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REPORT OF THE WORKING GROUP ON THE ASSESSMENT OF NORWAY POUT AND SANDEEL

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*General Secretary
ICES
Palægade 2-4
DK-1261 Copenhagen K
DENMARK

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1 INTRODUCTION

1.1 Participation

J. Cotter	UK (England)
H. Degel	Denmark
H. Gislason	Denmark
J. Lahn-Johannesen	Norway
K. Popp-Madsen	Denmark
S. Reeves (part time)	UK (Scotland)
D. Skagen (Chairman)	Norway

1.2 Terms of Reference

At the 80th Statutory Meeting it was decided (C. Res.1992/2:8:17) that the Working Group on the Assessment of Norway Pout and Sandeel (Chairman: Mr D. W. Skagen, Norway) should meet at ICES Headquarters from 6-12 October 1993 to:

a) update the description of the historical development of the fleet units exploiting Norway pout and sandeel and the catches of these species and the by-catch species;

b) quantify the species composition of by-catches taken in the fisheries for Norway pout and sandeel in the North Sea and adjacent waters;

c) resolve the age compositions of the 1990 catches to allow the time series of catch-at-age data to be maintained;

d) assess the status of Norway pout and sandeel in Sub-area IV and Divisions IIIa and VIa and advise on the need for any management measures, taking into account the outcome of the meeting of the Working Group on Methods of Fish Stock Assessment;

e) provide the data requested by the Multispecies Assessment Working Group;

f) provide information on the industrial fish stocks (Norway pout and sandeel), their age structures, their stock distributions, and their fisheries on an ICES statistical rectangle basis, in order to allow the Working Group on Ecosystems Effects of Fishing Activities to quantitatively evaluate the effects of industrial fisheries in the ecosystem;

g) prepare for the transfer of the Group's work to area-based Working Groups in 1994.

In addition, in a letter dated 20 December 1992 from the Chairman of ACFM, referring to the 1992 ACFM consultations held on 23 September 1992, working groups were requested to "evaluate and comment upon, the quality and adequacy of the fishery and sampling data upon which their assessments are based", "evaluate, and comment upon, the quality of their assessments" and express their consensus views on appropriate management advice for any of their stocks, pointing out any concerns and developments in the stocks and fisheries which they feel ACFM should address.

1.3 Sources of Data

1.3.1 Denmark

The Danish industrial landings are defined as all landings taken by fisheries using mesh size smaller than 32 mm and landed with the purpose of being converted to fish meal and oil.

Catches landed for human consumption, almost all taken by gears of mesh size equal to or greater than 31 mm, but for some reason (e.g. quality or price) used for reduction, are not included in this description.

The objectives of the Danish sampling scheme are:

- To collect data needed for estimation of the total landings taken in the Danish small meshed industrial fishery by species, statistical square and month.

- To collect information on age and length composition by species, month and area.

The basic sources of information are stored in four data bases:

- Sales-slip database.
- Logbook database.
- Species composition database.
- Biological database.

The sales-slip database:

For all landings which are sold, first hand buyers are obliged to report to the Ministry of Fisheries (MF) information on target species, quantity, price and area (ICES Division) for each landing. The information is recorded in the MF's *Sales-slip Database.*

The information on species composition in the industrial sales-slip database is not representative of the true species composition of the landings as only the target species is recorded (e.g. a landing of nominal Norway Pout may, and usually does, contain various quantities of other species taken as by-catch). Therefore, only information on total quantity of all species landed from each main area (ICES-Division) is used from this database.

The logbook database:

For the North Sea the general rule deals with vessels with an overall length of 17 m or more. In the Skagerrak and Kattegat the minimum length of vessels is set at 12 m. The logbooks contain information at least on a daily basis about, e.g., catch-data, catch-position (statistical rectangle), species and quantity. Information from these logbooks is recorded in the *Logbook Database* in the Ministry of Fisheries. The logbook information is used to estimate the relative distribution by ICES statistical rectangle of the landings identified as having been taken by the small meshed industrial fishery. In addition, catch per unit of effort is obtained from catches and fishing day according to this database.

The landings used in this relative distribution are those in which the species composition is consistent with those species typically landed for industrial purposes.

Species composition database:

The industrial landings are sampled for species composition on a routine basis by the Fishery Inspectors. One standard sample of 10 to 15 kg is taken from each landing sampled. The samples are sorted by species and total weight by species and the position of capture (ICES statistical rectangle) is recorded. The data are stored in the *Species composition database* in the Ministry of Fisheries. The total number of samples of landings in the North Sea, Skagerrak and Kattegat in the years 1989 to 1992 are given in the text table below.

Before the data are used to calculate the landings by species a quality check is carried out using information from research and commercial vessel surveys, historical data, the biological database (see below) and informal contacts in the most important port.

The species composition of landings by other nations in Danish ports is also estimated and included in this database.

Biological database:

Separate biological samples from industrial landings are taken on a routine basis by the Fishery Inspectors and handed over to The Danish Institute for Fisheries and Marine Research (DIFMAR). The sample size is about 10 kg. After sorting the sample by species the total weight by species, length composition and mean weight by length group are recorded. Otoliths are collected for age reading. The data, together with information on catch position, are stored in DIFMAR's *Biological database*.

The total number of samples taken in the North Sea, Skagerrak and Kattegat in the years 1989 to 1992 are given in the text table below.

Number of landings from the North Sea, Skagerrak and Kattegat sampled in the period 1989 to 1992.

	1989	1990	1991	1992
Species composition database	1,388	1,162	824	1,109
Biological database	178	64	307	422
Total number of samples	1,566	1,226	1,131	1,531
Landings ('000 tonnes)	1,322	960	1,207	1,376

Estimation of landings by species:

The total industrial landing by month and ICES Division or Sub-area are calculated using the sales-slip database. The landings are allocated to statistical rectangle using the relative geographical distribution from the logbook database of landings identified as having been taken by the small meshed industrial fishery. The output is industrial landings by statistical rectangle and month.

The relative species composition by statistical rectangle and month is estimated using the information in the species composition and biological data base. An average composition by rectangle is estimated taking the mean of all samples from that rectangle. If more than one sample is taken from the same landing, a mean composition of the landing is calculated and treated as one sample.

After calculation of average composition by rectangle a new average composition is calculated taking into account the species composition in all neighbouring rectangles. This is done by taking the mean species composition of the rectangles and all 8 surrounding rectangles.

The total landings by species, statistical rectangle and month are calculated using the estimated species composition and total landings by rectangle and month.

The reason for possible discrepancies between the species composition in the biological database and that in the logbook database is: 1) that the species composition in the logbook is based on a subjective estimate and, 2) that

there is a general tendency by the fishermen to underestimate the contents of protected by-catch species.

Estimation of the Fishing Effort

For effort calculation purposes, the number of fishing days is calculated as the number of days on which any fishing has taken place according to the logbook.

1.3.2 Norway

The term "industrial fisheries" in the Norwegian context refers to fisheries for Norway pout and sandeel by small meshed trawl, i.e. using mesh sizes ranging from 16 to 50 mm. In the sandeel fishery, a mesh size less than 16 mm may be used between 1 March and 31 October.

The current monitoring system for sampling landings caught by small meshed trawl aims at a representative sampling of the landings from the fisheries for Norway pout and sandeel, to provide data for informational and assessment purposes.

The main objectives of the current system are, through random sampling of the trawlers and their landings:

i) to obtain a geographical coverage of the fishing grounds on an annual/seasonal basis;

ii) to determine and record the species composition;

iii) to collect biological samples of the main species to allow estimates of age frequency and mean weight at age.

This has been achieved by establishing a sampling system at fish meal plants receiving industrial landings from the North Sea. In each port a person is appointed by the Institute of Marine Research on a part-time basis and is requested to sample two landings of Norway pout and one of sandeel per week.

A standard sample size of 50 kg is extracted from various parts of the landings in buckets of 10 litres. After sorting the sample, the number and weight of all species are recorded as well as the length distributions of the main species (Norway pout, sandeel, blue whiting, herring, horse mackerel, saithe, cod, haddock and whiting).

The species composition is calculated by unweighted arithmetic means, by quarter for the Norway pout fishery and by month for the sandeel fishery.

The general species composition in the Norway pout fishery demonstrates that the major components were Norway pout (65%), blue whiting (20%) and herring (5%), as an average of 1991 and 1992.

In the sandeel fishery, sandeel constitutes about 95% of the landings.

Classification of landings

Norwegian official fishery statistics identify landings from industrial trawlers, i.e., trawlers using small-meshed gear, by codes for species which make up at least 70% of a landing by weight. The codes commonly used are D12 for Norway pout, D13 for blue whiting and E02 for sandeel. In cases where none of these codes are appropriate, the code is M02. Landings labelled D12, D13 and M02 are all officially reported to ICES as Norway pout when derived from the North Sea east of longitude 0° or from the Skagerrak.

Effort data are derived from logbook records of landings containing at least 70% by weight of either Norway pout or sandeel.

1.3.3 Scotland

With the continuing decline in the amount of effort in the Division VIa sandeel fishery, there has been an associated decline in the sampling coverage of landings from the fishery. The landings are generally sampled as part of routine market-sampling operations which rely on a sampling team being present in Shetland when a landing from Division VIa is made. Relatively few boats are involved in the fishery so landings are relatively infrequent; hence the decline in coverage. Arrangements are also made for the meal-plant operators to retain samples for subsequent collection, but this is a less reliable method of sampling. The samples are used for both age determination and species composition. Effort data are obtained from logbooks, but with boats fishing in Division VIa and then having to sail to Shetland to land the catch, the added steaming time has distorted the effort data. In addition, a small proportion of landings from the Division VIa fishery are made into foreign ports, particularly in the Faroes, so it is not possible to sample these landings. In recent years the few Scottish boats fishing for sandeel in the North Sea have landed virtually all of their catch into Denmark, so no samples have been obtained from these catches.

1.4 Quality of Data

The working group noted and discussed the 'Report of a Meeting between the European Commission and Norwegian Authorities to Evaluate and Describe Measures Relating to Monitoring and Control of Industrial By-Catches in the North Sea - Bergen, 21-25 June 1993'.

1.4.1 Sampling coverage

1.4.1.1 Denmark

To illustrate the geographical coverage of the Danish sampling scheme in relation to that of the fishery for Norway pout and sand eel combined, the number of samples and the total Danish catch by rectangle and quarter in 1992 are compared in Figures 1.4.1.1a,b,c and d. It can be seen that catches were sampled from all but the least productive rectangles, with those from the most productive rectangles being most heavily sampled. The sampling intensity is approximately 1 sample (10 kg) per 1000 tonnes of the two species landed.

1.4.1.2 Norway

Figure 1.4.1.2 shows the geographical distribution of the total landings of Norway pout in 1992 as per mille proportions per rectangle, together with the corresponding numbers of samples. A total of 63 samples were taken for 106,000 tonnes of Norway pout landed in that year, giving a sampling intensity of 0.6 samples of 50 kg per 1000 tonnes landed. The same is illustrated for sandeel in Figures 1.4.1.3a and b. In this case, a total of 27 samples were taken for a total of 89,000 tonnes landed, giving a sampling intensity of 0.3 per 1000 tonnes landed. The sandeel season in 1992 was very short, ending in early July.

1.4.2 Sources of bias

1.4.2.1 Samples

The manner of sampling by Denmark, Norway and Scotland has been described in Section 1.3. Possible sources of bias identified in these procedures are:

i) The catch in a vessel may be poorly mixed and heterogeneous. Fish at the surface of the hold may consist predominantly of those from the last haul, those which tend most readily to float upwards as a result of the motion of the ship, or those which the crew wish the inspector to see first. These effects could bias species compositions and biological measurements if samples are only taken from the top of the hold. Composite samples formed from subsamples drawn from evenly spread locations in the bulk of the catch would be preferable when possible. However, it may also be an advantage to sample from the last haul because the catch is better preserved and the source area is better known.

ii) Samples collected visually could be biased towards the species composition expected in the catch, or towards the more prominent individuals. A sampling procedure which does not involve human choice of fish should be arranged if possible to minimise bias. The volume of each sample should be sufficiently large to make the inclusion of the larger fish in the catch possible. Since fish greater than about 40 cm are mostly removed from industrial catches nowadays, the sample volumes in use were felt to be adequate.

iii) The use of inspectors to draw samples for the purpose of collecting scientific samples could cause biases depending on the perceived likelihood of prosecution. The use of large volume samples when infringement of by-catch regulations is suspected may unduly weight those events.

1.4.2.2 Choice of sampling unit

A number of alternative sampling units can be considered, e.g. landings without regard to vessel, landings stratified by vessel, landings at given times and landings at given tonnage intervals. Depending on local circumstances, there is considerable potential for biases towards e.g. large vessels, different sea areas, different species according to the fishing habits of different skippers, etc. Ideally, each unit sample weight of fish within a given sampling stratum should have an equal probability of being sampled, given the sampling rate chosen for the stratum.

1.4.2.3 Treatment of data

Bias can arise in both the Danish and Norwegian systems for processing data because catch composition and total weight are not estimated for the same sampling units. This is mainly because the sampling of all landings to estimate composition is not at present practicable, and because randomisation cannot be perfect. The biases will depend on local circumstances but can be expected when there is a poor match between samples and landings with respect to statistical rectangles, fishing intentions of vessels, timing and perhaps other factors. These effects could possibly be reduced when calculating averages by weighting samples in relation to the proportion of the total catch which they appear to represent, but this would be unsatisfactory if many samples are missing. Data smoothing processes for composition data, e.g. the Danish system of averaging over sets of 9 adjacent rectangles, could be exacerbating mismatches between composition and tonnage measures, although it has the advantage of helping to reduce the problems of missing values for composition in some rectangles, and composition samples drawn from catches taken in more than one rectangle.

Problems of bias of a different kind can arise if the main species in catches are falsely declared in order to avoid fishery regulations.

1.4.3 Sampling variance

The variance of estimates of catch weights by species appears to be difficult to estimate using theoretically derived formulae because of the difficulties in linking qualitative and quantitative measures. If sampling does not effectively cover the fishing fleet and its activities in space, time and other significant respects, estimates of variance are likely to be too low. Also, any bias present in existing data is likely to lead to biased estimates of variance. Nevertheless, because of the importance of the herring by-catch in the Norwegian Norway pout fishery, Skagen (1993) has studied the variance of estimates of these by-catches by assuming that the proportion of herring in samples is Poisson distributed and that the samples provide a reasonable representation of actual catches. Then, using a Bootstrap re-sampling technique, he obtained a distribution of by-catch percentages as a function of the number of samples, N, taken. During 1992, 63 samples were collected from the Norway pout fishery. This implies that the range between the 10 and 90 percentiles for the proportion by weight of herring is somewhat less than half of the estimated mean value for the year. It was suggested that a modest increase of sampling effort from 1992 levels would be worthwhile. This method shows promise when there is only one species of interest in the by-catch. Extension to a multi-species situation would be complicated by the negative covariance between species' weights in a sample of fixed total weight.

1.5 Assessment Strategy

1.5.1 Background

Due to the breakdown of the sampling system in 1990, analytical assessments have not been made for the main North Sea stocks at subsequent Working Group meetings because standard VPAs require catch data for every year and season. At the last meeting (Anon., 1992), it was decided to attempt to estimate the missing catches as part of the assessment, rather than to use the very few samples that were available to estimate catches at age. At that meeting, two newly developed assessment models were tested, but neither of them worked satisfactorily at that time. One was a modified XSA, the other a separable VPA, which was specifically designed to handle the case where the catches are very low or zero, but where one survey index is available. For this purpose the separable VPA proved useful, and was used for the Shetland and Division VIa sandeel assessments in 1992 and again this year.

Since the last meeting both the separable VPA (Cook and Reeves, in press) and the seasonal XSA (see Appendix I) have been developed further. For most of the assessments done at the present meeting both programs have been tested, although time constraints prevented a full testing of the Seasonal Separable VPA (SSVPA). The seasonal XSA has the advantage that it can constrain the catches to a specified SOP, and it is also more flexible with respect to the treatment of the survey data. For the Shetland and Division VIa sandeel assessments the Working Group found no reason to change the previous practice.

1.5.2 Seasonal Separable VPA

The seasonal separable VPA (SSVPA) was first used at the previous Working Group meeting and is documented in the Working Group Report (Anon. 1992). Since then the method has been developed further, and it now includes an option to down-weight selected ages in the catch or survey data. This is appropriate where these ages are not well sampled or represented in the catches. The current implementation of the SSVPA, and its use in the assessment of industrial stocks is documented in Cook and Reeves (in press). The SSVPA program can still accept only a single research vessel series. However, where more than one series exists, as in the case of Norway Pout in the North Sea, the practice has been to combine the indices using factor analysis (Rosenberg *et al*, 1992).

1.5.3 Seasonal extended survivors analysis (SXSA)

This is a modification of the XSA used elsewhere within the ICES community. The basic theory is the same, but the practical implementation and tuning options are different. It operates on a seasonal basis and at present a half-yearly and quarterly version are available. In the present version, the unknown catches are estimated using estimated catchabilities and stock numbers. It is also possible to treat the current year as the year with unknown catches. This enables a prediction of the catches in the current year, where the information from survey indices is included.

A more detailed description of the method is given in a working paper which is attached to the report as Appendix I

2 TRENDS IN THE INDUSTRIAL FISHERIES

2.1 Division IIIa

The annual landings from the industrial fisheries for the years 1974-1992 are presented in Table 2.1. Minor revisions were made for sandeel in the period 1982-1989. The total landings have fluctuated between 93,000 t and

235,000 t without any particular trend. Since 1987 the landings have been below the long-term mean of 160,000 t, mainly due to a decline in the landings of clupeoids. The so-called mixed-clupeoid fishery is not included in this table from 1991 onwards because the mesh size in this fishery was increased to over 32 mm. Comparatively low landings in the period 1989-1991 were followed by a marked increase to 148,000 t in 1992, due to an overall increase in landings of all species except sprat.

2.2 North Sea

The annual landings from the industrial fisheries for the years 1974-1992 are presented in Table 2.2. For 1992 the landings have been broken down by quarters to indicate the seasonality of the various fisheries. Minor revisions were made for sandeel and sprat in the most recent years. The total landings were at a higher level in the 1970s than in more recent years, and have since then fluctuated without any particular trend, ranging from 1 million to 1.9 million t during the entire period. Landings increased from 1 million t in 1990 to over 1.3 million t in 1991 and exceeded 1.5 million t in 1992. There was an overall increase in landings of all species in 1991, especially sandeel. A further increase in 1992 was due to high landings of sprat and Norway pout.

2.2.1 Trends in the industrial sandeel fishery in the North Sea

Looking back at the industrial fishery as it has been performed during the last twenty years in the North Sea, the spatial distribution of the fishery has been rather variable lacking any consistency in trends. This may be related to the fact that the area definitions are not based on any biological criteria with the result that they to some extent divide high density areas in two as happens in the high density area which occurs in the central North Sea during May in most years. A small change in location of the catches causes a shift in the apparent importance from one area to another. The importance of Area 2A (Figure 2.2.1a) is an example. The importance of Area 2A has been highly variable, being the most important area in 1978, 1981 and 1989 and of little to medium importance in other years with Area 1A to a large extent shoring complementary changes (Figure 2.2.1b).

Some general remarks can be made. Looking at the relative importance of each of the sandeel areas as shown in Figure 2.2.1b and c, it can be seen that Area 1A is the area in which the biggest fraction of the yearly catch has been caught in most years. The area of former importance in the southwestern North Sea (Area 4) has since the mid-1980s been of insignificant importance. The area around Shetland became increasingly more important during the 1970s and had its maximum in 1981 and 1982 after which the importance of the area declined with almost no catches in 1991 and 1992. Area 2B was of little importance, except in the mid-1970s, until in 1986, it became one of the most important areas, although there was a significant decline in catches from this area in 1992. Area 1C was only of significant importance around 1980.

2.3 Division VIa

The annual landings of Norway pout and sandeel as officially reported to ICES are presented in Table 2.3. The landings of both species in 1992 were well below the long-term average. Norway Pout landings were slightly greater than in 1991, but have remained at a low level. Landings of sandeel were the lowest since 1981 and continue the decline since 1988.

3 BY-CATCHES IN INDUSTRIAL FISHERIES IN THE NORTH SEA

Fish suitable for marketing for human consumption may be removed from industrial catches and sold separately. They then count against the relevant Norwegian or EC quotas and are not considered to be part of industrial by-catches.

The annual landings of by-catches of the major protected species haddock, whiting and saithe are given separately in Table 2.2. By-catches of haddock were at a comparatively high level up to 1977, then dropped to the level of the long-term mean of 17,000 t and have since 1983 been below that level. By-catches of whiting were at considerably higher levels in some years, and above the long-term mean of 55,000 t up to the early 1980s. They declined to levels below 20,000 t in the period 1984-1987 but then increased to a level closer to the long-term mean. By-catches of saithe were at relatively high levels up to 1976, then suddenly dropped to a level of a few thousand tonnes where they have remained ever since.

The distribution of industrial landings by fisheries, and associated by-catches of selected species north and south of 57°N, based on Danish and Norwegian estimates combined, is shown in Table 3.1. In the north the 1992 figures clearly indicate a sandeel fishery with insignificant by-catches, a fishery for Norway pout with marked by-catches of herring, whiting, blue whiting and other non-listed species and a non-defined category of other species consisting mainly of blue whiting. In the south there was a fishery for sandeel with some by-catches of sprat, herring, whiting and other species, a sprat fishery with some by-catch of herring and a mixed fishery for other species such as herring, sprat, sandeel, Norway pout and others. The break-down of species in the column "other" in Tables 2.2 and 3.1 respectively are presented in Table 3.2.

4 NORWAY POUT IN DIVISION IIIA

4.1 Landings

Total landings as officially reported to ICES are shown in Table 4.1. In 1992 they amounted to 84,000 t. This is a considerable increase on the 1991 total of 49,000 t, and has previously only been exceeded in 1985 when the total was 86,000 t.

5 NORWAY POUT IN THE NORTH SEA

5.1 Landings

Annual landings as provided by Working Group members are shown by country in Table 5.1.1. In 1992 the landings were 255,000 tonnes which is an increase of 64% over 1991 and the highest landings on record for the last 8 years. Table 5.1.2, which contains the landings for 1990 to 1992 by month and country, shows that most of the increase took place from July to November in which months landings almost doubled compared to 1991. The area distribution is shown in Figure 5.1.1.

5.2 Fishing Effort and Catch Per Unit of Effort

Danish effort

Danish CPUE (tonnes per day fishing) by vessel category (Gross Register Tonnes) is shown in Table 5.2.1 for the period 1983 to 1992. CPUE has increased for all vessel categories since 1990 and, with the exception of the 251-300 GRT category, is now the highest on record.

In all years the CPUE of the 251-300 GRT vessels has been lower than the CPUE of the 201-250 GRT vessels. The consistently lower efficiency of these vessels may be explained by a low average horsepower which is at the same level as in the 201-250 GRT category. In previous years effort was standardized to a vessel size of 200 GRT by fitting a linear model to log CPUE versus GRT. In order not to smooth out the consistently lower CPUE of the 251-300 GRT category it was decided to use the raw CPUE values directly as an indication of relative fishing power. The effort was therefore standardized to the 151-200 GRT category by multiplying the quarterly number of fishing days of each vessel category by the average yearly CPUE of that category divided by the average yearly CPUE of the 151 to 200 GRT category. This approach was used to revise the time series of effort data back to 1984.

Norwegian effort

The number of fishing days and average GRT of Norwegian vessels fishing for Norway pout are shown by quarter in Table 5.2.2 for the period 1982 to 1992. The effort and mean GRT for the period 1982 to 1991 has been revised. The CPUE now refers to all landings reported as the category Norway pout. The total effort is obtained by dividing the estimated catch of biological Norway pout by the CPUE.

Combined Danish and Norwegian effort.

The Danish and Norwegian data were combined after the Norwegian data had been standardized to a vessel size of 175 GRT. This was done by fitting a linear model to the Danish log CPUE by vessel category with GRT as the independent variable:

$$\text{Log CPUE} = \log(a_{year}) + b*(\text{GRT}-50)$$

For the years 1988 to 1992 b was estimated to be 0.324. Prior to 1988 a value of b of 0.38 was used (Anon. 1988). The practice of using a constant b over several years was originally introduced in 1985 (Anon. 1985). In the present analysis, b was not found to vary significantly between years. The model was used to standardize the Norwegian data by multiplying the number of fishing days by:

$$\text{Effort}_{175} = \text{Effort}_x * [(x-50)/(175-50)]^b$$

where x is the average GRT of the vessel category. The combined Danish and Norwegian effort is shown in Table 5.2.3. Compared to 1991 total effort increased by 44% in 1992 and was the highest on record since 1984.

5.3 Catch at age

Catch in numbers at age was estimated from Danish and Norwegian samples (Table 5.3.1). The catch at age in 1992 was dominated by the 1991 year class. One year old fish accounted for 72% of the landings in weight in 1992 compared to 52% in 1991.

5.4 Weight, maturity and natural mortality at age

The mean weight at age in the catch by quarter for 1992 was estimated from Danish and Norwegian data (Table 5.4.1). The mean weight at age in the stock was the same as used in the 1990 report (Anon. 1990). Compared to previous reports the maturity at age 1 was reduced from 0.5 to 0.1. This follows the recommendation in the 1984 working group report (Anon 1984). Weight at age in the stock, maturity at age and natural mortality at age are given in Table 5.4.2.

5.5 Research Vessel Surveys

Updated research vessel indices are given in Table 5.5.1. Two points should be noted:

i) All indices back to 1982 from the Scottish Groundfish survey (SGFS) conducted in August have been re-computed uniformly and in the same way as other roundfish indices derived from the same surveys. Past indices have changed slightly but are believed to reflect changing abundances from year to year more accurately.

ii) In 1992, the net used on the English Groundfish survey (EGFS) conducted in August was changed from a Granton trawl to a GOV type. A correction factor for the 1992 results was estimated by regression analysis of year class numbers as described by Cotter (1993) using data from the English and Scottish GFSs, both being in the same season. Estimation was less accurate for Norway pout than for other species because of the short life span, and because Scottish data were in the form of a combined index representing round fish areas 1, 2 and 3 primarily (as shown in the table), rather than being disaggregated to the individual areas as would be preferred for the analysis. Data from the EGFS were available for the three areas individually. To compensate for expected effects on variance, the Scottish and English data were weighted 3 and 1 respectively in the GLM analysis. The selected model was:

$$\ln N = a.Age1 + b.Age2 + c.Yearclass + d.RFA + GOV + error$$

where N is the abundance index, Age1=0 for 0-group and 1 for older fish, and Age2=0 for 0-group and (age in years - 1) for older fish. (The use of dummy age variables in this way allows for the reduced availability of 0-group to the survey.) The SGFS results were arbitrarily designated as RFA=0 for the purpose of the model. All factors were found to be significant ($P<0.04$) except RFA which was marginal ($P=0.057$) but retained in the model nevertheless. The GOV net was estimated to fish 3.3 times more effectively than the Granton (-/+ 1 s.e.=2.0 and 5.7). The estimate is comparable to those obtained more accurately for cod, haddock and whiting (recently revised with data from EGFS 1993), and the decision was therefore taken to utilise it together with data from EGFS 1992 for tuning the Norway pout VPAs.

In Table 5.5.1 it is notable that the EGFS results for 0-group in 1992 are double those in 1991, and double again in 1993 to strengths not previously reached since the early 1980s. All three surveys indicate that the 1991 year class was strong as 1-group in 1992, but the IYFS and the EGFS differ in the relative strengths of the 2-group in 1993. The relative numbers of the 1990 year class as 3-group in 1993 show the same.

5.6 Stock Assessment

Separable seasonal VPA (SSVPA) and seasonal XSA (SXSA) were used to estimate the missing quarterly catch in numbers at age for 1990 and the state of the stock.

The SSVPA was used to fit catch at age data to combined Norwegian and Danish effort data from 1985 to 1992 and to combined EGFS, IYFS and SGFS survey indices. Only catch at age data for 1985 to 1989 and 1991/92 could be used. Because the SSVPA can only use one time series of survey indices at a time the available indices were combined by factor analysis using IYFS, EGFS and SGFS indices for ages 1 to 3 and SGFS for age 0. The resulting combined index as well as statistics from the factor analysis are given in Table 5.6.1. In the SSVPA the catch data, combined survey indices and effort data were given equal weight as this resulted in similar mean square residuals for each data set. Research vessel catchability was assumed to be constant for 2-year -old and older fish. Output statistics from the SSVPA are given in Table 5.6.2. The estimated selectivities increase with age and season to an extent which is not reflected by the CPUE data. The positive year/season effect residuals and positive research vessel residuals for 1992 suggest that the high research vessel indices are not reflected by the commercial CPUE.

The XSA is able to provide estimates of catches for which the SOP is in accordance with landings. Initially, the model was allowed to weight the various indices automatically by the inverse variance of the catchabilities. However, this procedure resulted in survey indices receiving 10-20 times the weight of the commercial cpue. As this resulted in large negative catch residuals for 1992, it was decided to give equal weight to commercial and research vessel cpue. This option, constraining the SOP of the unknown catches to the actual landings, and a linear model for catchability as a function of time with a 5 year cosine taper was applied in an attempt to estimate the 1990 catch at age data. Output statistics are given in Table 5.6.3. For ages 1 and 2 the log catch residuals are all negative in 1992 suggesting that commercial CPUE would underestimate the stock.

The XSA and SSVPA log catch residuals versus time are shown in Figure 5.6.1 for ages 1 and 2. For age 1 the catch residuals from both models show corresponding changes over time. Both series show large residuals in 1986 and 1989 and both decline from 1987 onwards.

Table 5.6.4 shows the estimated catch in numbers at age in 1990 from the SSVPA and the SXSA. For age 2 the results from both methods are very alike, but for age 1 the results differ in quarter 1 where the XSA estimates a catch at age 1 60% above the estimate from the SSVPA. The Working Group decided to use the catch in numbers estimated by SXSA since these were estimated

taking the observed wight of the landings into account. However, despite the fact that the catches estimated by the SSVPA are not constrained to have the same SOP as the landings, the results are very similar. This could give some confidence in the values adopted.

The results from the SXSA in terms of stock in numbers at age, total biomass and spawning stock biomass are given in Table 5.6.5. After a rapid decline from 370 thousand tonnes in 1984 to 92 thousand tonnes in 1986 the spawning stock biomass has gradually increased to 220 thousand tonnes at the beginning of 1992 (Figure 5.6.1). Quarterly fishing mortalities are given in Table 5.6.6.

Figure 5.6.2 compares the total stock biomass as estimated by SXSA and SSVPA to the stock biomass estimated by VPA at the 1990 meeting of the WG (Anon. 1990). With the exception of the terminal year the results from the SXSA show a close correspondence to the historic VPA. The biomass from the SSVPA is far below the biomass estimated by the two other methods, but shows the same trend over time.

The annual fishing mortality at age 1 is shown in Figure 5.6.3. The SXSA is seen to produce values in the same range as the historic VPA, albeit with less interannual variability, while the SSVPA estimates are consistently higher. Fishing mortality is estimated to have declined from a peak of 0.8 in 1985 to a level around 0.4 in recent years. This pattern is not reflected by the development of fishing effort which increased in 1992 to the highest value on record since 1984.

The sensitivity of the SXSA was investigated by retrospective analysis in which the terminal year was decreased from 1993 to 1989 (Figure 5.6.4). All of these runs produced almost identical values of total stock biomass at 1 January indicating that the results for the terminal year are quite robust.

5.7 Catch prediction

The SXSA can also be used to perform a catch prediction one year ahead provided catch at age data are available for all other quarters and years. The fishing effort was assumed to be equal to that in 1992. Using the estimate of the catch in numbers at age in 1990 and the IYFS and EGFS survey indices obtained in 1993 the total landings in 1993 were predicted to increase to 304 thousand tonnes, of which 129 thousand tonnes should be taken in the first two quarters. Preliminary estimates of the actual landings are approximately 68 thousand tonnes in the first two quarters of 1993.

6 NORWAY POUT IN DIVISION VIA

6.1 Landings

Landings of Norway pout as officially reported from Division VIa are given for the period 1974-1992 in Table 6.1. There have been considerable variations in landings over this period, varying from 38,000 t to 3,000 t. Landings in 1992 were relatively low, as in the previous two years.

7 SANDEEL IN DIVISION IIIA

7.1 Landings

Landings in 1992 are estimated to be about 39 000 tonnes (Table 7.1) representing an increase of almost 70% from 1991. The main part (34 610 tonnes) was recorded from the Skagerrak. Table 7.1 has been revised and the landings in 1982-89 are not likely to undergo further revision. For 1990-1992 a different method of estimating the Danish species composition has been used besides the one used hitherto. The estimated landings in these years are likely to be revised if the new method is adopted as standard in the future.

Landings in 1993 have not yet been estimated.

7.2 Biological Data

Sampling biological data was started in 1992 and continued in 1993. They show amongst other features that the landings do not consist entirely of *Ammodytes marinus* but also contain species like *A. lancea*, *Hyperoplus lanceolatus* and even *Gymnammodytes semisquamatus*. The second species is even the main constituent in some samples.

8 SANDEEL IN THE NORTH SEA

8.1 General

8.1.1 Landings in 1992 and 1993

Total landings in 1992 show a slight increase from 1991 and reached about 855,000 t (Table 8.1.1). Landings by country show an increase in Danish landings of about 50, 000 t while the Norwegian landings decreased by 40,000 tonnes. Table 8.1.2 shows that the fishery in 1992 came to an early end suggesting a lack of fishable concentrations of O-group sandeel in the second half of the year. Table 8.1.3 gives the monthly landings in each of the areas shown in Figure 2.2.1a.

Table 8.1.4 shows a substantial difference in development between the two assessment areas. In the northern

area landings went down by about 200,000 tonnes while those in the southern area increased by a similar amount to nearly 670,000 t which is the highest on record.

Figure 8.1.1 shows the distribution of the Danish and Norwegian catches combined by statistical rectangle in 1992. The landings from the new fishing grounds off the Firth of Forth increased further in 1992 to about 60 000 tonnes landed in Danish harbours. The exploitation began in 1990 with a catch of about 3 000 tonnes and increased to nearly 39 000 tonnes in 1991. In those two years the fishery off the Firth of Forth only took place in June.

Final landings figures for 1993 estimated by samples collected for species composition were not yet ready at the time of the Working Group meeting. Preliminary official figures, and data from log-books both point to a reduction of about 40% in the Danish landings as compared with 1992. As preliminary estimates of the Norwegian fishery do not indicate any major change from the previous year, this would indicate a Danish catch of about 450,000 t. One reason for the decrease in Danish landings was a strike in the last part of March and the first part of April 1993.

8.1.2 Effort and CPUE

The effort statistics and the estimation of CPUE were discussed by the Working Group and some preliminary revisions of the material were made.

Fishing effort (number of days fishing) are extracted from the fishermen's log-books if the landing is recorded as being more than 70% sandeel. In recent years the total landings selected in this way have exceeded those estimated from the market samples taken for species composition and presented in the catch tables of the Working Group report by the Working Group members. Discrepancies are thus apparent between catch figures in Table 8.1.2 and the "catch sampled for fishing effort" in Table 8.2.1.3. The misreporting has apparently increased in recent years and represents a bias confined to the second half year. While log-books are obligatory for Danish fishermen they are optional in the Norwegian industrial trawl fisheries. This makes it difficult to estimate the range of the bias so introduced. By-catches on the other hand, are not important in the case of sandeel.

One way to overcome the problem is to extract effort data from only those landings which are represented in the market samples for species composition, i.e. those for which there is evidence that the contents were sandeel. However, time did not permit such corrections to be made the last five years material in time for the Working Group meeting.

Another objection which could be made to the effort data, as hitherto presented, is the way in which they are standardised in order to obtain an estimate of the total international effort.

The Norwegian effort data (Table 8.2.1.2) are presented as the total number of fishing days and a mean GRT calculated by weighting each participating vessel's GRT by its number of trips. To convert the Norwegian CPUE to the standard CPUE corresponding to a vessel size of 200 tonnes, the multiplicative model CPUE=a*(gtr-50)**b was applied to all Danish data (Table 8.2.1.1), assuming that a is dependent on year and season, and b on season only, as originally suggested by the 1985 Working Group (Anon 1985). The ensuing values for b were 0.35 for the first half of the year and 0.24 for the second half of the year. The Norwegian data were standardized to a vessel size of 200 tonnes by applying these values of b to the mean GRT for each year and season.

The Danish effort data (Tables 8.2.1.1 and 8.3.1.1) are treated in 7 tonnage groups: 0-50, 51-100, 101-150, 151-200, 201-250, 251-300 and >300 GRT. Mean CPUEs are calculated for each group and a power function of the form:

$$\log \text{CPUE}(\text{season},\text{GRT}) = \log A + B^* \log \text{GRT}$$

is fitted by half-year and assessment area. CPUE for a 200 GRT vessel is then calculated using the parameters obtained and revised versions of which are shown in Tables 8.2.1.4 and 8.3.1.3. However, in order to estimate fishing power differentials between vessel categories, the vessels should ideally fish on the same concentration of fish, i.e. fish in the same place at the same time. This condition is not fulfilled by the routine outlined above and may in part explain the often very large differences in the two parameters estimated from one assessment to another. Figure 8.1.2 clearly shows that the smaller vessels are fishing close to the Danish coast while the larger the vessel the further is the area of action extended westward. A comparison of the vessel categories will thus include not only differences in fishing power but also very significant differences in stock densities and catchability.

The Working Group considered that a better approach would be to calculate efficiency coefficients and apply these to the actual number of days fishing by the respective vessel categories. The coefficients will probably be constant over an appreciable number of years considering the present stability in fleet composition.

A special feature apparent in Tables 8.2.1.3 and 8.3.1.1 is the fact that the CPUE of the vessel category 251-300 GRT is at the same level and often lower than the smaller 201-250 GRT group. The most probable explana-

tion is that, while the mean tonnage in the two categories are 229 and 276 GRT respectively, the mean horsepowers of 914 and 930 HP are only slightly different. This will make the bigger vessels less efficient and influence the fitted curve. Applying the revised method outlined above leaves the categories independent of each other.

8.2 Sandeel in the Northern North Sea

8.2.1 Fishing effort and CPUE

The effort data have been commented upon in the section above. It should be kept in mind that estimates for the second half-year are rather unreliable due to misreporting of catches. Table 8.2.1.1 giving Danish CPUE data has nevertheless been revised for both seasons and new standard CPUEs have been calculated as shown in Table 8.2.1.4. The low value in 1993 reflects the lower abundance of the 1992 year class. The Norwegian effort data are given in Table 8.2.1.2.

The standard international CPUEs have been calculated as the average of the Danish and Norwegian means weighted by the catch sampled for fishing effort and are shown in Table 8.2.1.3. The figures for 1982-1987 differ considerably from previous reports in which the Danish standard effort was scaled to the average value of the Norwegian time series because the Danish recorded CPUE was higher than the Norwegian CPUE. The Working Group could not accept this reason as being valid and pointed out that differences in the fishing areas of the two fleets could account for different CPUEs in the early period. Table 8.1.4 and Figure 2.2.1 suggest, for example, that the proportional catches in sandeel areas 2B and 3 have changed over the period in question and that Area 3 has been mainly exploited by Danish vessels.

8.2.2 Catch at age

Data were available from both the Danish and the Norwegian fisheries with a satisfactory coverage in the first half of 1992. The second half-year was poorly covered, as usual, but the season was short and the catch only amounted to about 14% of the total.

Age analyses have probably improved, but there are still appreciable differences between the two sets of national data. The Norwegian data give a higher average age than the Danish and the numbers per tonne are 67,500 and 115,300 for Norwegian and Danish data respectively. Again, geographical differences in the areas fished may be responsible. Catches in number at age are given in Table 8.2.2.1.

8.2.3 Weight at age

Mean weights at age for 1992 are shown in Table 8.2.3.1 together with revised data for 1991. The Danish and Norwegian data were combined by weighting by catches in number.

8.2.4 Stock assessment

A semi-annual XSA was run using the catch-at-age and effort data described above. The natural mortalities and the maturity ogive given in Tables 8.2.4.1 and 8.2.4.2 are the same as in previous assessments.

The estimates of unknown catches were constrained to give a sum of products equal to the assumed catch in tonnes, with weights at age being the mean values over the years 1989-1991.

Test runs weighting the catchabilities according to their inverse variance gave higher weight to the data from the second half of the year compared to the first half of the year, and also gave high weight to the oldest age groups. Since there is evidence that both the effort data and the age distributions may be more reliable for the first than for the second half of the year, and since the age distribution for the oldest ages is uncertain, the group decided to use the option for manual weighting of the catchabilities. The weighting factors are given in Table 8.2.4.3. The results in terms of stock numbers, fishing mortalities and estimates of unknown catches were not radically different by the two approaches.

The log catch residuals were generally quite high, but without any particular trend. This underlines the problems with using CPUE in the commercial fishery as the only data for calibrating the VPA, in particular when CPUE may reflect the concentration of fish in limited localities more than the total stock abundance. The results of the XSA are given in Table 8.2.4.3.

Average F over ages 1 - 2 is plotted against effort in Figure 8.2.1. The correspondence between F and effort is very poor.

The estimates of recruitment in the most recent years are very uncertain, because each of these is effectively determined by a single CPUE value. For this reason, and because actual catch data for comparison were not available, a prediction for the 1993
catches was not attempted.

For the above reasons, it is also apparent that the assessment will be quite unreliable for the most recent cohorts. The estimate of the state of the stock will therefore always lag behind. This can hardly be improved unless supplementary measures of stock abundance, e.g. by survey indices, become available.

8.3 Sandeel in the Southern North Sea

8.3.1 Fishing effort and CPUE

The mean CPUE per vessel category, the total estimated international effort and the calculated standard CPUEs revised back to 1987 are shown in Tables 8.3.1.1-8.3.1.3 respectively. After the rather low figures in 1991 the effort increased again in 1992 to the level of 1989 and 1990.

8.3.2 Catch at age

Catch in numbers at age were available for the Danish fishery. Catches from other nations were distributed by age using the Danish age distribution. Total catches in number at age are given in Table 8.3.2.1.

8.3.3 Weight at age

Weights at age in the catch were obtained from Denmark (Table 8.3.3.1). Weights at age in the stock, natural mortality and maturity ogive were not changed from previous years.

8.3.4 Assessment

A seasonal XSA was run on a half yearly basis, with the effort and catch at age data described above. The natural mortalities and the maturity ogive given in Tables 8.2.4.1 and 8.2.4.2 are the same as in previous assessments. The estimates of the unknown catches at age in 1990 were constrained to give a SOP equal to the assumed catch in tonnes, using as weights at age the mean values over the years 1989-1991.

As for the northern stock, test runs weighting the catchabilities according to their inverse variance gave higher weight to the data from the second half of the year compared to the first half of the year, and also gave high weight to the oldest age groups. Again, it was decided to use the option for manual weighting of the catchabilities. The weighting factors are given in Table 8.3.4.1. The results in terms of stock numbers, fishing mortalities and estimates of unknown catches were not radically different and for the run accepted are given in Table 8.3.4.1.

The log catch residuals were generally quite high, but without any particular trend.

Average F over ages 1 - 2 is plotted against effort in Fig 8.3.1. The correspondence between F and effort is generally quite good ($r = 0.77$ for 1982-1990), the first half of the year for 1991 being an exception. This fairly good correspondence may point to the age distributions as the most important source of the large log catch residuals. This again may possibly be influenced by the fishermen's tendency to remain on the same grounds as long as the fishery is satisfactory, which implies that strong year classes may be overrepresented in the catches.

The estimates of recruitment in the most recent years are very uncertain, since each of these are effectively determined by a single CPUE value.

For the reasons given above, and because actual catch data for comparison were not available, a prediction for the 1993 catches was not attempted.

8.4 Sandeel in the Shetland Area

8.4.1 Fishing effort and CPUE

The sandeel fishery at Shetland remained closed during 1992 and 1993, so there was no fishing effort or catch during these years. Standardised effort data for previous years are presented in Table 8.4.1, and catch-at-age data for the commercial fishery are given in Table 8.4.2. Total landings are shown in Tables 8.1.3 and 8.1.4.

8.4.2 Research vessel survey data.

The series of annual sandeel surveys at Shetland which started in 1984 was continued in 1992 and 1993. Details of the surveys, and of the calculation of the survey indices, were given in the previous Working Group Report (Anon. 1992). The surveys are conducted in August of each year which means that the indices from the 1993 survey were available to the Working Group. The indices are given in Table 8.4.3.

8.4.3 Weights at age.

With no recent commercial catch data from the stock, long-term average weights-at-age from the catch have been used to estimate biomass totals. These are given in Table 8.4.4.

8.4.4 Natural mortality and maturity

Natural mortality coefficients, and the proportion mature at age are as used previously. The values are given in Table 8.4.5.

8.4.5 Analytical assessment

Seasonal separable VPA (SSV) was used in the present assessment as it can use both commercial and survey data. At present the number of years' catch and survey data must correspond, so the present assessment only used catch data back to 1984. All available survey data up to and including 1993 were used.

Initial runs of the SSV gave equal weighting to commercial and survey catches at all ages. The diagnostics from these runs showed some large residuals on the commer-

cial catch at age 0, suggesting that these catches were less well sampled than those at older ages. Thus, in subsequent runs, the catch data at age 0 were given a weighting of 0.5 relative to the older ages. There was also a similar pattern in the research vessel catches at older ages (4+), so these were also down-weighted to the same extent. The survey data were given a weight of 0.5 relative to the catch and effort data as the survey has used a number of different vessels, including both commercial and research vessels.

Some diagnostics from the final SSV run are shown in Table 8.4.6. As previously, the catch residuals for the first half of 1987 show a large positive residual at age 1, with negative residuals at all older ages. This reflects the concentration of fishing effort on grounds where the relatively strong 1986 year class was concentrated, and thus represents a slight violation of the assumption of separability. The research vessel residuals show a suggestion of a shift from positive to negative over time. This may correspond to the shift from commercial to research vessels in conducting the survey.

8.4.6 Trends in biomass, fishing mortality and recruitment

Fitted populations since 1984 from the SSV are given in Table 8.4.7, along with spawning stock biomass estimates. This relatively short time series is a result of the constraint on the number of years of data which the program can handle. Trends in recruitment and spawning biomass are shown in Figure 8.4.1a and b. The estimates of the strength of the 1993 year-class, and the 1994 spawning biomass are subject to particularly high uncertainty and this is indicated on the graph. Fishing mortality estimates are given in Table 8.4.8.

The present assessment confirms that the 1991 year class is substantially stronger than any other recent year-classes, and its maturation at the start of 1993 has reversed the decline in spawning stock, which was at a historic low following a series of very poor year-classes. The first estimate of the 1993 year-class indicates that it may be of moderate strength.

8.4.7 Management considerations

The fishery was closed at the start of 1991 as the spawning stock had fallen to a historic low, and there was doubt over its ability to produce a strong year class and thus ensure stock recovery. Since then, the strong 1991 year-class has recruited to the stock. Research into factors affecting the availability of sandeels to seabirds at Shetland (Wright and Bailey, 1993), indicates that in 1991 there was a substantial influx of 0-group from areas to the south-west of Shetland. In general it seems highly likely that recruitment to the Shetland stock is not wholly dependent upon the amount of larvae spawned at Shetland, although the contribution from spawning areas outside of Shetland can vary considerably from year to year.

8.4.8 Quality of assessment

The assessment of the current state of the stock is based wholly on survey data and, for years where catch data are available, the fishing mortality is very low. Thus, this assessment is subject to particularly high uncertainty. In addition, the stock is at present dominated by the strong 1991 year-class so estimates of spawning stock are particularly sensitive to values of weight at age and maturity assumed for this year-class. Nonetheless, it is clear that this year-class is very strong and that it should have resulted in a marked increase in the spawning stock biomass, although the absolute level of that increase is uncertain.

8.4.9 Other issues

The main sandeel grounds off the south-east coast of Shetland are close to the site of the "Braer" oil spill in January 1993. Monitoring of the effects of the oil pollution have detected some contamination of sandeels, but whether this has had any deleterious effects on the population is as yet unclear. Work on this is still underway.

9 SANDEEL IN DIVISION VIa

9.1 Landings

Official landings of sandeels from Division VIa are given in Table 9.1 and in Figure 9.1.a. Landings in 1992 showed a further decline to just under 5,000 thousand t. This represents a 42% reduction on the 1991 figure, and is the lowest figure since the start of the fishery in 1980.

9.2 Fishing Effort and CPUE

Fishing effort data, in days absent by month, for the period 1981 to 1992 are given in Table 9.2. In recent years boats exploiting this fishery have occasionally landed their catch into the Faroes or Denmark, so the record of effort is incomplete. However, it is apparent that the reduced catches in 1992 were in line with a further decline in effort. As in 1991, the absence of a local processing plant is the main reason for the decline in the fishery.

Due to the low number of fishing trips made in 1992, and to the loss of information due to boats landing abroad, it was not possible to standardise effort to a fixed vessel size. For similar reasons, no correction has been made for the additional steaming time required to land the catch in Shetland. Nominal effort figures were

used for 1992. These are given in Table 9.3, together with standardised effort figures for previous years. The problems arising from this deterioration in the quality of the effort data are addressed in Section 9.6.

In 1992 and 1993 the August survey of sandeels at Shetland was extended to cover the west coast grounds. As there are only two years of data from this survey, and as there were differences in the grounds covered in the two years (due to bad weather), it is not yet possible to use these survey data in the assessment.

9.3 Catch at age

Catch at age data by month for 1992 are given in Table 9.4, and catch at age data by half-year for 1983 to 1992 are given in Table 9.5. There are some minor revisions of past data to allow for landings into foreign ports.

In 1992, sampling coverage was once again incomplete, but the 14 samples obtained came from areas/months which accounted for 67% of the total catch.

9.4 Weight at age

In view of the incomplete sampling coverage in recent years, long-term mean weights at age in the catch were used to estimate biomass totals. These are given in Table 9.6.

9.5 Natural Mortality and Maturity

Values used for natural mortality and proportion mature at age are as used previously. The values are given in Table 9.7.

9.6 Analytical Assessment

The assessment used a semi-annual separable VPA with equal weight given to the catch and effort data. The catches at age 0 were given a relative weighting of 0.5, to remove some large residuals at this age. As the diagnostics from this run (Table 9.8) show, there are still some quite large residuals at this age, but further down-weighting was not considered appropriate as the 0-group fish are an important component of the catch. The year/season effect residuals for 1992 are not particularly large, suggesting that the problems with the effort data have not caused any additional problems in the assessment. The residual mean-square associated with the effort data is rather smaller than that associated with the catch data, suggesting that it may be appropriate to give more weight to the effort data. In view of the known problems with these data, however, this has not been done.

9.7 Trends in Biomass, Fishing Mortality and Recruitment

Figures 9.1a-d show trends in landings, fishing mortality, recruitment and spawning stock. Population estimates from the SSV are given in Table 9.9, along with spawning stock biomass estimates, and fishing mortality is given in Table 9.10. Fishing mortality has always been lower than 0.2, and has declined steadily since 1989 to its present very low level. The 1991 year-class appears rather stronger than other recent year-classes, but its precise strength is still uncertain. The first estimate of the 1992 year class is also large but this estimate is subject to particularly high uncertainty, and the available survey data do not suggest that it is a strong year-class so this estimate has been omitted from the graph. Spawning biomass appears to be increasing, and the maturation of the 1991 year-class at the start of 1993 should have continued this trend.

9.8 Management considerations

Following the previous assessment of this stock, ACFM commented that this stock was virtually unexploited at present. Since then there has been a further decline in fishing effort and landings. With a recent strong year-class and an increasing spawning stock, there appears to be no reason for concern over this stock.

9.9 Quality of Assessment

The low level of landings and effort in this fishery has led to problems in catch sampling. Together with the tendency for some boats to land their catch into foreign ports, this means that there has been a decline in the quality of both catch and effort data in recent years. As fishing mortality is very low relative to natural mortality, it can be seen that this assessment is subject to particularly high uncertainty.

10 AREA DISTRIBUTION

10.1 Sandeels

The distribution of sandeels is not well shown by national groundfish surveys because they are not caught effectively by the gears used. Instead, an attempt was made to use fish stomach contents to provide indications of distribution. Data on the percentage by weight of sandeels in total stomach contents were available to the Working Group for cod in 1980, 1981, 1982 by quarter, and in 1985, 1986 and 1987 for the first and third quarters only. Preliminary data for mackerel in 1991 by quarter were also available. Except for these mackerel data, the results of the 1991 stomach sampling project were not yet available. Figures 10.1 a,b,c,d and e illustrate the results of the most complete surveys for

cod, those in 1980, 1981, 1985, 1986 and 1987; and Figure 10.1 f illustrates the results for mackerel in 1991.

Worthwhile distributional information is available from both predator species. Stocks of sandeel are revealed around Shetland, Orkney, along the coasts of eastern Scotland, eastern England, Netherlands, Germany and Denmark, as well as in the central and northeastern North Sea. The indications are, however, variable from quarter to quarter and year to year in the maps of cod stomach contents, and one cannot readily say whether this reflects varying distribution of sandeels or varying distribution or eating habits of the cod. The percentages of sandeels in mackerel stomachs in 1991 were generally higher than those for cod in earlier years, suggesting that the mackerel may be the better indicator. Their more patchy and seasonal distribution counts against this, however.

The Working Group did not have time to consider whether the occurrence of sandeels in stomach contents could provide a valid quantitative indicator of stock sizes. The uncertainties would include the effects of the presence of alternative prey for the indicator species, varying stocks of the indicator which would affect competition for food, varying feeding habits and migrational patterns, varying distributions in the water column, and possibly a host of other factors. Since these factors could vary from one sandeel stock to another, there would be reservations about relative stock sizes as well.

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Table 2.1 Species composition in the industrial fisheries in Division IIIa ('000 t), 1974-1992[1].

Year	Sandeel	Sprat[2]	Herring[3]	Norway pout	Blue whiting	Total
1974	8	71	76	13	-	168
1975	17	101	57	19	-	194
1976	22	59	38	42	-	161
1977	7	67	32	21	-	127
1978	23	78	16	25	-	142
1979	34	96	13	25	6	174
1980	39	84	25	26	14	188
1981	59	76	63	30	+	228
1982	25	40	54	44	5	168
1983	29	26	89	30	16	190
1984	26	36	112	46	15	235
1985	6	20	116	9	19	170
1986	73	11	65	6	9	164
1987	5	14	72	3	25	119
1988	23	9	97	8	15	152
1989	18	10	52	6	9	93
1990	16	10	51	27	10	114
1991	23	14	22	32	11	97
1992[4]	39	2	47	42	18	148
Mean 1974-1991	25	46	58	23	12[5]	160

[1]Data from 1974-1984 from Anon. (1986), 1985-1992 provided by Working Group members.
[2]Total landings from all fisheries.
[3]For years 1974-1985, human consumption landings used for reduction are included in these data.
[4]Preliminary.
[5]Mean 1979-1991.

Table 2.2 Species compositon in the industrial fisheries in the North Sea ('000 t), 1974-1992.

Year	Sandeel	Sprat	Herring	Norway pout	Blue whiting	Haddock	Whiting	Saithe	Other	Total
1974	525	314	-	736	62	48	130	42		1,857
1975	428	641	-	560	42	41	86	38		1,799
1976	488	622	12	435	36	48	150	67		1,791
1977	786	304	10	390	38	35	106	6		1,675
1978	787	378	8	270	100	11	55	3		1,612
1979	578	380	15	320	64	16	59	2		1,434
1980	729	323	7	471	76	22	46	-		1,675
1981	569	209	84	236	62	17	67	1		1,245
1982	611	153	153	360	118	19	33	5	24	1,476
1983	537	88	155	423	118	13	24	1	42	1,401
1984	669	77	35	355	79	10	19	6	48	1,298
1985	622	50	63	197	73	6	15	8	66	1,100
1986	848	16	40	174	37	3	18	1	33	1,170
1987	825	33	47	147	30	4	16	4	73	1,179
1988	893	87	179	102	28	4	49	1	45	1,388
1989	1,039	63	146	162	28	2	36	1	59	1,537
1990	591	71	115	140	22	3	50	8	40	1,033
1991	843	110	131	155	28	5	38	1	38	1,350
1992	854	214	128	252	45	11	27	-	30	1,561
1st qrt.	26.8	5.7	18.6	59.8	2.9	2.3	3.8	0.1	7.8	127.8
2nd qrt.	753.8	4.8	6.3	19.8	16.9	1.8	5.9	-	4.9	814.2
3rd qrt.	73.8	165.5	81.4	85.2	19.4	1.7	7.5	-	11.9	446.4
4th qtr.	+	37.8	21.7	87.6	5.6	5.0	9.7	-	5.0	172.4
Mean 1974-1991	687	218	67	313	58	17	55	11	47	1,472

Table 2.3 Landings (t) from the fisheries for sandeel and Norway pout in Division VIa. (Data as officially reported to ICES.)

Year	Sandeel	Norway pout	Total
1974	+	6,721	6,721
1975	+	8,655	8,655
1976	17	19,933	19,950
1977	67	5,206	5,273
1978	+	23,250	23,250
1979	-	20,502	20,502
1980	211	17,870	18,081
1981	5,972	7,757	13,729
1982	10,873	4,911	15,784
1983	13,051	8,325	21,376
1984	14,166	7,794	21,960
1985	18,586	9,697	28,283
1986	24,469	5,832	30,301
1987	14,479	38,267	52,746
1988	24,465	6,742	31,207
1989	18,785	28,196	46,981
1990	16,515	3,316	19,831
1991	8,532	4,348	12,880
1992[1]	4,137	5,158	9,295
Mean 1974-1991	9,455	12,629	22,084

[1]Preliminary.

Table 3.1 North Sea. Distribution of landings and associated by-catches of selected species ('000 t) from industrial fisheries by Denmark and Norway by landing categories to the north and south of 57°N, respectively, in 1992. (Data provided by Working Group members.)

Area	Fishery (target species)	Species composition									Total
		Norway pout	Sandeel	Sprat	Herring	Haddock	Whiting	Saithe	Blue whiting	Other	
north	Norway pout	238		+	11	7	15	+	10	10	292
	Sandeel	2	101	+	1	1	1		+	+	107
	Sprat[1]			+	+						+
	Other	6	2	1	5	+	1		34	2	50
	Sum	246	103	1	17	9	17	+	44	12	449
south	Fishery (target species)										
	Norway pout	+			+	+	+			+	+
	Sandeel	+	716	13	11	+	5			6	751
	Sprat[1]	+	2	159	14	+	1		+	2	179
	Other	6	19	40	85	2	3		1	9	166
	Sum	6	737	212	110	2	10		1	17	1096
Grand Total		252	840	213	127	11	27	+	45	29	1545

[1]Includes catches taken with purse seine by Norway.

Table 3.2 Sum of Danish and Norwegian by-catch by species and year in tonnes.

Species	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Gadus morhua	2352	4175	544	710	1092	1404	2988	2948	570	1044
Scomber scombrus	2075	1278	4	534	2663	6414	8013	5212	7466	4631
Trachurus trachurus	95[3]	133[3]	22789	16658	7391	18104	22723	14918	5704	6651
Trigla sp.	2[3]	2168	0	888[2]	45342[2]	5394[2]	9391[2]	2598[2]	5622[2]	4209
Limanda limanda	116[3]	149[3]	187	3209	4632	3781	7743	4706	5578	3986
Argentina spp.	10069[3]	6977[3]	8714	5210	3033	1918	778	2801	3434	2024
Hippoglossoides platessoides	44[3]	170[3]	59	718	1173	946	2160	1673	1024	1694
Pleuronectes platessa	10[3]	0	34	119	109	372	582	566	1305	218
Merluccius merluccius[3]	472	546	349	165	261	242	290	429	28	359
Trisopterus minutus	0	0	0	68[3]	0	5[2]	48[2]	121[2]	79[2]	111
Molva molva[3]	773	528	51	1	40	39	37	13	65	10
Glyptocephalus cynoglossus	314[3]	241[3]	236[3]	132	341	44	255[3]	251[3]	1439[3]	195[3]
Gadiculus argenteus[3]	4511	2690	1210	729	3043	2494	741	476	801	0
Others	21093	29261	31715[1]	3853	3604	3670	3528	3154	4444	4553
Total	41926	48316	65892	32994	72724	44827	59277	39866	37559	29685

[1]Danish cod and mackerel included.
[2]Only Danish catches.
[3]Norwegian catches. Danish catches included in "Others".

Table 4.1 Norway pout. Annual landings (tonnes) in Division IIIa. (Data as officially reported to ICES.)

Country	1976	1977	1978	1979	1980	1981	1982	1983	1984
Denmark	40,144	20,694	23,922	23,951	26,235	29,273	51,317	36,124	67,007
Norway	50[2]	104	362	1,182	141	752	1,265	990	947
Sweden	2,255	318	591[3]	32	39	60	60	52	+
Total	42,449	21,116	24,875	25,165	26,415	30,085	52,685	37,166	67,954

Country	1985	1986	1987	1988	1989	1990	1991[1]	1992[1]
Denmark	85,082	32,056	47,527	45,034	16,873	41,215	49,341	83,866
Norway	831	400	1,680	1,178	309	40	23	221
Sweden	-	+	-	-	+	+	3	5
Total	85,913	32,456	49,207	46,212	17,182	41,255	49,326	84,092

[1]Preliminary.
[2]Including by-catch.
[3]Includes North Sea.

Table 5.1.1 Norway pout annual landings ('000 t) in Sub-area IV, the North Sea, by countries in 1958-1992. (Data provided by Working Group members.)

Year	Denmark	Faroes	Norway	Sweden	UK (Scotland)	Others	Total
1958	-	-	-	-	-	-	-
1959	-	-	7.8	-	-	-	69.3
1960	17.2	-	13.5	-	-	-	30.7
1961	20.5	-	8.1	-	-	-	28.6
1962	121.8	-	27.9	-	-	-	14.7
1963	67.4	-	70.4	-	-	-	137.8
1964	10.4	-	51.0	-	-	-	61.4
1965	8.2	-	35.0	-	-	-	43.2
1966	35.2	-	17.8	-	-	+	53.0
1967	169.6	-	12.9	-	-	+	182.6
1968	410.8	-	40.9	-	-	+	451.8
1969	52.5	19.6	41.4	-	-	+	113.5
1970	142.1	32.0	63.5	-	0.2	0.2	238.0
1971	178.5	47.2	79.3	-	0.1	0.2	305.3
1972	259.6	56.8	120.5	6.8	0.9	0.2	444.8
1973	215.2	51.2	63.0	2.9	13.0	0.6	345.9
1974	464.5	85.0	154.2	2.1	26.7	3.3	735.8
1975	251.2	63.6	218.9	2.3	22.7	1.0	559.7
1976	244.9	64.6	108.9	+	17.3	1.7	435.4
1977	232.2	50.9	98.3	2.9	4.6	1.0	389.9
1978	163.4	19.7	80.8	0.7	5.5	-	270.1
1979	219.9	21.9	75.4	-	3.0	-	320.2
1980	366.2	34.1	70.2	-	0.6	-	471.1
1981	167.5	16.6	51.6	-	+	-	235.7
1982	256.3	15.4	88.0	-	-	-	359.7
1983	301.1	24.5	97.3	-	+	-	422.9
1984	251.9	19.1[1]	83.8	-	0.1	-	354.9
1985	163.7	9.9	22.8	-	0.1	-	196.5
1986	146.3	6.6	21.5	-	-	-	174.4
1987	108.3	4.8	34.1	-	-	-	147.2
1988	79.0	1.5	21.1	-	-	-	101.6
1989	95.6	0.8	65.3	-	0.1	0.3	162.7
1990	61.5	0.9	77.1	-	-	-	139.5
1991	85.0	1.3	68.3	-	-	+	154.6
1992	146.9	2.6	105.5	-	0	0.1	255.1

Table 5.1.2 Norway Pout, North Sea. National landings (t) by month, 1990-1992. (Data provided by Working Group members.)

Month	Denmark	Norway	Faroes	Total[1]
1990				
Jan	8,049	1,210		9,282
Feb	8,436	4,402		12,773
Mar	4,892	1,122		6,017
Apr	1,730	10,185		7,733
May	385	9,388		5,909
Jun	4,620	13,180		12,406
Jul	4,080	4,693		8,116
Aug	1,335	9,281		9,269
Sep	3,016	3,593		6,106
Oct	6,085	4,592		9,842
Nov	12,043	9,495		19,810
Dec	6,802	5,961		11,672
Total	61,473	77,102	850	139,425
1991				
Jan	11,601	5,755		17,495
Feb	10,141	6,996		17,275
Mar	5,633	2,514		8,212
Apr	410	3,913		4,358
May	96	3,878		4,006
Jun	-	9,491		9,567
Jul	316	7,107		7,483
Aug	3,460	8,397		11,952
Sep	10,683	4,808		15,615
Oct	20,894	7,017		28,135
Nov	12,086	3,826		16,040
Dec	9,629	4,632		14,375
Total	84,949	68,334	1,230	154,513
1992				
Jan	12,442	8,180		20,622
Feb	13,880	9,362		23,242
Mar	13,337	2,588		15,925
Apr	1,626	3,687		5,313
May	321	7,526		7,847
Jun	1,456	5,175		6,631
Jul	3,228	10,846		14,074
Aug	10,677	13,970		24,647
Sept	36,521	9,977		46,489
Oct	34,605	19,160		53,765
Nov	18,801	10,895		29,696
Dec	31	4,093		4,124
Total	146,925	105,459	2,586	254,970

[1]Monthly totals for 1990 estimated assuming Faroes catch is distributed over months as the sum of the Danish and Norwegian landings.

Table 5.2.1 Norway pout. Danish CPUE data (tonnes/day fishing) by vessel category for 1983-1992.

Vessel GRT	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
51-100	11.37	12.53	11.60	10.83	11.73	20.26	14.64	9.68	12.56	-
101-150	24.51	21.35	17.98	19.49	20.70	19.83	19.93	18.21	24.14	26.43
151-200	29.00	24.17	20.76	22.97	22.20	23.91	24.06	25.62	28.22	34.20
201-250	32.71	27.82	24.80	25.20	27.51	30.50	27.43	25.34	29.45	37.50
251-300	32.05	26.59	22.86	25.12	25.58	24.03	26.10	21.87	28.15	31.90
301-	31.81	37.47	26.86	26.63	31.10	40.09	28.92	25.91	36.73	41.84

Table 5.2.2 Days fishing and average GRT of Norwegian vessels fishing for Norway pout by quarter, 1982-1992.

		q1	q2	q3	q4
1982	Effort	528	1578	1043	616
	Ave GRT	161.2	122.5	160.5	170.9
1983	Effort	293	1168	2039	552
	Ave GRT	167.6	168.4	159.9	171.7
1984	Effort	509	1442	1576	315
	Ave GRT	141.7	121.3	140.9	182.2
1985	Effort	363	417	230	250
	Ave GRT	142.7	144.2	175.2	196.8
1986	Effort	429	598	195	222
	Ave GRT	166.5	121.8	170.7	212.4
1987	Effort	412	555	208	334
	Ave GRT	181.5	144.5	130	177.3
1988	Effort	296	152	73	590
	Ave GRT	200.2	131.7	191.1	202.9
1989	Effort	132	586	1054	1687
	Ave GRT	215.4	101.2	181.7	162.4
1990	Effort	369	2022	1102	1143
	Ave GRT	200.2	156.2	178.8	177
1991	Effort	774	820	1013	836
	Ave GRT	192.1	167.3	166.5	176.1
1992	Effort	1072	787	1514	1332
	Ave GRT	206.3	181.3	202.2	199.8

Table 5.2.3 Combined Danish and Norwegian fishing effort on North Sea Norway pout, 1982-1992.

Table 5.2.3						
		q1	q2	q3	q4	Total
1982	Norway	505	1283	995	608	3391
	Denmark*	1922	502	3929	2234	8587
Total		2427	1785	4924	2842	11978
						Total
1983	Norway	286	1144	1942	546	3919
	Denmark	2318	505	3725	3620	10168
Total		2604	1649	5667	4166	14087
						Total
1984	Norway	452	1165	1396	322	3336
	Denmark*	1887	454	3783	4433	10557
Total		2339	1619	5179	4755	13893
						Total
1985	Norway	324	374	230	266	1194
	Denmark	2177	232	2044	3340	7793
Total		2501	606	2274	3606	8987
						Total
1986	Norway	418	484	192	245	1340
	Denmark	1868	87	1249	2984	6188
Total		2286	571	1441	3229	7528
						Total
1987	Norway	420	499	176	336	1431
	Denmark	1169	7	1333	1946	4455
Total		1589	506	1509	2282	5886
						Total
1988	Norway	314	132	76	630	1152
	Denmark	910	3	464	1957	3334
Total		1224	135	540	2587	4486
						Total
1989	Norway	145	439	1072	1630	3285
	Denmark	565	76	1323	2009	3973
Total		710	515	2395	3639	7258
						Total
1990	Norway	392	1918	1113	1149	4571
	Denmark	890	297	342	964	2493
Total		1282	2215	1455	2113	7064
						Total
1991	Norway	807	803	990	838	3439
	Denmark	1153	24	384	1412	2973
Total		1960	827	1374	2250	6412
						Total
1992	Norway	1152	800	1614	1412	4978
	Denmark	1682	101	1213	1264	4260
Total		2834	901	2827	2676	9238

Table 5.3.1 NORWAY POUT in the North Sea. Catch in numbers at age by quarter (millions). + represents less than half a million. Data for 1990 only partly available and, therefore not included.

Year	1978				1979				1980			
Age	1	2	3	4	1	2	3	4	1	2	3	4
0	0	0	304	1,225	0	0	968	864	0	0	24	641
1	2,931	1,181	2,385	1,400	5,079	3,270	4,244	2,154	5,044	2,586	7,711	3,920
2	1,371	650	780	322	940	249	763	167	1,075	689	1,960	512
3	93	194	30	6	170	27	49	11	59	29	18	6
4+	4	+	0	0	3	1	0	0	2	5	0	0
Age Year	1981				1982				1983			
0	0	0	77	36,560	0	0	151	1,058	0	0	421	2,520
1	2,223	1,072	1,316	1,038	5,267	3,251	6,576	3,017	3,969	1,723	5,495	4,053
2	1,688	621	944	301	415	275	431	46	1,224	1,165	1,485	358
3	76	77	17	3	216	23	62	0	14	9	16	7
4+	6	2	0	0	0	0	0	0	0	0	1	1
Age Year	1984				1985				1986			
0	0	0	1	2,209	0	0	6	665	0	0	0	5,436
1	2,732	2,230	5,238	3,457	2,220	840	1,373	2,932	395	180	1,186	1,687
2	1,361	1,153	1,666	727	1,337	142	777	171	1,066	60	245	36
3	142	266	8	0	188	13	19	0	72	2	6	0
4+	0	0	0	0	1	0	0	0	3	0	0	0
Age Year	1987				1988				1989			
0	0	0	8	221	0	0	24	2,947	0	0	147	4,585
1	2,665	1,073	1,585	2,138	246	82	183	632	1,711	647	1,653	1,719
2	398	60	165	230	699	71	250	405	48	133	207	90
3	12	0	0	5	20	0	0	0	6	6	0	13
4+	1	0	0	0	0	0	0	0	0	0	0	0
Age Year	1990				1991				1992			
0					0	0	76	2,607	0	0	34	456
1					1,485	419	1,010	1,030	3,340	997	2,608	2,643
2					1,335	397	67	185	1067	230	372	254
3					93	19	1	17	117	20	1	2
4+					6	0	0	0	3	0	0	0

Table 5.4.1 Norway pout. North Sea 1986-1992. Mean weight at age by quarter. Danish and Norwegian catches combined (grams).

		Age Group				
Year	Quarter	0	1	2	3	4
1986	1	-	6.69	29.74	44.08	82.51
	2	-	14.49	42.92	55.39	-
	3	-	28.81	43.39	47.60	-
	4	7.20	26.90	44.00	-	-
1987	1	-	8.13	28.26	52.93	63.09
	2	-	12.59	31.51	-	-
	3	5.80	20.16	34.53	-	-
	4	7.40	23.36	37.32	46.60	-
1988	1	-	9.23	27.31	38.38	69.48
	2	-	11.61	33.26	-	-
	3	9.42	26.54	39.82	-	-
	4	7.91	30.60	43.31	-	-
1989	1	-	7.98	26.74	39.95	-
	2	-	13.49	28.70	44.39	-
	3	7.48	26.58	35.44	-	-
	4	6.69	26.76	34.70	46.50	-
1990	1	-	6.51	25.47	37.72	68.00
	2	-	13.75	25.30	40.35	-
	3	6.40	20.29	32.92	39.40	-
	4[1]	66.7	21.7	38.9	52.94	-
1991	1	-	7.85	20.54	35.43	44.3
	2	-	12.95	28.75	49.87	-
	3	6.06	30.95	44.28	67.25	-
	4	6.64	30.65	43.10	59.37	-
1992	1	-	8.12	25.73	41.80	43.9
	2	8.00	11.31	31.25	49.49	-
	3	6.70	26.52	42.42	50.00	-
	4	8.14	27.49	44.14	50.30	-

[1]Mean of 1989 and 1991 values.

Table 5.4.2 Norway pout. Mean weight at age in the stock, proportion mature and natural mortality.

Ae	w(g)				Matprop	M (per quarter)
	Q1	Q2	Q3	Q4		
0	-	-	4	6	0	0.4
1	7.0	15.0	25.0	23.0	0.1	0.4
2	22.0	34.0	43.0	42.0	1.0	0.4
3	40.0	50.0	60.0	58.0	1.0	0.4
4	56.0	56.0	-	-	1.0	0.4

Table 5.5.1 Research vessel indices for NORWAY POUT.

Year Class	IYFS[1] February			EGFS[2] August				SGFS[3] August		
	1-group	2-group	3-group	0-group	1-group	2-group	3-group	1-group	2-group	3-group
1968	-	6	-	-	-	-	-	-	-	-
1969	35	22	-	-	-	-	-	-	-	-
1970	1,556	653	-	-	-	-	-	-	-	-
1971	3,425	438	-	-	-	-	-	-	-	-
1972	4,207	399	-	-	-	-	-	-	-	-
1973	25,626	2,412	-	-	-	-	-	-	-	-
1974	4,242	385	-	-	-	-	25	-	-	-
1975	4,599	334	-	-	-	239	25	-	-	-
1976	4,813	1,215	-	-	770	119	-	-	-	-
1977	1,913	240	-	1,388	314	20	7	-	-	12
1978	2,690	611	-	1,209	600	60	25	-	346	9
1979	4,081	557	-	1,599	824	283	11	1,928	127	22
1980	1,375	403	9	151	385	13	1	185	44	1
1981	3,315	663	58	1,770	712	29	3	991	91	8
1982	2,331	802	71	1,818	517	93	2	490	69	5
1983	3,925	1,423	23	1,501	1,008	74	18	615	173	9
1984	2,109	384	65	160	300	47	-	636	54	1
1985	2,043	469	13	136	219	41	3	389	23	4
1986	3,023	760	178	109	152	34	5	338	209	14
1987	127	260	46	2	26	153	9	38	21	2
1988	2,079	773	129	45	350	45	2	382	51	6
1989	1,320	677	33	400	264	118	48[5]	206	42	24
1990	2,497	902	259	627	161	324[5]	34[4,5]	732	221	-
1991	5,121	2,644	-	401	1,877[5]	388[4,5]	-	1,715	-	-
1992	2,681	-		874[5]	1,095[4,5]	-				
1993	-			1,722[4,5]						

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area.
[2]English groundfish survey, arithmetic mean catch in no./h, 22 selected rectangles within Roundfish areas 1, 2, and 3.
[3]Scottish groundfish surveys, arithmetic mean catch no./h.'
[4]Preliminary.
[5]GOV adjusted to Granton trawl by dividing by 3.3.

Table 5.6.1 Factor analysis of RV indices.

Norway Pout, Compound RV indices from factor analysis.					
Year class	Age 0	Age 1	Age 2	Age 3	
1969		11	4		
1970		362	87		
1971		748	62		
1972		903	57		
1973		4752	276		
1974		910	55		
1975		980	80		
1976		1008	147		
1977	1388	421	30	12	
1978	1209	653	140	9	
1979	1599	1308	121	22	
1980	151	270	39	1	
1981	1770	875	74	8	
1982	1818	531	89	5	
1983	1501	793	152	9	
1984	160	521	53	1	
1985	136	387	40	4	
1986	109	381	112	14	
1987	2	34	39	2	
1988	45	423	68	6	
1989	400	260	71	24	
1990	627	519	186	50	
1991	401	1566	333		
1992	874	812			
1993	1722				
Norway Pout, Combined RV indices				(EGFS only at age 0)	
Indices by year					
Year	Age 0	Age 1	Age 2	Age 3	
1977	1388	1008	80		
1978	1209	421	147		
1979	1599	653	30		
1980	151	1308	140	12	
1981	1770	270	121	9	
1982	1818	875	39	22	
1983	1501	531	74	1	
1984	160	793	89	8	
1985	136	521	152	5	
1986	109	387	53	9	
1987	2	381	40	1	
1988	45	34	112	4	
1989	400	423	39	14	
1990	627	260	68	2	
1991	401	519	71	6	
1992	874	1566	186	24	
1993	1722	812	333	50	

cont'd.

Table 5.6.1 cont'd.

NORWAY POUT AGE 1

Sample covariance matrix

1.5624		
1.4540	1.6042	
1.4811	1.4233	1.5331

Sample correlation matrix

1.0000		
.9184	1.0000	
.9570	.9076	1.0000

Survey	Factor loadings	Uniqueness
IYFS	1.2097	.9909E-01
EGFS	1.0897	.1443E+00
SGFS	1.1115	.6265E-01

Number of iterations= 3<IFAIL= 0>

Year	weight	Estimated factor scores
1969	1.0000	11.0844
1970	1.0000	362.1911
1971	1.0000	747.8005
1972	1.0000	903.3392
1973	1.0000	4752.1175
1974	1.0000	910.2424
1975	1.0000	980.3978
1976	1.0000	1008.7862
1977	1.0000	421.8632
1978	1.0000	653.3688
1979	1.0000	1308.2776
1980	1.0000	270.2200
1981	1.0000	875.2059
1982	1.0000	530.8837
1983	1.0000	793.2482
1984	1.0000	521.2563
1985	1.0000	386.5806
1986	1.0000	381.9121
1987	1.0000	35.9577
1988	1.0000	422.6774
1989	1.0000	260.2895
1990	1.0000	519.3272
1991	1.0000	1565.9553
1992	1.0000	812.1595

NORWAY POUT AGE 2

Sample covariance matrix

1.6894		
1.2881	1.7114	
1.5256	1.2301	1.7645

Sample correlation matrix

1.0000		
.7575	1.0000	
.8836	.7079	1.0000

Survey	Factor loadings	Uniqueness
IYFS	1.1877	.2789E+00
EGFS	.9401	.4495E+00
SGFS	1.0454	.2329E+00

Number of iterations= 5<IFAIL= 0>

Year	weight	Estimated factor scores
1968	1.0000	1.4096
1969	1.0000	4.4237
1970	1.0000	87.4793
1971	1.0000	61.5517
1972	1.0000	56.7009
1973	1.0000	276.3134
1974	1.0000	54.9459
1975	1.0000	80.4938
1976	1.0000	146.8698
1977	1.0000	30.1576
1978	1.0000	140.2933
1979	1.0000	121.1062
1980	1.0000	39.4195
1981	1.0000	74.0093
1982	1.0000	88.5136
1983	1.0000	152.3998
1984	1.0000	53.3988
1985	1.0000	39.9034
1986	1.0000	112.0290
1987	1.0000	39.3166
1988	1.0000	67.5331
1989	1.0000	71.1216
1990	1.0000	186.2226
1991	1.0000	332.7308

NORWAY POUT AGE 3

Sample covariance matrix

1.1480		
.3083	1.6476	
.6380	1.1110	1.3258

Sample correlation matrix

1.0000		
.2241	1.0000	
.5171	.7517	1.0000

Survey	Factor loadings	Uniqueness
IYFS	.7417	.9980E+00
EGFS	.9661	.6790E+00
SGFS	1.0663	.1991E-01

Number of iterations= 5<IFAIL= 0>

Year	weight	Estimated factor scores
1977	1.0000	11.8920
1978	1.0000	9.2810
1979	1.0000	21.7471
1980	1.0000	.9921
1981	1.0000	7.8217
1982	1.0000	4.9260
1983	1.0000	9.0655
1984	1.0000	1.0204
1985	1.0000	3.9208
1986	1.0000	13.8245
1987	1.0000	2.0979
1988	1.0000	5.9234
1989	1.0000	24.1278
1990	1.0000	50.2456

Table 5.6.2 Output statistics from seasonal separable VPA.

NORWAY POUT NORTH SEA + Combined RV Indices.

Input parameters

weight for effort data = 1.0000
weight for RV data = 1.0000
RV catchability constant above age = 2

IFAIL on exit from E04FDF = 5

Initial sum of squares = 492.5397
Final sum of squares = 17.3270

Residual mean square = .1575

Coefficient of determination = .9648
Adj. Coeff. of determination = .9463

Number of observations = 169
Number of parameters = 59

IFAIL on exit from E04YCF = 0

Selectivities at age

age	1	2	3	4
0	.0000	.0000	.0002	.0354
1	.0921	.1744	.2145	.3818
2	.5516	.7488	1.0229	1.8880
3	.5516	.7488	1.0229	1.8880

Year/season effects

year	1	2	3	4
1985	1.0170	.2376	1.0156	1.5331
1986	.9167	.1581	1.1950	1.4113
1987	.7211	.2147	.5640	1.2216
1988	.4764	.0734	.2724	1.0744
1989	.2885	.2814	.7666	1.3810
1990	.5129	.8758	.5782	.8344
1991	.8718	.3362	.3616	.6466
1992	.8891	.2677	.7899	.9827

RV catchabilities

age	logQ
0	-6.9679
1	-4.2672
2	-3.4469
3	-.9676

cont'd.

Table 5.6.2 cont'd.

Estimated populations

	1985				1986			
	1	2	3	4	1	2	3	4
0	89482.	59982.	40207.	26947.	185789.	124538.	83480.	55947.
1	25874.	15794.	10157.	5476.	17108.	10540.	6873.	3565.
2	4427.	1693.	950.	225.	2044.	826.	492.	97.
3	16.	6.	3.	1.	8.	3.	2.	0.

	1987				1988			
	1	2	3	4	1	2	3	4
0	40435.	27104.	18168.	12177.	153712.	103036.	69067.	46295.
1	35673.	22376.	14448.	8581.	7817.	5015.	3319.	2098.
2	1394.	628.	358.	135.	3608.	1860.	1180.	599.
3	5.	2.	1.	0.	9.	5.	3.	1.

	1989				1990			
	1	2	3	4	1	2	3	4
0	131837.	88373.	59238.	39703.	149939.	100507.	67372.	45156.
1	29873.	19500.	12445.	7077.	25343.	16204.	9324.	5521.
2	933.	534.	290.	89.	2800.	1414.	492.	183.
3	53.	30.	16.	5.	4.	2.	1.	0.

	1991				1992			
	1	2	3	4	1	2	3	4
0	288491.	193382.	129627.	86887.	321905.	215779.	144641.	96943.
1	29388.	18180.	11492.	7128.	56923.	35157.	22492.	12727.
2	2691.	1115.	581.	269.	3733.	1532.	841.	251.
3	25.	10.	5.	3.	53.	22.	12.	4.

Total fishing mortality

	1985				1986			
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.054	.000	.000	.000	.050
1	.094	.041	.218	.585	.084	.028	.256	.539
2	.561	.178	1.039	2.894	.506	.118	1.222	2.665
3	.561	.178	1.039	2.894	.506	.118	1.222	2.665

	1987				1988			
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.043	.000	.000	.000	.038
1	.066	.037	.121	.466	.044	.013	.058	.410
2	.398	.161	.577	2.306	.263	.055	.279	2.028
3	.398	.161	.577	2.306	.263	.055	.279	2.028

cont'd.

Table 5.6.2 cont'd.

	1989				1990			
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.049	.000	.000	.000	.030
1	.027	.049	.164	.527	.047	.153	.124	.319
2	.159	.211	.784	2.607	.283	.656	.591	1.575
3	.159	.211	.784	2.607	.283	.656	.591	1.575

	1991				1992			
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.023	.000	.000	.000	.035
1	.080	.059	.078	.247	.082	.047	.169	.375
2	.481	.252	.370	1.221	.490	.200	.808	1.855
3	.481	.252	.370	1.221	.490	.200	.808	1.855

Fitted separable catches

	1985				1986			
	1	2	3	4	1	2	3	4
0	0.	0.	6.	704.	0.	0.	0.	4978.
1	1912.	529.	1651.	2039.	1145.	236.	1292.	1246.
2	1596.	229.	523.	191.	680.	76.	298.	81.
3	132.	10.	15.	0.	52.	2.	5.	0.

	1987				1988			
	1	2	3	4	1	2	3	4
0	0.	0.	7.	236.	0.	0.	19.	2741.
1	1893.	678.	1362.	2677.	277.	53.	156.	590.
2	382.	77.	132.	107.	693.	82.	239.	456.
3	10.	0.	0.	4.	16.	0.	0.	0.

	1989				1990			
	1	2	3	4	1	2	3	4
0	0.	0.	7.	4227.	0.	0.	5.	1085.
1	646.	771.	1564.	2432.	965.	1901.	900.	1255.
2	114.	84.	133.	73.	574.	573.	185.	125.
3	7.	6.	0.	11.	1.	1.	0.	0.

	1991				1992			
	1	2	3	4	1	2	3	4
0	0.	0.	59.	2486.	0.	0.	32.	535.
1	1873.	855.	709.	1296.	3698.	1324.	2906.	3323.
2	860.	206.	150.	163.	1212.	231.	394.	185.
3	73.	15.	1.	13.	97.	17.	1.	2.

Log catch residuals

	1985				1986			
	1	2	3	4	1	2	3	4
0	-.0346	-.0004	.0050	-.0570	-.0973	-.0327	-.7240	.0881
1	.1492	.4623	-.1843	.3635	-1.0639	-.2727	-.0855	.3030
2	-.1769	-.4773	.3953	-.1088	.4497	-.2409	-.1943	-.8051
3	.3504	.2775	.2327	-.4213	.3254	.1857	.1596	-.3494

cont'd.

Table 5.6.2 cont'd.

	1987				1988			
	1	2	3	4	1	2	3	4
0	.0792	.0892	.1720	-.0656	.0000	.0000	.2198	.0725
1	.3420	.4585	.1513	-.2250	-.1184	.4449	.1633	.0684
2	.0407	-.2527	.2235	.7624	.0083	-.1448	.0478	-.1183
3	.2268	-.3224	-.3759	.2662	.2447	.0000	-.4088	-.4735

	1989				1990			
	1	2	3	4	1	2	3	4
0	.0527	-.0561	.0067	.1104	.0000	.0000	.0000	.0000
1	.9780	-.1055	-.3550	-.2235	.0000	.0000	.0000	.0000
2	-.8616	.5520	.3960	.2103	.0000	.0000	.0000	.0000
3	.0089	.0317	-.6624	.1125	.0000	.0000	.0000	.0000

	1991				1992			
	1	2	3	4	1	2	3	4
0	.0000	.0000	.2451	.0474	.0000	.0000	.0755	-.1814
1	-.2323	-.7130	.3540	-.2296	-.0869	-.2834	-.1081	-.2288
2	.4394	.6546	-.8055	.1290	-.1275	-.0041	-.0580	.3172
3	.2441	.2281	-.0344	.2408	.1913	.1804	-.1726	-.0276

RMS for catch data = .2957

Year/season effect residuals

year	1	2	3	4
1985	-.0168	.0194	-.1107	-.0614
1986	-.0030	.3674	-.7295	-.0890
1987	-.1266	-.0593	.0675	-.2918
1988	.0269	-.3067	-.2325	-.0379
1989	-.0160	-.3121	.2225	.0522
1990	-.0006	.0112	.0061	.0125
1991	-.1066	-.0167	.4181	.3303
1992	.2426	.2968	.3584	.0851

RMS for effort data = .2256

Log RV residuals

	1985	1986	1987	1988	1989	1990	1991	1992
	1	1	1	1	1	1	1	
0	.0479	-.0473	-.2946	-.1168	.1170	.1491	.0389	.1059
1	.3620	.4783	-.2721	-1.1705	.0099	-.3124	.2308	.6740
2	.0752	-.2055	-.1044	-.0255	.2717	-.2710	-.1882	.4477
3	-.0879	.5208	-.2721	.0778	-.1797	.0916	-.2363	.0857

RMS for RV data = .2999

Table 5.6.3

Norway pout in the North Sea
****

XSA stock analysis with input from file:
file.lst

Unknown catches have been estimated
They were estimated so that they conform the SOP

Catcabilities at oldest age have been shrunk towards
those of the second oldest age.
with weight of the oldest: .0

The linear funct. model used for estimating catchabilities
A cosine taper over 5 years was applied

CPUE indexes have been weighted using fixed weights

Estimates of unknown catches

Year	Seas	Age	Catch	Init. c
1990	1	1	1547.8	2297.0
1990	1	2	661.7	500.0
1990	1	3	23.9	35.0
1990	1	4	6.7	6.0
1990	2	1	1689.2	938.0
1990	2	2	616.8	1032.0
1990	2	3	22.3	20.0
1990	3	0	21.8	215.0
1990	3	1	964.0	773.0
1990	3	2	188.1	305.0
1990	3	3	6.8	6.0
1990	4	0	1591.1	1814.0
1990	4	1	1017.4	907.0
1990	4	2	133.3	181.4
1990	4	3	4.8	18.1

SOP in season 1 28282.99
SOP in season 2 39729.99
SOP in season 3 26157.99
SOP in season 4 45252.99

Survivors (Year, age, number at end of the year)

1992	0	34564.00
1992	1	14221.36
1992	2	549.21
1992	3	24.50
1991	3	13.51
1990	3	10.41
1989	3	38.60
1988	3	23.55
1987	3	16.72
1986	3	34.96
1985	3	26.58
1984	3	20.67
1983	3	3.30
1982	3	83.51

cont'd.

Table 5.6.3 cont'd.

VPA: log catch residuals (log(actual/fitted))
using effort in commercial fleet and est. catchabilities

Year	1982				1983			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	.754	-.869	.	.	2.118	-.024
1	.181	-.011	-.089	-.253	-.196	-.687	-.569	-.504
2	-.019	.062	.031	-.101	-.642	.050	-.617	-.405
3	.599	-1.112	-.867	.	-.431	-.128	-.447	.647
4	.	.	.	.	.	.	.	.

Year	1984				1985			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	-3.310	.231	.	.	-.383	-.505
1	.006	-.029	-.057	-.175	.337	.556	.003	.509
2	-.578	-.010	-.520	.271	.161	-.288	.332	-.209
3	.051	1.842	-1.662	.	.976	.416	-.369	.
4	.	.	.	.	.	.	.	.

Year	1986				1987			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	.	.973	.	.	.702	-.872
1	-1.083	-.758	.513	.226	.604	.643	.283	.325
2	.855	-.071	.688	-.732	.059	-.437	-.253	.808
3	.379	-1.444	-1.227	.	-.348	.	.	-.466
4	.	.	.	.	.	.	.	.

Year	1988				1989			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	1.615	.516	.	.	-1.458	.601
1	-.498	.410	.124	-.100	.979	.316	-.427	-.075
2	.293	.436	.696	.610	-1.096	.446	-.093	-.442
3	.203	.	.	.	-.981	-.665	.	-.894
4	.	.	.	.	.	.	.	.

Year	1990				1991			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	.068	-.078	.	.	.596	-.402
1	.260	-.150	.068	-.078	-.414	-.695	.013	-.311
2	.260	-.150	.068	-.078	.569	.440	-.823	.068
3	.260	-.150	.068	-.078	.753	.299	-1.789	.613
4	.	.	.	.	.	.	.	.

Year	1992			
Season	1	2	3	4
Age				
0	.	.	.126	-1.311
1	-.725	-.564	-.498	-.249
2	-.390	-.747	-.280	-.218
3	.569	.283	-2.799	-1.631
4	.	.	.	.

cont'd.

Table 5.6.3 cont'd.

VPA: Log inverse catchabilities

Year	1982				1983			
Season	1	2	3	4	1	2	3	4
Fleet no: 1								
0	.	.	16.422	11.899	.	.	16.452	11.797
1	10.764	10.285	9.994	9.465	10.737	10.184	9.888	9.361
2	9.470	9.052	8.741	9.188	9.337	9.066	8.658	9.106
3	9.470	9.052	8.741	9.188	9.337	9.066	8.658	9.106
4	.	.	.	.	.	.	.	.
Fleet no: 2								
0	.	.	.	.	.	.	.	.
1	2.983	.	.	.	2.865	.	.	.
2	2.066	.	.	.	1.955	.	.	.
3	2.066	.	.	.	1.955	.	.	.
4	.	.	.	.	.	.	.	.
Fleet no: 3								
0	.	.	5.253	.	.	.	5.665	.
1	.	.	3.642	.	.	.	3.671	.
2	.	.	3.486	.	.	.	3.206	.
3	.	.	3.486	.	.	.	3.206	.
4	.	.	.	.	.	.	.	.
Fleet no: 4								
0	.	.	.	.	.	.	.	.
1	.	.	3.520	.	.	.	3.464	.
2	.	.	2.895	.	.	.	2.856	.
3	.	.	2.895	.	.	.	2.856	.
4	.	.	.	.	.	.	.	.

Year	1984				1985			
Season	1	2	3	4	1	2	3	4
Fleet no: 1								
0	.	.	16.328	11.661	.	.	16.275	11.495
1	10.729	10.070	9.798	9.292	10.653	9.957	9.749	9.247
2	9.216	9.023	8.557	8.994	9.180	8.945	8.498	8.927
3	9.216	9.023	8.557	8.994	9.180	8.945	8.498	8.927
4	.	.	.	.	.	.	.	.
Fleet no: 2								
0	.	.	.	.	.	.	.	.
1	2.882	.	.	.	2.882	.	.	.
2	1.859	.	.	.	1.791	.	.	.
3	1.859	.	.	.	1.791	.	.	.
4	.	.	.	.	.	.	.	.
Fleet no: 3								
0	.	.	6.039	.	.	.	6.284	.
1	.	.	3.782	.	.	.	3.849	.
2	.	.	3.060	.	.	.	2.856	.
3	.	.	3.060	.	.	.	2.856	.
4	.	.	.	.	.	.	.	.
Fleet no: 4								
0	.	.	.	.	.	.	.	.
1	.	.	3.509	.	.	.	3.537	.
2	.	.	2.761	.	.	.	2.722	.
3	.	.	2.761	.	.	.	2.722	.
4	.	.	.	.	.	.	.	.

cont'd.

Table 5.6.3 cont'd.

Year	1986				1987			
Season	1	2	3	4	1	2	3	4
Fleet no: 1								
0	.	.	16.192	11.339	.	.	16.072	11.187
1	10.561	9.867	9.706	9.223	10.479	9.813	9.671	9.223
2	9.130	8.872	8.466	8.868	9.056	8.769	8.504	8.807
3	9.130	8.872	8.466	8.868	9.056	8.769	8.504	8.807
4	.	.	.	.	.	.	.	.
Fleet no: 2								
0	.	.	.	.	.	.	.	.
1	2.891	.	.	.	2.890	.	.	.
2	1.720	.	.	.	1.651	.	.	.
3	1.720	.	.	.	1.651	.	.	.
4	.	.	.	.	.	.	.	.
Fleet no: 3								
0	.	.	6.442	.	.	.	6.591	.
1	.	.	3.899	.	.	.	3.967	.
2	.	.	2.696	.	.	.	2.522	.
3	.	.	2.696	.	.	.	2.522	.
4	.	.	.	.	.	.	.	.
Fleet no: 4								
0	.	.	.	.	.	.	.	.
1	.	.	3.582	.	.	.	3.601	.
2	.	.	2.694	.	.	.	2.688	.
3	.	.	2.694	.	.	.	2.688	.
4	.	.	.	.	.	.	.	.

Year	1988				1989			
Season	1	2	3	4	1	2	3	4
Fleet no: 1								
0	.	.	15.906	11.122	.	.	15.599	11.087
1	10.414	9.798	9.671	9.258	10.369	9.842	9.715	9.332
2	9.010	8.695	8.579	8.770	8.999	8.629	8.687	8.760
3	9.010	8.695	8.579	8.770	8.999	8.629	8.687	8.760
4	.	.	.	.	.	.	.	.
Fleet no: 2								
0	.	.	.	.	.	.	.	.
1	2.897	.	.	.	2.944	.	.	.
2	1.588	.	.	.	1.566	.	.	.
3	1.588	.	.	.	1.566	.	.	.
4	.	.	.	.	.	.	.	.
Fleet no: 3								
0	.	.	6.620	.	.	.	6.517	.
1	.	.	4.002	.	.	.	4.052	.
2	.	.	2.350	.	.	.	2.253	.
3	.	.	2.350	.	.	.	2.253	.
4	.	.	.	.	.	.	.	.
Fleet no: 4								
0	.	.	.	.	.	.	.	.
1	.	.	3.598	.	.	.	3.630	.
2	.	.	2.650	.	.	.	2.640	.
3	.	.	2.650	.	.	.	2.640	.
4	.	.	.	.	.	.	.	.

cont'd.

Table 5.6.3 cont'd.

Year	1990				1991			
Season	1	2	3	4	1	2	3	4
Fleet no: 1								
0	.	.	15.542	11.065	.	.	15.573	11.122
1	10.336	9.913	9.779	9.433	10.287	9.974	9.867	9.523
2	9.034	8.573	8.839	8.745	9.079	8.546	8.995	8.753
3	9.034	8.573	8.839	8.745	9.079	8.546	8.995	8.753
4	.	.	.	.	.	.	.	.
Fleet no: 2								
0	.	.	.	.	.	.	.	.
1	2.982	.	.	.	3.001	.	.	.
2	1.599	.	.	.	1.610	.	.	.
3	1.599	.	.	.	1.610	.	.	.
4	.	.	.	.	.	.	.	.
Fleet no: 3								
0	.	.	6.337	.	.	.	6.006	.
1	.	.	4.043	.	.	.	3.990	.
2	.	.	2.207	.	.	.	2.185	.
3	.	.	2.207	.	.	.	2.185	.
4	.	.	.	.	.	.	.	.
Fleet no: 4								
0	.	.	.	.	.	.	.	.
1	.	.	3.659	.	.	.	3.630	.
2	.	.	2.692	.	.	.	2.708	.
3	.	.	2.692	.	.	.	2.708	.
4	.	.	.	.	.	.	.	.

Year	1992			
Season	1	2	3	4
Fleet no: 1				
0	.	.	15.624	11.122
1	10.350	10.141	9.940	9.613
2	9.075	8.540	9.123	8.842
3	9.075	8.540	9.123	8.842
4	.	.	.	.
Fleet no: 2				
0	.	.	.	.
1	2.954	.	.	.
2	1.623	.	.	.
3	1.623	.	.	.
4	.	.	.	.
Fleet no: 3				
0	.	.	5.487	.
1	.	.	3.863	.
2	.	.	2.150	.
3	.	.	2.150	.
4	.	.	.	.
Fleet no: 4				
0	.	.	.	.
1	.	.	3.519	.
2	.	.	2.671	.
3	.	.	2.671	.
4	.	.	.	.

Table 5.6.4 Norway pout. Estimates of catch in numbers at age ($*10^{-6}$) in 1990 from SSVPA and SXSA.

Quarter	1		2		3		4	
Age	SXSA	SSEP	SXSA	SSEP	SXSA	SSEP	SXSA	SSEP
0					22	5	1591	1085
1	1548	965	1689	1901	964	900	1017	1255
2	662	574	617	573	188	185	133	125
3	24	1	22	1	7	0	5	0
4	7							
SOP	28283	20940	39730	40676	26158	24383	45253	48118
Landings	28283		39730		26158		45253	

Table 5.6.5

VPA: Stock numbers at age at start of season

Year	1982				1983			
Season	1	2	3	4	1	2	3	4
Age								
0			237450.	159044.			151586.	101267.
1	106760.	67251.	42418.	23050.	105744.	67633.	43925.	24945.
2	2969.	1650.	881.	238.	12981.	7699.	4207.	1604.
3	888.	418.	262.	125.	122.	70.	40.	13.
4	6.	4.	3.	2.	85.	57.	36.	24.
SSN	14539.				23762.			
SSB	175926.				369212.			
TSN	110623.				118931.			
TSB	848515.				1035398.			

Year	1984				1985			
Season	1	2	3	4	1	2	3	4
Age								
0			79173.	53070.			54888.	36787.
1	65818.	41882.	26249.	13307.	33765.	20816.	13266.	7768.
2	13403.	7870.	4331.	1539.	6089.	2987.	1886.	628.
3	782.	408.	56.	31.	437.	139.	82.	40.
4	20.	13.	9.	6.	25.	16.	11.	7.
SSN	20786.				9927.			
SSB	373323.				176445.			
TSN	80022.				40316.			
TSB	787975.				389168.			

Year	1986				1987			
Season	1	2	3	4	1	2	3	4
Age								
0			101205.	67840.			30455.	20408.
1	24115.	15841.	10471.	6048.	41024.	25317.	16092.	9489.
2	2807.	1009.	627.	220.	2673.	1466.	934.	491.
3	281.	129.	85.	52.	118.	69.	46.	31.
4	31.	19.	12.	8.	41.	26.	18.	12.
SSN	5531.				6934.			
SSB	91625.				94504.			
TSN	27234.				43855.			
TSB	243549.				352955.			

Year	1988				1989			
Season	1	2	3	4	1	2	3	4
Age								
0			85709.	57433.			87989.	58975.
1	13499.	8847.	5863.	3780.	36086.	22783.	14704.	8959.
2	4610.	2519.	1630.	887.	2017.	1313.	760.	348.
3	141.	78.	52.	35.	263.	171.	109.	73.
4	25.	17.	11.	7.	29.	19.	13.	9.
SSN	6126.				5917.			
SSB	117882.				81761.			
TSN	18275.				38395.			
TSB	202926.				309103.			

cont'd.

Table 5.6.5 cont'd.

Year	1990				1991			
Season	1	2	3	4	1	2	3	4
Age								
0			95525.	64014.			214359.	143627.
1	35667.	22641.	13794.	8457.	41607.	26675.	17537.	10928.
2	4413.	2416.	1115.	593.	4836.	2149.	1115.	693.
3	159.	87.	40.	21.	288.	117.	63.	41.
4	44.	24.	16.	11.	18.	7.	5.	3.
SSN	8183.				9303.			
SSB	130898.				148045.			
TSN	40283.				46749.			
TSB	355601.				410171.			

Year	1992			
Season	1	2	3	4
Age				
0			77795.	52120.
1	94142.	60371.	39652.	24444.
2	6482.	3472.	2139.	1129.
3	313.	114.	60.	39.
4	16.	8.	5.	4.
SSN	16225.			
SSB	221894.			
TSN	100952.			
TSB	814986.			

Table 5.6.6

VPA: Fishing mortalities at age

Year	1982				1983			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	.001	.008	.	.	.003	.031
1	.062	.060	.206	.171	.046	.031	.163	.216
2	.184	.223	.812	.263	.121	.200	.531	.309
3	.341	.069	.331	.000	.149	.168	.630	.883
4	.000	.000	.000	.000	.000	.044	.000	.000

Year	1984				1985			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	.000	.052	.	.	.000	.022
1	.052	.067	.272	.368	.083	.050	.133	.578
2	.130	.193	.592	.774	.303	.059	.646	.388
3	.245	1.233	.189	.000	.684	.120	.321	.000
4	.000	.000	.000	.000	.035	.000	.000	.000

Year	1986				1987			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	.000	.102	.	.	.000	.013
1	.020	.014	.147	.400	.082	.053	.126	.312
2	.582	.075	.604	.219	.197	.051	.238	.766
3	.362	.019	.089	.000	.131	.000	.000	.214
4	.122	.000	.000	.000	.030	.000	.000	.000

Year	1988				1989			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	.000	.064	.	.	.000	.102
1	.022	.011	.039	.223	.059	.038	.094	.299
2	.201	.035	.204	.739	.029	.144	.368	.367
3	.183	.000	.000	.000	.033	.047	.000	.234
4	.000	.000	.000	.000	.000	.000	.000	.000

Year	1990				1991			
Season	1	2	3	4	1	2	3	4
Age								
0	.	.	.000	.031	.	.	.000	.022
1	.054	.094	.088	.156	.044	.019	.072	.121
2	.198	.360	.226	.311	.395	.249	.075	.381
3	.198	.360	.226	.311	.475	.217	.028	.656
4	.198	.000	.000	.000	.476	.000	.000	.000

Year	1992			
Season	1	2	3	4
Age				
0	.	.	.001	.011
1	.044	.020	.083	.139
2	.220	.083	.233	.311
3	.573	.234	.019	.076
4	.279	.000	.000	.000

Table 6.1 Norway Pout. Annual landings (t) in Division VIa. (Data officially reported to ICES).

Country	1974	1975	1976	1977	1978	1979	1980	1981
Denmark	-	193	-	-	4,443	15,609	13,070	2,877
Faroes	1,581	1,524	6,203	2,177	18,484	4,772	3,530	3,540
Germany	179	-	8	-	-	-	-	-
Netherlands	-	322	147	230	21	98	68	182
Norway	144[3]	-	82[3]	-	-	-	-	-
Poland	75	-	-	-	-	-	-	-
UK (Scotland)[2]	4,702	6,614	6,346	2,799	302	23	1,202	1,158
Russia	40	2	7,147	-	-	-	-	-
Total	6,721	8,655	19,933	5,206	23,250	20,502	17,870	7,757

Country	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	751	530	4,301	8,547	5,832[4]	37,714[5]	5,849[5]	28,180[5]
Faroes	3,026	6,261	3,400	998	-	-	376	11
Germany	-	-	70	-	-	-	-	-
Netherlands	548	1,534	-	139	-	-	-	-
Norway	-		-	-	-	-	-	-
Poland	-	-	-	-	-	-	-	-
UK (Scotland)[2]	586	-	23	13	-	553	517	5
Russia	-	-	-	-	-	-	-	-
Total	4,911	8,325	7,794	9,697	5,832	38,267	6,742	28,196

Country	1990	1991	1992[1]
Denmark	3,316[5]	4,348	5,147
Faroes	-	-	-
Germany	-	-	-
Netherlands	-	-	10
Norway	-	-	-
Poland	-		-
UK (Engl.& Wales)	-	-	1
UK (Scotland)	+	-	-
Russia	-	-	-
Total	3,316	4,348	5,148

[1]Preliminary.
[2]Amended using national data.
[3]Including by-catch.
[4]Includes Division VIb.
[5]Included in Division IVa.

Table 7.1 SANDEEL, Division IIIa. Landings in tonnes . Official figures 1982-85, estimates provided by Working Group members 1986-92.

	Denmark	Norway	Sweden
1982	25364	-	5
1983	29169	178	31
1984	26436	-	-
1985	5610	-	-
1986	73133	-	-
1987	5410	-	-
1988	23159	-	-
1989	18170	-	-
1990*	15831	-	-
1991*	22989	-	-
1992*	38830		

*)preliminary

Table 8.1.1 Landings ('000 t) of sandeel from the North Sea, 1952-1992. (Data provided by Working Group members.)

Year	Denmark	Germany	Faroes	Netherlands	Norway	Sweden	UK	Total
1952	1.6	-	-	-	-	-	-	1.6
1953	4.5	+	-	-	-	-	-	4.5
1954	10.8	+	-	-	-	-	-	10.8
1955	37.6	+	-	-	-	-	-	37.6
1956	81.9	5.3	-	+	1.5	-	-	88.7
1957	73.3	25.5	-	3.7	3.2	-	-	105.7
1958	74.4	20.2	-	1.5	4.8	-	-	100.9
1959	77.1	17.4	-	5.1	8.0	-	-	107.6
1960	100.8	7.7	-	+	12.1	-	-	120.6
1961	73.6	4.5	-	+	5.1	-	-	83.2
1962	97.4	1.4	-	-	10.5	-	-	109.3
1963	134.4	16.4	-	-	11.5	-	-	162.3
1964	104.7	12.9	-	-	10.4	-	-	128.0
1965	123.6	2.1	-	-	4.9	-	-	130.6
1966	138.5	4.4	-	-	0.2	-	-	143.1
1967	187.4	0.3	-	-	1.0	-	-	188.7
1968	193.6	+	-	-	0.1	-	-	193.7
1969	112.8	+	-	-	-	-	0.5	113.3
1970	187.8	+	-	-	+	-	3.6	191.4
1971	371.6	0.1	-	-	2.1	-	8.3	382.1
1972	329.0	+	-	-	18.6	8.8	2.1	358.5
1973	273.0	-	1.4	-	17.2	1.1	4.2	296.9
1974	424.1	-	6.4	-	78.6	0.2	15.5	524.8
1975	355.6	-	4.9	-	54.0	0.1	13.6	428.2
1976	424.7	-	-	-	44.2	-	18.7	487.6
1977	664.3	-	11.4	-	78.7	5.7	25.5	785.6
1978	647.5	-	12.1	-	93.5	1.2	32.5	786.8
1979	449.8	-	13.2	-	101.4	-	13.4	577.8
1980	542.2	-	7.2	-	144.8	-	34.3	728.5
1981	464.4	-	4.9	-	52.6	-	46.7	568.6
1982	506.9	-	4.9	-	46.5	0.4	52.2	610.9
1983	485.1	-	2.0	-	12.2	0.2	37.0	536.5
1984	596.3	-	11.3	-	28.3	-	32.6	668.6
1985	587.6	-	3.9	-	13.1	-	17.2	621.8
1986	752.5	-	1.2	-	82.1	-	12.0	847.8
1987	605.4	-	18.6	-	193.4	-	7.2	824.6
1988	686.4	-	15.5	-	185.1	-	5.8	892.8
1989	824.4	-	16.6	-	186.8	-	11.5	1039.1
1990	496.0	-	2.2	0.3	88.9	-	3.9	591.3
1991[1]	701.4	-	11.2	-	128.8	-	1.2	842.6
1992	751.1	-	9.1	-	89.3	0.5	4.9	855.0

[1]Preliminary.
+ = less than half unit.
- = no information or no catch.

Table 8.1.2 Sandeel North Sea. Monthly landings (t) by country, 1987-1992. (Data provided by Working Group members.)

Year	Month	Denmark	Faroes	Norway	Scotland	Total[1]
1987	Jan	-	-	-	-	-
	Feb	-	-	-	-	-
	Mar	15,159	-	4,681	7	19,847
	Apr	59,495	412	13,921	875	74,703
	May	143,719	1,141	27,308	2,385	174,553
	Jun	278,659	10,251	80,527	1,233	370,670
	Jul	94,532	6,815	15,230	925	117,502
	Aug	7,320	-	37,049	1,521	45,890
	Sep	6,471	-	8,451	280	15,202
	Oct	-	-	6,214	1	6,215
	Nov	12	-	-	-	12
	Dec	-	-	-	-	-
	Total	605,367	18,619	193,381	7,227	824,594
1988	Jan		-	-	-	-
	Feb		-	-	-	-
	Mar	48,766		21,582	4	70,352
	Apr	147,839		27,181	1,518	186,538
	May	246,852		65,160	2,481	314,493
	Jun	169,526		32,995	744	203,265
	Jul	33,120	n/a	104	633	33,857
	Aug	21,155		5,212	198	26,565
	Sep	9,224		9,111	181	18,516
	Oct	9,885		13,709	36	23,630
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	686,367	15,531	185,054	5,795	877,216[1]
1989	Jan	-		-	-	-
	Feb	-		-	-	-
	Mar	62,927		23,117	106	86,150
	Apr	164,296		27,953	1,345	193,594
	May	300,524		61,764	4,912	376,200
	Jun	235,779	n/a	59,079	5,124	299,982
	Jul	31,670		187	-	31,857
	Aug	6,533		9,581	-	16,114
	Sep	22,705		5,086	-	27,791
	Oct	-		65	-	65
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	824,434	16,612	186,832	11,487	1,022,753[1]

[1]Excluding the Faroes.

Table 8.1.2 (cont'd)

Table 8.1.2 (cont'd)

Year	Month	Denmark	Faroes	Norway	Scotland	Total[1]
1990	Jan	-		-	-	-
	Feb	-		-	-	-
	Mar	24,700		11,542	-	36,242
	Apr	94,670		13,673	906	109,249
	May	181,582		35,394	2,184	219,160
	Jun	121,981	n/a	6,660	797	129,438
	Jul	17,307		1,101	-	18,408
	Aug	48,992		17,519	-	66,511
	Sep	6,793		2,541	-	9,334
	Oct	-		474	-	474
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	496,025	2,230	88,904	3,887	588,816[1]
1991	Jan	-		-	-	-
	Feb	-		-	-	-
	Mar	23,454		7,349	-	30,803
	Apr	78,374		12,582	30	90,986
	May	204,894	n/a	50,110	1,124	256,519
	Jun	217,334		13,176	-	230,509
	Jul	129,548		8,267	-	137,815
	Aug	43,024		16,955	-	59,979
	Sep	4,801		16,153	-	20,955
	Oct	-		4,242	-	4,242
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	701,429		128,834	1,154	831,808[1]
1992	Jan	-		-	-	-
	Feb	-		-	-	-
	Mar	22,686		3,490	392	26,269
	Apr	148,866		10,998	2,975	160,256
	May	242,170		29,149	1,469	274,294
	Jun	265,879		44,197	-	311,545
	Jul	64,910	n/a	1,464	-	66,374
	Aug	6,574		-	-	6,574
	Sep	1		-	-	1
	Oct	16		-	-	16
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	751,102	9,139	89,298	4,836	854,462

[1]Excluding the Faroes.

Table 8.1.3 Monthly landings of sandeels from each area in Figure 2.2.1a, 1989-1992.

Month	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland
1989											
Mar	0	14,831	441	2,221	63,853	-	4,695	-	-	76	11
Apr	61,528	10,782	-	34,479	61,686	-	22,350	1,024	133	421	1,193
May	121,323	4,771	-	113,244	61,961	240	38,946	4,013	328	20,452	1,763
Jun	43,429	158	11	12,924	133,876	-	16,613	21,379	3,282	67,624	536
Jul	1,272	154	-	1,284	290	-	17,825	3,778	790	6,412	-
Aug	786	32	-	2,688	7,240	-	4,891	333	-	109	-
Sep	-	227	-	1,057	5,195	1,291	20,017	-	-	-	-
Oct	-	-	-	-	65	-	-	-	-	-	-
Nov	-	-	-	-	-	-	-	-	-	-	-
Total	228,338	30,955	455	167,897	334,166	1,531	125,337	30,527	4,533	95,094	3,503
1990											
Mar	1,556	368	119	230	33,271	136	529	-	-	18	286
Apr	37,364	167	-	37,794	23,175	56	6,379	2,049	51	1,909	1,450
May	85,255	147	-	18,544	39,329	-	18,343	11,555	3,185	41,163	608
Jun	15,337	418	-	7,992	13,574	-	12,728	28,437	10,564	39,688	-
Jul	1,478	218	-	2,934	3,590	8	4,926	3,440	-	1,814	-
Aug	429	43	-	10,987	40,325	370	13,678	-	-	679	-
Sep	-	-	-	1,931	2,686	-	4,440	-	-	277	-
Oct	-	-	-	-	474	-	-	-	-	-	-
Nov	-	-	-	-	-	-	-	-	-	-	-
Total	141,419	1,361	119	80,412	156,424	570	61,023	45,481	13,800	85,548	2,344
1991											
Mar	902	494	-	1,582	26,528	737	548	-	4	8	-
Apr	8,443	356	680	27,611	34,413	418	18,032	138	-	892	3
May	86,975	4,631	-	9,615	106,294	615	39,939	4,038	660	3,144	-
Jun	91,485	1,005	-	26,522	12,671	-	34,263	10,261	115	54,187	-
Jul	30,976	411	-	43,619	15,253	-	13,174	8,195	215	25,972	-
Aug	4,624	223	-	4,631	37,052	-	4,567	-	-	8,882	-
Sep	4,789	-	-	391	15,762	-	13	-	-	-	-
Oct	-	-	-	-	4,242	-	-	-	-	-	-
Nov	-	-	-	-	-	-	-	-	-	-	-
Total	228,194	7,120	680	113,971	252,215	1,320	110,596	22,632	993	93,086	3
1992											
Mar	3,900	30	653	10,778	8,480	92	1,619	-	-	717	-
Apr	70,224	403	828	35,672	20,817	-	28,568	1,539	-	2,204	-
May	111,120	760	85	94,723	27,301	3	24,752	488	167	14,875	-
Jun	218,335	2,574	2,030	17,870	9,406	108	22,712	10,291	1,712	26,507	-
Jul	18,802	180	622	9,711	1,070	68	18,128	7,771	935	9,087	-
Aug	-	-	-	162	10	-	5,416	-	-	986	-
Sep	-	-	-	-	-	-	-	-	-	1	-
Oct	-	-	-	-	-	-	-	-	-	7	-
Nov	-	-	-	-	-	-	-	-	-	-	-
Total	422,381	3,948	4,218	168,916	67,083	271	101,204	20,089	2,834	54,381	-

Table 8.1.4 Annual landings ('000 t) of Sandeels by area of the North Sea [Denmark, Norway and UK (Scotland)]. (Data provided by Working Group members.)

Year	Area											Assessment areas[1]	
	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland	Northern	Southern
1972	98.8	28.1	3.9	24.5	85.1	0.0	13.5	58.3	6.7	28.0	0.0	130.6	216.3
1973	59.3	37.1	1.2	16.4	60.6	0.0	8.7	37.4	9.6	59.7	0.0	107.6	182.4
1974	50.4	178.0	1.7	2.2	177.9	0.0	29.0	27.4	11.7	25.4	7.4	386.6	117.1
1975	70.0	38.2	17.8	12.2	154.7	4.8	38.2	42.8	12.3	19.2	12.9	253.7	156.5
1976	154.0	3.5	39.7	71.8	38.5	3.1	50.2	59.2	8.9	36.7	20.2	135.0	330.6
1977	171.9	34.0	62.0	154.1	179.7	1.3	71.4	28.0	13.0	25.3	21.5	348.4	392.3
1978	159.7	50.2		346.5	70.3		42.5	37.4	6.4	27.2	28.1	163.0	577.2
1979	194.5	0.9	61.0	32.3	27.0	72.3	34.1	79.4	5.4	44.3	13.4	195.3	355.9
1980	215.1	3.3	119.3	89.5	52.4	27.0	90.0	30.8	8.7	57.1	25.4	292.0	401.2
1981	105.2	0.1	42.8	151.9	11.7	23.9	59.6	63.4	13.3	45.1	46.7	138.1	378.9
1982	189.8	5.4	4.4	132.1	24.9	2.3	37.4	75.7	6.9	74.7	52.0	74.4	479.2
1983	197.4	-	2.8	59.4	17.7	-	57.7	87.6	8.0	66.0	37.0	78.2	419.0
1984	337.8	4.1	5.9	74.9	30.4	0.1	51.3	56.0	3.9	60.2	32.6	91.8	532.8
1985	281.4	46.9	2.8	82.3	7.1	0.1	29.9	46.6	18.7	84.5	17.2	79.7	513.5
1986	295.2	35.7	8.5	55.3	244.1	2.0	84.8	22.5	4.0	80.3	14.0	375.1	457.4
1987	275.1	63.6	1.1	53.5	325.2	0.4	5.6	21.4	7.7	45.1	7.2	395.9	402.8
1988	291.1	58.4	2.0	47.0	256.5	0.3	37.6	35.3	12.0	102.2	4.7	384.8	487.6
1989	228.3	31.0	0.5	167.9	334.1	1.5	125.3	30.5	4.5	95.1	3.5	492.4	526.3
1990	141.4	1.4	0.1	80.4	156.4	0.6	61.0	45.5	13.8	85.5	2.3	219.5	366.7
1991	228.2	7.1	0.7	114.0	252.8	1.8	110.5	22.6	1.0	93.1	+	372.9	458.9
1992	422.4	3.9	4.2	168.9	67.1	0.3	101.2	20.1	2.8	54.4	0	176.7	668.6

[1]Assessment areas: Northern - Areas 1B, 1C, 2B, 2C, 3.
Southern - Areas 1A, 2A, 4, 5, 6.

Table 8.2.1.1 Sandeel Northern North Sea. Danish CPUE data.

Year	Vessel size (GRT)						
	5-50	50-100	100-150	150-200	200-250	250-300	>300
				First half year			
1982	11.2	17.2	31.8	26.7	47.6	40.8	25.8
1983	11.1	17.1	23.6	23.9	31.6	36.4	41.3
1984	14.6	24.8	33.4	32.1	44.4	55.5	19.7
1985	12.1	17.2	35.7	51.2	57.9	67.2	55.8
1986	21.0	32.0	45.5	50.2	63.9	57.4	71.8
1987	23.7	37.8	67.0	66.5	78.6	79.9	113.0
1988	19.0	25.6	34.4	42.5	48.0	47.8	75.3
1989	16.3	25.2	36.7	41.0	49.6	51.4	76.2
1990	14.5	21.6	27.3	27.8	29.5	27.4	39.7
1991	16.7	25.5	38.4	42.5	47.6	47.5	72.2
1992	16.6	24.6	36.3	34.7	60.6	46.9	76.9
1993	14.9	19.3	33.6	36.5	47.2	51.1	51.8
				Second half year			
1982	-	17.7	33.6	46.7	19.9	-	-
1983	17.9	25.7	31.0	32.9	44.5	34.3	57.1
1984	113.2	22.0	21.5	35.2	-	28.3	24.0
1985	21.6	23.5	25.8	39.6	60.7	33.3	-
1986	17.1	27.5	50.2	50.0	77.9	74.0	80.7
1987	21.3	31.8	23.9	24.3	42.6	25.4	46.3
1988	16.8	21.3	30.0	32.4	38.0	33.1	43.9
1989	16.6	22.3	23.6	27.3	28.3	35.6	25.0
1990	17.6	32.5	29.4	34.1	40.4	32.6	53.3
1991	15.1	26.3	40.8	44.8	54.4	51.3	72.5
1992	20.4	25.4	35.2	38.2	53.6	50.9	52.1

Table 8.2.1.2 Sandeel northern North Sea. Norwegian effort data.

Year	Fishing days		Mean gross register tonnage (GRT)	
	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
1976	595	-	198.8	-
1977	2,212	457	172.3	184.9
1978	1,747	806	203.4	203.7
1979	1,407	1,720	213.8	188.9
1980	2,642	1,099	215.5	210.3
1981	1,740	404	216.6	190.9
1982	1,206	-	209.1	-
1983	304	66	254.6	191.1
1984	145	-	182.6	-
1985	366	-	219.5	-
1986	1,562	567	201.1	187.4
1987	2,123	1,584	218.8	200.9
1988	3,571	925	203.3	198.2
1989	4,292	588	192.3	202.1
1990	2,275	683	207.9	185.6
1991	1,749	958	199.7	194.1
1992	1,202	23	204.5	212.7

Table 8.2.1.3 Fishing effort indices for SANDEEL in the Northern North Sea (days fishing multiplied by scaling factors for each vessel category to represent days fishing for a vessel of 200 GRT)

Year	Norwegian			Danish		Mean CPUE (t/day)	Total Intnat. catch ('000 t)	Derived Intnat. effort ('000 days)
	Standardized fishing days	Catch sampled for fishing effort (;000 t)	CPUE (t/day)	Catch sampled for fishing effort ('000 t)	CPUE (t/day)			
				First half of year				
1976	593	11.1	18.7	-	-	18.7	110.3	5.9
1977	2,061	50.4	24.4	-	-	24.5	276.0	11.2
1978	1,761	44.9	25.5	-	-	25.5	109.7	4.3
1979	1,451	29.6	20.4	-	-	20.4	47.7	2.3
1980	2,733	112.8	41.3	-	-	41.3	220.9	5.4
1981	1,804	42.8	23.7	-	-	23.7	93.3	3.9
1982	1,231	26.9	21.9	13.5	34.9	26.2	62.3	2.4
1983	338	8.7	25.7	17.4	28.9	27.8	54.5	2.0
1984	139	3.5	25.2	54.1	41.2	40.2	74.1	1.8
1985	382	8.7	22.8	47.4	46.7	43.0	69.9	1.6
1986	1,565	60.4	38.6	154.1	54.7	50.2	221.3	4.4
1987	2,212	122.9	55.6	213.2	72.5	66.3	360.9	5.4
1988	3,598	143.8	40.0	158.1	45.1	42.7	332.0	7.8
1989	4,214	146.9	34.9	267.3	45.9	42.0	435.2	10.4
1990	2,316	58.6	25.3	94.9	28.8	27.5	148.7	5.4
1991	1,748	67.7	38.7	210.6	45.0	43.5	282.2	6.5
1992	1,214	53.7	44.2	124.0	42.4	42.9	151.2	3.5
1993	-	-	-		39.4	-	-	-
				Second half of year				
1976	108	2.0	18.5	-	-	18.5	44.9	2.4
1977	445	11.8	26.5	-	-	26.5	110.0	4.2
1978	811	22.5	27.6	-	-	27.8	53.3	1.9
1979	1,688	52.2	30.9	-	-	30.9	147.7	4.8
1980	1,117	33.1	29.6	-	-	29.5	71.1	2.4
1981	398	7.9	19.6	-	-	19.9	44.9	2.3
1982	-	-	-	1.8	32.3	33.0	12.0	0.4
1983	65	2.4	36.9	12.3	36.6	37.3	23.7	0.6
1984	-	-	-	10.7	29.6	30.2	17.7	0.6
1985	-	-	-	16.4	38.0	38.8	16.8	0.4
1986	555	21.8	39.3	96.1	60.2	57.4	153.8	2.7
1987	1,586	68.1	42.9	5.5	30.8	42.1	76.9	1.8
1988	922	26.9	29.2	41.5	32.4	31.6	71.4	2.3
1989	590	11.5	19.5	44.9	26.1	25.2	57.2	2.3
1990	667	22.8	34.2	65.8	35.7	35.9	70.8	2.0
1991	949	30.3	31.9	96.0	46.5	43.8	90.7	2.1
1992	23	1.5	64.0	48.0	41.5	42.2	25.5	0.6

Table 8.2.1.4 Standard CPUE for a vessel of 200 GRT calculated from the data given in Table 8.2.1.1.

Northern North Sea

Half-year		R-square	a	b	CPUE
1987	I	0.97	4.108	0.5417	72.5
	II	0.40	11.070	0.1973	31.5
1988	I	0.96	3.837	0.4650	45.1
	II	0.94	5.482	0.3394	33.1
1989	I	0.99	2.817	0.5267	45.9
	II	0.67	9.197	0.2014	26.7
1990	I	0.94	5.421	0.3150	28.8
	II	0.84	6.650	0.3215	36.5
1991	I	0.98	3.302	0.4981	45.0
	II	0.98	2.656	0.5444	47.5
1992	I	0.92	3.036	0.5075	44.7
	II	0.91	5.709	0.3785	42.4
1993	I	0.93	2.810	0.4983	39.4
	II	-	-	-	-

Table 8.2.2.1 Sandeels in the northern North Sea. Catch in numbers, half-year (millions).

Age group	1977		1978		1979		1980		1981	
	1	2	1	2	1	2	1	2	1	2
0	3,686	3,067	-	7,820	-	44,203	17	8,349	17	9,128
1	24,307	2,856	6,127	1,001	2,335	1,310	13,394	1,173	5,505	346
2	2,351	913	2,338	307	1,328	433	8,865	214	4,109	94
3	516	142	573	39	242	66	1,050	19	904	14
4	124	99	78	1	5	10	645	4	128	6
5+	20	43	66	1	7	-	183	4	46	-

Age group	1982		1983		1984		1985		1986	
	1	2	1	2	1	2	1	2	1	2
0	2	6,530	-	7,911	-	-	1	349	7	7,105
1	3,518	65	5,684	303	11,692	1,207	2,688	109	23,934	7,077
2	2,132	-	1,215	316	1,647	121	3,292	239	2,600	473
3	556	-	89	19	153	43	1,002	89	200	-
4	76	-	8	-	5	-	377	7	-	-
5+	9	-	4	-	-	-	103	4	-	-

Age group	1987		1988		1989		1990[1]		1991	
	1	2	1	2	1	2	1	2	1	2
0	-	455	2,453	13,196	6,163	3,380	1,599	18,293	-	13,616
1	26,236	5,768	9,855	1,283	57,002	4,038	10,551	-	41,855	866
2	10,855	198	25,922	340	2,233	274	1,481	-	2,342	28
3	350	-	1,319	119	3,406	-	232	-	908	8
4	107	-	26	17	-	-	-	-	225	3
5+	48	-	-	-	-	-	-	-	93	-

Age group	1992	
	1	2
0	137	6,797
1	9,871	48
2	4,056	3
3	486	-
4	195	-
5+	110	-

[1]Based on Norwegian data only.
Note: 1 = Jan-Jun.
2 = Jul-Dec.

Table 8.2.3.1 SANDEEL North Sea. Northern area. Mean weight at age (g) in the catch for 1991 (revised) and 1992. Data from Denmark and Norway.

1991	Half-year	
Age	1	2
0	2.87	3.42
1	7.43	9.57
2	14.23	14.99
3	22.40	16.20
4	29.93	-
5+	33.15	-
1992		
Age	1	2
0	-	5.48
1	5.45	18.03
2	10.86	25.40
3	18.49	21.56
4	25.28	39.33
5+	38.15	-

Table 8.2.4.1 SANDEEL Natural Mortality Coefficients

Age	I	II
0		0.8
1	1.0	0.2
2	0.4	0.2
3	0.4	0.2
4	0.4	0.2
5	0.4	0.2
6	0.4	0.2
7+	0.4	0.2

Table 8.2.4.2 SANDEEL, Proportion mature at age

Age	Proportion Mature
0	0
1	0
2	1
3	1
4	1
5	1
6	1
7+	1

Table 8.2.4.3

Sandeel in the Nort Sea
Northern stock
****

XSA stock analysis with input from file:
file.lst

Unknown catches have been estimated
They were estimated so that they conform the SOP

Catcabilities at oldest age have been shrunk towards
those of the second oldest age.
with weight of the oldest: .0

The linear funct. model used for estimating catchabilities

CPUE indexes have been weighted using fixed weights

Estimates of unknown catches

Year	Seas	Age	Catch	Init. c
1990	1	1	8653.0	22901.0
1990	1	2	5783.2	3435.0
1990	1	3	640.2	229.0
1990	1	4	2.2	1.0
1990	1	5	138.0	1.0
1990	2	0	11388.4	15804.0
1990	2	1	1366.1	1580.0
1990	2	2	529.7	1.0
1990	2	3	95.5	1.0
1990	2	4	.3	1.0

SOP in season 1 148400.0
SOP in season 2 70800.0

Survivors (Year, age, number at the end of the year)

1992	0	273662.47
1992	1	6996.33
1992	2	100.92
1992	3	257.01
1992	4	40.62
1991	4	7.54
1990	4	1.00
1989	4	137.35
1988	4	11.09
1987	4	78.99
1986	4	872.11
1985	4	95.69
1984	4	65.41
1983	4	148.41
1982	4	112.82

cont'd.

Table 8.2.4.3 cont'd.

VPA: Fishing mortalities at age

Year	1982		1983		1984		1985	
Season	1	2	1	2	1	2	1	2
Age								
0	.	.093	.	.114	.	.000	.	.002
1	.291	.013	.225	.027	.532	.172	.216	.019
2	1.231	.000	.373	.180	.220	.025	1.008	.252
3	.763	.000	.339	.128	.137	.058	.327	.049
4	.359	.000	.035	.000	.045	.000	1.042	.064
5	.355	.000	.000	.000	.000	.000	.666	.057

Year	1986		1987		1988		1989	
Season	1	2	1	2	1	2	1	2
Age								
0	.	.024	.	.007	.	.058	.	.062
1	.362	.303	.235	.122	.466	.179	.841	.282
2	.884	.535	1.122	.076	1.230	.071	.584	.154
3	.382	.000	1.115	.000	1.041	.350	1.799	.000
4	.000	.000	.602	.000	.480	.801	.000	.000
5	.000	.000	.042	.000	.000	.000	.000	.000

Year	1990		1991		1992	
Season	1	2	1	2	1	2
Age						
0	.	.080	.	.197	.	.016
1	.471	.225	1.057	.141	.466	.006
2	.895	.246	.800	.024	1.690	.026
3	.692	.255	.924	.023	.742	.000
4	.692	.255	1.608	.302	1.154	.000
5	.692	.000	3.551	.	.	.

VPA: Stock numbers at age at start of season

Year	1982		1983		1984		1985	
Season	1	2	1	2	1	2	1	2
Age								
0		101487.		100526.		41276.		240481.
1	17629.	6144.	38968.	13073.	36224.	9013.	16803.	6749.
2	3268.	464.	4553.	2233.	9939.	5501.	5734.	1236.
3	1190.	343.	364.	174.	1426.	896.	4252.	2039.
4	298.	138.	280.	181.	125.	80.	645.	125.
5	36.	17.	126.	85.	218.	146.	185.	60.
SSN	4791.		5324.		11707.		10817.	
SSB	113840.		117442.		204047.		218615.	
TSN	22420.		44292.		47931.		27619.	
TSB	228428.		370732.		385165.		302629.	

Year	1986		1987		1988		1989	
Season	1	2	1	2	1	2	1	2
Age								
0		386134.		82108.		337310.		77305.
1	97823.	31531.	152683.	60051.	33121.	9233.	129214.	19189.
2	4917.	1285.	17644.	3190.	39765.	6003.	5794.	2268.
3	745.	352.	568.	102.	2245.	437.	4169.	6.
4	1589.	1065.	275.	96.	77.	32.	250.	168.
5	142.	95.	950.	611.	579.	388.	329.	220.
SSN	7393.		19437.		42666.		10542.	
SSB	147319.		335258.		711461.		210867.	
TSN	105216.		172120.		75787.		139756.	
TSB	636434.		1098672.		877066.		856936.	

Year	1990		1991		1992	
Season	1	2	1	2	1	2
Age						
0		222365.		112276.		619187.
1	29649.	7930.	83558.	7875.	39600.	8598.
2	10933.	2849.	4837.	1404.	5142.	127.
3	1458.	499.	1690.	421.	1062.	314.
4	5.	2.	293.	13.	312.	50.
5	318.	100.	83.	0.	8.	0.
SSN	12714.		6903.		6524.	
SSB	220560.		129185.		117066.	
TSN	42363.		90461.		46124.	
TSB	368807.		546972.		315065.	

cont'd.

Table 8.2.4.3 cont'd.

VPA: log catch residuals (log(actual/fitted))
using effort in commercial fleet and est. catchabilities

Year	1982		1983		1984		1985	
Season	1	2	1	2	1	2	1	2
Age								
0	.000	2.158	.000	1.962	.000	.000	.000	-1.727
1	.173	-.871	.101	-.516	1.064	1.334	.281	-.437
2	.974	.000	-.037	1.290	-.460	-.677	1.180	2.029
3	.753	.000	.125	.918	-.675	.119	.312	.366
4	.000	.000	-2.141	.000	-1.797	.000	1.470	.625
5	.000	.000	.000	.000	.000	.000	.000	.000

Year	1986		1987		1988		1989	
Season	1	2	1	2	1	2	1	2
Age								
0	.000	-1.114	.000	-1.864	.000	-.056	.000	.001
1	-.214	.399	-.850	-.104	-.533	.031	-.231	.486
2	.036	.875	.070	-.674	-.205	-.986	-1.238	-.209
3	-.544	.000	.322	.000	-.115	.578	.145	.000
4	.000	.000	-.296	.000	-.889	1.406	.000	.000
5	.000	.000	.000	.000	.000	.000	.000	.000

Year	1990		1991		1992	
Season	1	2	1	2	1	2
Age						
0	.000	.399	.000	1.255	.000	.000
1	-.155	.399	.468	-.118	.268	-1.992
2	-.155	.399	-.454	-1.999	.913	-.628
3	-.155	.399	-.051	-2.060	.348	.000
4	-.155	.399	.502	.521	.790	.000
5	.000	.000	.000	.000	.000	.000

VPA: Log inverse catchabilities

All years

Season		1	2
Age	Fleet		
0	1	.	3.621
1	1	2.284	2.584
2	1	1.642	2.493
3	1	1.899	2.460
4	1	1.899	2.460
5	1	.	.

VPA: Weighting factor for catchablities *1000

All years

Season		1	2
Age	Fleet		
0	1	20	2
1	1	100	10
2	1	100	10
3	1	100	10
4	1	20	2
5	1	20	2

Table 8.3.1.1 Sandeel. Southern North Sea. Danish CPUE data.

Year	Vessel size (GRT)						
	5-50	50-100	100-150	150-200	200-250	250-300	>300
				First half year			
1982	16.1	26.9	43.1	47.2	59.2	53/2	59.6
1983	17.0	20.6	36.3	44.4	49.1	51.2	50.9
1984	19.9	26.3	42.6	50.4	60.9	56.4	60.1
1985	13.8	21.2	35.5	43.4	49.8	49.1	56.3
1986	23.2	31.4	41.1	49.8	58.9	58.4	69.4
1987	23.9	33.9	53.9	67.4	76.1	76.4	115.5
1988	19.2	26.8	42.9	52.3	60.0	56.6	82.8
1989	19.4	24.5	43.3	52.3	58.9	55.2	74.3
1990	20.0	20.8	30.4	33.7	39.8	35.7	49.1
1991	27.0	30.0	49.5	50.3	62.8	60.7	92.8
1992	18.4	23.4	53.1	63.2	83.8	82.4	115.9
1993	17.2	18.1	38.1	40.2	58.6	60.9	89.5
				Second half year			
1982	-	20.3	37.5	40.5	-	27.9	-
1983	15.1	21.3	25.1	32.4	45.4	34.0	34.7
1984	12.7	16.4	26.9	34.2	36.5	40.2	40.9
1985	13.2	19.5	26.0	35.8	36.2	38.2	39.4
1986	18.4	25.2	32.5	44.5	45.8	51.8	55.5
1987	16.2	22.6	41.4	45.8	49.3	45.6	75.4
1988	18.8	29.3	29.9	31.1	38.6	31.1	44.0
1989	26.7	26.2	27.0	38.3	38.0	29.3	40.4
1990	27.9	32.8	36.4	41.3	48.3	45.2	42.7
1991	21.4	26.8	41.8	49.4	65.1	53.7	98.3
1992	21.3	28.7	36.7	42.6	44.8	39.1	58.3

Table 8.3.1.2 SANDEEL Southern North Sea.
Standardized CPUE, based on Danish Data. (Revised)

Year	Half-year	CPUE (t/day)	Total international ('000 t)	Total Intl. fishing effort ('000 days)
				Half-year
1982	1	48.2	426.5	8.9
	2	35.7	52.6	1.5
1983	1	42.8	359.8	8.4
	2	33.9	59.3	1.8
1984	1	50.5	461.1	9.1
	2	32.9	71.1	2.2
1985	1	41.9	417.1	10.0
	2	33.6	110.6	3.3
1986	1	53.7	386.4	7.2
	2	44.1	75.5	1.7
1987	1	69.1	297.7	4.3
	2	45.7	105.1	2.3
1988	1	52.7	462.0	8.8
	2	33.8	33.4	1.0
1989	1	50.7	506.1	10.0
	2	33.4	18.5	0.6
1990	1	35.1	341.7	9.7
	2	41.2	24.0	0.6
1991	1	57.2	326.6	5.7
	2	54.4	132.3	2.4
1992	1	67.2	621.1	9.2
	2	41.5	73.0	1.8
1993	1	49.0		

Table 8.3.1.3 Standard CPUE for a vessel of 200 GRT calculated from the data given in Table 8.3.1.1.

Southern North Sea

Half-year		R-square	a	b	CPUE
1987	I	0.97	3.678	0.5536	69.1
	II	0.94	2.825	0.5256	45.7
1988	I	0.97	3.387	0.5181	52.7
	II	0.86	8.559	0.2593	33.8
1989	I	0.94	3.622	0.4983	50.7
	II	0.51	15.501	0.1448	33.4
1990	I	0.88	6.272	0.3249	35.1
	II	0.83	15.413	0.1855	41.2
1991	I	0.90	5.896	o.4290	57.2
	II	0.92	3.496	0.5182	54.4
1992	I	0.93	1.687	0.6956	67.2
	II	0.93	7.294	0.3283	41.5
1993	I	0.90	1.874	0.6159	49.0
	II	-	-	-	-

Table 8.3.2.1 SANDEELS in the Southern North Sea. Catch in numbers, half-year (millions)

Age groups	1976		1977		1978		1979		1980		1981		1982	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
0	4	-	-	13,263	922	41,224	181	1,947	62	72	415	43,420	242	5,039
1	16,308	249	19,500	269	58,839	2,774	16,018	5,210	33,269	4,738	13,394	407	56,545	4,718
2	14,505	2,358	5,596	27	16,948	385	22,737	2,085	12,472	840	11,719	1,892	6,224	490
3	1,522	392	6,300	8	1,793	124	4,487	138	3,794	575	2,466	115	3,277	344
4	1,234	102	965	8	1,006	97	1,265	110	375	9	774	36	1,813	36
5	171	20	445	3	114	26	441	30	63	-	353	3	94	4
6	72	58	239	3	21	26	244	-	50	-	84	-	24	-
7+	1	16	159	-	39	9	35	-	+	-	21	-	8	-

Age groups	1983		1984		1985		1986		1987		1988		1989	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
0	955	9,298	20	-	6,573	11,940	-	112	-	298	1,420	-	29	1
1	2,232	240	62,517	9,423	7,790	1,896	43,629	5,350	4,351	3,095	2,349	-	44,444	1,619
2	35,029	2,806	2,257	92	39,301	3,229	7,333	293	22,771	6,664	10,074	234	405	165
3	934	513	13,272	577	2,490	2,234	1,604	241	1,158	196	17,914	2,084	957	35
4	234	2	267	44	233	163	30	9	141	45	1,920	63	3,350	122
5	122	-	109	-	18	77	-	9	24	6	617	5	18	1
6	25	-	66	-	7	30	-	-	-	-	146	-	-	-
7+	6	-	-	-	7	28	-	-	-	-	86	-	-	-

Age groups	1990		1991		1992	
	1	2	1	2	1	2
0			-	12,115	2	134
1			20,058	11,411	60,337	3,903
2			9,224	344	10,021	382
3			1,320	111	1,002	157
4			454	-	427	25
5+			-	-	69	2
6					103	5
7+					22	2

Note: 1 = Jan-Jun
2 = Jul-Dec

Table 8.3.3.1 SANDEEL, North Sea. Southern area. Mean weight at age (g) in the catch for 1992. Data from Denmark.

1992	Half-year	
Age	1	2
0	2.00	3.40
1	7.43	9.43
2	13.83	16.61
3	17.51	20.04
4	20.91	22.11
5	22.92	23.90
6	30.11	23.20
7+	19.43	25.60

Table 8.3.4.1

Sandeel in the North Sea
Southern stock
****

XSA stock analysis with input from file:
file.lst

Unknown catches have been estimated
They were estimated so that they conform the SOP

Catcabilities at oldest age have been shrunk towards
those of the second oldest age.
with weight of the oldest: .0

The linear funct. model used for estimating catchabilities

CPUE indexes have been weighted using fixed weights

Estimates of unknown catches

Year	Seas	Age	Catch	Init. c
1990	1	1	12993.0	10000.0
1990	1	2	15758.0	20000.0
1990	1	3	2804.4	2000.0
1990	1	4	406.4	1.0
1990	1	5	2098.4	1.0
1990	2	0	964.0	1000.0
1990	2	1	1100.7	500.0
1990	2	2	395.3	100.0
1990	2	3	182.9	100.0
1990	2	4	22.7	1.0
1990	2	5	117.3	1.0

SOP in season 1 341700.0
SOP in season 2 24000.0

Survivors (Year, age, number at end of the year)

1992	0	32449.08
1992	1	132551.81
1992	2	11057.83
1992	3	1207.18
1992	4	800.48
1992	5	98.41
1991	5	143.02
1990	5	1345.48
1989	5	23.52
1988	5	166.06
1987	5	26.58
1986	5	336.99
1985	5	.10
1984	5	169.29
1983	5	233.12
1982	5	97.17

cont'd.

Table 8.3.4.1 cont'd.

VPA: Fishing mortalities at age

Year	1982		1983		1984		1985	
Season	1	2	1	2	1	2	1	2
Age								
0	.	.056	.	.017	.	.000	.	.015
1	.254	.049	.063	.014	.321	.123	.147	.078
2	.697	.129	.653	.117	.187	.012	1.102	.370
3	.835	.247	.421	.507	1.242	.264	.526	1.586
4	.947	.055	.294	.004	.620	.233	.180	.208
5	.462	.036	.292	.000	.347	.000	.157	1.896
6	.409	.000	.312	.000	.316	.000	.062	.433

Year	1986		1987		1988		1989	
Season	1	2	1	2	1	2	1	2
Age								
0	.	.001	.	.003	.	.000	.	.000
1	.140	.036	.092	.142	.067	.000	.470	.048
2	.520	.040	.234	.112	.960	.067	.405	.026
3	.357	.095	.243	.066	.536	.127	.457	.031
4	.187	.088	.081	.037	1.538	.590	.340	.021
5	.000	.024	.391	.184	1.032	.027	.386	.038
6	.000	.000	.000	.000	2.509	.	.000	.000

Year	1990		1991		1992	
Season	1	2	1	2	1	2
Age						
0	.	.004	.	.014	.	.003
1	.263	.052	.193	.268	.186	.026
2	.901	.063	.831	.081	.442	.031
3	.834	.146	.337	.048	.388	.111
4	.628	.076	.696	.000	.290	.028
5	.628	.076	.000	.000	.366	.018
6	.000	.000	.000	.000	.179	.015

cont'd.

Table 8.3.4.1 cont'd.

VPA: Stock numbers at age at start of season

Year	1982		1983		1984		1985	
Season	1	2	1	2	1	2	1	2
Age								
0		110095.		705345.		168388.		1020730.
1	311608.	117619.	41797.	20743.	281711.	96939.	68543.	30413.
2	13936.	4693.	83625.	29993.	15198.	9196.	64274.	11925.
3	6509.	1784.	3075.	1433.	20116.	2750.	6753.	2738.
4	3314.	760.	1094.	559.	642.	233.	1671.	948.
5	298.	123.	574.	285.	442.	207.	137.	85.
6	112.	49.	137.	67.	288.	139.	283.	178.
SSN	24169.		88505.		36686.		73118.	
SSB	343051.		1127023.		528209.		946863.	
TSN	335777.		130302.		318396.		141662.	
TSB	1589483.		1294213.		1655052.		1221037.	

Year	1986		1987		1988		1989	
Season	1	2	1	2	1	2	1	2
Age								
0		145451.		108008.		374857.		175092.
1	412442.	177966.	59566.	27807.	44075.	21412.	153935.	41358.
2	21003.	8906.	128872.	73821.	18216.	4268.	15965.	7656.
3	6286.	3135.	6371.	3662.	50007.	20263.	3053.	1335.
4	208.	121.	2177.	1447.	2560.	154.	13730.	6825.
5	627.	422.	87.	39.	1064.	208.	66.	30.
6	94.	63.	388.	260.	240.	0.	166.	111.
SSN	28218.		137896.		72086.		32980.	
SSB	378234.		1758738.		1075184.		498832.	
TSN	440660.		197462.		116160.		186915.	
TSB	2028002.		1997003.		1251482.		1114573.	

Year	1990		1991		1992	
Season	1	2	1	2	1	2
Age						
0		365669.		1261517.		72417.
1	72453.	25599.	154451.	54512.	547426.	166213.
2	29774.	7457.	18444.	5035.	32958.	13928.
3	5594.	1564.	5454.	2659.	3658.	1648.
4	1005.	343.	1040.	337.	2017.	1005.
5	5190.	1773.	261.	175.	267.	122.
6	115.	77.	1408.	944.	916.	512.
SSN	41677.		26607.		39816.	
SSB	583169.		368599.		0.	
TSN	114130.		181059.		587242.	
TSB	872980.		986405.		0.	

cont'd.

Table 8.3.4.1 cont'd.

VPA: log catch residuals (log(actual/fitted))
using effort in commercial fleet and est. catchabilities

Year	1982		1983		1984		1985	
Season	1	2	1	2	1	2	1	2
Age								
0	.000	2.719	.000	1.369	.000	.000	.000	.606
1	.377	-.091	-.953	-1.562	.589	.439	-.287	-.423
2	.154	.680	.147	.406	-1.182	-2.112	.496	.949
3	.413	.489	-.216	1.025	.788	.173	-.166	1.560
4	.822	-.351	-.290	-3.135	.375	.708	-.956	.192
5	.104	-.763	-.297	.000	-.205	.000	-1.093	2.400
6	.000	.000	.000	.000	.000	.000	.000	.000

Year	1986		1987		1988		1989	
Season	1	2	1	2	1	2	1	2
Age								
0	.000	-1.480	.000	-.505	.000	.000	.000	-5.268
1	-.010	-.522	.094	.538	-.949	.000	.875	.794
2	.073	-.605	-.211	.117	.485	.426	-.505	.003
3	-.226	-.596	-.095	-1.251	-.020	.232	-.306	-.676
4	-.589	-.002	-.908	-1.164	1.318	2.427	-.318	-.402
5	.000	-1.314	.665	.429	.919	-.665	-.192	.185
6	.000	.000	.000	.000	.000	.000	.000	.000

Year	1990		1991		1992	
Season	1	2	1	2	1	2
Age						
0	.000	.882	.000	.884	.000	.000
1	.315	.882	.547	1.134	.031	-.411
2	.315	.882	.775	-.255	-.335	-.443
3	.315	.882	-.049	-1.612	-.386	-.004
4	.315	.882	.960	.000	-.395	-.724
5	.315	.882	.000	.000	-.163	-1.149
6	.000	.000	.000	.000	.000	.000

VPA: Log inverse catchabilities

All years

Season		1	2
Age	Fleet		
0	1	.	6.013
1	1	3.933	3.325
2	1	2.701	3.136
3	1	2.779	2.292
4	1	3.062	2.954
5	1	3.062	2.954
6	1	.	.

Weighting factors for catchabilities (*100)

All years

Season		1	2
Age	Fleet		
0	1	20	2
1	1	100	10
2	1	100	10
3	1	100	10
4	1	20	2
5	1	20	2
6	1	20	2

Table 8.4.1

Sandeel at Shetland
Standardised Effort, (days absent), by half-year, 1984-1993.
UK (Scotland) data.

Year	1	2
1984	852	539
1985	358	302
1986	404	157
1987	180	98
1988	200	72
1989	168	0
1990	102	0
1991	0	0
1992	0	0
1993	0	0

Table 8.4.2

Sandeel at Shetland
Commercial catch at age, (millions), 1984-1993

	1984		1985		1986		1987	
	1	2	1	2	1	2	1	2
0	1940	4833	153	2039	898	1328	19	400
1	1843	481	1076	252	522	94	873	111
2	1064	154	313	157	352	25	53	16
3	501	36	166	83	327	24	35	10
4	134	10	55	20	141	11	38	8
5	38	9	17	11	58	3	16	7
6	14	1	6	3	14	1	4	1
7	9	1	2	1	6	0	1	0

	1988		1989		1990		1991	
	1	2	1	2	1	2	1	2
0	52	478	33	0	14	0	0	0
1	30	3	8	0	162	0	0	0
2	151	3	7	0	22	0	0	0
3	107	1	199	0	14	0	0	0
4	48	1	96	0	60	0	0	0
5	26	2	34	0	29	0	0	0
6	15	0	14	0	5	0	0	0
7	4	0	4	0	6	0	0	0

	1992		1993	
	1	2	1	2
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0

Table 8.4.3

Sandeel at Shetland
Survey indices, Mean No. fish per 30 minute tow 1984-1993.

	Year									
Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	345774	121905	681869	-	73371	813752	90148	1009024	199301	635331
1	47590	74509	49816	-	898	9059	30118	10001	465958	18180
2	34613	38843	11399	-	7189	977	3771	1925	1215	73176
3	9921	23455	15376	-	4843	3820	1346	1694	347	2176
4	3999	10872	7049	-	4612	3893	1736	750	168	361
5	1369	1959	2893	-	3031	2017	1142	53	43	150
6	856	962	1210	-	1619	462	444	21	10	72
7	258	119	191	-	20	86	329	5	12	23

Table 8.4.4

Sandeel at Shetland
Mean Weights at age (g) in catch by half-year, 1974-1990.

Age	1	2
0	0.746	1.618
1	3.095	5.053
2	5.409	7.87
3	8.585	10.483
4	11.143	13.255
5	13.705	15.787
6	15.605	19.472
7	21.254	24.482

Table 8.4.5

Sandeel at Shetland
Natural Mortality and proportion mature at age.

Age	Natural Mortality		Proportion Mature
	1	2	
0	0	0.8	0
1	1	0.2	0
2	0.4	0.2	1
3	0.4	0.2	1
4	0.4	0.2	1
5	0.4	0.2	1
6	0.4	0.2	1
7	0.4	0.2	1

Table 8.4.6

Sandeel at Shetland
Diagnostics from Semi-Annual Separable VPA.

weight for effort data = 1.0000
weight for RV data = 0.5000
RV catchability constant above age = 3

IFAIL on exit from E04FDF = 5

Initial sum of squares = 471.6854
Final sum of squares = 28.3959
Residual mean square = 0.2309

Number of observations = 171
Number of parameters = 48

RMS for catch data = 0.3889
RMS for effort data = 0.3996
RMS for RV data = 0.1594

IFAIL on exit from E04YCF = 0

Coefficient of determination = 0.9398
Adj. Coeff. of determination = 0.9168

No.	parameter	s.d.				
					Season	
1	-0.4719	0.2592	Year/Season Effect	1984	1	
2	-0.7492	0.2784		1984	1	
3	-1.3178	0.2584		1985	1	
4	-0.5862	0.2694		1985	2	
5	-0.5158	0.2397		1986	1	
6	-1.4961	0.2626		1986	2	
7	-1.7894	0.2397		1987	1	
8	-1.7729	0.2662		1987	2	
9	-1.3061	0.2413		1988	1	
10	-3.2155	0.2832		1988	2	
11	-1.5331	0.258		1989	1	
12	-1.4294	0.2833		1990	1	
13	-2.6905	0.4568	Selectivity at age	0	1	
14	0.0391	0.4382	" "	0	2	
15	-0.7752	0.3137	" "	1	1	
16	-1.0084	0.3434	" "	1	2	
17	-0.6234	0.3091	" "	2	1	
18	-1.7525	0.3427	" "	2	2	
19	-0.0768	0.2973	" "	3	1	
20	-1.5729	0.3403	" "	3	2	
21	0.1219	0.2956	" "	4	1	
22	-1.4078	0.3444	" "	4	2	
23	0.189	0.2952	" "	5	1	
24	-0.536	0.3467	" "	5	2	
25	0.2623	0.3181	" "	6	1	
26	-1.0022	0.3832	" "	6	2	Age
27	9.8025	1.0506	Est. Population	1993	2	0
28	6.6533	0.7607	" "	1993	2	1
29	8.4967	0.6341	" "	1993	2	2
30	4.3635	0.5242	" "	1993	2	3
31	4.5166	0.4575	" "	1993	2	4
32	2.7905	0.4202	" "	1993	2	5
33	1.7072	0.4181	" "	1993	2	6
34	3.7108	0.4238	" "	1993	2	7
35	2.1279	0.3671	" "	1984	2	7
36	1.7372	0.3028	" "	1985	2	7
37	1.3429	0.3517	" "	1986	2	7
38	1.5869	0.3745	" "	1987	2	7
39	2.042	0.3996	" "	1988	2	7
40	2.5824	0.4391	" "	1989	2	7
41	2.8828	0.4861	" "	1990	2	7
42	3.0387	0.4682	" "	1991	2	7
43	3.1763	0.4444	" "	1992	2	7
44	-3.3484	0.4247	RV Catchability, Age	0		
45	-3.562	0.4068	" "	1		
46	-4.2259	0.401	" "	2		
47	-3.9486	0.4025	" "	3		
48	-4.0111	0.4603	" "	4		

	Selectivities at age		RV catchabilities
age	1	2	logQ
0	0.0678	1.0398	-3.3484
1	0.4606	0.3648	-3.562
2	0.5361	0.1733	-4.2259
3	0.9261	0.2074	-3.9486
4	1.1297	0.2447	-4.0111
5	1.208	0.5851	-4.0111
6	1.3	0.3671	-4.0111
7	1.1297	0.2447	

	Year/season effects		Year/season effect residuals	
year	1	2	1	2
1984	0.6238	0.4728	0.4719	0.2913
1985	0.2677	0.5564	0.4507	-0.4509
1986	0.597	0.224	-0.2304	-0.1952
1987	0.1671	0.1698	0.2348	-0.3897
1988	0.2709	0.0401	-0.1432	0.7446
1989	0.2159	0	-0.0905	0
1990	0.2394	0	-0.6932	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0

Log catch residuals

	1984		1985		1986		1987		1988		1989		1990
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
0	0.3262	-0.1443	-0.3714	-0.4968	0.1345	-0.2981	0.129	0.5067	0.3393	1.2388	-0.257	0	-0.3063	0
1	-0.2011	-0.1416	0.816	-0.3254	-0.2744	0.0666	1.1429	0.0116	-0.1914	0.3685	-1.5307	0	0.3697	0
2	0.2901	0.2909	0.0638	0.2	0.1001	0.0634	-0.2192	0.063	-0.1383	-0.6318	-0.4955	0	0.2776	0
3	0.096	-0.0899	-0.2904	0.2761	-0.2217	0.2776	-0.5963	0.0361	0.2455	-0.5764	0.595	0	0.3111	0
4	-0.1561	-0.1879	-0.3089	0.0128	-0.3079	0.3609	-0.2587	0.1235	-0.1048	-0.0601	1.0213	0	-0.0748	0
5	-0.3448	0.0776	-0.1835	0.0094	0.0918	-0.3913	-0.152	0.1917	-0.2966	0.2681	0.6061	0	0.5176	0
6	0.0706	-0.1798	0.041	0.4734	0.1871	0.5757	-0.1459	0.1686	0.1947	-1.137	0.1681	0	-0.6047	0
7	-0.1834	0.1828	-0.2199	0.4202	0.2578	-0.6169	-0.2282	-0.5904	0.1547	0.3817	-0.1241	0	-0.1375	0

Log RV residuals

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	1	1	1	1	1	1	1	1	1	1
0	-0.4326	-0.7887	0.078	0	0.2096	0.9116	0.2429	-0.3158	0.095	0
1	-0.4164	0.1156	0.1696	0	-0.7743	0.2202	0.325	0.1506	0.3047	-0.095
2	0.2175	0.2788	0.0558	0	-0.2932	-0.0668	0.4852	-0.4192	-0.2694	0.0111
3	0.0501	0.3229	0.2799	0	0.0353	-0.3548	0.3519	0.2414	-1.1089	0.1822
4	0.1427	0.3149	0.2192	0	0.1931	0.1893	-0.1452	0.2041	-0.2878	-0.3818
5	0.1785	0.2227	0.3482	0	0.2059	0.1971	0.0952	-0.8768	-0.3787	-0.1691
6	0.4341	0.3903	0.5353	0	0.334	-0.0369	0.0464	-0.7567	-1.1292	-0.0888

Table 8.4.7

Sandeel at Shetland
Fitted Populations from SSV

		1984		1985		1986		1987
	1	2	1	2	1	2	1	2
0	0	23369	0	17542	0	16600	0	1288
1	13945	3849	6423	2089	4419	1235	5909	2013
2	3361	1612	2652	1540	1396	679	932	571
3	1235	464	1216	636	1145	442	535	307
4	367	122	345	171	464	158	345	192
5	120	38	89	43	122	40	123	67
6	28	8	24	11	25	8	29	15
7	25	8	11	6	11	4	9	5
SSB	35484		30456		24847		15808	

		1988		1989		1990		1991
	1	2	1	2	1	2	1	2
0	0	1422	0	3740	0	1577	0	54000
1	485	157	613	204	1680	554	709	261
2	1549	898	127	76	167	99	453	304
3	454	237	730	401	62	33	81	54
4	243	120	192	101	328	168	27	18
5	150	73	97	50	83	42	137	92
6	50	24	58	29	41	20	34	23
7	16	8	25	13	35	18	31	21
SSB	18160		11859		7612		6514	

		1992		1993	*1994*
	1	2	1	2	*1*
0	0	4691	0	18079	*0*
1	24264	8926	2108	775	*8123*
2	213	143	7308	4899	*635*
3	249	167	117	79	*4011*
4	44	30	137	92	*65*
5	15	10	24	16	*75*
6	75	51	8	6	*13*
7	36	24	61	41	*5*
SSB	5921		43810		*39930*

Table 8.4.8

Sandeel at Shetland
Total Fishing Mortality from SSV

		1984		1985		1986		1987
	1	2	1	2	1	2	1	2
0	0.042	0.492	0.018	0.579	0.041	0.233	0.011	0.177
1	0.287	0.172	0.123	0.203	0.275	0.082	0.077	0.062
2	0.334	0.082	0.144	0.096	0.32	0.039	0.09	0.029
3	0.578	0.098	0.248	0.115	0.553	0.046	0.155	0.035
4	0.705	0.116	0.302	0.136	0.674	0.055	0.189	0.042
5	0.754	0.277	0.323	0.326	0.721	0.131	0.202	0.099
6	0.811	0.174	0.348	0.204	0.776	0.082	0.217	0.062
7	0.705	0.116	0.302	0.136	0.674	0.055	0.189	0.042
Mean F(1-3)	0.517		0.31		0.438		0.149	

		1988		1989		1990		1991
	1	2	1	2	1	2	1	2
0	0.018	0.042	0.015	0	0.016	0	0	0
1	0.125	0.015	0.099	0	0.11	0	0	0
2	0.145	0.007	0.116	0	0.128	0	0	0
3	0.251	0.008	0.2	0	0.222	0	0	0
4	0.306	0.01	0.244	0	0.27	0	0	0
5	0.327	0.023	0.261	0	0.289	0	0	0
6	0.352	0.015	0.281	0	0.311	0	0	0
7	0.306	0.01	0.244	0	0.27	0	0	0
Mean F(1-3)	0.184		0.138		0.153		0	

		1992		1993
	1	2	1	2
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
Mean F(1-3)	0		0	

Table 9.1

Sandeel, Division VIa
Landings in tonnes, 1980-1992, as officially reported to ICES.

Country	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
UK (Scotland)	211	5972	10873	13051	14166	18586	24469	14479	24465	18785	16515	8532	4909

Table 9.2 Fishing effort (days absent) by month and year in the Division VIa SANDEEL fishery, 1981-1992, UK (Scotland).

Month	1981	1982	1983	1984	1985	1986	1987	1988	1989[1]	1990[1]	1991[1]	1992[1]
Jan	-	-	-	-	-	-	-	-	-	-	-	-
Feb	-	-	-	-	-	-	-	-	-	-	-	-
Mar	-	-	-	-	-	-	-	-	-	-	-	-
Apr	4	54	21	11	7	7	3	26	13	-	-	-
May	4	121	112	119	131	104	22	87	50	29	5	-
Jun	-	168	112	128	124	117	79	139	99	138	54	24
Total	8	343	245	258	262	228	104	252	162	167	59	24
Jul	90	118	126	125	101	126	93	108	110	75	31	32
Aug	132	89	76	63	76	94	67	59	22	5	18	13
Sep	70	34	-	-	28	67	26	28	3	-	-	-
Oct	3	4	-	-	8	15	-	8	-	-	-	-
Nov	-	-	-	-	-	-	-	-	-	-	-	-
Dec	-	-	-	-	-	-	-	-	-	-	-	-
Total	295	245	202	188	213	302	186	203	135	80	49	45
Annual Total	303	588	447	446	475	530	290	455	297	247	108	69

[1]Vessels landing in Scotland only.

Table 9.3 Standardized effort (days absent) by half year in the Division VIa sandeel fishery (1982-1992). UK (Scotland) data.

Year	I	II	Total
1982	379	271	650
1983	315	244	559
1984	323	241	564
1985	355	285	640
1986	337	389	726
1987	154	245	399
1988	420	329	749
1989	282	257	539
1990	300	141	441
1991[1]	99	51	150
1992[2]	24	45	69

[1]Adjusted for extra distance to processing plant.
[2]Raw figures, not standardized.

Table 9.4

Sandeel, Division VIa
Numbers caught (millions), by month, 1992. UK Scotland data.

Age	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
0	-	-	122	509	68	-	-	699
1	-	-	226	156	21	-	-	403
2	-	-	29	23	3	-	-	55
3	-	-	8	19	3	-	-	30
4	-	-	5	9	1	-	-	15
5	-	-	1	4	1	-	-	6
6	-	-	4	7	1	-	-	12
7+	-	-	1	2	+	-	-	3

Table 9.5

Sandeel, Division VIa
Catch at age (millions), 1983 - 1992.

		1983		1984		1985		1986		1987
	1	2	1	2	1	2	1	2	1	2
0	391	2253	186	1751	53	3207	368	2702	105	595
1	521	106	863	99	139	13	859	996	521	676
2	136	29	226	67	437	163	140	68	97	232
3	86	21	138	115	181	117	171	219	17	37
4	111	18	67	38	139	73	58	103	45	31
5	29	3	28	26	55	28	38	40	23	20
6	12	3	8	8	27	12	9	12	4	7
7	2	1	1	3	7	1	6	6	1	4

		1988		1989		1990		1991		1992
	1	2	1	2	1	2	1	2	1	2
0	795	173	185	284	21	588	673	94	122	578
1	187	72	211	21	602	158	423	52	226	177
2	1216	548	136	64	229	6	158	66	29	26
3	235	131	569	294	122	11	10	39	8	22
4	41	28	135	76	324	52	15	23	5	10
5	52	45	228	23	75	19	27	37	1	5
6	21	24	19	12	18	1	10	12	4	7
7	3	8	6	8	2	1	1	0	1	3

Table 9.6

Sandeel, Division VIa

Mean weight at age (g) in catch, 1981-1992.

Age	1	2
0	1.35	1.6
1	4.34	5.86
2	8	9.15
3	11.38	12.92
4	13.84	15.43
5	16.8	17.51
6	17.75	19.56
7+	22.27	21.93

Table 9.7

Sandeel, Division VIa

Natural Mortality and proportion mature at age

Age	Natural Mortality		Proportion Mature
	1	2	
0	0	0.8	0
1	1	0.2	0
2	0.4	0.2	1
3	0.4	0.2	1
4	0.4	0.2	1
5	0.4	0.2	1
6	0.4	0.2	1
7+	0.4	0.2	1

Table 9.8

Sandeel in Division VIa.
Diagnostics from Semi-Annual Separable VPA

weight for effort data = 1.0000

RMS for catch data = 0.4482
RMS for effort data = 0.2782

Initial sum of squares = 477.3743
Final sum of squares = 40.6195
Residual mean square = 0.3173

Coefficient of determination = 0.9149
Adj. Coeff. of determination = 0.8817

Number of observations = 179
Number of parameters = 51

IFAIL on exit from E04YCF = 0
IFAIL on exit from E04FDF = 5

No.	parameter	s.d.			Season	
1	0.1668	0.2874	Year/season Effect	1983	1	
2	-0.8325	0.2963		1983	2	
3	-0.0697	0.2844		1984	1	
4	-0.1278	0.2882		1984	2	
5	0.3214	0.2772		1985	1	
6	-0.1993	0.2817		1985	2	
7	0.0206	0.2713		1986	1	
8	0.5311	0.2703		1986	2	
9	-0.9813	0.2649		1987	1	
10	-0.2147	0.2645		1987	2	
11	0.0928	0.259		1988	1	
12	0.1069	0.2577		1988	2	
13	0.3348	0.2604		1989	1	
14	-0.1245	0.2659		1989	2	
15	0.0877	0.2819		1990	1	
16	-1.3672	0.2906		1990	2	
17	-1.2606	0.3022		1991	1	
18	-1.2256	0.3088		1991	2	
19	-2.8262	0.3202		1992	1	
20	-1.9474	0.3183		1992	2	
21	-5.8714	0.4769	Selectivity at age	0	1	
22	-3.8271	0.4753		0	2	
23	-3.319	0.33		1	1	
24	-3.6306	0.3337		1	2	
25	-2.4282	0.31		2	1	
26	-2.9162	0.3174		2	2	
27	-2.4038	0.2989		3	1	
28	-2.1168	0.3034		3	2	
29	-2.041	0.2929		4	1	
30	-1.6384	0.3052		4	2	
31	-1.5366	0.2893		5	1	
32	-1.3671	0.3045		5	2	
33	-1.4842	0.309		6	1	
34	-1.2346	0.3204		6	2	Age
35	13.0888	0.9558	Est. Population	1992	2	0
36	10.8834	0.5598		1992	2	1
37	8.3468	0.4726		1992	2	2
38	7.6497	0.4242		1992	2	3
39	5.7086	0.3958		1992	2	4
40	5.0167	0.3814		1992	2	5
41	5.8357	0.3904		1992	2	6
42	4.4431	0.4247		1992	2	7
43	2.4165	0.436		1983	2	7
44	2.7682	0.306		1984	2	7
45	2.7321	0.283		1985	2	7
46	3.2591	0.2876		1986	2	7
47	3.0434	0.3202		1987	2	7
48	3.2611	0.319		1988	2	7
49	3.389	0.3751		1989	2	7
50	3.4855	0.4419		1990	2	7
51	3.3732	0.4529		1991	2	7

Selectivities at age

age	1	2
0	0.0028	0.0218
1	0.0362	0.0265
2	0.0882	0.0541
3	0.0904	0.1204
4	0.1299	0.1943
5	0.2151	0.2549
6	0.2267	0.2909
7	0.1299	0.1943

Year/season effects

year	1	2
1983	1.1815	0.435
1984	0.9327	0.88
1985	1.379	0.8193
1986	1.0208	1.7008
1987	0.3748	0.8068
1988	1.0973	1.1128
1989	1.3976	0.8829
1990	1.0916	0.2548
1991	0.2835	0.2936
1992	0.0592	0.1426

Year/season effect residuals

1	2
-0.1668	0.5771
0.0947	-0.1399
-0.2018	0.0993
0.0469	-0.3201
0.2592	-0.0366
0.1949	-0.0665
-0.4454	-0.0829
-0.1365	0.5634
0.1032	-0.5952
0.2517	0.0015

Log catch residuals

	1983		1984		1985		1986		1987	
	1	2	1	2	1	2	1	2	1	2
0	0.2615	0.8878	0.4216	0.8245	-1.0283	0.5362	-0.1902	-0.1923	0.5478	0.2838
1	-0.0555	0.4923	0.598	-0.3682	-0.7761	-1.4755	0.0865	0.876	0.0346	0.657
2	-0.6028	-0.2945	-0.0977	-0.4013	0.1081	0.5161	0.1064	-0.2472	-0.529	0.4025
3	-0.0841	-0.4003	0.3423	0.3256	0.0144	0.2244	0.1985	0.0927	-0.2688	-0.1812
4	0.3494	-0.4516	0.3057	-0.1615	0.43	0.374	-0.3586	-0.1747	0.3792	-0.7636
5	0.2168	-0.7338	-0.4361	-0.1101	0.1854	0.4183	-0.1136	-0.127	0.2528	-0.3846
6	0.2478	0.1142	0.0586	0.3989	0.1598	0.199	-0.3003	-0.1242	-0.2246	-0.2271
7	-0.0844	0.2405	-0.8755	0.3229	0.6842	-0.6736	0.329	-0.0613	-0.2005	0.4157

	1988		1989		1990		1991		1992	
	1	2	1	2	1	2	1	2	1	2
0	1.0849	-0.4308	-0.3532	-0.6562	-1.3244	0.3192	0.3757	-1.3764	0.2064	-0.2064
1	-0.345	-0.1666	-0.3299	-1.0275	-0.2201	1.0341	0.7349	-0.2756	0.2545	0.2458
2	0.3647	0.4212	-0.3135	0.268	0.5785	-0.763	0.3135	0.2143	0.1184	-0.0751
3	-0.0349	-0.505	0.1096	0.0386	0.5602	-0.3113	-0.5519	0.8173	-0.4969	-0.3401
4	-0.0436	-0.3652	-0.3226	-0.3635	0.2706	-0.1079	0.15	0.4861	0.6102	0.3392
5	-0.1625	0.0669	1.9568	0.5191	-0.1902	0.1784	-0.6168	-0.1388	-0.8144	0.0707
6	-0.0009	0.4515	-0.3074	0.0325	0.7142	-0.5034	-0.0883	0.1835	-0.2997	-0.5418
7	-0.4437	0.5969	-0.1415	0.6799	-1.0681	-0.3103	-0.2447	0	0.2663	0.4007

Table 9.9

Sandeel, Division VIa

Fitted Populations (millions)

		1983		1984		1985		1986		1987
	1	2	1	2	1	2	1	2	1	2
0	0	69466	0	30404	0	106400	0	186808	0	33206
1	19062	8207	20726	9004	8984	3840	31481	13632	54220	24034
2	2899	1935	3645	2487	3952	2593	1688	1143	5855	4197
3	1066	710	1400	953	1757	1149	1837	1241	772	553
4	634	403	499	328	635	393	771	500	749	529
5	120	69	274	166	205	113	249	148	266	182
6	46	26	46	27	98	53	68	40	71	48
7	18	11	24	16	25	15	40	26	30	21
SSB	47331		57952		66139		51361		72389	

		1988		1989		1990		1991		1992
	1	2	1	2	1	2	1	2	1	2
0	0	29305	0	94985	0	96335	0	397115	0	483497
1	9827	4244	8615	3680	28064	12122	28855	12833	118846	53287
2	10571	7109	1851	1213	1615	1087	5410	3909	5722	4217
3	2976	1997	4958	3237	856	575	794	573	2850	2100
4	372	239	1294	799	2156	1386	413	295	410	301
5	335	196	143	78	499	292	977	681	206	151
6	110	63	109	59	46	27	203	141	468	342
7	41	26	48	30	51	33	41	29	116	85
SSB	132077		94545		62836		78962		98235	

Table 9.10

Sandeel, Division VIa

Fishing Mortality

		1983		1984		1985		1986		1987
	1	2	1	2	1	2	1	2	1	2
0	0.003	0.009	0.003	0.019	0.004	0.018	0.003	0.037	0.001	0.018
1	0.043	0.012	0.034	0.023	0.05	0.022	0.037	0.045	0.014	0.021
2	0.104	0.024	0.082	0.048	0.122	0.044	0.09	0.092	0.033	0.044
3	0.107	0.052	0.084	0.106	0.125	0.099	0.092	0.205	0.034	0.097
4	0.153	0.085	0.121	0.171	0.179	0.159	0.133	0.33	0.049	0.157
5	0.254	0.111	0.201	0.224	0.297	0.209	0.22	0.433	0.081	0.206
6	0.268	0.127	0.211	0.256	0.313	0.238	0.231	0.495	0.085	0.235
7	0.153	0.085	0.121	0.171	0.179	0.159	0.133	0.33	0.049	0.157
Mean F (1-3)		0.114		0.126		0.154		0.187		0.081

		1988		1989		1990		1991		1992
	1	2	1	2	1	2	1	2	1	2
0	0.003	0.024	0.004	0.019	0.003	0.006	0.001	0.006	0	0.003
1	0.04	0.029	0.051	0.023	0.04	0.007	0.01	0.008	0.002	0.004
2	0.097	0.06	0.123	0.048	0.096	0.014	0.025	0.016	0.005	0.008
3	0.099	0.134	0.126	0.106	0.099	0.031	0.026	0.035	0.005	0.017
4	0.143	0.216	0.182	0.172	0.142	0.05	0.037	0.057	0.008	0.028
5	0.236	0.284	0.301	0.225	0.235	0.065	0.061	0.075	0.013	0.036
6	0.249	0.324	0.317	0.257	0.247	0.074	0.064	0.085	0.013	0.042
7	0.143	0.216	0.182	0.172	0.142	0.05	0.037	0.057	0.008	0.028
Mean F (1-3)		0.153		0.159		0.096		0.040		0.014

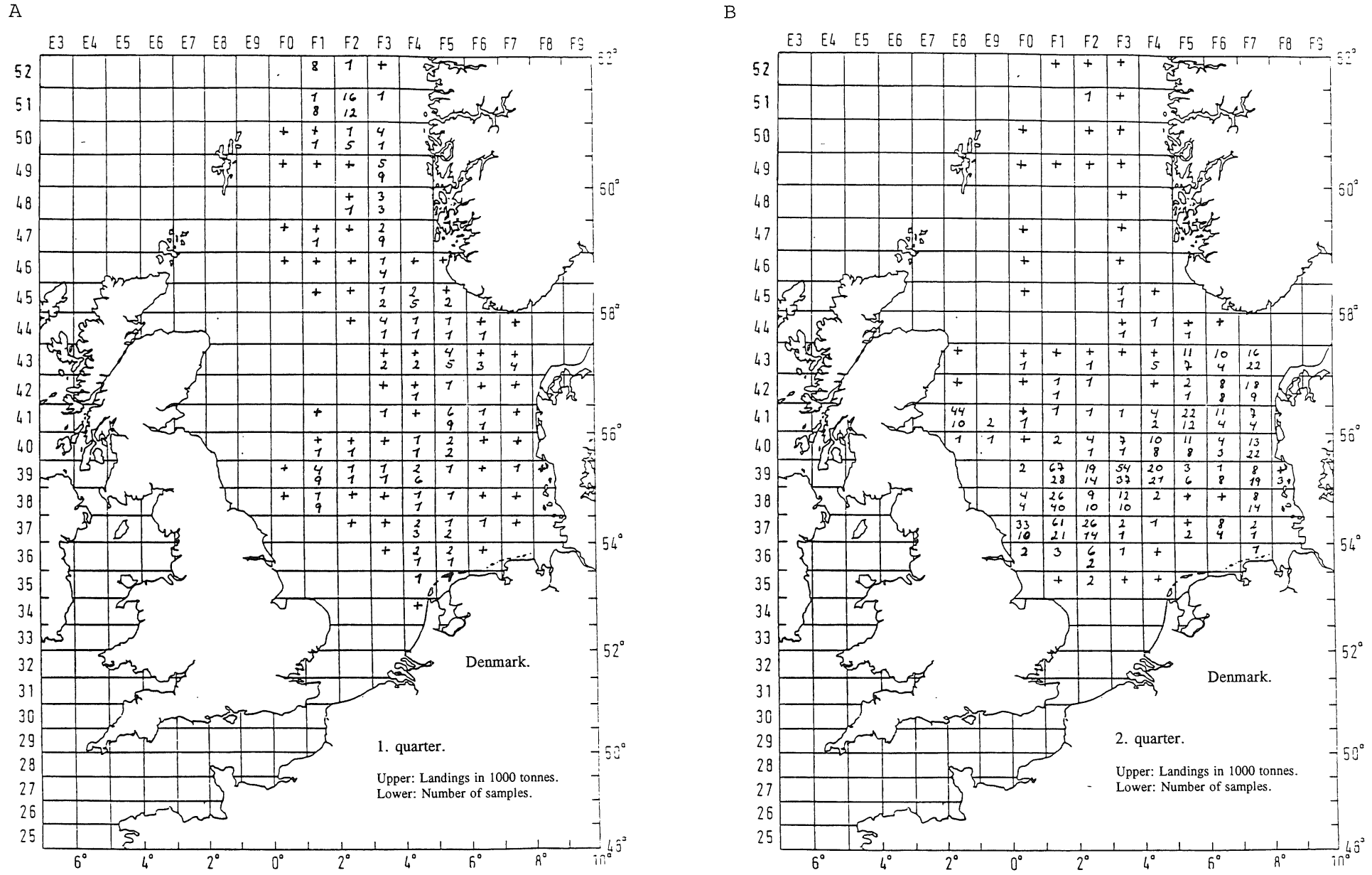
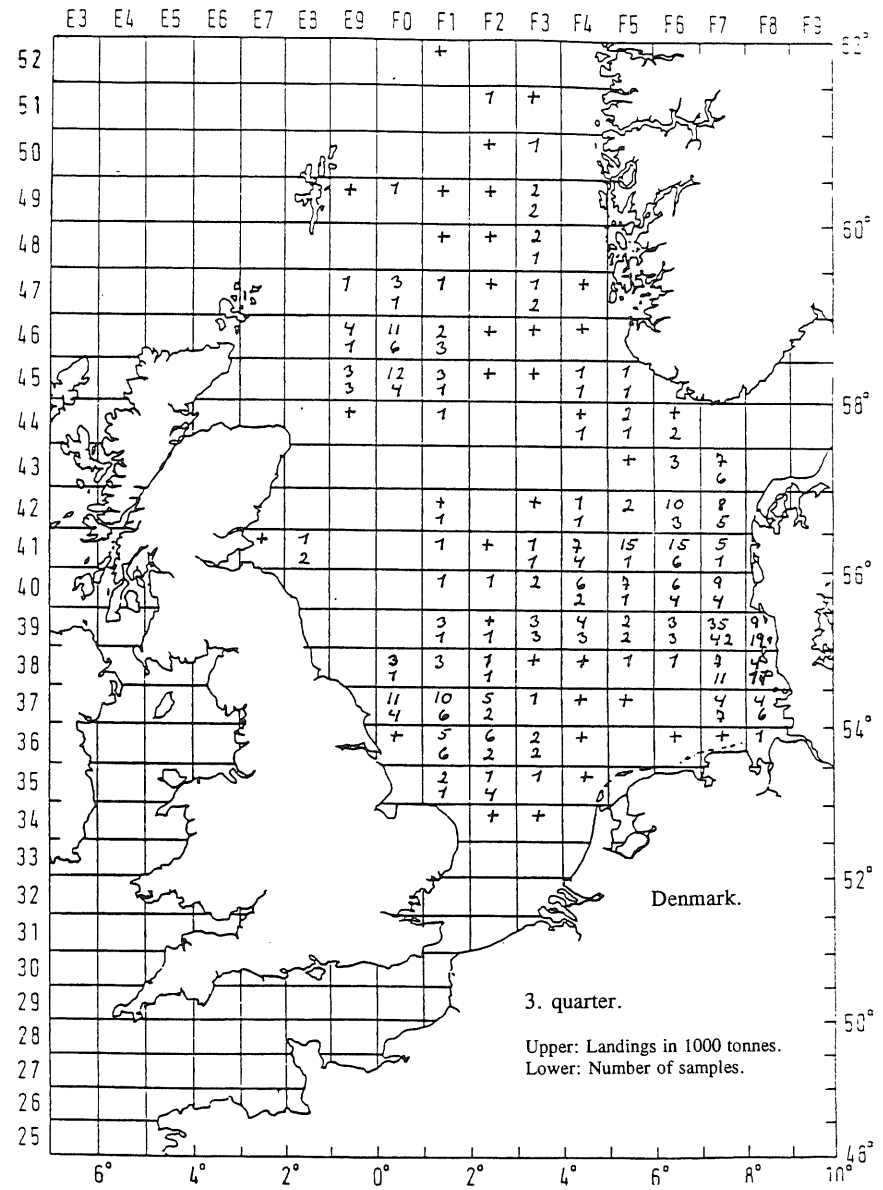


Figure 1.4.1.1 Total Danish industrial landings ('000 t) and corresponding number of samples by statistical rectangle in 1992.

C



D

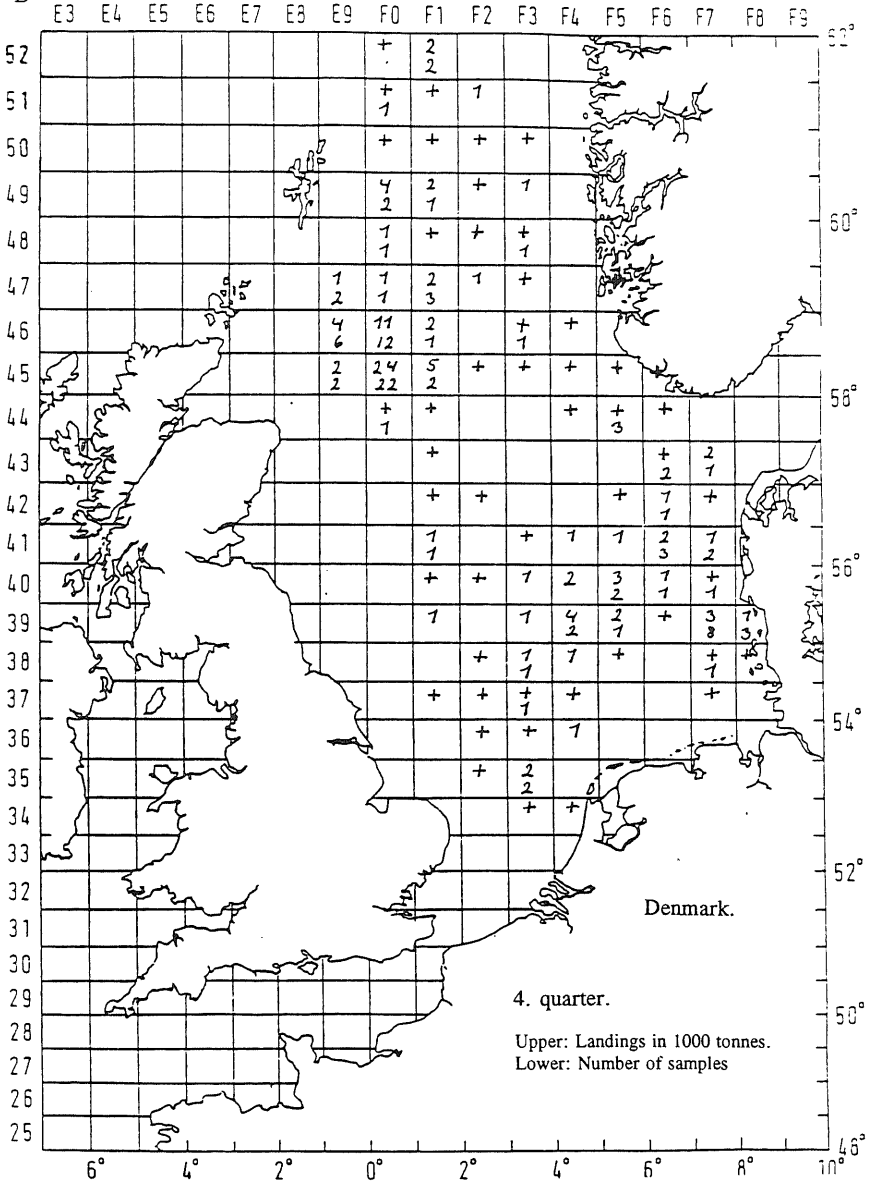
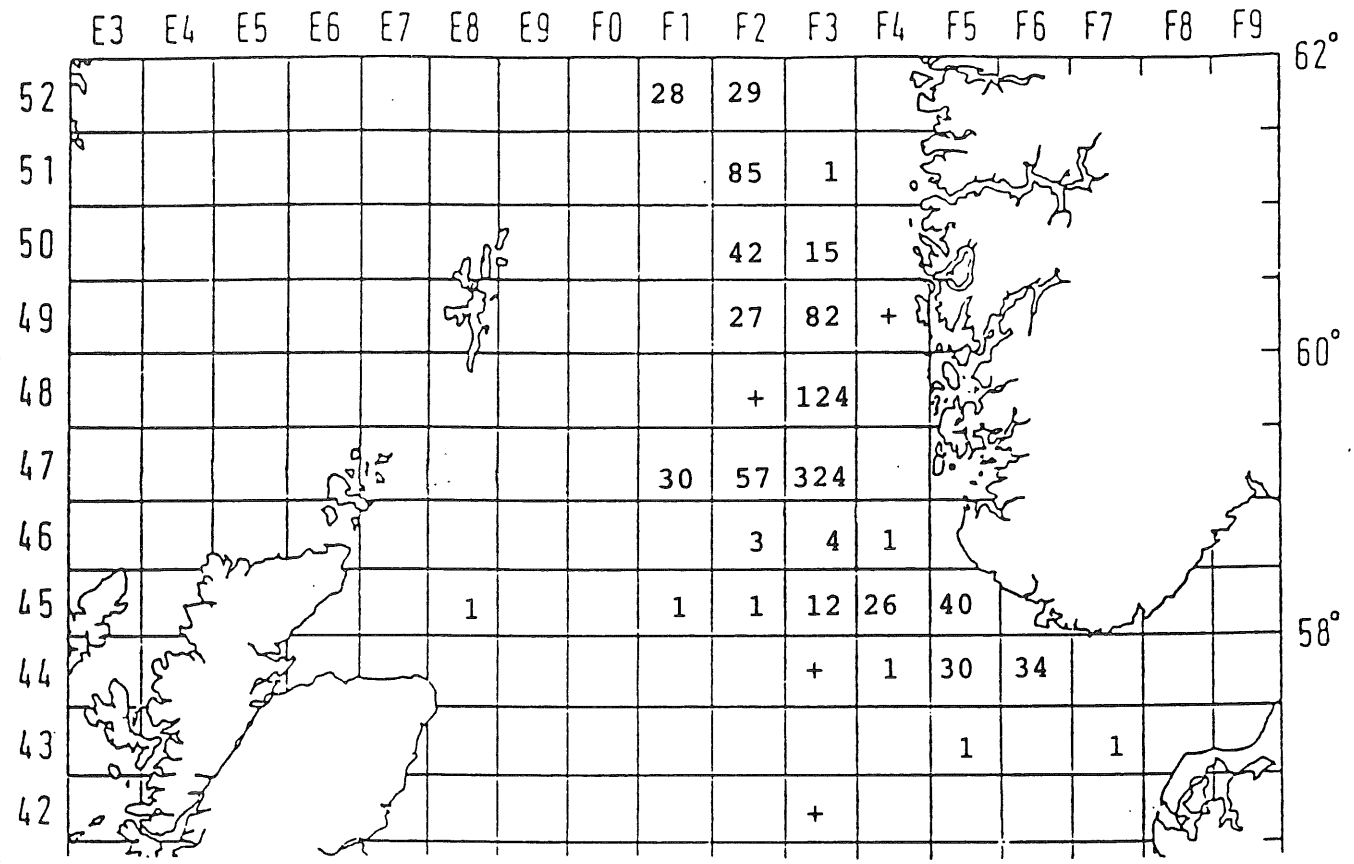


Figure 1.4.1.1 (cont'd.)



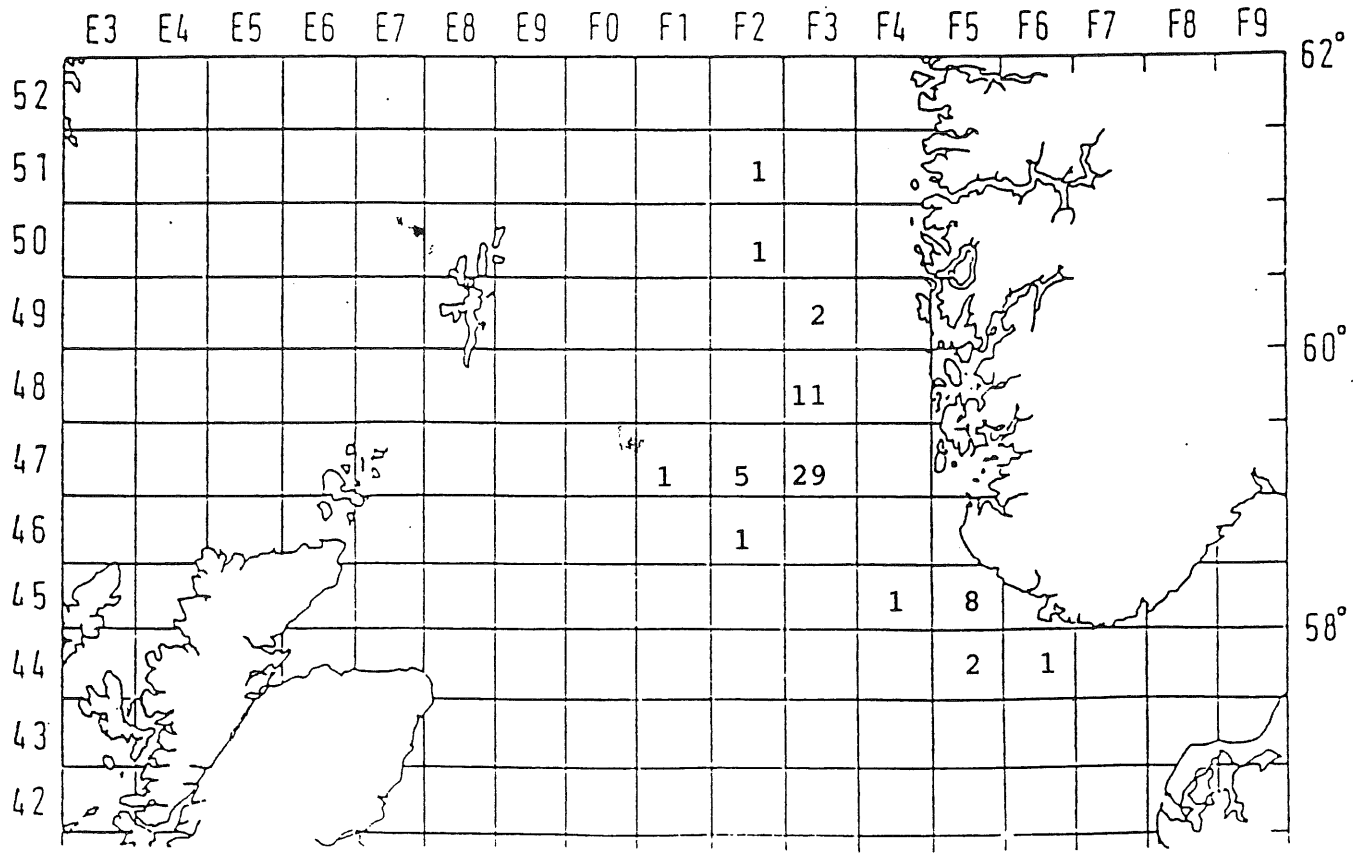


Figure 1.4.1.2 Norway pout 1992. Landings (0/00) by statistical rectangles and corresponding number of samples.

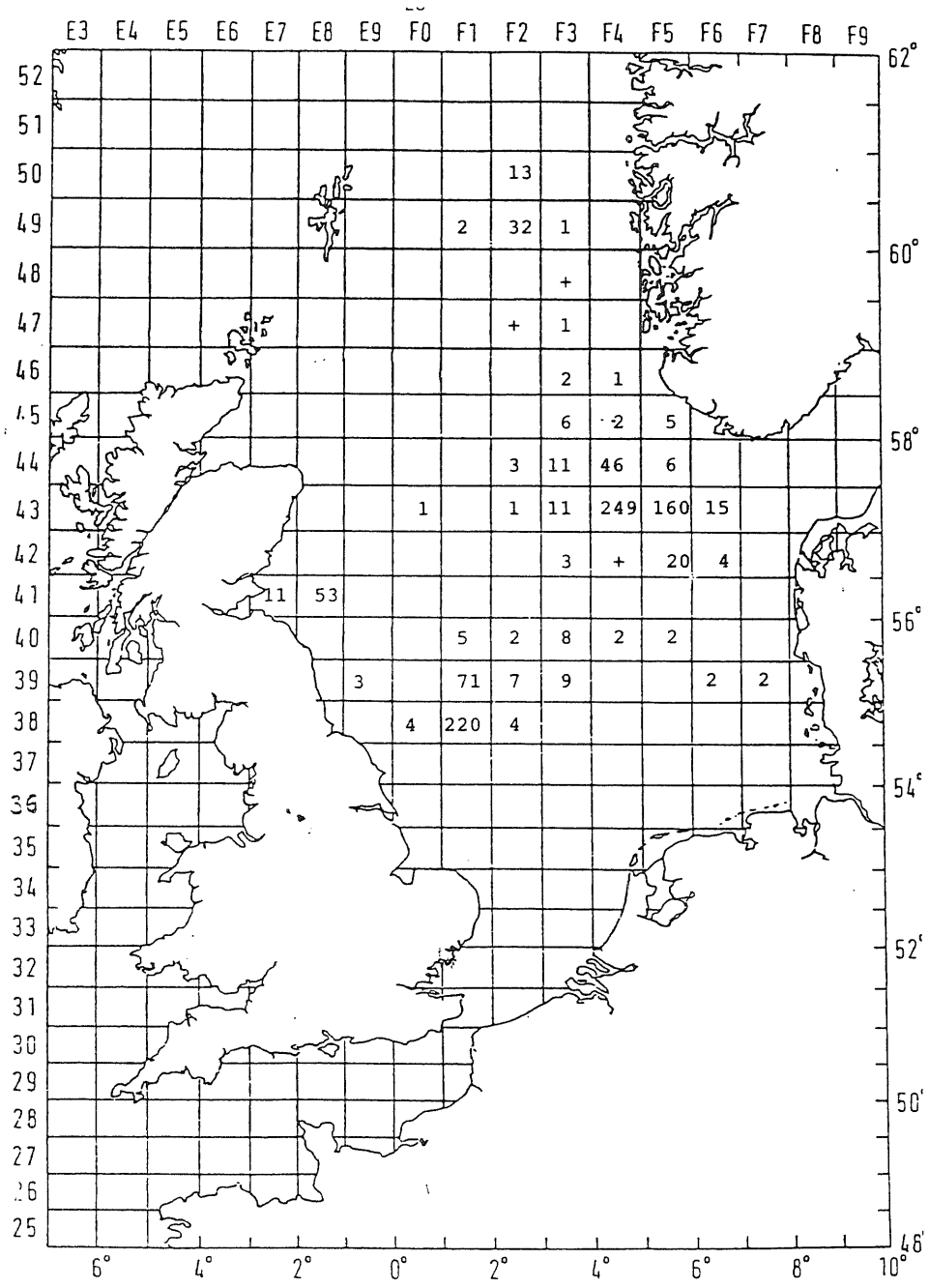


Figure 1.4.1.3a Sandeel 1992. Landings (0/00) by statistical rectangles.

NORWAY

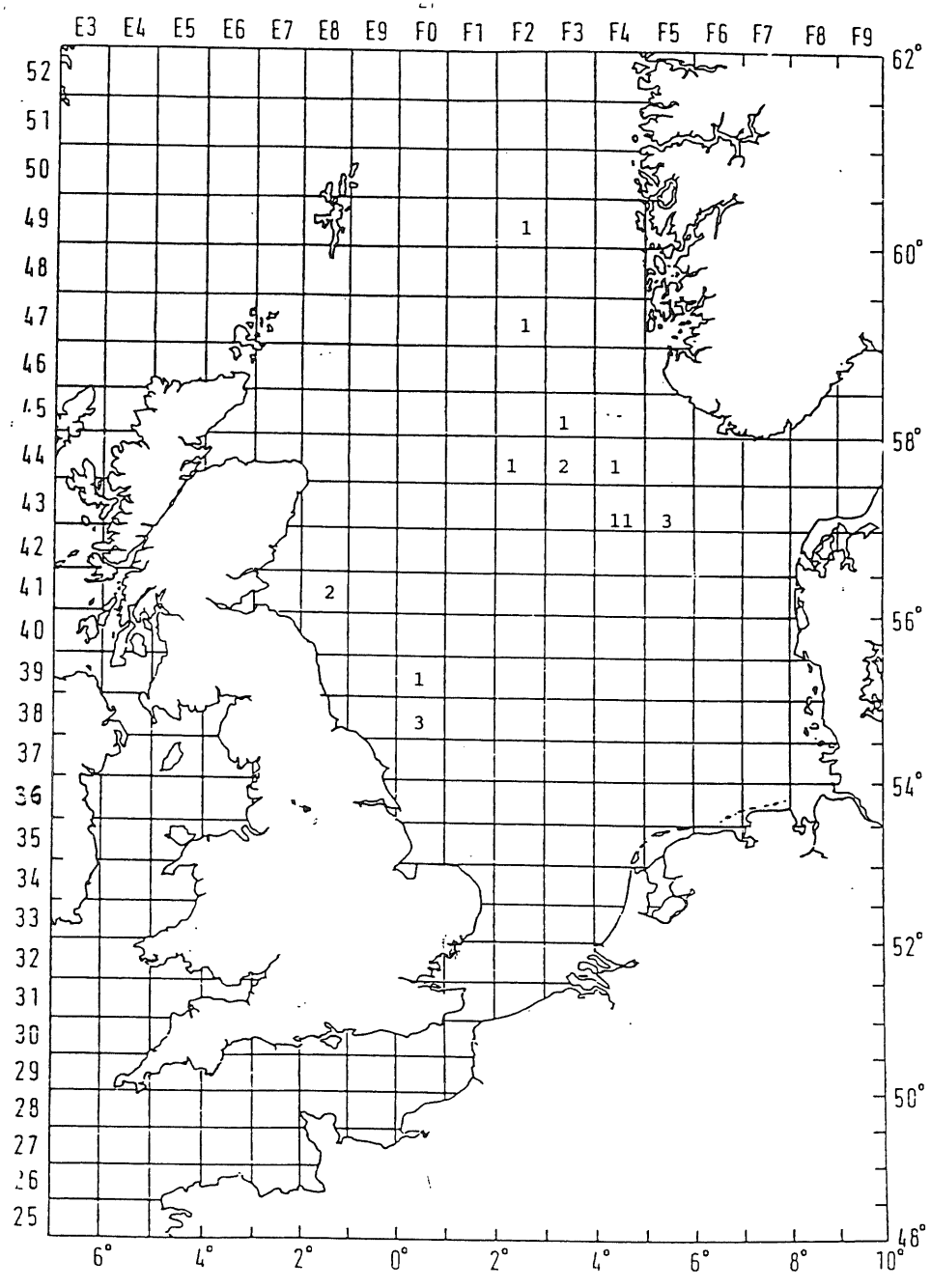


Figure 1.4.1.3b Sandeel 1992. Number of samples by statistical rectangles

NORWAY

Figure 2.2.1a Danish sandeel areas and assessment areas by the Working Group.

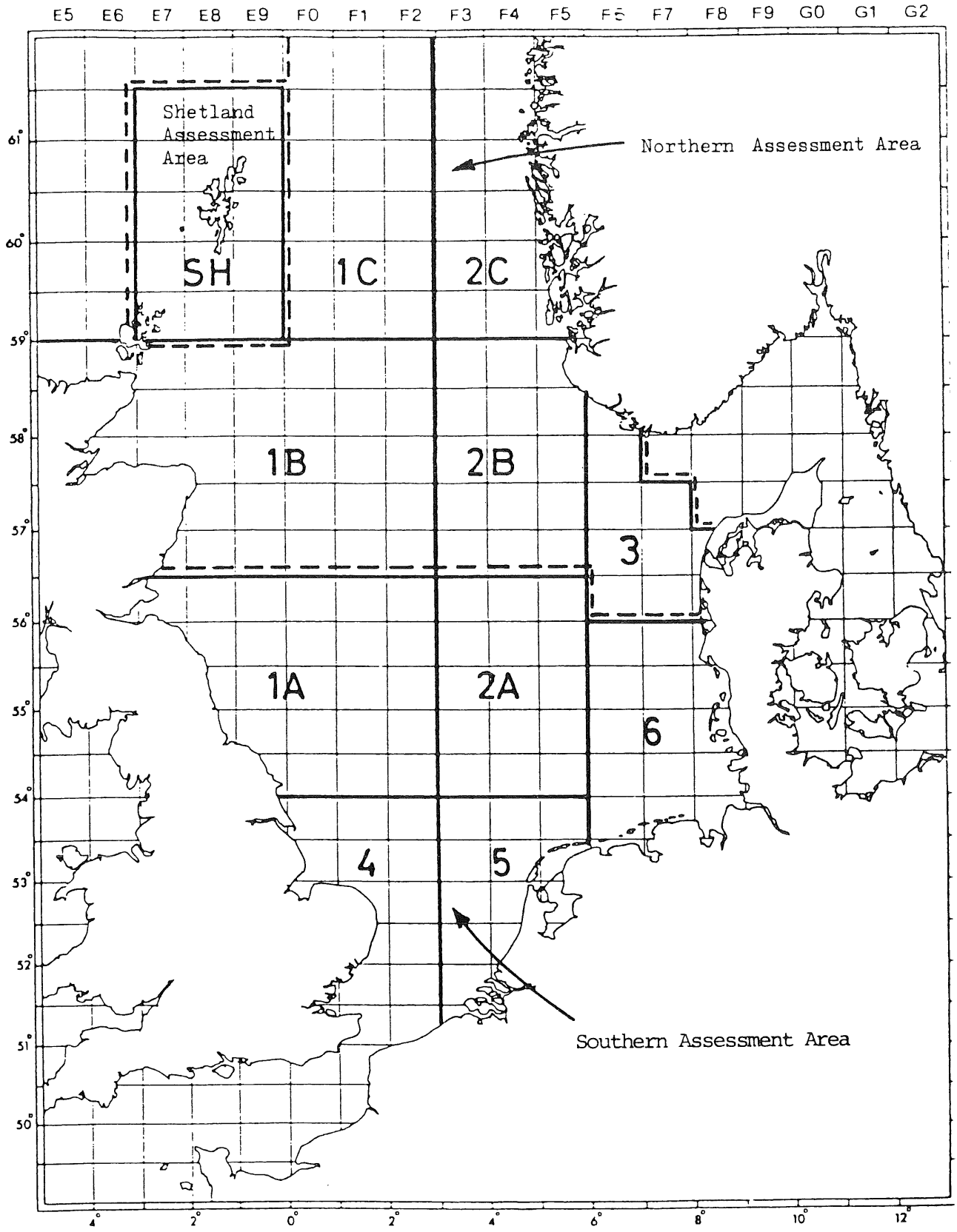
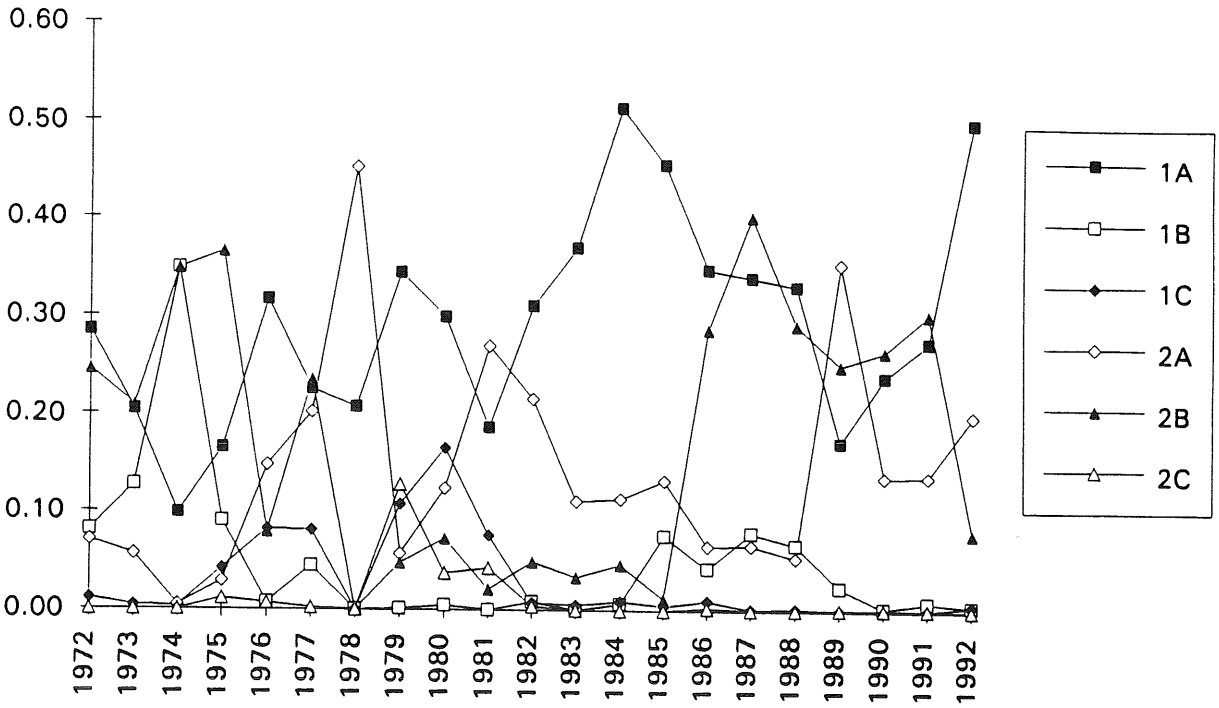
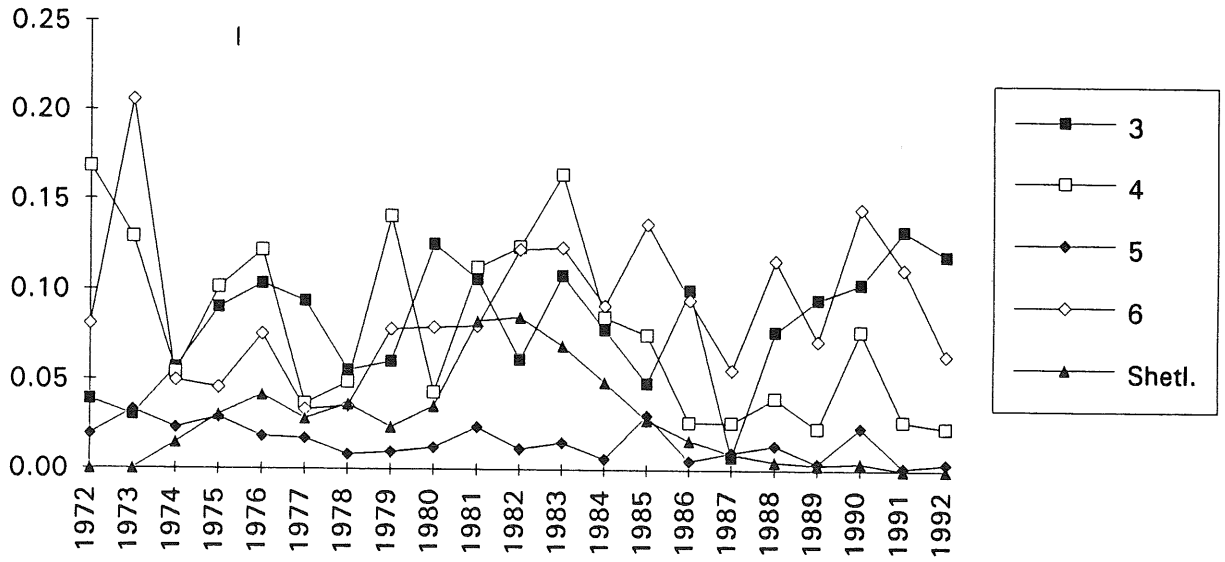


Figure 2.2.1 b) Relative importance of fishing areas (Danish sandeel areas).



c) Relative importance of fishing areas (Danish sandeel areas).



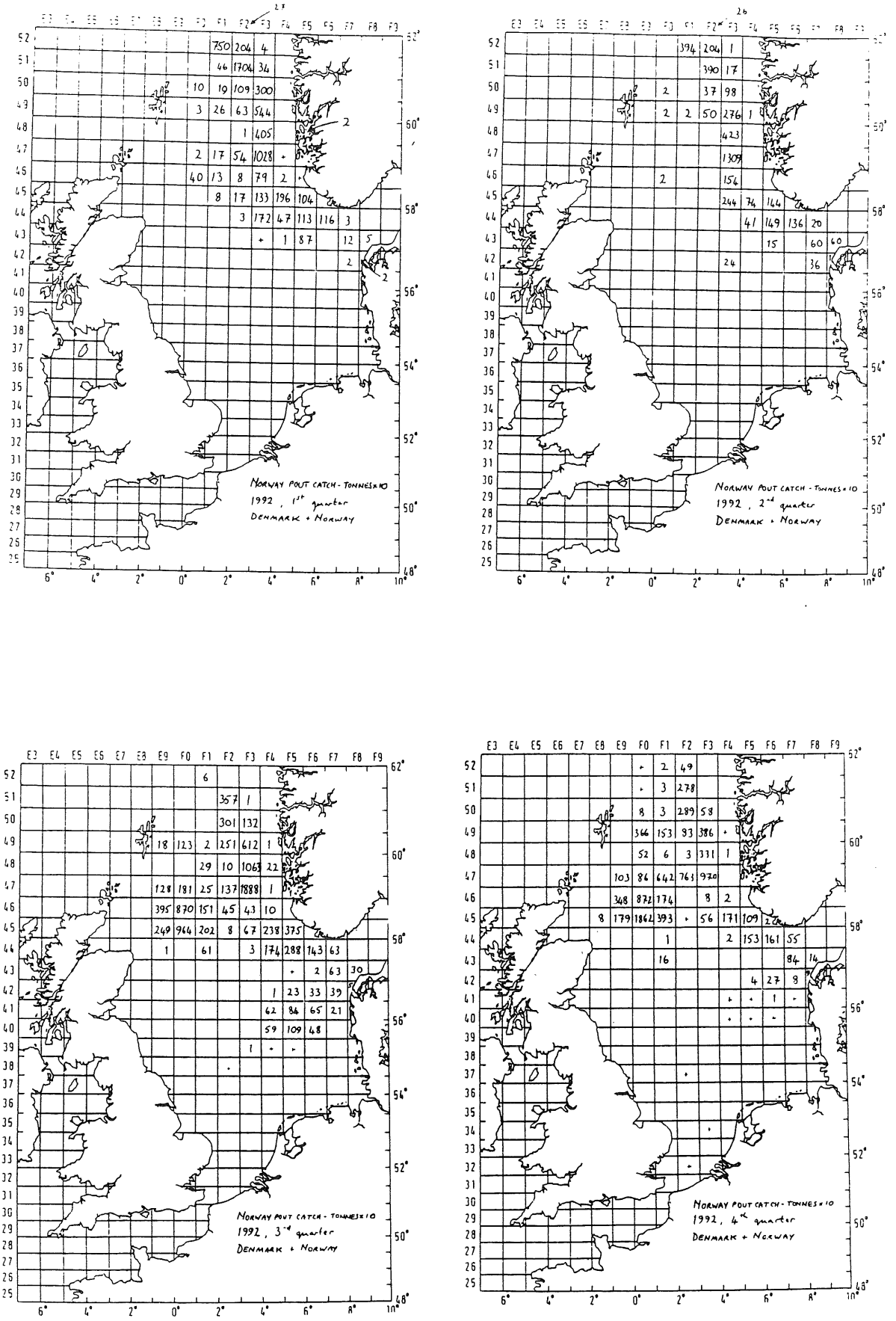


Figure 5.1.1 Norway pout, North Sea. Danish and Norwegian landings ($t \times 10$) by rectangle and quarter, 1992.

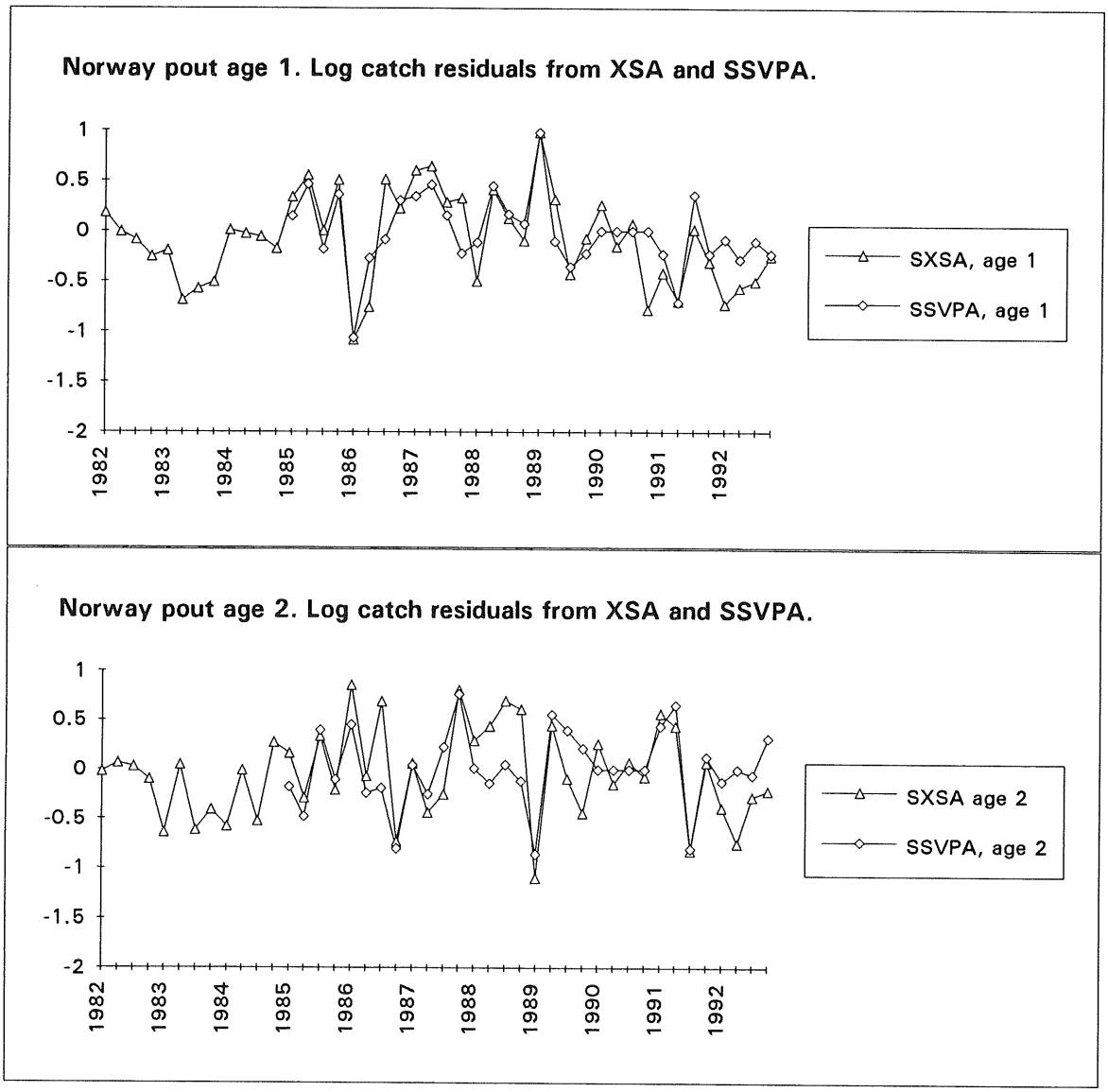

Norway pout age 1. Log catch residuals from XSA and SSVPA.
1
0.5
0
-0.5
-1
-1.5
-2
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
SXSA, age 1
SSVPA, age 1
Norway pout age 2. Log catch residuals from XSA and SSVPA.
1
0.5
0
-0.5
-1
-1.5
-2
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
SXSA age 2
SSVPA, age 2

Figure 5.6.1

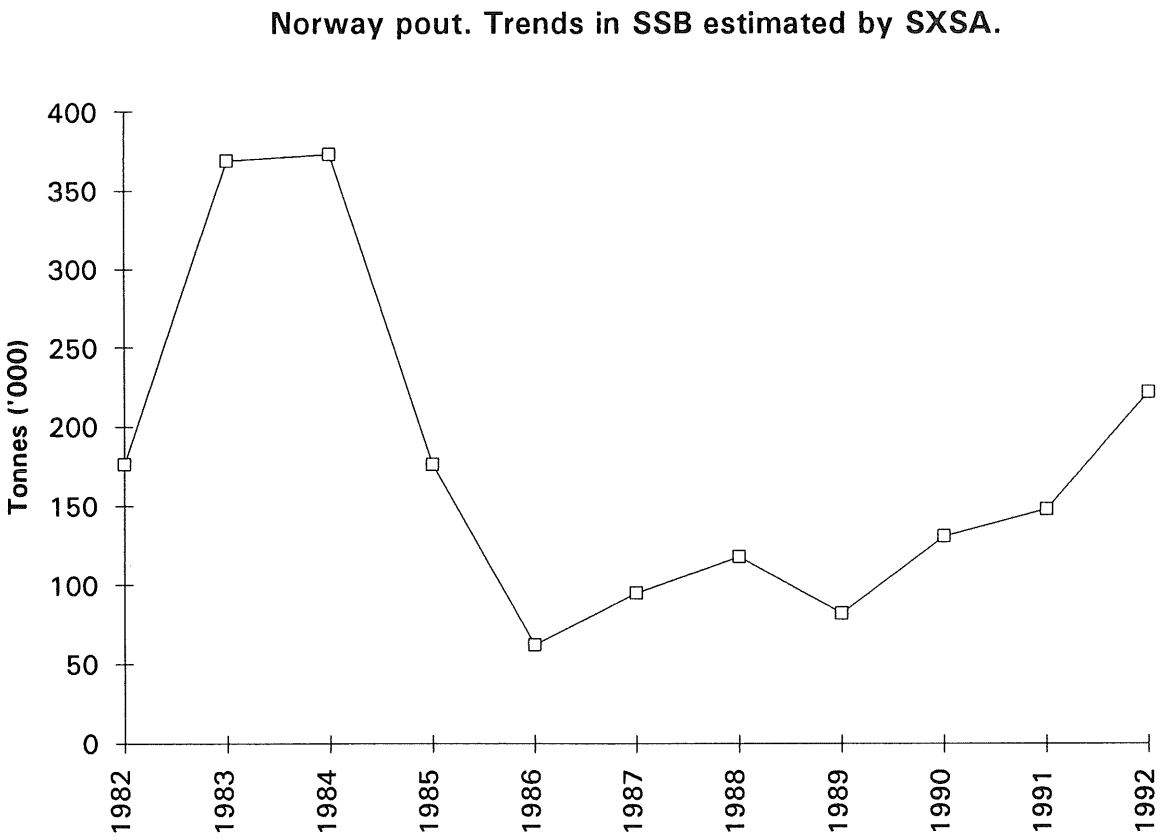


Figure 5.6.1 (continued)

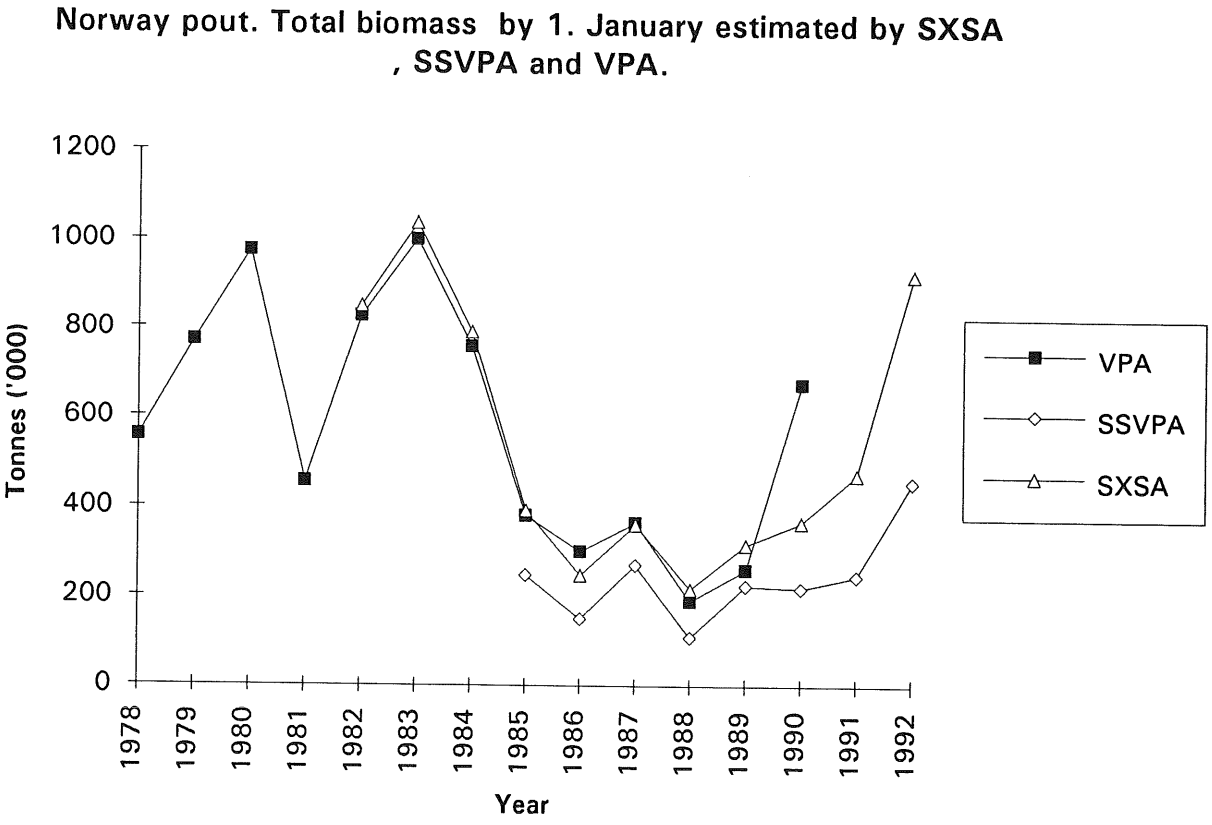

Norway pout. Total biomass by 1. January estimated by SXSA , SSVPA and VPA.
Tonnes ('000)
1200
1000
800
600
400
200
0
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Year
VPA
SSVPA
SXSA

Figure 5.6.2

Norway pout. Fishing mortality at age 1 as estimated by SXSA, SSVPA and VPA.

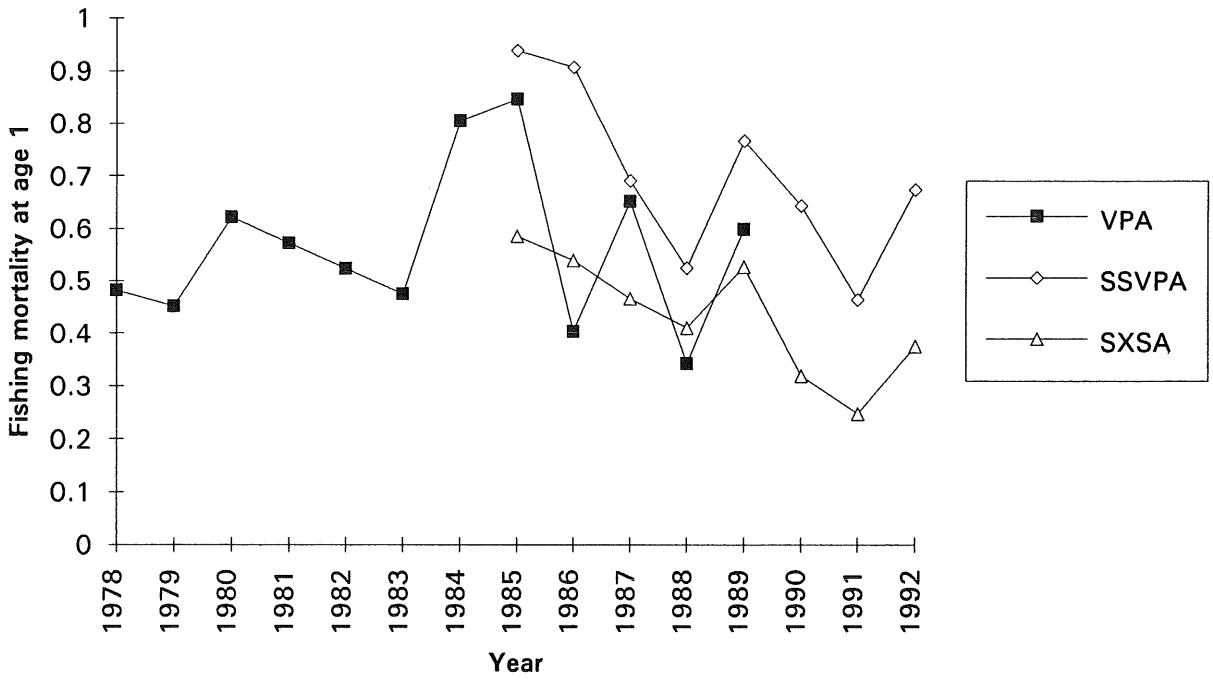


Figure 5.6.3

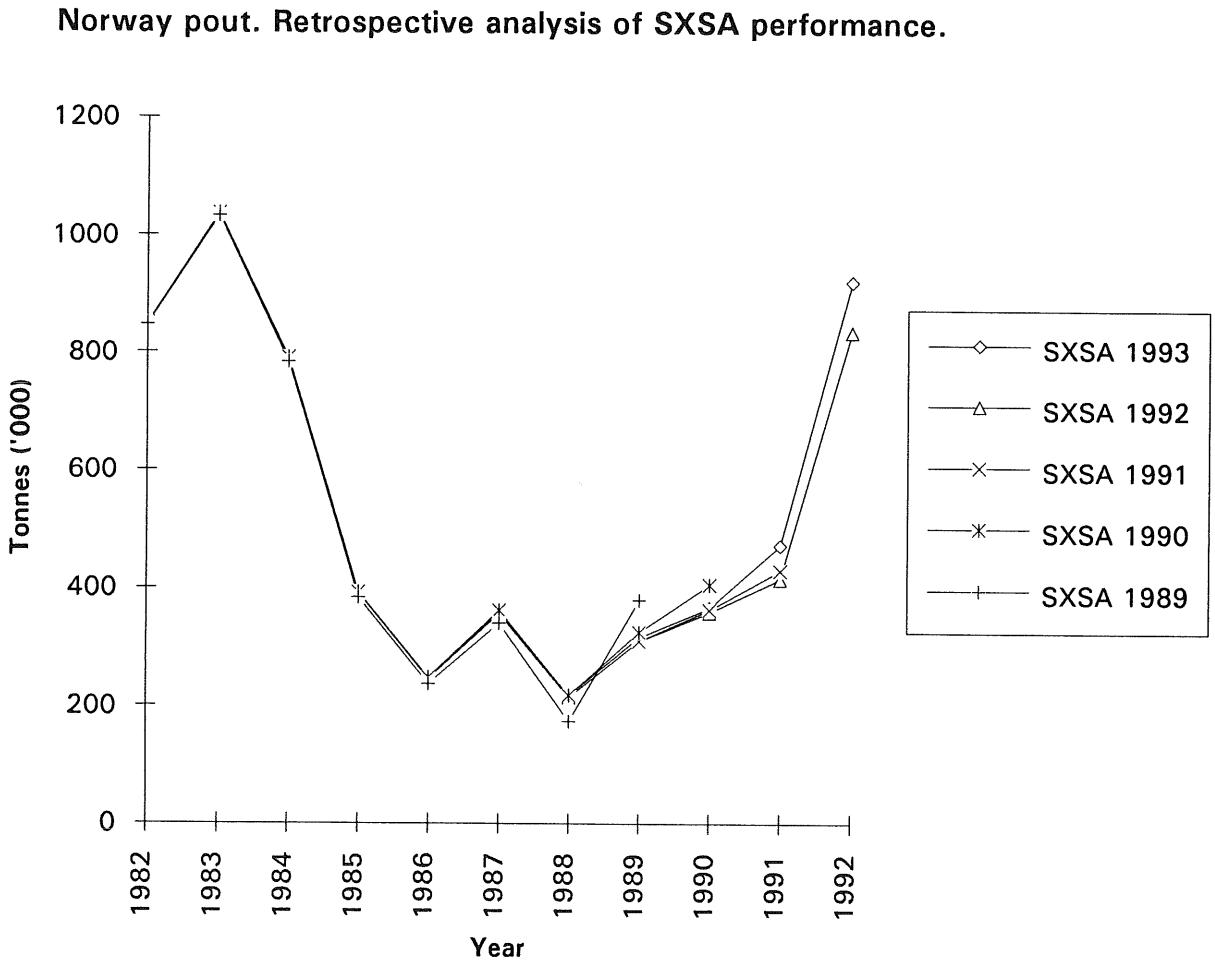
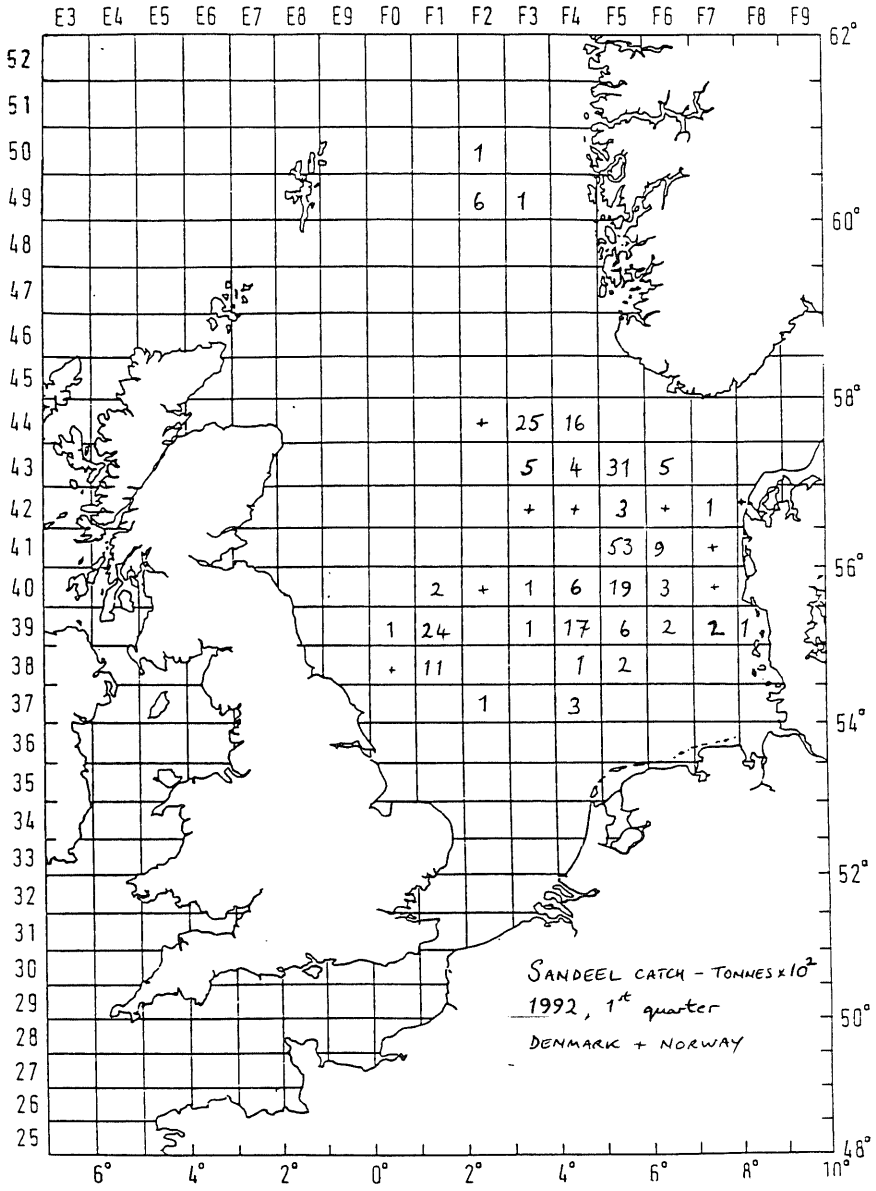

Norway pout. Retrospective analysis of SXSA performance.
Tonnes ('000)
1200
1000
800
600
400
200
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Year
SXSA 1993
SXSA 1992
SXSA 1991
SXSA 1990
SXSA 1989

Figure 5.6.4



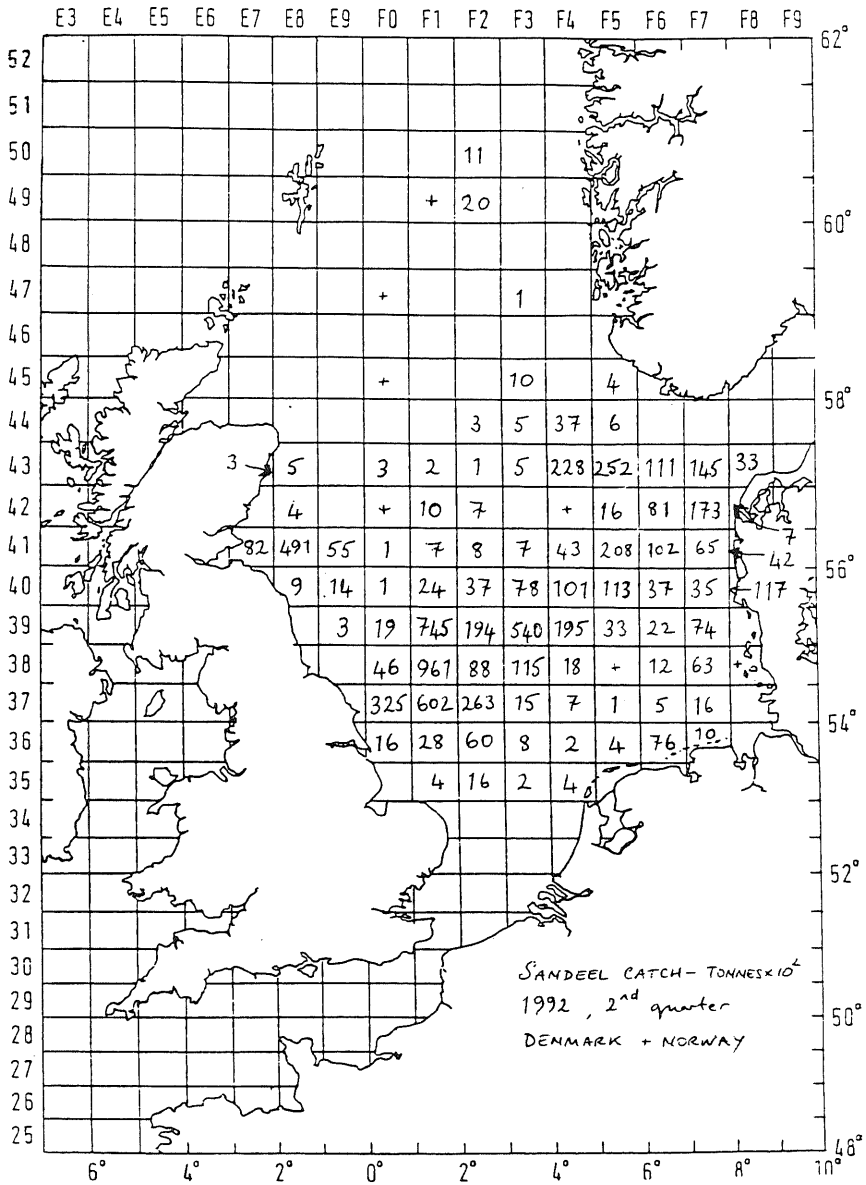
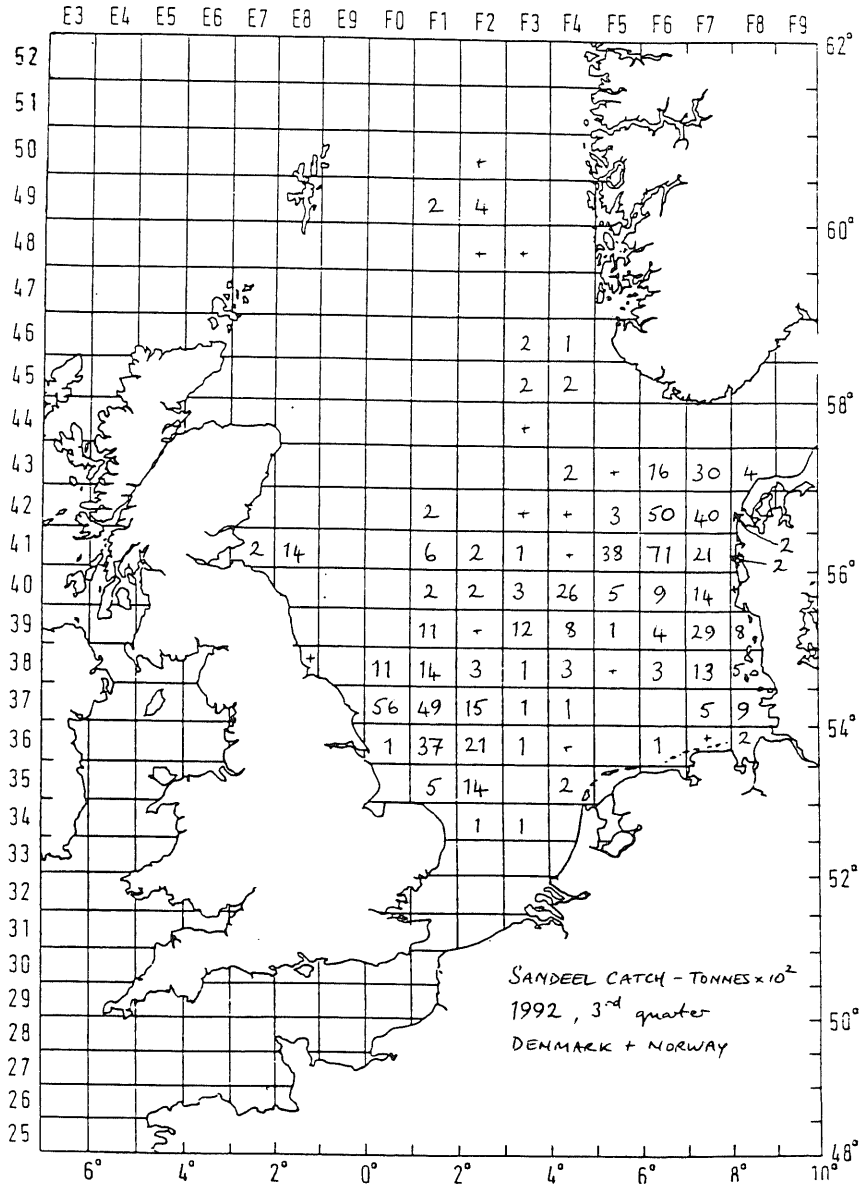


Figure 8.1.1 Sandeel, North Sea. Danish and Norwegian landings (hundred t) by rectangle and quarter, 1992.

cont'd.



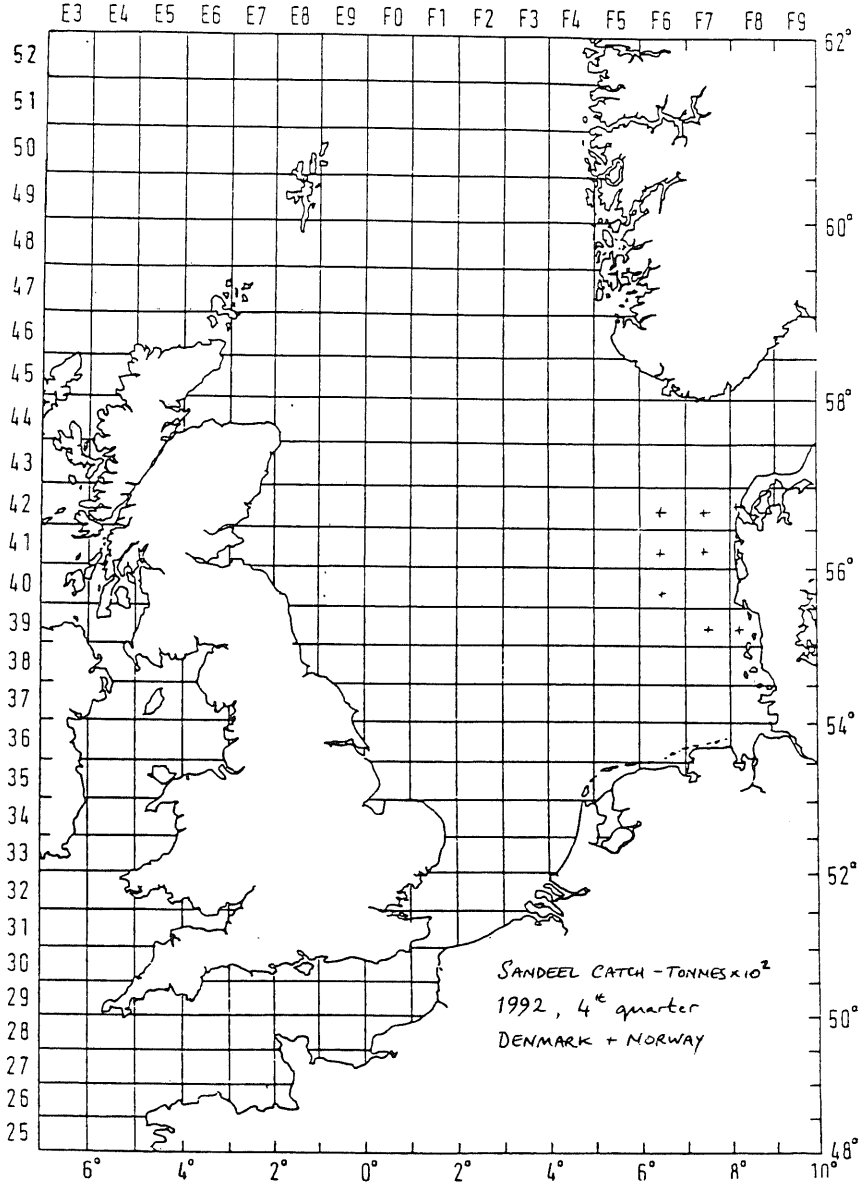


Figure 8.1.1 (continued)

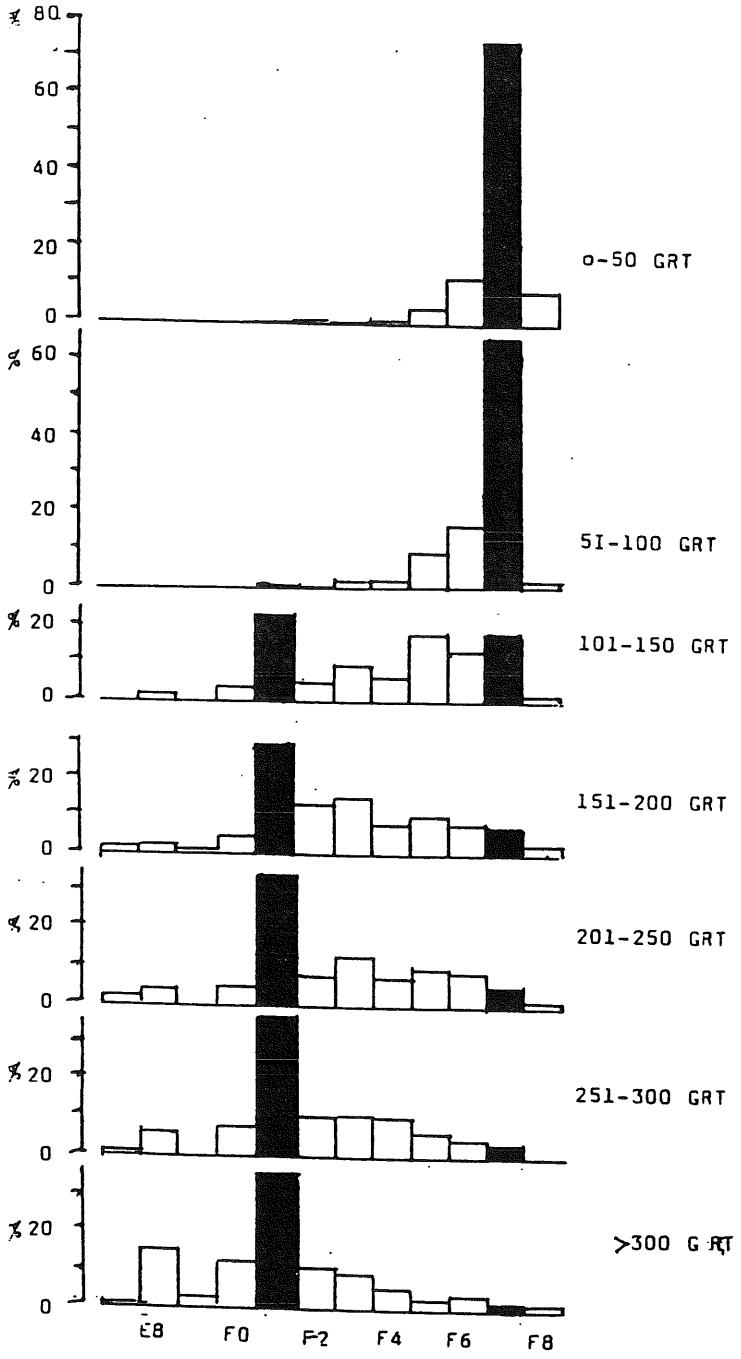


Figure 8.1.2 Sandeel, North Sea 1992. East-west distribution of fishing grounds by vessel size shown as percentages of yearly catch taken in the columns of ICES statistical rectangles (See Figure 8.1.1).

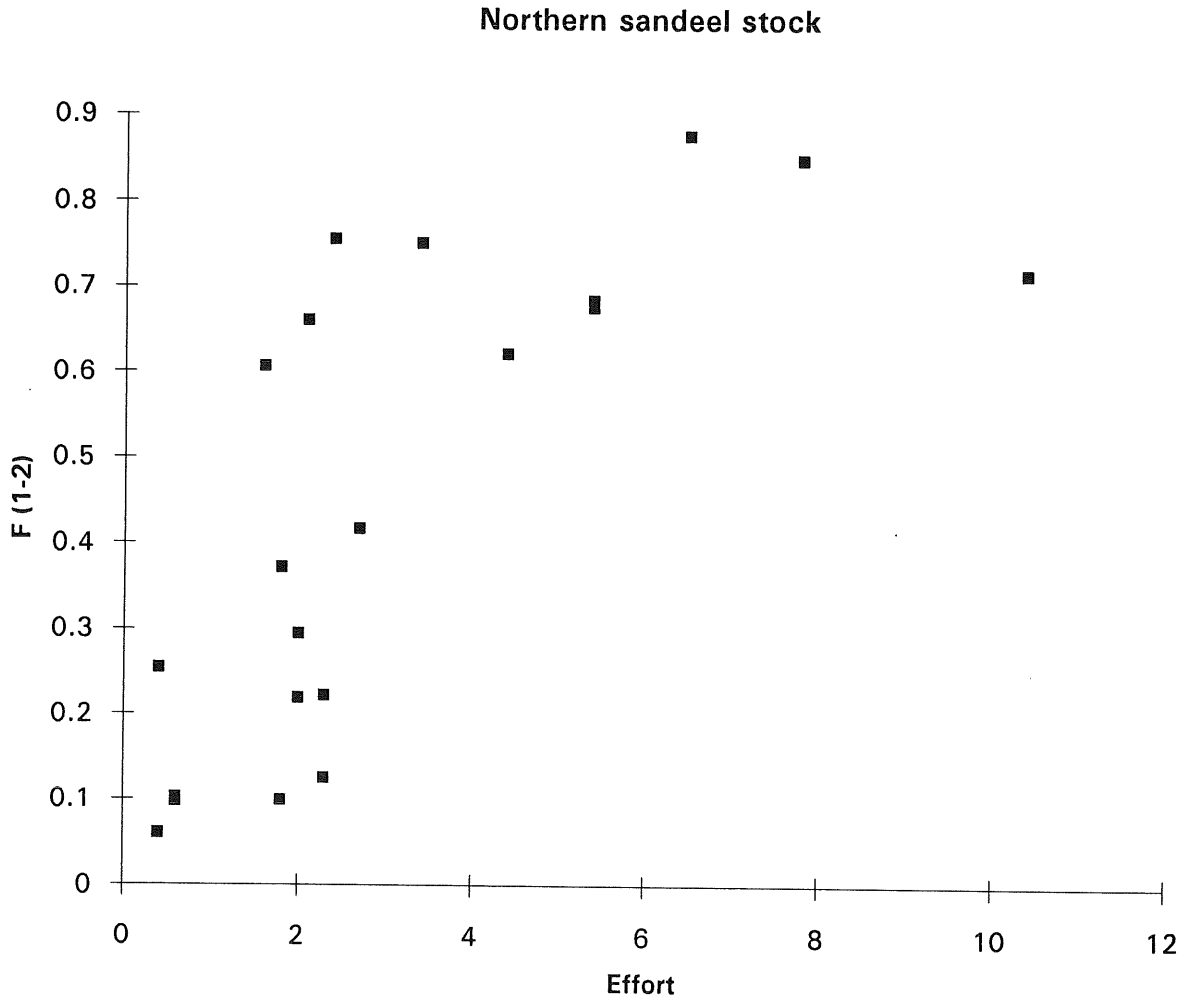


Figure 8.2.1 Sandeel in the northern part of the North Sea. F_{1-2} plotted against fishing effort (thousand days) by half year.

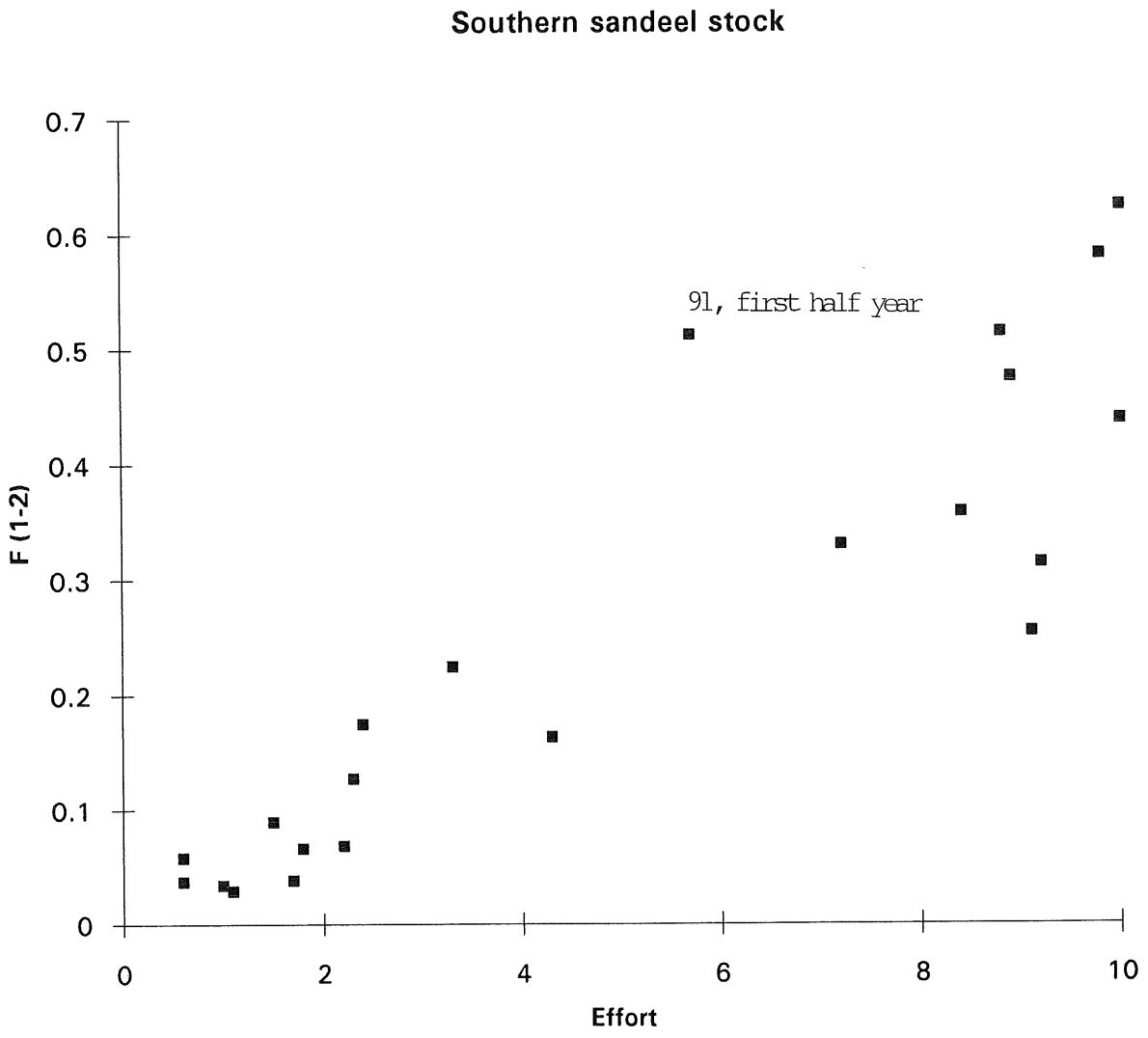
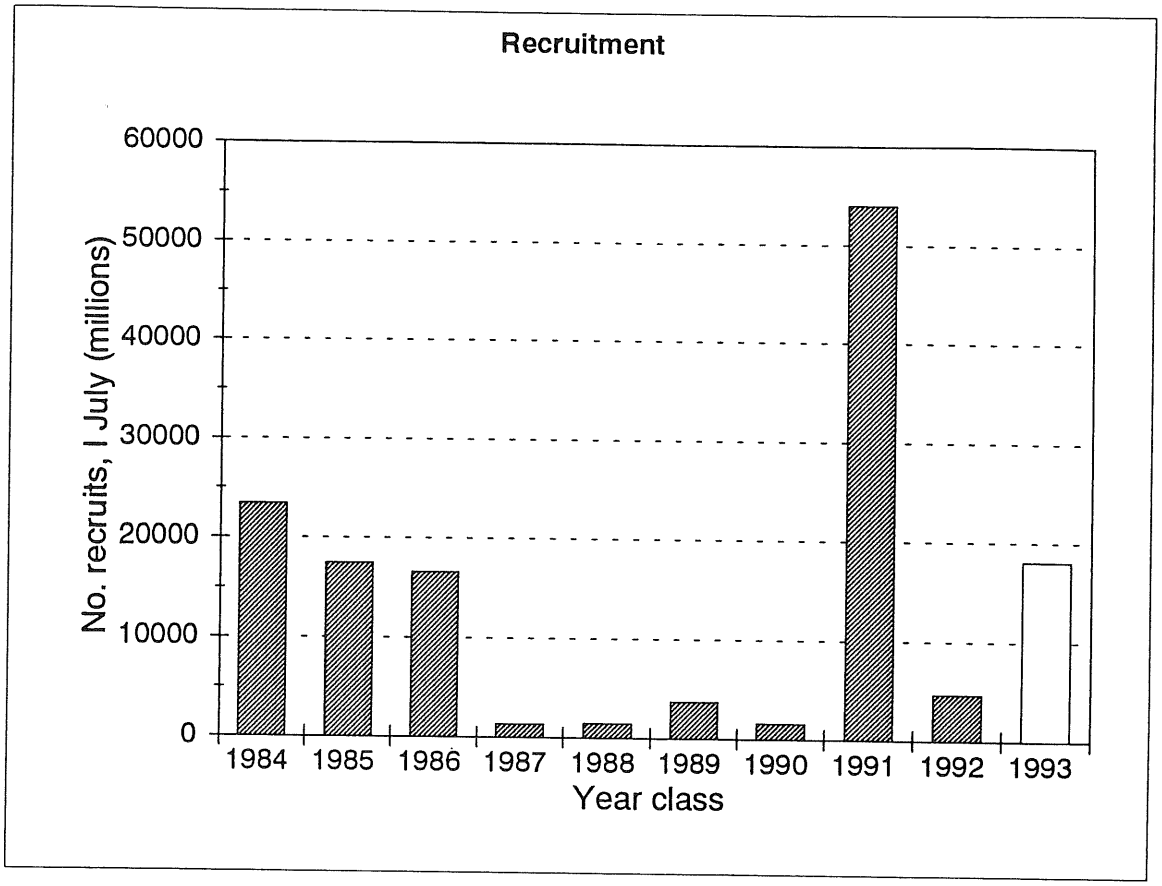


Figure 8.3.1 Sandeel in southern part of the North Sea. F_{1-2} plotted against fishing effort (thousand days) by half year.

Figure 8.4.1

Sandeels at Shetland
Trends in Recruitment and Spawning stock.



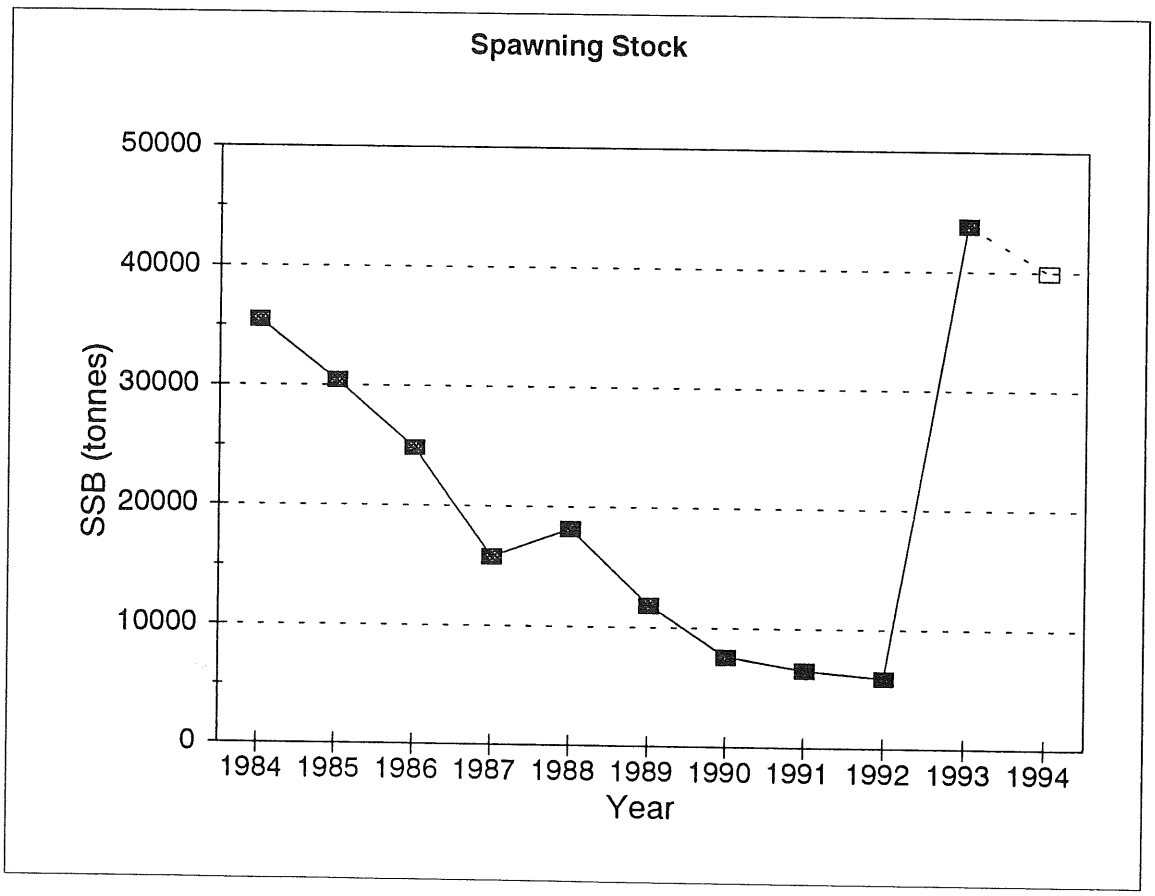
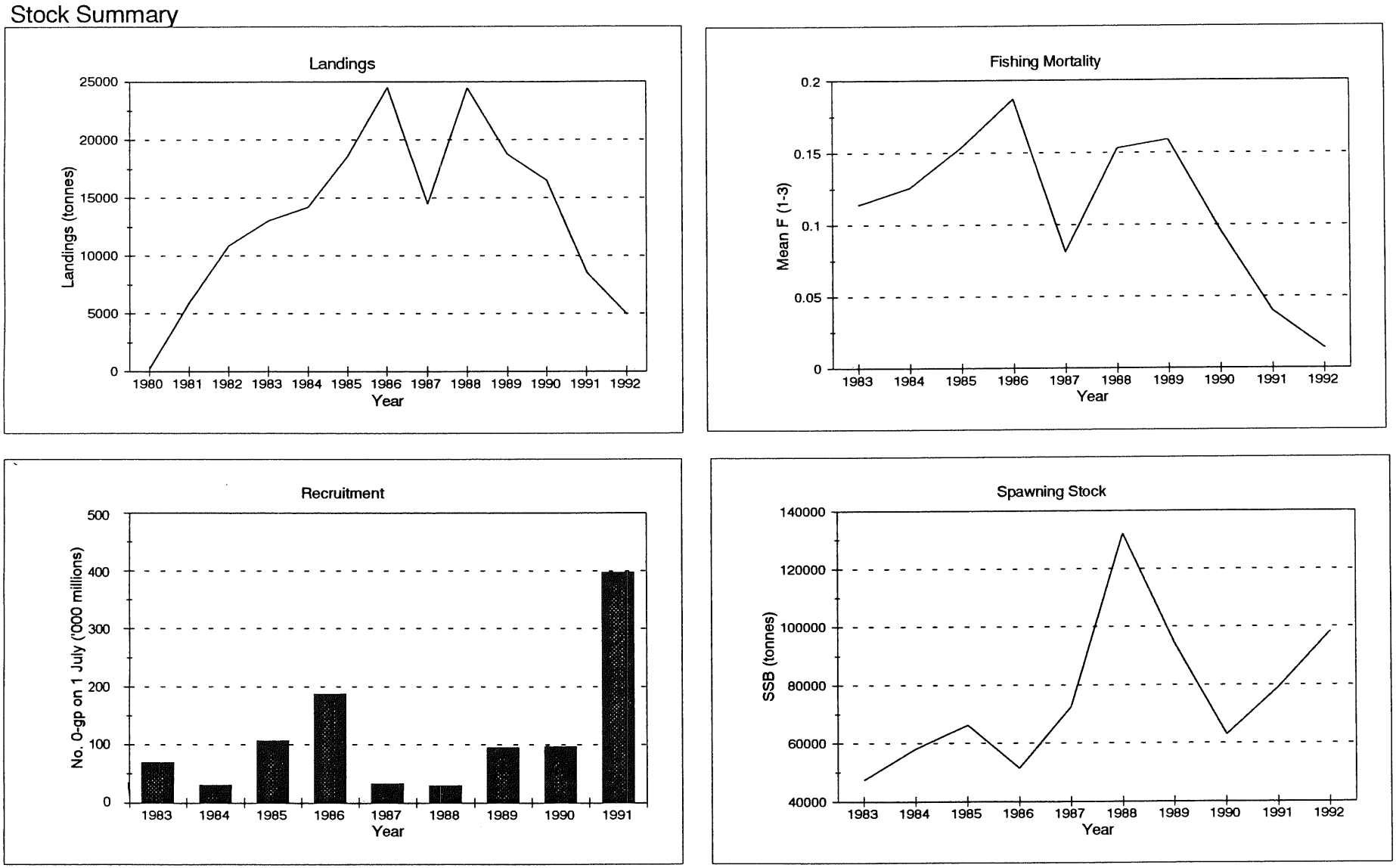


Figure 9.1 Sandeel in Division VIa.



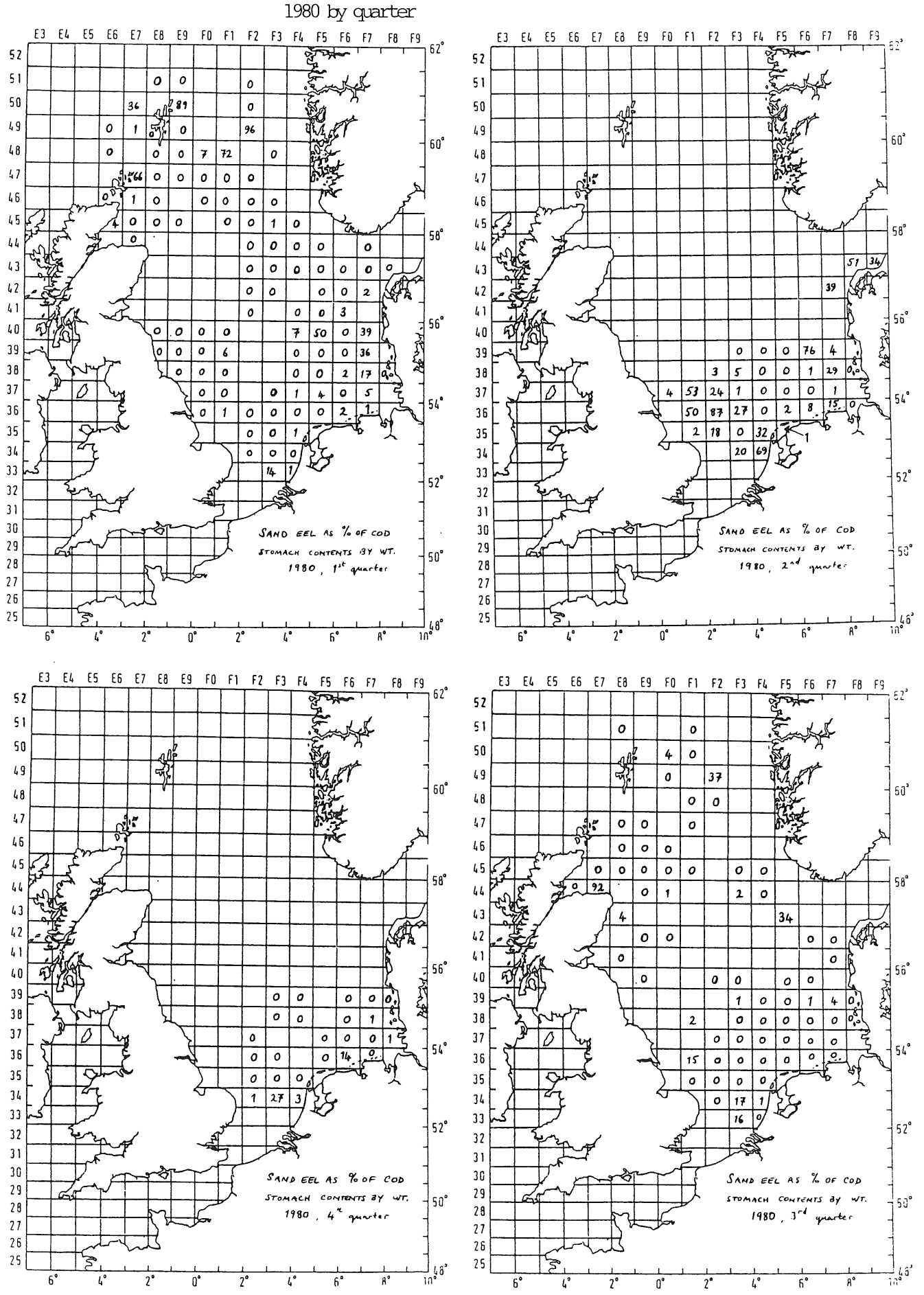
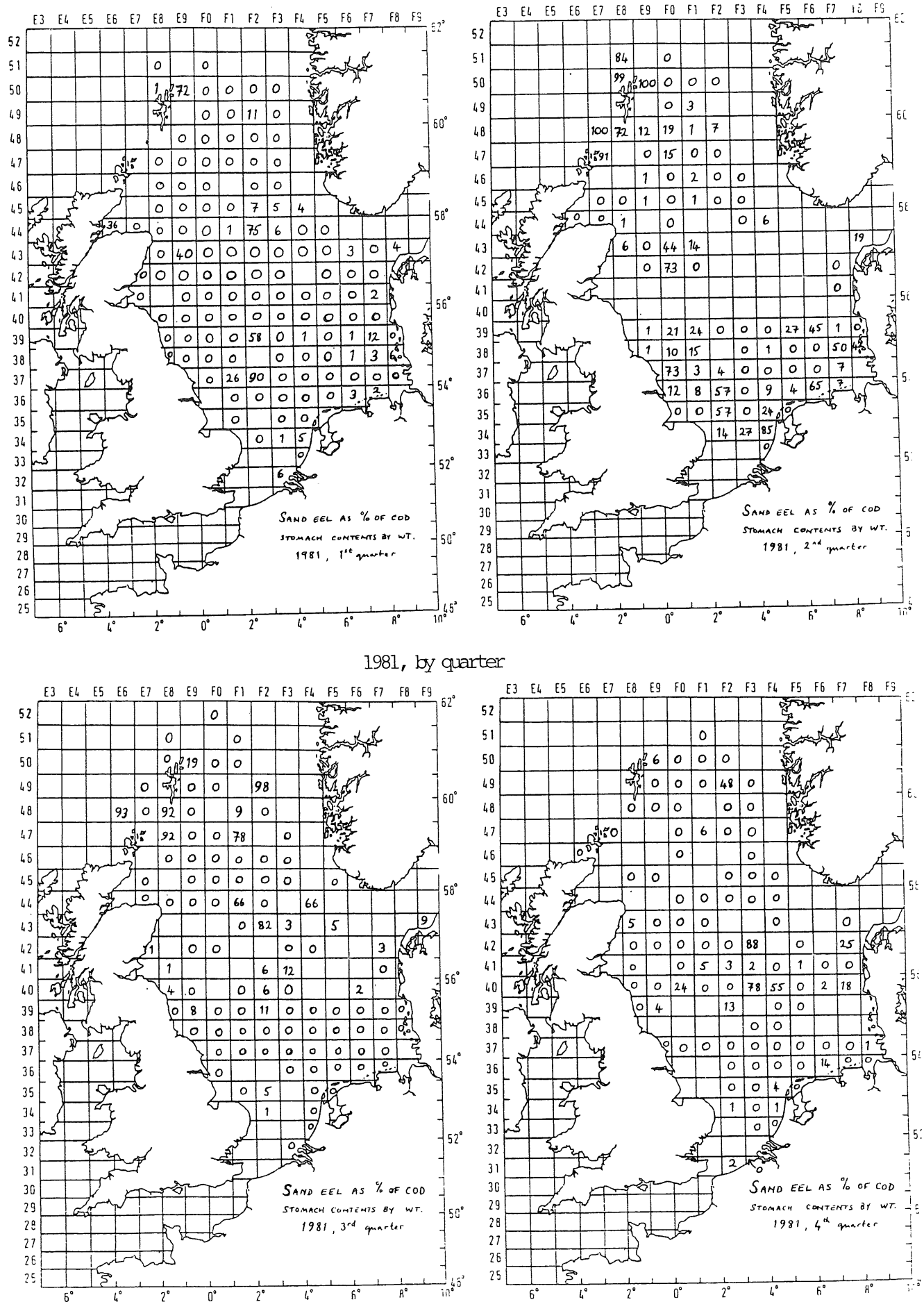


Figure 10.1a Relative abundance of sandeel, expressed as the percentage of cod stomach contents by weight.

Figure 10.1b Relative abundance of sandeel, expressed as the percentage of cod stomach contents by weight. 1981 by quarter



1981, by quarter

1985, 1st and 3rd quarters

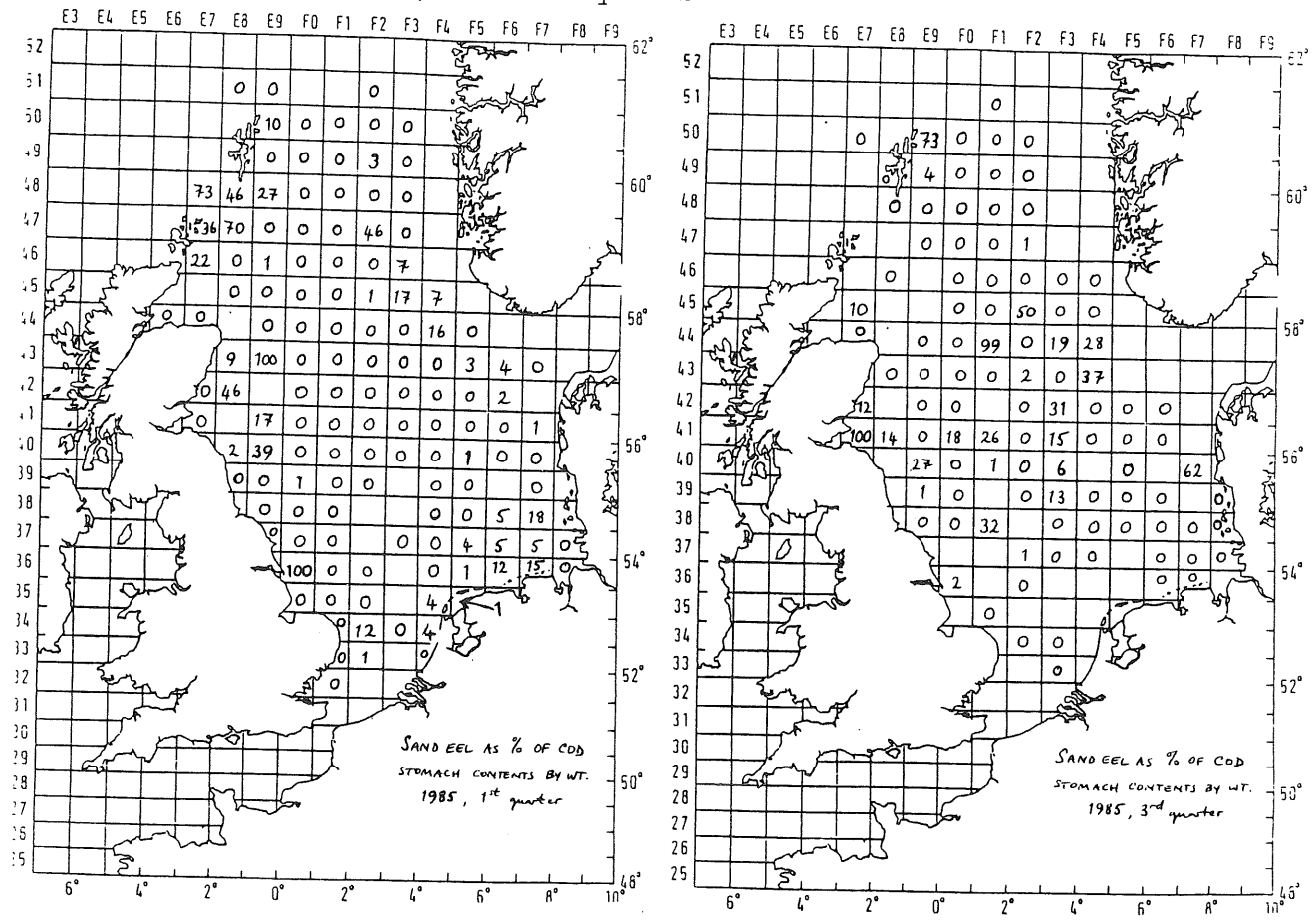
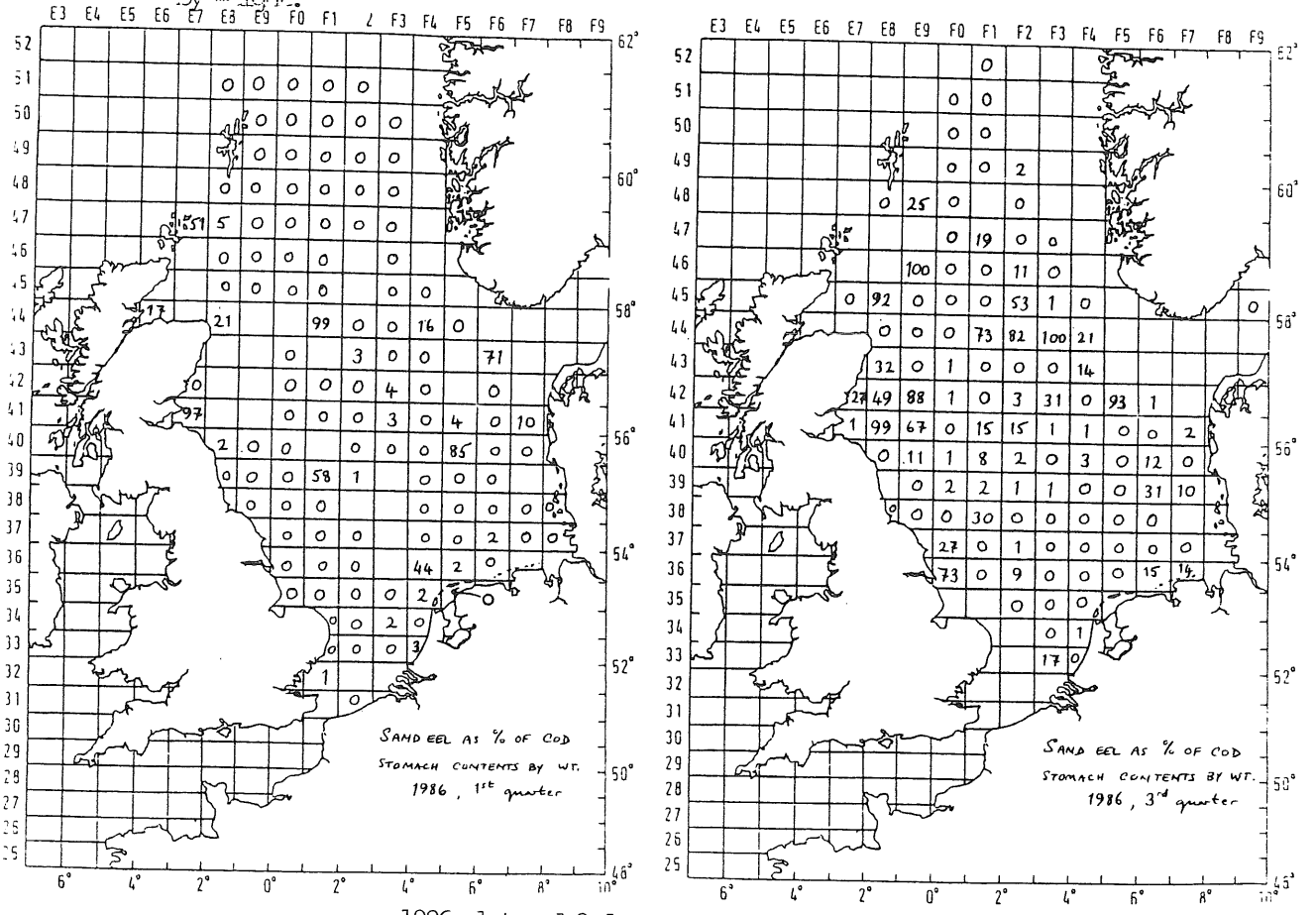


Figure 10.1c Relative abundance of sandeel, expressed as the percentage of cod stomach contents by weight.



1986, 1st and 3rd quarters

Figure 10.1d Relative abundance of sandeel, expressed as the percentage of cod and stomach by weight.

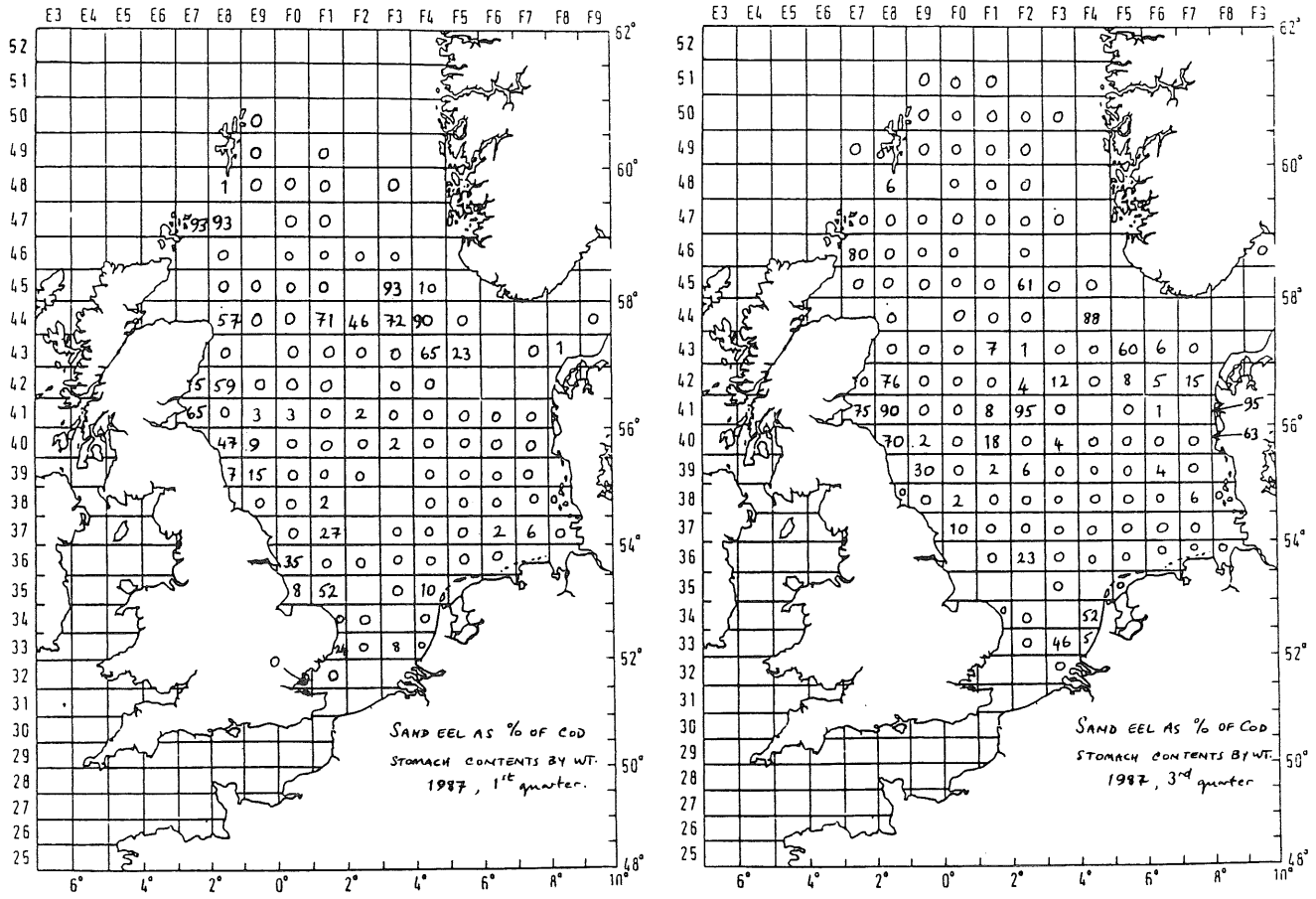


Figure 10.1e Relative abundance of sandeel, expressed as the percentage of cod stomach contents by weight.

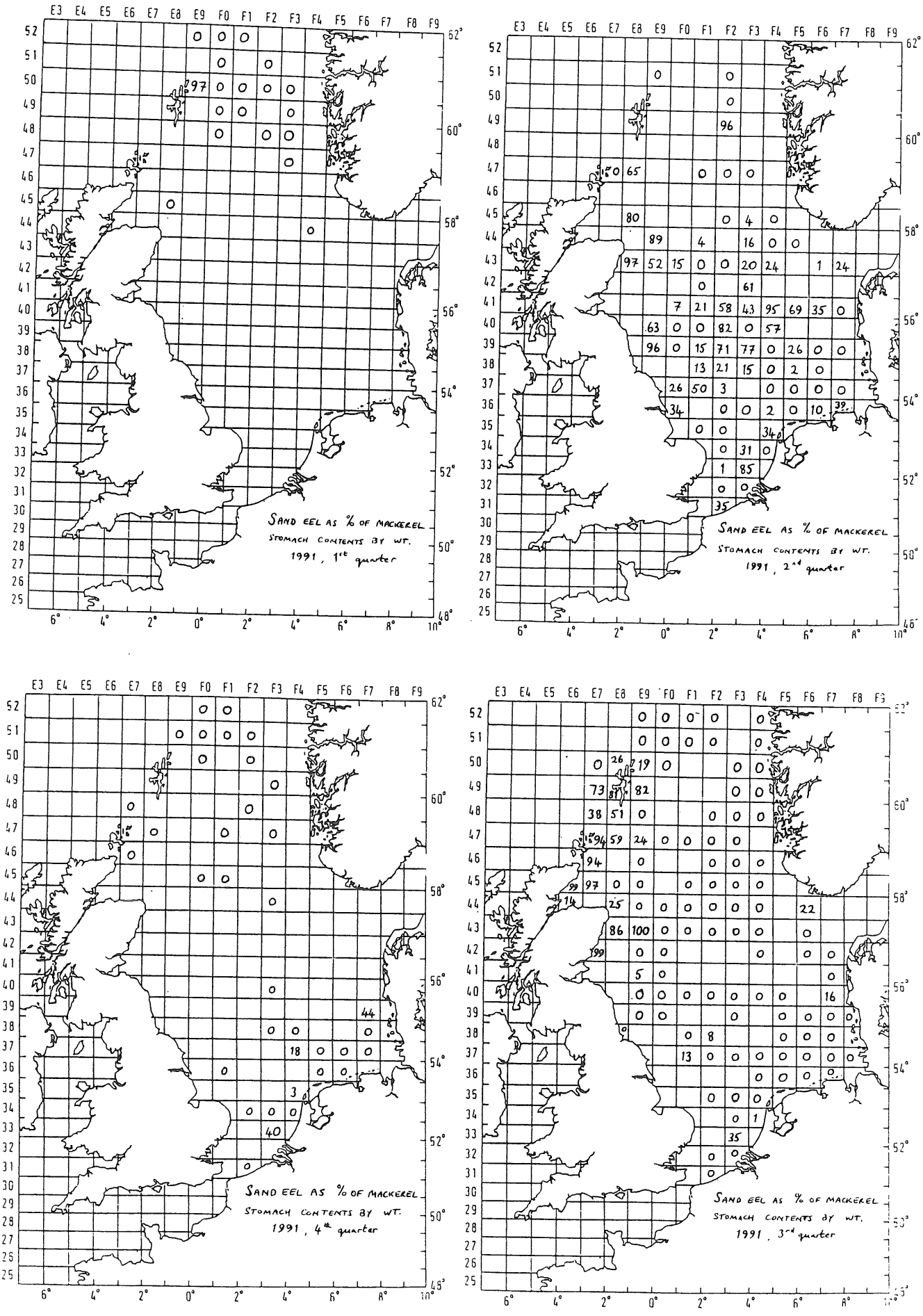


Figure 10.1f Relative abundance of sandeel, expressed as the percentage of cod stomach contents by weight.

APPENDIX 1

A seasonal extended survivors analysis (SXSA) with optional estimation of unknown catches at age.

Dankert W. Skagen
Institute of Marine Research
P.O.Box 1870
N-5024 Bergen - Nordnes
Norway

Theory

The extended survivors analysis (XSA) as developed by Shepherd (ref) on the basis of previous work by Doubleday (ref), is one of several methods for calibrating av VPA with additional measures of relative stock abundance. Given the natural mortalities (m) at age and the catches (C) at age in a year class cohort, the catch equations

$$N_1 = N_0 e^{-z} \quad ; \quad \bar{N} = \frac{N_0 - N_1}{z} \quad ; \quad z = m + f \quad ; \quad f = C/\bar{N}$$

where f is the fishing mortality, z the total mortality and N0, N1, and N are the numbers at age in the cohort in the beginning,and the end of the season, and the mean number in the season, respectively, define the stock abundance at age and the fishing mortalities at age as one-parameter families of unique trajectories. Thus, the stock numbers at age and fishing mortalities at age are defined by specifying either one f or one N at age. In XSA, the strategy is to estimate the N at the end of the last year and season (the survivor number S).

The additional information (tuning indices =u) can in principle be any measure related to the stock abundance at age and time by some defined model. In practice, it is usually regarded as proportional to N, where the proportionality factor r (=1/q, i.e. the inverse catchability) can be estimated.

The S'es and r's are estimated by minimizing the weighted sum of squares

$$\sum \left(\log N - \log(r \cdot u) \right)^2 \cdot w$$

taken over all possible entries.

As shown by Shepherd, given N(S), the estimator for log(r) for a given age and fleet is the mean of all individual estimates $\log(\hat{r}) = \log(N) - \log(u)$.

The estimator for log S is the mean of all entries for the cohort of

$$\hat{S} = \left(\log(r \cdot u) - Z \right) \cdot w / e^{F}$$

where the capital letters denote cumulated mortalities from the actual age to the age at survivors stage.

As weighting factor, some measure of the precision of the estimate of r is relevant. Here we use the inverse empirical variance of the $\log(\hat{r})$.

If there are several fleets, each fleet will be given a set of r's and accompanying weighting factors. The data for each season from a given fleet are treated as separate fleets, i.e. catchabilities are defined by season.

Thus, given the S'es, the r's and the weighting factors can be estimated, and given the r's and the previous N's, the S'es can be estimated. This leads to an iterative procedure, which is repeated until convergence.

When the tuning data are the CPUE in the commercial fishery, the r's at age and season will be inversely proportional to the F at age for the same season, i.e. 1/r can be used as the selection pattern, the effort being the year factor. This is utilized in estimating unknown catches, by applying these f's to the estimated stock numbers.

Implementation

The program is written in FORTRAN. It was originally implemented on a UNIX workstation. With a sufficiently small number of years, ages and fleets, it can be compiled and run on a PC with some minor modifications. Two versions are available at present, one for half-yearly and one for quarterly assessments, the main difference being the lay-out of the printout tables. The program used Popes approximation:

$$N_1 = N_0 e^{-m} - C e^{-m/2}$$

instead of the catch equations for the VPA.

The communication with the program is through a list file, where options and file names are specified. An example is included at the end of the paper.

In the present version, the stock number related to each tuning index is the mean N for the age, season and year in question. Biomasses are computed for the start of the season specified as the spawning season.

At present, missing catches all have to be from the same year, but may be from different seasons.

Input files

General.

All input files must be space separated, pure ASCII files. Concealed tabs and other codes sometimes included by text editors will often lead to problems. In files where data are given by age, all ages from the younges age to the plus age must be included in every record. This includes dummy numbers for the younges age prior to the recruiting season.

Standard input data:

-catch in numbers at age
-weight at age in the catch
-weight at age in the stock
-natural mortality
-maturity ogive
-effort and corresponding catch at age (tuning file)

The common format for these files is records with:

year season values-at-age

The format of the tuning file is:

year season fleetnumber effort catch-at-age

In addition, this program needs some special files:

Survivor file:

Lists proposed numbers for the survivors, one cohort per line, which are used to start the iterative process. These values are not critical, but they should be of a reasonable order of magnitude.
The format is:

Dummy-identification (numeric) Survivor-number update-code

The update code should normally be 1. If it is set to 0, the survivor number for this cohort will remain as proposed, and data from this cohort will not be included in any estimation procedures. This may sometimes be useful for the oldest cohorts, or for cohorts which are poorly covered with tuning data.

Manual weighting.

It is possible to give weighting factors manually, instead of using the inverse variances. A file specifying such weights must be included, since it is read even if it is not used. The format is the same as for tuning data. If this option is selected, it will apply to all fleets.

Missing catches.

If missing catches are to be estimated, the assumed catch in tonnes and proposed numbers caught have to be given. The proposed numbers are only used to start the process.
The format of the file should be:

year season number-at-age (0..plusage)

If the number specified is -1, this catch will be regarded as known, and the number given in the ordinary catch in numbers file will be used.

Special features and options

Estimation of inverse catchabilities.

In the estimate for r, the contribution from each age and year is weighted according to the number of entries for that cohort. This is done to reduce the influence of cohorts that are poorly characterized.

There is also an option for tapered weighting, where the r is determined for each year using a weighted mean over the nearest year. If this option is used, it will apply to all fleets and seasons. This weighting is by a cosine function. This option allows for slow trends in the catchabilities. It may be useful if such trends are suspected, either to account for them or to verify this suspicion. Abrupt changes in catchability, e.g due to change of gear in survey, will appear as a gradual change in the estimated catchability. Thus, this option is not well suited for treating this kind of problems.

Cathability at age.

Shrinkage is not implemented in this model. However, there is an option for taking the catchability at the oldest age as a weighted mean of the value for that age and the age before. Giving zero weight to the oldest implies that the value for the second oldest will be used for both. The use of this option is very often necessary to stabilize the iteration.

Fitted vs. actual catches.

Fitted catches are the product of the effort and the stock number, divided by the inverse catchability, i.e. the catches that one would expect if the fishing mortalities were separable, the catchability at age representing the selection pattern and the effort the yearly fishing mortality level. There is an option where the catches used in the subsequent VPA are weighted means of actual and fitted catches. This option should probably not be used for routine assessment.

Options for estimating unknown catches.

As noted previously, the primary estimate of the unknown catches is the fitted catches described above. One may use them as they are, or scale them so that the SOP (the sum of catch at age * weight at age) equals the carch in tonnes given as input.

The estimated of the unknown catches are included in the estimates of catchabilities and survivor numbers, as if they were known. The reason for this is that one would like to have catch estimates which, when entered as known, would lead to the same overall assessment.

Treatment of the plus group.

In the present version, the plus group is treated dynamically over the years. For each season, the plus group is reduced by the effect of the catches and the natural mortality, the rest is transferred to the next season. If the season is the first in a year, the survivors from the oldest true age the previous year are added to the plus group pool. The starting value is the N estimated from the catch in the first year and season, using the catchability in the commercial fleet for the oldest true age.

A trend in the plus group numbers for which there is no evidence from other observations should be taken as a signal that the assessment is unreliable.

Catches in the current year.

A potential use of the method is in the situation where survey information exists for the current year. Treatin the catches this year as unknown, gives a prediction of the catches in the current year which takes the survey information into account. An appropriate effort for the commercial fishery should be included in the tuning file, and the unckown catches constrained by this effort.

Example if command file for the SXSA

```
!Youngest age
0
!Plus age
4
!No of seasons per year
4
!Recruiting season
3
!Spawning season
1
!First VPA year
1982
!Last VPA year
1989
!Number of fleets
4
!Fleet number for the commercial fishery
1
!Are missing catches to be estimated (y/n)
n
!**Only if missing catches are to be estimated
!Number of missing catches
!15
!Number of seasons having missing catches
!4
!Level of unknown catches determined by SOP=s or Effort=e
!e
!**End if missing catches
!Choose 1=computed weighting,2=fixed weighting of tuning data
2
!Max. value of weighting factor for a fleet (0: no limit)
0
!Relative weighting of oldest vs second oldest age r
0.0
!Relative weighting for real catches vs fitted catches
1.0
!Minimum value for survivors number
1.0
!Number of taper years (0=no taper)
3.0
!Name of output file
pout895.fix
!Name of 12 input files
caton.qrt
canum93
weca.qrt
west.qrt
natmor.qrt
matprop.qrt
fprop.qrt
mprop.qrt
tun93.fix
tunweig.xsa
surviv.xsa
miss93.xsa
```