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REPORT OF THE INDUSTRIAL FISHERIES WORKING GROUP

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1 INTRODUCTION

1.1 Participation

H. Degel	Denmark
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D. Skagen (Chairman)	Norway
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1.2 Terms of Reference

At the 79th Statutory Meeting it was decided (C.Res.1991/2:7:17) that the Industrial Fisheries Working Group should meet at ICES Headquarters from 18-25 March 1992 to:

a) describe the historical development of the fleet units exploiting the target species in the industrial fisheries and the catches of the target and by-catch species;

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

c) resolve, if possible, 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 the stocks of the target species in the industrial fisheries, i.e., sprat in Sub-area IV and Divisions IIIa, VIa, and VIId,e and Norway pout and sandeel in Sub-area IV and Divisions IIIa and VIa, and advise on the need for any management measures;

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

f) prepare for the transfer of its work to area-based Working Groups by 1993, advise how this might be best achieved and consider what difficulties might arise and how these could be overcome.

In addition, the Working Group was requested by the Chairman of ACFM to evaluate an 'adequate' 1993 TAC for Division IIIa sprat, this having been requested of ICES by Sweden.

1.3 Source of Data

1.3.1 Denmark

A reorganization of the sampling scheme was agreed in 1991 and this became fully effective from mid-April 1991. According to the new sampling scheme, all samples are now taken by fishery inspectors who take two different kinds of randomly-distributed samples:

1) Samples used for checking that no landing contains more by-catch than allowed. To do this all species in each sample are identified. In 1991, the number of landings which was sampled was 815.

2) Samples for scientific purposes. These samples are collected according to a sampling scheme by month and harbour, taking into account the seasonal changes in the fishery. Samples are sent to the Danish Institute for Fisheries and Marine Research for length measurement and age determination. 350 samples were taken for this purpose in 1991.

In previous years the scientific samples were taken by collectors independent of the fishery inspection.

The samples are taken directly from the vessel or from the fish pump during unloading.

Although the guidelines state that between 5 and 10 kg, depending on the size of the fish, should be sampled, the size of the samples becomes quite variable due to the fact that industrial landings are often rather inhomogeneous and contain a variable number of species. Additional samples from the same vessel are taken if the first-hand impression gives reason to believe that a particular landing is violating the rules. These samples will be recognized as one big sample in the files.

The effort data are based on logbook records on catches with a content of either Norway pout or sandeel of more than 70% of the landing.

1.3.2 Norway

History of sampling

In the years 1961-1966, a small-scale sampling programme, initiated by the Institute of Marine Research, was carried out at a fish meal plant in Egersund to obtain estimates of the species composition in industrial landings. Each sample consisted of 3 x 10 liters collected from the top, the middle and the bottom layer of the landing. The programme was reestablished and extended to three different ports in 1971. By late 1975 sampling by grab was introduced because it became apparent that, particularly during summer, chemical

preservation of landings preventing any fish from being used for human consumption might lead to under-estimates of larger fish. The grab samples usually were in the range of 100-150 kgs, to some extent depending upon the size of the landings. Sampling was kept at a satisfactory level up to and including 1985. Due to the closing down of an important fish meal plant in one of the ports in early 1986, however, and reduced sampling activity in another port, the sampling scheme gradually deteriorated, eventually coming to an abrupt halt during summer 1990 when yet another plant was closed down.

Sampling regime

A reorganization of the sampling scheme became imminently important when the previous one ceased to function. To ensure a fair geographical coverage of the main fishing grounds it was determined to establish regular sampling in three ports, namely Egersund, Åkehamn and Måløy. The new scheme commenced in January 1991, first in Åkehamn, and later on in Egersund. From January 1992 sampling has also been carried out in Egersund. The aim was to obtain two samples a week from each port and a sufficient number of fish from the target species Norway pout and blue whiting to be aged at the Institute of Marine Research in Bergen. Similar considerations have been made concerning sampling of the sandeel fishery but restricted to one sample a week from Egersund and Åkehamn and random samples from Måløy.

The standard weight of a sample is set to 50 kgs which may be extracted automatically in portions of 5 kgs each from the transportation pipes of the fish meal plant. If this device is not available, sampling will be made by buckets of 10 liters each on board the vessel. Each species is weighed and length measurements are made of selected species.

In 1991, a total of 60 samples was derived from the Norway pout fishery. Forty-nine samples collected from the block of statistical rectangles 46-48, F2-3, representing 53% of the landings. Eleven samples were collected from rectangles further to the north, representing 33% of the landings, whereas the southern rectangles, representing 14% of the landings, remained unsampled.

A total of 24 samples was derived from the sandeel fishery represent statistical rectangles containing 64% of the landings.

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

1.4 Quality of Data

1.4.1 Denmark

The objective of the new scheme was to ensure an efficient seasonal and geographical coverage of all fishing areas. Figures 1.4.1 and 1.4.2 show the relative number of landings and samples by month and areas in 1991, respectively. It can be seen that all months and all major areas were well sampled. The number of samples (815) which were taken for determination of species composition are sampled from a total of 20,194 landings, but the proportion between the two figures has to be seen in the light of the last figure including all landings where the industrial catch exceed only 50 kg, which means that a lot of catches not directly associated with the industrial fishery (e.g., the shrimp fishery) are included in this figure. All in all, the data collected should provide a sufficient basis for an accurate estimate of the species composition of the landings of the Danish industrial fishery through all seasons and areas.

Although 350 samples were collected for estimating length and age compositions, these samples do not cover areas and seasons in a satisfactory way. This is partly due to the fact that not all samples were aged leaving some periods poorly covered in respect to age composition. This affects, in particular, the second half of the year in the northern part of the North Sea, where unfortunately only a poor coverage of sandeel was achieved.

Looking at the age readings for sandeel, there seems to be some discrepancy between the Norwegian and Danish data in the period April to June when intensive growth seems to create some problems (see Section 8 for more details). These problems could be overcome by a more intensive and coordinated sampling in this period. On top of this, there seems to be a need for a more consistent way of age readings among the countries.

The sampling used for calculating the age and length compositions for Norway pout was much better than was the case for sandeel and has improved compared to last year. However, there are still quarters and areas for which the number of samples has to be increased in order to achieve a sufficient coverage.

1.4.2 Norway

Sampling has been properly carried out by experienced people and shows a convincing degree of consistency. The expansion of sampling from two to three ports in 1992 is expected to increase the sampling intensity, thus yielding a better geographical coverage of landings from the fishing grounds. This will in turn provide higher accuracy in estimating the species composition, particularly in the Norway pout and blue whiting fishery.

Some effort data are excluded if vital information is missing. This is the reason why not all landings are included.

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% in weight of a landing. The codes commonly used are D12 for Norway pout, D13 for blue whiting and E02 for sandeel. In case none of these codes are appropriate, the code will be M02. Up to and including 1988, M02 indicated landings mainly consisting of Norway pout and blue whiting or some by-catches in the *Pandalus* fishery. This category usually played an insignificant part compared with the total landings of D12 and D13. In 1989 and 1990, however, a substantial increase of M02 landings revealed significant by-catches of herring and to a lesser extent mackerel and horse mackerel. 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.

1.5 Assessment Strategies

1.5.1 Background

Due to the lack of acceptable data, the 1991 Working Group was unable to produce catch numbers at age for Norway pout and the two North Sea sandeel stocks for 1990. Due to this, it was not possible to do an analytical assessment that year, and it will not be possible to run a standard VPA in the forthcoming years. In the case of the Shetland and Division VIa sandeel stocks, the assessments present other problems as the low (or in the case of Shetland during 1991, zero), effort has exacerbated the usual problems of poor convergence properties of the VPA and poor estimation of input values.

To overcome these problems, two approaches for performing assessments under these conditions were proposed. Both methods have potential for estimating numbers for missing catches.

Catch numbers obtained this way should be regarded as purely artificial numbers which are optimal according to the model specifications, and not as estimates of the real age composition of the catches.

1.5.2 Seasonal separable VPA

A program implementing a seasonal, separable VPA, which can also use research vessel survey data, was made available to the Working Group by Dr R.M.Cook. It is documented more fully in Appendix 1, but a brief description of inputs required by the program is given below.

The program requires the user to supply relative weights for the effort data and the research vessel data. The catch data are given a weight of one, so weights for the other data are taken relative to the catch data. To estimate selectivities, the program assumes that the selectivity at the oldest age is a fixed ratio of the selectivity at some younger, reference age. The user is prompted to supply values for the reference age and the ratio for each season. Where research vessel data are to be used, the user is also prompted to supply an age above which survey catchability is constant.

In the current context, a separable VPA has the advantage of not treating the catch data as exact, and as it also estimates fitted catches for each year/season, it was thought to have application in the estimation of missing catch data. However, the program was developed for assessment purposes, and thus does not at present constrain the fitted catches to have the same sum of products as the known landings for which age compositions are required to be estimated. The current version of the program can only use one set of survey data during a run.

1.5.3 XSA estimate of unknown catches at age

The Extended Survivors Analysis (XSA) was adapted to estimate catches at age when the total catch in the season and the weights at age are given, but the age composition of the catches is unknown.

The XSA itself estimates survivor numbers, i.e., the population numbers at the end of the most recent season, for each cohort in the population. This is done by minimizing the sum

$$SSQ = \sum_{year}\sum_{age}\sum_{season}\sum_{fleet} (\log \hat{P} - \log P)^2/w$$

where $\hat{P}$ is the population number derived from CPUE data after estimating catchabilities, and P is the population number emerging form the VPA. The symbol w stands for a weighting factor for each P. In the present version, this is the estimate of the standard deviation of the inverse logarithmetic catchability. The present version operates on a seasonal basis.

The estimation of unknown catches is done as a searching routine. The process is started with a set of catch numbers, for which a full XSA is made. Then, taking one catch number at a time, a full XSA is done with an increase and a decrease of that catch, and the alternative giving the smallest SSQ is chosen. Then, the next catch number is adjusted in the same way, and the process is repeated until convergence.

In the present version, any number of fleets can be used, but the tuning data have to be specified by season.

This program is still at a developmental stage, and is not sufficiently tested. Test runs done at the meeting revealed that in some instances the final estimates of the unknown catches were very sensitive to the starting numbers. The reason for this is not known. Therefore, the results obtained by this method should be regarded as preliminary. Work on the model will continue, and it may be possible to present more definite results to the Multispecies Assessment Working Group meeting later this year.

1.6 General Considerations on Management of Short-Lived Species (Norway Pout, Sandeel and Sprat)

The Working Group has in general not made predictions (except for SHOT predictions for some stocks) or yield-per-recruit analyses, which normally form the background for management advice. The Norway pout, sandeel, and sprat are short-lived and enter the fishery at a very young age, which makes the prediction highly dependent on the recruitment. Recruitment indices are available for some of the stocks, but their predictive power is limited and they have on some occasions been very misleading. In addition, since these are important prey species, their natural mortality is known to vary. At present, variations in M are not taken into account. Moreover, the present assessments are not satisfactory for these short-lived species, both for methodological reasons and because of problems with the quality and quantity of data. Finally, the growth rate may vary quite a lot from year to year, and there is no means to predict growth. For these reasons, the relation between yield per recruit and fishing mortality will vary substantially from year to year, which means that biological reference points related to fishing mortalities will be of limited value.

At present, there are no recommended TACs (on biological grounds) for these species. To some extent, the fisheries are self-regulating, since they become unprofitable at a certain level of CPUE. The threshold CPUE will depend on many factors, however, and there is no guarantee that it will correspond to a biologically sound lower level of the stock size. The Working Group recognizes, however, that the major stocks of Norway pout and sandeels seem to have tolerated the present level of exploitation. As pointed out earlier (*Anon.*, 1991a), the fishing mortality comprises a relatively small fraction of the total mortality for these stocks.

To the extent that the CPUE reflects the size of the stock, one might indicate a biologically advisable CPUE based on a "minimum biologically acceptable level" (MBAL) of the stock size. An MBAL is difficult to define, and may not be very appropriate for these stocks, however, for several reasons. The relationship between stock and recruitment is by no means clear. For sandeel in particular, the definition of the spawning stock units is in itself problematic, due to the exchange of larvae between local occurrences of stationary adult fish. Moreover, the objective of an MBAL for these stocks is wider than a consideration of the spawning stock level for the stock itself, due to their importance as prey for many other species. If the objective of a viable ecosystem shall be achieved, one must also keep these stocks at levels which ensure sufficient food supplies for their predators. What this implies in terms of management measures is at present unclear.

At present, the multispecies assessment programme for the North Sea (MSVPA) is insufficient as a tool for elucidating these aspects of management. In particular, it has no tuning facilities in its present form, and it does not take into account the area distribution of prey and predators.

A possible additional guideline for management may be obtained by considering the probability structure of the short-term prediction, taking into account what is known about the statistical properties of the input parameters. A study along this line (Skagen, 1991) indicated that the risk of reducing the SSB for sandeel below the historical minimum would increase quite sharply if the exploitation level was increased above the present level. Another general result was that if management concentrates on keeping one factor (e.g., the yearly catch) constant, this will lead to increased variations in other factors, like spawning stock biomass and fishing mortality. This study only considered the effect of variable recruitment. If it is to be applied as background for management, other factors must be included. The same procedure has been implemented in the multispecies prediction programme MSFOR (*Anon.*, 1991b).

Another possible approach is to evaluate the spawning stock needed to give an egg production to ensure recruitment at a level necessary to sustain the stock size, along the line suggested by Serebryakov (1990). However, in its present form this approach only considers the possible relationship between spawning stock biomass and recruitment under constant environmental and ecological conditions.

For sandeel in particular, the area distribution poses special problems. This fish is likely to be very stationary, and is found on many separate grounds. Since larvae are exchanged between these grounds, the age composition in the different grounds may be quite different. The fishermen often tend to stick to a fishing ground as long as the fishery is satisfactory there. This implies that the fishery is far from a random sampling of the stock, which is an underlying assumption in most of the current assessment procedures.

Since there are so many problems associated with the industrial stocks (and other short-lived stocks), which are different from those encountered for most other stocks, the Working Group suggests that ACFM consider alternative guidelines for developing management advice in its future terms of reference relating to these stocks. There is also clearly a need for development of alternative assessment strategies, which take into account problems of the kind mentioned above.

2 TRENDS IN THE INDUSTRIAL FISHERIES FOR SANDEEL, SPRAT AND NORWAY POUT IN DIVISION IIIa, THE NORTH SEA, AND DIVISION VIa

A discussion of the definition of "industrial fisheries" was included in the 1990 Report of the Industrial Fisheries Working Group and is not repeated here. As a working definition of such fisheries, the Group includes in its assessments and tables all data from trawl fisheries prosecuted with a mesh size smaller than 32 mm. For some species, notably sprat, some of the catches from these fisheries are used for human consumption rather than for processing into meal and oil.

2.1 Division IIIa

The annual landings from the industrial fisheries for the years 1974-1991 are presented in Table 2.1. There were some minor revisions for sprat in 1990, and from 1982 to 1987. The total landings have fluctuated between 92,000 t and 228,000 t, with no well-marked trend.

Landings in the three most recent years have been well below the long-term mean of 164,000 t, mainly due to decreases in the landings of the clupeoids. Landings of Norway pout were low during the period 1985-1989 but have increased to a near-average level in 1990 and 1991.

2.2 North Sea

The annual landings from the industrial fisheries for the years 1974-1991 are given in Table 2.2. For 1991, the landings have been broken down by quarters to indicate the seasonality of the various fisheries. An extra column has been added to Table 2.2 this year giving catches of "other" species. A breakdown of the species composition of this category is presented in Table 3.3. There were some minor revisions to the data for 1989 and 1990 for herring, Norway pout, blue whiting, and the by-catch of protected species. The total landings of all species have varied without trend between 1.0 million and 1.9 million t. Landings increased from a low value of 1.0 million t in 1990 to 1.3 million t in 1991, with increased catches of all species, especially sandeels. There has been a downward trend in landings of sprat and Norway pout, though this seems to have been arrested in the most recent years.

2.3 Division VIa

The annual landings as officially reported from the industrial fisheries for the years 1974 to 1991 are presented in Table 2.3. There were minor revisions to the data for 1989, and data for 1990 and 1991 were added. The total landings have shown considerable variations, fluctuating between 10,000 t and 54,000 t with a mean of 27,000 t. The variations are mainly due to the Norway pout fishery. Landings in 1990 and 1991 were well below the long-term mean, due mainly to reductions in Norway pout in 1990 and sandeels in 1991.

2.4 Fleets in the Industrial Fisheries

It should be noted that some of the fleets below may land all or part of their catches for human consumption.

2.4.1 Division IIIa

Danish fleet

The directed industrial fisheries with small meshed gears (<32 mm) mainly have Norway pout and sandeel as target species. The former is fished in deeper water while the sandeel fishery takes place in the western Skagerrak, more or less as an extension of the fishing area in sandeel area 3.

Until 1991, fishing on sprat and juvenile herring was carried out with 16 mm mesh. From January 1991 this so-called "mixed clupeoid" fishery has only been allowed with mesh larger than 32 mm.

Industrial fishing in the late 1980s was carried out by about 200 trawlers of which about half were entirely dependent upon this fishery. In 1991, about 130 trawlers took part in the mixed clupeoid fishery.

Apart from the mixed clupeoid fishery and the industrial fisheries with small-meshed gear, by-catches of industrial species are landed from other fisheries, e.g., for shrimp, herring, and blue whiting.

Norwegian fleet

The Norwegian fishery for sprat in Division IIIa is mainly an inshore and fjord fishery, taking place from June to December. The fleet comprises small purse seiners. The fishery, which is a genuine sprat fishery, is for the canning industry. In the period 1987-1991, the average landing contained nearly 93 % in weight of sprat (*Anon.*, 1992).

Swedish fleet

The Swedish fishery for sprat is based on two types of gear: purse seiners in the fjords and a mixed clupeoid fishery in Skagerrak/Kattegat using small-meshed (16 mm) trawls. Only small amounts are taken in the fjords for the canning industry (*Anon.*, 1992).

2.4.2 North Sea

Danish fleet

Industrial fishing in the North Sea commenced at the end of the 1940s. It was directed at the young herring in the Bløden ground area and a rapid expansion took place from 1951. In 1952, the first sandeel landings were processed and Norway pout became a target species at the end of the 1950s. In the 1970s, sprat took the place of the young herring. Today sandeel is the prime target and constitutes about 70 % of the total industrial landings, with Norway pout and sprat of less importance.

The industrial fishery in the North Sea is carried out by about 400 vessels (1988). About 1/3 of these are purely confined to industrial fishing, including the largest vessels (super trawlers) which are not allowed to participate in consumption fishing in the North Sea. The remainder, 2/3 of the industrial vessels, are also enganged in a human consumption fishery outside the sandeel season. Consumption landings in 1988 made up about 40 % in value of the total landings of the "mixed" group of trawlers.

The numbers of vessels by size in the two categories of vessels are shown below (1988):

GT	Mix	Industrial
0-50	70	26
50-100	61	14
100-250	112	57
>250	29	32
Total	272	129

English fleet

With the exception of a small fishery for sandeels in the 1970s, the only English industrial fishery in the North Sea has been that for sprat. This has taken place inshore in three main areas: the northeast coast, the Wash, and the Thames estuary. These fisheries reached their peak in the late 1970s, when total English landings from the North Sea reached 55,000 t. However, in recent years there have only been irregular landings, mainly taken in the winter period. The fleets that prosecute these fisheries are predominantly 10-17 m single or pair-boat mid-water trawlers and a few drift netters. In 1991/1992, the only significant fishery was in the Thames estuary, where 25 vessels took part.

Norwegian fleet

Prior to 1956 herring was the only target species sought. A minor fishery for sandeel commenced in the summer of 1956 but had little impact on the annual industrial landings up to and including 1973 (Table 8.1.1). The fishing season usually lasted from mid-May to the end of June. From 1974 onwards a regular seasonal fishery took place, which in recent years starts in early March and may end in late October. The first landings of Norway pout were recorded in 1957 and during the 1960s a significant fishery developed throughout the year (Table 5.1.1). Blue whiting occurred as by-catch and in some landings even outweighed the Norway pout. In the period 1970-1975 the annual landings increased from 100,000 t to a maximum of 300,000 t and then dropped to 184,000 t in 1976.

The number of trawlers using small-mesh gear and fishing all year round has varied considerably over the years. In the period 1960-1972, the figures were fairly stable around an average of 309. They then increased to 357 in 1973, to 455 in 1974 and to 573 in 1975, of which about 300-350 trawlers were assumed to be more engaged in the Norway pout, blue whiting, and sandeel fishery than that for herring.

The closure of the directed fishery for herring in 1977 caused a serious problem for many trawlers and the number rapidly decreased to eventually stabilize at about 200 in the early 1980s. Since then the reduction of the fleet has continued so that in 1990 only 155 vessels were licensed to perform industrial trawling.

The fleet currently consists of a majority of rather old vessels, half of which were built in 1964 and earlier (the oldest one back in 1934). The gross tonnage varies from 20 to 310 GRT.

By and large, however, the remaining fleet has become more effective over the years, by replacing old engines,

using bigger demersal trawls and installing devices for easier handling and better preservation of the catch.

Of the 99 trawlers fishing in 1990, 80 participated in the Norway pout fishery and 65 in the sandeel fishery thus indicating the interaction between these fisheries.

Alternative fisheries for this fleet may be that for human consumption when using appropriate trawls, that for herring or mackerel within certain quotas or that for capelin for a limited number of the bigger vessels.

The Norwegian fishery for sprat in the North Sea is carried out by purse seiners. During recent decades, only a few vessels have participated in this fishery.

2.4.3 Fisheries around Shetland and in Division VIa

The industrial fishery around Shetland started in the early 1970s. Originally the boats targetted Norway Pout, but soon switched to sandeel due to their ready availability in inshore waters which were closer to port. This convenience was an important feature of the fishery; the catch required no sorting or gutting and thus the boats could operate with smaller crews, and the inshore grounds meant that smaller and older boats could prosecute the fishery. Many of the boats which were involved in the fishery during its peak in the early 1980s were rather old and are now no longer fishing. Boats involved in the Shetland sandeel fishery have tended to be rather opportunistic, taking sandeels during the summer and switching to other fisheries such as whitefish or scallops during other seasons.

The sandeel fishery in Division VIa has developed in a similar way to the Shetland fishery. Initially some boats followed the Shetland lead in fishing Norway pout, but as at Shetland, sandeel soon became the more important target species. The sandeel grounds in Division VIa are less inshore than the Shetland grounds, but they are still relatively small and localised. The boats fishing the Division VIa grounds include both small, inshore boats and also, more recently, a few large purse-seiners. As at Shetland, the seasonal nature of the sandeel fishery means that the boats involved are not dedicated industrial trawlers, but switch to other fisheries during the rest of the year, with the purse-seiners, for instance, tending to fish pelagic species during the winter. Occasional Scottish purse-seiners fish the North Sea sandeel stocks, but at present this activity is at a very low level.

2.4.4 Divisions VIId,e

English fleet

There is a regular English fishery for sprat in the Lyme Bay, mainly for the human consumption market. Landings have averaged 3,400 t over the past 10 years, with a range of 1,500-1,800 t. The fleet currently comprises 6 vessels of 14-18 m length and around 20 smaller vessels less than 12 m in length.

3 BY-CATCHES IN THE INDUSTRIAL FISHERIES IN THE NORTH SEA

The annual landings of by-catches of the major protected species (haddock, whiting and saithe) in the industrial fisheries are given in Table 3.1. There were revisions to the data for 1989 and 1990, mainly affecting whiting and saithe, and data for 1991 were added. The by-catch of haddock declined in the early 1980s, since when it has remained at a relatively low level, though with a slight increase in the past three years. By-catches of whiting showed a similar downwards trend but have increased markedly since 1988. By-catches of saithe are relatively small.

Maps showing the geographical distribution of industrial catches including by-catches are available for 1991. They are not published in the present report, but are retained in the files of the Working Group.

The distribution north and south of 57°N of the industrial landings by target species and associated by-catches is shown in Table 3.2 for 1991. For Danish landings, the definition of target species is more than 50% of the total catch in a particular square and month. For Norwegian landings, the corresponding definition is at least 70%. Compared to the same table in last year's report, an extra column giving "other" by-catch species has been added. These are given by species in Table 3.3.

In the north, the main fisheries were targetted on sandeel and Norway pout, with the principal by-catches being herring, whiting, and other species in the Norway pout fishery. In the south, the target species were mainly sandeel and sprat, with herring being the chief by-catch species in both fisheries. However, in this area there were also significant fisheries with no clearly defined target species. These took large quantities of herring as a by-catch, as well as smaller amounts of whiting and other species.

4 NORWAY POUT IN DIVISION IIIA

4.1 Landings

Total landings as officially reported to ICES are shown in Table 4.1. In 1991, they amounted to 49,000 t. With 1989 as an exception, the landings have been at a level of 40,000 to 50,000 t since 1987.

5 NORWAY POUT IN THE NORTH SEA

5.1 Landings

Landings as provided by Working Group members are shown by country in Table 5.1.1. The data for Norway for 1989 and 1990 were revised. In 1991, the total landings were 154,500 t which is an increase of 11% compared to 1990. Landings by month and country for 1989 to 1991 are given in Table 5.1.2. In 1991, 40% of the landings were taken in the first half of the year.

5.2 Fishing Effort and Catch per Unit Effort

Danish CPUE

The Danish CPUE by vessel category is shown in Table 5.2.1. for the period 1983-1991. A general increase for all vessel categories is observed in 1991 compared to 1990. The biggest increase has occurred among the smaller and larger categories (30-40 %), while the medium categories have increased by only 10-15% on average.

Norwegian effort

Table 5.2.2 shows the number of fishing days and the average GRT by quarter in the period 1982-1991 for the Norwegian fleet fishing for Norway pout. The figures for 1988 to 1990 were revised to comply with the previous years.

Total Danish and Norwegian effort

As in previous years, the Danish and Norwegian effort data were standardized to a vessel size of 200 GRT. The Danish CPUE and GRT data were fitted using a non-linar model of the form:

$$CPUE = a \times (GRT-50)^b$$

The result for 1991 was:

$$CPUE_{91} = 4.674 \times (GRT-50)^{0.357}$$

The plot is shown in Figure 5.2. By using this regression, the Norwegian effort data were standardized to a 200 GRT vessel category. The standardized effort by quarter is given in Table 5.2.3.

The level of effort in 1991 was at a similar level as in 1990, except for the second quarter, when both the Danish and Norwegian effort decreased.

5.3 Catch at Age

Catch-at-age data for 1989 and 1990 were revised in accordance with the revision of the Norwegian landings (Tables 5.3.1 and 5.3.2). For 1990, the data only cover the first three quarters and they should, due to the low number of samples, be regarded as subject to a large uncertainty.

Danish and Norwegian samples were used to estimate the catch in numbers at age for 1991 (Table 5.3.1). Compared to 1990 the number of samples has increased. However, there are still particular quarter and area combinations for which the number of samples has to be increased further in order to achieve a sufficient coverage.

5.4 Weight at Age

Mean weight at age by quarter for 1986 to 1991 is shown in Table 5.4. The data for 1989 and 1990 have been revised. The weight at age for 1991 was estimated based on data from Denmark and Norway.

5.5 Research Vessel Surveys

Updated reseach vessel indices are given in Table 5.5.1. The preliminary International Bottom Trawl Survey index for the 1991 year class as 1-group is twice as high as the index for the 1990 year class, almost 4 times the index for the 1989 year class, and the highest on record since 1974. In the English Ground Fish Survey, however, the index for the 1991 year class as 0-group indicates a year class which is of the same size as the 1989 year class and lower than the 1990 year class.

The RCT3 program was used to make a calibration regression of the survey indices *versus* the stock in numbers at age 1 from the VPA presented in the 1990 report (*Anon.*, 1990), Table 5.5.2. In predictions up to and including 1982, the IYFS index of age 1 abundance received the highest weight, but in later years the EGFS index of 0-group abundance performed better. However, as the slope of the regression of EGFS O-group abundance against VPA 1-group is around 0.4, the relationship is highly curvilinear and the regression should, therefore, be treated with caution. It is, therefore, dubious whether the RCT3 is able to resolve the conflict between the IYFS and the EGFS concerning the strength of the 1991 year class.

5.6 Estimates of Catch in Numbers at Age for 1990

The XSA and the Seasonal Separable VPA (SSV) (see Section 1.5) were used in an attempt to estimate the missing catch in numbers at age for 1990 (Table 5.6.1).

The input data for the XSA included commercial effort as well as IYFS indices for ages 1 and 2, EGFS indices for ages 0, 1, 2 and 3, and SGFS indices for ages 1, 2 and 3. The SSV is only able to utilize data from one survey at a time and data have to be available for the

same range of age groups as in the commercial catch. Runs were made with IYFS data, ages 1 to 3, and with EGFS ages 0 to 3. In both cases the reference age was set to 1 and survey catchability assumed to be constant for age 1 and older.

The SSV estimates of catches at age proved to be highly sensitive to whether survey indices were included or not. Including the IYFS indices for ages 1 to 3, or the EGFS indices for ages 0 to 3 produced estimates of catch at age in 1989 and 1990 for which the SOP was far above the observed landings. Excluding survey information, the SOP was closer to the observed, and the Working Group, therefore, decided not to utilize the survey indices in the final run.

The XSA estimates provide catches at age for which the SOP is in accordance with the landings. However, the method is still under development, and trial runs in which predictions of the catch at age in other years than 1990 were made showed that the estimates in some cases were dependent on the choice of starting point.

Given the technical problems encountered with the way the XSA estimates missing catch-at-age data, the poor agreement between SOP and SSV estimates and the sensitivity of the latter method to inclusion of survey data, the Working Group was not able to decide upon the best estimate of the age composition of the landings of Norway pout in 1990.

5.7 Stock Assessment

An attempt was made to assess the stock by using a quarterly separable VPA in which the selectivity at age was assumed to be constant above age 1.

Two separate runs were made. In the first run no survey data were included, in the second IYFS data for ages 1 to 3 were given a weight 5 times higher than the effort data.

The results are summarized in Tables 5.7.1 - 5.7.6. The two runs produce very different results which illustrate that the IYFS and the commercial CPUE are telling two different stories. When the separable VPA is based on commercial effort data rather than IYFS CPUE, higher values of selectivity are generally found on the older ages. The higher selectivity results in a higher level of fishing mortality for the older ages in particular and in a different development of population numbers and biomass over time.

Figure 5.7 illustrates the change in spawning stock biomass with time, as estimated with and without IYFS survey data and as found by *ad hoc* tuning on commercial data at the 1990 meeting of the Working Group. The SSV run in which survey data were excluded is in line with the results from *ad hoc* tuning, while the SSV run in which the IYFS received a high weight in most years results in lower estimates of SSB than the other two and in less pronounced changes over time.

These results mean that the Working Group could not decide on the current state of the stock.

It should be noted that in the 1984 report of this Working Group, a figure of 0.1 was adopted for the proportion of fish mature at age 1. In practice, assessments in that and subsequent years have used a value of 0.5. Future assessments should use the adopted value of 0.1.

For comparison with previous values, the SSB figures given above have assumed a value of 0.5.

6 NORWAY POUT IN DIVISION VIa

6.1 Landings

Landings of Norway pout as officially reported from Division VIa are given for the period 1974-1991 in Table 6.1. There have been considerable annual variations in landings over this period, varying from 38,000 t to 3,000 t. Landings in the last two years have been amongst the lowest in the period.

7 SANDEEL IN DIVISION IIIa

7.1 Landings

Estimated landings of sandeels from Division IIIa for the period 1982-1991 are given in Table 7.1. Revised figures for 1990 increased the landings by about 10,000 t from the preliminary estimate in last year's report. Compared with 1990, the preliminary figures for 1991 show a decline of about 2,000 t to about 23,400 t.

Further revision of years prior to 1990 may result in changes and, consequently, the years in question are marked 'Preliminary' in Table 7.1.

8 SANDEEL IN THE NORTH SEA

8.1 Landings in 1991

Total landings, which dropped in 1990, showed a new increase in 1991 to about 842,000 t or 12% more than the average for 1981-1990.

Table 8.1.1 shows nominal landings by countries since the beginning of the sandeel fishery in 1952. The increase is reflected in all national landings except for the UK from which only one vessel made a few trips to the

sandeel grounds in the central North Sea. Table 8.1.2 indicates that the main increase took place in June (about 80%) and especially in July when the landings increased by a factor of 7½ compared to the previous year.

Catches by sandeel area (Figure 8.1) are given in Tables 8.1.3 and 8.1.4.

8.2 Sandeel in the Northern North Sea

8.2.1 Fishing effort and CPUE

Fishing-effort data based on logbooks were available for about 78% of the Norwegian and 60% of the Danish landings.

The Danish data by half-year and vessel category for 1982-1991 are shown in Table 8.2.1.1.

A power function, CPUE (half year, GRT) = a * GRT^b, was fitted to each half-year data separately and a Danish CPUE standardized to a 200 GRT vessel was calculated on this basis. The estimates so obtained are shown below:

Half-year	R-square	a	b	Standard CPUE
1	0.98	3.37	0.49	44.7
2	0.97	2.74	0.54	47.5

The Norwegian data are shown in Table 8.2.1.2. They comprise fishing days and mean GRT for the vessels sampled. The fishing days are standardized to a 200 GRT by applying the factor: Mean GRT/200, i.e., assuming a linear relation between fishing power and GRT.

A standardized international CPUE is then calculated as the average of the Danish and Norwegian means weighted by catch, and a standardized international effort is estimated as total international catch divided by the standardized international CPUE. The last procedure and its results are shown in Table 8.2.1.3. The Working Group detected a number of inconsistencies in the table but was not in a position to make corrections at the meeting.

The derived international effort indicates a rather stable level in the late 1970s followed by a significantly lower level in the early 1980s. The effort increases again in the late 1980s.

The Danish and Norwegian CPUE estimates show a significant correlation. Leaving out years with landings below 10,000 t gives

CPUE Norw. = 11.59 + 0.53 * CPUE Denm.

r = 0.73 (d.f. = 11) (0.01>P>0.001).

8.2.2 Catch at age

Sampling the landings for numbers at age improved in 1991 without reaching a fully satisfactory level. The data are shown in Table 8.2.2.1. Year class 1990 appears to be strong as suggested by the relatively high catch of 0-groups in 1990.

The estimated numbers are based on Danish and Norwegian samples applied to the respective landings by area and month. Comparing the two sets of data revealed rather big differences in average weight at age and, consequently, in the derived number caught at age. This feature is mainly confined to the first half of the year in the northern North Sea and seems to be correlated with the high growth rate in that period.

Samples throughout May showed an increase in modal length of about 3.5 cm, and it is obvious that it requires a high sampling rate stratified on short time intervals (weeks) and areas in order to achieve a reliable estimate of catch in number.

Another problem in this connection appears to be the age determination. Again the difficulties may be referred to the growth period when the decision on whether a new year's growth is apparent in the otolith or not can lead to errors in allocating a fish to a year class.

8.2.3 Weight at age

Mean weights at age are shown in Table 8.2.3.1. The Danish and the Norwegian data were combined weighted by catches in number.

8.2.4 Stock assessment

A semi-annual separable VPA was run using available catch-at-age and effort data for the northern North Sea sandeel stock. Natural mortalities and proportions mature were as given in Tables 8.2.4.1 and 8.2.4.2. The program was run to investigate the possibility of estimating catches for 1990 and providing a rough assessment of the stock. The results from the run clearly indicated that neither would be possible. The output from the program run is too extensive to include in full, but selected output is given in Table 8.2.4.3. The model estimated an extremely high year/season effect for the first half of 1990. This parameter corresponds to the fitted effort required to produce the apparent mortality over this period, given the fitted exploitation pattern. The

value was more than three times higher than any other figures and did not correspond with the actual effort during 1990. The net result was that estimated populations for recent years were greatly in excess of previous estimates. This result appears to be due to problems in the age compositions of years for which such data are available. This may also be exacerbated by the tendency of the sandeel fleet to fish grounds where specific year classes of sandeels are present. This would imply that the exploitation pattern during a given season would not remain constant and thus violate the assumption on which the separable VPA is based.

8.3 Sandeel in the Southern North Sea

8.3.1 Fishing effort and CPUE

In 1991, Norway only caught about 4,000 t in the southern North Sea and the following data refer to the Danish fishery.

CPUE by vessel size is shown in Table 8.3.1.1. It is already apparent from these data that a substantial increase took place in 1991 and especially in the second half year which in general shows the highest figures on record.

Standardized CPUEs referring to a 200 GRT vessel were calculated in the same way as described in Section 8.2.1 and gave the following parameters:

Half-year	a	b
1	6.0349	0.4231
2	3.7312	0.5049

The standardized CPUEs and the total international effort are shown in Table 8.3.1.2. The latter shows a decrease from 1990 in the first half year and an increase in the second.

8.3.2 Catch at age

In 1990, no estimate of numbers caught at age could be made for the southern North Sea due to lack of sampling. In 1991, the situation has improved, especially in the first half year when nearly all landings were covered while this only was the case in about 36 % of the landings in the second half year.

The numbers obtained are shown in Table 8.3.2.1.

8.3.3 Weight at age

Weight at age is shown in Table 8.3.3.1. The apparent decline from the first to the second half year is either due to misinterpretation of age or to insufficient sampling in the 3rd quarter.

8.3.4 Stock assessment

A semi-annual separable VPA was run for the southern North Sea sandeel stock. Some output from the run is given in Table 8.3.4.1. As with the northern North Sea stock, there were clearly problems, as the fitted populations for recent years were again unrealistically high, and the year/season effect for the first half of 1990 was estimated as being very high, although not to the same extent as in the northern stock. It appears that the problems with the age compositions of the available catch data, the missing data for 1990, and the variation in the exploitation pattern apply to the southern North Sea stock as well as the northern North Sea stock, and that again the assessment results are unusable.

8.4 Sandeel in the Shetland Area

8.4.1 Fishing effort and CPUE

With the closure of the inshore fishery, there was no fishing effort or catch during 1991, apart from a Danish catch of 3 tonnes from the offshore part of the Shetland area. Standardized effort data for previous years are presented in Table 8.4.1.1, and landings for 1986 onwards are given in Table 8.1.3.

8.4.2 Survey catch data

Surveys of sandeels at Shetland have been conducted during August of each year since 1984, except 1987. During the surveys the objective is to take three hauls at different times of day on each of the main sandeel grounds. The numbers caught at age are then standardiszd to a haul duration of 30 minutes to give overall survey indices. In order that these values are strictly comparable from year to year, values for a particular ground which has not been fished during a given year (usually because of poor weather), are interpolated from existing data. This is done by fitting a GLM to the catch-at-age data, and thus modelling the data in terms of area and year effects. The estimates of these parameters can then be used to estimate values for the missing area/year combinations. The survey indices are given in Table 8.4.2.1.

8.4.3 Weight at age

In the absence of any commercial catch data for 1991, biomass totals have been calculated using long-term average catch weights-at-age. These are given in Table 8.4.3.1.

8.4.4 Analytical assessment

A semi-annual separable VPA, which can use research vessel survey indices was used for the analysis. Values of natural mortality and proportion mature at age were as used previously.

To run the separable VPA for Shetland, the catch and effort data were both given a relative weight of 1, but a value of 0.1 was chosen for the survey data. This value was chosen because the survey has been conducted using different vessels in different years. These have included both commercial sandeel boats and a research vessel, so there is good reason to expect year-to-year differences in the sampling efficiency during the survey. Because of this, and because there was no survey during 1987, it is appropriate to downweight the survey data to prevent these inconsistencies having too much influence on the final result.

In the current context there seems to be no reason to assume any differences in the vulnerability of fish at ages older than three, so the selectivity at the oldest age (age 7) has been taken to be the same as that at age 4 during both halves of the year.

Diagnostics from the separable VPA are given in Table 8.4.4.1. These show that the exploitation pattern changes between the two halves of the year, reflecting the predominance of the 0-group in the second half. The catch residuals for the first half of 1987 show a large positive value for the 1-group catch and negative values at all older ages. This appears to reflect the concentration of effort on the relatively strong 1986 year class. The research vessel residuals show more negative values in recent years, presumably reflecting a drop in sampling efficiency due to the use of a research vessel rather than commercial sandeel boats.

With the current closure of the fishery, fishing mortality was effectively zero during 1991. Estimates of fishing mortality during previous years resulting from the current assessment are given in Table 8.4.4.2. Fitted populations and stock biomass totals are given in Table 8.4.4.3. The numbers of 0-group recruits (on 1 July) are given in Figure 8.4.4.1, and biomass totals are shown in Figure 8.4.4.2.

Recruitment estimates from the current VPA are generally similar to those resulting from the previous assessment, although there is a considerable downward revision of the previous estimate of the 1989 year class. This year class now appears to be only slightly stronger than the two preceding year classes, although this year class was rather strongly represented in survey catches as 0-group and 1-group, so the actual strength of this year class is still not clear. The first estimate of the strength of the 1990 year class indicates that it is rather small, and of similar size as that of the 1987 year class. It is necessary to be very cautious in interpreting the provisional estimate of the 1991 year class as it is based on only one year's survey data, and is thus a particularly uncertain estimate. Nonetheless, it appears that the 1991 year class is very strong. This is supported by its survey index, which is the highest 0-group value recorded, and by the wide distribution of 0-group catches during the survey, where they were found in good numbers on most grounds. This included grounds in the north of Shetland, where 0-group fish have never previously featured in survey catches.

The current VPA estimates the 1991 spawning stock biomass at around 13.1 thousand tonnes, although it is neccesary to treat this value with some caution because of the uncertainty about the strength of the 1989 year class. This estimate represents a slight reduction from the 1990 SSB, which is currently estimated at 13.6 thousand tonnes. These figures represent downward revisions of the figures from the previous assessment which can be attributed to the change in assessment methodology and the use of the additional survey data. Even allowing for these changes, and for the uncertainty involved in the estimate, the 1991 spawning stock appears to have been one of the smallest recorded.

8.4.5 Management considerations

The fishery was closed during 1991 following analyses which suggested that the spawning stock biomass had fallen to a point where its ability to produce a strong year class might be affected. The current assessment indicates that an apparently small spawning stock at the beginning of 1991 may have produced a very strong year class. At present the short-term prospects for the stock are largely dependent upon the apparent strength of this year-class. In the meantime, the spawning stock is still at a low level and seems likely to remain so at least until the maturation of the 1991 year class at the beginning of 1993.

9 SANDEEL IN DIVISION VIa

9.1 Landings

Official landings of sandeels from Division VIa are given in Table 9.1. Landings in 1991 were 46% lower than in 1990.

9.2 Fishing Effort and CPUE

Fishing effort data, in days absent by month, for the sandeel fishery in Division VIa over the period 1981-1991 are given in Table 9.2.1. The total nominal effort during 1991 shows a 56% reduction when com-

pared to 1990. Effort figures standardized to a vessel size of 40 GRT are given in Table 9.2.2.

The large reduction in catch and effort in 1991 when compared to previous years is due to the closure of the fishmeal plant in Stornaway in the Western Isles during summer 1990. This meant that boats fishing sandeels off the west coast of Scotland during 1991 had to sail to Shetland or further in order to land their catch. This extra overhead appears to have contributed to the continued decline of the fishery.

The additional time at sea required to land catches at Shetland also means that the effort figures for 1991 are likely to represent an overestimate of the amount of time actually spent fishing. To try and account for this, the effort figures for 1991 used in the assessment were revised downwards as follows: a mean trip length was calculated by dividing the total standardized effort (in days absent) by the number of arrivals (i.e., the number of times vessels landed catches). Investigation indicated that these uncorrected figures for mean trip length were high compared to previous years. On the assumption that it would take a vessel 48 hours to steam from the west coast grounds to Shetland, land its catch and return again, two days were subtracted from the mean trip length. The revised effort figures were then calculated by multiplying this corrected trip length by the number of arrivals during each half of the year. This procedure revised the first-half standardized effort figure for 1991 from 127 down to 99 days absent, and corrected the figure for the second half of the year to 51 days from 81 days. These corrected effort figures for 1991 are given in Table 9.2.2

9.3 Catch at Age

Catch-at-age data by month for 1991 are given in Table 9.3.1. Catch at age by half-year for 1983-1991 are given in Table 9.3.2. Sampling coverage was rather poor during 1991, and samples were only obtained from catches during June and July. Numbers caught at age during May and August had to be estimated using these samples. Thus there may be some problems with the age compositions of the 1991 data. However, 84% of the total catch was taken during June and July, so the May and August catches contributed relatively little to the total catch.

9.4 Weight at Age

The absence of samples for May and August means that weights at age are not available for these months. Values for June and July are given in Table 9.4.1. Biomass totals were calculated using long-term mean weights at age in the catch. These are given in Table 9.4.2.

9.5 Analytical Assessment

Initial analysis of the current catch data was performed using a tuned semi-annual VPA as has been used in other recent assessments of this stock. However, the results obtained in this way gave unrealistically high estimates of F, and little correspondence between F and effort. For this reason, subsequent assessment work has used a semi-annual separable VPA. In running the program, effort data were given equal weight to the catch data, and selectivity at the oldest age was assumed to be the same as the selectivity at age 4 during both halves of the year. Values of natural mortality and proportion mature at age were as given in Tables 8.2.4.1 and 8.2.4.2.

Input catch-at-age data are given in Table 9.3.2, with diagnostics given in Table 9.5.2. Estimated values of F-at-age are given in Table 9.5.3, and mean F (ages 1 to 3) is plotted as a time series in Figure 9.5.1. Estimated numbers in the sea and biomass totals are given in Table 9.5.4. Trends in recruitment and biomass totals are shown in Figures 9.5.2 and 9.5.3, respectively.

The current assessment has resulted in the estimates for all recent year-class strengths being revised upwards. This appears to be a function of the 1991 catch data rather than the change in assessment methodology, as when a separable VPA was run using catch data up until 1990, the results were similar to the corresponding standard VPA. This upward revision of all year class estimates is presumably related to the poor convergence properties of a VPA such as this one where catches are low and natural mortalities high.

The relatively large discrepancies between current and previous estimates of year-class strength give reason to treat the absolute values of the current estimates with some caution. However, the year-to-year changes appear similar in the current and previous assessments, so it appears possible to draw some broad conclusions about recent recruitment to the stock. The 1987 and 1988 year classes appear to have been rather small, following the large 1986 year class. The previous assessment suggested that the 1989 year class might be quite strong and this is supported by the current assessment. This assessment also suggests that the 1990 year class is of moderate strength, being slightly larger than the 1987 year class. The first, very provisional, estimate of the 1991 year class suggests that it might be quite strong.

Year-to-year changes in the current estimates of spawning stock appear comparable with those indicated by the previous assessment, although the absolute values differ. The 1991 spawning stock appears to have been slightly larger than the 1990 biomass, due to the maturation of the 1989 year class. Spawning stock at the beginning of 1992 is estimated to be slightly larger than

the 1991 stock. With the apparent strength of the 1991 year class, it seems likely that the 1993 spawning stock will be at least as big as the 1992 estimate.

Fishing mortality on this stock has declined in line with the decrease in effort. The current assessment suggests a mean F over ages 1 to 3 of around 0.05.

10 SPRAT IN DIVISION IIIa

10.1 Landings

The landings for the period 1974-1991, as provided by the Working Group members, are shown in Table 10.1. The Norwegian data from 1982 onwards have been revised, with only small changes. The Swedish and Norwegian landings include the coastal and fjord fisheries. The Danish data, based on biological analyses of catch compositions, are much lower than the figures presented in the official statistics. The official statistics include all landings from the mixed clupeoid fishery, which, at present, mainly consists of herring catches. On 1 January 1991, the mesh size in the Danish mixed clupeoid fishery was increased from 16 to 32 mm. In 1991, there was an increase in the total catch compared to the last three years, but the catches are still at a very low level compared to the early 1980s.

10.2 Research Vessel Surveys

10.2.1 Acoustic surveys

No acoustic estimates of the sprat stock were available for 1991.

10.2.2 International Young Fish Survey

The IYFS index for 1-group and for total sprat for 1992, together with the indices from previous years, are shown in Table 10.2. The main concentrations were observed in the southeastern part of Kattegat (Figure 10.1). This year's indices are at a higher level than in the previous years, with the 1-group index at the same level as in the mid-1970s. The high 1-group index is mainly due to very high values in a few squares on the coast of Sweden, and are presumably based on a small number of hauls.

10.3 State of the stock and catch predictions

According to the IYFS indices, the 1991 year class is indicated to be stronger than in previous years.

A SHOT estimate was performed using the IYFS index at age 1 as recruitment index and a Y/B ratio of 0.6, based on the assumption that the fishing effort has been on the same level as in previous years. The change in Y/B ratio from 0.77 to 0.60 in 1985 was made to reflect a shift from a mainly industrial fishery to a coastal fishery for human consumption at that time. The estimated catch for 1992 is 43,500 t, which implies an increase of more than 200 % compared to 1991 (Table 10.3). SHOT predictions for 1993 were run with different levels of recruitment index, using the lowest and highest 3-years' average indices in the period 1974-1992. These catch predictions are very uncertain, since they depend largely on the IYFS-index for 1-year-olds in 1991, which again is generated by high values in a very restricted area. The predictions for 1993, using the lowest (550) and highest (4.738) average index values, respectively, give estimated landing values between 21,000 and 51,000 t.

The data available on the sprat stock in Division IIIa are very sparse. Therefore, the Working Group decided that it is not in a position to evaluate more precisely an adequate stock estimate as the basis for sprat TAC in Division IIIa.

11 SPRAT IN THE NORTH SEA

11.1 Landings

Landings by area and country are given in Table 11.1.1. The Norwegian landings from 1982 and onwards have been revised and catches in the fjords of western Norway excluded. Sprat in the fjords of western Norway is not considered as part of the North Sea sprat stock. However, there is uncertainty concerning the sprat stock identity. The Norwegian catches in the western fjords are presented in Table 11.1.2.

The preliminary figure of 109,500 t for the landings of sprat in 1991 is 54% above last year's figures. After some years with very low or no Norwegian landings of sprat from the North Sea, the Norwegian purse-seine fishery for sprat in 1991 gave around 30,000 t.

Table 11.1.3 shows the data available for landings by area and quarter. Most of the landings were taken in Division IVb east in the third and fourth quarters. According to Norwegian logbook information, 25,100 t were taken in the central North Sea (Division IVb east). There is, however, reason to believe that part of this may have been taken in Division IVb west.

Once again there was no fishing for sprat off the northeast coast of England. There were no Scottish sprat landings from the North Sea in 1991.

In the Wash there were good landings in January and February but nothing during the rest of the year.

The Thames Estuary fishery produced very good landings both at the beginning and the end of the year,

and the total landings for the 1991/1992 season are estimated at 5,000 t. In December, sprat in the catches had a modal length of 11.5 cm and a range of 8.5 to 14.0 cm, with the 1990 year class contributing 80% to the catch in the early part of the season.

11.2 Catch at Age

Quarterly catch-at-age data in numbers were available from Denmark, Norway and UK (England) and are presented in Table 11.2. The catches were dominated by 1-and 2-group fish. The 0-group came into the Danish fishery in quarter 3, representing 12% of the catch in numbers in the 4th quarter. Data on age compositions are, however, based on few samples for the offshore fishery, only 25 samples (3,033 fish) from landings were taken, with 1 (104 fish) to 6 (356 fish) samples per month. No information on the distribution of samples throughout the fishing areas were available, and the Working Group considered the data to be very poor and unsuitable for reliable catch-at-age estimation.

11.3 Weight at Age

Danish data for quarterly mean weights at age are given in Table 11.3.

11.4 Research Vessel Surveys

11.4.1 Acoustic surveys

No acoustic estimates were available for 1991.

11.4.2 International Young Fish Survey

Preliminary data from the IYFS in the North Sea in February 1992 are given in Table 11.4. The indices are based on the number of sprat < 10 cm, which, as no age distribution was available, are considered as 1-group sprat. The preliminary index for Division IVb in 1992 is 1,639. Except for the value in 1989, the IYFS index is the highest recorded in the period 1972-1992.

In Munk (1991), which was presented to the Working Group, the changes in mean size of the 1-group sprat are illustrated. The data available are catches from a small pelagic midwater trawl that has been used routinely during the International Young Fish Surveys since 1977. The mean size of sprat in this gear has increased from 5.0 cm to 6.5 cm during the last 15 years. The mean size of 1-group sprat in the GOV bottom trawl, used during the same surveys, remained at about 8 cm during the period. Munk proposes in his paper that the GOV, because of its larger mesh, is selecting the larger sprat, and that this gear failed to describe the large year classes of the late 1970s because of their exceptionally small lengths at age.

The variability in mean size of sprat, dependent on the relative importance of late spawning (in August), may thus introduce significant bias to indices from the GOV-sampling on IYFS.

11.5 Catch Predictions

The IYFS index for the 1991 year class is higher than in the two previous year classes.

Both due to the possible bias in the IYFS indices, and the continuing influence of the unrealistically high 1989 index, the Working Group decided not to present any SHOT forecast this year.

11.6 Recent Developments in Sprat Biology

At its meeting in 1983, the Working Group stressed the need for a workshop on the problems with the assessment of the sprat stocks of the North Sea and adjacent waters. A workshop was held in 1986, and its work was reported in ICES, Doc. C.M.1987/H:49. In the report, a significant data set was presented and aspects of sprat biology were discussed thoroughly. A series of new initiatives on the item was proposed. At present, however, the understanding is still not sufficient to combine available data to a proper assessment.

Thus, further improvement of the understanding of sprat biology is needed. The following items are identified as the more important ones for improvement of the assesssment:

1) Clarification of spawning period, juvenile growth and subsequent size distributions within age groups;

2) Verification and calibration of otolith reading for age determination;

3) Improvement of sampling and calculation of indices from research vessel surveys (e.g., consideration of the high abundances within restricted areas);

4) Identification of stocks within the North Sea and adjacent waters, and their spatial distribution.

12 SPRAT IN DIVISION VIa

The landings of sprat from Division VIa in 1991 are presented in Table 12.1. The total catches, were 1,459 t of which 88% were taken in the fourth quarter. All the catches were taken by UK (Scotland). The catch in numbers at age and mean weight at age are shown in Table 12.2.

13 SPRAT IN DIVISIONS VIId,e

13.1 Landings

The nominal landings are shown in Table 13.1.1.

In the eastern Channel, landings were very small at the beginning of the year, but for the second year running, there was an upturn in the landings in November and December, again with landings being made at Poole.

In the western Channel, the 1991/1992 Lyme Bay fishery season began in August and ended in March. The preliminary catch for the 1991/1992 season is 2,280 t, which is some 600 t more than in the 1990/1991 season (Table 13.1.2).

13.2 Catch at Age

The catch in numbers at age in the Lyme Bay fishery is shown in Table 13.2.1. In the early part of the 1991/1992 season, the 1989 year class contributed 45% to the catch, with the 1990 and 1988 year classes contributing 36% and 15%, respectively.

13.3 Weight at Age

The mean weight at age for the Lyme Bay fishery is shown in Table 13.3. The mean weight at age in all of the year classes in 1991-1992 were above the long-term average.

14 TRANSFER TO OTHER WORKING GROUPS

There are special problems associated with the assessment of the state of the stocks of the short-lived species such as those considered by the present Working Group. Further progress in solving these problems depends on improved methodology and a better understanding of the biology of these species, including their interactions with other species. There exists in the present membership of the Working Group a considerable pool of knowledge and expertise concerning the biology and fisheries for these species, and the requirements for improved methodology.

The Working Group feels that the transfer of the industrial target species to large area-based working groups could result in a loss of expertise and insufficient attention being given to methods to overcome the special assessment problems presented by species with a short life span.

It, therefore, recommends that the work on alternative assessement methods in connection with short-lived species be continued.

The majority of the Working Group members consider that the most effective way would be the establishment of an assessment working group for short-lived species, where theoretical work can develop concurrently with the practical problems. If this working group should prove impossible to establish, these members suggest the following alternatives:

1. An *ad hoc* study group to consider this item.

2. Have these problems addressed as a special point in the agenda for the Working Group on Methods of Fish Stock Assessment.

The remaining members held the view that the routine assessment work should be transferred to area-based working groups, and that the specific assessment and biological problems related to these species should be addressed according to one of the alternatives (1 or 2) above.

If all or part of the work is to be transferred to area-based working groups, this Working Group has the opinion that it is natural to transfer the work related to Norway pout and sandeel to the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak for the North Sea stocks, to the Working Group on the Assessment of Northern Shelf Demersal Stocks for the stocks in Division VIa, and the sprat stocks to the Herring Assessment Working Group for the Area South of 62°N.

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Table 2.1 Landings[1] from the industrial fisheries for Sandeel, Sprat, and Norway Pout in Division IIIa ('000 t), 1974-1991.

Year	Major fisheries					
	Clupeoids			Gadoid species		
	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	18	40	54	44	5	161
1983	28	26	89	30	16	189
1984	19	36	112	46	15	228
1985	14	20	116	9	19	178
1986	80	11	65	6	9	171
1987	4	14	72	3	25	118
1988	22	9	97	8	15	151
1989	17	10	52	6	9	92
1990[4]	16	10	51	27	10	114
1991[4]	23	14	22	32	11	97
Mean 1974-1990	25	48	60	22	12[5]	164

[1]Data from 1974-1984 from Anon. (1986), 1985-1991 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 1979-1990.

Table 2.2 Landings from the industrial fisheries for Sandeel, Sprat and Norway Pout in the North Sea ('000 t), 1974-1991. For 1991, the data are given both by year and quarters. (Data provided by Working Group members.)

Year	Major fisheries					By-catch protected species[1]	Other[5]	Total[5]
	Clupeoids			Gadoid species				
	Sandeel	Sprat[3]	Herring	Norway pout	Blue whiting			
1974	525	314	-	736	62	220		1,857
1975	428	641	-	560	42	128		1,799
1976	488	622	12	435	36	198		1,791
1977	786	304	10	390	38	147		1,675
1978	787	378	8	270	100	69		1,612
1979	578	380	15	320	64	77		1,434
1980	729	323	7	471	76	69		1,675
1981	569	209	84	236	62	85		1,245
1982	611	153	153	360	118	57	24	1,476
1983	537	88	155	423	118	38	42	1,401
1984	669	77	35	355	79	35	48	1,298
1985	622	50	63	197	73	29	66	1,100
1986	848	16	40	174	37	22	33	1,170
1987	825	33	47	147	30	24	73	1,179
1988	893	87	179	102	28	54	45	1,388
1989	1,035	63	146	162	28	40	59	1,533
1990	590	77	115	140	22	61	40	1,039
1991[2]	842	110	131	155	28	45	38	1,349
1st Quarter	30.8	2.0	12.5	43.0	4.6	5.7	12.9	111.6
2nd Quarter	585.1	0.1	11.4	17.9	17.5	5.7	7.0	644.9
3rd Quarter	221.8	67.5	79.7	35.1	3.7	21.1	11.3	440.2
4th Quarter	4.2	38.2	27.4	58.6	2.3	12.1	8.2	151.0
Mean 1974-1990	678	224	71	322	63	80	48[4]	1,287[4]

[1]Haddock, whiting and saithe summarized from Table 3.1.
[2]Preliminary.
[3]Includes human consumption landings. Quarterly data for Denmark, Norway and UK only.
[4]Mean 1982-1990.
[5]Data for other species not available for period 1974-1981.

Table 2.3 Landings ('000 t) from the industrial fisheries for Sandeel, Sprat and Norway Pout in Division VIa. (Data officially reported to ICES.)

Year	Sandeel	Sprat	Norway pout	Total
1974	+	7,026	6,721	13,747
1975	+	9,053	8,655	17,708
1976	17	8,042	19,933	27,992
1977	67	4,844	5,206	10,117
1978	+	12,401	23,250	35,651
1979	-	1,321	20,502	21,823
1980	211	5,202	17,870	23,283
1981	5,972	3,414	7,757	17,143
1982	10,873	3,524	4,911	19,308
1983	13,051	3,834	8,325	25,210
1984	14,166	2,648	7,794	24,608
1985	18,586	3,554	9,697	31,837
1986	24,469	870	5,832	31,171
1987	14,479	851	38,267	53,597
1988	24,465	4,378	6,742	35,585
1989	18,785	1,293	28,196	48,274
1990[1]	16,515	813	3,316	20,644
1991[1]	7,777	1,459	4,348	13,584
Mean 1974-1990	9,509	4,298	13,116	26,923

[1]Preliminary.

Table 3.1 North Sea. Total reported by-catch ('000 t) of HADDOCK, WHITING, and SAITHE from industrial fisheries. (Data provided by Working Group members.)

Species	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991[1]
Haddock	22	17	19	13	10	6	3	4	4	2	3	5
Whiting	46	67	33	24	19	15	18	16	49	36	50	38
Saithe	-	1	5	1	6	8	1	4	1	1	8	1

[1]Preliminary.

Table 3.2 North Sea. Distribution of landings from industrial fisheries ('000 t) by Denmark and Norway by target species and associated by-catches of selected species to the north and south of 57°N, respectively in 1991. (Data provided by Working Group members).

Area	Target species		By-catch					Total all Species
	Species	Landings	Herring	Haddock	Whiting	Saithe	Other	
North	Norway pout	153	12	3	11	1	37	217
	Sandeel	227	1	+	3	-	5	236
	Sprat[1]	1	-	-	-	-	-	1
	Others	-	4	+	3	-	6	13
	Sum	381	17	3	17	1	48	467
South	Norway pout	+	+	-	-	-	-	+
	Sandeel	603	18	1	5	-	5	632
	Sprat[1]	105	5	+	1	-	+	111
	Others	-	91	+	16	-	13	120
	Sum	708	114	1	22	-	18	863
	Total	1,089	131	4	39	1	66	1,330

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

Table 3.3 Sum of Danish and Norwegian by-catch by species and year in tonnes.

Species	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Gadus morhua	1217	2352	4175	710	544	1092	1404	2988	2948	8570
Scomber scombrus	1198	2075	1278	4	534	2663	6414	8013	5212	7466
Trachurus trachurus	76[3]	95[3]	133[3]	22789	16658	7391	18104	22723	14918	5704
Trigla sp.	16[3]	2[3]	2168	888[2]	45342[2]	5394[2]	9391[2]	2598	5622[2]	
Limanda limanda	115[3]	116[3]	149[3]	187[3]	3209	4632	3781	7743	4706	5578
Argentina spp.	6425[3]	10069[3]	6977[3]	8714[3]	5210	3033	1918	778	2801	3434
Hippoglossoides platessoides	268[3]	44[3]	170[3]	59[3]	718	1173	946	2160	1673	1024
Pleuronectes platessa	66[3]	10[3]		34[3]	119	109	372	582	566	1305
Merluccius merluccius[3]	298	472	546	349	165	261	242	290	429	28
Trisopterus minutus				68[3]		5[2]	48[2]	121[2]	79[2]	
Molva molva[3]	516	773	528	51	1	40	39	37	13	65
Glyptocephalus cynoglossus	299[3]	314[3]	241[3]	236[3]	132	341	44[3]	225[3]	251[3]	1439[3]
Gadiculus argenteus[3]	2578	4511	2690	1210	729	3043	2494	741	776	801
Others	11065	21025	29261	32557[1]	3916	3604	3670	3492	3154	5383

[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
Denmark	40,144	20,694	23,922	23,951	26,235	29,273	51,317	36,124
Norway	50[2]	104	362	1,182	141	752	1,265	990
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

Country	1984	1985	1986	1987	1988	1989	1990	1991[1]
Denmark	67,007	85,082	32,056	47,527	45,034	16,873	41,705	49,303
Norway	947	831	400	1,680	1,178	309	40[1]	23
Sweden	+	-	+	-	-	-	-	-
Total	67,954	85,913	32,456	49,207	46,212	17,182	41,745	49,326

[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 1958-1991. (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	0.6	65.3	-	0.1	-	161.6
1990	61.5	0.9	77.1	-	-	-	139.5
1991	85.0	1.2	68.3	-	-	-	154.5

[1]Including by-catch.

Table 5.1.2 Norway Pout, North Sea. National landings (t) by months, 1989-1991. (Data provided by Working Group members.)

Month	Denmark	Norway	Faroes	Total[1]
1989				
Jan	7,952	795		8,778
Feb	2,829	1,161		4,004
Mar	1,480	912		2,401
Apr	742	3,452		4,209
May	-	2,654		2,664
Jun	838	5,044		5,903
Jul	10,451	7,522		18,037
Aug	12,698	4,128		16,886
Sep	10,481	6,880		17,423
Oct	13,826	16,234		30,168
Nov	23,816	11,124		35,065
Dec	10,451	5,430		15,938
Total	95,564	65,336	576	161,476
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

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

Table 5.2.1 NORWAY POUT. Danish CPUE data (tonnes/day fishing) by vessel category for 1983-1991.

Vessel GRT	1983	1984	1985	1986	1987	1988	1989	1990	1991
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
151-200	29.00	24.17	20.76	22.97	22.20	23.91	24.06	25.62	28.22
201-250	32.71	27.82	24.80	25.20	27.51	30.50	27.43	25.34	29.45
251-300	32.05	26.59	22.86	25.12	25.58	24.03	26.10	21.87	28.15
301-	31.81	37.47	26.86	26.63	31.10	40.09	28.92	25.91	36.73

Table 5.2.2 NORWAY POUT. Norwegian fishing effort in number of days and average vessel size (GRT). Landings with less than 70% Norway pout excluded.

Year		Quarter			
		1	2	3	4
1982	Effort	733	2,240	1,934	740
	Ave.GRT	161.2	122.5	160.5	170.9
1983	Effort	302	1,671	2,302	811
	Ave. GRT	150.3	155.4	147.8	154.8
1984	Effort	473	1,633	1,622	282
	Ave. GRT	146.2	121.0	139.9	175.5
1985	Effort	600	805	595	443
	Ave. GRT	142.7	144.2	175.2	196.8
1986	Effort	5.3	294	693	261
	Ave. GRT	166.5	121.8	170.7	212.4
1987	Effort	715	599	290	431
	Ave. GRT	181.5	144.5	130.4	177.3
1988	Effort	234	218	672	508
	Ave. GRT	200.2	131.7	178.8	173.6
1989	Effort	178	527	1,208	1,148
	Ave. GRT	215.4	101.2	181.7	162.4
1990	Effort	735	1,338	895	951
	Ave. GRT	200.2	156.2	178.8	177.0
1991	Effort	883	782	836	712
	Ave. GRT	192.1	167.6	167.0	176.1

Table 5.2.3 NORWAY POUT. Danish and Norwegian effort (no. of fishing days) standardized to a vessel size of 200 GRT.

Year	Country	Quarter 1	2	3	4	Total
1982	Norway	654	1,699	1,722	682	4,757
	Denmark	1,922	502	3,929	2,234	8,587
Total		2,576	2,201	5,651	2,916	13,344
1983	Norway	259	1,461	1,957	708	4,385
	Denmark	2,317	510	3,739	3,602	10,168
Total		2,576	1,971	5,696	4,310	14,553
1984	Norway	400	1,229	1,335	263	3,227
	Denmark	1,887	454	3,783	4,433	10,557
Total		2,287	1,683	5,118	4,696	13,784
1985	Norway	500	675	556	439	2,170
	Denmark	2,179	208	2,009	3,290	7,686
Total		2,679	883	2,565	3,729	9,856
1986	Norway	457	222	638	269	1,586
	Denmark	1,645	0	1,397	3,332	6,374
Total		2,102	222	2,035	3,601	7,960
1987	Norway	689	529	273	412	1,903
	Denmark	1,271	7	1,335	1,790	4,403
Total		1,960	536	1,608	2,202	6,306
1988	Norway	235	784	644	481	1,544
	Denmark	645	3	545	1,986	3,179
Total		880	787	1,189	2,467	4,723
1989	Norway	292	359	995	1,032	2,628
	Denmark	659	108	1,802	2,265	4,834
Total		901	467	2,797	3,297	7,462
1990	Norway	438	1,182	847	779	3,546
	Denmark	977	80	524	1,706	3,287
Total		1,715	1,262	1,371	2,485	6,833
1991	Norway	866	716	811	669	3,062
	Denmark	979	18	517	1,524	3,038
Total		1,845	734	1,328	2,193	6,100

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	35[illegible]
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							
0					0	0	76	2,607				
1					1,485	419	1,010	1,030				
2					1,335	397	67	185				
3					93	19	1	17				
4+					6	0	0	0				

Table 5.3.2 Norway Pout in the North Sea 1990. Catch in numbers at age estimated from available samples (millions).

	Quarters		
Age	1	2	3
0	-	-	215
1	2,297	938	773
2	500	1,032	305
3	35	20	6
4	6	-	-

Table 5.4 NORWAY POUT. North Sea 1986-1991. Mean weight at age by quarters. 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	-	-	-	-	-
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	-

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	16
1980	1,375	403	9	151	385	13	1	185	37	1
1981	3,315	663	58	1,770	712	29	3	1,031	90	7
1982	2,331	802	71	1,818	517	93	2	505	78	6
1983	3,925	1,423	23	1,501	1,008	74	18	597	186	12
1984	2,109	384	65	160	300	47	-	649	51	1
1985	2,043	469	13	136	219	41	3	412	24	5
1986	3,023	760	178	109	152	34	5	338	114	-
1987	127	260	46	2	26	153	9	128	25	3
1988	2,079	773	129	45	350	45	2	462	94	8
1989	1,320	677	-	400	264	118	-	323	48	-
1990	2,497	-	-	627	161	-	-	761	-	-
1991	4,964[4]	-	-	401	-		-	-	-	-

[1]International Bottom Trawl Survey, arithmetic mean catch in no./h in standard area.
[2]English groundfish survey, arithmetic mean catch in no./h, Roundfish areas 1, 2, and 3.
[3]Scottish groundfish surveys, arithmetic mean catch no./h.'
[4]Preliminary.

Table 5.5.2

Analysis by RCT3 ver3.1 of data from file :

pout.dat

North Sea Norway pout as 1-group, 0, 1 & 2 group data

Data for 5 surveys over 15 years : 1977 - 1991

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1980

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.20	-5.16	.25	.844	3	7.23	3.49	.764	.041
IYFS2	.84	-.79	.16	.931	3	6.00	4.26	.324	.227
EGFS0	16.37	******	3.18	.033	3	5.02	-31.90	62.196	.000
EGFS1	.86	-1.09	.09	.977	3	5.96	4.04	.197	.595
SGFS1									
					VPA Mean =		4.32	.417	.137

Yearclass = 1981

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.31	-6.06	.20	.927	4	8.37	4.90	.389	.514
IYFS2	2.23	-9.40	.89	.396	4	6.50	5.07	1.607	.030
EGFS0	.64	-.20	.50	.676	4	7.48	4.60	.843	.109
EGFS1	1.61	-5.91	.46	.709	4	6.57	4.67	.797	.122
SGFS1									
					VPA Mean =		4.09	.588	.224

Yearclass = 1982

	I----------Regression----------I					I----------Prediction---------I			
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
IYFS1	1.20	-5.27	.19	.926	5	7.75	4.05	.266	.518
IYFS2	1.95	-7.78	.66	.499	5	6.69	5.25	1.090	.031
EGFS0	.65	-.26	.41	.717	5	7.51	4.63	.611	.098
EGFS1	1.60	-5.84	.37	.755	5	6.25	4.15	.531	.130
SGFS1	.63	.08	.29	.930	3	6.23	4.00	.580	.109
					VPA Mean =		4.20	.569	.114

cont'd.

Table 5.5.2 cont'd

Yearclass = 1983

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
IYFS1	1.42	-6.87	.36	.742	6	8.28	4.87	.511	.241
IYFS2	1.69	-6.29	.54	.554	6	7.26	6.00	1.018	.061
EGFS0	.65	-.25	.36	.744	6	7.31	4.51	.479	.274
EGFS1	1.84	-7.27	.45	.649	6	6.92	5.45	.734	.116
SGFS1	.76	-.61	.51	.698	4	6.39	4.25	.816	.094
					VPA Mean =		4.27	.541	.214

Yearclass = 1984

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
IYFS1	1.48	-7.47	.45	.591	7	7.65	3.87	.592	.204
IYFS2	1.91	-7.98	1.02	.221	7	5.95	3.42	1.361	.039
EGFS0	.66	-.37	.35	.705	7	5.08	2.99	.582	.210
EGFS1	2.00	-8.50	.73	.360	7	5.71	2.93	1.088	.060
SGFS1	.77	-.67	.43	.695	5	6.48	4.30	.604	.196
					VPA Mean =		4.26	.495	.291

Yearclass = 1985

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
IYFS1	1.66	-8.91	.48	.583	8	7.62	3.74	.608	.185
IYFS2	1.84	-7.50	.90	.286	8	6.15	3.82	1.117	.055
EGFS0	.55	.43	.31	.769	8	4.92	3.15	.452	.335
EGFS1	1.67	-6.31	.58	.489	8	5.39	2.68	.884	.088
SGFS1	1.06	-2.71	.65	.500	6	6.02	3.70	.890	.087
					VPA Mean =		4.17	.524	.250

Yearclass = 1986

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
IYFS1	1.78	-9.88	.49	.589	9	8.01	4.37	.592	.167
IYFS2	2.02	-8.68	.92	.287	9	6.63	4.72	1.132	.046
EGFS0	.51	.79	.28	.812	9	4.70	3.16	.382	.401
EGFS1	1.37	-4.37	.50	.579	9	5.03	2.51	.754	.103
SGFS1	1.14	-3.22	.63	.514	7	5.83	3.42	.836	.084
					VPA Mean =		4.09	.541	.200

cont'd.

Table 5.5.2 cont'd.

Yearclass = 1987

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
IYFS1	2.05	-12.08	.59	.475	10	4.85	-2.15	2.003	.026
IYFS2	2.48	-11.74	1.14	.199	10	5.56	2.06	1.540	.044
EGFS0	.46	1.10	.28	.806	10	1.10	1.61	.555	.336
EGFS1	1.14	-2.89	.50	.560	10	3.30	.88	1.060	.092
SGFS1	1.11	-3.01	.56	.542	8	4.86	2.39	.875	.135
					VPA Mean =		4.04	.531	.368

Yearclass = 1988

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
IYFS1	.83	-2.36	.52	.660	11	7.64	3.94	.612	.120
IYFS2	2.13	-9.49	.92	.385	11	6.65	4.66	1.103	.037
EGFS0	.36	1.83	.27	.882	11	3.83	3.19	.325	.426
EGFS1	.75	-.42	.41	.758	11	5.86	3.95	.482	.194
SGFS1	1.06	-2.66	.49	.710	9	6.14	3.83	.597	.126
					VPA Mean =		3.89	.684	.096

Yearclass = 1989

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
IYFS1	.85	-2.60	.54	.630	12	7.19	3.51	.631	.106
IYFS2	2.34	-11.00	1.03	.316	12	6.52	4.28	1.211	.029
EGFS0	.35	1.92	.25	.885	12	5.99	3.99	.295	.484
EGFS1	.77	-.61	.43	.723	12	5.58	3.69	.506	.165
SGFS1	1.10	-2.95	.49	.688	10	5.78	3.40	.592	.120
					VPA Mean =		3.83	.665	.096

Yearclass = 1990

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I----------Regression----------I					I----------Prediction---------I			
IYFS1	.84	-2.50	.54	.632	12	7.82	4.04	.637	.109
IYFS2									
EGFS0	.34	1.94	.25	.891	12	6.44	4.14	.294	.510
EGFS1	.76	-.55	.44	.726	12	5.09	3.32	.521	.163
SGFS1	1.11	-3.02	.49	.688	10	6.64	4.34	.607	.120
					VPA Mean =		3.82	.668	.099

cont'd.

Table 5.5.2 cont'd.

Yearclass = 1991

Survey/ Series	Regression: Slope	Regression: Inter-cept	Regression: Std Error	Regression: Rsquare	Regression: No. Pts	Prediction: Index Value	Prediction: Predicted Value	Prediction: Std Error	Prediction: WAP Weights
IYFS1 IYFS2	.82	-2.38	.54	.634	12	8.51	4.60	.675	.134
EGFS0 EGFS1 SGFS1	.34	1.96	.24	.897	12	6.00	3.99	.288	.731
					VPA Mean =		3.80	.672	.135

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1980	60	4.11	.15	.10	.40	28	3.37
1981	105	4.66	.28	.16	.35	104	4.64
1982	64	4.17	.19	.12	.37	104	4.64
1983	112	4.72	.25	.22	.77	65	4.17
1984	45	3.81	.27	.25	.84	35	3.56
1985	35	3.56	.26	.21	.66	33	3.50
1986	35	3.58	.24	.28	1.38	37	3.64
1987	11	2.46	.32	.62	3.76	12	2.56
1988	37	3.63	.21	.18	.73	32	3.47
1989	45	3.81	.21	.10	.26		
1990	54	3.99	.21	.16	.59		
1991	57	4.05	.25	.16	.42		

Table 5.6.1 Norway Pout. North Sea. Sampled data from Table 5.3.2 and estimated catch in numbers at age by quarter for 1990 (millions).

Quarter	Age	Sampled data	Estimated XSA	Estimated SSV
1	0	-	-	-
	1	2297	1319	1461
	2	500	749	4037
	3	35	13	9
	4	6	2	-
SOP	(tonnes)	28284	28284	112679
2	0	-	-	-
	1	938	1433	1336
	2	1032	784	1352
	3	20	5	3
SOP	(tonnes)	39730	39730	52702
3	0	215	-	4
	1	773	818	1028
	2	305	289	368
	3	6	2	1
SOP	(tonnes)	26158	26158	33035
4	0		1080	1259
	1		1020	2071
	2		226	364
	3		-	1
SOP	(tonnes)	45253	45253	84737

Table 5.7.1 NORWAY POUT. North sea. Diagnostics from quarterly separable VPA without research vessel data.

```
weight for effort data =   1.0000

IFAIL on exit from E04FDF =  0          IFAIL on exit from E04YCF =  0
Initial sum of squares = 1977.4819      Coeff. of determination = .8768
Final sum of squares   =  243.6080      Adj. Coeff.   "     "   = .7976
Residual mean square   =    2.9001

Number of observations = 139    RMS for catch data  =    1.4816
Number of parameters   =  55    RMS for effort data =     .5143
```

Year/season effects

year	1	2	3	4
1984	.5500	.6699	2.5921	.8803
1985	.9205	.3021	3.1469	.9087
1986	1.1471	.1988	1.1477	2.1254
1987	1.2301	.1595	.7396	2.9609
1988	1.0879	.1140	.7596	1.3876
1989	.2586	.2200	.3299	1.7405
1990	.5568	.4316	.5611	.9481
1991	.7768	.2750	.4102	.6540

Selectivities at age

age	1	2	3	4
0	.0000	.0000	.0000	.0237
1	.0574	.1231	.1095	.1995
2	1.2321	1.5514	.6463	1.0429
3	1.2321	1.5514	.6463	1.0429

Year/season effect residuals

year	1	2	3	4
1984	.5978	.0939	-.0080	.8470
1985	.2410	.2453	-1.0317	.5847
1986	-.2216	-.7171	-.2545	-.3870
1987	-.3614	.3846	-.0506	-1.1234
1988	-1.0393	-.3326	-.3792	-.2518
1989	.4211	-.0743	1.3102	-.1884
1990	.2978	.2458	.0662	.1363
1991	.0645	.1544	.3475	.3826

Log catch residuals

	1984				1985			
	1	2	3	4	1	2	3	4
0	.2109	-.9611	-1.6403	1.2094	-.0715	.0679	.1901	.2101
1	.2511	-.4564	-.2652	.4352	.7219	.5475	-.6119	1.4616
2	-1.9221	-1.2940	.2654	1.8364	-1.4077	-1.4999	.1788	1.4806
3	1.1612	2.5828	.2702	-4.0142	1.6738	1.1524	1.5110	-3.2230

	1986				1987			
	1	2	3	4	1	2	3	4
0	-.6095	.1682	-5.5162	1.1568	.1803	1.2481	2.4675	-1.5086
1	-.9851	-.3344	.3859	.1810	.5671	1.3845	.8057	-.1767
2	-.5260	-.5079	.9139	-.4361	-1.2877	.0448	1.1465	1.3643
3	1.7375	1.0494	2.1629	-3.6663	1.2335	-2.6319	-2.5418	3.5584

	1988				1989			
	1	2	3	4	1	2	3	4
0	.0000	.0000	1.4066	-.2978	.2898	-.5232	1.6604	.6207
1	-.8169	.0175	-.5121	.0945	.3835	-.7036	-.1026	-1.2156
2	-.8312	.1748	1.1294	1.7928	-1.9266	-.1550	1.3028	-.3914
3	2.7110	.0000	-1.9027	-1.7202	.6524	1.2383	-4.0887	2.1521

	1990				1991			
	1	2	3	4	1	2	3	4
0	.0000	.0000	.0000	.0000	.0000	.0000	1.4322	-1.4322
1	.0000	.0000	.0000	.0000	.0349	-.5149	.5210	-.0410
2	.0000	.0000	.0000	.0000	-1.0174	-.2832	-.8307	.0837
3	.0000	.0000	.0000	.0000	.0366	.3955	-1.3172	1.4147

Table 5.7.2 NORWAY POUT, North Sea. Fitted populations from quarterly separable VPA without research vessel data.

Estimated populations (millions)

	1984				1985			
	1	2	3	4	1	2	3	4
0	128290.	85995.	57644.	38636.	101669.	68151.	45683.	30618.
1	82825.	53792.	33203.	16755.	25363.	16126.	10415.	4946.
2	22427.	7634.	1810.	227.	9422.	2032.	852.	75.
3	107.	36.	9.	1.	61.	13.	6.	0.

	1986				1987			
	1	2	3	4	1	2	3	4
0	139722.	93658.	62781.	42081.	59146.	39647.	26576.	17814.
1	20086.	12605.	8245.	4874.	26820.	16752.	11010.	6806.
2	2765.	451.	222.	71.	2138.	315.	165.	68.
3	19.	3.	2.	0.	5.	1.	0.	0.

	1988				1989			
	1	2	3	4	1	2	3	4
0	492857.	330372.	221455.	148441.	252204.	169057.	113322.	75961.
1	11130.	7009.	4633.	2857.	96278.	63586.	41484.	26820.
2	2527.	443.	249.	102.	1452.	708.	337.	183.
3	2.	0.	0.	0.	16.	8.	4.	2.

	1990				1991			
	1	2	3	4	1	2	3	4
0	201680.	135190.	90621.	60744.	2852787.	1912280.	1281840.	859228.
1	48857.	31719.	20162.	12709.	39811.	25522.	16538.	10599.
2	12705.	4289.	1472.	686.	7051.	1815.	794.	408.
3	20.	7.	2.	1.	171.	44.	19.	10.

Table 5.7.3 NORWAY POUT, North Sea. Fitted Fs from quarterly separable VPA without research vessel data.

	1984				1985			
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.021	.000	.000	.000	.022
1	.032	.082	.284	.176	.053	.037	.345	.181
2	.678	1.039	1.675	.918	1.134	.469	2.034	.948
3	.678	1.039	1.675	.918	1.134	.469	2.034	.948

	1986				1987			
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.050	.000	.000	.000	.070
1	.066	.024	.126	.424	.071	.020	.081	.591
2	1.413	.308	.742	2.216	1.516	.248	.478	3.088
3	1.413	.308	.742	2.216	1.516	.248	.478	3.088

	1988				1989			
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.033	.000	.000	.000	.041
1	.062	.014	.083	.277	.015	.027	.036	.347
2	1.340	.177	.491	1.447	.319	.341	.213	1.815
3	1.340	.177	.491	1.447	.319	.341	.213	1.815

	1990				1991			
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.023	.000	.000	.000	.016
1	.032	.053	.061	.189	.045	.034	.045	.130
2	.686	.670	.363	.989	.957	.427	.265	.682
3	.686	.670	.363	.989	.957	.427	.265	.682

Table 5.7.4 Norway Pout. North Sea. Diagnostics from quarterly separable VPA with upweighted IYFS survey data.

```
weight for effort data =   1.0000
weight for RV data     =   5.0000
RV catchability constant above age =   1

Initial sum of squares = 2946.2139
Final sum of squares   =  472.2912
Residual mean square   =    4.1796

Coefficient of determination =   .8397
Adj. Coeff. of determination =   .7588

Number of observations = 171
Number of parameters   =  58

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

RMS for catch data  =   1.8859
RMS for effort data =    .6674
RMS for RV data     =   1.5279
```

RV catchabilities

age	logQ
0	-16.5099
1	-2.6238
2	-1.1884
3	-1.1884

Year/season effects

year	1	2	3	4
1984	.5958	.7867	2.4515	.8371
1985	2.0609	.4906	5.1278	1.2191
1986	.7814	.1476	.6382	.5077
1987	2.9569	.1214	.5990	6.4258
1988	.4306	.1001	.4096	.6518
19[illegible]	.2356	.2119	.3687	2.5908
19[illegible]	.4177	.3948	.5865	.6828
1991	.7227	.3302	.9382	1.9642

Year/season effect residuals

year	1	2	3	4
1984	.5178	-.0668	.0478	.8973
1985	-.5650	-.2395	-1.5200	.2907
1986	.1623	-.4193	.3323	1.0449
1987	-1.2384	.6580	.1602	-1.8982
1988	-.1124	-.2020	.2384	.5038
1989	.5140	-.0369	1.1991	-.5862
1990	.5851	.3348	.0218	.4646
1991	.1367	-.0283	-.4797	-.7170

Log catch residuals

	1984				1985			
	1	2	3	4	1	2	3	4
0	.3867	-1.1158	-2.2172	-1.0523	-.6275	-.4168	-.9366	-2.3639
1	.5668	-.5325	.0343	1.5832	-.1219	-.2528	-1.1146	2.2347
2	.2483	.8747	2.2367	3.6410	-.9587	-.1394	1.4170	2.7403
3	1.0042	2.4242	-.0860	-4.5370	.3185	.7087	.9449	-3.7676

	1986				1987			
	1	2	3	4	1	2	3	4
0	-.2169	.2249	-5.8091	-.0177	-.8247	1.1437	1.6618	-4.5020
1	-.6035	-.3908	.6880	1.9840	-.6806	1.0066	.4523	-.5937
2	.6532	.4302	2.1889	1.4996	-1.7254	1.5313	2.7518	1.9332
3	.9196	-.0097	1.4407	-3.7278	-2.2356	-4.1768	-3.9680	1.0959

	1988				1989			
	1	2	3	4	1	2	3	4
0	.0000	.0000	2.7121	-.5581	1.2824	.1640	1.5607	-1.2849
1	.8310	.5077	.5384	2.0154	1.6706	.1894	.7384	.1699
2	.2381	.2456	1.8828	2.8864	-.7640	1.2418	2.8079	1.1324
3	.9379	.0000	-3.9917	-3.4690	-1.7450	-.9249	-6.1436	.1159

	1990				1991			
	1	2	3	4	1	2	3	4
0	.0000	.0000	.0000	.0000	.0000	.0000	3.0274	-1.6757
1	.0000	.0000	.0000	.0000	.3298	-.8059	-.2730	-.1703
2	.0000	.0000	.0000	.0000	.4009	.9816	.0487	1.4064
3	.0000	.0000	.0000	.0000	-.2749	-.0696	-2.1677	1.0075

Selectivities at age

age	1	2	3	
0	.0000	.0000	.0001	.222
1	.0627	.1898	.1560	.123
2	.7050	.5525	.1463	.086
3	.7050	.5525	.1463	.086

Log RV residuals

	1984	1985	1986	1987	1988	1989	1990	1991
	1	1	1	1	1	1	1	1
0	-.0373	1.0962	-1.6997	1.9152	-.1640	-.1973	-.6427	-.2704
1	.2785	.7600	2.1605	.5306	-5.1186	.3548	.2077	.8266
2	-1.7081	-.6082	-1.0681	-3.1773	-.0660	.2396	-1.6042	-.9223
3	.2389	.6671	-.3371	1.8986	.8604	3.0510	1.8060	.7298

Table 5.7.5 Norway Pout. North Sea. Estimated fishing mortality from quarterly separable VPA with upweighted IYFS survey data.

				1984				1985
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.186	.000	.000	.000	.271
1	.037	.149	.382	.104	.129	.093	.800	.151
2	.420	.435	.359	.072	1.453	.271	.750	.105
3	.420	.435	.359	.072	1.453	.271	.750	.105

				1986				1987
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.113	.000	.000	.000	1.430
1	.049	.028	.100	.063	.186	.023	.093	.795
2	.551	.082	.093	.044	2.085	.067	.088	.554
3	.551	.082	.093	.044	2.085	.067	.088	.554

				1988				1989
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.145	.000	.000	.000	.577
1	.027	.019	.064	.081	.015	.040	.058	.320
2	.304	.055	.060	.056	.166	.117	.054	.223
3	.304	.055	.060	.056	.166	.117	.054	.223

				1990				1991
	1	2	3	4	1	2	3	4
0	.000	.000	.000	.152	.000	.000	.000	.437
1	.026	.075	.091	.084	.045	.063	.146	.243
2	.295	.218	.086	.059	.510	.182	.137	.169
3	.295	.218	.086	.059	.510	.182	.137	.169

Table 5.7.6 Norway pout. North Sea. Estimated population numbers from quarterly separable VPA with upweighted IYFS survey data (mill.).

	1984				1985			
	1	2	3	4	1	2	3	4
0	149072.	99926.	66983.	44892.	118836.	79658.	53396.	35780.
1	51185.	33052.	19081.	8726.	24978.	14712.	8985.	2707.
2	3704.	1631.	708.	332.	5274.	827.	423.	134.
3	181.	80.	35.	16.	207.	32.	17.	5.

	1986				1987			
	1	2	3	4	1	2	3	4
0	207873.	139341.	93403.	62607.	100881.	67623.	45329.	30384.
1	18285.	11671.	7607.	4616.	37484.	20872.	13672.	8347.
2	1560.	603.	372.	227.	2906.	242.	152.	93.
3	81.	31.	19.	12.	146.	12.	8.	5.

	1988				1989			
	1	2	3	4	1	2	3	4
0	152900.	102492.	68702.	46051.	153921.	103177.	69161.	46359.
1	4874.	3180.	2092.	1315.	26701.	17636.	11355.	7186.
2	2527.	1251.	793.	501.	813.	462.	275.	175.
3	36.	18.	11.	7.	317.	180.	107.	68.

	1990				1991			
	1	2	3	4	1	2	3	4
0	168262.	112790.	75605.	50678.	156187.	104695.	70179.	47040.
1	17459.	11401.	7090.	4337.	29182.	18694.	11770.	6815.
2	3496.	1746.	941.	579.	2672.	1076.	601.	351.
3	94.	47.	25.	16.	366.	147.	82.	48.

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[1]
Denmark	3,316[5]	4,348
Faroes	-	-
Germany	-	-
Netherlands	-	-
Norway	-	-
Poland	-	
UK (Scotland)	+	-
Russia	-	-
Total	3,316	4,348

[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 III.
Landings in tonnes as officially reported to ICES except where indicated.

Country	1982	1983	1984	1985
Denmark	21,540	34,286[1]	27,679[1]	14,058
Norway	-	178	-	-
Sweden	5	31	-	-

Country	1988[2]	1989[2]	1990	1991[2]
Denmark	22,356	17,236[1]	25,574[1]	23,424
Norway	-	-	-	-
Sweden	-	-	-	-

[1]Estimate provided by Working Group members.
[2]Preliminary.

Table 8.1.1 Landings ('000 t) of Sandeel from the North Sea, 1952-1991. (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	-	6.9	1034.7
1990	496.0	-	2.2	0.3	88.9	-	2.5	589.9
1991[1]	701.4	-	11.2	-	128.8	-	0.5	841.9

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

Table 8.1.2 Sandeel North Sea. Monthly landings (t) by country, 1987-1991. (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	1,192	193,451
	May	300,524		61,764	2,303	364,591
	Jun	235,779	n/a	59,079	3,338	298,196
	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	186,842	6,939	1,018,215[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	286	36,528
	Apr	94,670		13,673	1,450	109,793
	May	181,582		35,394	668	217,644
	Jun	121,981	n/a	6,660	92	128,733
	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	2,496	587,425[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	511	255,521
	Jun	217,334		13,176	-	230,510
	Jul	129,548		8,267	-	137,815
	Aug	43,024		16,955	-	59,979
	Sep	4,801		16,153	-	20,954
	Oct	-		4,242	-	4,242
	Nov	-		-	-	-
	Dec	-		-	-	-
	Total	701,429		128,834		830,810[1]

[1]Excluding the Faroes.

Table 8.1.3 North Sea SANDEEL. Catch (tonnes) by month and area [Denmark, Norway, and UK (Scotland)] in 1986 - 1991 for areas in Figure 8.1.
(Data provided by Working Group members.)

Month	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland
1986											
Mar	403	376	1,893	2,282	6,911	-	178	-	255	265	375
Apr	22,648	20,623	1,971	6,951	26,234	622	7,019	376	-	1,263	2,069
May	92,298	2,345	154	19,553	22,952	555	20,123	1,502	1,147	4,269	4,771
Jun	158,538	2,533	692	17,656	61,493	134	44,534	1,655	367	50,804	2,841
Jul	20,466	1,911	1,344	4,714	79,976	11	10,465	18,046	2,263	19,049	686
Aug	413	6,404	2,239	3,169	38,368	555	1,923	944	14	4,601	2,152
Sep	309	347	209	638	566	84	588	5	-	61	773
Oct	160	1,183	-	295	9,620	-	5	-	-	-	315
Total	295,235	35,722	8,502	55,258	244,120	1,961	84,835	22,528	4,046	80,312	13,982
1987											
Mar	319	7,175	753	1,729	9,646	-	218	-	-	-	7
Apr	8,066	26,465	21	2,573	35,361	-	445	471	-	14	875
May	80,175	1,973	80	25,627	58,415	262	2,081	347	979	1,088	2,385
Jun	138,904	20,609	239	10,601	161,637	-	480	1,396	357	24,963	1,233
Jul	46,253	1,181	-	8,079	15,086	-	1,113	17,429	6,322	14,299	925
Aug	1,100	4,873	-	8,013	31,827	-	545	1,765	-	2,152	1,521
Sep	242	704	49	2,866	7,698	94	741	-	-	2,622	280
Oct	-	668	-	-	5,564	-	-	-	-	-	1
Nov	-	-	-	-	-	-	12	-	-	-	-
Dec	-	-	-	-	-	-	-	-	-	-	-
Total	275,059	63,648	1,142	53,488	325,234	356	5,635	21,408	7,658	45,138	7,227
1988											
Mar	-	25,627	-	234	43,482	-	1,005	-	-	-	4
Apr	58,156	26,432	525	6,288	83,185	-	8,237	1,689	495	538	993
May	178,614	3,192	625	21,750	62,602	-	13,224	8,295	206	24,053	1,932
Jun	48,998	1,968	126	11,767	31,143	205	14,385	18,341	7,459	68,129	744
Jul	9,548	21	38	2,346	66	-	7,913	6,967	1,853	9,472	633
Aug	1	593	721	2,468	4,619	133	15,860	-	1,971	1	196
Sep	231	500	-	1,336	12,254	-	4,013	-	-	1	181
Oct	536	103	-	825	19,135	2	2,993	-	-	-	36
Nov	-	-	-	-	-	-	-	-	-	-	-
Total	291,084	58,436	2,035	47,014	256,486	340	67,630	35,292	11,984	102,194	4,179
1989											
Mar	-	14,831	441	2,221	63,853	-	4,695	-	-	76	11
Apr	61,395	10,782	-	34,469	61,676	-	22,350	1,024	133	421	1,193
May	120,385	4,771	-	113,153	60,380	240	38,946	4,013	328	20,452	1,763
Jun	42,807	158	11	12,924	132,713	-	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	-	-	-	-	-	-
Total	226,645	30,955	452	167,796	331,412	1,531	125,337	30,527	4,533	95,094	3,503
1990											
Mar	1,566	368	119	230	33,271	136	529	-	-	18	286
Apr	37,010	167	-	37,794	22,908	56	6,379	2,049	51	1,909	1,450
May	84,824	147	-	18,501	39,258	-	18,343	11,555	3,185	41,163	608
Jun	15,337	418	-	7,895	13,574	-	12,728	28,437	10,564	39,688	-
Jul	1,478	218	-	28,934	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	140,644	1,361	119	80,272	156,091	570	61,043	45,481	13,800	85,548	2,344

Cont'd

Table 8.1.3 cont'd.

Month	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland
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

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.)

	Area											Assessment areas[1]	
Year	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	227.1	31.0	0.5	167.8	331.4	1.5	125.3	30.5	4.5	95.1	3.5	489.7	525.0
1990	140.6	1.4	0.1	80.3	156.1	0.6	61.0	45.5	13.8	85.5	2.3	219.2	365.7
1991	228.2	7.1	0.7	114.0	252.2	1.3	110.6	22.6	1.0	93.1	+	371.9	458.9
1992													

[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	40.0	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	40.7	66.5	67.5	86.7	83.0	102.5
1988	19.0	25.6	34.4	42.5	48.0	47.8	75.3
1989	16.3	25.2	36.8	41.0	49.1	51.4	76.0
1990	14.5	21.6	27.3	27.8	29.1	27.4	40.2
1991	16.7	25.5	38.4	42.4	47.7	47.5	73.7
	Second half year						
1982	-	17.7	26.7	46.7	19.9	-	-
1983	17.9	25.7	23.9	32.9	44.5	34.3	57.1
1984	113.2	22.0	32.1	35.2	-	28.3	24.0
1985	21.6	23.5	51.2	39.6	60.7	33.3	-
1986	17.1	27.5	50.2	50.0	77.9	74.0	80.7
1987	21.3	31.3	67.5	28.5	42.6	26.8	22.7
1988	16.8	21.3	42.5	32.4	38.0	33.1	43.9
1989	20.7	26.2	41.0	38.0	37.7	29.3	40.4
1990	17.6	32.5	27.8	34.0	40.4	32.6	55.3
1991	15.0	25.9	42.4	47.6	54.4	51.9	72.5

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	2,699	1,130	204.7	206.1
1981	1,780	414	212.6	189.0
1982	1,222	-	210.1	-
1983	324	66	267.8	208.0
1984	145	-	185.8	-
1985	366	-	212.8	-
1986	1,562	567	192.4	182.3
1987	2,123	1,584	210.5	193.0
1988	3,794	994	215.5	206.4
1989	4,843	667	187.5	186.6
1990	2,275	683	205.7	185.6
1991	1,830	1,002	197.5	191.0

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	2,047	50.4	24.6	-	-	24.6	276.0	11.2
1978	1,762	44.9	25.5	-	-	25.5	109.7	4.3
1979	1,457	29.6	20.3	-	-	20.3	47.7	2.3
1980	2,732	112.8	41.3	-	-	41.3	220.9	5.3
1981	1,837	42.8	23.2	-	-	23.2	93.3	4.0
1982	1,254	27.0	21.5	13.5	34.9	21.8	62.3	2.9
1983	377	8.5	22.5	17.4	28.9	20.4	54.5	2.7
1984	140	3.5	25.0	54.1	41.2	26.1	74.1	2.8
1985	378	8.7	23.0	47.4	46.7	27.4	69.9	2.6
1986	1,531	59.2	38.6	154.1	54.7	35.5	221.3	6.2
1987	2,178	123.6	56.7	213.2	75.1	50.5	360.9	7.1
1988	3,926	155.5	39.6	158.1	42.7	41.2	332.0	8.1
1989	4,700	164.1	35.0	267.3	44.5	40.9	449.1	11.0
1990	2,275	66.0	29.0	94.9	28.0	28.4	148.4	5.2
1991	1,807	67.9	37.6	210.6	44.7	42.6	282.9	6.6
				Second half of year				
1976	108	2.0	18.5	-	-	18.5	44.9	2.4
1977	439	11.8	26.9	-	-	26.9	110.0	4.1
1978	814	22.5	27.6	-	-	27.6	53.3	1.9
1979	1,670	53.2	31.9	-	-	31.9	147.7	4.6
1980	1,148	33.2	28.9	-	-	28.9	71.1	2.5
1981	402	7.9	19.6	-	-	19.6	44.9	2.3
1982	-	-	-	1.8	33.0	30.5	12.0	0.4
1983	67	2.4	35.8	12.3	37.4	37.0	23.7	0.6
1984	-	-	-	10.7	30.2	22.8	17.7	0.8
1985	-	-	-	16.4	38.8	34.9	16.8	0.5
1986	540	19.8	36.7	96.1	61.5	52.6	153.8	2.9
1987	1,555	68.2	43.9	5.5	33.9	42.7	76.9	1.8
1988	1,008	28.9	28.7	41.5	33.7	32.6	71.4	2.3
1989	647	12.3	19.0	44.9	32.8	29.8	57.2	1.9
1990	683	21.5	31.5	65.8	35.1	34.2	70.8	2.1
1991	957	31.3	32.7	96.0	47.5	40.2	92.8	2.3

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	6,124	3,380	1,595	18,293	-	14,385
1	26,236	5,768	9,855	1,283	56,661	4,038	10,527	-	41,984	825
2	10,855	198	25,922	340	2,219	274	1,478	-	2,203	82
3	350	-	1,319	119	3,385	-	231	-	727	-
4	107	-	26	17	-	-	-	-	144	-
5+	48	-	-	-	-	-	-	-	81	-

[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.
Data from Denmark and Norway.

Age	Half-year	
	1	2
0	-	-
1	5.5	5.2
2	12.3	17.4
3	19.0	25.2
4	22.8	-
5+	35.5	-

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, Northern North Sea
Some output from semi-annual separable VPA

weight for effort data = 1.0000

IFAIL on exit from E04FDF = 0
IFAIL on exit from E04YCF = 0
Initial sum of squares = 379.7021 RMS for catch data = .8671
Final sum of squares = 53.9438 RMS for effort data = .6212
Residual mean square = 1.3157

Coefficient of determination = .8579
Adj. Coeff. of determination = .7263

Number of observations = 80
Number of parameters = 39

Selectivities at age

age	1	2
0	.0001	.0169
1	.2970	.1581
2	.2893	.1005
3	.1056	.0994
4	.1056	.0994

Year/season effects

year	1	2
1983	.9688	.5879
1984	.6165	.2734
1985	.8947	.1813
1986	.9180	1.9028
1987	1.4888	.5796
1988	2.5675	.6594
1989	3.5347	.2723
1990	11.3795	.8154
1991	4.6002	.7369

Year/season effect residuals

year	1	2
1983	.0317	-.9728
1984	.5200	.0803
1985	.0735	.0214
1986	.9169	-.5719
1987	.5688	.1399
1988	.1557	.2561
1989	.1420	.9493
1990	-1.7764	-.0472
1991	-.6323	.1449

Estimated populations

	1983		1984		1985		1986	
	1	2	1	2	1	2	1	2
0	187249.	187046.	43144.	43099.	159265.	159094.	350977.	350599.
1	50843.	14028.	83212.	25491.	19276.	5437.	71266.	19962.
2	8446.	4278.	10466.	5869.	19987.	10342.	4325.	2223.
3	517.	313.	3301.	2073.	4675.	2851.	8315.	5058.
4	99.	60.	242.	152.	1652.	1008.	2293.	1395.

	1987		1988		1989		1990	
	1	2	1	2	1	2	1	2
0	109014.	108891.	2052179.	2049671.	2155174.	2152358.	190025.	189647.
1	152537.	36064.	48450.	8315.	910746.	117286.	962665.	12068.
2	12098.	5271.	26941.	8593.	6134.	1479.	91979.	2292.
3	1503.	861.	4072.	2081.	6584.	3038.	1178.	237.
4	3428.	1963.	665.	340.	1596.	736.	2421.	488.

	1991	
	1	2
0	1685333.	1682975.
1	84045.	7888.
2	8685.	1539.
3	1729.	713.
4	179.	74.

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	23.2	34.8	53.1	68.6	81.0	76.2	98.0
1988	19.2	26.8	42.9	52.3	60.0	56.6	82.8
1989	19.4	24.4	43.2	52.3	58.6	55.2	75.3
1990	20.0	20.8	30.4	33.7	39.4	35.7	49.5
1991	27.0	30.0	49.5	50.3	62.7	60.7	93.4
				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	14.9	23.4	39.7	47.9	52.6	43.1	65.2
1988	18.8	29.3	29.9	31.1	38.6	31.1	44.0
1989	26.7	26.2	27.0	38.0	37.7	29.3	40.4
1990	27.9	32.8	36.4	41.3	49.3	45.2	41.7
1991	21.8	26.9	42.2	50.0	65.1	53.7	98.3

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

Year	Half-year	CPUE (t/day)	Total international ('000 t)	Total Intl. fishing effort ('000 days)
				Half-year
1982	1	48.15	426.5	8.9
	2	35.74	52.6	1.5
1983	1	42.79	359.8	8.4
	2	33.86	59.3	1.8
1984	1	50.51	461.1	9.1
	2	32.93	71.1	2.2
1985	1	41.86	417.1	10.0
	2	33.59	110.6	3.3
1986	1	53.72	386.4	7.2
	2	44.05	75.5	1.7
1987	1	67.58	297.7	4.4
	2	44.71	105.1	2.4
1988	1	51.53	462.0	9.0
	2	36.14	33.4	0.9
1989	1	51.05	506.1	9.9
	2	32.95	18.5	0.6
1990	1	34.08	341.7	10.0
	2	43.10	24.0	0.6
1991	1	56.80	326.6	5.8
	2	54.15	132.3	2.4

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	-	44,288	1,619
2	35,029	2,806	2,257	92	39,301	3,229	7,333	293	22,771	6,664	10,074	234	4,509	165
3	934	513	13,272	577	2,490	2,234	1,604	241	1,158	196	17,914	2,084	954	35
4	234	2	267	44	233	163	30	9	141	45	1,920	63	3,338	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	
	1	2	1	2
0			-	12,115
1			20,058	11,411
2			9,224	344
3			1,320	111
4			454	-
5+			-	-

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 1991. Data from Denmark.

Age	Half-year	
	1	2
0	-	2.6
1	8.2	7.5
2	16.4	13.6
3	16.9	12.0
4	17.2	-
5+	-	-

Table 8.3.4.1. SANDEEL,. Southern North Sea
Some output from semi-annual separable VPA

weight for effort data = 1.0000

IFAIL on exit from E04FDF = 0

Initial sum of squares = 398.8143
Final sum of squares = 52.3917
Residual mean square = 1.0075

Coefficient of determination = .8686
Adj. Coeff. of determination = .7726

Number of observations = 91 RMS for catch data = .8019
Number of parameters = 39 RMS for effort data = .5358

IFAIL on exit from E04YCF = 0

Selectivities at age

age	1	2
0	.0007	.0063
1	.1181	.1503
2	1.0856	.5263
3	.6374	.7366
4	.6374	.7366

Year/season effects

year	1	2
1983	.8369	.3242
1984	.7367	.2070
1985	2.0754	1.2699
1986	.6326	.1694
1987	.3910	.2326
1988	1.0075	.1308
1989	.5151	.0244
1990	3.1765	.0698
1991	1.1519	.2660

Year/season effect residuals

year	1	2
1983	.1781	-.4141
1984	.3856	.2353
1985	-.5558	-1.1732
1986	.3038	.1779
1987	.2924	.2058
1988	.0615	-.1995
1989	.8276	1.0730
1990	-.9814	.0231
1991	-.5118	.0716

Estimated populations

	1983		1984		1985		1986	
	1	2	1	2	1	2	1	2
0	1338494.	1336361.	158556.	158315.	1612675.	1608687.	221377.	221057.
1	40537.	13509.	599244.	202073.	71043.	20452.	717088.	244805.
2	35133.	9494.	10534.	3174.	160376.	11296.	13835.	4667.
3	3745.	1472.	6553.	2747.	2330.	416.	4740.	2123.
4	133.	52.	949.	398.	1931.	345.	134.	60.

	1987		1988		1989		1990	
	1	2	1	2	1	2	1	2
0	197839.	197586.	1875980.	1872763.	67085.	66994.	390106.	388837.
1	99221.	34854.	88652.	28953.	840796.	291048.	30098.	7608.
2	195392.	85675.	27556.	6187.	23243.	8907.	237417.	5060.
3	3495.	1826.	62063.	21888.	4729.	2282.	7199.	637.
4	1534.	802.	1260.	444.	16274.	7856.	1835.	162.

	1991	
	1	2
0	**********	
1	174639.	56072.
2	6164.	1183.
3	3994.	1285.
4	495.	159.

Table 8.4.1.1 Standardised effort (days absent) by half-year in the Shetland sandeel fishery (1982-1991).
UK (Scotland) data.

Year	I	II	Total
1982	934	866	1800
1983	768	642	1410
1984	852	539	1391
1985	358	302	660
1986[1]	404	157	561
1987	180	98	278
1988	200	72	272
1989	168	-	168
1990	102	-	102
1991	-	-	0

[1]1986 figures incorporate an estimate of Danish effort.

Table 8.4.2.1 Sandeels, Shetland
Survey CPUE (Nos. at age per 30 min haul), 1984-1991.

	Age							
Year	0	1	2	3	4	5	6	7
1984	345774	47590	34613	9921	3999	1369	856	258
1985	121905	74509	38843	23455	10872	1959	962	119
1986	681869	49816	11399	15376	7049	2893	1210	191
1987[1]	-	-	-	-	-	-	-	-
1988	73371	898	7189	4843	4612	3031	1619	20
1989	813752	9059	977	3820	3893	2017	462	86
1990	90148	30118	3771	1346	1736	1142	444	329
1991	1009024	10001	1925	1694	750	53	21	5

[1]No survey during 1987.

Table 8.4.3.1 SANDEEL, Shetland.
Long-Term Mean weight (g)
at age in the catch, 1974-1990.

Age	I	II
0	0.746	1.618
1	3.095	5.053
2	5.409	7.870
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 8.4.4.1 SANDEEL, Shetland. Diagnostics from semi-annual separable VPA.

```
weight for effort data =  1.0          Number of observations = 157
weight for RV data = 0.10              Number of parameters   =  46
RV catchability constant above age 3

                                       IFAIL on exit from E04FDF =  0
Initial SSQ =  535.4649                IFAIL on exit from E04YCF =  0
Final SSQ   =   24.5534
Resid. mean square  =  .2212           RMS for catch data  =     .4835
                                       RMS for effort data =     .3385
Coeff. of determination = .9541        RMS for RV data     =     .1118
Adj. Coeff.   "      "  = .9356
```

Selectivities at age			RV catchabilities	Year/season effects			Year/season effect resids	
age	1	2	(log Q)	year	1	2	1	2
0	.0463	.9009	-3.6260	1984	.8149	.5350	.2046	.1677
1	.3013	.2743	-4.0223	1985	.3109	.5518	.3012	-.4425
2	.3725	.1387	-4.6251	1986	.7029	.2090	-.3937	-.1258
3	.7085	.1713	-4.1122	1987	.1747	.1676	.1898	-.3763
4	.8879	.2077	-3.8673	1988	.2564	.0389	-.0881	.7770
5	.9641	.5000	-3.8673	1989	.1669	.0000	.1669	.0000
6	1.0289	.3140	-3.8673	1990	.1752	.0000	-.3808	.0000
7	.8879	.2077	-3.8673	1991	.0000	.0000	.0000	.0000

Log catch residuals

	1984		1985		1986		1987	
	1	2	1	2	1	2	1	2
0	.6442	-.3932	-.5422	-.9030	.1707	-.7184	.0379	.6054
1	-.1061	-.0798	.9486	-.2161	-.1491	.2355	1.1514	-.0828
2	.3627	.3449	.1526	.2809	.0637	.0812	-.1095	.0736
3	.0629	-.0588	-.2338	.3892	-.3012	.3179	-.6670	-.0725
4	-.2018	-.1579	-.2696	.1082	-.3491	.4405	-.3044	.0377
5	-.4226	.0900	-.1307	.1158	.0480	-.3090	-.1460	.1620
6	.0315	-.1389	.0868	.5693	.1501	.6546	-.1321	.1380
7	-.2703	.1717	-.1658	.5304	.2301	-.5238	-.2017	-.6041

	1988		1989		1990		1991	
	1	2	1	2	1	2	1	2
0	.1759	1.7120	-.4835	.0000	-.0134	.0000	.0000	.0000
1	-.3110	.0568	-1.8143	.0000	.4752	.0000	.0000	.0000
2	-.1430	-.8283	-.5298	.0000	-.0692	.0000	.0000	.0000
3	.3084	-.6513	.6306	.0000	.1623	.0000	.0000	.0000
4	-.1607	-.2599	1.1766	.0000	-.1075	.0000	.0000	.0000
5	-.3181	.1090	.6471	.0000	.6062	.0000	.0000	.0000
6	.2362	-1.2464	.2598	.0000	-.6139	.0000	.0000	.0000
7	.2123	.2953	.0352	.0000	-.0749	.0000	.0000	.0000

Log RV residuals

	1984	1985	1986	1987	1988	1989	1990	1991
	2	2	2	2	2	2	2	2
0	-.0708	-.1329	.0117	.0000	-.0242	.1493	.0669	.0000
1	-.0460	.0532	.0626	.0000	-.1716	-.0094	.0445	.0667
2	.0793	.0816	.0241	.0000	-.0638	-.0419	.0312	-.1104
3	.0230	.0732	.0508	.0000	-.0064	-.1080	.0085	-.0411
4	.0419	.1049	.0585	.0000	.0233	.0218	-.1374	-.0110
5	.0553	.0711	.1117	.0000	.0333	.0148	-.0279	-.4300
6	.1603	.1363	.1859	.0000	.0895	-.0751	-.0586	-.3686
7	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

Table 8.4.4.2 SANDEEL, Shetland. Fitted Fs from separable VPA.

	1984 1	1984 2	1985 1	1985 2	1986 1	1986 2	1987 1	1987 2
0	.038	.482	.014	.497	.033	.188	.008	.151
1	.246	.147	.094	.151	.212	.057	.053	.046
2	.304	.074	.116	.077	.262	.029	.065	.023
3	.577	.092	.22	.094	.498	.036	.124	.029
4	.724	.111	.276	.115	.624	.043	.155	.035
5	.786	.267	.3	.276	.678	.104	.168	.084
6	.838	.168	.32	.173	.723	.066	.18	.053
7	.724	.111	.276	.115	.624	.043	.155	.035
F(1-3)	.376	.104	.143	.107	.324	.041	.081	.033

	1988 1	1988 2	1989 1	1989 2	1990 1	1990 2	1991 1	1991 2
0	.012	.035	.008	0	.008	0	0	0
1	.077	.011	.05	0	.053	0	0	0
2	.095	.005	.062	0	.065	0	0	0
3	.182	.007	.118	0	.124	0	0	0
4	.228	.008	.148	0	.156	0	0	0
5	.247	.019	.161	0	.169	0	0	0
6	.264	.012	.172	0	.18	0	0	0
7	.228	.008	.148	0	.156	0	0	0
F(1-3)	.118	.008	.077	0	.081	0	0	0

Table 8.4.4.3 SANDEEL, Shetland. Fitted populations (millions) and biomass totals (tonnes) from separable VPA.

	1984 1	1984 2	1985 1	1985 2	1986 1	1986 2	1987 1	1987 2
0	0	26364	0	18061	0	22776	0	2241
1	14596	4201	7316	2451	4937	1469	8478	2959
2	3397	1681	2970	1773	1725	890	1136	714
3	1277	480	1278	687	1345	548	708	419
4	377	123	359	183	512	184	433	248
5	126	38	90	45	133	45	144	82
6	28	8	24	12	28	9	33	19
7	27	9	12	6	12	4	10	6
SPN	5232		4733		3755		2464	
SSB	36276		32900		29097		19749	
TSB	81451		55543		44377		45988	

	1988 1	1988 2	1989 1	1989 2	1990 1	1990 2	1991 1	1991 2
0	0	3635	0	6867	0	1734	0	37898
1	866	295	1577	552	3086	1077	779	287
2	2314	1410	239	150	452	284	882	591
3	571	319	1148	684	123	73	232	156
4	333	178	259	150	560	321	60	40
5	196	103	145	83	123	70	263	176
6	61	32	83	47	68	38	57	38
7	19	10	34	20	54	31	56	38
SPN	3494		1908		1380		1550	
SSB	25171		18039		13635		13115	
TSB	27851		22920		23187		15526	

Table 9.1 Sandeel. Division VIa.
Landings in tonnes, 1984-1991, as officially reported to ICES.

Country	1984	1985	1986	1987	1988	1989	1990	1991[1]
UK (Scotland)	14,166	18,586	24,469	14,479	24,465	18,785	14,360	7,777

[1]Preliminary.

Table 9.2.1 Fishing effort (days absent) by month and year in the Division VIa SANDEEL fishery, 1981-1991, UK (Scotland).

Month	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
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
Total	8	343	245	258	262	228	104	252	162	167	59
Jul	90	118	126	125	101	126	93	108	110	75	31
Aug	132	89	76	63	76	94	67	59	22	5	18
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
Annual Total	303	588	447	446	475	530	290	455	297	247	108

Table 9.2.2 Standardized effort (days absent) by half year in the Division VIa sandeel fishery (1982-1991). 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

[1]Provisional (see Sect. 9.2).

Table 9.3.1 Sandeels. Division VIa. Numbers caught (millions), 1991, UK (Scotland) data.

Month	Age Group								Total
	0	1	2	3	4	5	6	7+	
Apr	-	-	-	-	-	-	-	-	-
May	68	42	13	+	+	1	+	-	125
Jun	497	312	126	9	14	24	9	1	992
Jul	69	38	49	29	16	27	9	-	237
Aug	25	13	17	11	6	10	3	-	86
Sep	-	-	-	-	-	-	-	-	-
Oct	-	-	-	-	-	-	-	-	-
Total	658	406	205	49	37	62	21	1	1,439

Table 9.3.2

SANDEEL: VIa: CATCH AT AGE IN NUMBERS (+ REPRESENTS < HALF A UNIT)
UNITS = MILLIONS:

	1983		1984		1985	
	1	2	1	2	1	2
0	391	2253	186	1751	53	3207
1	521	106	863	99	139	13
2	136	29	226	67	437	163
3	86	21	138	115	181	117
4	111	18	67	38	139	73
5	29	3	28	26	55	28
6	12	3	8	8	27	12
7+	2	1	1	3	7	1

	1986		1987		1988		1989		1990		1991	
	1	2	1	2	1	2	1	2	1	2	1	2
0	368	2702	105	595	795	173	170	275	20	392	564	94
1	859	996	521	676	187	72	205	20	508	121	355	52
2	140	68	97	232	1216	548	128	60	200	5	138	66
3	171	219	17	37	235	131	535	278	105	11	9	39
4	58	103	45	31	41	28	127	71	284	51	15	23
5	38	40	23	20	52	45	22	22	66	19	26	37
6	9	12	4	7	21	24	18	11	16	1	10	12
7+	6	6	1	4	3	8	6	8	2	1	1	0

Table 9.4.1 SANDEELS, Division VIa.
Mean weight (g) at age in the catch by month, 1991. UK (Scotland) data.

Age	Apr	May	Jun	Jul	Aug	Sep
0	-	-	1.3	2.0	-	-
1	-	-	5.7	5.6	-	-
2	-	-	9.8	9.9	-	-
3	-	-	16.5	14.3	-	-
4	-	-	19.4	18.8	-	-
5	-	-	21.5	19.1	-	-
6	-	-	20.7	21.2	-	-
7	-	-	17.7	-	-	-
8	-	-	-	-	-	-

Table 9.4.2 SANDEELS, Division VIa, long-term mean weight (g) at age in catch, 1980-1991.

Age	I	II
0	1.324	1.598
1	4.150	5.796
2	7.767	9.180
3	11.183	12.725
4	13.446	15.298
5	16.667	17.470
6	17.592	19.528
7+	21.877	22.051

Table 9.5.2 SANDEEL, Division VIa
Diagnostics from semi-annual Separable VPA.

weight for effort data = 1.00
Number of observations = 161
Number of parameters = 48

Initial SSQ = 473.0754
Final SSQ = 53.3867
Resid. mean square = .4724
IFAIL on exit from E04FDF = 0
IFAIL on exit from E04YCF = 0

Coeff. of determination = .8871
Adj. Coeff. " " = .8402
RMS for catch data = .6042
RMS for effort data = .2491

Selectivities at age

age	1	2
0	.0038	.0311
1	.0424	.0304
2	.0973	.0599
3	.1006	.1349
4	.1303	.1957
5	.2024	.2603
6	.2410	.3107
7	.1303	.1957

Year/season effects

year	1	2
1983	1.1564	.4669
1984	.9480	.9422
1985	1.1358	.8508
1986	.9736	1.5942
1987	.3993	.8184
1988	1.3158	1.0573
1989	1.0355	.7608
1990	.8849	.2641
1991	.3676	.3045

Year/season effect residuals

1	2
-.1453	.5062
.0784	-.2082
-.0078	.0615
.0943	-.2554
.1958	-.0509
.0132	-.0153
-.1455	.0660
.0735	.5277
-.1566	-.6317

Log catch residuals

	1983		1984		1985		1986	
	1	2	1	2	1	2	1	2
0	.1961	1.3084	.6368	1.3447	-1.9873	.8632	-.5632	-.5950
1	-.1719	.3107	.3891	-.6007	-.6147	-1.5227	.1674	1.0006
2	-.6485	-.4295	-.1809	-.5305	.1734	.3434	.1864	-.1491
3	-.1431	-.5481	.2636	.2042	.1417	.1154	.1113	.0242
4	.3658	-.5303	.3304	-.1858	.6790	.3734	-.2654	-.0798
5	.3035	-.8275	-.3925	-.1956	.4686	.3569	.0327	-.0656
6	.2469	.0312	-.0074	.3026	.2902	.0838	-.3086	-.1173
7	-.0529	.1770	-.8403	.3092	.9314	-.6760	.3869	-.0018

	1987		1988		1989		1990	
	1	2	1	2	1	2	1	2
0	.6749	.1490	1.8870	-.9577	-.4365	-1.1898	-1.9826	.6532
1	-.0970	.6003	-.7214	-.2775	-.0059	-.8559	.0258	.9591
2	-.4903	.4926	.1948	.4989	-.2077	.2025	.7573	-.8847
3	-.2998	-.1599	-.0997	-.3216	.3600	.1237	.4587	-.5176
4	.3009	-.7938	-.0581	-.1400	.1426	-.0962	.4377	-.0916
5	.2775	-.3892	-.2764	.1166	.1141	.6752	.1088	.2491
6	-.3369	-.2795	-.1784	.5423	-.1385	-.0330	.7874	-.5772
7	-.2560	.4083	-.5786	.7017	.2307	.8611	-.9131	-.4185

	1991	
	1	2
0	1.5765	-1.5765
1	.9576	.3718
2	.1893	.4521
3	-.8201	.8800
4	-.1615	.4006
5	-.7674	-.1012
6	-.2686	.2394
7	-.5209	.0000

Table 9.5.3 SANDEELS, Division VIa, fitted Fs-at-age.

	1983 1	1983 2	1984 1	1984 2	1985 1	1985 2	1986 1	1986 2
0	.004	.015	.004	.029	.004	.026	.004	.050
1	.049	.014	.040	.029	.048	.026	.041	.048
2	.113	.028	.092	.056	.111	.051	.095	.096
3	.116	.063	.095	.127	.114	.115	.098	.215
4	.151	.091	.124	.184	.148	.167	.127	.312
5	.234	.122	.192	.245	.23	.221	.197	.415
6	.279	.145	.229	.293	.274	.264	.235	.495
7	.151	.091	.124	.184	.148	.167	.127	.312
F(1-3)	.093	.035	.076	.071	.091	.064	.078	.120

	1987 1	1987 2	1988 1	1988 2	1989 1	1989 2	1990 1	1990 2
0	.002	.025	.005	.033	.004	.024	.003	.008
1	.017	.025	.056	.032	.044	.023	.038	.008
2	.039	.049	.128	.063	.101	.046	.086	.016
3	.040	.110	.132	.143	.104	.103	.089	.036
4	.052	.160	.171	.207	.135	.149	.115	.052
5	.081	.213	.266	.275	.210	.198	.179	.069
6	.096	.254	.317	.328	.250	.236	.213	.082
7	.052	.160	.171	.207	.135	.149	.115	.052
F(1-3)	.032	.061	.105	.079	.083	.057	.071	.020

	1991 1	1991 2
0	.001	.009
1	.016	.009
2	.036	.018
3	.037	.041
4	.048	.060
5	.074	.079
6	.089	.095
7	.048	.060
F(1-3)	.030	.023

Table 9.5.4 SANDEELS, Division VIa, fitted populations and biomass totals

	1983 1	1983 2	1984 1	1984 2	1985 1	1985 2	1986 1	1986 2
0	0	72451	0	27067	0	88751	0	173123
1	18726	8012	21507	9283	7917	3390	26034	11225
2	2821	1868	3549	2398	4054	2689	1484	1000
3	1043	688	1345	906	1679	1109	1893	1271
4	635	405	478	313	591	378	733	478
5	118	69	274	167	193	114	237	144
6	44	25	45	27	97	55	67	39
7	17	11	23	15	23	15	39	26
SSB	45225		54895		63637		48534	
TSB	122938		144149		96492		156575	

	1987 1	1987 2	1988 1	1988 2	1989 1	1989 2	1990 1	1990 2
0	0	34953	0	23861	0	66239	0	42807
1	49622	21922	10263	4361	6954	2991	19485	8433
2	4805	3424	9609	6263	1898	1271	1313	892
3	674	479	2415	1567	4355	2907	900	610
4	760	534	318	198	1007	652	1943	1283
5	259	177	337	191	120	72	416	258
6	70	47	106	57	108	62	44	26
7	29	21	39	24	44	28	53	35
SSB	61259		114251		81846		55255	
TSB	267191		156842		110706		136118	

	1991 1	1991 2	1992 1
0	0	82803	0
1	12788	5657	67186
2	3759	2687	4549
3	651	465	2112
4	436	308	359
5	903	621	233
6	178	121	462
7	42	29	93
SSB	61439		77823
TSB	114509		356645

Table 10.1 Landings of SPRAT in Division IIIa (tonnes 10^{-3}). (Data provided by Working Group members).

Year	Skagerrak				Kattegat			Div. IIIa total
	Denmark	Sweden	Norway	Total	Denmark	Sweden	Total	
1974	17.9	2.0	1.2	21.1	31.6	18.6	50.2	71.3
1975	15.0	2.1	1.9	19.0	60.7	20.9	81.6	100.6
1976	12.8	2.6	2.0	17.4	27.9	13.5	41.4	58.8
1977	7.1	2.2	1.2	10.5	47.1	9.8	56.9	67.4
1978	26.6	2.2	2.7	31.5	37.0	9.4	46.4	77.9
1979	33.5	8.1	1.8	43.4	45.8	6.4	52.2	95.6
1980	31.7	4.0	3.4	39.1	35.8	9.0	44.8	83.9
1981	26.4	6.3	4.6	37.3	23.0	16.0	39.0	76.3

Year	Skagerrak		Kattegat		Division IIIa Total
	Denmark	Norway	Denmark	Sweden	
1982	10.5	1.9	21.4	5.9	39.7
1983	3.4	1.9	9.1	13.0	26.4
1984	13.2	1.8	10.9	10.2	36.1
1985	1.3	2.5	4.6	11.3	19.7
1986	0.4	1.1	0.9	8.4	10.8
1987	1.4	0.4	1.4	11.2	14.4
1988	1.7	0.3	1.3	5.4	8.7
1989	0.9	1.1	3.0	4.8	9.8
1990	1.3	1.3	1.1	6.0	9.7
1991[1]	4.2	0.8	2.2	6.6	13.8

[1]Preliminary.

Table 10.2 Indices of Sprat, 1-group, ≥2-group, and all ages in Division IIIa from IYFS, 1974-1992.

Year	1-group	≥2-group	Total
1974	1,325	-	-
1975	5,339	-	-
1976	2,069	-	-
1977	5,713	984	6,697
1978	5,119	2,117	7,236
1979	3,338	1.482	4,820
1980	4,960	3,592	8,558
1981	2,809	3,068	5,877
1982	1,577	4,965	6,272
1983	1,173	1,685	2,858
1984	4,141	2,216	6,357
1985	2,077	2,667	4,744
1986	684	4,834	5,518
1987	1,830	16,543	18,373
1988	945	8,238	9,183
1989	442	2,891	3,333
1990	503	471	974
1991	693	1,245	1,938
1992	5,380	1,698	7,078

Table 10.3 SPRAT in Division IIIa. Spreadsheet for SHOT prediction.

running recruitment weights

older	0.00		G-M =	0.00
central	1.00		exp(d)	1.00
younger	0.00	ex	exp(d/	1.00

Year	Land -ings	Recrt Index	W'td Index	Y/B Ratio	Hang -over	Act'l Prodn	Est'd Prodn	Est'd SQC.	Act'l Expl Biom	Est'd Expl Biom	Est'd Land -ings
1982	397	1577		0.77	0.23				516		
1983	264	1173	1173	0.77	0.23	224			343		
1984	361	4141	4141	0.77	0.23	390			469		
1985	197	2077	2077	0.60	0.40	221			328		
1986	108	684	684	0.60	0.40	49	77	125	180	209	125
1987	144	1830	1830	0.60	0.40	168	200	163	240	272	163
1988	87	945	945	0.60	0.40	49	100	118	145	196	118
1989	98	442	442	0.60	0.40	105	45	62	163	103	62
1990	97	503	503	0.60	0.40	96	54	71	162	119	71
1991	138	693	693	0.60	0.40	165	77	85	230	141	85
1992		5380	5380	0.60	0.40		632	435		724	435

Table 11.1.1 Sprat catches in the North Sea ('000 t), 1981-1991.
Catches in fjords of western Norway excluded.
(Data provided by Working Group members except where indicated.)

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991[1]
Division IVa West											
Denmark	2.8	-	-	-	0.9	0.6	0.2	0.1	+	-	
Germany	-	-	-	-	-	-	-	-	-	-	
Netherlands	-	-	-	-	6.7	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	0.1
UK (Scotland)	1.0	+	-	+	6.1	+	+	-	-	+	-
Total	3.8	+	-	+	13.7	0.6	0.2	0.1	+	+	0.1
Division IVa East (North Sea) stock											
Denmark	-	+	-	-	+	0.2	+	+	+	-	-
Norway	-	0.3	-	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	+[5]	2.5
Total	-	0.3	-	-	+	0.2	+	+	+	+	2.5
Division IVb West											
Denmark	53.6	23.1	32.6	5.6	1.8	0.4	3.4	1.4	2.0	10.0	9.4
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-
Norway	0.2	10.2	0.9	0.5	-	-	-	3.5	0.1	1.2	4.4
UK (England)	-	-	-	+	-	-	-	-	-	-	-
UK (Scotland)	0.7	0.2	+	+	-	-	0.1	-	-	-	-
Total	54.5	33.5	33.5	6.1	1.8	0.4	3.5	4.9	2.1	11.2	13.8
Division IVb East											
Denmark	127.5	91.2	39.2	62.1	36.6	10.3	28.0	80.7	59.2	59.2	67.0
Germany	4.8	1.5	-	0.6	0.6	0.6[3]	-	-	-	-	-
Norway	0.2	7.6	10.8	3.1	-	-	-	0.6	-	0.6	25.1
Sweden	-	-	-	-	-	-	-	-	-	+[2]	+[2]
Total	132.5	100.3	50.0	65.8	37.2	10.9	28.0	81.3	59.2	59.8	92.1
Division IVc											
Belgium	-	-	-	-	+	+	+	-	+[2]	+[2]	+[2]
Denmark	4.3	2.4	1.0	0.5	+	0.1	+	0.1	0.5	1.5	1.7
France	-	-	-	-	-	+	-	-	+[2]	-	+[2]
Netherlands	-	-	-	0.1	-	-	-	0.4	0.4[2,3]	-	+[2,3]
Norway	-	2.2	0.5	3.4	-	-	-	-	-	-	-
UK (England)	14.0	14.9	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8
Total	18.3	20.1	5.1	4.9	3.4	4.3	0.7	1.1	1.8	1.7	3.5
Total North Sea											
Belgium	-	-	-	-	+	+	+	-	+	+[2]	+[2]
Denmark	188.2	116.6	72.6	68.1	39.5	11.7	31.7	82.3	61.9	69.2	78.1
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	+	-	-	+	-	+[2,3]
Germany	4.8	1.5	-	0.6	-	0.6	-	-	-	-	-
Netherlands	-	-	-	0.1	0.6	-	0.5	0.4	0.4	-	+[2,3]
Norway	0.4	20.6	12.0	7.0	6.1	-	-	4.1	0.1	1.8	29.6
Sweden	-	-	-	-	-	-	-	-	-	+[2]	+[2]
UK (England)	14.0	14.9	3.6	0.9	3.4	4.1	0.7	0.6	0.9	0.2	1.8
UK (Scotland)	1.7	0.2	+	+	-	+	0.2	-	-	+	-
Total	209.1	153.8	88.4	76.7	49.6	16.4	33.1	87.4	63.3	71.2	109.5

[1]Preliminary. [2]Official statistics. [3]Includes Divisions IVa-e. [5]Includes Division IVb East.
+ = less than 0.1. - = magnitude known to be nil.

Table 11.1.2 Sprat catches ('000 t) in the fjords of western Norway, 1982-1991.

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
6.1	3.2	4.4	7.1	2.2	8.3	-[1]	2.4	2.7	3.2

[1]Not available.

Table 11.1.3 Sprat catches (t) in the North Sea by quarter in 1985 (Denmark, Norway and the UK), 1986, 1987, 1988 (Denmark and the UK), 1989 (Denmark, Norway and the UK), 1990 (Denmark and Norway), and 1991 (Denmark, Norway and UK). Catches in fjords of western Norway excluded.

Year	Quarter	Area					Total
		IVa West	IVa East (North Sea stock)	IVb West	IVb East	IVc	
1985	1	1	-	97	6,533	1,370	8,001
	2	-	-	149	659	-	808
	3	44	15	176	4,535	5	4,775
	4	7,550	9	1,407	24,913	1,547	35,426
Total		7,595	24	1,829	36,640	2,922	49,010
1986	1	282	123	104	2,899	4,134	7,542
	2	5	39	206	5,048	22	5,320
	3	3	10	6	389	9	417
	4	373	63	80	2,005	51	2,571
Total		663	235	396	10,341	4,216	15,851
1987	1	70	10	148	17	564	809
	2	-	7	118	3,297	57	3,479
	3	-	6	65	6,999	46	7,116
	4	98	-	3,191	16,456	17	19,762
Total		168	23	3,522	26,769	684	31,166
1988	1	-	-	5	206	529	740
	2	-	-	229	682	28	939
	3	-	11	4,682	72,317	73	77,083
	4	55	-	651	7,529	31	8,266
Total		55	11	5,567	80,734	621	87,028
1989	1	-	39	1,127	14,702	1,231	17,099
	2	-	-	241	242	14	497
	3	31	-	784	43,190	110	44,115
	4	10	-	2	1,092	101	1,205
Total		41	39	2,154	59,226	1,456	62,916
1990	1	-	-	222	4,896	-	5,118
	2	-	-	426	320	39	785
	3	-	-	6,759	31,054	10	37,823
	4	-	-	3,812	23,565	1,420	28,797
Total		-	-	11,219	59,835	1,469	72,523
1991	1	-	-	31	899	1,117	2,047
	2	-	-	55	87	1	143
	3	144	-	9,038	58,312	-	67,494
	4	-	-	4,821	33,389	-	38,210
Total		144	-	13,945	92,687	1,118	107,894

Table 11.2 North Sea Sprat. Catch in numbers (millions) taken by quarter in 1987 to 1991 by Denmark, Norway, and UK (England).

Country	Fishing area	Quarter	Age					
			0	1	2	3	4	5
1987								
Denmark	North Sea	3	-	555.11	85.23	1.00	-	-
	(Sub-area IV)	4	28.79	1,546.19	319.81	8.44	-	-
UK (Engl.)	Thames (Div. IVc)	1	-	1.01	37.18	12.14	0.76	-
1988								
Denmark	North Sea	1		0.24	23.04	1.19	-	-
	(Sub-area IV)	2	-	1.05	101.47	5.23	-	-
		3	-	471.43	4,615.42	9.68	-	-
		4	-	37.63	461.13	2.36	-	-
UK (Engl.)	Thames (Div.IVc)	1	-	7.53	34.24	6.89	1.66	0.14
Norway	North Sea	3	-	0.4	125.6	48.7	3.9	-
	(Division IVb)	4	0.7	11.0	13.2	6.2	-	-
1989								
Denmark	North Sea	1	-	551.35	864.77	21.57	-	-
	(Sub-area IV)	2	-	12.00	18.81	0.47	-	-
		3	60.04	2,026.65	2,120.30	273.77	-	-
		4	1.52	51.31	53.69	6.93	-	-
UK (Engl.)	(Thames + Wash)	1	-	11.1	32.40	31.42	1.01	-
	(Division IVc)	4	0.08	5.84	0.80	0.50	-	-
Norway	(Division IVb)	2	-	0.11	0.60	4.70	0.05	-
1990								
Denmark	(Division IVb)	1	-	537.96	225.91	28.26	2.05	0.13
		2			No samples			
		3	-	877.98	1,164.78	-	-	-
		4			No samples			
	(Division IVc)	2-4			No samples			
Norway	(Division IVb)	2-3			No samples			
1991								
Denmark	(Division IVb)	1	-	34.39	1.98	0.22	0.04	0.04
		2	-	0.51	3.36	0.93	0.05	-
		3	9.71	664.81	1086.27	328.04	79.07	-
		4	296.05	1896.74	271.93	34.60	4.58	-
Norway	(Division IV)	3			No samples			
UK (Engl.)	Thames	1	-	12.56	49.26	17.75	0.97	0.60
	(Division IVc)	4	-	44.29	9.43	1.59	-	-

Table 11.3 North Sea sprat mean weight at age (g) 1991 (Danish data).

Age	Quarter			
	1	2	3	4
0	-	-	4.0	4.0
1	4.2	-	13.0	14.2
2	12.6	-	15.8	18.8
3	15.0	-	18.7	19.7

Table 11.4 North Sea SPRAT. IYFS research vessel indices (no./hr).

Year	North Sea all ages	Division IVb 1-group	Division IVb E 1-group
1970	-	-	-
1971	-	-	-
1972	873	90	-
1973	713	123	-
1974	2,631	481	-
1975	-	-	-
1976	2,127	1,186	-
1977	3,031	136	-
1978	2,208	1,474	-
1979	569[1]	248[1]	-
1980	3,770	1,402	1,916
1981	2,107	886	1,146
1982	602	183	512
1983	852	512	944
1984	-[2]	347	638
1985	638	659	1,187
1986	170	73	103
1987	1,248	807	1,446
1988	1,097	145	269
1989	5,020	4,246	7,532
1990	905	177	267
1991	1,268	1,121	1,960
1992	-[2]	1,639[3]	2,218[3]

[1]Low figures due to abnormal conditions on the survey.
[2]Not yet available.
[3]Preliminary.

Table 12.1 Sprat in Division VIa, 1982-1991. Landings in tonnes as officially reported to ICES.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991[1]
Denmark	-	-	-	-	-	269[2]	364	-	-	-
Germany	-	-	-	-	-	-	-	-	-	-
Ireland	287	-	192	51	348	-	150	147	-	-
Netherlands	2,156	1,863	-	-	-	-	-	-	-	-
Norway	24	-	-	557	-	-	-	-	-	-
UK (Engl.& Wales)	-	-	-	-	2	-	-	-	+	-
UK (Scotland)[3]	1,057	1,971	2,456	2,946	520	582	3,844	1,146	813	1,459
Total	3,524	3,834	2,648	3,554	870	851	4,378	1,298	813	1,459

[1]Preliminary.
[2]Includes Division VIb.
[3]Amended from national data.

Table 12.2 Catch in numbers (millions) at age and mean weight at age (g) in the catch for Sprat in Division VIa. [(Data from UK (Scotland).]

Age	Quarter	0		1		2		3		4		5		Total catch	
		Catch	w	Catch	w	Catch	w	Catch	w	Catch	w	Catch	w	No.	Tonnes
							1989								
W. Scotland	4	-	-	5.47	9.3	3.51	14.4	8.24	14.2	-	-	-	-	17.22	253
Clyde	4	0.29	3.3	17.49	12.2	11.65	18.9	15.52	19.5	0.91	23.1	-	-	45.86	878
							1990								
W. Scotland	4	0.53	9.1	14.58	12.4	0.71	13.0	0.04	14.3	+	15.3	-	-	15.86	224
Clyde	1	-	-	0.24	4.2	2.02	11.8	1.59	18.5	2.86	19.6	-	-	6.71	121
Clyde	4	2.70	3.9	20.93	14.3	0.86	22.3	1.36	24.4	1.08	22.2	-	-	26.93	467
							1991								
W. Scotland	1	-	-	0.01	3.5	0.80	11.4	0.06	18.3	-	-	-	-	0.87	13
	4	0.43	5.6	52.34	13.4	7.08	17.2	1.05	17.3	0.25	18.8	-	-	61.15	917
Clyd	1	-	-	-	-	6.15	15.4	1.31	20.4	1.59	26.1	0.30	27.9	9.35	170
	4	1.07	4.9	29.34	11.9	0.49	16.1	0.02	27.2	0.15	22.4	-	-	31.07	609

Table 13.1.1 Nominal catch of sprat in Divisions VIId,e, 1982-1991.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991[1]
Belgium	-	3	-	-	-	-	-	-	-	-
Denmark	286	638	1,417	-	15	250	2,529	2,092	608	-
France	44	60	47	14	-	23	2	10	-	-
Germany	-	-	-	-	-	-	-	-	-	-
Netherlands	1,533	1,454	589	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
UK (Engl. & Wales)	4,749	4,756	2,402	3,771	1,163	2,441	2,944	1,319	1,508	2,567
Total	6,612	6,011	4,455	33,785	1,178	2,714	5,475	3,421	2,116	2,567

[1]Preliminary.

Table 13.1.2 Lyme Bay area fishery, 1961-1992. Monthly catches (t) (UK vessels only).

Season	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
1961-1962	-	-	-	1	27	4	427	428	35	922
1962-1963	-	-	-	309	238	131	148	187	58	1,071
1963-1964	-	-	-	263	53	82	385	276	24	1,083
1964-1965	-	-	-	25	56	20	242	465	8	816
1965-1966	-	-	-	47	81	165	610	302	17	1,222
1966-1967	-	-	-	3	152	368	703	355	1	1,583
1967-1968	-	-	18	76	238	422	560	43	3	1,360
1968-1969	11	-	4	122	142	298	373	123	1	1,074
1969-1970	-	-	-	140	131	276	915	283	76	1,821
1970-1971	-	7	38	90	184	549	553	106	20	1,547
1971-1972	-	-	369	101	232	228	410	70	-	1,410
1972-1973	-	-	107	209	132	87	404	165	49	1,153
1973-1974	-	-	313	186	194	350	311	96	40	1,490
1974-1975	184	451	209	533	838	405	157	30	-	2,807
1975-1976	-	-	66	649	289	111	204	6	-	1,325
1976-1977	289	440	1,039	123	594	347	234	103	5	3,174
1977-1978	31	680	768	725	115	84	201	54	-	2,658
1978-1979	-	252	368	545	450	209	58	37	28	1,947
1979-1980	-	-	90	674	706	337	150	38	2	1,997
1980-1981	-	-	458	815	1,423	1,872	2,069	138	54	6,829
1981-1982	-	-	11	475	1,854	4,311	855	265	100	7,871
1982-1983	-	-	54	844	1,017	641	522	90	31	3,199
1983-1984	-	-	82	477	1,076	1,772	157	101	55	4,350
1984-1985	-	-	331	834	643	252	225	94	19	2,398
1985-1986	-	104	463	1,401	769	132	52	1	-	2,933
1986-1987	-	9	138	312	192	393	313	145	18	1,520
1987-1988	-	-	471	675	636	163	322	129	58	2,454
1988-1989	-	2	1,179	413	491	306	285	53	-	2,729
1989-1990	-	80	424	340	77	48	128	131	-	1,228
1990-1991	6	221	227	497	84	93	173	315	30	1,646
1991-1992[1]	0	205	450	952	60	358	----------N/A--------			2,025

[1]Provisional.

Table 13.2.1 Lyme Bay sprat fishery, 1966-1992.
Numbers caught per age group (millions).

	Age group					
Season	0/1	1/2	2/3	3/4	4/5	5/6
1966-1967	0.55	11.67	44.00	18.56	11.67	3.60
1967-1968	2.28	46.79	33.10	5.08	0.66	0.39
1968-1969	0.08	29.99	29.24	4.03	0.44	0.10
1969-1970	0.13	17.53	62.78	18.60	2.73	0.35
1970-1971	0.01	4.12	46.03	26.94	1.57	0.54
1971-1972	0.80	20.22	28.01	22.96	4.12	0.34
1972-1973	1.51	32.20	22.20	10.20	3.96	0.38
1973-1974	0.50	22.91	46.12	9.08	5.06	2.42
1974-1975	0.30	40.77	82.73	12.67	8.84	3.55
1975-1976	0.16	13.33	25.25	23.28	6.39	1.47
1976-1977	0.73	40.34	108.52	34.87	6.56	0.37
1977-1978	0.12	19.48	69.33	43.89	7.50	0.48
1978-1979	9.20	41.71	44.64	18.97	5.72	0.01
1979-1980	1.17	26.97	55.45	7.58	4.07	0.33
1980-1981	0.76	51.33	220.79	55.35	6.15	0.26
1981-1982	1.08	52.00	161.91	131.28	20.94	0.55
1982-1983	1.16	4.81	49.74	58.89	25.41	0.25
1983-1984	7.19	13.18	47.05	74.09	40.61	9.16
1984-1985	1.21	40.15	44.27	28.25	9.60	1.23
1985-1986	1.53	15.24	105.48	21.05	7.78	1.01
1986-1987	-	10.36	42.40	17.14	2.84	0.70
1987-1988	-	25.49	47.47	29.66	9.52	1.07
1988-1989	2.31	20.10	88.99	26.10	4.86	0.62
1989-1990	0.16	15.40	22.43	24.12	3.24	0.35
1990-1991	2.76	25.12	46.53	8.80	3.55	0.04
1991-1992[1]	1.59	32.40	40.06	13.83	0.42	0.03

[1]August-December only.

Table 13.3 Lyme Bay area SPRAT, 1974-1992. Mean weight at age.

Season	Quarter	Age group						Overall mean
		0/1	1/2	2/3	3/4	4/5	5/6	
1974-1975	3	4.4	11.0	17.6	24.4	29.0	30.7	15.9
	4	3.6	9.2	18.9	25.6	29.6	30.7	19.0
	1	4.7	8.6	14.8	20.6	23.3	24.8	12.3
	Season	3.9	9.8	18.1	25.2	29.4	30.6	17.4
1975-1976	3	-	15.4	17.1	22.1	28.6	27.0	19.1
	4	3.7	9.5	16.4	24.1	29.1	28.0	19.2
	1	2.5	9.6	15.7	23.0	28.9	26.7	17.7
	Season	3.1	9.7	16.3	23.8	29.0	27.8	18.9
1976-1977	3	-	12.8	16.8	20.4	27.2	26.2	17.3
	4	3.3	7.7	17.7	23.7	28.1	32.7	17.2
	1	2.6	8.2	15.1	21.0	27.2	-	12.3
	Season	2.9	9.3	16.8	22.0	27.7	28.1	16.5
1977-1978	3	-	8.2	16.3	22.4	26.4	32.4	18.6
	4	-	6.8	18.1	22.6	24.9	30.5	19.3
	1	6.4	5.2	14.5	21.8	22.4	28.7	9.8
	Season	6.4	6.2	16.7	22.3	25.5	31.3	17.5
1978-1979	3	3.5	15.4	19.2	25.4	29.6	-	20.9
	4	6.3	11.8	16.5	23.9	29.6	-	15.2
	1	4.9	10.1	13.1	19.9	28.3	-	10.6
	Season	5.7	12.1	16.8	24.5	29.6	-	16.2
1979-1980	3	3.0	18.2	23.6	25.8	32.9	30.7	23.1
	4	3.5	16.5	23.2	27.0	31.6	-	22.4
	1	4.0	9.7	19.2	22.1	20.7	-	12.5
	Season	3.9	14.3	22.9	26.8	30.7	31.0	21.0
1980-1981	3	-	17.4	24.3	25.6	29.9	34.5	24.4
	4	5.2	16.1	21.4	24.8	29.9	32.0	21.7
	1	3.1	11.8	17.1	21.0	28.6	34.5	16.3
	Season	3.1	13.5	19.9	23.6	29.7	32.9	19.7
1981-1982	3	-	17.3	19.5	21.4	33.0	-	19.6
	4	6.1	14.7	21.5	25.5	28.5	31.0	23.4
	1	6.4	12.1	16.5	20.2	-	-	14.7
	Season	6.4	12.9	20.3	25.2	28.5	31.0	21.4
1982-1983	3	-	16.0	18.9	24.9	27.5	32.9	23.9
	4	6.1	15.8	19.6	24.7	27.9	32.4	23.7
	1	-	13.0	18.8	22.5	26.1	-	20.0
	Season	6.1	14.1	19.3	24.4	27.8	32.4	22.9
1983-1984	4	4.1	15.2	20.6	23.6	27.1	27.6	23.2
	1	-	16.2	19.9	23.3	26.9	28.7	23.3
	Season	4.1	15.3	20.5	23.5	27.0	27.5	23.2
1984-1985	3	-	12.5	17.3	22.9	25.7	-	18.7
	4	5.9	16.0	19.4	23.5	26.5	27.9	20.3
	1	5.9	11.5	17.2	22.8	26.7	30.7	13.9
	Season	5.9	14.0	18.7	23.4	26.4	28.1	18.8
1985-1986	3	-	16.0	19.2	22.6	22.0	-	19.3
	4	6.4	15.6	17.9	21.9	23.6	32.0	18.6
	1	5.7	15.9	19.0	22.9	28.3	-	17.5
	Season	6.3	15.7	18.2	22.0	23.4	32.0	18.7

Season	Quarter	Age group						Overall mean
		0/1	1/2	2/3	3/4	4/5	5/6	
1986-1987	4	-	18.1	20.9	24.6	27.8	29.6	22.4
	1	-	13.3	18.6	23.5	29.6	-	17.3
	Season	-	14.8	19.9	24.4	28.0	29.6	20.6
1987-1988	4	-	15.4	23.1	26.9	27.3	27.7	24.8
	1	-	14.0	17.4	19.4	-	-	15.3
	Season	-	14.2	21.5	26.3	27.3	27.7	21.7
1988-1989	3	-	13.9	18.7	24.3	26.8	25.0	20.0
	4	5.7	14.1	19.1	24.0	25.8	27.0	19.0
	1	4.8	13.5	17.6	23.9	24.6	-	16.7
	Season	5.7	13.9	18.7	24.2	26.2	25.7	19.1
1989-1990	3	1.9	13.0	18.4	21.6	25.7	-	19.3
	4	-	13.4	18.8	21.9	25.6	25.8	18.9
	1[1]							
	Season	1.9	13.0	18.4	21.6	25.7	25.8	18.9
1990-1991	3	5.6	17.5	23.0	26.1	26.8	31.9	22.7
	4	4.8	16.3	22.4	25.1	26.8	-	22.0
	1	5.0	11.6	16.8	24.4	26.3	-	14.3
	Season	5.0	13.6	20.7	25.5	26.7	31.9	18.9
1991-1992	3	4.7	16.6	22.6	25.4	29.2	34.6	20.7
	4	6.6	17.1	23.0	26.3	30.9	-	21.0

[1]No samples.

Figure 1.4.1 The relative landings and sampling frequency in 1991 by month in the Danish industrial fishery

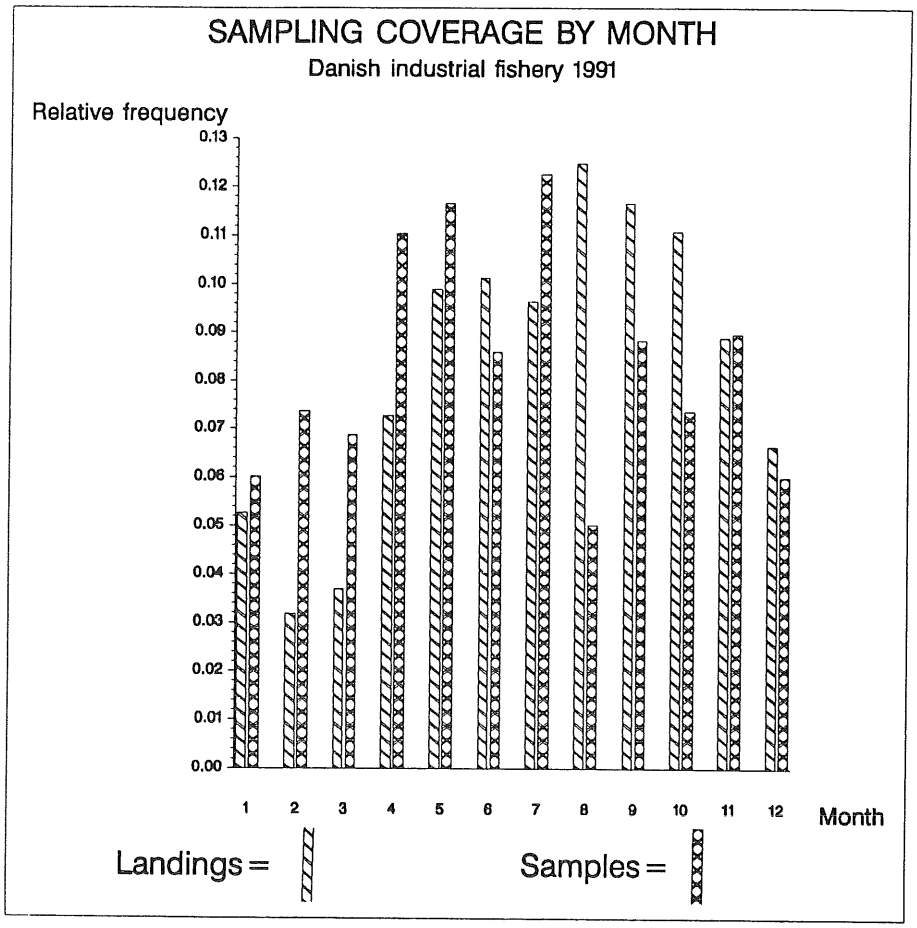


Figure 1.4.2 The relative landings and sampling frequency in 1991 by ICES fishing area in the Danish industrial fishery.

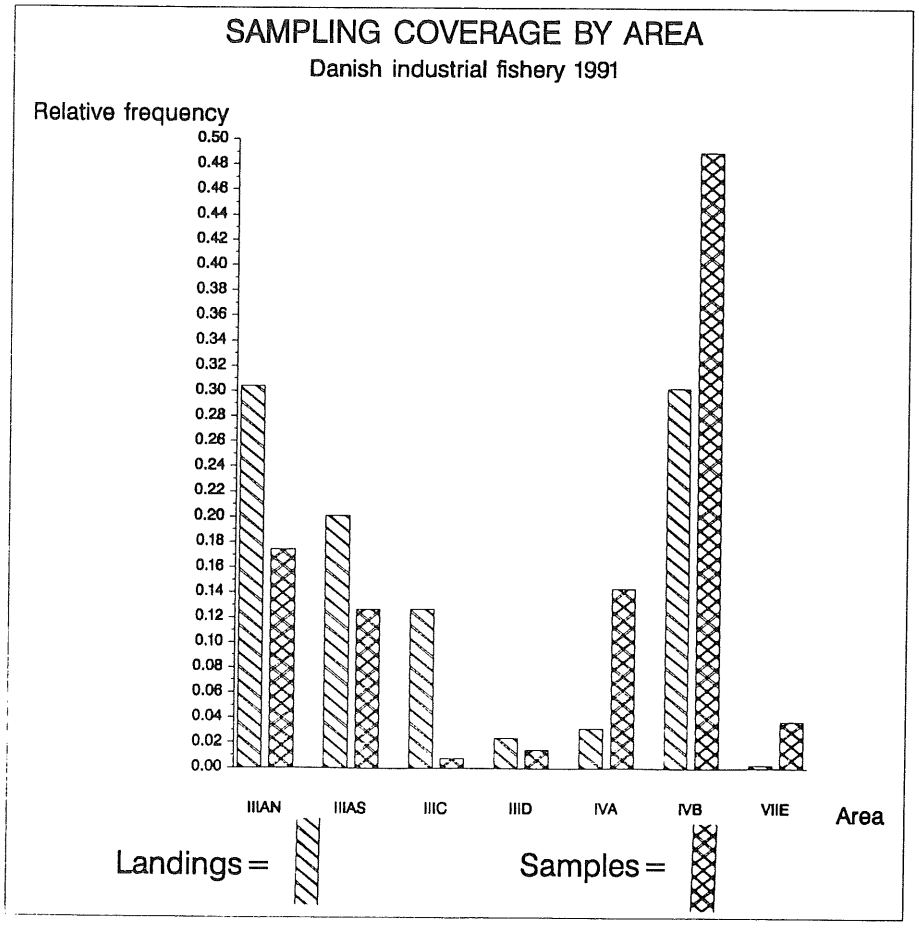


Figure 5.2 Norway pout. North Sea. Danish CPUE versus GRT for 1991.

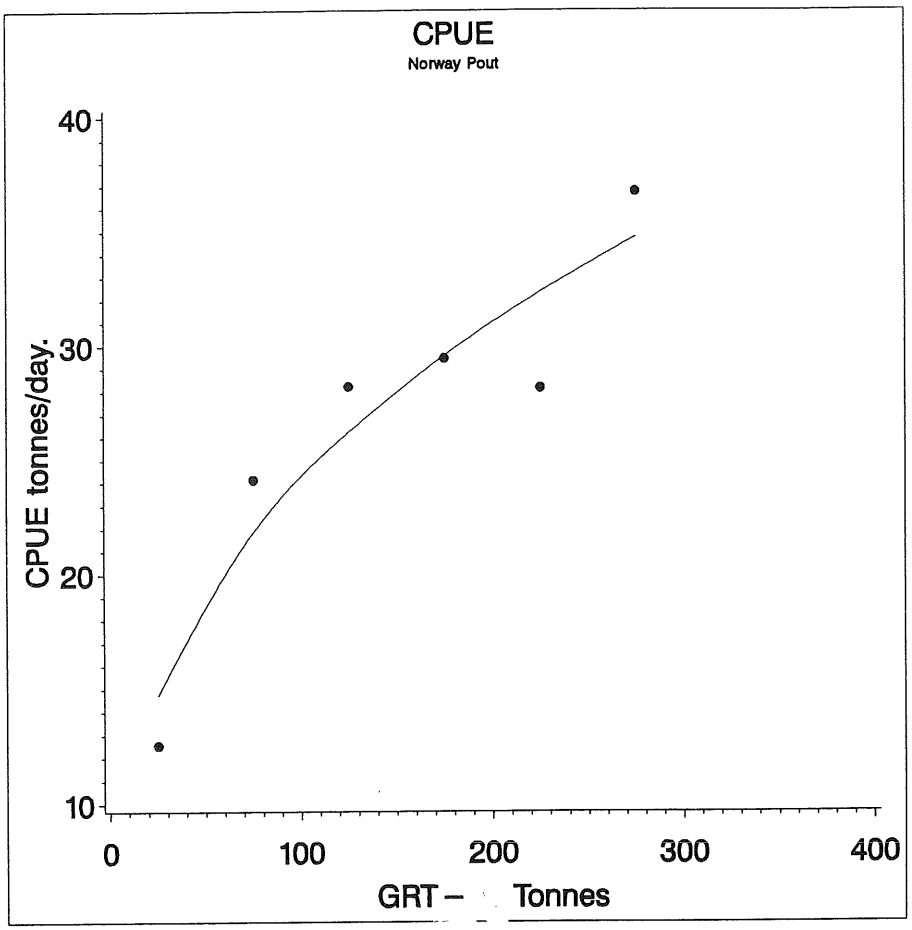


Figure 5.7 Norway pout. Estimated SSB by year from VPA (Anon., 1990), a Seasonal Separable VPA with commercial CPUE data (Psep), and a Seasonal Separable VPA with IYFS data (IYFS).

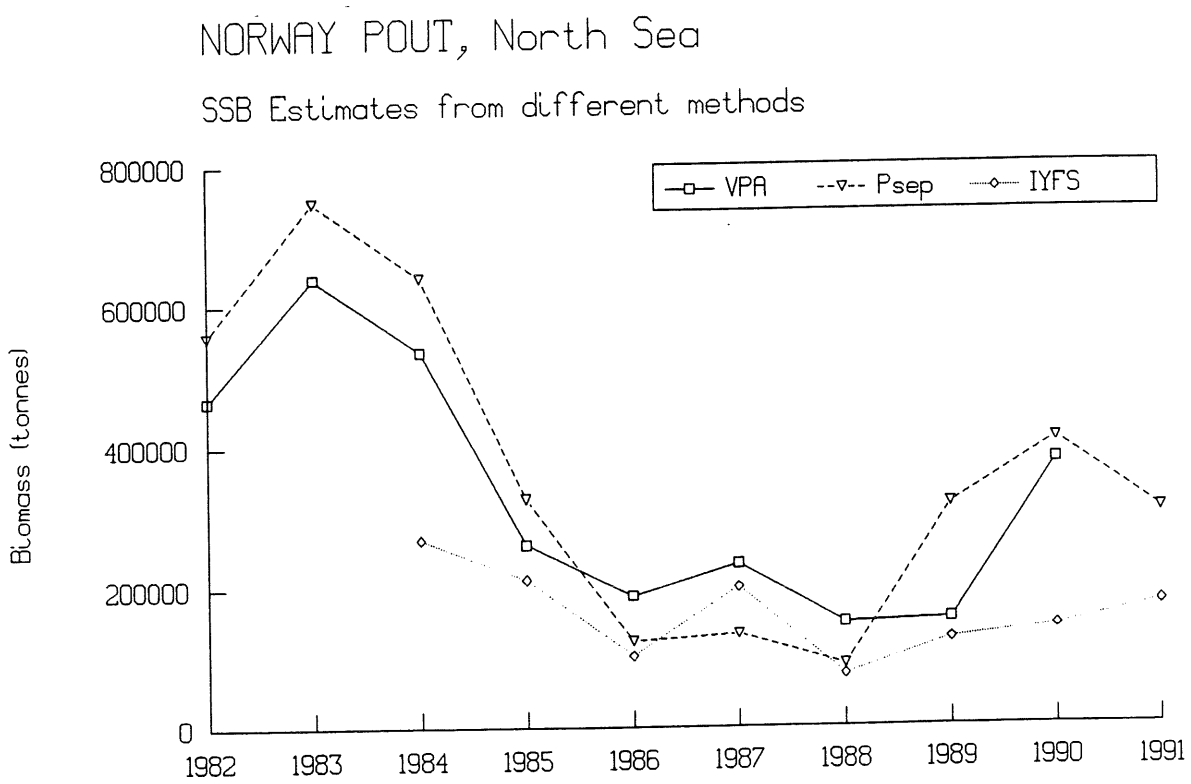


Figure 8.1 Danish SANDEEL areas and assessment areas by the Working Group.

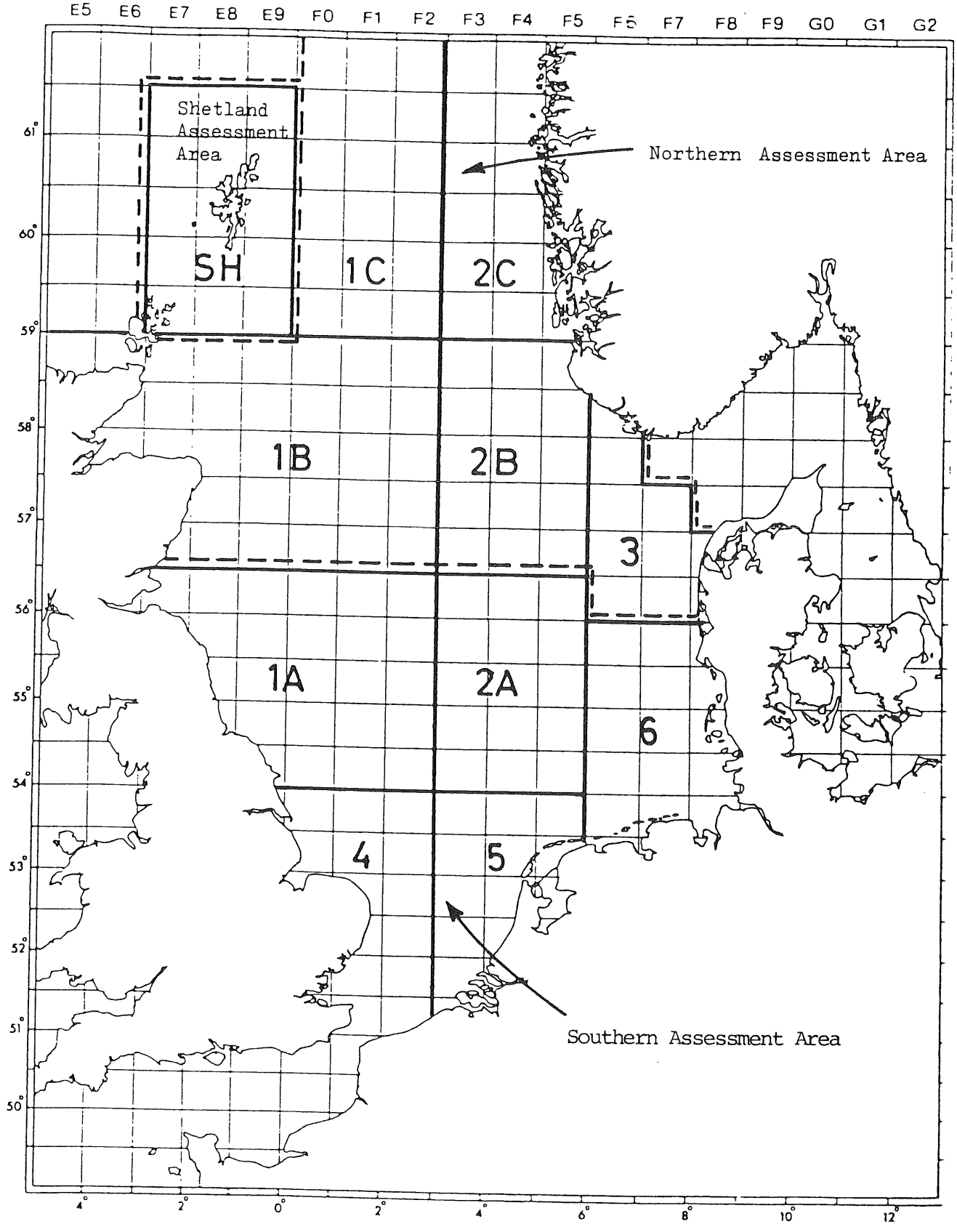


Figure 8.4.4.1
Sandeels at Shetland
Numbers of 0-group on 1 July

Figure 8.4.4.2
Sandeels at Shetland
Biomass Totals

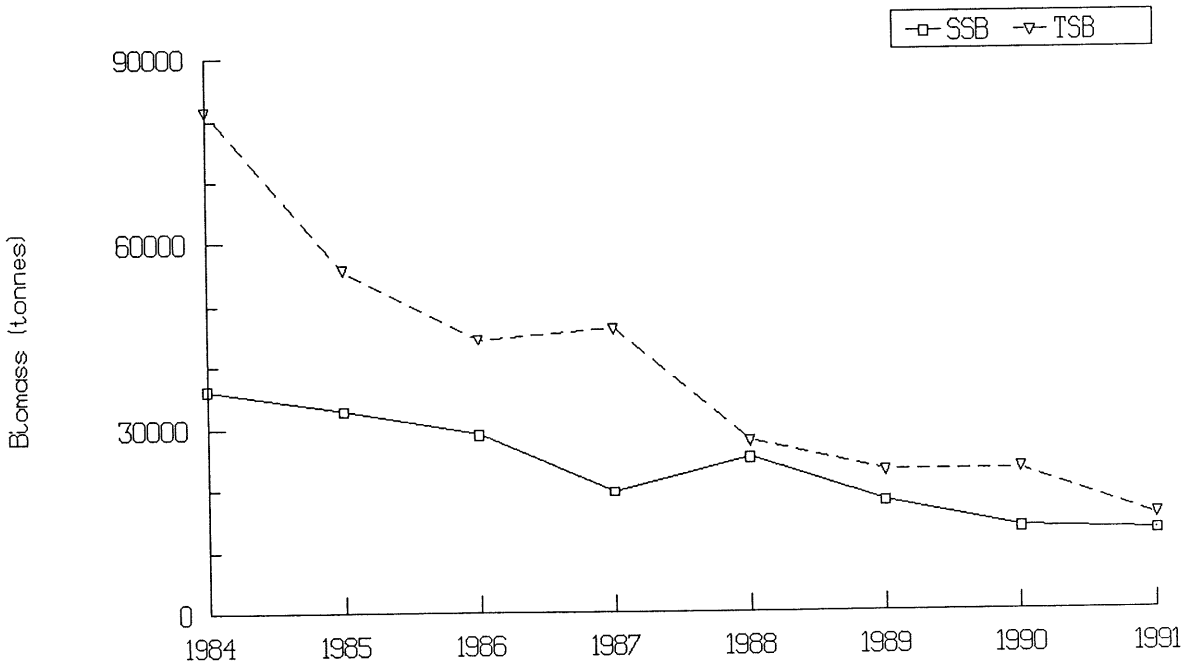


Figure 9.5.1
Sandeels, Division VIa
Mean Fishing Mortality

Figure 9.5.2
Sandeels, Division VIa
Numbers of 0-group on 1 July

Figure 9.5.3
Sandeels, Division VIa
Biomass Totals

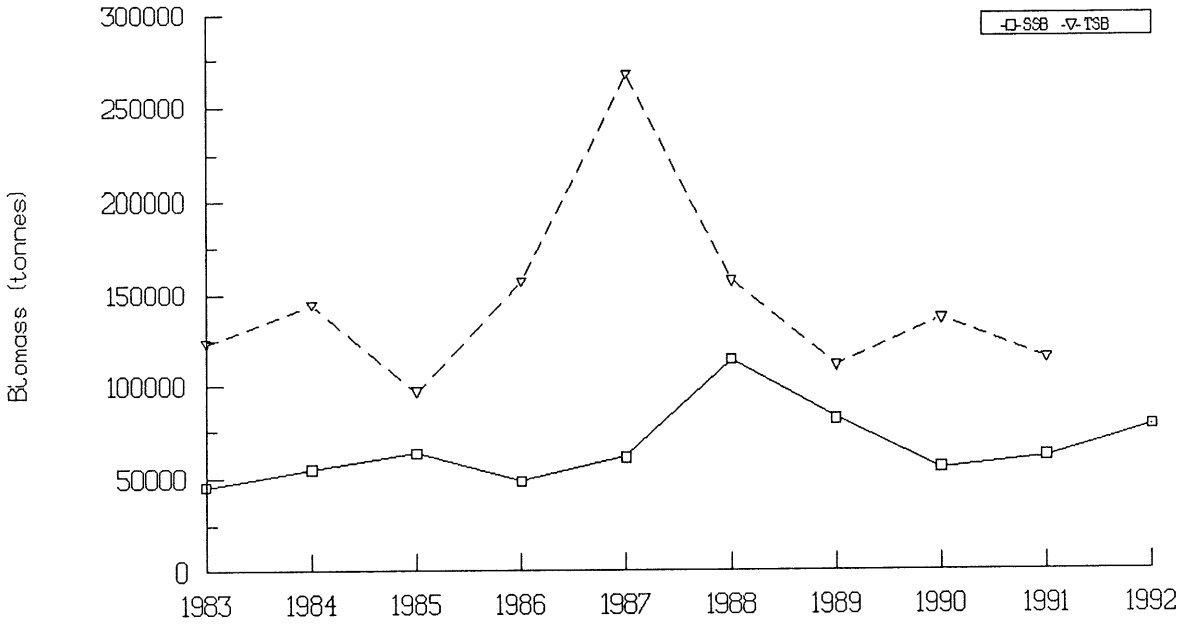
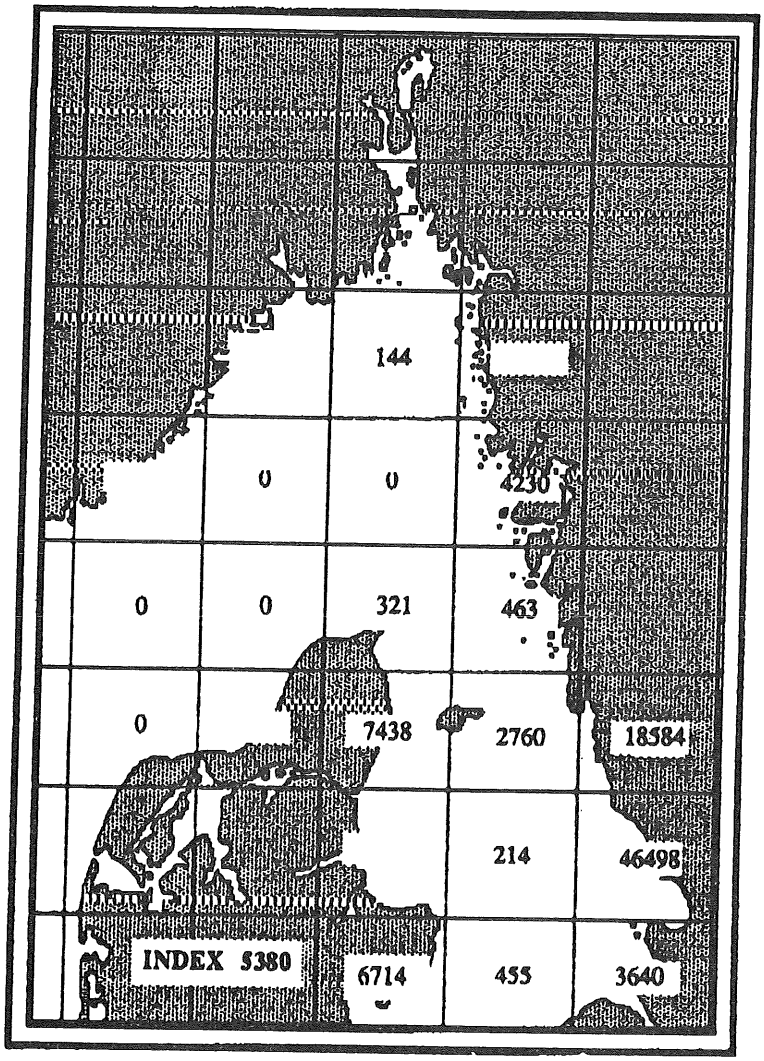


Fig. 10.1 The IYFS index for 1-group sprat for 1992 in Division IIIa.



APPENDIX 1

PARTIALLY SEPARABLE SEASONAL VPA

by
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INTRODUCTION

There are a variety of ways of analysing catch at age data. These range from tuned VPA to statistical models such as CAGEAN (Deriso et al), ADAPT (Gavaris) and Survivors (Doubleday and Rivard). These methods in their present implementation are suitable for the analysis of annual catch at age data. There is a trend towards the analysis of seasonal catch at age data and a number of stocks, such as Norway pout and sandeel are already analysed on a seasonal basis using VPA tuning. The method described here is an adaptation of methods like ADAPT, Survivors and CAGEAN for seasonal data.

THE METHOD

The approach assumes that there is some auxilliary data in addition to the catch data. These may be effort data and/or research vessel indices. The analysis estimates populations and fishing mortalities by minimising a weighted sum of squares of the form;

$$\Sigma (\log C - \log C')^2 + w1 * \Sigma (\log E - \log f)^2 + w2 * \Sigma (\log I - \log Q - \log N)^2$$

where C =observed catch
C'=Fitted catch
E =observed effort
f =fitted effort
I =observed population index
Q =research vessel catchability
N =fitted population
w1=relative weight for effort data
w2=relative weight for RV index data

The catch data are treated in two components. In the first component, it is assumed that the fishing mortality is "separable" into an age effect, s, and a year effect, f, (ie fitted effort above) ie;

$$Fsep(i,j,k)=s(i,k)*f(j,k)$$

where i=index for age
j=index for year
k=index for season

Since s is indexed by age and season, this means the selectivity at age can change with season.

For this component of the catch data, effort data for at least

some years and seasons must be provided.

The method treats the remainder of the catch data (if any) as exact. The procedure is therefore to choose populations which are the survivors on the margins of the number at age matrix, and values of s,f and Q to minimise the sum of squares above. The fitted catches, C, are given by the equation;

$$C=f*s*P*cumZ*(1-exp(-Z)/Z$$

where cumZ is the cumulative total mortality down the cohort, P is the terminal population (ie N=PcumZ) and Z is given by;

$$Z=f*s + M + Foth$$

where M is the natural mortality and Foth is the fishing mortality for the "exact" catch data. Foth can be calculated given estimates of P and s and f from the conventional VPA equations.

The procedure can therefore be written as a pseudo algorithm as follows;

1. choose initial values of s,f,Q and P
2. do an ordinary VPA to solve for Foth (Fsep and M are known)
3. calculate C for separable component of catch data
4. calculate sum of squares function
5. find revised values of s,f,Q and P which reduce SSQ
6. compare revised values with last iteration
7. if difference is large go to 2 else stop.

IMPLEMENTATION

The method outined above is implemented in the program PSEP which is still in a state of development. At present a moderate amount of testing has been done and the core calculations appear to be done correctly.

The following data must be provided

1. Catch at age and associated effort for the separable fleet
2. Catch at age total catch
3. Research vessel data as cpue by age and year
4. Natural mortality

If the catch data in 1 = catch data in 2 then all the catch data are treated as separable. Similarly if 1 is zero, then all the catch data are treated as exact (this option only works if the age and year range of the RV data is the same as the catch data). If 1 is less than 2 then (2-1) catch data are treated as exact. Research vessel data are optional but if not available then there must be data of type 1.

When the programme runs you are prompted for an input data file and then name of an output file. You are then asked for the relative weight to be given for the effort data and RV data. These are the weights w1 and w2 above and should correspond to the inverse of standard deviation of these data relative to the catch

data. Next you are asked to specify the age above which RV catchability is constant. This is to reduce the number of parameters if possible. It assumes that fish above a certain age are sampled equally by the survey vessel. Next you are asked to specify the selectivity (s) on the oldest age. This is done by setting it equal to s for a younger age multiplied by a constant. You must specify which younger age you want and the multiplier. It is sensible to choose an age at which selectivity is near the maximum. The choice of multiplier is a matter of judgement. Clearly a number between 0 and 1 is required. 1 will tend to give a flat topped selection curve.

The program then performs a minimisation which may take some time. After completion of the calculations, you are asked if you wish the parameter covariance matrix is to be printed. This is usually very large and if you want to save the forests, answer no. This matrix is useful to check that there is no redundancy in the parameters.

Fairly extensive output is provided. The input data is printed followed by your choice of weights etc. The program then prints the parameter "IFAIL" from the minimisation routine (E04FDF). It should be zero. If it is 5, there is some doubt about the minimum found but the result is probably acceptable. Any other number indicates the minimisation has failed. You are then given some summary information about the sum of squares including the coefficient of determination. The IFAIL parameter for E04YCF indicates whether the parameter covariance matrix has been successfuly calculated. It should be zero. Then follows a list of the parameters (in logs) and their standard deviation. This will give an indication of the precision of the parameters. At present the parameters in this list are not identified but they are in the order, f,s,P and Q. Following the correlation matrix, the parameter values are printed. The program then prints the estimated populations and fishing mortalities follwed by tables of residuals. These should be examined carefully for patterns. For each type of data (ie catch, effort and RV), the root mean square (RMS) is printed. This is an indication of the residual variance associated with each data type. The values should be similar for each data type. If not there may be a problem. One solution is to repeat the analysis using the inverse of the values scaled to the catch RMS as relative weights for the effort and RV data.

ADDITIONAL NOTES

The program at present is very large. In the PC version, the maximum number of years for semiannual data is 9. It is presently compiled only for semiannual or annual data. It will need to be recompiled for quarterly data. This is easily done by modifying two PARAMETER statements, one at the start of the main program and the other at the start of the subroutine LSFUN1. In each case the number of years is altered by modifying the variable NYX and the number of seasons by modifying NQX (ie =4 for quarterly data). I have not extensively tested the program with quarterly data, but it will work. I have had a number of overflow errors when testing it with this type of data, however.

The program will work with missing data. Effort data are not required for all years/seasons but there must be enough to be able to estimate the year/season effects. Catch data for the separable analysis can also be missing provided effort data for that year/season is present. Thus it is possible to estimate catches and fishing mortality rates when catch at age data is missing. In this case, the missing data should be entered into the data file as zeros.