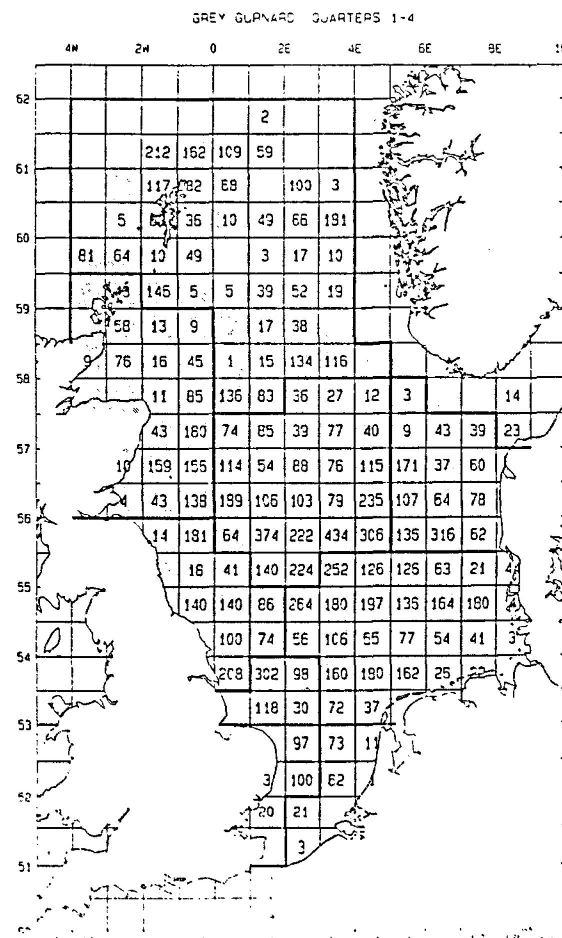

GREY GURNARD QUARTERS 1-4

Fig. 4.8

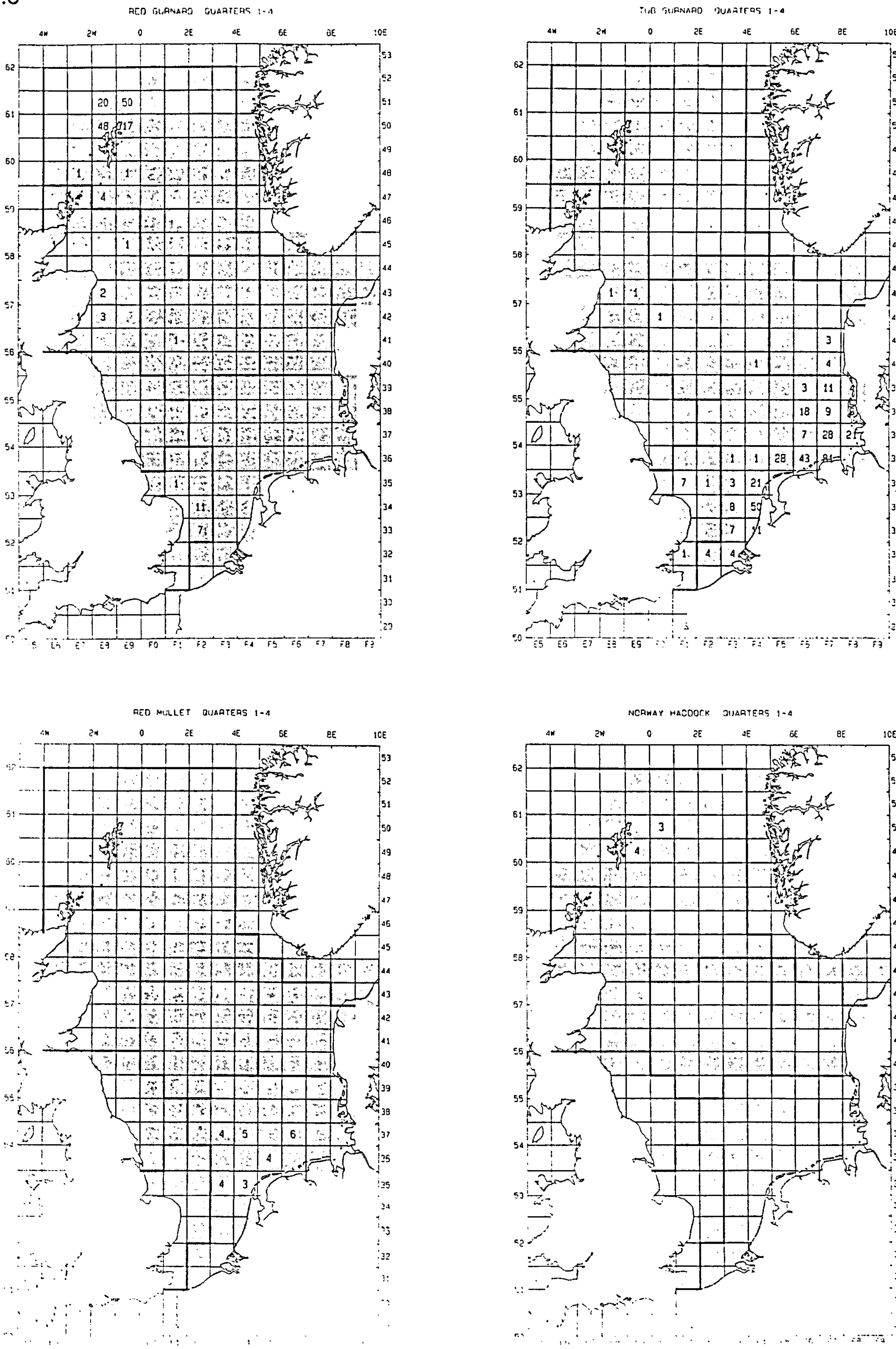
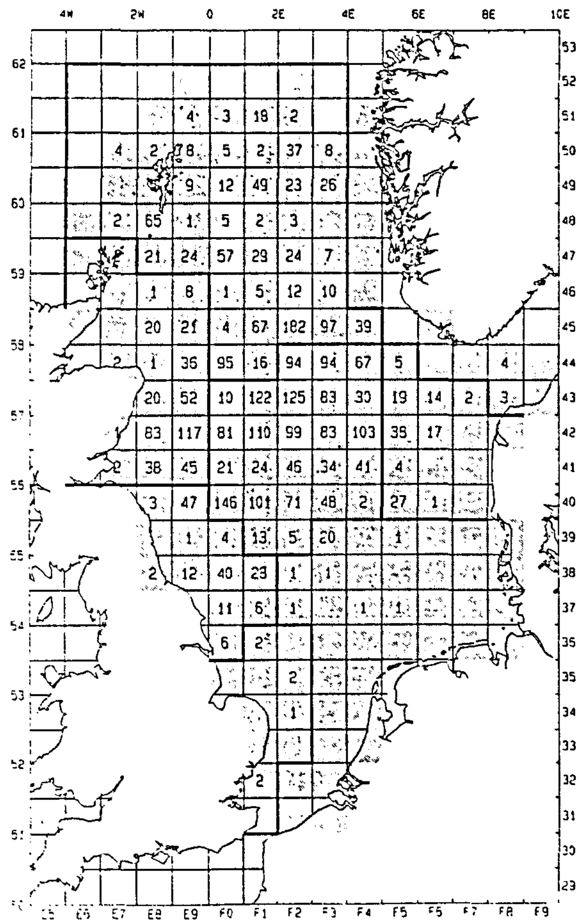
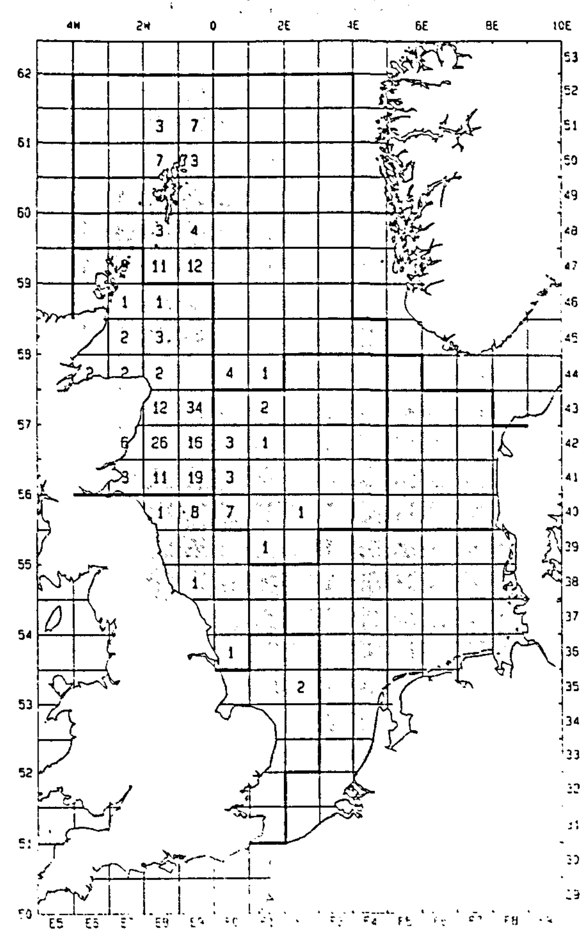

RED GURNARD QUARTERS 1-4
TUB GURNARD QUARTERS 1-4
RED MULLET QUARTERS 1-4
NORWAY HADDOCK QUARTERS 1-4

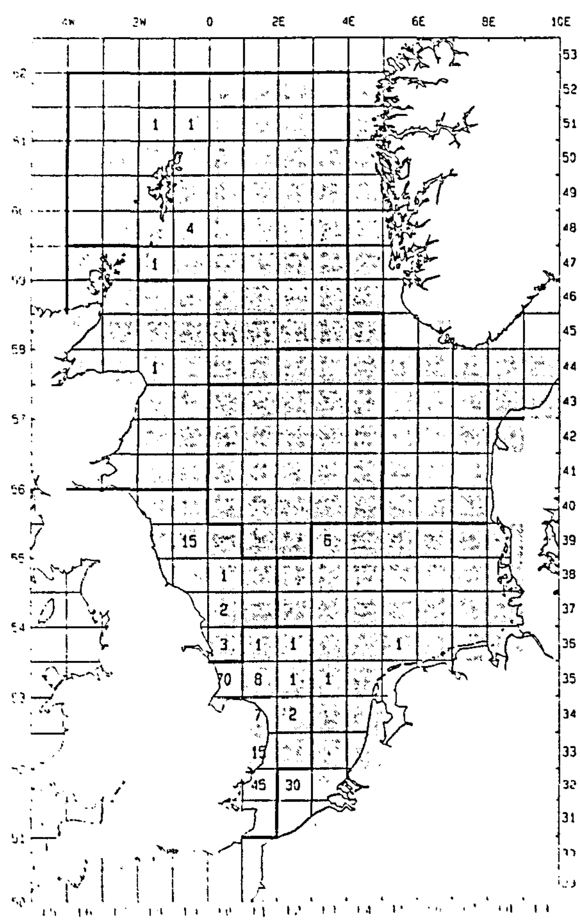
Fig. 4.9



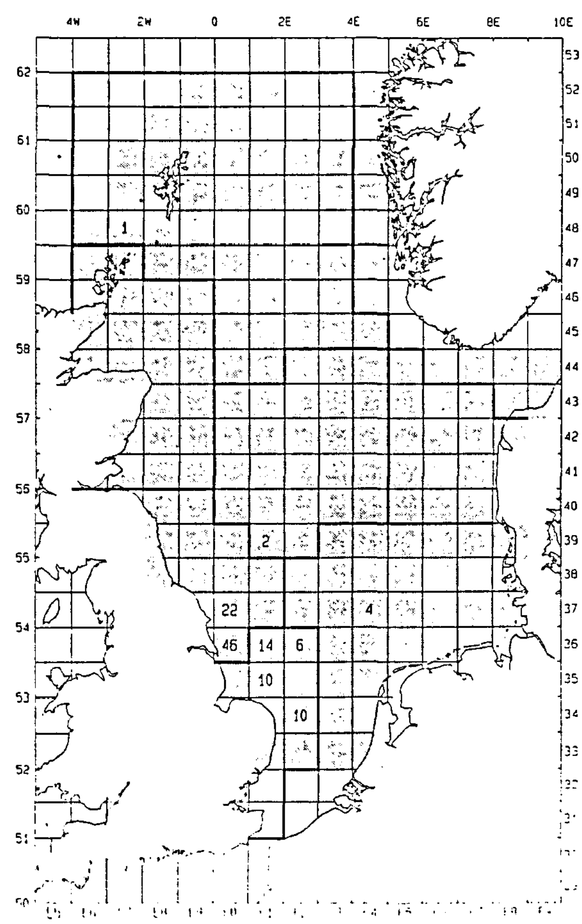
R RADIATA QUARTERS 1-4



R NAEVUS QUARTERS 1-4

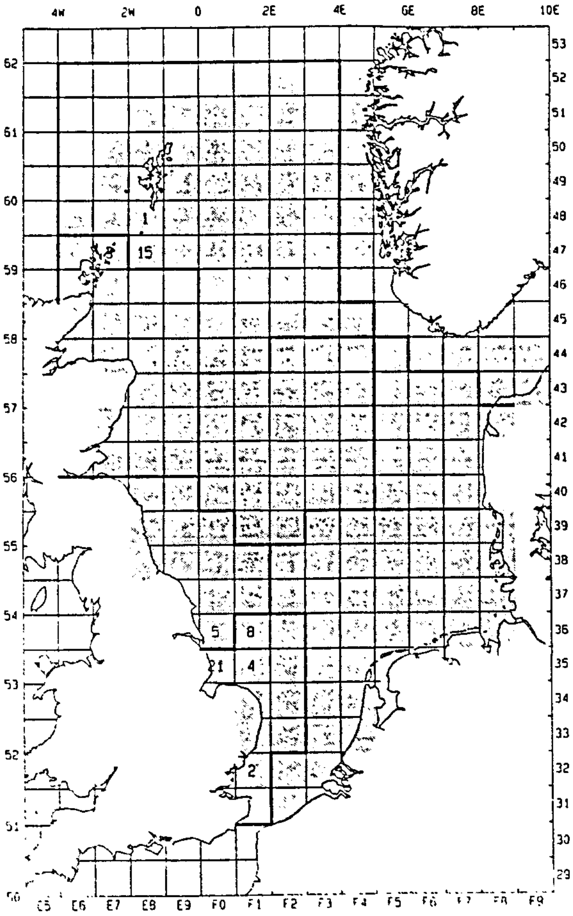


R CLAVATA QUARTERS 1-4

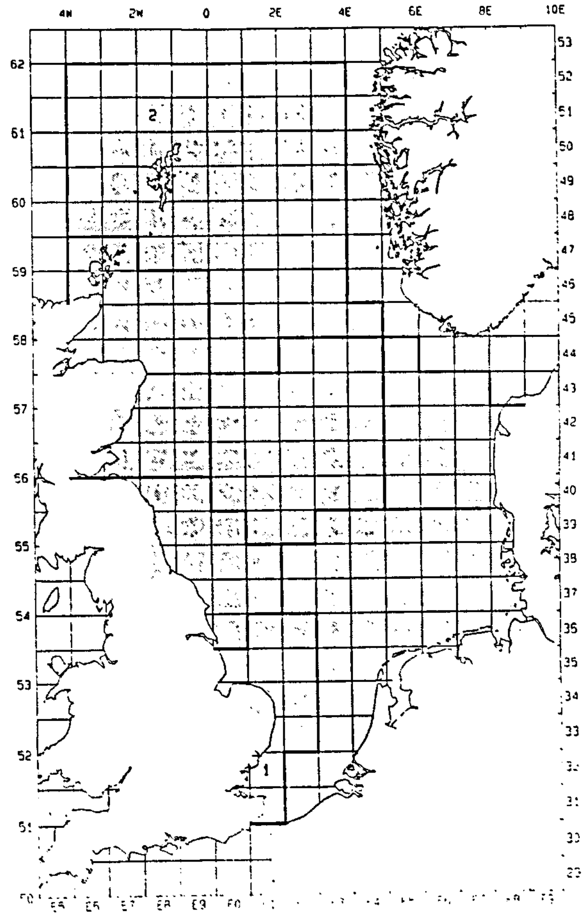


R MONTAGUI QUARTERS 1-4

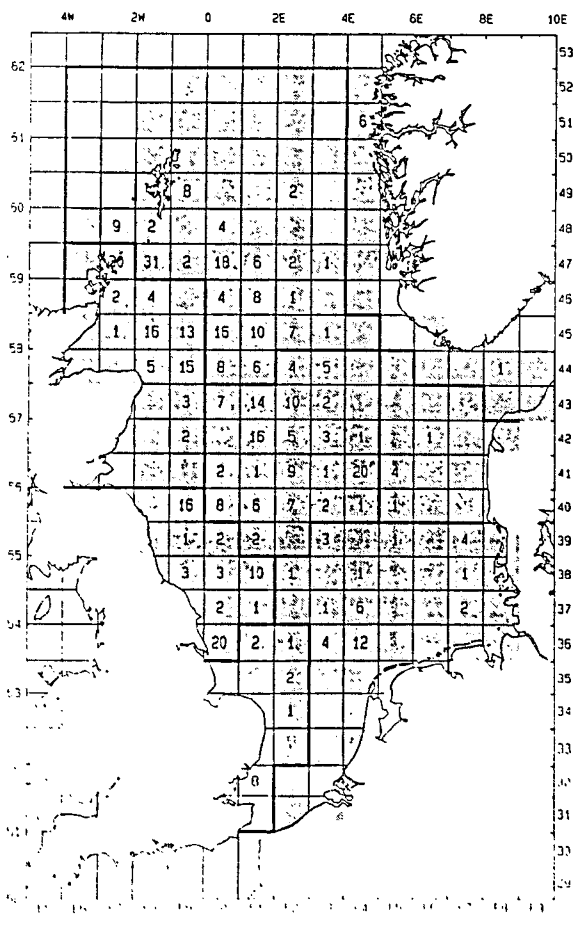
Fig. 4.10



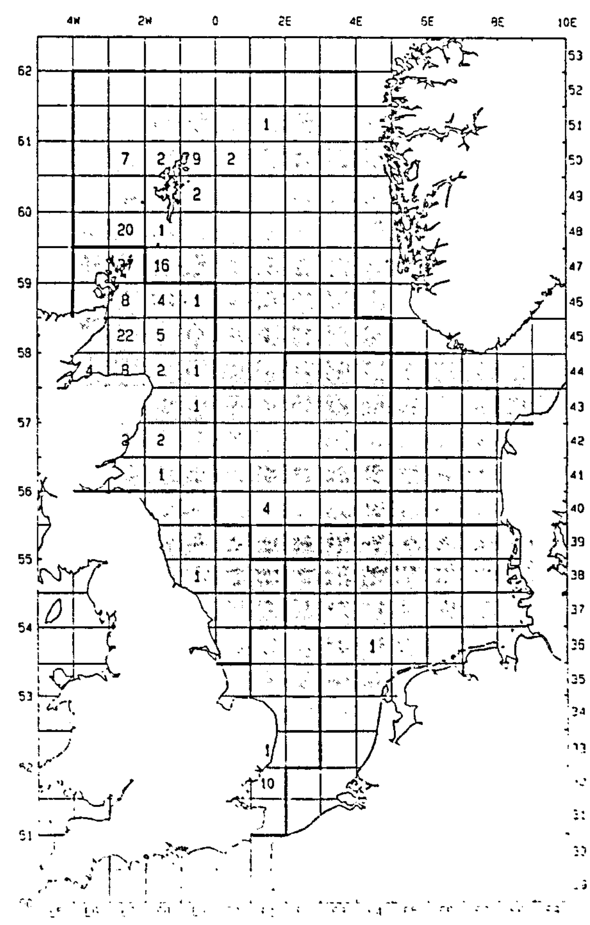
R.FULLONICA QUARTERS 1-4



R BATIS QUARTERS 1-4



SPURDOG QUARTERS 1-4



LESSER SPOTTED DOGFISH QUARTERS 1-4

Fig. 4.11

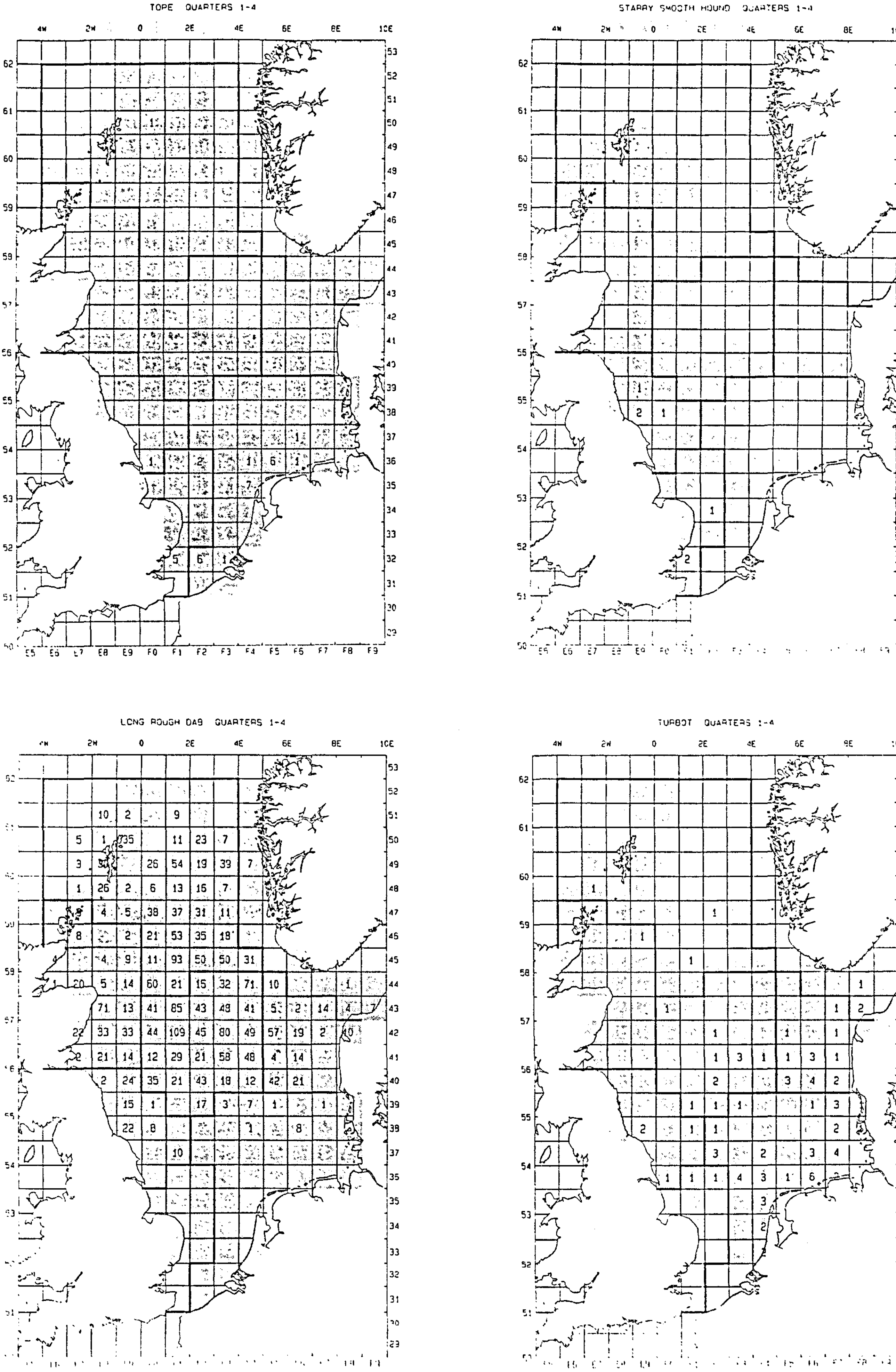

TOPE QUARTERS 1-4
STARRY SMOOTH HOUND QUARTERS 1-4
LONG ROUGH DAB QUARTERS 1-4
TURBOT QUARTERS 1-4

Fig. 4.12

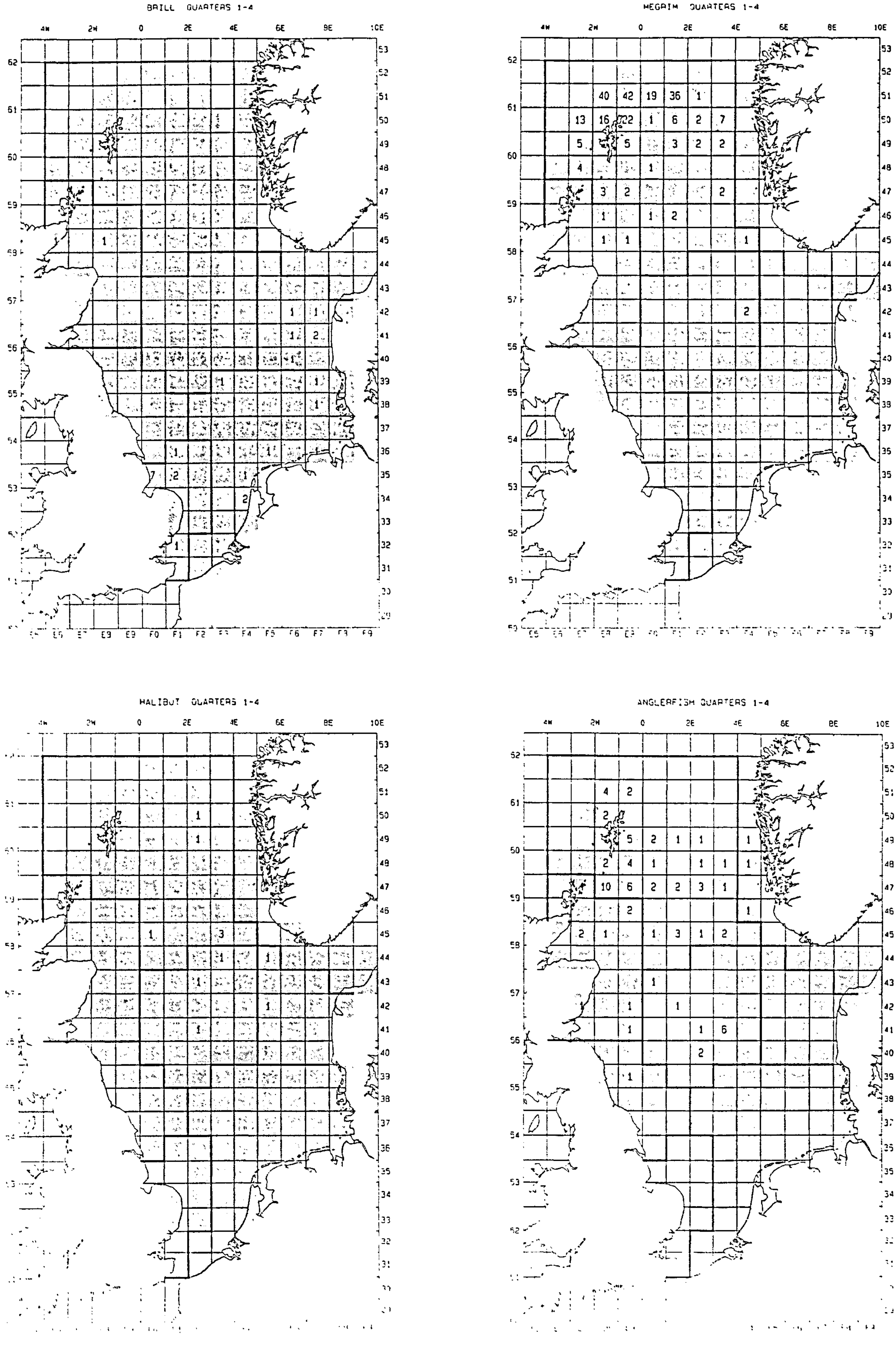
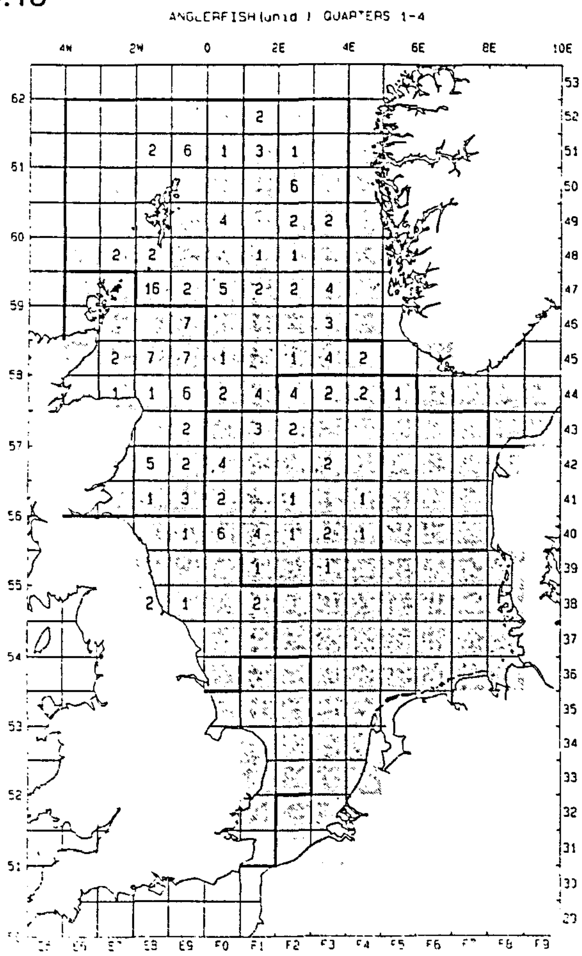
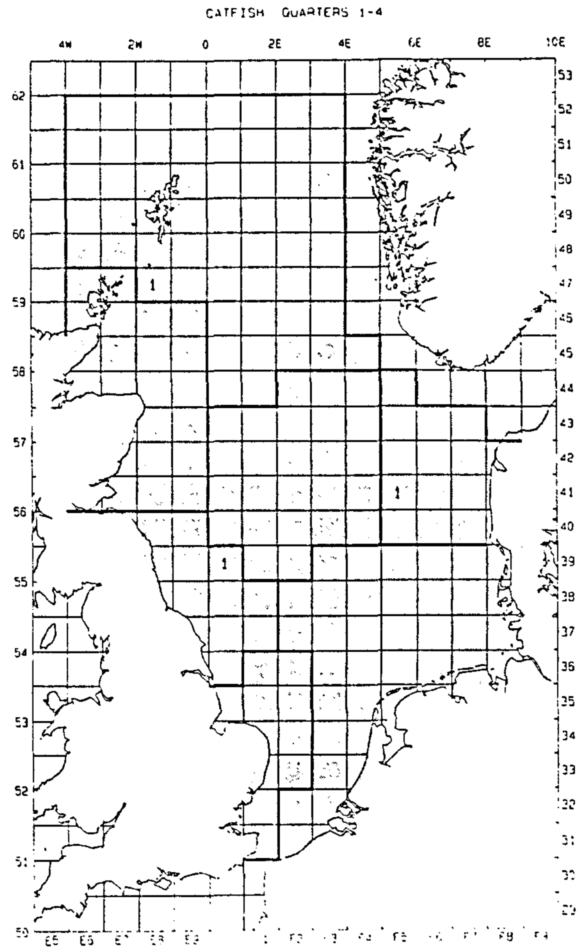
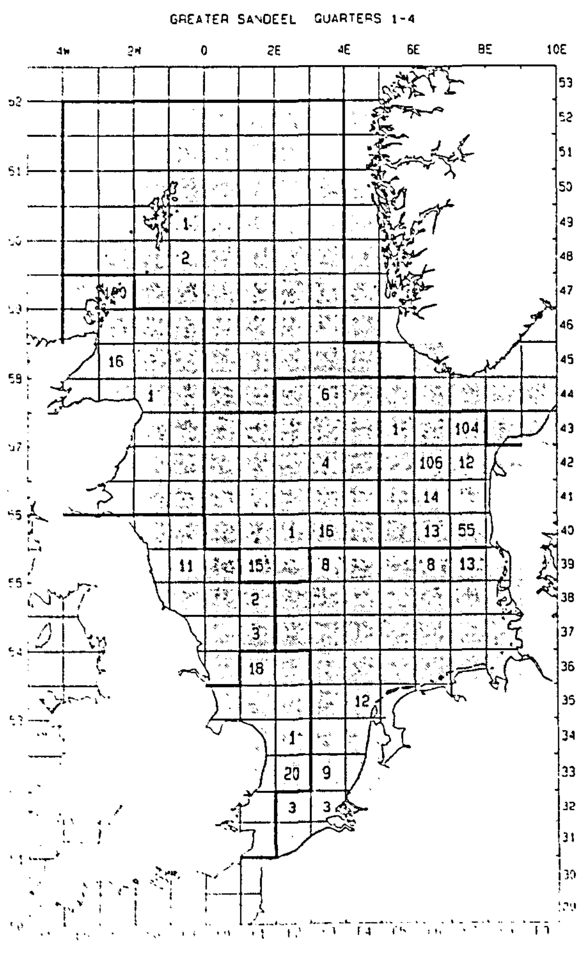

BRILL QUARTERS 1-4
MEGRIM QUARTERS 1-4
HALIBUT QUARTERS 1-4
ANGLERFISH QUARTERS 1-4

Fig. 4.13


ANGLERFISH(unid) QUARTERS 1-4


CATFISH QUARTERS 1-4


GREATER SANDEEL QUARTERS 1-4

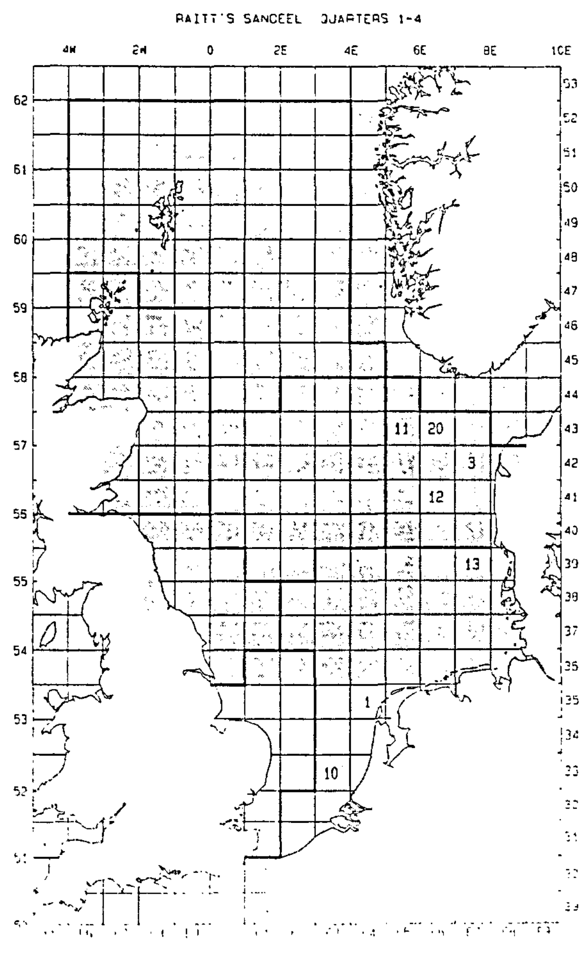

RAITT'S SANDEEL QUARTERS 1-4

Figure 4.14 Sampling areas for pelagic 0-group gadoids in June 1991.

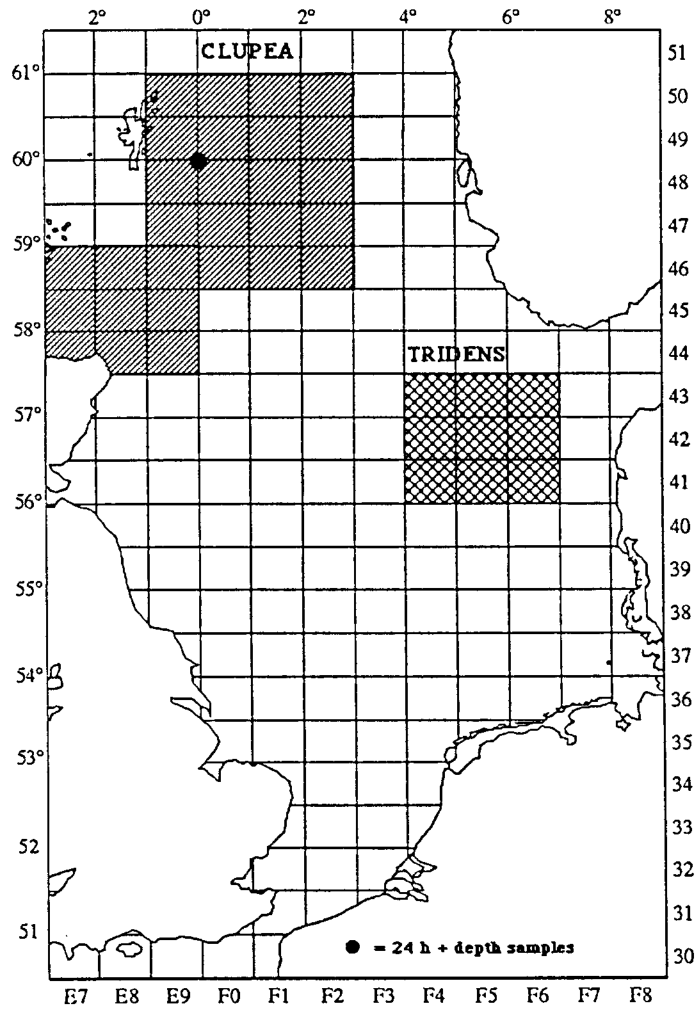
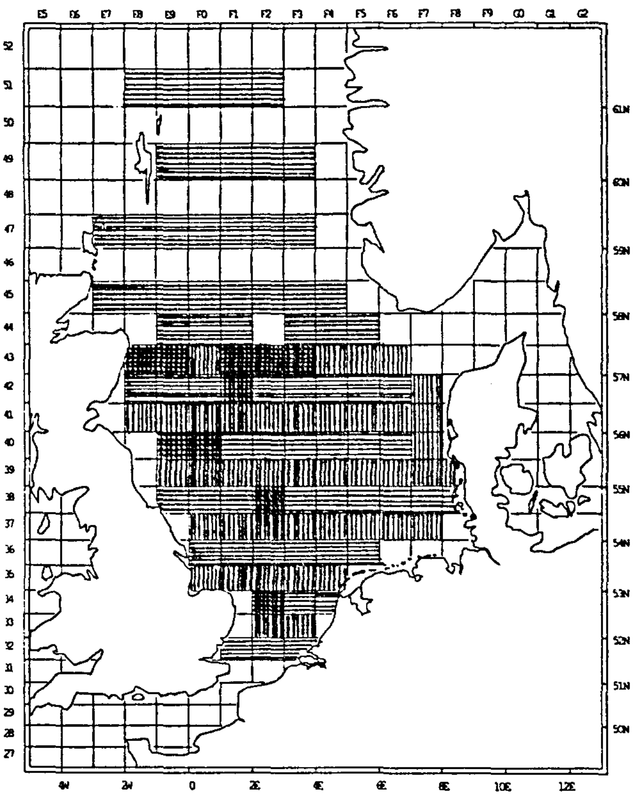


Figure 7.1 Example of differences in reported regurgitation rates by different countries.

a Statistical squares fished by Cirolana (hatched horizontally) and Tridens (hatched vertically) during the second quarter of 1991.

b Percentage of grey gurnard stomachs classified as regurgitated by statistical square during the second quarter of 1991



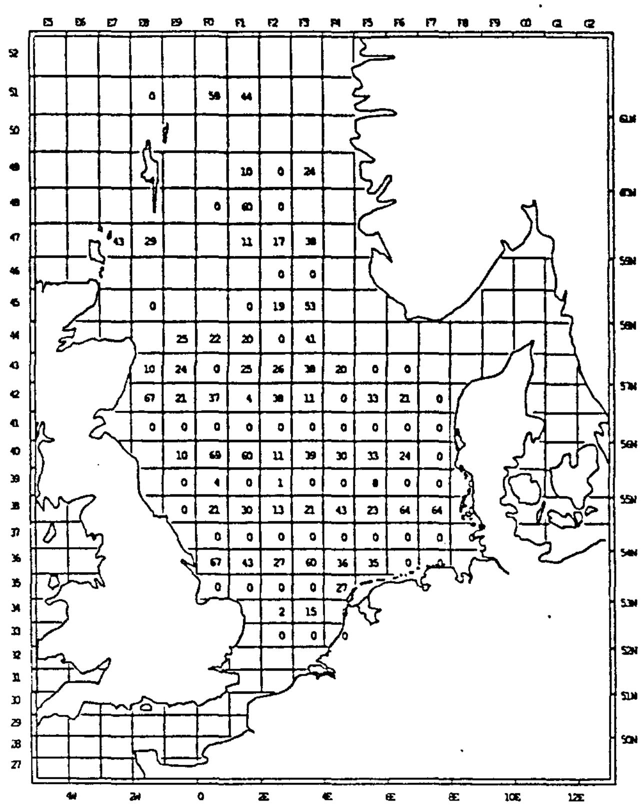


Table 4.1 Number of stomachs examined at sea for each species and quarter for 1981 and 1991.

Species	Quarter 1		Quarter 2		Quarter 3		Quarter 4		Total	
	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991
Cod	4146	2338	2430	3227	2329	2411	2513	2151	11418	10127
Haddock	2810	2908	3795	5183	5825	7819	4966	3745	17396	19655
Whiting	7832	6990	4211	11900	3727	13076	3447	9717	19217	41683
Mackerel	248	315	1277	2772	2737	3177	683	686	4945	6950
Saithe	547	1115	185	1241	899	708	559	812	2190	3876
Pollack		0		58		15		8		81
Ling		52		71		33		48		204
Hake		54		176		226		93		549
Torsk		3		14		5		5		27
Bib		56		17		0		29		102
Blue whiting		0		0		7		0		7
Scad		31		941		1555		986		3513
Grey gurnard		2036		4653		4135		1987		12811
Red gurnard		132		19		17		2		170
Tub gurnard		0		106		148		137		391
Red mullet		0		26		0		0		26
Sebastes viv.		0		0		7		0		7
Rays		962		877		1702		649		4190
S. acanthias		49		336		58		75		518
S. caniculus		35		43		93		4		175
Tope		1		3		11		17		32
M. asterias		0		3		3		1		7
L.R. dab		574		414		1172		353		2513
Turbot		13		25		17		33		88
Brill		14		10		1		2		27
Megrim		60		40		128		16		244
Halibut		2		7		0		2		11
Angler		29		54		111		66		260
Catfish		1		2		0		0		3
Hyperoplus		3		779		8		4		794
Sandeel		0		65		0		0		65
Total	15583	17773	11898	33062	15517	36643	12168	21628	55166	109106

Table 4.2 Number of stomachs examined at sea for each predator size class (all data standardized to 1981 size classes) for each of the primary predator species and quarter.

size class	<= 99		100-149		150-199		200-249		250-299		300-399		400-499		500-699		700-999		>= 1000	
year	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991	1981	1991
Quarter 1																				
cod	1		113	97	251	195	531	160	601	93	837	402	455	327	556	630	684	425	117	91
haddock			238	363	444	681	512	546	629	412	690	712	195	176	42	54		1		
whiting		51	1525	1406	1638	1616	1623	1470	1616	1465	1250	1089	176	53	4	2				
saithe									2	2	45	452	36	486	170	189	265	66	29	6
mackerel						65		139	145*	49	75	69	28	9						
Quarter 2																				
cod			36	9	176	259	328	515	370	352	538	588	391	521	392	637	180	200	19	29
haddock		12	457	32	576	834	693	1175	802	964	840	1451	360	311	66	55	1	1		
whiting		1	428	656	756	2208	889	2996	1161	3424	924	2055	53	71						
saithe								3		7	14	176	7	280	45	146	113	64	6	7
mackerel						2		291	253*	612	556	1615	468	121						
Quarter 3																				
cod	90	376	355	222	232	16	87	166	185	446	370	556	337	296	367	283	257	85	49	13
haddock		700	772	1881	679	494	1049	1404	1333	1561	1451	1589	455	273	82	51	4	3		
whiting		990	231	1679	321	1053	843	2452	1131	3485	1032	2878	163	54	6	1				
saithe				1		1		1	1	9	83	110	201	378	358	157	241	50	15	
mackerel								80	764*	731	1519	2170	454	170						
Quarter 4																				
cod	1	52	189	396	199	318	199	116	233	104	424	551	404	220	453	248	357	117	54	13
haddock		47	692	647	812	574	919	426	947	698	1012	1035	503	214	80	90	1			
whiting		201	524	1373	519	1829	729	1971	821	2207	740	2102	110	73	4					
saithe						2					10	75	62	494	170	222	143	21	174	4
mackerel						20		43	120*	102	416	485	147	36						

NB. * : 200 - 299

Table 5.1 Number of stomachs examined at sea and the numbers analysed to date by each country.

country	species	Nr. examined	Nr. analysed
Germany	haddock	19655	1500
Scotland	whiting	41683	13241
Denmark	saithe	3876	1500
	rays	4190	1300
Netherlands	cod	10577	9170
	grey gurnard	11906	6151
	other species	14004	2821
Norway	mackerel	6950	1605
England	pelagic 0-gr.	3500	2646
Sweden	var. North Sea	791	791
	var. Skag./Katt.	3464	1632

Table 6.1. Data format for stomach content data (from Anon., 1992b)

Position	Name	Type[a)]	Range of values	Comment
	Sample identification			
1-2	Ecosystem name	2N	1-8	North Sea: 01
3-4	Year	2N	01-99	Year - 1900
5	Quarter	1N	1-4	
6-9	Square/stratum	4AN		ICES rectangle or survey stratum #
10-19	Predator code	10N		NODC 10-digit
20-24	Sample (Fish) nr	5N	1-99999	Unique fish I.D.
	Haul information			
25-27	Country	3A		ICES alpha codes; no Data:XXX
28-31	Ship	4A		ICES alpha, if available; otherwise:XXXX
32-34	Sampling method	3A		See footnote [b)]; no data: XXX
35-40	Station/haul	6AN		Use national system; no data:XXXXXX
41-42	Month	2N	01-12	Not known: 99
43-44	Day	2N	01-31	Not known: 99
45-48	Time of day	4N	0-2399,9999	hh/mm, local time start of tow; not known: 9999
49	Quadrant	1N	1-4, 9	See footnote [c)]; not known:9
50-53	Latitude	4N	0-9000,9999	Dd/mm; not known:9999
54-58	Longitude	5N	0-18000,99999	Ddd/mm; not known:99999
59-61	Depth (meters)	3N	1-999	Mean depth of tow; not known:999
62-64	Temperature (bottom)	3N	-9.9 to 99.8	XX.X one implied decimal; not known:999
	Predator information			
65-68	Pred. (mean) length	4N	1-9999	mm XXXX
69-73	Pred. (mean) weight	5N	1-99999	grams XXXXX; not known:99999
74-75	Pred. (mean) age	2N	0-99	Not known:99
76-79	Pred. lower length bound	4N	1-9999	mm XXXX
80-83	Pred. upper length bound	4N	1-9999	mm XXXX
84-90	CPUE	7N	1-9999999	Weighting coeff. for sample; not known: 1
	Sample information			
91-93	Nr with food	3N	0-999	0, 1 for individual samples
94-96	Nr regurgitated	3N	0-999	0, 1 for individual samples
97-99	Nr with skeletal remains	3N	0-999	0, 1 for individual samples
100-102	Nr empty	3N	0-999	0, 1 for individual samples
	Prey information			
103-112	Prey species code	10N		NODC 10-digit
113-116	Prey lower length bound	4N	1-9999	mm XXXXg; not known:9999
117-120	Prey upper length bound	4N	1-9999	mm XXXXg; not known:9999
121-128	Prey weight	8N	1-99999999	Total weight mg XXXXXXXX
129-134	Prey number	6N	1-999999	Total number; not known:999999
135	Digestion stage	1N	0-2, 9	See footnote [d)]; not known 9

[a] All numeric fields (N) right justified, zero filled; all alpha (A) and mixed alpha/numeric fields (AN) left justified, space filled.
[b] DEM: demersal trawl; PEL: pelagic
[c] 1: NB/EL;2: NB/WL
[d] 0:pristine condition; 1: partly digested; 2: skeletal remains

Table 8.1 1991 IBTS data available in RIVO data base

Q	vessel	nr of hauls	trawl list	length data	numbers of otoliths collected cod	hadd	whit	norw	sait	herr	spra	mack	scad	amm	hype	grgu
1	Argos	54	+	+	.	.	.	.	.	1371	307	.	.	.	.	.
	Dana	40	+	+	104	162	1017	.	.	4524	2666	.	.	.	.	.
	Isis	23	+	+	.	.	.	.	.	.	.	.	.	.	.	.
	J.Hjort	51	+	+	460	533	464	213	.	2200	.	.	.	.	.	.
	Scotia	59	+	+	462	1239	1161	385	55	686	121	53	.	.	.	.
	Thalassa	77	+	+	204	565	1208	62	.	877	299	.	.	.	.	.
	Tridens	31	+	+	516	379	807	85	26	474	241	23	0	6	2	.
	W.Herwig	91	+	+	621	920	857	.	.	542	.	.	.	.	.	.
	total	426			2367	3798	5514	745	81	10674	3634	76	0	6	2	0
2	Cirolana	73	+	+	497	1339	1434	332	104	1129	428	236	.	202	80	.
	Isis	29	+	+	.	.	.	.	.	.	.	.	.	.	.	.
	J.Hjort	36	+	+*	216	390	331	129	.	96	.	.	.	.	.	.
	Scotia	54	+	+	467	888	954	187	172	976	295	.	.	.	.	.
	Tridens	51	+	+	960	513	1034	115	7	390	187	120	228	(219)	(102)	.
	W.Herwig	171	+	+	1717	950	1106	271	.	598	.	.	.	.	.	.
	total	414			3857	4080	4859	1034	283	3189	910	356	228	678	**182	0
3	Cirolana	87	+	+	648	980	1404	339	173	578	277	162	.	26	58	.
	Isis	25	+	+	.	.	.	.	.	.	.	.	.	.	.	.
	J. Hjort				.	.	.	.	.	1572	.	.	.	.	.	.
	Scotia	90	+	+	504	1888	1522	324	271	2408	86	.	.	.	.	.
	Tridens	45	+	+	394	685	788	146	146	300	50	73	298	(55)	(50)	.
	total	247			1546	3553	3714	809	590	4858	413	235	298	2516	**108	0
4	Cirolana	61	+	+	400	955	1393	399	86	826	486	167	.	.	.	.
	Dana	70	+	+*	149	694	622	191	.	.	.	90	.	.	.	.
	G.O. Sars	47	+	+*	.	108	90	.	.	327	.	.	.	.	.	.
	Isis	35	+	+	.	.	.	.	.	.	.	.	.	.	.	.
	Tridens	37	+	+	365	110	906	45	.	488	189	40	100	.	.	.
	total	250			914	1867	3011	635	86	1641	675	297	100	0	0	0

* preliminary data
** including market samples
( ) otoliths not yet read

Table 9a Number of Norway pout otoliths collected

Size group (cm)	Roundfish area 1	2	3	4	5	6	7	Total
1 st quarter								
8 - 9	5	2	2					9
10 - 11	60	55	33	16	16			180
12 - 14	91	56	52	25	25			249
15 - 19	146	43	37	14	35			275
20 - 24	5	11	9	7				32
Total	307	167	133	62	76	0	0	745
2 nd quarter								
8 - 9	1							1
10 - 11	36	17	4	2			2	61
12 - 14	124	101	56	61		4	25	371
15 - 19	190	73	98	62		9	12	444
20 - 24	13	5	7	3				28
Total	364	196	165	128	0	13	39	905
3 rd quarter								
<=5	8		2	1				11
6	14		5				1	20
7	19	6	7				1	33
8 - 9	43	13	14				3	73
10 - 11	26	22	8					56
12 - 14	83	22	20	10			4	139
15 - 19	216	99	92	26			16	449
20 - 24	20		5	2				27
Total	429	162	153	39	0	0	25	808
4 th quarter								
7	7	1	1					9
8 - 9	37	8	12	5				62
10 - 11	40	12	16	16		2		86
12 - 14	39	22	15	8				84
15 - 19	90	37	26	19		16	1	189
20 - 24	5	6	1	2				14
Total	218	86	71	50	0	18	1	444

Table 9b Number of sprat otoliths collected

Size group (cm)	Roundfish area 1	2	3	4	5	6	7	Total
1 st quarter								
5					2	14	2	18
6				1	6	54	34	95
7			8	3	4	225	199	439
8 - 9	4		49	185	43	1238	293	1812
10 - 11	1	2	64	145	57	315	63	647
12 - 14	7	3	69	45	84	65	59	332
15 - 19	2				4	1		7
Total	14	5	190	379	200	1912	650	3350
2 nd quarter								
<=5					3			3
6					3	1		4
7			7		13	9		29
8 - 9			27	15	47	29	1	119
10 - 11		6	58	82	69	83	27	325
12 - 14		84	43	120	97	113	3	460
15 - 19		3		6	8	3		20
Total	0	93	135	223	240	238	31	960
3 rd quarter								
8 - 9			4	10	10			24
10 - 11			30	46	40	13		129
12 - 14		2	2	131	60	36		231
15 - 19				18	7	4		29
Total	0	2	36	205	117	53	0	413
4 th quarter								
6				2		1		3
7				2	2	10		14
8 - 9		12		8	13	32		65
10 - 11		1		53	81	68	2	205
12 - 14		50		40	102	130	12	334
15 - 19		6			14	34		54
Total	0	69	0	105	212	275	14	675

Table 9c Number of lesser sandeel otoliths collected

Size group (cm)	Roundfish area 1	2	3	4	5	6	7	Total
1 st quarter								
7		1						1
8 - 9		2						2
10 - 11								0
12 - 14		1						1
15 - 19	1				1			2
Total	1	4	0	0	1	0	0	6
2 nd quarter								
8 - 9	9		1		6			16
10 - 11	79	1	2		9	1	1	93
12 - 14	235	31	6		15	5	15	307
15 - 19	69	59	26	4	29	21	5	213
20 - 24		22	19	1	6		1	49
Total	392	113	54	5	65	27	22	678
3 rd quarter								
7	308							308
8 - 9	743			2				745
10 - 11	546	1		2				549
12 - 14	418	40		2		1		461
15 - 19	382	14			6	11		413
20 - 24	38				1	1		40
Total	2435	55	0	6	7	13	0	2516
4 th quarter								
Total	0	0	0	0	0	0	0	0

Table 9d Number of greater sandeel otoliths collected

Size group (cm)	Roundfish area 1	2	3	4	5	6	7	Total
1 st quarter								
30 - 34	2							2
Total	2	0	0	0	0	0	0	2
2 nd quarter								
15 - 19					8	5	5	18
20 - 24		17	6	1	5	5	8	42
25 - 29		4	6	1		4		15
30 - 34			2			3		5
Total	0	21	14	2	13	17	13	80
3 rd quarter								
15 - 19				2	4	5		11
20 - 24				3	9	11		23
25 - 29				1	8	8		17
30 - 34						4		4
35 - 39					1	2		3
Total	0	0	0	6	22	30	0	58
4 th quarter								
Total	0	0	0	0	0	0	0	0

Table 9e Number of herring otoliths collected

Size group (cm)	Roundfish area 1	2	3	4	5	6	7	Total
1 st quarter								
8 - 9						39	27	66
10 - 11			1	1	10	529	350	891
12 - 14		8	54	164	69	1281	857	2433
15 - 19	34	293	169	345	133	790	540	2304
20 - 24	536	223	202	531	98	203	274	2067
25 - 29	1251	86	50	108	53	86	66	1700
30 - 34	76				1	1	4	82
Total	1897	610	476	1149	364	2929	2118	9543
2 nd quarter								
5							2	2
6							23	23
7							54	54
8 - 9							15	15
10 - 11					5			5
12 - 14				1	22	85	40	148
15 - 19	14	25	48	101	117	207	70	582
20 - 24	288	290	338	390	78	130	118	1632
25 - 29	420	186	195	143	41	73	118	1176
30 - 34	37	4	12			9	3	65
Total	759	505	593	635	263	504	443	3702
3 rd quarter								
8 - 9			1					1
10 - 11			9			5		14
12 - 14			6			31	10	47
15 - 19	18	34	63	47		39	33	234
20 - 24	175	128	149	190	19	18	163	842
25 - 29	2518	511	405	224	20	16	32	3726
30 - 34	906	251	312	46	2			1517
35 - 39	5							5
Total	3622	924	945	507	41	109	238	6386
4 th quarter								
10 - 11		1				14	1	16
12 - 14		35		25	8	86	26	180
15 - 19		79		14	12	182	28	315
20 - 24	4	61		58	3	183	17	326
25 - 29	356	119		31	4	161		671
30 - 34	105	9		1		6		121
Total	465	304	0	129	27	632	72	1629

Table 12.1 Minimum desirable level of identification for non-fish prey observed in stomachs.

1500000000	PHAEOPHYTA
3600000000	PORIFERA
3700000000	CNIDARIA
3701000000	HYDROZOA
3730000000	SCYPHOZOA
3740000000	ANTHOZOA
3744000000	OCTOCORALLIA
3747000000	ALCYONACEA
3800000000	CTENOPHORA
5000000000	ANNELIDA
5001000000	POLYCHAETA
5001010105	APHRODITE ACULEATA
5001130000	PHYLLODOCIDAE
5001200000	TOMOPTERIDAE
5001240000	NEREIDAE
5001250000	NEPHTYIDAE
5001300000	EUNICIDAE
5001600000	CAPITELLIDAE
5501620203	ARENICOLA MARINA
5001650100	SABELLARIA
5001671700	PECTINARIA
5001680000	TEREBELLIDAE
5100000000	GASTROPODA
5105040145	BUCCINUM UNDATUM
5105050812	NEPTUNEA ANTIQUA
5127000000	NUDIBRANCHIA
5300000000	POLYPLACOPHORA
5500000000	BIVALVIA
5507010101	MYTILUS EDULIS
5507010601	MODIOLUS MODIOLUS
5509050401	PECTEN MAXIMUS
5515220000	CARDIIDAE
5515290000	SOLENIDAE
5515310000	TELLINIDAE
5515350203	ABRA ALBA
5515470000	VENERIDAE
5515510101	CYPRINA ISLANDICA
5517000000	MYINA
5600000000	SCAPHOPODA
5700000000	CEPHALOPODA
5704000000	SEPIIDA
5706010000	LOLIGINIDAE
5706010102	LOLIGO VULGARIS
5706010103	LOLIGO FORBESI
5706010301	ALLOTHEUTIS SUBULATA
5708010000	OCTOPODIDAE
5708010202	OCTOPUS VULGARIS
5708010401	ELEDONE CIRROSA
6001010108	NYMPHON GRACILE
6001080103	PYCNOGONUM LITTORALE
6100000000	CRUSTACEA
6109000000	CLADOCERA
6118000000	CALANOIDA
6119000000	HARPACTICOIDA
6132000000	LEPADOMORPHA
6134000000	BALANOMORPHA
6143000000	MALACOSTRACA
6145000000	LEPTOSTRACA
6153000000	MYSIDA
6154000000	CUMACEA
6158000000	ISOPODA
6168000000	AMPHIPODA
6169000000	GAMMARIDEA
6170000000	HYPERIIDEA
6174000000	EUPHAUSIACEA
6177000000	PENAEIDEA
6179000000	CARIDEA
6179180000	PANDALIDAE
6179180100	PANDALUS
6179180101	PANDALUS BOREALIS
6179180104	PANDALUS MONTAGUI
6179180108	PANDALUS PROPINQUIS
6179180110	PANDALUS BREVIROSTRIS
6179220000	CRANGONIDAE
6179220100	CRANGON
6179220110	CRANGON INTERMEDIA
6179220118	CRANGON CRANGON
6179220119	CRANGON ALLMANNI
6181010202	HOMARUS VULGARIS
6181010301	NEPHROPS NORVEGICUS
6183000000	ANOMURA
6183040000	CALLIANASSIDAE
6183060000	PAGURIDAE
6183100000	GALATHEIDAE
6183120000	PORCELLANIDAE
6184000000	BRACHYURA
6188000000	CANCRIDEA
6188010101	CORYSTES CASSIVELANUS
6188020301	ATELECYCLUS ROTUNDATUS
6188030109	CANCER PAGURUS
6189000000	BRACHYRHYNCHA
6189010000	PORTUNIDAE
6189010701	CARCINUS MAENAS
6189010900	MACROPIPUS
6213000000	INSECTA
7200000000	SIPUNCULA
7300000000	ECHIURA
7400000000	PRIAPULIDA
7800000000	ECTOPROCTA
8000000000	BRACHIOPODA
8100000000	ECHINODERMATA
8117030205	ASTERIAS RUBENS
8127010600	OPHIURA
8129031000	AMPHIURA
8149000000	ECHINOIDA
8149010101	ECHINUS ESCULENTUS
8163020101	SPATANGUS PURPUREUS
8163030101	ECHINOCARDIUM CORDATUM
8170000000	HOLOTHUROIDEA
8300000000	CHAETOGNATHA
8400000000	UROCHORDATA
8401000000	ASCIDIACEA
8407000000	THALIACEA
8411000000	SALPIDA
8413000000	LARVACEA
8500010102	BRANCHIOSTOMA LANCEOLATA