International Council for the
Exploration of the Sea

C.M.1983/Assess:7

INDUSTRIAL FISHERIES WORKING GROUP

ICES headquarters, 23 February - 1 March 1983

This document is a report of a Working Group of the
International Council for the Exploration of the
Sea and does not necessarily represent the views of
the Council. Therefore, it should not be quoted with-
out prior consultation with the General Secretary.

---

x) General Secretary,
   ICES,
   Palægade 2-4,
   DK-1261 Copenhagen K,
   Denmark.

TABLE OF CONTENTS

Table of Contents (ctd)

REPORT OF THE INDUSTRIAL FISHERIES WORKING GROUP

1. INTRODUCTION

1.1 Participants

R S Bailey	United Kingdom (Scotland)
E Bakken	Norway
A Corten	Netherlands
P Johnson	United Kingdom (England)
J Lahn-Johannessen	Norway
B Mesnil	France
J G Pope (Chairman)	United Kingdom (England)
K Popp Madsen	Denmark
P Sparre	Denmark

K Hoydal attended the meeting as ICES Statistician.

1.2 Terms of Reference

It was decided at the 70th Statutory Meeting of ICES (C.Res.1982/2:5:2), that

"the Industrial Fisheries Working Group (Chairman: Mr J G Pope) should meet at ICES headquarters 23 February to 1 March 1983 to:

(i)   report the results for the by-catch species, e.g., herring, cod, haddock, whiting, mackerel and saithe in the North Sea and adjacent waters to the relevant ICES Stock Assessment Working Groups,

(ii)   assess the state of the stocks of the target species for industrial fisheries, i.e., sprat in the North Sea, Divisions IIIa and VIId-e, Norway pout and sandeels,

(iii) review which data are available in the Working Group files for evaluating density dependence in the parameters of the models used in fish stock assessment,

(iv)   specify deficiencies in data required for assessments."

1.3 Timing of Meeting and Participation

The Working Group would suggest that meetings be delayed until mid-March in future years so that results from the International Young Fish Survey will be available for consideration and also full data from the preceding year should be available from all countries. If the Working Group is to continue to monitor the Division IIIa sprat stock, Swedish participation would be appreciated.

1.4 Management Considerations

The comments of the Working Group upon management considerations made in 1982 remain valid (Anon., 1982).

The interrelationship of the fishing on the three target species is investigated in Section 2. If the sprat stock continues to decline, some diversion of fishing effort towards other species might be expected and, as pointed out in Section 3, there is already some evidence of a movement by both medium and small vessels to fish for 0-group herring in Division IVb E in the 3rd and 4th quarters. Another alternative is the fishery for Norway pout, but not all vessels engaged in the sprat

fishery can make this transition because of the greater distances involved. Since the fishery on O-group herring is undesirable, the Working Group would draw the attention of ACFM to the need to indicate alternative resources or solutions for all vessels taking part in these fisheries and other components of the industrial fleet that will suffer from lack of sprat, subject to suitable safeguards.

1.5   Request from the Commission of EEC

The Working Group noted the request of the Commission of the EEC for information on the state of the sprat stock in ICES Division IIIa. They draw the attention of the Commission to Section 6 of this report, which sets out an assessment of this stock, as required by the terms of reference of the Working Group.

1.6   Comments on Methodology

Due to the particular biological characteristics of the species and the practice of the industrial fisheries, the classical assessment and prognosis procedures may prove inappropriate. Among the possible reasons for this, the following may be given:

–   The species are short-lived and fisheries tend to direct their effort on the very early age groups; their production thus directly depends on the strength of the incoming year classes.

–   Another consequence is that VPA is likely to produce reliable estimates of stock abundance only when the cohorts are practically fished out; thus, catch predictions carried out through the usual projections are hardly sensible. Uncertainties about the rate of natural mortality (known to be high) and its possible variations with age are another limitation to the use of VPA predictions.

As a result of these points, trial VPA might then be used only for historical description of the stocks and the fisheries. They tend to show, however, that fishing mortality on the first ages is quite high, generally above 1.0 on a yearly basis. At this level of exploitation rate, the normal prognosis method aimed at deriving management options in critical range of F values may well be over-sophisticated, and the concept of long-term management erroneous.

The Working Group, therefore, considered some alternate approaches for producing advice, which is timely, accurate and practicable. These may include:

Inference from survey results, as already available (IYFS and other demersal or pelagic surveys, acoustic surveys) or to be initiated or reconsidered for this purpose.

Use of statistics from commercial fisheries such as catches in recent years as a rough approximation, or early results of the fisheries to predict the yield in the rest of the season.

Further comments on advantages and limitations of these approaches, when applied to Norway pout and sprat, are given in Sections 4.9 and 6.9, 7.9 and 8.9.

2.   DESCRIPTION OF THE FISHERIES

In order to understand the mortality processes occurring in the industrial fisheries, some study is appropriate of the industry structure and also the timing and possibilities for exploitation of the total industrial resource.

2.1   Brief Description of the Industrial Fishery Structure

In the report from the meeting of the Industrial Fisheries Working Group last year (Doc. C.M.1982/Assess:6) it is said: "..Although it is not possible to rule out that management on purely biological consideration might be pertinent, it is obviously a greater under- standing of the operations of the fleets and economic constraints that determine the need for management of these fisheries...".

The Working Group does not have the expertise and knowledge to take economic factors into account, and in recent meetings in ICES it has been ruled out that ICES should take into account other factors than the biological.

This point taken, however, nobody will claim that the biological considerations should be seen in isolation in the management process. Additional to the biological constraints, economic and social con- straints have to be brought in to form the basis for final manage- ment decisions.

The point has been made that where the stock assessments in almost all cases have to be made on an international basis, the assessments of economic and social effects are on a national basis, and, therefore, bodies inside ICES should not worry about that.

This is a fair comment, but still the question is left, is the information on biological constraints given in a form, which makes it possible for the other parties in the management process to make full use of it?

There is an increasing interest in bringing biologists and economists together on a national level, at present. This national and international cooperation might be very helpful in making clearer "... how to tailor its biological output to best suit the needs of economical analysis..." to quote a phrase from the last ACFM report. In passing by, it should be mentioned that "economical" should probably not be too narrowly interpreted; it is the link to socio-economy, the assessment of both economical and social consequences, rather than the ultimate economic optimisation that is in question.

From national experience, a certain knowledge on how to present the stock assessments in a more useful form has already been accumulated, and the Working Group agreed that one important approach was to break the unit-stock biological assessments down on "unit-fleets".

To start the ball rolling, an attempt is made in this year's report to outline the general characteristics of the fleets fishing mainly for reduction purposes.

2.2   A Definition of 'Industrial Fisheries'

The usual definition of industrial fisheries is that these are fisheries with small-meshed gear for reduction purposes. In Rec.2 of NEAFC, a list of species is given, which can be fished by small- meshed trawl gear, and this list includes the species usually taken for reduction purposes, e.g., Norway pout, sprat, blue whiting and sandeel. The Rec.2 also lists herring and mackerel, which were also at that time subject to important directed fisheries for reduction purposes.

As described in last year's report from this Working Group, a closer inspection of the industrial fisheries shows that economically the fisheries depend on catches of certain species of trash fish - and a by-catch. This by-catch consists of species, which are usually

taken for human consumption. The by-catch can be split into two compartments, one consisting of undersized non-marketable specimens of the human consumption species, and one of marketable size groups, which are sorted out and landed for human consumption.

Using the term trash fish, those species spring to mind for which - at least up to now - it has not been possible to find any profitable production for human consumption, e.g., Norway pout and sandeel. Others might be used for human consumption, but the markets are not able to accommodate large amounts of the species, so with high catch rates and landings, a major part will go for reduction purposes. Sprat is an example here, and in some periods, herring and mackerel.

However, when switching from species to fishing fleets, the definition becomes easier. It is possible to describe a number of fleets, which, as their main operation, fish and supply raw material to fishmeal plants. In the following section, a preliminary description will be given of these fleets.

The industrial fleets

Denmark

The Danish industrial fleets, proper, consist of two major groups.

1. The large steel-hull vessels. This fleet consists of approximately 240 vessels. A typical trip takes from 8-14 days. The vessels range in the size of 200-300 GRT and carries a crew of 4-5. The carrying capacity is also about 200-300 tonnes, including ice. This fleet fishes mainly for Norway pout on and north of Fladen Ground, and switches to sandeel especially during the spring-summer season.

2. The medium-sized wooden-hull vessels. This fleet consists of about 400 vessels. The fleet mainly exploits small clupeoids and sandeel during the spring-summer season. There are 3-4 crew members. This fleet mainly operates in Sub-divisions 5B and 6 (see Figure 3.5.1).

In addition, there are industrial landings from a group of small vessels which change, in an opportunistic fashion, between industrial and other fisheries. This group will be described later on.

Norway

The Norwegian industrial fleet consists of two size groups, altogether 100 vessels.

1. Larger trawlers, 150-300 GRT. They fish for Norway pout and Blue whiting in the Norwegian Deep during autumn and winter, and may change to sandeel during spring-summer going as far down as to the Dogger Bank. They may also participate in the capelin fishery in the Barents Sea from late January to May.

2. Smaller trawlers, 50-150 GRT. They behave very much as the larger ones, but do not have capelin, and rarely sandeel, as an alternative catch opportunity.

Faroes

The Faroese industrial fishery in the North Sea is at the moment at a very low level. From a 32 vessels in 1975-76, the fleet has now been reduced to 10 vessels. They are larger steel-hull vessels, ranging from 130 to 300 GRT with HP from 400 to 900 and carrying a crew of 4. An additional 4 or 5 may switch from human consumption fishery at the Faroes, if catch rates and prices are high. The fishery is mainly for Norway

pout. In later years, a greater part of the activity has taken place
in the Norwegian EEZ than previously. A trip lasts 14 days, and the
landings have in recent years mainly been in Denmark.

Fleets that change between industrial and human consumption fisheries

There are a number of fleets that occasionally fish for reduction
purposes, depending on markets and fishing opportunities.

Denmark

These are mainly the smallest group of trawlers. They have a restricted
operation area and can change between small-meshed and large-meshed
fisheries. They mainly exploit small clupeoids and sandeel in the
southern part of the North Sea and close to the Danish coast.

United Kingdom

There are up to 30 Scottish vessels taking part in the sandeel fishery
around Shetland and Fair Isle. Local Shetland boats fish around
Shetland and can also make trips to Fair Isle, while Scottish east
coast vessels fish mainly at Fair Isle and in past years in the north-
eastern North Sea. The participation depends on the market and
on opportunities for fishing roundfish. In the years with large concen-
trations of sprat in winter off the English and Scottish coasts, Scottish
vessels participated in these fisheries.

At the peak of the English northeast coast fishery (mid-1970s), up to
135 vessels participated (15-25 m). About 60-70% of these were of
Scottish origin. Single- and pair-boat pelagic trawls were used.
Fishing was on a daily basis, and average catch per landing was usually
between 40-50 tonnes.

Average catch disposals were: fishmeal 75%, fresh 20% (mainly exported
to Norway), and petfood 5%.

Up to 90 smaller vessels (12-15 m) have engaged in the estuarine Wash
and Thames fisheries. These mainly work as pelagic pair-trawlers with a
few singles. They land on a daily basis on average 10-15 tonnes per
landing, when fishing is good. About 70% of the catch goes to fishmeal,
and some has been transhipped by Russian and Norwegian vessels.

Norway

A varying part of the Norwegian purse-seine fleet participates in the
fishery for sprat, mainly in November-February (prior to the
start of the capelin fishery in the Barents Sea). As the abundance of
sprat in offshore areas has declined, the number of seiners taking part
in the sprat fishery has declined. In recent years 20-50 vessels,
mostly of medium-size, have participated.

The land-based industry

Faroes

One fishmeal plant in the Faroes processes approximately 100 000 tonnes
yearly. The importance of industrial catches from the North Sea has
been dwindling, the major supply is now blue whiting, capelin and
offal from the fish fillet factories. 40 people are employed.

Norway

The approximately 200 000 tonnes of industrial landings from Norwegian
vessels from the North Sea form the main basis for 10-12 fishmeal
plants in southern and western Norway (south of 62°).

Denmark

9 production units process the approximately 1.2 million tonnes of industrial fish landed yearly. 2 of the largest, situated in Esbjerg, handle about half of the landings. The full capacity of these 9 production units is 15 000 tonnes per 24 hours, which is the capacity necessary to handle the peak landings during the sandeel season. 1 100 - 1 200 persons are employed.

United Kingdom

The 9 United Kingdom fishmeal plants have an estimated intake capacity of 3 710 tonnes per 24 hour day, which, with 260 days operation, gives a yearly intake capacity of 960 000 tonnes. The actual intake in 1980 was approximately 225 000 tonnes. A major part of this consists of species other than dealt with in this report.

2.3   The Interrelation of Fishing Intensity on the Three Target Species of the Industrial Fisheries

The three main target species of the industrial fisheries in the North Sea are exploited in rather definite seasons as specified in last year's report. Basically, the sandeel is caught during the second and third quarters of the year, while the Norway pout is exploited throughout the year, but most heavily in the third and fourth quarters. The sprat is most heavily exploited in the first, third and fourth quarters. The possibility for complete substitution of effort, for example sprat to sandeel, does not, therefore, exist, but some substitution of effort does seem to occur.

Results shown in the Appendix tentatively suggest that fishing mortality on the various target stocks vary with relative abundance. Clearly, this relationship needs further study. An analysis by quarter might be useful, as it might help with the problem of specifying terminal fishing mortalities for the VPAs and also indicating the relationship between mortalities on 0-group sandeel in the third quarter and mortalities on other species.

The Working Group would, therefore, recommend that national laboratories with suitable data (such as effort data) might try to extend this analysis for next year's meeting.

2.4   Description of the Industrial Fisheries (Comments to Table 2.4.1)

During the past ten years, total industrial landings from the North Sea have fluctuated between 1.0 million and 1.8 million tonnes (Table 2.4.1). Following a sharp increase from 1973 to 1974, the annual landings remained at a fairly stable level up to 1980, but then decreased to 1.2 million tonnes in 1981. Preliminary data covering the first three quarters of 1982 are on the same level as the total for 1981.

The total landings of the target industrial species (Norway pout, sandeel and sprat), which determine the annual flcutuations, show the same trend as above, ranging from 0.9 million to 1.6 million tonnes over the years. It should be noted that despite comparatively large annual variations in landings of each species from 1974 to 1980 (Norway pout 200 000 - 700 000 tonnes, sandeel 400 000 - 700 000 tonnes and sprat 300 000 - 600 000 tonnes), the total landings of target species remained fairly constant. This may suggest a significant flexibility of fishing effort diverting from one fishery to another, as the abundance and availability of the main stocks may change by time. Whereas the annual landings of Norway pout and sandeel tend to vary irregularly, mainly due to changes in recruitment, those of sprat dropped from 600 000 to 300 000 tonnes from 1976 to 1977. A further sharp decrease to 100 000 tonnes has taken place from 1980 to 1982, the reasons of which are not yet known.

Total annual landings of by-catches for reduction purposes have fluctuated between 150 000 and 280 000 tonnes. Landings of blue whiting have mainly varied according to the abundance of young immature fish in the Norwegian Deeps, ranging from 36 000 to 100 000 tonnes over the years. Annual landings of Rec.4 or protected species (haddock, whiting and saithe) were at a comparatively high level up to 1977, ranging from 130 000 to 220 000 tonnes, but decreased to 67 000 tonnes in 1978, mainly as a result of by-catch regulations, and have remained at this level. Herring by-catches, since first reported in 1976, were kept at a rather low level (7 000 - 15 000 tonnes) up to 1980. In 1981, they increased sharply to 84 000 tonnes and have been recorded at 92 000 tonnes up to the third quarter of 1982.

Fish caught during the course of the industrial fisheries and sold for human consumption are not included in these figures, but should be regarded as a facet of the industrial fisheries.

3. BY-CATCHES IN THE INDUSTRIAL FISHERIES IN THE NORTH SEA AND DIVISION IIIa

3.1 Herring By-Catches in 1981 in the North Sea

Estimates of herring by-catches for 1981, given in last year's report, have now been supplemented with new data for the second half of that year (Tables 3.1.1 and 3.1.2). The new figures show a dramatic increase of by-catches in Division IVb, reaching a value of 75 000 tonnes in 1981. This is an increase of about 10 times as compared to earlier years. The catch was taken almost exclusively in the eastern part of Division IVb, and the main fishing was in the third quarter of the year. As the catch consisted mainly of 0-group herring, the number of individuals represented by this catch was extremely high (8.3×10^9).

The above figures for by-catches in 1981 are not very accurate, as the major catches in the eastern part of Division IVb were only poorly sampled.

3.2 Herring By-Catches in 1982 in the North Sea

Data available for the first three quarters of the year (Tables 3.1.1 and 3.2.1) show a continuation of the very high by-catches in the eastern part of Division IVb. The preliminary by-catch figure for the first three quarters of 1982 (89 000 tonnes) is even higher than the total by-catch in the previous year. Actually, these catches can hardly be considered as by-catches in a sprat fishery, but rather as the result of a directed fishery on 0-group herring. Sampling intensity in the eastern part of Division IVb was increased in 1982 (88 samples taken), so the figures presented here should be considered as more reliable.

There was also some increase in herring by-catches in Division IVc, but this increase was relatively minor compared to the developments in Division IVb. Half the herring by-catch in Division IVc was taken in the sprat fisheries in offshore waters, and consisted mainly of 1- and 2-ringers. The other half was taken in conjunction with the sprat fisheries in the Thames and Wash estuaries, and these by-catches - although no age data for them were available - must be assumed to consist of 0-group herring.

3.3 Seasonal and Geographical Distribution of Herring By-Catches in the North Sea

The new data presented to the Working Group in this report confirm the view already expressed in last year's report (C.M.1982/Assess:6, p.8):

"... during the years 1979-81 by-catches of herring were mainly
concentrated in a few restricted areas and seasons. The largest
by-catches of herring, both in weight and in numbers, were taken
in the Danish coastal zone north of Esbjerg. The by-catches
consist of very small 0-group herring, which are taken mainly
in the third quarter of the year. Because of the small size of
the herring at this time of the year, even a relatively low
by-catch in weight will represent a high number of individuals".

The present data show that even in weight, herring "by-catches" in
Danish coastal waters in the last 2 years have been formidable, and the
number of individuals taken is very much higher than earlier estimates
ever indicated. Compared to the catches taken in this fishery, by-catches
of herring in other areas and seasons are of relatively minor importance:
about 95% of all herring taken as by-catch in the North Sea are taken in
the summer fishery along the Danish coast. During the past 2 years,
this fishery has started in July, reached its peak in August, and
declined again in September. During September 1982, Denmark closed the
sprat/herring fishing in the 15 miles coastal zone between Hvide Sande
and Hanstholm. By this time, however, the fishery was already declining,
and a very large catch of 0-group herring had been taken in the
preceding 2 months.

The area where 0-group herring are caught extends from the German border,
up the west coast of Jutland and into the Skagerrak. Most fish are
caught by small boats making day trips.

3.4   Herring By-Catches in Division IIIa

No by-catch data for recent years were available from the Danish and
Swedish sprat and herring fisheries in this area. Incidental reports
from the fishery indicate that large numbers of 0-group herring were
also taken in this area in 1982, the catches possibly being
approximately 1/3 of those taken off the west coast of Jutland.

Catches of 0-group herring in Division IIIa were taken mainly along
the north coast of Jutland and around Skagen: the timing of the fishery
in this area coincides with the fishery off the west coast, i.e.,
July-September.

Along the Norwegian coast small amounts of herring are taken in the sprat
fishery for human consumption. The total amount of herring taken was
850 tonnes in 1981 and 470 tonnes in 1982.

In the Kattegat, by-catches of undersized herring are taken in the
directed herring fishery for human consumption. This fishery is
conducted mainly in the fourth quarter of the year, and the undersized
herring are separated from the consumption herring (>18 cm) by means of
sorting machines. Although the by-catches of undersized herring taken
in this fishery may be quite considerable, the actual numbers are
probably much less than those taken in the summer "sprat" fishery in
the Skagerrak, due to the rapid growth of 0-group herring.

3.5   By-Catches of Other Species

In the North Sea, major industrial fisheries are recognized for Norway
pout, sandeel, sprat and blue whiting, respectively. Any of these species
may occasionally occur as part of the by-catch in another fishery. This
is particularly the case for samples from vessels, which switch over from
one target species to another during the same trip, as for instance in
the fisheries for Norway pout and blue whiting in the Norwegian Deep
(Table 3.5.1). Other Rec.2 species, such as the silver smelts (<u>Argentina</u>
<u>silus</u> and <u>Argentina</u> <u>sphyraena</u>) may also contribute to the by-catches,
particularly in the fishery for blue whiting.

Within the framework of the present Working Group, blue whiting might well be considered as a by-catch species, although to some extent directed fisheries are conducted with small-meshed bottom trawl in the Norwegian Deep, and occasionally by pelagic blue whiting trawl in April-May on the continental slope off Shetland (Table 3.5.2).

Among the protected species, whiting and haddock appear to be the predominant ones in by-catches used for reduction purposes (Tables 3.5.2 and 3.5.3, and Figure 3.5.1). Prior to 1977, saithe also formed a major component in such by-catches, while the contribution of cod has been rather insignificant. Since 1977, the by-catch of protected species has been reduced compared with previous years, mainly as a result of by-catch regulations. By-catches of protected species used for human consumption would probably indicate the opposite trend, where saithe and cod might comprise greater proportions than haddock and whiting. Some clue to the relative contribution of these species to the Norway pout fishery is presented in Table 3.5.4. At this stage, however, the Working Group was not able to estimate the magnitude of protected species for human consumption derived from the industrial fisheries.

The non-Rec.2 - non Rec.4 species form a numerous group, some of which may be rather important for human consumption, as for instance, ling, blue ling and tusk, while the remaining species are used for reduction purposes. This latter fraction is usually very small by weight.

Table 3.5.5 shows the catch composition in the Norwegian sandeel fishery.

3.6 By-Catch Numbers at Age

Numbers at age and mean weight at age for haddock and whiting by-catches for reduction purposes were updated by Denmark in 1982 on a quarterly basis (Tables 3.6.1 and 3.6.2).

4. NORWAY POUT

4.1 Landings 1980-82

Landings of Norway pout from the North Sea by country for the years 1957-82 are given in Table 4.1.1, those for 1982 being incomplete. The monthly landings by country in the years 1980-82 are given in Table 4.1.2.

Division VIa. Landings of Norway pout from Division VIa by country are given in Table 4.1.3.

Division IIIa. Landings of Norway pout from Division IIIa by country are given in Table 4.1.4.

4.2 Effort Data

Norwegian effort data

Cpue data (tonnes per number of fishing days per GRT) by quarters from 1972-82 have been derived from sampling the industrial fleet fishing for Norway pout and blue whiting in the Norwegian Deeps (Table 4.2.1 and Figure 4.2.1). The considerable seasonal fluctuations are assumed to reflect the changes of abundance and availability of the target species, but may also be influenced by the prevailing weather conditions during winter. The curve also indicates long-term variations over the years with 1974-76, 1980 and 1982 as outstanding ones. The comparatively high cpue values in the latter half of 1982 were caused by Norway pout and, in particular, young blue whiting being very abundant on the

fishing grounds. The annual cpue values were reduced by the fractions produced by blue whiting and other by-catches to be correlated with the IYFS abundance indices for Norway pout (Figure 4.2.2). The fairly good relationship between the two sets of data indicates that the IYFS indices may be used to give a prognosis for the Norway pout fishery in the same year.

Faroese effort data

The Faroese series (kg/trawl/hour) was updated with the 1982 data (Table 4.2.2 and Figure 4.2.3). This series is in very good agreement with the Norwegian data and shows the same high cpue level for the last half of 1982.

4.3   Catch at Age and VPA Results

North Sea (Sub-area IV)

Table 4.3.1 shows the number caught by quarter from 1974 to the third quarter of 1982. Table 4.3.1 is based on Danish, Scottish and Norwegian samples (these landings account for about 95% of the total landings). The remaining landings, taken by Faroese vessels, were included by proportional raising of the quarterly summed numbers caught by other countries.

For 1982, data on age compositions were available from Denmark and Norway, while Scotland had no catch. Danish data were given for the three first quarters of 1982 only. Very large catches of 0-group Norway pout were taken in the fourth quarter of 1981, in contrast to previous years.

In last year's report two VPA runs were made. One run under the assumption that $M = 1.0$ year^{-1} and the other one under the assumption $M = 2.0$ year^{-1}. As F is probably in the order of magnitude 1.0 year^{-1}, it can be questioned whether a VPA gives any sort of evaluation of the Norway pout fishery.

For a short-lived species as the Norway pout with a high natural mortality (specimens older than three years are rare), knowledge on the fishing mortality is not essential for assessment of the state of exploitation; what really matters in this case is the ratio of M to F. When M is high, the stock must have a fast turnover and can allow for a high F, as those fish caught would otherwise die from natural causes. Due to these considerations, it was attempted to obtain an estimate of Z for Norway pout.

The first method tested is due to Beverton and Holt (1956). This method assumes Z to remain constant for the age groups used in the analysis; i.e., let t' be some age (of a cohort) for which all fish of that age or older are under full exploitation, and let $\bar{t}$ be the average age of all fish from the cohort of age t' or older, then

$$Z = \frac{1}{\bar{t} - t'}$$

Table 4.3.4 shows Z for the 1973-79 cohorts calculated by Beverton and Holt's formula, and an example of the actual calculations. As M, and thus Z, may increase as a function of age, the Z estimates given in the second column of Table 4.3.4 are probably underestimates.

The second method for estimation of Z uses cpue data from IYFS as input. Z from February in the first year of life to February in the second

year of life is estimated from

$$Z = \log \frac{cpue\ (1)}{cpue\ (2)}$$

As can be seen from Table 4.3.4, Zs derived from IYFS indices are
(on average) larger than those estimated by Beverton and Holt's formula.
The conclusion on Table 4.3.4 is that Z for Norway pout is in the
range

$$1.5 - 2.5\ year^{-1}$$

It was decided to aim at input M values in the VPA, which produce a
total mortality of 2.0 for the 1-group, and 3.0 for the 2-group and
older fish, the higher value for the mature specimens being perhaps
due to spawning stress or migration. The quarterly natural mortalities
used in the VPA are given in Table 4.3.2.

In Table 4.3.4, a comparison of some of the Zs estimated from the three
methods are presented. Terminal Fs, i.e., Fs for the third quarter of
1982, are based on the assumption that the Norway pout fishery has
remained fairly constant from 1978 until now. Terminal Fs equal
(approximately) the average Fs for the years 1978-80 (third quarter).

Table 4.3.3 shows stock numbers derived from VPA.

Figure 4.3.1 shows stock biomass (derived from VPA) together with
annual landings. Weight at age data for the stock are read from
a curve smoothed to weight at age data of catch. As can be seen,
the stock biomass has remained rather constant from 1975 to 1981.

As there are indications that $F \leq M$ for the age groups dominating
the catch, the exploitation level of the Norway pout stock is con-
sidered low, and there is by no means reasons to believe that the
fishery at its present level will cause a decline in the long-term
yield. There is clearly a need for an independent estimate of M.

West of Scotland (Division VIa)

Numbers caught at age by quarters for Scottish landings 1971-82
were available, but there were no data from other nations fishing in
the area, mainly Denmark and the Faroes. No VPA was run for this area.

Skagerrak and Kattegat (Division IIIa)

Landings from this area are almost entirely by Denmark. No data on
age composition are available.

4.4 Research Vessel Surveys

Series of research vessel data given in the previous report are
extended in Table 4.4.1. Areas to which each series apply are shown
in Figure 4.4.1. Table 4.4.2 shows data from English surveys 1976-82.

Regression of IYFS indices of 1- and 2-group Norway pout on VPA
estimates and regression of pelagic 0-group survey indices were carried
out. Summary of the results are given in Table 4.4.3. Due to the
timing of the present meeting, preliminary IYFS results for 1983 were not
available to the Working Group. Only the 1-group IYFS index vs
VPA recruits shows a functional relationship (r = 0.84).

4.5   Weight at Age in Catch

Mean weight at age by quarters in Norwegian catches are given in
Table 4.5.1. Danish weight at age data are given in Table 4.5.2.

4.6   Percentage Landings in Weight by Age

Table 4.6.1 shows the percentage landings by weight in 1979-81. In
1979 and 1980, the 1-group constituted about 70% and the 2-group about
25%. In 1981, the picture changed due to the relatively small 1980
year class, so that 1- and 2-groups in 1981 yield about the same catch.

4.7   Other Measures of Mortality

No additional measures of fishing mortality on Norway pout were avail-
able to the Working Group. Data on predation mortalities derived from
the 1981 international stomach content survey are hoped to be used
in next year's meeting.

4.8   Equilibrium Yield

Yield per recruit curves for Norway pout were given in Doc. C.M.1977/F:7
for various values of M and t_c. In that report, it is tentatively
concluded that no increase in yield per recruit could be obtained
by either an increase or a decrease in F.

4.9   Catch Predictions

Fisheries for Norway pout in the North Sea are restricted to an area
north of 56°N, with a marked seasonal peak in the third quarter in the
western part, and rather steady catches in the three first quarters of
recent years, off the Norwegian coast. Young of
the year recruit during their first winter, and the major part of the
catches is composed of 1-group fish; these represent about 70% of the
catch in weight in each year, with about 10% taken in the first quarter
and 30% in the third quarter. Numbers caught at age 1, however, may
sometimes be equivalent, if not higher, in the first quarter of some
years. Age 2 fish still contribute about 20% of the yearly catches in
weight, and the cohorts are virtually fished out after age 3. It should
be noted, however, that in 1981 the contribution of 1 and 2 year olds,
in weight, was approximately equal, due to the poor 1980 year class.

The most comprehensive series, in time and areal coverage, is that of
IYFS indices. These may be available about the end of the first quarter
in each year. IYFS index at age 1 are plotted in Figure 4.9.1,
together with the statistics of landings in the same year, and both
show parallel fluctuations. The results of other surveys are also
plotted.

For prediction purposes, it was decided to add age 1 and age 2 indices
as observed each year (instead of those for each year class, as was done
last year) and correlate this new index with the total landings in the
same calendar year, excluding the years 1970 to 1974, for the reasons
given in last year's report.

The plot is shown in Figure 4.9.2.

The regression was used to infer the 1982 catch from the 1982 IYFS
indices, and this produced an estimate of 417 000 tonnes, which is
very close to the figure extrapolated from the provisional catch data
for the three first quarters of 1982 (390 000 tonnes). The 1983 IYFS
indices were not available at the time of this meeting. They should be
available for ACFM at their next meeting,and should be used in the
equation given in Figure 4.9.2 to derive the estimate of this year's catch.

4.10   Density-Dependent Population Parameters

Raitt (1968) described density-dependent growth in Norway pout during
the early 1960s. He compared a series of weak year classes (1963-66)
with a series of strong year classes (1959-62) and found that growth
in the weak year classes was consistently better than in the strong
year classes. The difference in growth mainly arose during the first
year of life, and it could be as much as ≥ 2.5 cm for 1-year old fish.
During the remainder of their lives, the weak year classes just main-
tained the difference.

In addition to the difference in growth rate, the weak year classes also
showed an increased fecundity per unit weight (by a factor of 2.0 or 2.5)
and a reduced age at first spawning; instead of spawning at 2 years at
age, they all started spawning at age 1.

Since the work of Raitt was published, more data on length at age have
been collected during the annual Scottish autumn surveys, and also
from commercial catches taken by various countries.

Data collected during the most recent years (year classes 1970-81) in
the Scottish autumn surveys have been compared with Raitt's data for
the earlier periods in Figure 4.10.1. It appears that in recent years
the fish have been growing even more slowly than in Raitt's period,
with the slowest growth (1959-62).

The same is seen when length at age data for year classes 1973-76 taken
in the commercial catches during winter are compared with Raitt's
data (Figure 4.10.2). Length at age data from commercial winter
catches (from Doc. C.M.1978/G:12) could not be compared directly to
Raitt's data, as the latter contain only data collected during autumn
and spring surveys. In order to make a comparison, autumn and spring
figures from Raitt's paper have been averaged to obtain "winter" length
at age data for the Scottish surveys. Again it is seen that growth
in the most recent year classes (1973-76) was even slower than in
Raitt's period of slow growth.

In order to find out whether the recent slow growth is due to the
same density dependence as described by Raitt, one has to compare stock
density in recent years with those in the early 1960s. The only
time series available to the Working Group for this purpose was the
Scottish autumn surveys, which were already used by Raitt, and
which have been continued up till present (Table 4.4.1). Figure 4.10.3
shows the abundance of year classes 1959-81, both as 0-group and
as 1-group plotted in a time axis. The difference in abundance
between the two periods used by Raitt (indicated as A and B) is very
obvious both in the 0-group and the 1-group series.

A comparison of recent year classes (period C for which length data
are available from commercial catches, and period D with data from
Scottish surveys) is more complicated. The average abundance as
1-group fish in recent years is certainly not higher than in Raitt's
period of high recruitment (1959-62). In fact, the abundance of
1-group fish has fluctuated randomly over the entire period, without
showing a clear long-term trend.

For the 0-group fish, however, the picture is completely different.
Here the abundance in recent years has been much higher than in earlier
years, even higher than in Raitt's period with high recruitment. The
mean abundance of year classes born after 1970 is approximately
6 times as high as the mean for the earlier year classes, including
the year classes 1960-62 (no estimate is available for 1959). Thus,
it can be concluded that after 1970 there has been a very strong

increase in recruitment, which was reflected in the abundance of 0-group fish. Because of the strong development of the fishery after 1970, the abundance of the fish at age 1.75 (autumn survey) had been so much reduced already, that at this age the abundance of the year classes was not much different from that in the period 1959-62.

Raitt showed that density-dependent growth mainly occurred during the first year of life. As the abundance of Norway pout during their first year of life has been much higher in recent years than in the earlier period, one should expect that growth rate would be lower now than in any of the earlier periods. This is precisely what is shown by the length at age data in Figure 4.10.1a,b.

It can, therefore, be concluded that despite the high fishing mortality in the last decade, the abundance of Norway pout has been so high (due to greatly increased recruitment) that growth was reduced even below the minimum level recorded in both of the earlier periods.

No new data were available to the Working Group concerning fecundity in recent years, so no comparison could be made between the present situation and the early 1960s.

5.   SANDEEL

5.1   Landings 1981-82

North Sea 1981

Total landings of sandeels from the North Sea for the period 1952-82 are given in Table 5.1.1, with new data for the latter half of 1981; the total catch in that year was 569 000 tonnes, a decrease from 728 000 tonnes in 1980. All countries fishing sandeel, except the United Kingdom, reported a decrease in catch.

Monthly landings for the years 1979-82 are given in Table 5.1.2. In 1981, the fisheries showed the usual seasonal pattern, although a higher percentage (39%) of the catch was taken in the second half of the year than in 1980 (19%), owing largely to bigger Danish catches in the period July-October.

Landings by months for the areas shown in Figure 5.1.1 are given in Table 5.1.3, and annual totals in Table 5.1.4. Increases in catch in 1981 were recorded mainly in the southern part of the North Sea and at Shetland.

North Sea 1982

In 1982, total landings from the North Sea increased to 611 000 tonnes, moderate increases in catch being reported by Denmark and the United Kingdom, and a small decrease by Norway (Table 5.1.1). The proportion of landings taken in the second half of the year decreased to 15% of the annual total, and no Norwegian landings were reported in this period.

Substantial increases in catch were reported in Subarea 1a and 6 in the southern North Sea, but perhaps the most significant change was the decrease of landings from the offshore areas of the northern North Sea (Subareas 1c and 2c). The only areas, where catches were made after July, were Subareas 3 and 6 (off the Danish coast) and at Shetland.

Division VIa

The new Scottish fishery in the Minch almost doubled in 1982 to a catch of 10 900 tonnes (Table 5.1.5).

Division IIIa

According to preliminary data on landings reported to ICES, a decrease in landings occurred in 1982 to 22 000 tonnes (Table 5.1.6).

5.2   Fishing Effort and Catch at Age

Fishing effort

The only new data available were the number of hours fishing at Shetland in 1982 (Table 5.2.1). These data indicate a 12% increase in effort since 1981.

Catch at age

As in the previous report, catch in numbers per age were compiled for three assessment areas, shown in Figure 5.1.1 (southern area, northern area, excluding Shetland, and Shetland). Relevant data were provided by Denmark, Norway and the United Kingdom. The small landings by Faroes and Sweden were allocated to age, using Danish and Norwegian data.

The catches in number at age for 1981 and 1982 are given by months in Tables 5.3.1 - 5.3.3. In the southern area (Table 5.3.1), there was a major increase in the catch of 0-group in 1981, which was due to the increase in landings in the second half of the year. In 1982, catches of 0-group reverted to a low level, and 1-group made up the largest age component. In the northern area (Table 5.3.2), catches were composed mainly of 0-3 groups, the total numbers caught decreasing significantly in both 1981 and 1982. At Shetland (Table 5.3.3), the 0-group continued to make the largest contribution to the catches, although in 1982 the 1-group showed a proportionately greater increase in the catches.

5.3   VPA Results

Trends in the sandeel fisheries in recent years were analysed by VPA. For consistency with the previous year, separate assessments were made for the southern and northern areas of the North Sea, and for Shetland (see Figure 5.1.1). For the first two of these areas, the analysis was carried out using half-yearly data, while for Shetland the annual data were used. The value of natural mortality M was taken to be 0.5 year^{-1} for all ages in all years.

The input catch in number data are given in Tables 5.3.4, 5.3.7 and 5.3.10. After trial VPA runs were made, a further analysis was carried out, using, as input, mean values of F over the period 1978-80. In the case of Shetland, the input values of F were corrected by making a correlation between mean values of F and fishing effort over the period 1976-81. The resulting values of fishing mortality are given in Tables 5.3.5, 5.3.8 and 5.3.11, and the stock size in numbers in Tables 5.3.6, 5.3.9 and 5.3.12. The results of these analyses are given for each assessment area separately below.

For ease of comparison, the principal results from each analysis are summarised in Tables 5.3.13 and 5.3.14.

Southern area of the North Sea

The analysis was carried out on the assumption that the fishing mortality on age groups 1-4 in the second half of 1982 was the same as in the same period in the years 1978-80. The results indicate some increase in F in the first half of the year in 1982 and, therefore, also in the year as a whole. In fact, the estimate of F in 1982 is the highest recorded.

In the historic series, the value of F on 0-group sandeels during the second half of the year has not been consistently higher or lower than that on older age groups, although it has varied considerably from year

to year in a way that shows no correlation with fishing mortality on older sandeels (Table 5.3.14). In the absence of independent recruitment indices, there is thus no reliable method of estimating the value of F on the O-group in 1982. If one assumes that it is the same as the average during the period 1978-80 (0.16), the recruitment of the 1982 year class is estimated to be rather low (40% of the long-term mean), whereas the 1981 year class is estimated to be the largest recorded (Table 5.3.13).

Another approach investigated was to correlate the estimated year class strength as O-group against catch in number of O-group (Figure 5.3.1). Up to 1976, negligible quantities of O-group were caught in the southern North Sea. For the subsequent period 1977-81 there is a very weak relationship. By taking a regression forced through the origin, the low catch of O-group in 1982 might indicate that the provisional estimate of the 1982 year class is not totally inaccurate.

No recent effort data are available for comparison with estimates of F. Effort data for the years 1972-78, given in Doc. C.M. 1979/G:26, show some correlation with estimates of F from VPA for the same period $(r = 0.68, n = 6)$ (Table 5.3.15). This suggests that effort data would be of value in making assessments for this area and might perhaps be refined.

Northern area of the North Sea (excluding Shetland)

In the northern area, catches during the second half of 1982 were almost entirely of O-group sandeels. Values of input F on 2-group and older were, therefore, applied to the catches made during the period 1978-80, obtained from a VPA trial. The results suggest a small reduction in F in 1982 on the 1 year olds and older (Table 5.3.14), but coupled with the large decrease in numbers at age caught (Table 5.3.7), this indicates a significant decrease in the size of the sandeel stock in the northern area.

As input F on the O-group in the last half of 1982 a value of 0.40 was used, which was the average for the period 1978-80. Compared with the southern area, the estimates of F on the O-group have been much more constant (Table 5.3.14), in which case the average may not be an unreasonable figure to take. On this basis, recruitment of the 1981 and 1982 year classes was low. However, the complete absence of Norwegian catches during the latter half of 1982 (which was the result of a positive decision not to fish for O-group sandeel) may indicate some decrease in total effort on the O-group in which case the estimate of the 1982 year class may be too low.

As in the case of the southern area, there is some correlation between the catch in number of O-group and the estimate of final year class strength (Figure 5.3.1). Unless effort on this age group changed markedly, then this also indicates that the 1982 year class may be rather poor. If in fact effort on O-groups has decreased, this correlation may be of little value.

A comparison of estimates of F with earlier fishing effort data given in Table 5.3.15 also indicates some correlation. Further data for this area also might, therefore, provide evidence for input F values.

Shetland

Since fish aged 1 and older are mainly taken in the first half of the year, and the O-group mainly in the second half, effort data for the respective periods were used to provide estimates of input F for these two age categories (Table 5.2.1). The results indicate a significant

increase in F on ages 1 and older in 1982. Fishing mortality on the
0-group appears to have remained roughly constant from 1980-82. If
this is so, then the 1982 year class appears to be the largest so
far recorded.

The data on fishing effort and estimates of F are given in Table
5.3.15, and scatter diagrams illustrating the correlation are shown
in Figure 5.3.2. Excluding 1975, when the fishery did not exploit
the 0-group (only the second year of the fishery in this area), there
is a weak correlation in the case of both 1-7 year olds and the
0-group.

Comparison of areas

The VPAs carried out for each area must be treated with considerable
reservation because of lack of reliable estimates of M or of independent
evidence of stock size or mortality rates. They nevertheless indicate
little evidence of inter-dependence between the areas. Recruitment
estimates are not correlated. In the northern part of the North Sea
it would appear, that the sandeel stock may be increasing at Shetland
and decreasing in the offshore areas of the northeastern North Sea.

5.4   Research Vessel Surveys

No relevant data were available for comparison with the results of VPA.

5.5   Weight at Age

Data for 1981 and 1982 were provided by Denmark for the total North Sea
(Table 5.5.1). Since these were mainly collected in the southern
part, they show no clear evidence of a change in weight at age
compared with previous years.

Norwegian data for 1982 in Table 5.5.2 support data given in earlier
reports for the northern North Sea, but data for the southern North
Sea indicate much higher weights at age. The reason for this is
not known, but further research on this subject is desirable.

Corrected and updated mean weights at age for Shetland are given in
Table 5.5.3. These indicate no significant change in 1982.

Mean weights at age appropriate for the middle of the year (1 July)
have been calculated as the mean of all estimates in the months of
June and July published in previous reports. As estimates for the
older ages are subject to sampling errors, the estimates have been
smoothed by fitting von Bertalanffy growth curves. The observed and
corrected means for each assessment area are given in Table 5.5.4.

5.6   Percentage Landings in Weight by Age

Table 5.6.1 gives percentage landings by age updated for 1981 and
1982. In the northern area, the catch was distributed mainly among
0-3 year olds. In the southern area, 1981 was unusual in that the
0-group made up 42% of the total weight. At Shetland, the 0-group
continued to form the largest single component by weight and reached
its highest level (48%) in 1982.

5.7   Other Measures of Mortality

No new data were available for comparison with the results of VPA.

5.8   Yield per Recruit

Using smoothed weight at age data given in Tables 5.5.4, and
exploitation patterns derived from the VPA results (Tables 5.3.5,

5.3.8 and 5.3.11), yield per recruit curves were calculated for each assessment used assuming a) current exploitation patterns and b) the same exploitation patterns with complete cessation of fishing on the O-group.

The current exploitation patterns used were:

Proportional F on each age (average for years 1977-81)

Age	Southern North Sea	Northern North Sea	Shetland
0	0.17	0.55	1.00
1	0.60	0.76	1.00
2 and older	1.00	1.00	1.00

The yield curves are shown in Figure 5.8.1.

At current levels of F estimated by VPA, the following increase in yield per recruit is estimated, if O-group exploitation is ended:

	Mean F	Estimated gain in Y/R by ending fishing on O-group
Southern North Sea	$0.95^{1)}$	9%
Northern North Sea	$0.95^{1)}$	45%
Shetland	$0.70^{2)}$	22%

1) Mean F on 2-5 groups 1977-81.
2) Estimated F in 1982.

In all cases, the percentage gain would be higher at higher levels of fishing mortality. These results indicate that some gain in yield might be achieved by management practices designed to avoid exploitation on the recruiting year class in the latter half of the year.

5.9   Catch Prediction

In the absence of reliable estimates of recruitment to any of the North Sea sandeel assessment areas, calculated predictions of catch in 1982 at different levels of fishing mortality would be misleading.

At Shetland, where there is some correlation between estimates of F on the O-group and fishing effort in the second half of the year, catches in 1982 suggest that the 1982 year class may be a strong one. If so, the catches in the first half of 1983 may be above average. There is, however, no method of predicting the strength of the 1983 year class, which, in an average year, would be expected to contribute almost half of the catch in weight.

Predicting recruitment to the southern and other areas of the North Sea i even less certain and, for this reason, no forecast can be made for 1983.

5.10   Density-Dependent Population Parameters

No papers on density-dependent growth on sandeel have been published yet, but it is likely that the phenomenon does occur in a pronounced way in this species.

The former Industrial Fisheries Working Group has repeatedly drawn attention to the great differences in growth rate between different areas of the North Sea (see, for example, Doc. C.M.1978/G:12). The sandeel in offshore areas of the northern North Sea grow very much more

rapidly than those in the southern North Sea and than those around the Shetlands. Length at age 2-6 may differ by 5-10 cm, and the weight of sandeels in the offshore northern area may even be three times as high as that of comparable age groups in the other areas.

Differences in growth rate may also occur between different fishing grounds in the same part of the North Sea. Macer (1966) found differences in growth between sandeels on the southern edge of the Dogger Bank and those slightly further south on the Norfolk Banks. He suggested that these differences could be caused by depletion of food supplies on one of the sandeel grounds. Also along the Danish coast, pronounced differences in growth rate are observed between neighbouring fishing grounds for sandeel.

The explanation of the differences in growth by differences in food supply is a very reasonable one, because it is unlikely that genetic differences will exist between sandeel populations of adjacent fishing grounds. Because the sandeel shoals are restricted to certain well-defined areas (related to the type of the bottom), it is quite conceivable that they will exhaust their food supply earlier on one ground than on another.

Although the growth rate of sandeels on specific fishing grounds will probably be related to the density for that particular ground, it will be much more difficult to demonstrate such a relationship for the North Sea as a whole. Food supply (and thus growth rate) for individual fish may not only be determined by the total number of sandeels in the sea, but also by the abundance of other fish species competing for the same supply of food (large copepods). Fluctuations in the stocks of pelagic plankton feeders such as sprat and herring may, therefore, have at least as strong an effect upon the food supply of sandeel (on an overall North Sea scale) as the density of sandeels themselves.

6.   SPRAT IN DIVISION IIIa

6.1   Landings

Revised landing figures for 1981 and preliminary data for 1982 are shown in Table 6.1.1. The new information shows a decrease from the high 1980 catch of 105 000 tonnes to 87 000 tonnes in 1981. In 1982, this figure was approximately halved, and though Danish landings in the last quarter of the year are not included, it is not likely that the final figure for 1982 will substantially exceed 50 000 tonnes. The three nations, which mainly exploit the sprat in Division IIIa, show about the same rate of decline from 1981 to 1982, i.e., 50-60%.

The catch trend in Division IIIa shows some similarities to those in the adjacent waters. In Figure 6.1.1, a comparison is made of the development in the sprat fisheries in the North Sea, Division IIIa and Sub-divisions 22-25 in the Baltic. Roughly speaking, there is an increase in landings during the first half of the 1970s, followed by a decline to about the former level in the late 1970s and early 1980s. The decrease in Division IIIa was apparently delayed by the strong 1979 year class (see Section 6.9), while the earlier decrease in the Baltic is ascribed to a transfer of effort caused by good cod year classes (Doc. C.M.1982/Assess:16).

The distribution of landings on the Kattegat and Skagerrak, respectively, by quarters of each year during the period 1981-82 is shown in Table 6.1.2. From Table 6.1.1 it appears, that the major part of the sprat landings were taken in the Kattegat until 1980, when a reversal took place, indicating a northerly displacement of the main distribution of Division IIIa sprat.

6.2 Effort

No data are available on the industrial effort in Division IIIa. There are reasons to believe, however, that the level has been rather stable in the last 5-6 years.

6.3 Age Composition by Weight

Using the mean weights shown in Section 6.5, the following averages for the third quarter in the period 1976-80 were arrived at:

Age group	0	1	2	3	4+
% of total catch (in weight)	3.4	89.4	5.7	1.2	0.2

The figures indicate the importance of the 1-year old sprat and emphasize the difficulties involved in making useful prognoses for this stock.

6.4 Research Vessel Surveys

Acoustic surveys have been carried out in the Skagerrak and Kattegat in 1976 and 1979-82 by Sweden, Norway and Denmark. The surveys were mainly directed at herring, and sprat data from the later years have not been worked up to a useful level. One reason for this is, that the shallower part of Kattegat is not included in the surveys and may contain the major biomass of the sprat stock in Division IIIa. Even so, the surveys have shown a clear trend of decline since 1979. The percentage proportion of sprat in the trawl catches also indicates a decrease in the distribution area, i.e., concentration closer to the coast.

6.5 Weight at Age

Mean weights per quarter averaged over the period 1976-79 are shown in Figure 6.5.1. The rapid growth between the second and third quarters makes it difficult to produce a "standard" set of values applicable to all years. The mean weights shown in the text table below are based on Figure 6.5.1

Quarter	W.R. 0	I	II	III	IV
1	−	3.2	11.0	17.5	25.0
2	−	3.8	12.2	22.0	27.4
3	2.5	8.4	19.0	26.5	28.5
4	4.3	15.0	19.5	27.0	−

6.6 Fishing Mortality and Stock Size (VPA)

Numbers caught at age have been estimated since 1975, using Danish data raised to total catch excluding the fjords of western Norway (IVa E). The results are shown by quarters in Table 6.6.1, including July-September 1982, as Danish data were not yet available for the last quarter of that year.

A VPA was run on the following assumptions:

Natural mortality: 0.275 per quarter (1.10 annually)

Input fishing mortality: 0.250 per quarter (1.00 annually)

Age at first maturity: 1.5 years.

For technical reasons, no runs were made for the second quarter of 1982.

The calculated quarterly Fs are shown in Figure 6.6.1. As could be expected, the highest values occur in the third quarter with additional high figures in the last quarter of some years. The highest annual values are F = 1.92 and 1.73 in 1977 and 1978, respectively, followed by a decrease to F = 0.9 in 1980-81. The detailed results are shown in Table 6.6.2.

The spawning stock declined from 1975 to a very low value in 1978, followed by an increase in the last years. Stock in numbers calculated by VPA is shown in Table 6.6.3.

6.7-6.8: No calculations of other measures of mortality and equilibrium yield were calculated.

6.9   Prognosis

Indices of 1-group abundance of sprat in Division IIIa have been collected by Sweden in connection with IYFS since 1971. The time series is shown in Table 6.9.1 together with VPA figures on 1-group strength as at 1 January.

There appears to be some correlation (r = 0.6) between the two sets of estimates, but unfortunately, the Swedish data for year classes 1981 and 1982 could not be made available during the meeting of the Working Group, and, therefore, no prognosis could be made.

A correlation between IYFS 1-year old index and yield in the same year gave reasonable correlations (r = 0.79) significant on the 0.05 level and is shown in Table 6.9.2.

The results for the 1982 and 1983 surveys should, therefore, be examined by ACFM to eventually make a prognosis for this stock.

7.   SPRAT, NORTH SEA

7.1   Landings, 1981-82

Landings by fishing nations and by areas for the years 1972-82 are given in Table 7.1.1. For Denmark, catch data for the last quarter of 1982 were not available, and landing figures exclude by-catches. For other nations, the catch figures are assumed to include by-catches.

Total landings decreased from 323 000 tonnes in 1980 to 209 000 tonnes in 1981, and further to about 130 000 tonnes in 1982, assuming an estimated Danish catch of 20 000 tonnes in the last quarter. The decrease was observed in both the western and eastern parts of Division IVb, while catches in Division IVc remained at the same level. The decline in total landings from 1980 to 1982 was mainly due to reduced Danish catches, which account for 70-90% of the total.

The overall catch statistics of Table 7.1.1 seem to confirm the observations in later years: a declining stock and a shift in the distribution towards the southern part of the North Sea.

Sprat catches by months and by international reporting areas (Table 7.1.1) in 1981 and 1982 are given together with data of the two preceding years in Table 7.1.3. Except for reductions in quantity, no marked changes in the fishing pattern were observed. A major part (40-50%) of the landings came from Division IVb east in July-October.

Division VIa

Landings of sprat from this area are now of minor importance. In 1981 and 1982, landings were 1 600 and 1 100 tonnes, respectively, mainly from the inshore fishery to the west of Scotland (Table 7.1.2).

7.2   Effort Data

No data on fishing effort were available.

7.3   Catch at Age and VPA Results

Catch at age

Numbers caught per age group were compiled for Sub-area IV. Data for 1981 and 1982 were available for catches by Denmark, Norway, England and Scotland. Danish data for 1982, however, covered only the first three quarters of the year. Data for landings in 1982 by other nations were not presented, but these accounted for a minor part of the total.

Table 7.3.1 is an extension of the previous data series on catch in number by age group for each quarter of the year; the third quarter of 1982 being the last.

VPA

Catch in number by age (Table 7.3.2) were used for VPA on a quarterly basis in the same way as in previous analyses.

No effort data or other means for a calibration of the input Fs were available. The acoustic surveys (see Section 7.4) in January 1983 were limited in coverage, and the estimated biomass could not be utilized in the VPA.

Lacking other options, the VPA was run on the same basis as outlined in the 1982 report of the Working Group. Fishing mortalities in the third quarter of 1982 were assumed approximately equal to the average

Fs of each age group, separately for ages 1-4 year olds in the third
quarter of the years 1978-80. The input fishing mortality on the
0-group was chosen so that this recruiting year class was in accord
with the low recruitment in later years: 23×10^9 at the beginning of
the third quarter of 1982. The natural mortality, M, was set at 0.8,
corresponding to 0.2 for each quarter, as applied in earlier analyses.

The mean weights at age in the first quarter given in the previous
Working Group report (C.M.1982/Assess:6, p.23) were used to compute
the stock biomass at the beginning of the year. The adult stock,
spawners, was calculated as the sum of age groups 2, 3 and 4.

The resulting Fs per quarter are given in Table 7.3.3, and the stock
as number and biomass in Table 7.3.4. The overall changes in F and
stock biomass during the period 1974-82 are given in Figure 7.9.5.

7.4   Acoustic Survey

The ICES-coordinated acoustic survey for North Sea sprat in January
1983, in which United Kingdom vessels participated, covered only the
western part of the North Sea. Estimates of sprat biomass for each
half statistical rectangle are given in Figure 7.4.1, standardized to
a target strength of -29dB kg^{-1} as in the previous report. The total
biomass estimate for the area surveyed is 80 000 tonnes.

For comparison with previous years, biomass estimates for each ICES
Sub-division are given below:

Estimated biomass of sprat ('000 tonnes) in each Sub-division
standardized to a target strength of -29dB/kg

	1981	1982	1983
IVa W	3.6	4.9	2.1
IVb W	99.3	48.7	14.6
IVb E	26.8	23.6	No survey
IVc	65.4	90.0	62.5
Total	195.1	167.2	79.2 (excl. IVb E)

(1981 estimates from C.M.1982/Assess:6; 1982 estimates
from Johnson, C.M.1982/H:13.)

The "Planning Group on ICES-Coordinated Herring and Sprat Surveys", which
met in Aberdeen in mid-February, provided evidence from in situ measure-
ments of a relationship between a target strength per kg and length of
the form
$$\text{TS kg}^{-1} = -8.7 \log l - 19.6 \text{ dB/kg (l in cm).}$$

If this is accepted, then biomass estimates of small sprat (1-group)
are likely to be too high by a factor of approximately 1.6. From the
composition of samples of sprat taken during the 1983 survey in
different areas, the Planning Group estimated that the corrected estimate
of biomass should be 70 000 tonnes. Detailed data on the length com-
position of sprat by area on the previous surveys were not available
to the Working Group, and no corresponding corrections have been made.
It was recommended by the Planning Group that corrected estimates,
allocated into 1-group and older sprat, should be included in the report
of the 1983 survey to be reported to the Statutory Meeting.

Trawl survey results

Trawl survey results are given in Section 7.9.

7.5 Weight at Age

In the previous Working Group report, a new set of weight at age by quarters was presented. The data were mainly based on observed weights of sprat in Danish catches in recent years, except for the 1-group in the first quarter. For this age group, a weight of 1.0 gram at the beginning of the year was chosen to represent weight in the stock.

As no additional information on weights were presented, the reported weight (C.M.1982/Assess:6, p.23) were applied for the calculation of stock biomass given in Table 7.3.4 and Figure 7.9.5.

7.6 Age Composition by Weight

An illustration of the dependence of the fishery on two age groups was given in last year's report of this Working Group (Assess:6, p.23). The mean contribution of each age group, 1974-77, was calculated from catch in number and mean weight in catch.

For comparison, the percentage contribution shown is compared to similar data for 1981 (the last year of complete catch data):

	Age groups					
	0	1	2	3	4	5
1974-77	1.0	32.7	51.2	13.6	1.4	0.2
1981	0.6	48.0	41.3	9.8	0.2	+

As can be seen from the figures, recent catches are, as in previous years, dependent on 1- and 2-group sprat, accounting for 85-90% by weight. The reduction in older ages is also notable.

Data on catches can, therefore, provide little information, which may be used to make a catch prognosis into next year.

7.7 Other Measures of Mortality

No additional measures of mortality were available to the Working Group.

7.8 Factors Affecting Yield

Equilibrium yield

To broaden the range of aids used for the assessment of this stock, the logistic approach has been considered instead of the usual analytical model, but still using the results of VPA as given in Section 7.3.

In this exercise, stock biomass at the beginning of the year (instead of cpue that is normally used as an index of biomass) has been plotted against the ratios of catch in weight in each fishing season to mid-season (1st of January) biomass, the latter being estimates of fishing pressure.

The equilibrium line has been fitted in two different ways (Figure 7.8.1). In the first (Walters' first approximation), biomass is regressed on the catch/biomass ratio in the previous year; in the second (Gulland), the catch/biomass ratio is an average of ratios in the two preceding years. In both calculations, values for the years 1981 and 1982 have been used, although biomasses derived from VPA are strongly dependent on input parameters.

Yield curves were thus obtained by multiplying the fitted estimate of the biomass by the corresponding catch/biomass ratio on the abscissa, giving an equilibrium catch in weight. These curves are plotted in Figure 7.8.2, together with observed landings, plotted against the catch/biomass ratio.

The Group attached limited confidence to these results as a means of predicting MSY, but they are worth considering on the following grounds:

-   Y/R curves for a species with high natural mortality are generally flat-topped and this is misleading, as they tend to show that yield can be increased or stabilized at very high values of fishing mortality. Logistic yield curves give a more realistic picture, where yield obviously decreases as fishing pressure becomes excessive.

-   Although some environmental effect is suggested to have played a part in the decrease of the North Sea sprat stock, these curves also indicate that in recent years, fishing pressure has been far in excess of the likely MSY value, leading to catch/mean biomass ratios well above unity.

-   The curves also show that the MSY level is obtained for a catch/biomass ratio similar to the rate of natural mortality (about 1.0 in this case, whereas M = 0.8) as is often assumed as a rough approximation.

Environmental effects and interactions with other species

Although this Working Group and previous ones have attempted to explain the developments in the sprat stock mainly as the results of man's interference through fishery, this approach may in the end not lead to an answer to all questions with which we are faced at present. The sudden development of the North Sea sprat population in the early 1970s clearly could not be attributed to any change in the sprat fishery, and conversely, the present decline may also be partly due to factors other than the fishery.

The hypothesis of a natural cause for the decline of the sprat stock (working in combination with a high fishing mortality) is supported by the fact that the sprat stock in Division IIIa has shown a simultaneous decline with that in the North Sea, although fishing mortality and exploitation pattern may probably be different between the two regions. Also, in the North Sea, the sprat stock first started to decline in the northwestern part, although this area was not the one with the highest fishing intensity. During the 1979 fishing season, the main sprat concentrations seemed to shift towards the southern North Sea, and from 1980 onwards, major sprat concentrations appeared in the Thames estuary, where they had been absent for more than 10 years.

All these phenomena suggest that, in addition to the fishery, some environmental factor has been responsible for the shift in distribution and decline of the sprat population. Whether this environmental factor was a change in hydrographic conditions, food supply, or predation, is something that is not at all clear at this moment. One study is available (Last, 1982), which suggests that predation in the very young stages may have increased. This author showed that juvenile herring along the English east coast were feeding heavily upon pre-metamorphosis sprat during the summer months. If this is a widespread phenomenon, the present revival of herring stocks in the North Sea (and Division IIIa) could have had a detrimental effect upon sprat recruitment. In this respect, it is worth noting that the strongly improved sprat recruitment started at the time when the North Sea herring had reached a very low level.

However, this hypothesis about herring-sprat interaction is largely speculation at present, and more quantitative data should be collected to establish the relationship in a convincing way. Still, it would be prudent at present to acknowledge the possible existence of such a

relationship, and thus the possibility that sprat recruitment will remain relatively low for a period to come.

7.9   Catch Prognosis

Prediction of the last winter season's catches for North Sea sprat

A paper by Burd and Johnson (1983) shows a series of regressions of international landings of sprat for each winter season from 1971/72 to 1980/81 on the IYFS results for the following February. That is, the landings of the 1980/81 season are related to the 1981 IYFS results. These (Figure 7.9.1) indicate a generally close correspondence of the two results, which would enable the IYFS result to be used to predict the most recent season's catches before statistics become available.

Prediction of the future seasons' catches

The exploitation of North Sea sprat can be described as follows: the young of the year become progressively available to the fishery as ages 0 and 1 in the first winter of their life. As age 1 fish, they are caught in the first quarter in the western central North Sea (Division IVb west) fishery developing from November to March, and later in the eastern fishery, which occurs mainly in July-November. Mostly age 1 and older (up to age 4) fish are ultimately caught, mainly in the western fishery.

The relative catch weight at age in the western Division IVb fishery is about 33% of age 1 and 50% of age 2 fish, while the eastern Division IVb fishery is composed of 74% of age 1 fish.

Since such a large proportion of fish are taken by the second winter of life, the range of survey indices available to explain exploitable biomass and to make yield prognosis is limited to those of 0-group fish in the last quarter or 1-group fish in the first quarter. Available indices are plotted in Figure 7.9.2, together with the landings statistics in the subsequent year and the subsequent season. In principle, the most obvious choice of index is the IYFS 1-year olds, but due to an interruption in 1975 and adverse conditions in 1979, this series is rather short. It has, however, the advantage of an extensive coverage of the North Sea, though a serious limitation is that inshore areas on the English coast are not sampled.

In the future, the Isaac Kidd mid-water trawl (IKMT) surveys conducted at the same time may provide an alternative series. Alternatively, a joint index derived from standard bottom trawl and IKMT sprat catches may be worth considering. An IYFS is carried out while recruitment is in progress; IKMT selectively catches smaller individuals than those caught by the bottom trawl, and this might give rise to a serious bias if only one of the two indices are considered. In recent years, when the stock was rapidly declining, both equally show the trend downward, as does the 0-group index for the Scottish November mid-water survey, but several more years of data will be needed before these new indices could be used with confidence for catch predictions. Catches by area for the Scottish 0-group survey in 1980-82 are shown in Figure 7.9.3.

An alternate solution can be found with the acoustic surveys, when some technical and practical problems have been solved. One problem is the differential target strength between sprat of different size and/or age, which prevents year comparisons on a relative scale; another is the discrimination between young sprat and plankters, and the third one is the practicability of the method in shallow areas where young sprat are aggregated. In spite of these problems, recent figures confirm the decline of abundance in the western part of the North Sea.

The use of statistics of catches at age 1 in the first quarter in commercial fisheries has been considered as an alternative means of predicting yield in the subsequent autumn/winter season. It proved unsuccessful, partly because it was not possible to separate these catches between areas and fisheries, partly because no account could be taken of fishing effort. Such effort statistics and cpue data would in any case have to be used with great care, as there are indications that the catch per unit effort has increased in some localities, and evidence exists that this is linked to the reduction of distribution area along with the reduction of the stock.

For all the reasons given, the Working Group is not in a position to produce any definite prediction through this approach, but the sharp decline indicated by all available clues should be a matter of concern.

ACFM should certainly consider the level of the 1983 IYFS 1-year old index, when this becomes available. Landings by seasons are shown plotted against this index for their convenience (Figure 7.9.4). It seems to indicate that while a low index tends to predict a low catch, a high index does not necessarily lead to a high catch in the next season.

As outlined above, all indicators of changes in stock size independently demonstrate a decline during the last 5 years. At the same time, the area of distribution has contracted, and the centre has shifted towards the southern North Sea. Possibly also, recruitment has decreased. Figure 7.9.5 shows the changes in catch and biomass since 1974.

Uncertainties exist about the size of the sprat stock at present, but indications are that it is of an order of 100 000 tonnes. Maintaining fishing at the rate estimated for later years, together with continuing low recruitment, will possibly reduce the stock further by the end of 1983.

Other pelagic fisheries have demonstrated that catch per effort may not be reduced at low stock levels. It is, therefore, possible that fishing will continue at economically acceptable rates for some vessel types (e.g., purse seines) until a sudden collapse of the fishery occurs.

Several possible causes of the decline in sprat abundance have been hypothesized in Section 7.8, such as high fishing intensity, environmental change and predation by herring. Since each of these causes seems likely to continue to act into 1983, it seems probable that,at best, the 1983 landing will be no bigger than that of 1982.

ACFM should examine the IYFS results for 1 year olds, when they become available and give the best advice possible in the light of the result.

7.10   Density-dependent population parameters

From the data available to the Working Group, no conclusions could be drawn as regards the effect of stock density upon growth rate or other stock parameters.

8.   CHANNEL SPRAT (ICES Divisions VIId,e)

The Working Group was presented with no data to establish the relationships of the sprat population in Divisions VIId and e. Evidence is, however, provided in Section 8.4, that there are spawning concentrations in both the eastern and western parts of the Channel. That in the eastern Channel may be an offshoot of the spawning area in the southern North Sea, whereas that in the western Channel appears to be isolated both from spawning concentrations in the eastern Channel and in the

Celtic Sea. Since the majority of catches are at present taken in the western Channel, the Working Group decided tentatively to treat Division VIIe as an assessment unit.

8.1 Landings, 1972-82

The nominal annual catches by countries for the years 1972 -82 are presented in Table 8.1.1, but a breakdown into eastern (Division VIId) and western (Division VIIe) Channel proportions is not available.

It is known that most of the United Kingdom and Netherlands catches are taken in the western Channel (west of 2°W), and it is likely that most of the French landings originate from the eastern Channel. The Danish landings may include an element of catch from outside this Division, although it is known from sightings and boardings by the United Kingdom Fishery Protection Service that Danish pair-trawlers have been operating in the western Channel since about 1979 in the winter months. Their catches have consisted of mackerel, horse mackerel, pilchard and sprat, and varying mixtures of these, but some of their effort has been directed towards sprat.

However, accepting the catches as presented, it is seen that there has been a substantial increase in catch in 1979 and 1980, but the situation in 1981 and 1982 is not clear.

Western Channel (Division VIIe)

General description of the fishery

A detailed description of the fishery is only possible for the United Kingdom component at present. The majority of the United Kingdom catches is taken from the Lyme Bay area (03°40' - 04°00'W) within 20 miles of the coast over the months September-February. This fishery has been regularly sampled since 1966, and catch statistics are available from 1905 on.

Figure 8.1.3 shows the total seasonal catches by United Kingdom vessels from the 1946/47 season to date, and the seasonal nature of the fishery is illustrated by Table 8.1.2, which shows the monthly catches from the 1961/62 season to date.

Up to 1959, the fishery was undertaken by small local vessels working bottom trawls with sprat mesh cod-ends attached. Seasonal catches then varied mainly between 500 - 1 500 tonnes, and the main outlets were for canning and fresh sale. In 1959, pelagic pair trawling was first successfully introduced, and over the following decade this method gradually became the predominant one, although seasonal catches showed only a gradual increase up to the early 1970s. In this period, an alternative market developed for pickle-cured fish, which were exported in barrels to Sweden and to the Federal Republic of Germany. In 1969, single boat pelagic trawling was introduced, and this method in turn became the predominant one over the next few years, particularly after the general introduction of headline transducers.

The next significant change took place in the mid-1970s, when a few larger single boat pelagic trawlers commenced fishing earlier in the season than was formerly the case, and catches then showed a considerable increase in the July-September quarter (See Table 8.1.2).

At this time, a high proportion of the summer-caught fish were sent for fishmeal due to the fact that they were still feeding and so unsuitable for fresh or pickle-cured outlets. In earlier years, the start of the fishing season was primarily determined by the feeding state of the fish, since in this region sprat usually cease feeding towards the end of September or in early October.

The final significant development in this fishery to date took place
in 1979-80, when an overspill of effort from the southwest mackerel
fishery developed due to restrictions on mackerel landings. This resulted
in larger Scottish pair trawlers and some purse seiners fishing sprat,
together with other pelagic species, as an alternative to mackerel.
Transhipment operations by Russians and Norwegian vessels also commenced
at about this time and has further encouraged catches.

The increased catch resulting from the entry of these larger vessels
into the fishery is shown in Table 8.1.3.

In addition, there has recently been some fishing further west, mainly
by larger visiting vessels, between the Eddystone and Falmouth
(1979-80: 1 770 tonnes; 1980-81: 711 tonnes; 1981-82: 427 tonnes). In
the current (1982-83) season, there had been no sprat landings up to
December by larger vessels due to their exclusion from the mackerel fishery.

Entry of these larger vessels also resulted in an expansion of the
fishing area, which is illustrated in Figure 8.1.2., where a typical
earlier local boat only season (1973-74) is contrasted with a later
season (1980-81), when about 63% of the catch was accounted for by
larger visiting vessels.

Similar details are not available for other nations fishing in Sub-area VII.

8.2   Effort Data

There have been considerable changes in the sizes of vessels and types
of gear used in the Lyme Bay fishery during the period under review. This
poses considerable problems in deriving a standardized measure of effort,
which could be used to interpret changes in fishing mortality.

There are general indications that effort has shown a substantial
increase in more recent years.

8.3   Age Structure of the Exploited Population

The exploited population in Division VIIe consists of a much higher
proportion of older fish than appear in the North Sea sprat fisheries.
This is illustrated by Table 8.3.1, where a comparison between the average
contributions by weight of different age groups to the English
northeast coast and Lyme Bay sprat fisheries over the seasons 1966/67 -
1979/80 is presented. Also shown are the mean weights and lengths for age
together with mean ages.

It is evident that fish are not fully recruited into the Lyme Bay
fishery until their third year (2/3 years), and second year fish are only
partially represented, where in the northeast coast fishery full recruit-
ment took place a year earlier. This results in an average difference in
age of one year between the exploited populations in the two fisheries,
with a consequent larger mean weight in the Lyme Bay fishery. First
year fish rarely appear in the Lyme Bay fishery, and smaller second year
fish are not well represented either. These usually appear in greater
numbers towards the end of a season, when fishing effort tends to move
closer inshore. The nursery areas supporting the Lyme Bay fishery are
not known.

The average weights and lengths at age in the Lyme Bay fishery are also
consistently larger than those taken in the northeast coast fishery.

Catch at age and VPA results

Sampling data for sprat in Division VIIe are only available for United
Kingdom landings. Although these data do not account for the total catch,
to provide an indication of trends in fishing mortality, stock size and
recruitment, a VPA was carried out on the United Kingdom data alone.

Catch at age

The numbers caught per age group over the seasons 1966/67 - 1981/82 are presented in Table 8.3.2. These relate to landings by United Kingdom vessels only.

VPA results

A separate VPA program was used, utilizing the catch at age data on 2-6 year old fish.

Information on input Fs was lacking, and a series of runs were carried out, using terminal fishing mortalities of 0.1, 0.3, 0.5 and 0.8, combined with two exploitation patterns (terminal S = 0.2 and 0.3), and three values of natural mortality (M = 0.75, 0.85 and 0.95). The age of unit selection was taken as age 2/3.

The terminal population outputs from the separable VPAs were then used to initiate equivalent traditional VPAs.

A comparison of period mean biomass levels derived from the two methods over the years 1966-78 on various assumptions (representing the period of full convergence) is shown in Table 8.3.3.

A value for natural mortality rate (M) is not known for the Lyme Bay sprat, although for North Sea sprat 0.8 year^{-1} has been used.

An approximate estimate for total mortality rate (Z) in the Lyme Bay fish was derived, using the long-term mean catch in numbers by age groups for the 16 season period 1966-1981.

The results for the fully recruited age groups were as follows:

Age interval	'Z'
3-4	0.89
4-5	1.53
5-6	1.85

The best represented age groups are 3- and 4-year old fish, and the results suggest, that M in this age interval is <0.90.

The increasing Z in the older age groups could be a consequence of increased F or, more likely, an availability loss to the fishery (which is predominantly coastal, with most catches taken within 15 miles of the coast), and/or increasing natural mortality in these older age groups.

A representative table (Table 8.3.4) illustrates the pattern of annual fishing mortalities derived from a traditional VPA generated by terminal populations provided in turn from a separable VPA, using parameters M = 0.85; terminal S = 0.3; and terminal F = 0.5. This value of F was selected, assuming that an increase in fishing mortality was the result of the increased catch in the last few years. Weighted average fishing mortalities in each year ($\overline{F}c$ and $\overline{F}p$ as defined by Shepherd, 1982) are also shown.

A corresponding table (Table 8.3.5) shows the numbers of fish generated from this analysis, together with the total stock biomass for 2-6 year olds in each year. A point of interest arising from this table is an apparently cyclical change in recruitment and stock biomass over this period. This cyclical change had been analyzed earlier, using slightly different parameters on the separable VPA (M = 0.5; terminal F = 0.3; and terminal S = 0.2); the results are shown in Figure 8.3.1.

8.4 Research Vessel Surveys

Acoustic

An acoustic survey for sprat was undertaken by R/V "Corella" in Lyme Bay
and the surrounding region during December 1981. At this time, most of
the sprat fishing effort was concentrated within the western half of
the Bay inside the dashed limit line shown in Figure 8.1.1. A total catch
of 4 310 tonnes was returned for this area over the period of the survey.
In addition, a number of research vessel pelagic trawl hauls were made by
"Corella", and information was also obtained from other research vessels,
which happened to be operating in the region at that time, to assist in
trace identification. Although sprat were also present in areas outside
those outlined in Figure 8.1.1, they were mixed with far greater and
varying proportions of mackerel, scad, and pilchard, which made it
impossible to acoustically separate sprat. The results shown in Figure
8.4.1 only relate to that part of the overall survey, where sprat
appeared to be the predominant pelagic species. The estimated total biomass
is shown for each of these sub-areas, and the grand total amounts to some
20 000 tonnes, subject to the usual qualficiations of acoustic results.

Spawning

Data on spawning distribution of sprat in the western Channel are some-
what limited. Earlier surveys were undertaken by English research vessels
in May-June 1967 and July 1968, which covered this region as part of
broader surveys aimed at investigating the spawning distributions of
pelagic species likely to be of interest for industrial fishing develop-
ment, including mackerel, scad, pilchard and sprat. The results of
these surveys were reported by Wallace and Pleasance (1972) (Figure 8.4.2).
The 1967 survey showed a continuity of sprat spawning along the whole
length of the Channel, with a southern boundary of distribution at about
49°N off the Brittany coast and a westward limit at 6°10'W (Scilly
Isles). Patches of higher density spawning were evident off Mounts Bay
(Cornwall), Start Point and Lyme Bay in the western Channel.East of 2°W
spawning densities showed a considerable increase with an unbroken
extension into the Southern Bight of the North Sea.

The 1968 survey (July) showed very much reduced sprat spawning levels,
with a residual patch in the western Channel off Start Point and Lyme
Bay, but then a complete break in spawning between 2°W and 1°W.

Results of more limited surveys undertaken by the MBA Laboratory at
Plymouth reported by Demir and Southward (1974) showed that in a more
restricted inshore area between Falmouth and Start Point, sprat spawning
commenced in January, attained a peak in February, followed by a rapid
decline in March-April, with final eggs taken in July. This cycle
essentially relates to the Eddystone Bay area, within about 15 miles of
the coast.

More recent surveys have been undertaken in the Channel by the Lowestoft
Laboratory. The first of this series, in April 1978, covered the western
Channel between Portland Bill and the Scilly Isles, up to 30 miles off
the coast. Subsequent surveys in April-May 1979, and in April, April-May
and June 1981 covered the whole eastern and a large part of the western
Channel, and, although these were designed specifically to investigate
sole spawning distribution, sprat eggs were also assessed, and preliminary
results are now available.

The spawning distributions from these later surveys are shown in Figures
8.4.3 - 8.4.6. They show that the spawnings in the western and eastern
halves of the Channel appear to be fairly discrete, separated by a zone
of lower density between the Cherbourg peninsula and Portland Bill.

Several fairly consistent patches of higher density are evident within the western Channel, one associated with Lyme Bay, another southeast from Start Point, and a third broader and more extended area further west, offshore from Eddystone Bay.

The 1981 surveys provided a first opportunity to construct at least part of an egg production curve for western Channel sprat, using stage I eggs only. Provisional results are shown in Figure 8.4.7, and if this line declining sequence is taken as an approximation to the descending limb of a spawning curve, which peaks in April, and assuming a symmetrically equivalent area for the build-up phase, then a rough assessment of spawning biomass can be made.

Fecundity data were not available for sprat from this region, and resort was made to De Silva's (1973.) values for west of Scotland fish.

The average length of fish in the winter 1980/81 fishery, preceding the spawning season, was 13.7 cm, and a length distribution weighted average fecundity per fish was about 33 820 eggs. The average weight of these fish in April was 17.7 g, so that one tonne of spawning females might be expected to generate 1.91×10^9 eggs. The sex ratio of spawning fish caught in April was about 31% males:69% females by number, and, since the average weight of females was a little higher than that of males, this ratio then became 29% males:71% females by weight. This results in the potential fecundity per tonne of spawning fish with both sexes combined being reduced to 1.36×10^9 eggs.

The total estimated production for the western Channel from Figure 8.4.7 amounted to 155×10^{12} eggs, which results in a spawning biomass estimate of 114 000 tonnes, if the various assumptions made are valid. The estimate applies to the whole western Channel area surveyed and not just the population in the more immediate vicinity of the Lyme Bay fishery. It is only a very provisional estimate, which, at best, can only provide a guide to the likely order of magnitude of the spawning stock.

A further problem lies in the degree to which western and eastern Channel populations are isolated from each other in relation to treating them as separate management units. The spawning density distribution charts show that there is a substantial spawning stock present in the eastern Channel (an estimate for this is not yet available, but in process of preparation). These charts also suggest some degree of isolation between the two areas, but further work is obviously required in this direction. Unfortunately, information on the stock structure of the eastern Channel fish is almost non-existent for more recent years, since there has been very little commercial fishing in the region except for a few very small localised coastal fisheries.

8.5   Weight at Age - Lyme Bay Fishery

Table 8.5.1 provides an analysis of mean weights at age by quarters and seasons over the period 1972-82, together with a comparable period mean analysis of seasonal variations in mean weights at age.

A seasonal decline in average weight at age is evident over the winter quarters in all age groups.This is partly a consequence of the fish fasting over this period, subsisting on their fat reserves, and also a decline in mean length at age, resulting from a general shift in fishing area closer to the coast during the winter, when a higher proportion of smaller fish is caught.

This trend is illustrated by Figure 8.5.1, which shows the average length and age distributions by quarters and seasons for the period 1972-78. The age groups are here numbered in terms of being 1st, 2nd, and 3rd year fish etc. Fish less than 10.5 cm in length (i.e., 2-year fish) show a proportionate increase during the 4th and 1st quarters, which results in more and smaller 2-year fish, until they outnumber 3-year fish in the first quarter.

The average growth parameters for the period 1972-81, derived from weight and length at age, are as follows:

Linear regressions	L_{T+1}/L_T	$\sqrt[3]{W_{T+1}} / \sqrt[3]{W_T}$
Intercept	6.97	1.58
Slope	0.56	0.50
R	1.0	1.0
K	0.58	0.69
L_∞	15.93 cm	W_∞ 31.23 g

8.6-8.7: No percentage catch in weight and other measures of mortality were calculated.

8.8 Equilibrium Yield

No yield curve was calculated.

.9 Prognosis

Results from the 1981 egg surveys suggest that the sprat spawning stock within the western Channel (Division VIIe) was probably within the range of 100 000 - 150 000 tonnes.

The VPA results show the mature biomass around a peak level in 1980-81, mainly due to the strong 1978 year class. Since exploitation has been relatively light, the 1981 biomass could be considered a near virgin stock estimate.

The VPA showed an extreme maximum/minimum stock range of about 3:1 over the years 1966-78, when full conveyance of the series had occurred. If the 1981 estimate of the spawning stock biomass is taken as a maximum level, then a longer-term mean level could fall within the range of 65 000 - 100 000 tonnes.

Using Gulland's 0.5 M B_0 formula to estimate long-term maximum yield produces a catch within the range of 28 000 - 42 000 tonnes. The assumption in the Gulland formula that maximum yield occurs at a rate of exploitation equal to natural mortality is in broad agreement with the yield curve shown for North Sea sprat(Section 7.8 in this report).

A consideration of biomasses calculated from the English inshore fishery suggests that the yields given above would relate to exploitation over the whole of Division VIIe rather than the coastal fishery of Lyme Bay.

9. EVALUATION OF SAMPLING AND REPORTING PROCEDURES

9.1 Statistical Requirements

The Working Group considers that the statistical requirements set out in Section 7.1 of last year's report (C.M.1982/Assess:6) remain in force.

9.2 The Present Situation

At present, annual landings, weight, and catches at age are available to the Working Group, both for the target species and the major by-catch species; however, the Danish data for the fourth quarter of 1982 were not available due to the early date of the Working Group. In future years, the Working Group should meet not earlier than mid-March. In most cases, data are also available by month or quarter and by sampling sub-areas.

The availability of effort data is much less satisfactory, and, for this reason, estimation of abundance based on cpue (both to estimate mortality rates and recruitment) is not possible. No data are available on a fleet basis for a major part of the fishery.

9.3 Recommendations

If the Working Group is to fulfill its terms of reference, data of the type described above are required in a disaggregated form. To summarize, these are:

1) Catch and effort data by statistical rectangle and month, sub-divided by different fleet components.(This is impossible for some countries to produce without logbooks, which still require implementation.)

2) Catch in number at age by Sub-area and month.

3) Original survey data, not only published mean values etc.

4) Weight at age data by month and Sub-area.

Since many of the data required exist, priority should be given to making them available, perhaps by the provision of a computerized data base. Only when what already exists is available, will it be possible to assess the need for new types of data.

Furthermore, our poor knowledge of the value of natural mortality on these fish stocks makes it difficult to interpret data from the three target species. Investigations into what the natural mortality is, how it comes about, and whether it varies with time would be very beneficial

There appears to exist a general lack of knowledge concerning the importance, structure and fishing strategy of the industrial fisheries. The Working Group consequently recommends that each nation undertaking such a fishery produce a detailed description including statistics on vessel categories, operational structure (target species, areas, periods), shore installations and other pertinent features for the next meeting of the Working Group.

9.4 Urgent Needs

The Working Group considers it needs the following particularly urgently:

1) IYFS surveys results of the year must be available to the Working Group.

2) The Working Group needs a means for predicting sprat catches in the next season. In practise, this must be a reliable estimate of 1-group sprat abundance by the spring.

3) The Working Group needs some method to enable predictions of landings to be made for the next season, based on previous year's catches of 0- and 1-group fish, presumably based on fishing effort data.

9.5 The Working Group considered that a Workshop on the Biology of Sprat would be extremely valuable and should be convened by ICES. Information on possible stock separation for sprat would be particularly appreciated.

10. References

Anon. 1982. Working Group for Norway Pout, Sandeel and Sprat Fisheries in the North Sea and Adjacent Waters, ICES Headquarters, 16-22 March 1982. ICES, Doc. C.M.1982/Assess:6(mimeo.).

Beverton, R J H and S J Noe. 1956. A review of methods estimating mortality in fish populations with special reference to bias in catch samples. Rapp.p.-v.Réun. Cons.int.Explor.Mer, 140:67-83.

De Silva, S S. 1973. Aspects of the reproductive biology of the sprat, Sprattus sprattus (L.), in inshore waters of the west coast of Scotland. J.Fish.Biol., 5:689-705.

Demir, N and A J Southward. 1974. The distribution of eggs and larvae of teleost fishes off Plymouth in 1969 and 1970. J.Mar.Biol.Ass.U.K., (1974):54.

Last, J M. 1982. The food of juvenile sprat (Sprattus sprattus L.) and herring (Clupea harengus L.) in inshore waters of the southern North Sea. ICES, Doc. C.M.1982/H:12 (mimeo.).

Macer, C T. 1966. Sandeels (Ammodytidae) in the southwestern North Sea, their biology and fishery. Fish.Invest.(Lowestoft), Ser.II, 24(6).

Shepherd, J G. 1982. Two measures of overall fishing mortality. ICES, Doc. C.M.1982/G:28 (mimeo.).

Wallace, P D and Pleasance, C A. 1972. The distribution of eggs and larvae of some pelagic fish species in the English Channel and adjacent waters in 1967 and 1968. ICES, Doc. C.M.1972/J:8 (Pelagic Fish Cttee)(mimeo.).

APPENDIX

THE INTERRELATION OF FISHING INTENSITY ON THE THREE TARGET SPECIES

OF THE INDUSTRIAL FISHERIES

by

J G Pope

The following simple investigation illustrates how substitution occurs.
Average fishing mortalities for North Sea Norway pout (ages 1 and 2),
northern North Sea sandeel (ages 1 to 4), southern North Sea sandeel
(ages 1 to 4), and North Sea sprat (ages 1 to 3) were calculated from the
VPA results given in later sections of this report and last year's report.
These are shown in Appendix Table 1 for each year from 1974 to 1981. These
are treated as if they were fishing effort data, and a total effort (total
fishing mortality on all four stocks) was calculated. This has remained
rather constant in the years considered, except for 1980 and 1981. The
fishing mortality on each of the four stocks was then expressed as a
percentage of this total (%F). This %F has been compared with the % of
the total landings taken from each stock %Y in the scatter diagrams shown
in Appendix Figure 1 (Norway pout), Appendix Figure 2 (northern North Sea
sandeel), Appendix Figure 3 (southern North Sea sandeel) and Appendix
Figure 4 (sprat).

Only the figure for Norway pout shows a strong relationship between %F and
%Y, but though not statistically significant, the other figures seem to
suggest some tendency of %F to increase when %Y is high. In one sense,
this result may seem tautological, since clearly catches can be expected
to increase in the short term, when fishing mortality increases, but for
these stocks fishing mortality is high and, thus, a considerable
proportion of the exploitable stocks is already being taken. There thus
seems to be the strong possibility that such a relation exists between
%F and %Y, and that it results more from a change in exploitable biomass
than simply from the changes in catch generated by changes in F.

The result may be generalized by adjusting the %F on each stock to allow
for the differences in mean level of mortality and mean catch on each
species. A simple adjustment was performed as follows to give $\widehat{F}\%$ the
normalised fishing mortality percentage as:

$$\widehat{F}(s,a)\% = \frac{\underset{\text{all } a}{\Sigma} Y(s,a)}{\underset{\text{all } a \ \text{all } s}{\Sigma \ \Sigma} Y(s,a)} \ \times \ \frac{\underset{\text{all } a \ \text{all } s}{\Sigma \ \Sigma} F(s,a)}{\underset{\text{all } a}{\Sigma} F(s,a)} \ \times \ F(s,a)\%$$

where the indices s and a refer to stocks and years, respectively.
Appendix Figure 5 indicates the scatter of all $\widehat{F}\%$ against the appropriate
Y%. The impression that fishing mortality changes in response to catch
proportion and hence presumably to stock biomass is thus sustained. This
analysis would suggest that such changes of mortality may help to rest
overstressed stocks, but, as with all pulse fishing situations, how
effective this may be will depend on the balance of the overall resources
and the available fishing effort.

Appendix Table 1. Average fishing mortality for each of the
target species, the total and percentages
for each year from 1974 to 1981.

Year	Norway pout		N.North Sea sandeel		S.North Sea sandeel		Sprat		Total F
	F	%F	F	%F	F	%F	F	%F	
1974	2.12	55	.82	21	.32	8	.59	15	3.85
1975	1.25	33	1.11	29	.38	10	1.07	28	3.81
1976	.85	23	.59	16	.68	19	1.52	42	3.64
1977	.69	21	1.09	32	.65	19	.93	28	3.36
1978	.72	21	.60	17	.73	21	1.43	41	3.48
1979	.66	19	.28	8	1.11	32	1.44	41	3.49
1980	1.18	22	1.59	29	.82	15	1.89	34	5.48
1981	.68	17	1.19	29	.89	22	1.30	32	4.06
Year	Y	%Y	Y	%Y	Y	%Y	Y	%Y	Total Y
1974	736	47	387	25	117	8	314	20	1553
1975	560	35	254	16	157	10	641	40	1611
1976	435	29	135	9	331	22	622	41	1522
1977	390	27	348	24	392	27	304	21	1435
1978	270	19	163	12	577	42	378	27	1389
1979	320	26	195	16	356	28	380	30	1251
1980	470	32	292	20	401	27	323	22	1487
1981	235	24	138	14	379	39	209	22	961

Appendix, Figure 1. NORWAY POUT.
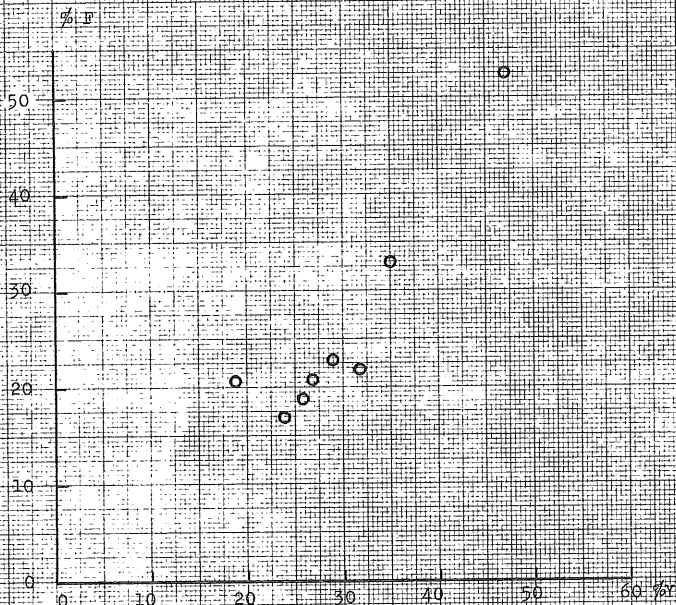
Appendix, Figure 2. Northern North Sea SANDEEL.
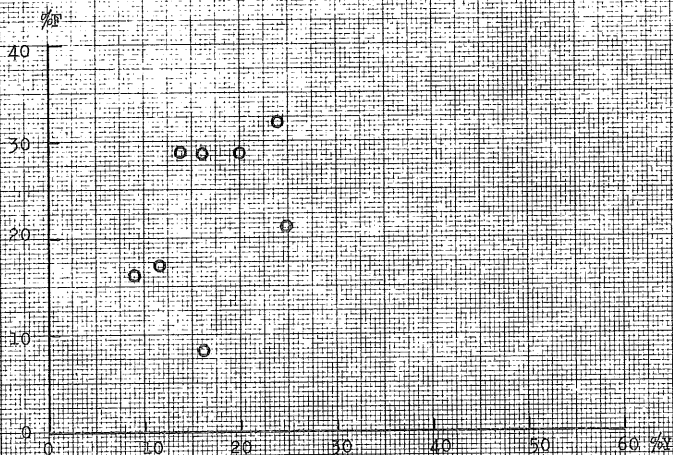
Appendix Figure 3. Southern North Sea SANDEELS.
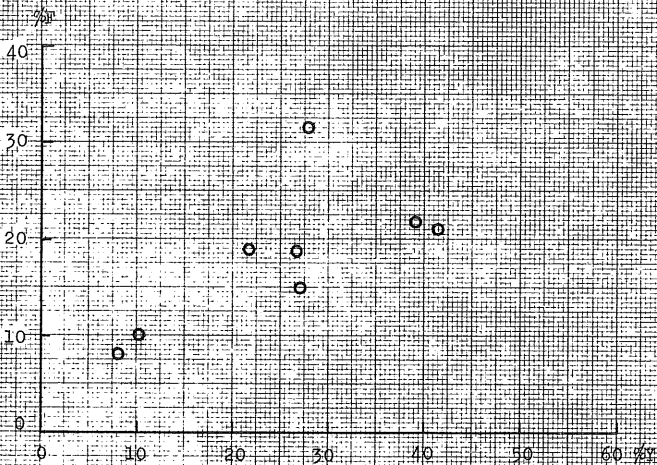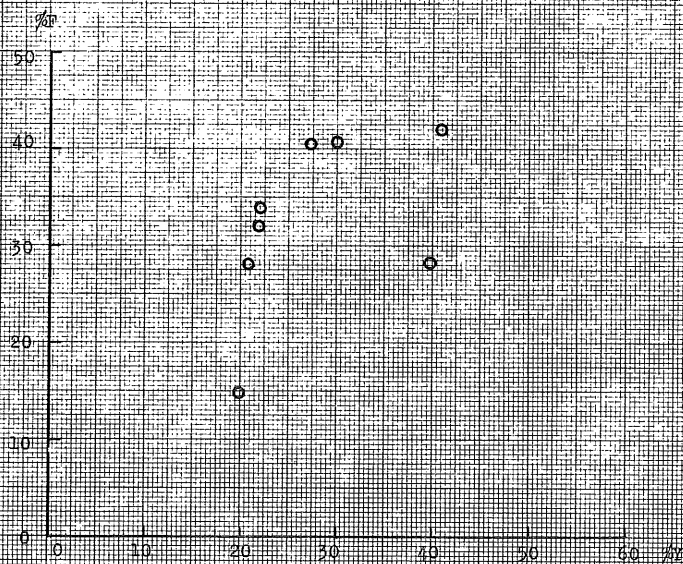
Appendix Figure 4. SPRAT.
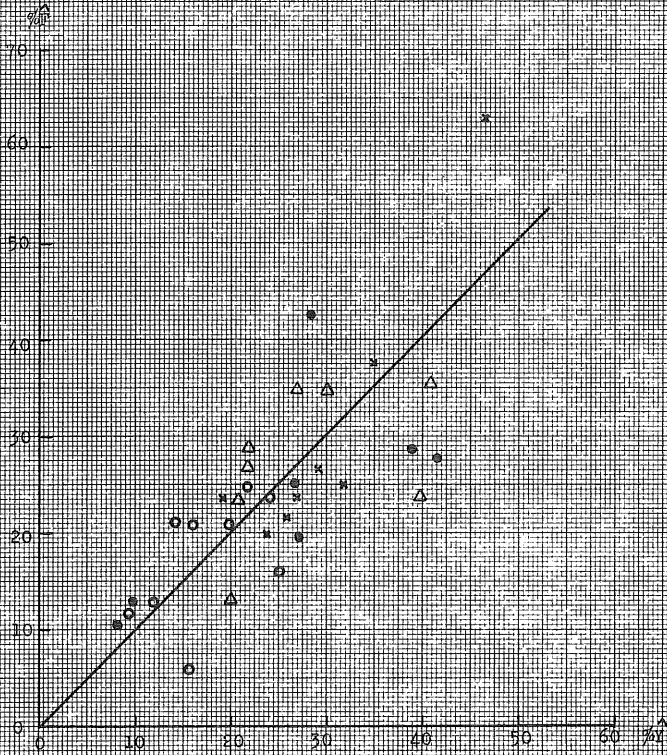
Appendix Figure 5.

Table 2.4.1 Total industrial landings (tonnes x 10^{-3}) from the North Sea, 1973 - 1982.

Year	Target industrial species				By-catch for reduction[6]				Total[4]
	Norway pout	Sandeel	Sprat	Sum	Blue Whiting[1]	Protected Species[2]	Herring[3]	Sum	
1973	345.9	296.9	262.3	905.1	56.8	131.8		188.6	1 093.7
1974	735.8	524.8	313.6	1 574.2	62.2	220.4		282.6	1 856.8
1975	559.7	428.2	641.2	1 629.1	42.0	127.8		169.8	1 798.9
1976	435.4	487.6	621.5	1 544.5	36.0	198.0	12.0	246.0	1 790.5
1977	389.9	785.6	304.0	1 479.5	38.4	147.3	9.5	195.2	1 674.7
1978	270.1	786.8	378.3	1 435.2	99.9	67.6	7.8	175.3	1 610.5
1979	319.8	577.8	379.6	1 272.2	63.3	78.0	15.3	156.6	1 433.8
1980	470.4	728.5	323.4	1 522.3	75.1	71.3	7.3	153.7	1 676.0
1981	235.4	568.6	209.1	1 013.1	80.2	89.4	84.2	235.8	1 266.9
1982[5]	289.8	610.9	113.1	1 014.0	54.0	56.8	92.2	203.0	1 217.0

1) C.M.1983/Assess:3
2) C.M.1982/Assess:8 and 9 (Haddock, whiting, saithe)
3) C.M.1982/Assess:7
4) Does not include other species which on an average range between 20 000 and 40 000 tonnes
5) Incomplete
6) By-catches do not include fish landed for human consumption

Table 3.1.1 HERRING by-catch in tonnes by year and Division

Division	1976	1977	1978	1979	1980	1981	1982[*]
Div.IVa West	4 105	502	27	443	705	7 933	301
Div.IVa East	-	186	-	2	48	-	500
Div. IVb	7 847	8 790	7 545	14 882	6 008	75 533	89 764
Div.IVc and VIId	-	-	223	1	494	702	1 675
Total	11 952	9 478	7 795	15 328	7 255	84 168	92 240

* Preliminary

Table 3.1.2 HERRING by-catch in numbers at age (millions) for 1981

Winter-rings	0	1	2	3	4	5	6	7	8+
Div.IVa W Moray F.	1	20	5	-	-	-	-	-	-
" rest	20	4	-	6	4	9	6	2	2
Div. IV E	-	-	-	-	1	1	1	-	-
Div. IVb	7 861	392	40	8	1	-	-	-	-
Div.IVc, VIId	.... Not sufficient age data available ....

Table 3.2.1 HERRING by-catch in numbers at age (millions) for 1982

Winter-rings	0	1	2	3	4	5	6	7	8+
Div.IVa W Moray F.	-	-	-	-	-	-	-	-	-
" rest	-	-	-	-	-	1	1	-	1
Div.IVa E	-	2	5	-	-	-	-	-	-
Div.IVb	8 269	390	27	2	-	-	-	-	-
Div.IVc, VIId	.... Not sufficient age data available ....

Table 3.5.1 NORTH SEA. Species composition in Norwegian Norway POUT landings (tonnes) for reduction purposes, 1975-1982.

Year	Quarter	Landings	Norway pout	Blue whiting	Cod	Haddock	Whiting	Saithe	Herring	Mackerel	Others
1975	1-4	297 222	218 900	40 210	1 188	9 840	13 243	4 330			9 511
1976	1-4	200 777	108 937	34 600	783	3 133	6 744	12 850			33 730
1977	1-4	143 001	98 291	20 737	661	920	2 707	4 390			15 300
1978	1-4	136 455	80 755	39 989	659	766	1 462	2 494			10 351
	1	24 504	17 087	4 971	153	298	1 032	179	2	3	995
	2	40 310	18 963	17 504	202	406	315	289		2	2 808
1979	3	33 602	23 856	6 584	98	625	132	309	1		2 178
	4	19 387	15 158	1 871	26	1 254	189	99		4	1 221
	1-4	117 803	75 046	30 930	479	2 583	1 659	876	3	9	7 202
	1	14 469	10 355	810	195	947	759	107			1 296
	2	36 896	18 281	13 623	207	1 414	312	130			2 929
1980	3	42 900	32 449	6 400	136	655	42	87			3 131
	4	13 794	8 375	1 129	12	902	86	18			3 272
	1-4	108 059	69 460	21 962	550	3 918	1 199	342			10 628
	1	8 565	6 996	363	58	102	359	75		1	611
	2	28 700	17 276	7 826	111	336	221	72		25	2 833
1981	3	30 127	19 790	6 135	64	841	69	1 024		12	2 192
	4	9 217	7 249	745	26	453	150	50		4	541
	1-4	76 609	51 311	15 069	259	1 731	799	1 221		42	6 177
	1	8 555	7 443	158	58	186	306	41			363
	2	48 017	33 502	9 731	135	948	59	176			3 466
1982	3	68 498	28 991	27 702	78	1 202	120	4 368		17	6 020
	4	30 191	17 408	10 019	11	288	180	418			1 867
	1-4	155 261	87 344	47 610	282	2 624	665	5 003		17	11 716

Table 3.5.2 Total reported by-catch (tonnes) of HADDOCK, WHITING
SAITHE and BLUE WHITING for reduction purposes, 1975-1982[1].

Species	1975	1976	1977	1978	1979	1980	1981	1982[2]
Haddock	41 380	48 204	34 993	9 659	17 414	25 154	17 894	19 970
Whiting	86 376	149 759	106 104	55 274	59 021	45 747	70 167	31 875
Saithe	37 678	66 766	6 197	2 566	1 635	363	1 221	5 003
Blue whiting	41 955	36 024	38 389	99 874	63 333	75 129	80 189	54 031

1) C.M.1983/Assess:3; C.M.1982/Assess:8 and 9.

2) Preliminary

Table 3.5.3 North Sea. Total industrial landings in tonnes (sandeel excluded) and estimated by-catches of HADDOCK and WHITING for 1981 and the first three quarters of 1982. Sprat is also excluded from Norwegian and United Kingdom totals.

1981

Area	Quarter I Total ind.	Haddock	Whiting	Quarter II Total ind.	Haddock	Whiting	Quarter III Total ind.	Haddock	Whiting	Quarter IV Total ind.	Haddock	Whiting
1	4 071	412	414	619	86	192	147 705			42 078		
2	1 205	185	289	56	0	0					2 596	5 926
3	0	0	0	0	0	0						
4	32 706	1 489	3 128	15 429	494	549				28 036	1 827	1 262
5A	24 315	604	864	38 611	492	518				27 495	1 369	2 346
5B	0	0	0	1 979	0	469				5 546	29	449
6	74 566	590	25 872	19 644	289	7 494	114 724	527	4 214	61 871	20	3 246

1982

Area	Quarter I Total ind.	Haddock	Whiting	Quarter II Total ind.	Haddock	Whiting	Quarter III Total ind.	Haddock	Whiting	Quarter IV Total ind.	Haddock	Whiting
1	9 451											
2		1 546	2 895	310	1		97 864	3 121	695			
3												
4	37 060	3 674	4 632	7 675	946	677	21 812	772	105			
5A	18 706	1 078	1 692	45 525	1 738	280	78 986	3 640	1 046			
5B	15	1	4	532	31	99	45 291	56	596			
6	50 955	355	16 514	5 418	112	1 524	85 462		420			

Table 3.5.4 By-catch landed for human consumption by Faroese Industrial Trawlers
from ICES Div. IVa. Target species Norway POUT SANDEEL 1975-1982 (tonnes).

	1975	1976	1977	1978	1979	1980	1981[*]	1982[*]
Total land-ings Ind. Trawlers	67 832	68 960	57 630	20 548	26 025	43 212	26 944	22 462
Landed for human consumption								
Cod	652	448	257	50	111	150	94	60
Haddock	82	85	45	12	7	27	29	15
Whiting	-	-	-	-	7	21	21	56
Ling	7	208	306	88	68	44	71	18
Monkfish	28	96	87	24	-	12	49	2
Saithe	287	425	318	213	407	1 020	417	672
Others	269	132	159	8	201	247	56	182
Σ	1 325	1 394	1 172	395	801	1 521	737	1 005

* Preliminary

Table 3.5.5   North Sea, species composition in Norwegian
             SANDEEL landings 1979-1982 (tonnes).

Year	Landings	Sandeel	Cod	Haddock	Whiting	Saithe	Herring	Mackerel	Others
1979	103 273	101 420	231	520	208	250	-	-	644
1980	147 748	144 752	54	1 118	382	-	-	-	1 442
1981	53 370	52 641	29	504	68	6	4	6	112
1982	47 647	46 514	86	703	107	-	8	-	229

Table 3.6.1   HADDOCK.   North Sea 1982.   Danish industrial by-catch

Quarter	Catch in tonnes	Catch in numbers (10^{-6}) at age					
		0	I	II	III	IV	V
1	6468	—	88.5	4.7	9.1	1.1	0.4
2	1177	—	20.4	0.7	1.5	—	—
3	6387	196.8	38.9	6.8	—	—	—
4	2610	56.1	9.6	0.8	0.9	0.3	—
Total	16642	252.9	157.4	13.0	11.5	1.4	0.4

Quarter	Mean weight at age (in grammes)					
	0	I	II	III	IV	V
1	—	23	115	325	623	612
2	—	25	160	365	—	—
3	6.5	75	320	—	—	—
4	15	91	320	450	825	—
Weighted $\overline{W}$	8.4	40	237	340	666	612

Table 3.6.2 WHITING. North Sea 1982. Danish industrial by-catch

Quarter	Catch in tonnes	Catch in numbers (10^{-6}) at age						
		0	I	II	III	IV	V	VI
1	18831	—	93.3	27.2	43.5	7.9	2.1	0.3
2	2414	—	21.6	1.4	1.8	—	—	—
3	2741	37.2	6.7	1.3	4.6	—	—	0.4
4	7117	31.5	4.3	7.5	12.4	1.2	0.1	0.1
Total	31103	68.7	125.9	37.4	62.2	9.1	2.2	0.8

Quarter	Mean weight at age (grammes)						
	0	I	II	III	IV	V	VI
1	—	34	125	190	350	400	500
2	—	36	150	212	—	—	—
3	20	71	200	250	—	—	800
4	18	60	240	330	445	400	700
Weighted $\overline{w}$	19	37	152	223	363	400	488

Table 4.1.1   NORWAY POUT. Annual landings (in thousand tonnes) by countries.
North Sea 1957-1982

Year	Denmark	Faroes	Norway	Sweden	UK (Scotland)	Others	Total
1957			0.2				0.2
1958							
1959	61.5		7.8				69.3
1960	17.2		13.5				30.7
1961	20.5		8.1				28.6
1962	121.8		27.9				149.7
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	75.0		3.0		319.8
1980	366.2	34.1	69.5		0.6		470.4
1981	167.5	16.6	51.3		+		235.4
1982[1]	187.1[2]	15.4	87.3		0		-

[1] Preliminary

[2] January - September only

Table 4.1.2   NORWAY POUT. North Sea. National landings (tonnes) by
months 1980-1982 (Denmark, Norway, United Kingdom (Scotland))

Month	Denmark	Norway	Faroes	UK (Scotland)	Total
1980					
Jan	14 792	4 962	2 299	193	22 246
Feb	18 620	3 459	3 534	315	25 928
Mar	11 653	1 934	2 010	–	15 597
Apr	7 233	2 103	158	8	9 502
May	7 853	8 004	2 249	–	18 106
Jun	3 114	8 174	2 104	–	13 392
Jul	55 385	8 673	3 001	–	67 059
Aug	66 255	10 492	2 325	–	79 072
Sep	71 144	13 284	7 846	87	92 361
Oct	60 474	1 340	3 976	–	65 790
Nov	28 749	6 248	3 279	–	38 276
Dec	20 938	787	1 282	–	23 077
Total	366 210	69 460	34 063	603	470 336
1981					
Jan	11 782	2 822	784		15 388
Feb	20 632	2 892	1 601		25 125
Mar	10 923	1 282	1 577	–	13 782
Apr	6 103	3 119	2 147	–	11 369
May	1 414	6 733	2 291	–	10 438
Jun	4 541	7 424	1 726	–	13 691
Jul	7 471	5 510	2 817	–	15 798
Aug	25 715	10 226	724	–	36 665
Sep	16 465	4 054	–	–	20 518
Oct	23 721	2 502	958	–	27 181
Nov	17 174	1 413	1 136	–	19 723
Dec	21 540	3 334	810	–	25 684
Total	167 481	51 311	16 573	0	235 365
1982					
Jan	13 072	3 968	223	–	17 263
Feb	12 998	1 769	641	–	15 408
Mar	12 117	1 706	1 379	–	15 202
Apr	10 162	6 028	1 098	–	17 288
May	542	7 705	1 068	–	9 315
Jun	0	19 769	1 160	–	20 929
Jul	32 488	10 984	2 225	–	45 697
Aug	38 939	8 708	1 891	–	49 538
Sep	66 734	9 299	1 608	–	77 641
Oct		8 104	2 072	–	
Nov	n/a	4 943	1 330	–	n/a
Dec		4 361	675	–	
Total	187 052*)	87 344	15 370	0	–

#)January-September only

Table 4.1.3   NORWAY POUT.   Annual landings (tonnes) in Division VIa (For 1971-1981 data officially reported to ICES)

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982*)
Belgium	1	-	-	-	-	-	-	-	-	-.	-	-
Denmark	363	186	42	-	193	-	-	4 443	15 609	13 070	**	751[4]
Faroes	-	-	1 743	1 581	1 524	6 203	2 177	18 484	4 772	3 530	3 540	...[1]
Germany, Fed.Rep.	-	-	-	179	-	8	-	-	-	-	-	-
Netherlands	-	-	-	-	322	147	230	21	98	68	182	
Norway	-	-	-	144[3]	-	82[3]	-	-	-	-	-	-
Poland	-	-	-	75	-	-	-	-	-	-	-	-
UK (Scotland)[2]	1 622	3 760	9 282	4 702	6 614	6 346	2 799	302	23	1 202	1 158	586
USSR	-	-	-	40	2	7 147	-	-	-	-	-	-
Total	1 986	3 946	11 067	6 721	8 655	19 933	5 206	23 250	20 502	17 870		

[1] Included in the North Sea.   [2] Amended using national data.   [3] Including by-catch.   [4] Landings in foreign ports Jul-Dec not included.
*) Preliminary.   **) No final data received from Denmark.

Table 4.1.4   NORWAY POUT.   Annual landings (tonnes) in Division IIIa (For 1971-1981 data officially reported to ICES

Country	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982[3]
Denmark	25 800	17 259	23 152	10 669	15 666	40 144	20 694	23 922	23 951	26 235	**	51 023[4]
Faroes			643									
Norway	296			62*)	925*)	50*)	104	362	1 182	141	752	704
Sweden		1)	1)	1)	3 272	2 255	318	591[2]	32	39	60	101[5]
Total	26 096	17 259	23 795	10 731	19 863	42 449	21 116	24 875	25 165	26 415		

*) Including by-catch.   [1] Included in the North Sea.   [2] Includes North Sea.   [3] Preliminary.
[4] Landings in foreign ports Jul-Dec nor included.   [5] Data from Data Form 5.   **) No final data received from Denmark.

Table 4.2.1   NORWAY POUT. Catch per unit of effort, tonnes per
               days fishing per GRT, by quarter in the Norwegian fishery

Quarter Year	1	2	3	4	Mean all year
1972	1.182	1.658	1.503	1.846	1.546
1973	0.860	1.581	1.675	1.267	1.282
1974	1.695	1.827	2.029	2.202	1.976
1975	1.680	1.779	2.380	2.431	1.969
1976	2.541	1.651	1.204	1.323	1.456
1977	1.845	1.188	1.467	1.622	1.455
1978	0.841	0.905	1.601	1.259	1.085
1979	1.180	1.016	1.709	1.781	1.455
1980	1.000	2.322	2.002	1.545	1.585
1981	1.055	1.498	1.660	1.448	1.440
1982	1.228	2.159	2.665	2.566	2.170

Table 4.2.2   Faroese cpue data, industrial trawlers
             NORWAY POUT in ICES Division IVa and IVc (kg/hours)

Month	1978	1979	1980	1981	1982
January	1 389	1 830	1 543	2 005	1 109
February	932	1 207	1 755	1 104	1 384
March	896	1 207	1 478	1 210	1 839
April	670	1 061	1 523	1 204	1 777
May	1 110	885	1 978	1 308	1 553
June	1 052	1 542	2 508	1 015	1 755
July	784	1 178	1 576	1 294	2 301
August	1 242	1 331	2 387	1 051	2 571
September	3 007	2 495	2 807	-	2 297
October	2 215	2 139	2 648	1 663	2 297
November	1 915	2 003	1 993	1 387	2 346
December	2 168	2 455	2 222	1 496	2 003
Weight average/nom.	1 266	1 557	2 084	1 250	2 026
Total effort reported in Log books	11 300	6 660	9 918	11 256	7 287
Total catch reported Log books	14 307	10 375	20 673	14 072	14 777
Total landings	17 699	21 497	34 064	16 573	15 349*)

*)Preliminary

Table 4.3.1 Norway POUT. Input data for quarterly
VPA. Catch at age (no x 10^{-6}).

Year	Quarter	Age Groups				
		0	1	2	3	4
1974	1	–	13 450	414	26	1
	2	–	7 873	193	26	1
	3	846	9 966	489	145	–
	4	5 720	7 809	140	4	–
1975	1	–	3 742	1 726	13	–
	2	–	7 206	383	2	–
	3	889	7 117	349	–	–
	4	9 968	2 027	461	1	–
1976	1	–	4 950	589	91	–
	2	–	7 580	645	58	–
	3	197	5 349	590	2	–
	4	5 986	3 157	320	15	–
1977	1	–	9 171	950	33	3
	2	–	3 577	367	8	–
	3	61	3 580	861	45	–
	4	1 655	3 540	236	5	–
1978	1	–	2 931	1 371	93	4
	2	–	1 181	650	194	–
	3	304	2 385	786	30	–
	4	1 225	1 400	322	6	–
1979	1	–	5 079	940	170	3
	2	–	3 270	249	27	1
	3	968	4 243	763	49	–
	4	861	2 147	166	11	–
1980	1	–	5 025	1 072	59	2
	2	–	2 576	686	29	5
	3	24	7 709	1 959	18	–
	4	640	3 913	511	6	–
1981	1	–	2 223	1 688	76	6
	2	–	1 072	621	77	0
	3	76	1 309	944	17	1
	4	36 557	1 036	301	3	1
1982	1	–	5 264	415	216	0
	2	–	3 243	274	23	0
	3	151	6 563	429	62	0

Not used in VPA (bracket spanning 1974 Q1 through 1975 Q1)

Table 4.3.2 NORWAY POUT. Quarterly VPA. Fishing mortality (quarter^{-1}).

Year	Quarter	Age groups				
		0	1	2	3	4
1975	2	0	.22	.11	.18	.20
	3	.008	.37	.18	.06	-
	4	.12	.18	.57	.49	-
1976	1	-	.09	.09	.29	.20
	2	0	.20	.18	.43	-
	3	.002	.22	.34	.04	-
	4	.08	.20	.45	.51	-
1977	1	-	.18	.10	.11	.20
	2	0	.10	.07	.05	-
	3	.001	.15	.33	.55	-
	4	.04	.23	.20	.14	-
1978	1	-	.09	.16	.16	.20
	2	0	.05	.14	.82	-
	3	.003	.15	.36	.39	-
	4	.02	.13	.35	.17	-
1979	1	-	.10	.14	.45	.20
	2	0	.09	.07	.17	-
	3	.009	.16	.43	.73	-
	4	.01	.12	.22	.50	-
1980	1	-	.08	.10	.15	.20
	2	0	.06	.11	.14	-
	3	.001	.26	.80	.17	-
	4	.03	.21	.75	.11	-
1981	1	-	.12	.16	.33	.20
	2	0	.08	.11	.99	-
	3	0	.15	.34	.99	-
	4	.34	.17	.24	.80	-
1982	1	-	.08	.12	.38	.20
	2	-	.07	.14	.08	-
	3	-	.20	.50	.50	-

Quarterly natural mortality

Age Group	0				1				2				3				4			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
M	.25	.25	.25	.25	.25	.25	.25	.25	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5

Table 4.3.3   NORWAY POUT. Quarterly VPA. Stock number x 10^{-6}

Year	Quarter	Age Groups				
		0	1	2	3	4
1975	2	162 550	41 155	4 807	14	
	3	126 594	24 737	2 622	7	
	4	97 810	13 828	1 323	4	
1976	1	-	67 423	8 991	456	2
	2	144 489	48 160	5 001	207	-
	3	112 529	30 862	2 540	82	-
	4	87 464	19 348	1 093	48	-
1977	1	-	62 857	12 301	421	17
	2	82 762	40 910	6 732	230	-
	3	64 455	28 719	3 801	133	-
	4	50 145	19 225	1 651	47	-
1978	1	-	37 597	11 871	821	
	2	136 956	26 706	6 150	427	-
	3	106 662	19 760	3 233	114	-
	4	82 800	13 296	1 364	47	-
1979	1	-	63 407	9 126	582	24
	2	157 114	44 919	4 815	225	-
	3	122 361	32 110	2 728	116	-
	4	94 443	21 285	1 077	34	-
1980	1	-	72 794	14 692	527	12
	2	47 737	52 277	8 088	275	-
	3	37 178	38 448	4 379	144	-
	4	28 933	23 194	1 195	74	-
1981	1	-	21 971	14 634	343	40
	2	232 505	15 159	7 583	150	-
	3	181 075	10 864	4 123	34	-
	4	140 954	7 312	1 783	8	-
1982	1		77 826	4 785	852	2
	2		55 985	2 585	352	-
	3		40 751	1 358	196	-

Table 4.3.4   Estimation of Z for NORWAY POUT

Year class	a) $Z = \dfrac{1}{\bar{t}-t'}$	IYFS[b)] $Z = \log \dfrac{cpue\ (1)}{cpue\ (2)}$	$\bar{Z}_{VPA}\ (1-2)^{c)}$ average of 1 and 2 groups (weighted by stock numbers)
1973	1.92	2.36	-
1974	1.75	2.40	-
1975	1.73	2.62	1.52
1976	1.82	1.38	1.89
1977	1.50	2.08	1.69
1978	1.46	1.48	1.90
1979	-	1.99	1.81
Mean	1.70	2.04	1.76

a) for year class 1978 the estimation is:

Relative age	Quarter	Age group	Number caught C	C · t
t'=0.625				
0.75	1		5 079	3 809
1.00	2	1	3 270	3 270
1.25	3		4 243	5 304
1.50	4		2 147	3 221
1.75	1		1 072	1 876
2.00	2	2	686	1 372
2.25	3		1 959	4 408
2.50	4		511	1 278
2.75	1		76	209
3.00	2	3	77	231
3.25	3		17	55
3.50	4		3	11
3.75	1	4	0	0
Total			19 140	25 044

$$\bar{t} = \frac{25\ 044}{19\ 140} = 1.308$$

$$Z = \frac{1}{\bar{t}-t'} = \frac{1}{1.308-0.625} = 1.46$$

(Data from Table 4.3.1)

b) Data from Table 4.4.1   c) Derived from Tables 4.3.2-4.3.3

Table 4.4.1 Recruitment indices of Norway POUT 1959-1982
as shown by number per hour's fishing on research
vessel surveys.

Year class	Abundance on pelagic 0-group surveys	Abundance in northwestern North Sea in Scottish autumn surveys		Abundance on international young fish surveys [1]	
	Arithmetic mean 0-group	Geometric mean as 0-group	1-group	Arithmetic mean as 1-group	2-group
1959		—	106.8 (22)		
1960		10.9 (22)	28.1 (14)		
1961		59.6 (14)	181.7 (15)		
1962		25.0 (15)	141.8 (15)		
1963		8.5 (15)	6.6 (14)		
1964		14.0 (14)	18.6 (11)		
1965		1.2 (11)	6.1 (13)		
1966		16.4 (13)	—		
1967		—	243.2 (17)		
1968		4.5 (7)	—		6
1969		—	33.1 (4)	35	22
1970		101.7 (4)	111.7 (12)	1 556	653
1971	3 347 (26)	16.7 (12)	328.8 (22)	3 425	438
1972	545 (28)	36.3 (22)	16.6 (10)	4 207	399
1973	2 558 (28)	224.4 (10)	121.6 (22)	25 626	2 412
1974	3 237 (28)	84.4 (22)	9.5 (11)	4 242	385
1975	3 623 (28)	41.2 (11)	—	4 599	334
1976	10 884 (28)	—	131.5 (16)	4 813	1 215
1977	1 521 (28)	77.7 (16)	83.9 (34)	1 913	240
1978	2 974 (27)	144.3 (34)	—	2 690	611
1979	1 868 (27)	—	—	4 081	557
1980	500 (27)	—	18.7 (22)	1 375	403
1981	2 843 (27)	191.5 (22)	97.8 (29)	4 315	n/a
1982	970	36.1 (29)		n/a	

NB. Number of statistical rectangles sampled shown in brackets

[1] From report of International Gadoid Survey Working Group; standard area
C.M. 1981/H:10, standard area of 93 statistical rectangles.

Table 4.4.2 Recruitment indices of Norway POUT as shown by the number per
hour's fishing on English research vessel surveys.

Year/Class	Groundfish survey August North Sea 0-group (entire North Sea)	Norway pout survey November			
		0-group	1-group	2-group	3-group
		(main Norway Pout distribution area)			
1976	–				0.5
1977	61 295			22.2	8.2
1978	57 342		550.1	43.1	–
1979	69 087	644.9	451.9	12.3	3.6
1980	11 576	210.6	214.6	4.2	
1981	145 015	2 394.6	716.6		
1982	66 776	1 956.7			

Table 4.4.3   Regression of stock number from quarterly
               VPA on abundance indices.

Source	Year Classes	Intercept	Slope	Correction Coefficient
A	74 - 81	17 900	11.5	0.84
B	73 - 80	10 600	0.30	0.06
C	74 - 81	92 240	3.8	0.28

A: IYFS indices of one group abundance versus VPA
      numbers in first quarter.

B: IYFS indices of two group abundance versus VPA
      numbers in first quarter.

C: Pelagic 0-group indices of abundance versus VPA
      numbers in third quarter.

(Data from Tables 4.3.3 and 4.4.1.)

Table 4.5.1   Norway POUT, North Sea
Mean weight at age by quarters in Norwegian catches (grammes)

Age Group / Quarters	0	1	2	3	4
1979					
I	-	8.12	24.22	44.05	72.88
II	-	11.73	27.38	49.54	
III	4.96	27.47	48.60		
IV	9.48	32.01	55.44		
1980					
I	-	8.27	20.97	51.52	
II	-	11.19	25.36	45.10	
III	5.84	26.58	46.94		
IV	8.27	26.91	44.30		
1981					
I	-	7.82	23.21	50.83	
II	-	15.15	29.21	47.71	
III	2.58	28.36	55.25		
IV	7.18	27.10	43.68		
1982					
I	-	6.72	21.83	44.25	-
II	-	16.04	30.66	50.33	-
III	-	25.89	39.19	58.02	-
IV	7.17	24.42	46.97	-	-

Table 4.5.2 Norway POUT. Mean weight at age by
            quarters in Danish catches (grammes).

Age Group / Quarters	0	1	2	3	4
1981 I	-	7.50	22.78	41.70	61.43
II	-	12.42	23.92	37.18	-
III	3.99	26.79	38.39	63.97	95.0
IV	6.14	31.32	43.10	52.33	-
1982 I	-	6.35	24.38	36.45	53.0
II	-	6.99	22.19	39.0	-
III	4.14	22.52	42.86	59.34	-

Table 4.6.1 Norway POUT, North Sea. Quarterly and annual landings
in weight by age as a percentage of the overall landing.

Year and Quarter	Age				
	0	1	2	3	4
1979					
I	0	11%	6%	2%	-
II	0	10%	2%	0.3%	0
III	1%	32%	10%	-	0
IV	2%	19%	3%	-	0
1979 Total	3%	72%	21%	3%	-
1980					
I	0	8%	4%	-	-
II	0	5%	3%	-	-
III	-	38%	17%	-	-
IV	1%	19%	4%	-	-
1980 Total	1%	70%	28%	1%	-
1981					
I	0	7%	16%	1%	-
II	0	6%	6%	1%	0
III	-	16%	16%	-	-
IV	10%	14%	6%	-	0
1981 Total	10%	43%	44%	3%	-

- = less than 0.5%

Table 4.9.1 Norway POUT - Historical catches and survey indices obtained during each year.

Year of observation	Total catch x 1 000 t	Catch in numbers Age 1 and + x 10⁻⁶	IYFS 1-group 1st quarter	Scottish O-group Autumn	Pelagic O-group June	English Bottom Surveys		IYFS 1- and 2 groups 1st quarter
						nb/hour O-group August	O-group November	
1970	238		35	102	–			41
1971	305		1 556	17	3 347			1 578
1972	445		3 425	36	545			4 078
1973	346		4 207	224	2 558			4 645
1974	736	40 537	25 626	84	3 237			26 025
1975	560	23 027	4 242	41	3 623			6 654
1976	435	23 346	4 599	–	10 884			4 984
1977	390	22 376	4 813	78	1 521	958		5 147
1978	270	11 353	1 913	144	2 974	765		3 128
1979	320	17 118	2 690	–	1 868	1 031	645	2 930
1980	470	23 570	4 081	–	500	181	211	4 692
1981	235	9 378	1 375	191	2 843	2 071	2 395	1 932
1982	370*		4 315	36	970	1 518	1 957	4 718
1983								

* estimated figure

Table 5.1.1 Landings of SANDEEL from the North Sea 1952-82, in thousand tonnes.

Year	Denmark	Germany,Fed.Rep.	Faroes	Netherlands	Norway	Sweden	U.K.	Total
1952	1.6	0	0	0	-	0	0	1.6
1953	4.5	+	0	0	-	0	0	4.5
1954	10.8	+	0	0	-	0	0	10.8
1955	37.6	+	0	0	-	0	0	37.6
1956	81.9	5.3	0	+	1.5	0	0	88.7
1957	73.3	25.5	0	3.7	3.2	0	0	105.7
1958	74.4	20.2	0	1.5	4.8	0	0	100.9
1959	77.1	17.4	0	5.1	8.0	0	0	107.6
1960	100.8	7.7	0	+	12.1	0	0	120.6
1961	73.6	4.5	0	+	5.1	0	0	83.2
1962	97.4	1.4	0	0	10.5	0	0	109.3
1963	134.4	16.4	0	0	11.5	0	0	162.3
1964	104.7	12.9	0	0	10.4	0	0	128.0
1965	123.6	2.1	0	0	4.9	0	0	130.6
1966	138.5	4.4	0	0	0.2	0	0	143.1
1967	187.4	0.3	0	0	1.0	0	0	188.7
1968	193.6	+	0	0	0.1	0	0	193.7
1969	112.8	+	0	0	0	0	0.5	113.3
1970	187.8	+	0	0	+	0	3.6	191.4
1971	371.6	0.1	0	0	2.1	0	8.3	382.1
1972	329.0	+	0	0	18.6	8.8	2.1	358.5
1973	273.0	0	1.4	0	17.2	1.1	4.2	296.9
1974	424.1	0	6.4	0	78.6	0.2	15.5	524.8
1975	355.6	0	4.9	0	54.0	0.1	13.6	428.2
1976	424.7	0	-	0	44.2	-	18.7	487.6
1977	664.3	0	11.4	0	78.7	5.7	25.5	785.6
1978	647.5	0	12.1	0	93.5	1.2	32.5	786.8
1979	449.8	0	13.2	0	101.4	0	13.4	577.8
1980	542.2	0	7.2	0	144.8	0	34.3	728.5
1981	464.4	0	4.9	0	52.6	0	46.7	568.6
1982	506.9	0	4.9	0	46.5	0.4	52.2	610.9

- = no information

+ = less than half unit

Table 5.1.2   SANDEEL.   North Sea.   Monthly landings
(tonnes) by country, 1979-82.

Year and Month		Denmark	Faroes	Norway	U.K. (Scotland)	Total
1979	Mar	682	57	351		1 090
	Apr	19 528	695	4 956	906	26 085
	May	124 062	3 687	7 811	2 985	138 545
	Jun	166 055	6 395	32 447	3 907	208 804
	Jul	60 710	2 352	12 462	2 413	77 937
	Aug	68 630		17 110	2 518	88 258
	Sep	2 908		10 174	649	13 731
	Oct	7 175		16 109	26	23 310
	Nov	5				5
	Total	449 755	13 186	101 420	13 404	577 765
1980	Feb		68			68
	Mar	12 558	111	6 048		18 717
	Apr	31 228	735	7 103	2 060	41 126
	May	192 155	1 679	37 092	4 450	235 376
	Jun	214 867	3 566	61 603	10 877	290 913
	Jul	68 403	1 048	10 228	7 555	87 234
	Aug	10 290		2 849	5 311	18 450
	Sep	7 827		3 119	1 346	12 293
	Oct	4 863		16 055		20 918
	Nov			716		716
	Total	542 191	7 207	144 813	31 599	725 810
1981	Jan	4	-	-	-	4
	Feb	-	-	172	-	172
	Mar	8 758	268	4 731	-	13 757
	Apr	42 875	415	5 356	5 018	53 664
	May	120 410	439	27 179	7 430	155 458
	Jun	109 175	96	6 100	10 032	125 403
	Jul	118 130	1 300	5 575	10 403	135 408
	Aug	30 724	1 162	1 455	7 107	40 448
	Sep	16 836	1 181	-	5 968	23 985
	Oct	17 502	74	2 031	710	20 317
	Nov	-	-	-	-	-
	Total	464 414	4 935	52 599	46 668	568 616
1982	Jan	-		-	-	-
	Feb	-		-	-	-
	Mar	844		3 306	-	4 150
	Apr	83 948		8 895	5 953	98 796
	May	168 551		16 797	9 349	194 697
	Jun	188 963	n/a	17 516	10 011	216 490
	Jul	55 240		-	10 889	66 129
	Aug	7 310		-	8 017	15 327
	Sep	2 060		-	6 458	8 518
	Oct	-		-	1 329	1 329
	Nov	-		-	-	-
	Total	506 916	4 903	46 514	52 006	605 436 excl. Faroe

Table 5.1.3 SANDEEL. North Sea. Catch (tonnes) by month and area (Denmark, Norway, United Kingdom (Scotland)).

Year Month	1A	1B	1C	2A	2B	2C	3	4	5	6	Shetland
1979 Mar			351			682					
Apr	11 476	49	3 602	2 067	1 130	1 536	534	4 090			906
May	47 648	+	4 099	23 149	2 044	642	5 992	38 584	867	8 848	2 985
Jun	119 632	281	12 556	4 316	5 886	333	7 978	24 277	1 645	21 598	3 907
Jul	15 700	454	2 149	1 253	17 593	1 997	6 408	12 493	2 859	12 266	2 413
Aug		143	14 883		86	63 574	7 043			11	2 518
Sep			8 868	1 490	112	1 306	542			764	649
Oct		+	14 455		173	2 262	5 630			764	26
Nov						5					
Total	194 456	927	60 963	32 275	27 024	72 332	34 132	79 444	5 371	44 251	13 404
1980 Mar	581		6 048	1 938	605	9 433				1	
Apr	6 797	1 031	6 374	5 043	4 208	13 179		1 956			1 803
May	108 561	821	30 256	27 870	21 595	808	20 477	10 676	991	8 422	3 219
Jun	81 909	1 404	44 828	48 682	23 865	247	35 706	11 399	6 146	26 316	6 845
Jul	17 249	74	9 140	5 978	2 079	102	18 076	6 812	1 516	18 240	6 920
Aug			2 833		16		10 290				5 311
Sep			3 100		19		5 213			2 617	1 346
Oct			·15 995			3 218	242			1 463	
Nov			716								
Total	215 097	3 330	119 290	89 511	52 387	26 987	90 004	30 843	8 653	57 059	25 444
1981 Feb	–	–	172	–	–	–	–	–	–	1 422	–
Mar	–	–	4 703	–	–	7 364	–	–	–	–	–
Apr	18 116	–	5 257	4 535	–	9 132	4 863	2 238	678	3 412	5 018
May	63 193	19	25 712	16 685	2 840	5 445	4 953	19 111	852	8 779	7 430
Jun	22 388	1	4 631	8 477	990	1 699	15 475	27 018	11 184	23 429	10 016
Jul	–	90	906	87 721	5 111	227	6 001	15 074	584	7 991	10 403
Aug	–	–	1 455	8 304	–	–	22 420	–	–	–	7 107
Sep	–	–	–	12 081	453	· –	4 302	–	–	–	5 968
Oct	1 466	–	–	14 063	2 310	–	1 596	–	–	98	710
Nov	–	–	–	–	–	–	–	–	–	–	–
Total	105 163	110	42 836	151 866	11 704	23 867	59 610	63 441	13 298	45 131	46 652
1982 Mar	–	–	502	844	2 130	674	–	–	–	–	–
Apr	42 046	4 981	3 153	23 007	6 071	1 150	2 891	1 905	–	7 639	5 953
May	67 920	34	139	67 822	14 837	370	20 265	2 066	–	11 895	9 349
Jun	73 654	349	586	31 521	756	139	3 278	41 203	5 916	49 077	10 011
Jul	6 167	–	–	8 901	1 058	–	2 124	30 512	956	5 522	10 889
Aug	–	–	–	–	–	–	6 742	–	–	568	8 017
Sep	–	–	–	–	–	–	2 060	–	–	–	6 458
Oct	–	–	–	–	–	–	–	–	–	–	1 329
Nov	–	–	–	–	–	–	–	–	–	–	–
Total	189 787	5 364	4 380	132 095	24 852	2 333	37 360	75 686	6 872	74 701	52 006

Table 5.1.4 Annual landings ('000 tonnes) of SANDEELS by Sub-area of the North Sea (Denmark, Norway, United Kingdom (Scotland)).

Year	Sub-areas										
	1a	1b	1c	2a	2b	2c	3	4	5	6	Shetland
1972	98.8	28.1	3.9	24.5	85.1	0.0	13.5	58.3	6.7	28.0	0.0
1973	59.3	37.1	1.2	16.4	60.6	0.0	8.7	37.4	9.6	59.7	0.0
1974	50.4	178.0	1.7	2.2	177.9	0.0	29.0	27.4	11.7	25.4	7.4
1975	70.0	38.2	17.8	12.2	154.7	4.8	38.2	42.8	12.3	19.2	12.9
1976	154.0	3.5	39.7	71.8	38.5	3.1	50.2	59.2	8.9	36.7	20.2
1977	171.9	34.0	62.0	154.1	179.7	1.3	71.4	28.0	13.0	25.3	21.5
1978	159.7	50.2		346.5	70.3		42.5	37.4	6.4	27.2	28.1
1979	194.5	0.9	61.0	32.3	27.0	72.3	34.1	79.4	5.4	44.3	13.4
1980	215.1	3.3	119.3	89.5	52.4	27.0	90.0	30.8	8.7	57.1	25.4
1981	105.2	0.1	42.8	151.9	11.7	23.9	59.6	63.4	13.3	45.1	46.7
1982	189.8	5.4	4.4	132.1	24.9	2.3	37.4	75.7	6.9	74.7	52.0

Table 5.1.5 SANDEEL, Division VIa
            Landings in tonnes 1974-1981 as officially reported to ICES

Country \ Year	1974	1975	1976	1977	1978	1979	1980	1981	1982[**]
Denmark							109	[*]	
Norway			17	54					
UK(Scotland)[1]	+	+	+	13	+		211	5 972	10 873

1) Amended from national data
[*] Final data for Denmark not yet available
[**] Preliminary

Table 5.1.6 SANDEEL, Division IIIa
            Landings in tonnes as officially reported to ICES

Country	YEAR											
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982[**]
Denmark	21 567	7 919	9 878	7 912	16 421	21 418	16 082	21 731	33 305	39 357	40 423[*]	21 539
Faroes								2				
Sweden		1)	1)	1)	79	67	432	1 121[2]	3	9	32	

1) Included in the North Sea
2) Includes North Sea
[*] Final data for Denmark not yet available
[**] Preliminary

Table 5.2.1   Fishing effort (hours fishing) by month and year in
the Shetland SANDEEL fishery, 1975-1982

Year / Month	1975	1976	1977	1978	1979	1980	1981	1982
January	35							
February	20							
March	298	36	436	234				
April	725	1 175	1 209	654	308	626	1 457	1 153
May	868	1 203	1 408	2 030	990	886	2 069	2 523
June	989	2 043	1 893	1 859	1 027	1 832	2 387	2 497
July	1 724	2 632	1 673	1 350	693	1 647	2 277	2 240
August	2 333	2 023	947	1 683	760	1 192	1 652	1 928
September	730	670	528	1 473	340	395	1 062	1 695
October	186	484	212	934	9		135	357
November		245						
December								
Total	7 908	10 511	8 306	10 217	4 127	6 578	11 039	12 393

Table 5.3.1   SANDEELS Number caught x 10^{-6}. Southern area of the North Sea 1981-82.

Month	Age Group									
	0	1	2	3	4	5	6	7	8	
1981										
Jan	–	1.0	–	–	–	–	–	–	–	
Feb	–	–	–	–	–	–	–	–	–	
Mar	–	3.6	234.0	36.1	19.0	7.2	–	0.9	0.9	
Apr	–	3 775.0	1 944.5	227.2	122.4	51.1	3.2	4.0	4.0	
May	–	4 837.6	5 527.5	1 388.1	540.2	258.3	77.0	7.9	–	
Jun	411.4	4 650.2	3 902.2	791.0	85.4	33.4	3.5	3.5	–	
Jul	33 336.9	403.2	1 874.3	114.1	35.2	3.4	–	–	–	
Aug	3 334.7	–	–	–	–	–	–	–	–	
Sep	2 763.5	–	–	–	–	–	–	–	–	
Oct	3 574.7	–	–	–	–	–	–	–	–	
Nov	–	–	–	–	–	–	–	–	–	
Dec	–	–	–	–	–	–	–	–	–	
Σ	43 421.2	13 670.6	13 482.5	2 556.5	802.2	353.4	83.7	16.3	4.9	74 391.3
1982										
Jan	–	–	–	–	–	–	–	–	–	
Feb	–	–	–	–	–	–	–	–	–	
Mar	–	210.8	11.5	–	–	–	–	–	–	
Apr	–	14 723.1	1 126.2	678.1	163.3	27.6	–	–	–	
May	–	20 940.6	2 379.3	1 069.1	207.9	36.1	–	2.1	–	
Jun	239.9	20 134.4	2 648.2	1 498.6	1 424.6	29.0	23.6	5.6	–	
Jul	4 991.2	4 611.5	484.0	337.0	35.7	3.9	–	–	–	
Aug	–	61.7	1.9	3.8	–	–	–	–	–	
Sep	–	–	–	–	–	–	–	–	–	
Oct	–	–	–	–	–	–	–	–	–	
Nov	–	–	–	–	–	–	–	–	–	
Dec	–	–	–	–	–	–	–	–	–	
Σ	5 231.1	60 682.1	6 651.1	3 586.6	1 831.5	96.6	23.6	7.7	–	78 110.3

Table 5.3.2 SANDEELS 1981-82.Numbers caught x 10^{-6}. Northern area of the North Sea (Shetland excluded)

Month	Age Group									
	0	1	2	3	4	5	6	7	8	
1981										
Jan	–	–	–	–	–	–	–	–	–	
Feb	–	–	4.0	2.1	0.5	0.3	–	–	–	
Mar	–	1 494.6	816.5	43.8	–	–	–	–	–	
Apr	–	1 895.5	1 525.5	154.9	3.0	–	–	–	–	
May	–	1 139.0	1 354.9	567.0	51.9	9.8	4.4	1.9	–	
Jun	17.0	923.9	369.6	127.3	71.8	8.8	16.9	3.4	–	
Jul	2 082.2	276.7	89.1	13.7	6.4	–	–	–	–	
Aug	4 991.6	53.2	–	–	–	–	–	–	–	
Sep	975.0	3.5	–	–	–	–	–	–	–	
Oct	993.1	8.9	3.6	–	–	–	–	–	–	
Nov	–	–	–	–	–	–	–	–	–	
Dec	–	–	–	–	–	–	–	–	–	
$\sum$	9 058.9	5 795.3	4 163.2	908.8	133.6	18.9	21.3	5.3	–	20 105.3
1982										
Jan	–	–	–	–	–	–	–	–	–	
Feb	–	–	–	–	–	–	–	–	–	
Mar	–	496.4	46.3	8.3	–	–	–	–	–	
Apr	–	1 480.4	962.3	141.5	3.9	–	–	–	–	
May	–	1 183.2	1 045.2	374.6	70.2	9.1	–	–	–	
Jun	1.5	324.2	58.4	26.1	1.2	–	–	–	–	
Jul	1 919.8	20.6	–	–	–	–	–	–	–	
Aug	4 067.8	43.6	–	–	–	–	–	–	–	
Sep	480.6	–	–	–	–	–	–	–	–	
Oct	–	–	–	–	–	–	–	–	–	
Nov	–	–	–	–	–	–	–	–	–	
Dec	–	–	–	–	–	–	–	–	–	
$\sum$	6 469.7	3 548.4	2 112.2	550.5	75.3	9.1	–	–	–	12 765.2

Table 5.3.3 SANDEELS (Shetland). Numbers caught x 10^{-6}.

Year/Month	t	Age Groups								
		0	1	2	3	4	5	6	7	8
1979										
April	906	–	335.8	129.9	3.4	2.5				
May	2 985	–	498.8	111.8	27.9	4.2	3.4	0.9	0.5	
June	3 907	–	653.4	146.3	36.5	5.5	4.4	1.2	0.7	
July	2 413	42.1	263.7	89.0	14.7	13.1	7.2			
August	2 518	943.6	205.3	47.7	6.4	0.4				
September	649	311.5	10.3		1.1					
October	26	12.5	0.4							
Total	13 404	1 309.7	1 967.7	524.7	90.0	25.7	15.0	2.1	1.2	–
1980										
April	1 803	–	112.6	124.5	63.1	21.9	3.7	2.4		
May	3 219	0.6	401.9	126.5	52.6	14.7	7.6		0.6	
June	6 845	76.4	54.3	117.4	157.0	59.8	68.8	34.9	13.1	
July	6 920	5 132.6	81.7	10.0						
August	5 311	1 776.1	125.0	68.1	19.0	10.3	4.2	0.9		
September	1 346	225.4	35.5	26.4	10.2	2.3	1.4			
Total	25 444	7 211.1	811.1	472.9	301.9	109.0	85.7	38.2	13.7	–
1981										
April	5 018	–	1 076.9	445.3	66.3	12.1	5.4	5.6	0.6	0.2
May	7 430	0.5	369.1	556.7	171.6	32.9	11.4	10.9	1.3	1.1
June	10 016	104.3	470.9	421.6	161.3	68.1	36.5	9.7	1.1	1.7
July	10 403	5 618.5	427.8	57.9	16.8					
August	7 107	4 308.8	46.5	25.3	7.9	4.5	0.9			
September	5 968	3 287.0	84.0	7.8	2.7	1.7	1.9	0.4	0.4	
October	710	390.9	10.0	0.9	0.3	0.2	0.2			
Total	46 652	13 710.0	2 485.2	1 515.5	426.9	119.5	56.3	26.2	3.4	3.0
1982										
April	5 953	–	3 318.6	236.7	20.8	14.4	2.2	–	–	–
May	9 349	0.1	1 118.5	553.5	275.4	126.7	63.3	24.9	5.4	8.1
June	10 011	716.6	778.4	393.7	197.3	48.4	20.5	1.3	3.2	1.6
July	10 889	8 938.2	240.9	43.9	27.2	6.2	3.5	0.3	–	–
August	8 017	4 169.3	140.8	31.4	8.1	3.1	2.2	0.8	0.3	–
September	6 458	2 637.8	21.6	1.3	–	–	–	–	–	–
October	1 329	537.7	12.3	0.4	–	–	–	–	–	–
Total	52 006	16 999.7	5 631.1	1 260.9	528.8	198.8	91.7	27.3	8.9	9.7

Table 5.3.4   SANDEELS in the southern North Sea.   VPA catch in numbers, half year (x 10^{-6})

Year	1972		1973		1974		1975		1976		1977	
Age Group	1	2	1	2	1	2	1	2	1	2	1	2
0	0	0	13	0	670	76	0	0	4	0	0	13 263
1	2 839	86	14 497	206	5 989	226	11 458	480	16 308	249	19 500	269
2	15 695	1 148	2 515	53	3 930	10	1 694	1 046	14 505	2 358	5 596	27
3	418	35	3 832	151	497	0	2 838	170	1 522	392	6 300	8
4	128	24	183	5	1 968	3	529	253	1 234	102	965	8
5	94	16	89	3	205	0	666	0	171	20	445	3
6	20	0	31	2	22	0	91	0	72	58	239	3
7	3	0	7	1	11	0	2	0	1	16	124	0
8	29	-	53	-	73	-	3	-	0	-	36	-
Total	19 225	1 308	21 221	423	13 363	315	17 280	1 949	33 817	3 195	33 204	13 581

Year	1978		1979		1980		1981		1982	
Age Group	1	2	1	2	1	2	1	2	1	2
0	922	41 224	181	1 947	62	72	415	43 420	242	5 039
1	58 839	2 774	16 018	5 210	33 269	4 738	13 394	407	56 545	4 718
2	16 948	385	22 737	2 085	12 472	840	11 719	1 892	6 224	490
3	1 793	125	4 487	138	3 794	575	2 466	115	3 277	344
4	1 006	97	1 265	110	375	9	774	36	1 813	36
5	114	26	441	30	63	0	353	3	94	4
6	21	26	244	0	50	0	84	0	24	0
7	14	7	3	0	0	0	16	0	8	0
8	26	-	32	-	0	-	5	-	0	-
Total	79 684	44 665	45 409	9 520	50 086	6 234	29 226	45 873	68 227	10 631

Table 5.3.5   SANDEELS in the southern North Sea.   VPA.   Fishing mortalities per half-year, M = 0.5 year^{-1}

Year	1972		1973		1974		1975		1976		1977	
Age Group	1	2	1	2	1	2	1	2	1	2	1	2
0	0	0	0	0	0.006	0.001	0	0	0	0	0	0.08
1	0.15	0.007	0.45	0.01	0.27	0.02	0.19	0.01	0.54	0.01	0.35	0.008
2	0.57	0.08	0.28	0.009	0.30	0.001	0.16	0.14	0.56	0.17	0.52	0.004
3	0.15	0.02	0.41	0.03	0.11	0.000	0.54	0.06	0.34	0.15	0.99	0.003
4	0.39	0.12	0.13	0.004	0.57	0.002	0.23	0.18	0.78	0.14	0.68	0.01
5	0.50	0.16	0.96	0.06	0.29	0.000	0.57	0.00	0.18	0.03	1.56	0.03
6	0.04	0.00	0.54	0.05	1.17	0.000	0.28	0.00	0.15	0.18	0.65	0.01
7	0.01	0.00	0.02	0.002	0.56	0.000	(0.50)	–	0.004	0.13	0.76	0.00
8	(0.50)	–	(0.50)	–	(0.50)	–	(0.50)	–	–	–	(0.50)	–
Mean 1-4	0.32	0.06	0.32	0.01	0.31	0.006	0.28	0.10	0.56	0.12	0.64	0.006

Year	1978		1979		1980		1981		1982	
Age Group	1	2	1	2	1	2	1	2	1	2
0	0.006	0.42	0.001	0.02	0.001	0.002	0.002	0.29	0.005	(0.15)
1	0.67	0.06	0.30	0.16	0.54	0.14	0.55	0.03	0.82	(0.15)
2	0.92	0.05	1.01	0.23	0.75	0.10	0.64	0.21	0.86	(0.15)
3	0.45	0.05	1.16	0.09	0.94	0.36	0.52	0.04	0.70	(0.15)
4	0.60	0.11	1.18	0.30	0.41	0.02	1.37	0.20	1.84	(0.15)
5	0.21	0.07	1.06	0.18	0.29	0.00	1.56	0.04	1.25	(0.15)
6	0.38	1.22	2.06	0.00	0.56	0.00	1.34	0.00	(0.60)	–
7	0.09	0.06	(0.50)	–	0.005	0.00	(0.50)	–	(0.60)	–
8	(0.50)	–	(0.50)	–	–	–	(0.50)	–	–	–
Mean 1-4	0.66	0.07	0.91	0.20	0.66	0.16	0.77	0.12	1.06	(0.15)

Table 5.3.6   SANDEELS in the southern North Sea.   VPA.   Stock size in numbers x 10^{-6}

Year	1972		1973		1974		1975		1976		1977	
Age Group	1	2	1	2	1	2	1	2	1	2	1	2
0	–	57 140	–	36 845	–	97 826	–	56 408	–	94 694	–	188 174
1	22 390	14 946	44 501	22 016	28 695	17 106	76 120	49 236	43 930	20 017	73 748	40 397
2	40 318	17 747	11 565	6 806	16 965	9 774	13 123	8 734	37 923	16 913	15 370	7 098
3	3 372	2 260	12 812	6 634	5 254	3 655	7 604	3 452	5 884	3 252	11 104	3 213
4	441	232	1 729	1 186	5 033	2 208	2 847	1 754	2 538	908	2 189	867
5	264	124	160	48	920	537	1 717	758	1 144	741	618	101
6	603	452	83	38	35	8	418	246	591	396	560	228
7	254	195	352	268	28	12	7	0	192	149	258	94
8	82	–	152	–	208	–	10	–	0	–	101	–

Year	1978		1979		1980		1981		1982	
Age Group	1	2	1	2	1	2	1	2	1	2
0	–	134 660	–	117 426	–	45 463	–	192 381	–	40 759
1	134 896	53 971	68 902	39 649	89 738	40 926	35 344	15 870	111 839	38 162
2	31 224	9 678	39 594	11 230	26 308	9 679	27 715	11 404	12 001	3 963
3	5 504	2 723	7 198	1 748	6 919	2 112	6 800	3 148	7 223	2 782
4	2 495	1 068	2 011	479	1 240	638	1 142	227	2 351	291
5	668	420	747	202	277	161	489	80	145	32
6	76	41	304	30	131	58	125	25	59	0
7	175	125	9	0	24	18	45	0	20	0
8	73	–	91	–	0	–	14	–	0	–

Table 5.3.7 SANDEELS in the northern North Sea (Shetland excluded). VPA, catch in numbers, half-year ($\times 10^{-6}$)

Year	1972		1973		1974		1975		1976		1977	
Age Group	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec
0	0	4 930	0	337	472	9 979	99	9 282	237	6 126	3 686	3 067
1	3 398	846	4 057	143	19 850	384	7 186	74	5 697	648	24 307	2 856
2	2 045	0	1 657	68	1 347	53	5 249	105	1 130	84	2 351	913
3	115	0	836	20	1 424	11	1 508	1	445	368	516	142
4	79	0	89	0	276	7	248	0	101	19	124	99
5	62	0	58	1	73	5	87	0	39	10	17	28
6	60	0	1	0	2	0	0	0	15	8	3	15
Total	5 759	5 776	6 698	570	23 444	10 439	14 377	9 463	7 664	7 262	31 007	7 119

Year	1978		1979		1980		1981		1982	
Age Group	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec
0	0	7 820	0	44 203	17	8 349	17	9 128	2	6 530
1	6 127	1 001	2 335	1 310	13 394	1 173	5 505	346	3 518	65
2	2 338	307	1 328	433	8 865	214	4 109	94	2 132	0
3	573	39	242	66	1 050	19	904	14	556	0
4	78	1	5	10	645	4	128	6	76	0
5	45	1	2	0	144	3	19	0	9	0
6	21	0	5	0	38	1	27	0	0	0
Total	9 181	9 169	3 917	46 022	24 155	9 762	10 709	9 588	6 293	6 595

Table 5.3.8   SANDEELS in the northern North Sea (Shetland excluded). VPA. Fishing mortalities per half-year. $M = 0.5 \text{ year}^{-1}$

Year	1972		1973		1974		1975		1976		1977	
Age Group	1	2	1	2	1	2	1	2	1	2	1	2
0	0	0.27	0	0.008	0.01	0.48	0.003	0.37	0.004	0.12	0.13	0.16
1	0.31	0.12	0.40	0.02	0.90	0.04	0.82	0.02	0.44	0.08	1.08	0.36
2	0.54	0.00	0.40	0.03	0.33	0.02	1.09	0.05	0.42	0.05	0.52	0.42
3	0.26	0.00	0.66	0.03	1.21	0.02	1.26	0.003	0.35	0.58	0.52	0.28
4	0.56	0.00	0.48	0.00	0.73	0.04	1.18	0.00	0.34	0.10	0.42	0.75
5	3.37	0.00	2.07	0.19	1.68	(0.50)	0.86	0.00	0.88	0.65	0.13	0.34
6	(0.50)	–	(0.50)	–	(0.50)	–	–	–	(0.50)	–	(0.50)	–
Mean 1-4	0.42	0.03	0.48	0.02	0.79	0.03	1.09	0.02	0.39	0.20	0.64	0.45

Year	1978		1979		1980		1981		1982	
Age Group	1	2	1	2	1	2	1	2	1	2
0	0	0.24	0	0.86	0.001	0.39	0.001	1.00	0	(0.40)
1	0.57	0.18	0.11	0.09	0.76	0.14	0.51	0.06	1.79	(0.13)
2	0.60	0.15	0.40	0.23	1.59	0.13	1.06	0.06	(0.60)	–
3	0.55	0.07	0.18	0.07	1.49	0.09	1.39	0.06	(0.60)	–
4	0.26	0.003	0.01	0.03	2.13	0.06	1.41	0.21	(0.60)	–
5	1.06	0.07	0.01	0.00	0.80	0.04	(0.50)	–	(0.60)	–
6	(0.50)	–	(0.50)	–	(0.50)	–	(0.50)	–	–	–
Mean 1-4	0.50	0.10	0.18	0.10	1.49	0.10	1.09	0.10	–	–

Table 5.3.9   SANDEELS in the northern North Sea (Shetland excluded)

VPA. Stock size in numbers x 10^{-6}

Year Age Group	1972		1973		1974		1975		1976		1977	
	1	2	1	2	1	2	1	2	1	2	1	2
0	-	23 093	-	47 908	-	29 438	-	33 457	-	59 018	-	23 764
1	14 349	8 203	13 670	7 104	37 014	11 674	14 229	4 862	17 949	9 009	40 585	10 680
2	5 485	2 492	5 646	2 951	5 407	3 034	8 754	2 298	3 722	1 912	6 447	2 974
3	560	336	1 941	785	2 238	520	2 316	510	1 697	933	1 416	653
4	207	92	262	126	594	223	395	94	396	220	406	208
5	68	2	72	7	98	14	167	55	74	24	155	106
6	172	-	1	-	5	-	0	-	43	-	10	-

Year Age Group	1978		1979		1980		1981		1982	
	1	2	1	2	1	2	1	2	1	2
0	-	40 441	-	85 117	-	29 076	-	16 030	-	22 201
1	15 817	6 988	24 647	17 145	28 059	10 245	15 355	7 164	4 611	601
2	5 822	2 502	4 564	2 396	12 201	1 941	6 949	1 872	5 275	-
3	1 519	685	1 679	1 095	1 486	261	1 324	257	1 376	-
4	384	231	499	385	795	74	186	35	188	-
5	76	21	179	138	291	102	54	-	22	-
6	59	-	15	-	107	-	77	-	-	-

Table 5.3.10.   SANDEEL IN THE SHETLAND AREA

VIRTUAL POPULATION   ANALYSIS   **** VPA ****

CATCH IN NUMBERS   UNIT: MILLIONS

	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	953	9	4600	6109	5528	1310	7211	13710	17000
1	340	3336	2246	3355	5069	1908	611	2485	5051
2	67	1397	450	616	1193	525	473	1510	1261
3	25	232	157	53	117	90	302	427	529
4	27	57	28	70	28	26	109	170	199
5	5	28	15	8	23	15	36	50	92
6	2	19	6	8	3	2	38	20	27
7	6	9	2	4	1	1	14	3	9
8+	0	6	0	1	1	0	0	3	10
TOTAL	1945	5136	7503	10424	11963	3956	9044	18540	24758

Table 5.3.11.   SANDEEL IN THE SHETLAND AREA

VIRTUAL POPULATION   ANALYSIS   **** VPA ****

UNIT: Year-1
FISHING MORTALITY COEFFICIENT   NATURAL MORTALITY COEFFICIENT = 0.50

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1977-80
0	0.112	0.001	0.334	0.361	0.465	0.123	0.509	0.558	0.500	0.365
1	0.211	1.030	0.546	0.636	0.674	0.427	0.144	0.475	0.700	0.520
2	0.137	0.975	0.581	0.571	0.733	0.280	0.239	0.630	0.700	0.456
3	0.141	1.365	0.375	0.169	0.204	0.148	0.364	0.507	0.700	0.221
4	0.266	0.687	0.671	0.410	0.176	0.080	0.579	0.338	0.700	0.263
5	0.127	0.742	0.631	0.634	0.321	0.185	0.660	0.496	0.700	0.450
6	0.071	1.633	0.521	1.588	0.612	0.059	1.650	0.637	0.700	0.977
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.700	1.000
8+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.700	1.000
F(0- 6)	0.145	0.494	0.396	0.433	0.610	0.225	0.403	0.547	0.552	
F(1- 6)	0.199	1.058	0.540	0.603	0.795	0.355	0.212	0.517	0.700	

Table 5.3.12.   SANDEEL IN THE SHETLAND AREA

VIRTUAL POPULATION   ANALYSIS   **** VPA ****

STOCK SIZE IN NUMBERS   UNIT: MILLIONS
--------------------   BIOMASS UNIT: TONNES

1 JANUARY

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1974-80
0	11338	10944	20510	25239	18549	14203	22489	39895	53787	********	17591
1	5576	6145	6651	3625	10670	7070	7047	6197	13314	19787	7509
2	862	2740	1266	2329	2853	2761	2798	4616	5093	4161	2218
3	240	450	627	429	793	826	1257	1336	1298	932	659
4	144	127	71	261	220	394	432	522	438	591	235
5	52	67	39	22	105	112	220	179	226	147	88
6	29	26	19	12	7	40	56	69	66	68	28
7	12	17	3	7	2	2	26	7	22	20	10
8+	9	11	9	1	3	6	6	6	25	14	2

TOTAL NO	13252	20534	28971	37726	33180	25414	34906	54135	72819
SSB NO.	1539	3445	2024	3662	3957	4081	4771	6135	5218
TOT.BIOM	51234	68857	74109	97873	103197	85418	106245	146559	163595
SSB BIOM	12432	23474	17775	25596	33762	36450	44091	54885	49041

(See Table 5.5.4. for weight for calculating biomass)

Table 5.3.13. Recruitment. Numbers at age 0 at 1 July from VPA for the three sandeel assessment areas.

Year	Recruitment indices (no. of 0-group at 1 July)		
	Southern North Sea	Northern North Sea	Shetland[*]
1972	57 140	23 093	-
1973	36 845	47 908	-
1974	97 826	29 438	8 830
1975	56 408	33 457	8 523
1976	94 694	59 018	15 822
1977	188 174	23 764	19 656
1978	134 660	40 441	14 446
1979	117 426	85 117	11 108
1980	45 463	29 076	17 514
1981	192 381	16 030	30 999
1982	(40 759)	(22 201)	(41 889)

[*] No. of 0-group at 1 January reduced by $M = 0.25$ to 1 July.

Table 5.3.14. Fishing mortality in the three sandeel assessment areas from VPA.

| Year | Values of Fishing Mortality | | | F (Unweighted Mean F Ages 1-4) | | | | Values of F on 0-Group | | |
| | Southern North Sea | | | Northern North Sea | | | Shetland Whole Year | Southern North Sea | Northern North Sea | Shetland |
	1st Half Year	2nd Half Year	Total	1st Half Year	2nd Half Year	Total				
1972	0.32	0.06	0.38	0.42	0.03	0.45	-	0	0.27	-
1973	0.32	0.01	0.33	0.48	0.02	0.50	-	0	0.008	-
1974	0.31	0.006	0.32	0.79	0.03	0.82	0.19	0.007	0.49	0.11
1975	0.28	0.10	0.38	1.09	0.02	1.11	1.03	0	0.37	0.001
1976	0.56	0.12	0.68	0.39	0.20	0.59	0.54	0	0.12	0.33
1977	0.64	0.006	0.65	0.64	0.45	1.09	0.45	0.08	0.29	0.36
1978	0.66	0.07	0.73	0.50	0.10	0.60	0.50	0.43	0.24	0.46
1979	0.91	0.20	1.11	0.18	0.10	0.28	0.24	0.02	0.86	0.12
1980	0.66	0.16	0.82	1.49	0.10	1.59	0.28	0.003	0.39	0.51
1981	0.77	0.12	0.89	1.09	0.10	1.19	0.49	0.29	1.00	0.56
1982	1.06	(0.15)	(1.22)	(0.90)	(0.03)	(0.93)	(0.70)	(0.16)	(0.40)	(0.50)

Values in parentheses based entirely on input F values.

Table 5.3.15. Comparison of F derived from VPA with fishing effort in the
SANDEEL fisheries.

Year	Southern Area of North Sea		Northern Area of North Sea	
	Fishing Effort (hours x 10^{-3})*)	F	Fishing Effort (hours x 10^{-3})*)	F
1972	146.8	0.38	90.4	0.45
1973	152.4	0.33	57.7	0.50
1974	84.6	0.32	109.5	0.82
1975	92.5	0.38	118.7	1.11
1976	-	-	-	-
1977	154.8	0.65	196.9	1.09
1978	261.1**)	0.73	137.5**)	0.60
Correlation coefficient r	0.80		0.68	

	Shetland				
Year	Hours Fishing		Total	Weighted Mean F on ages 1-6	F on 0-Group
	1st Half	2nd Half			
1975	2 935	4 973	7 908	1.06	0.001
1976	4 457	6 054	10 511	0.54	0.334
1977	4 946	3 360	8 306	0.60	0.361
1978	4 777	5 440	10 217	0.80	0.465
1979	2 325	1 792	4 117	0.36	0.123
1980	3 344	3 234	6 578	0.21	0.509
1981	5 913	5 126	11 039	0.52	0.558
1982	6 173	6 220	12 393	(0.70)	(0.50)

*) Derived from total international catch/catch per unit effort in
the Danish fisheries (C.M.1979/G:26).

**) Based on March-June only.

Table 5.5.1. SANDEEL - North Sea.
Mean weight (g) at age by month in Danish catches, 1981-82.

1981	Month								
Age	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
0					1.64	2.70	3.47	3.47	3.12
1	3.00	3.21	3.57	5.85	6.50	11.00	10.00	10.00	10.00
2		5.23	5.67	9.45	12.39	9.12			
3		7.63	10.06	12.05	17.53	15.91			
4		9.41	11.24	13.41	28.04	16.04			
5		12.41	14.99	14.31	26.00	17.00			
6			22.00	15.60	47.77				
7		13.83	13.83	18.50	40.80				
8+		13.83	13.83						
1982									
0					1.39	1.69		4.31	
1		3.60	3.42	5.64	6.12	5.47			
2		7.38	8.07	10.12	11.35	10.81			
3			7.79	12.59	14.61	13.69			
4			10.45	15.81	18.14	18.83			
5			9.50	14.34	24.18	34.00			
6					24.21				
7				18.33	33.50				

Table 5.5.2. SANDEEL - North Sea.
Mean weight at age by month in Norwegian catches in 1982.

Age	Southern North Sea		Northern North Sea			
	May	June	Mar	Apr	May	Jun
0	-	-	-	-	-	1.45
1	7.62	9.86	5.10	6.17	8.39	8.31
2	16.46	23.27	11.99	13.82	16.09	16.62
3	34.86	37.75	26.47	31.16	32.86	28.89
4	56.00	-	-	46.67	50.00	52.43
5	-	-	-	-	58.80	-

Table 5.5.3. SANDEEL - Shetland.
Mean weight at age by month in Scottish catches (in grammes).

Year	Age Group	1	2	3	4	5	6	7	8	9	10	11	12
1979	0							2.44	1.54	1.76			
	1				1.91	3.30		4.26	4.13	4.92			
	2				3.22	6.24		6.71	6.31	-			
	3				6.15	7.51		9.27	7.91	8.20			
	4				7.47		11.14	14.18	9.95				
	5						12.40	13.55					
	6						12.20						
	7						15.80						
	8+												
1980	0					0.80		1.54	1.72	2.83			
	1				4.14	4.70	7.0	6.14	4.78	7.25			
	2				4.84	5.78	8.8	6.10	6.84	7.92			
	3				6.53	8.20	10.4	8.7	9.8				
	4				7.10	8.7	12.8		12.21	16.07			
	5				10.02	12.49	18.3		18.90	15.72			
	6				10.02	-	19.4		20.60				
	7					19.10	18.4						
	8+												
1981	0					0.10	1.04	1.21	1.37	1.66			
	1				2.1	3.54	4.69	5.60	6.75	5.36			
	2				4.7	5.26	7.76	6.68	10.38	10.18			
	3				8.6	7.29	10.44	5.70	12.80	13.4			
	4				9.5	9.03	16.62		12.38	14.36			
	5				12.1	11.41	15.56		11.35	18.89			
	6				12.7	13.00	24.57		17.80	-			
	7				13.7	9.68	23.00			13.00			
	8+					13.34	28.10						
1982	0					0.47	0.71	1.19		2.08	2.16		
	1				1.34	2.44	4.50	4.60		5.34	5.17		
	2				4.45	4.82	5.48	6.89		7.99	8.39		
	3				6.21	7.63	8.11	8.95					
	4				8.86	7.82	11.34						
	5				10.27	9.56	14.80	12.39	18.75				
	6					12.78	18.39	13.70	17.36				
	7					9.88	17.56		18.30				
	8+					16.67	24.45						

Table 5.5.4. SANDEEL - North Sea.
Mean weight at age for each assessment area averaged over
1979-82.

| Age | Mean Weight (g) (Average of all Estimates for Months of June and July) | | | | | |
| | Northern Area | | Southern Area | | Shetland | |
	Actual	Smoothed	Actual	Smoothed	Actual	Smoothed
0	2.0	1.9	1.6	1.6	1.3	1.5
1	11.3	11.8	6.8	6.5	4.9	3.9
2	24.1	25.7	10.7	11.6	7.0	7.1
3	39.3	38.4	15.2	15.5	9.5	10.6
4	54.5	48.3	19.2	18.1	14.0	14.1
5	53.6	55.2	19.9	19.6	16.4	17.5
6	56.8	59.9	20.6	20.6	23.0	20.5
7	-	62.9	25.6	21.1	22.6	23.1
8	80.0	64.8	17.0	21.4	25.1	25.3

Table 5.6.1 SANDEEL North Sea percentage annual landings by weight by age.

Stock	Year	AGE								
		0	1	2	3	4	5	6	7	8
Northern North Sea	1979	61	16	17	6	–	–	–	–	–
	1980	12	35	21	15	13	3	1	–	–
	1981	27	23	24	18	5	1	1	–	–
	1982	21	25	32	18	4	1	–	–	–
Southern North Sea	1979	1	28	47	16	6	2	1	–	–
	1980	–	61	25	12	2	–	–	–	–
	1981	42	17	29	8	3	1	–	–	–
	1982	2	67	14	10	7	–	–	–	–
Shetland	1979	11	37	45	4	2	1	–	–	–
	1980	45	16	12	11	6	6	3	1	–
	1981	34	31	22	7	3	2	1	–	–
	1982	48	25	13	8	4	2	1	+	+

Table 6.1.1 Landings of SPRAT in Division IIIa and in Norwegian fjords in Division IVa (10^{-3} tonnes). (Data provided by Working Group members).

Year	SKAGERRAK				KATTEGAT			IIIa TOTAL	Fjords of Western Norway (IVa E)	GRAND TOTAL
	Denmark	Sweden	Norway	Total	Denmark	Sweden	Total			
1969	0.8	1.9	1.7	4.4	0.8	1.6	2.4	6.8	11.8	18.6
1970	1.1	2.4	2.4	5.9	3.1	6.0	9.1	15.0	6.4	21.4
1971	0.7	2.4	2.9	6.0	1.5	9.6	11.1	17.1	4.4	21.5
1972	0.8	3.3	2.4	6.5	1.4	17.9	19.3	25.8	6.9	32.7
1973	19.4	2.5	3.2	25.1	19.3	16.2	35.5	60.6	8.8	69.4
1974	17.3	2.0	1.2	20.5	31.6	18.6	50.2	70.7	3.3	74.0
1975	14.9	2.1	1.9	18.9	69.7	20.9	90.6	109.5	2.9	112.4
1976	12.8	2.6	2.0	17.4	30.4	13.5	43.9	61.3	0.6	61.9
1977	7.2	2.2	1.2	10.6	53.3	9.8	63.1	73.7	5.4	79.1
1978	23.1	2.2	2.7	28.0	36.1	9.4	45.5	73.5	5.2	78.7
1979[*]	17.3	8.1	1.8	27.2	45.8	6.4	52.2	79.4	5.0	84.4
1980[*]	43.1	–	3.4	46.5	35.8	–	35.8	102.4	2.9	105.3
1981[**]	26.4	13.4	4.6	44.4	23.8	15.8	39.6	84.0	3.1	87.1
1982[**]	9.6	6.7	1.8	18.1	13.8	4.8	18.6	36.7	6.0	42.7

[*] Sweden: 20 124 tonnes in Div. IIIa. Included in total but allocation to Skagerrak and Kattegat not possible.

[**] Preliminary figures. Danish landings in October–December not included.

Table 6.1.2 Landings of SPRAT in Div. IIIa by quarters (tonnes)
             (Norwegian fjords in Div IIIa exluded).

Year	Months	Kattegat	Skagerrak	Total
1981	Jan - Mar	10 334	9 993	20 337
	Apr - May	3 029	3 682	6 711
	Jun - Aug	13 635	25 034	38 669
	Sep - Dec	12 610	5 674	18 284
	Total	39 618	44 383	84 001
1982	Jan - Mar	6 247	1 058	7 305
	Apr - May	2 903	6 410	9 313
	Jun - Aug	7 939	8 156	16 395
	Sep - Dec[*]	1 473	2 518	3 991
	Total	18 562	18 142	36 704

[*] Swedish and Norwegian catches only

Table 6.6.1 SPRAT in Div. IIIa. Numbers caught x 10^{-6}

Year	Quarter	Age groups 0	1	2	3	4	5
1975	Jan – Mar		435.86	200.44	56.28	2.46	
	Apr – Jun		230.75	398.91	146.51	0.16	
	Jul – Sep	32.81	5 979.74	527.61	50.92	0.34	
	Oct – Dec	139.22	985.73	54.32	0.68		
	Total	172.03	7 632.08	1 181.28	254.39	2.96	
1976	Jan – Mar		336.00	164.95	9.11	1.23	0.65
	Apr – Jun		556.41	57.07	27.38	0.91	
	Jul – Sep	509.96	2 334.72	171.39	16.80	2.21	
	Oct – Dec	918.64	1 084.09	23.24	0.55		0.11
	Total	1 428.60	4 311.22	416.65	53.84	4.35	0.76
1977	Jan – Mar		2 515.11	408.99	11.29		
	Apr – Jun		2 177.51	483.23	20.70	3.37	
	Jul – Sep	725.13	2 185.47	208.70	30.26	7.42	1.21
	Oct – Dec	1 948.34	813.86	142.90	0.79		
	Total	2 673.47	7 691.95	1 243.82	63.04	10.79	1.21
1978	Jan – Mar		4 376.51	203.89	12.52		
	Apr – Jun		5 004.51	33.18	3.57		
	Jul – Sep	23.99	3 987.97	61.57	14.70	0.70	
	Oct – Dec	261.12	262.21	16.70	0.84		
	Total	285.11	13 631.20	315.34	31.63	0.70	
1979	Jan – Mar		1 098.75	426.69	60.68	1.92	1.94
	Apr – Jun		763.41	239.49	2.39	-	-
	Jul – Sep	690.32	3 674.64	7.37	1.59	-	1.99
	Oct – Dec	260.04	1 360.87	22.45	2.51	-	3.13
	Total	950.36	6 897.67	696.00	67.37	1.92	7.06
1980	Jan – Mar		1 161.54	748.60	25.02	0.73	
	Apr – Jun		5 155.16	421.79	3.66		
	Jul – Sep	407.17	6 306.95	68.40	14.86		
	Oct – Dec	413.46	671.10	5.65			
	Total	820.63	13 294.75	1 244.44	43.54	0.73	
1981	Jan – Mar		1 369.29	1 498.93	20.67		
	Apr – Jun	218.29	374.10	478.02	20.58		
	Jul – Sep	416.08	3 757.70	98.14	17.39		
	Oct – Dec	33.69	1 112.97	110.94	5.28		
	Total	668.06	6 614.06	2 186.03	63.92		
1982	Jan – Mar		520.09	423.70	48.88	0.47	
	Apr – Jun		190.36	374.98	103.77	3.18	
	Jul – Sep	2.70	1 270.12	173.94	27.67		
	Oct – Dec						
	Total						

Table 6.6.2 SPRAT in Division IIIa. Quarterly VPA fishing mortalities (per quarter).

Year/Quarter		AGE GROUPS			
		0	1	2	3
1975	1	–	0.03	0.09	0.08
	2	–	0.02	0.28	0.33
	3	0.001	0.90	0.80	0.20
	4	0.007	0.39	0.18	–
1976	1	–	0.02	0.11	0.05
	2	–	0.06	0.06	0.20
	3	0.02	0.37	0.25	0.20
	4	0.05	0.32	0.05	–
1977	1	–	0.22	0.21	0.04
	2	–	0.32	0.44	0.09
	3	0.02	0.70	0.37	0.20
	4	0.06	0.68	0.52	–
1978	1	–	0.22	0.40	0.08
	2	–	0.46	0.11	0.03
	3	0.001	0.91	0.33	0.20
	4	0.011	0.14	0.15	–
1979	1	–	0.06	0.39	1.44
	2	–	0.06	0.43	0.19
	3	0.012	0.52	0.02	0.20
	4	0.006	0.40	0.10	–
1980	1	–	0.04	0.45	0.16
	2	–	0.23	0.54	0.03
	3	0.01	0.54	0.17	0.20
	4	0.02	0.11	0.02	–
1981	1	–	0.08	0.40	0.10
	2	0.05	0.03	0.23	0.15
	3	0.13	0.48	0.07	0.20
	4	0.02	0.28	0.12	–
1982	1	–	0.38	0.17	0.08
	2	–	0.25	0.25	0.25

$M = 0.275$ per quarter

Table 6.6.3 SPRAT in Div. IIIa. Quarterly VPA
Stock size in numbers x 10^{-6}

Year	Quarter	AGE GROUPS			
		0	1	2	3
1975	1	–	20 403	2 698	837
	2	–	15 119	1 876	587
	3	28 233	11 283	1 080	322
	4	21 416	3 479	370	–
1976	1	–	16 146	1 794	234
	2	–	11 973	1 219	170
	3	27 287	8 611	879	106
	4	20 283	4 529	518	–
1977	1	–	14 609	2 505	373
	2	–	8 923	1 549	274
	3	47 759	4 900	761	236
	4	35 649	1 853	398	–
1978	1	–	25 386	711	180
	2	–	15 499	364	126
	3	35 443	7 469	248	96
	4	26 900	2 279	135	–
1979	1	–	20 206	1 504	88
	2	–	14 395	775	16
	3	68 257	10 272	382	10
	4	51 246	4 647	284	–
1980	1	–	38 699	2 358	196
	2	–	28 387	1 147	127
	3	38 280	17 106	509	94
	4	28 722	7 581	328	–
1981	1	–	21 458	5 176	244
	2	–	15 111	2 641	167
	3	3 781	11 153	1 593	109
	4	2 521	5 242	1 125	–
1982	1	–	1 879	3 021	
	2	–	979	1 928	

Table 6.9.1 Comparison of IYFS and VPA estimates of recruitment of Division IIIa SPRAT.

Year Class	IYFS	VPA age 1 (Nos. x 10^{-6})
1971	1 004	
1972	1 322	
1973	1 324	
1974	5 074	20.4
1975	464	16.1
1976	1 403	14.6
1977	4 223	25.4
1978	886	20.2
1979	4 253	38.7
1980	2 423	21.5
1981		3.0

Table 6.9.2 SPRAT in Div. IIIa. Regression of Yield on IYFS-indices (1-group)

Year Class	IYFS	Catch (t x 10^{-3})
1974	5 074	112.4
1975	464	61.9
1976	1 403	79.1
1977	4 223	78.7
1978	886	84.4
1979	4 253	105.3
1980	2 423	87.1

intercept = 67.7

slope = 0.00721

r = 0.79

Table 7.1.1 SPRAT catches in the North Sea ('000 tonnes), 1972-82 (data provided by Working Group members).

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982a)
IVa West											
Denmark	-	-	5.3	0.5	0.6	0.1	-	-	-	2.8	-
Faroe Islands	-	-	0.2	12.9	2.5	0.4	-	-	-	-	-
France	-	-	-	-	-	+	-	-	-	-	-
German Dem.Rep.	-	-	-	-	-	+	-	-	-	-	-
Germany, Fed.Rep.	-	+	-	-	+	0.6	-	-	0.1	-	-
Netherlands	+	+	+	+	+	+	-	-	-	-	-
Norway	2.2	-	-	1.5	29.9	16.0	1.3	0	-	-	-
Poland	+	+	-	0.3	-	-	-	-	-	-	-
Sweden	-	1.0	2.2	11.0	+	0	-	-	-	-	-
U.K. (England)	-	0.2	-	-	-	0	-	-	-	-	-
U.K. (Scotland)	29.8	49.4	41.2	9.4	12.7	26.9	16.9	6.8	3.8	1.0	+
USSR	-	-	1.0	1.3	1.2	+	-	-	-	-	-
Total	32.0	50.6	49.9	36.9	46.9	44.0	18.2	6.8	3.9	3.8	+
IVa East (North Sea stock)											
Denmark	-	-	-	-	0.2	0.1	-	-	-	-	-
Norway	-	-	-	-	1.9	0.7	0.1	+	0.4	-	-
U.K. (Scotland)	-	-	-	-	+	0	-	-	-	-	-
Total	-	-	-	-	2.1	0.8	0.1	...	0.4	0	0
IVb West											
Belgium	-	-	-	-	+	0	-	-	-	-	-
Denmark	14.4	47.0	55.4	106.6	104.4	57.5	44.1	75.3 / 2.8b)	76.7 / 2.8b)	53.6	21.0x)
Faroe Islands	-	-	4.0	30.0	42.9	1.8	-	-	-	-	-
France	-	-	-	-	+	-	-	-	-	-	-
German Dem.Rep.	-	-	1.7	4.5	6.4	0.7	-	-	-	-	-
Netherlands	+	-	-	-	0	-	-	-	-	-	-
Norway	4.1	3.4	9.5	145.7	73.0	5.5	56.2	47.8	18.3	0.2	8.6
Poland	+	-	-	-	9.1	10.5	0	-	-	-	-
Sweden	-	-	-	-	7.9	0	-	-	-	-	-
U.K. (England)	21.8	34.6	25.5	32.5	49.7	51.9	53.9	12.9	2.4	0.7	0.2
U.K. (Scotland)	3.6	2.9	8.6	4.9	18.1	10.9	14.8	5.0	2.5	-	-
USSR	0.8	17.9	32.9	47.8	50.4	1.6	-	-	-	-	-
Total	44.7	105.8	137.7	381.1	362.3	123.9	169.0	143.8	102.7	54.5	29.8

a) Preliminary figure as reported.
b) IVb East and West.
+ = less than 0.1.
- = magnitude known to be nil.
x) first 9 months only.

/Cont'd.

Table 7.1.1 (ctd)

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982[a]
IVb East											
Denmark	28.8	93.9	104.0	215.2	201.1	126.8	161.0	191.5	149.0	127.5	53.8[x]
German Dem.Rep.	-	-	-	0.4	-	0.7	-	-	-	-	-
Germany, Fed.Rep.	1.7	11.0	17.5	0.5	1.7	4.3	-	1.8	6.1	4.8	1.5
Norway	-	-	-	-	5.1	0	29.8	27.4	33.7	0.2	7.2
Sweden	-	-	-	-	-	1.5	-	-	0.6	-	-
Total	30.5	104.9	121.5	216.1	207.9	133.3	190.8	222.7	189.4	132.5	62.5
IVc											
Belgium	0.1	0.2	+	+	-	0	-	-	-	-	-
Denmark	-	-	0.9	3.9	0.3	1.4	-	1.5	6.5	4.3	2.4[x]
France	-	+	0.3	0.1		+	-	-	-	-	-
German Dem.Rep.	-	-	-	-	0.1	+	-	-	-	-	-
Germany, Fed.Rep.	+	-	-	-	-	0.4	-	-	-	-	-
Netherlands	0.4	+	+	0.2	-	0	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-
UK(England)	+	0.8	3.4	2.9	0.7	0.2	0.2	3.1	16.2	14.0	3.7
USSR	-	-	+	+	0.2	-	0.0	1.4	4.3		14.9
Total	0.5	1.0	4.6	7.1	1.3	2.0	0.2	6.0	27.0	18.3	21.0
Total North Sea											
Belgium	0.1	0.2	+	+	+	+	+	+	+	-	-
Denmark	43.2	140.9	165.6	326.2	306.6	179.9	205.1	268.3	232.2	188.2	77.2[x]
Faroe Islands	-	-	4.2	42.9	45.4	2.2	-	2.8	2.8	-	-
France	-	+	0.3	0.1	-	+	-	-	-	-	-
German Dem.Rep.	-	-	1.7	4.9	6.5	1.4	-	-	-	-	-
Germany, Fed.Rep.	1.7	11.0	17.5	0.5	1.7	5.3	-	3.8	6.2	4.8	1.5
Netherlands	0.4	+	+	0.2	+	-	-	-	-	-	-
Norway	6.3	3.4	9.5	147.2	109.9	22.2	87.6	78.6	68.6	0.4	19.5
Poland	+	+	-	9.4	10.5	+	-	-	-	-	-
Sweden	-	1.0	2.2	11.0	7.9	1.5	-	-	0.6	-	-
UK(England)	21.8	35.6	28.9	35.4	50.4	52.1	53.9	14.3	6.7	14.0	14.9
UK(Scotland)	33.4	52.3	49.8	14.3	30.8	37.8	31.7	11.8	6.3	1.7	0.2
USSR	0.8	17.9	33.9	49.1	51.8	1.6	-	-	-	-	-
Total	107.7	262.3	313.6	641.2	621.5	304.0	378.3	379.6	323.4	209.1	113.3

a) Preliminary figures as reported.
x) First 9 months only.

Table 7.1.2 SPRAT in Division VIa. Landings in tonnes.

Countries	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Denmark							259			242	
Faroes		1	109	56	181						
France											
Germany, Fed.Rep.			22	123	37	+		97		2	
Ireland	908	1 650	713	517	673	282	533	12	1 787		
Netherlands	93	41	223	140	661	49	46	125	428		
Norway					35	267					24
Poland	7	6									−
UK/Scotl.[1]	5 225	7 502	5 959	8 127	6 455	4 246	11 563	1 087	2 987	1 410	1 057
Total	6 233	9 200	7 026	9 053	8 042	4 844	12 401	1 321	5 202	1 654	1 081

Source: ICES Statistician.
1) Amended from national data.

Table 7.1.3 SPRAT catches in thousand tonnes (Denmark, Norway and United Kingdom) in Sub-divisions (1979-1982).

1979

Month	AREAS				
	1	2	3	4	5
1	0.6		37.7	19.8	2.9
2	1.1		10.3	2.3	1.1
3	+		10.9	8.4	
4		+		2.7	
5			0.1	+	
6				1.1	
7			+	19.4	+
8				105.4	
9			5.0	19.6	
10	0.9		6.7	26.6	
11	4.0		27.2	15.2	
12	0.2		13.1	25.6	2.0

1981

Month	AREAS				
	1	2	3	4	5
1	0.6	-	12.7	3.0	10.3
2	-	-	14.4	9.1	6.9
3	-	-	+	3.1	+
4	-	-	+	0.2	+
5	-	-	1.5	0.4	0.2
6	-	-	0.4	0.6	0.2
7	-	-	-	20.5	-
8	-	-	1.4	26.3	-
9	2.8	-	2.9	35.9	-
10	+	-	-	20.1	-
11	0.1	-	13.3	8.3	-
12	0.3	-	8.0	-	0.7

1980

Month	AREAS				
	1	2	3	4	5
1	3.0		28.1	52.4	17.5
2	0.7		27.7	1.9	3.5
3			2.8	4.6	1.1
4	1.2		0.6	+	
5			0.2	+	+
6			0.7	1.3	
7			0.3	29.7	
8			0.5	34.9	
9			0.1	15.1	
10			10.6	36.6	0.1
11			15.1	24.7	
12			12.1	2.8	4.3

1982

Month	AREAS				
	1	2	3	4	5
1	+	-	23.7	17.9	13.3
2	-	-	1.8	1.0	7.1
3	-	-	0.8	0.1	+
4	-	+	+	-	-
5	-	-	+	0.1	-
6	-	-	0.1	0.1	-
7	-	-	-	4.7	+
8	-	-	-	15.1	-
9	-	-	-	21.2	-
10)x)	-	-	(+)	-	-
11)	-	-	(1.2)	(0.3)	-
12)	-	-	(2.1)	(0.5)	(0.5)

x) Danish data not available for last quarter.

Table 7.3.1 North Sea SPRAT catch in 1981. Numbers caught per age group x 10^{-6}.

Divisions	Months	Age groups					
		0	1	2	3	4	5
IVa W	Jan-Mar	-	-	7.8	1.6	-	-
	Apr-Jun	-	-	-	-	-	-
	Jul-Sep	-	57.8	145.7	-	-	-
	Oct-Dec	-	34.1	5.9	0.7	-	-
	Total	-	91.9	159.4	2.3	-	-
IVa E (excl. Norweg. fjord catch)	Jan-Mar	-	-	-	-	-	-
	Apr-Jun	-	-	-	-	-	-
	Jul-Sep	-	-	-	-	-	-
	Oct-Dec	-	-	-	-	-	-
	Total	-	-	-	-	-	-
IVb W	Jan-Mar	-	1 044.1	2 064.3	352.1	7.2	0.3
	Apr-Jun	3.4	6.7	106.9	23.5	-	1.5
	Jul-Sep	-	205.8	121.6	7.8	-	-
	Oct-Dec	48.3	1 069.0	626.8	52.6	0.1	-
	Total	51.7	2 325.6	2 919.6	436.0	7.3	1.8
IVb E	Jan-Mar	-	739.8	2 216.5	223.9	4.2	-
	Apr-Jun	19.6	78.2	63.7	1.6	-	-
	Jul-Sep	192.2	7 362.9	873.5	38.3	3.0	-
	Oct-Dec	95.1	1 186.4	796.3	11.6	0.4	0.4
	Total	306.9	9 367.3	3 950.0	275.4	7.6	0.4
IVc	Jan-Mar	-	465.4	930.0	477.9	10.7	1.2
	Apr-Jun	-	2.1	18.6	4.0	-	0.2
	Jul-Sep	-	-	-	-	-	-
	Oct-Dec	14.6	37.3	19.9	5.0	0.2	-
	Total	14.6	504.8	968.5	486.9	10.9	1.4
TOTAL NORTH SEA	Jan-Mar	-	2 249.3	5 218.6	1055.5	22.1	1.5
	Apr-Jun	23.0	87.0	189.2	29.1	-	1.7
	Jul-Sep	192.2	7 626.5	1 140.8	46.1	3.0	-
	Oct-Dec	158.0	2 326.8	1 448.9	69.9	0.7	0.4
	TOTAL	373.2	12289.6	7 997.5	1200.6	25.8	3.6

Table 7.3.1 (ctd) North Sea SPRAT in 1982. Numbers caught
per age group x 10^{-6}.

(Note: Danish catches not available for final quarter of year)

Divisions	Months	Age groups					
		0	1	2	3	4	5
IVa W	Jan-Mar	-	-	3.1	0.5	0.1	-
	Apr-Jun	-	-	-	-	-	-
	Jul-Sep	-	-	-	-	-	-
	Oct-Dec	-	-	-	-	-	-
	Total						
IVa E (excl. Norwegian fjord catch)	Jan-Mar	-	-	-	-	-	-
	Apr-Jun	-	+	0.1	0.1	-	-
	Jul-Sep	-	-	-	-	-	-
	Oct-Dec	-	-	-	-	-	-
	Total	-	+	0.1	0.1	-	-
IVb W	Jan-Mar	-	35.4	2 609.6	254.8	13.1	4.5
	Apr-Jun	-	-	11.7	-	-	-
	Jul-Sep	-	-	-	-	-	-
	Oct-Dec						
	Total						
IVb E	Jan-Mar	-	63.1	1 729.3	100.1	3.3	-
	Apr-Jun	-	3.4	7.3	5.4	0.7	-
	Jul-Sep	20.8	4 813.2	60.8	2.1	-	-
	Oct-Dec						
	Total						
IVc	Jan-Mar	-	922.2	1 535.8	239.7	99.9	0.5
	Apr-Jun	-	-	12.1	-	-	-
	Jul-Sep	-	-	-	-	-	-
	Oct-Dec						
	Total						
TOTAL NORTH SEA (excl. last quarter)	Jan-Mar	-	1 020.7	5 877.8	595.1	116.4	5.0
	Apr-Jun	-	3.4	31.2	5.5	0.7	-
	Jul-Sep	20.8	4 813.2	60.8	2.1	-	-
	Oct-Dec						

Table 7.3.2 North Sea SPRAT catch in 1974-1982. Numbers caught per age group x 10^{-6} in each three-month period.

Year	Months	Age group						
		0	1	2	3	4	5	6
1974	Jan-Mar	-	7 620.0	7 341.8	1 043.2	198.7	40.3	-
	Apr-Jun	-	361.8	2 083.5	148.6	26.1	4.7	-
	Jul-Sep	46.7	4 909.8	1 784.7	36.2	0.9	4.6	-
	Oct-Dec	1 549.3	6 172.9	865.1	74.5	10.6	7.2	-
1975	Jan-Mar	-	4 096.6	14 973.2	3 929.0	233.7	14.1	-
	Apr-Jun	-	446.2	1 163.2	68.9	6.5	-	-
	Jul-Sep	15.0	10 588.1	5 760.0	75.1	3.1	-	-
	Oct-Dec	675.2	6 351.6	6 122.5	660.2	57.3	4.4	-
1976	Jan-Mar	-	9 360.9	9 997.0	6 678.0	373.0	6.2	1.4
	Apr-Jun	-	2 017.2	964.6	740.1	40.9	0.8	-
	Jul-Sep	79.6	16 536.4	599.5	40.1	-	-	-
	Oct-Dec	2 780.4	8 443.7	2 659.4	612.7	37.1	-	-
1977	Jan-Mar	-	4 197.2	11 962.6	962.9	104.7	12.0	-
	Apr-Jun	-	540.3	670.9	52.7	1.5	-	-
	Jul-Sep	57.3	2 803.1	3 248.4	165.9	11.1	-	-
	Oct-Dec	1 060.8	4 705.0	3 049.5	311.2	1.5	-	-
1978	Jan-Mar	-	2 461.9	2 839.3	3 770.1	344.5	-	-
	Apr-Jun	-	1 077.5	123.8	3.2	0	-	-
	Jul-Sep	6.3	17 785.5	216.5	14.7	0.7	-	-
	Oct-Dec	636.8	6 932.7	3 955.8	1 159.0	214.9		
1979	Jan-Mar	-	2 770.0	6 422.2	2 670.6	131.2	0.7	-
	Apr-Jun	-	203.6	452.0	14.0	1.1	-	-
	Jul-Sep	-	25 379.1	388.3	2.1	0	-	-
	Oct-Dec	433.0	8 394.8	1 494.6	122.4	34.9	-	-
1980	Jan-Mar	-	1 448.0	12 764.4	1 323.2	103.7	0.7	-
	Apr-Jun	-	134.0	84.5	2.4	0.3	-	-
	Jul-Sep	15.1	10 143.3	811.6	4.7	-	-	-
	Oct-Dec	515.7	4 518.5	2 767.4	111.8	19.5	-	-
1981	Jan-Mar	-	2 249.3	5 218.6	1 055.5	22.1	1.5	-
	Apr-Jun	23.0	87.0	189.2	29.1	-	1.7	-
	Jul-Sep	192.2	7 626.5	1 140.8	46.1	3.0	-	-
	Oct-Dec	158.0	2 326.8	1 448.9	69.9	0.7	0.4	-
1982	Jan-Mar	-	1 020.7	5 877.8	595.1	116.4	5.0	-
	Apr-Jun	-	3.4	31.2	5.5	0.7	-	-
	Jul-Sep	20.8	4 813.2	60.8	2.1	-	-	-
	Oct-Dec		Incomplete data					

Table 7.3.3 North Sea SPRAT. Fishing mortality by quarters (VPA). M = 0.8 year^{-1}. Input fishing mortalities are in brackets. 1974 and quarter 1 of 1975 from previous report.

Year	Quarter	Age groups				
		0	1	2	3	4
1974	1	—	.052	.30	.59	1.41
	2	—	.003	.13	.15	.69
	3	.0003	.053	.15	.05	.44
	4	.0141	.087	.10	.14	(1.00)
1975	1	—	.046	.31	.92	.84
	2	—	.005	.035	.034	.046
	3	.000	.156	.245	.047	.028
	4	.004	.132	.446	.706	(1.000)
1976	1	—	.072	.315	1.339	1.213
	2	—	.020	.045	.488	.386
	3	.001	.224	.035	.043	.000
	4	.039	.170	.217	1.597	(1.000)
1977	1	—	.077	.386	.114	1.720
	2	—	.013	.033	.008	.086
	3	.001	.084	.220	.032	1.568
	4	.012	.198	.332	1.287	(1.000)
1978	1	—	.034	.176	.889	.445
	2	—	.019	.010	.002	.000
	3	.000	.478	.022	.008	.002
	4	.005	.346	.695	1.615	(1.000)
1979	1	—	.026	.627	1.685	.829
	2	—	.002	.079	.029	.013
	3	.000	.452	.090	.005	.000
	4	.007	.263	.575	.489	(1.000)
1980	1	—	.029	.809	1.748	1.041
	2	—	.003	.010	.011	.007
	3	.000	.364	.129	.026	.000
	4	.013	.273	.834	1.435	(1.000)
1981	1	—	.071	.582	.930	1.478
	2	—	.003	.036	.054	.000
	3	.006	.464	.312	.113	1.167
	4	.006	.249	.829	.250	(1.000)
1982	1	—	.046	1.912	1.037	.849
	2	—	.000	.039	.021	(.01)
	3	(.001)	(.4)	(.1)	(.01)	0

Table 7.3.4 North Sea SPRAT. Number in stock, N x 10^{-9}, at the beginning of each quarter and biomass, tonnes x 10^3, at the beginning of the year (VPA). M = 0.8 year $^{-1}$. 1974 and quarter 1 from 1975 from previous report.

Year	Quarter	Age groups					Biomass	
		0	1	2	3	4	Total	Adult
1974	1	–	166	31	2.5	.3	598	432
	2	–	129	19	1.2	+		
	3	148	105	14	.8	+		
	4	121	82	9.6	.6	+		
1975	1	–	98	61	7.1	.4	702	576
	2	–	99	37	2.3	.2		
	3	222	81	29	1.8	.1		
	4	182	57	19	1.4	.1		
1976	1	–	148	41	9.8	.6	613	465
	2	–	113	24	2.1	.1		
	3	97	91	19	1.1	.1		
	4	79	59	15	.8	.1		
1977	1	–	62	41	9.9	.1	522	460
	2	–	47	23	7.2	+		
	3	122	38	18	5.8	+		
	4	100	29	12	4.6	+		
1978	1	–	81	19	7.0	1.1	354	273
	2	–	64	13	2.3	.6		
	3	176	51	11	1.9	.5		
	4	144	26	8.6	1.6	.4		
1979	1	–	117	15	3.5	.3	289	172
	2	–	94	6.6	.5	.1		
	3	84	76	5.0	.4	.1		
	4	69	40	3.7	.3	.1		
1980	1	–	56	25	1.7	.2	273	217
	2	–	45	9.1	.2	+		
	3	55	36	7.4	.2	+		
	4	45	21	5.3	.2	+		
1981	1	–	36	13	1.9	+	162	126
	2	–	28	5.9	.6			
	3	38	22	4.7	.5			
	4	31	12	2.8	.3			
1982	1	–	25	7.4	1.0	.2	100	75
	2	–	20	.9	.3	.1		
	3	23	16	.7	.2			

Adult = 2+3+4

Table 7.9.1 North Sea SPRAT.
Available statistics relevant to yield prognosis.

Year of observation	Catch ('000 t) Calendar year	Catch ('000 t) season a)	Catch x 10^-6 Age 1 and older	Surveys IYFS N.Sea No/hr all ages	IYFS Div. IVb 1-gr.	IYFS IVb E IKMT 1-gr.	IYFS IVb E Bottom trawl 1-gr.	Mid-water surveys November 0-gr.	Mid-water surveys November 1-gr.	Commercial fisheries NE Engl. fishery winter x 10^-6 1-gr.	North Sea x 10^-6 Catches first quarter 1-gr.
1970		84								1 172	
1971	86	111								730	
1972	108	156		873	90					218	
1973	262	237		713	123					1 022	
1974	314	379	32 735	2 631	481					1 517	7 620
1975	641	628	54 554	–	–					339	4 097
1976	621	445	59 109	2 127	1 186					557	9 361
1977	304	291	32 801	3 031	136					361	4 197
1978	378	440	40 900	2 208	1 474					732	2 462
1979	380	484	48 482	569 b)	248 b)					330	2 770
1980	323	269	34 238	3 770	1 402	328	1 916	2 831	81	59	1 448
1981	203	206	21 517	2 107	886	107	1 146	1 075	60	–	2 249
1982	113 c)	?	12 532 c)	602	183	49	512	1 044	38	–	1 021
1983											

a) Season beginning in winter of the mentioned year
b) Low figures due to abnormal conditions on the survey
c) Catch statistics for the three first quarters only

Table 8.1.1. Nominal catch (tonnes) of SPRAT in Division VIId,e, 1972-82 (data for 1972-81 as officially reported to ICES).

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982[*]
Belgium	-	13	-	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	447	74	1 796	9 981	7 483	b)	286[a]
Faroe Islands	-	-	-	-	6	-	-	-	-	-	-
France	488	1 269	520	147	115	120	225	2 373	1 867	146	-
German Dem.Rep.	-	37	-	-	-	-	-	-	-	-	-
Germany, Fed.Rep.	-	4	-	-	-	-	34	6	52	1	-
Netherlands	10	11	16	109	49	115	826	441	1 401	1 015	1 000
Norway	-	-	-	-	-	-	-	-	65	-	-
Poland	-	-	1	-	-	-	-	-	-	-	-
U.K. (Eng. & Wales)	1 378	1 990	3 256	1 315	3 107	2 928	2 118	2 032	6 864	10 183	4 500
Total	1 876	3 324	3 793	1 571	3 724	3 237	4 999	14 833	17 732		

[*] Preliminary
a) Landings in foreign ports Jul-Dec not included.
b) As per 22 February 1983, no final data available.

Table 8.1.2. Lyme Bay area fishery - Monthly catches (tonnes). (United Kingdom vessels only.)

Season	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Season Total
1961-62				1	27	4	427	428	35	922
1962-63				309	238	131	148	187	58	1 071
1963-64				263	53	82	385	276	24	1 083
1964-65				25	56	20	242	465	8	816
1965-66				47	81	165	610	302	17	1 222
1966-67				3	152	368	703	355	1	1 583
1967-68			18	76	238	422	560	43	3	1 360
1968-69	11	-	4	122	142	298	373	123	1	1 074
1969-70				140	131	276	915	283	76	1 821
1970-71		7	38	90	184	549	553	106	20	1 547
1971-72			369	101	232	228	410	70		1 410
1972-73			107	209	132	87	404	165	49	1 153
1973-74			313	186	194	350	311	96	40	1 490
1974-75	184	451	209	533	838	405	157	30		2 807
1975-76			66	649	289	111	204	6		1 325
1976-77	289	440	1 039	123	594	347	234	103	5	3 174
1977-78	31	680	768	725	115	84	201	54		2 658
1978-79		252	368	545	450	209	58	37	28	1 947
1979-80			90	674	706	337	150	38	2	1 997
1980-81			458	815	1 423	1 872	2 069	138	54	6 829
1981-82			11	475	1 854	4 311	855	265	100	7 871
1982-83			54	844	1 017	641	(522)*			
Period Mean Values										
1961-65				129	91	81	362	332	29	1 024
1966-70	2	1	12	86	170	383	621	182	20	1 477
1971-75	37	90	213	336	337	236	297	73	18	1 637
1976-80	64	274	545	577	658	570	542	74	18	3 322

*) Data incomplete.

Table 8.1.3. Lyme Bay SPRAT.
Catches (tonnes) by principal types of vessel and gear
(1977-82).

Season	Local Vessels (Pelagic Trawl)	Scottish Pair Trawl	Purse Seine	Total
1977-78	2 673	-	-	2 673
1978-79	1 945	100	-	1 945
1979-80	1 703	297	-	2 000
1980-81	2 513	3 884	432	6 829
1981-82	3 345	2 714	1 813	7 872
1982-83 (Sep-Dec only)	(2 551)	0	0	(2 551)

<u>Table 8.3.1.</u> Comparison of period mean age structures of the exploited populations in the United Kingdom northeast coast and Lyme Bay area SPRAT fisheries (1966/67 - 1979/80 seasons).

		Age Groups						
		1	2	3	4	5	6	Total
Northeast coast	Tonnes	1 424	10 954	7 115	1 639	236	28	21 396
	% Weight	6.7	51.2	33.2	7.7	1.1	0.1	
Lyme Bay	Tonnes	7	303	882	437	135	29	1 793
	% Weight	0.4	16.9	49.2	24.4	7.5	1.6	

Comparison of mean weights (g) for age in the northeast coast and Lyme Bay fisheries (with seasonal variation).

	Age Groups					
	1	2	3	4	5	6
Northeast coast	2.95	9.62	16.19	21.16	26.38	–
(S.D.)	(0.89)	(1.60)	(1.58)	(2.75)	(2.63)	–
% C. of V.	30.0	16.6	9.8	13.0	10.0	–
Lyme Bay	4.51	10.75	18.48	24.11	28.03	29.28
(S.D.)	(1.34)	(2.45)	(2.15)	(1.43)	(2.08)	(2.71)
% C. of V.	30.0	23.0	12.0	6.0	7.0	9.0

Comparison of mean lengths (cm) for age in the northeast coast and Lyme Bay fisheries (with seasonal variation).

	Age Groups					
	1	2	3	4	5	6
Northeast coast	7.80	10.97	12.66	13.82	14.77	–
(S.D.)	(0.74)	(0.51)	(0.46)	(0.56)	(0.47)	–
% C. of V.	9.5	4.7	3.6	4.0	3.2	–
Lyme Bay	8.93	11.30	13.31	14.45	15.18	15.44
(S.D.)	(0.83)	(0.81)	(0.42)	(0.23)	(0.30)	(0.46)
% C. of V.	9.0	7.0	3.0	2.0	2.0	3.0

Overall mean weights of fish in catch		
	Northeast Coast	Lyme Bay
Mean (g)	9.98	17.12
S.D.	2.77	1.25
% C. of V.	27.73	7.31

Overall mean ages of fish in catch		
Mean (years)	2.07	3.03
S.D.	0.34	0.30
% C. of V.	16.58	9.98

Table 8.3.2   Lyme Bay area SPRAT fishery, 1966-82.
Numbers caught per age group x 10^{-6} in each season.

Season	Age group					
	0/1	1/2	2/3	3/4	4/5	5/6
1966-67	0.55	11.67	44.00	18.56	11.67	3.60
1967-68	2.28	46.79	33.10	5.08	0.66	0.39
1968-69	0.08	29.99	29.24	4.03	0.44	0.10
1969-70	0.13	17.53	62.78	18.60	2.73	0.35
1970-71	0.01	4.12	46.03	26.94	1.57	0.54
1971-72	0.80	20.22	28.01	22.96	4.12	0.34
1972-73	1.51	32.20	22.20	10.20	3.96	0.38
1973-74	0.50	22.91	46.12	9.08	5.06	2.42
1974-75	0.30	40.77	82.73	12.67	8.84	3.55
1975-76	0.16	13.33	25.25	23.28	6.39	1.47
1976-77	0.73	40.34	108.52	34.87	6.56	0.37
1977-78	0.12	19.48	69.33	43.89	7.50	0.48
1978-79	9.20	41.71	44.64	18.97	5.72	0
1979-80	1.17	26.97	55.45	7.58	4.07	0.33
1980-81	0.76	51.33	220.79	55.35	6.15	0.26
1981-82	1.08	52.00	161.91	131.28	20.94	0.55

Table 8.3.3   Lyme Bay SPRAT.

Period mean (1966-78) spawning biomass estimates.

	S	F	Separable VPA	Traditional VPA
M = 0.85	0.2	0.2	32 670	32 809
		0.3	29 809	29 935
		0.5	27 555	27 665
M = 0.85	0.3	0.2	21 249	21 386
		0.3	19 936	20 060
		0.5	18 954	19 031

Table 8.3.4 Lyme Bay SPRAT. Annual fishing mortalities (traditional analysis, using terminal populations generated by separable VPA).

Annual M = 0.85 year^{-1}.   S = 0.3.   F = 0.5.

Year	Age groups					$\bar{F}_c$	$\bar{F}_p$
	2	3	4	5	6		
1966	0.03	0.50	0.72	0.51	0.15	0.49	0.19
1967	0.08	0.25	0.20	0.10	0.06	0.17	0.13
1968	0.03	0.13	0.09	0.04	0.04	0.09	0.06
1969	0.02	0.17	0.24	0.15	0.10	0.17	0.08
1970	0.01	0.12	0.21	0.06	0.07	0.14	0.06
1971	0.04	0.12	0.17	0.09	0.03	0.10	0.07
1972	0.07	0.11	0.11	0.08	0.02	0.09	0.08
1973	0.05	0.29	0.11	0.15	0.12	0.21	0.11
1974	0.11	0.48	0.25	0.32	0.31	0.32	0.21
1975	0.02	0.18	0.51	0.40	0.16	0.30	0.11
1976	0.09	0.49	0.93	0.58	0.08	0.47	0.23
1977	0.06	0.46	0.86	1.38	0.16	0.53	0.21
1978	0.04	0.35	0.46	0.55	0.01	0.33	0.15
1979	0.02	0.14	0.19	0.36	0.10	0.16	0.07
1980	0.05	0.33	0.41	0.47	0.08	0.29	0.15
1981	0.08	0.51	0.76	0.58	0.15	0.45	0.22

$\bar{F}_c$ and $\bar{F}_p$ - see Shepherd, 1982.

Table 8.3.5 Lyme Bay SPRAT. Number in stock at beginning of each year (traditional analysis using terminal populations generated by separable VPA).

Annual $M = 0.85$ year^{-1} $S = 0.3$ $F = 0.5$

Year	Age groups					2-6 Biomass (tonnes)
	2	3	4	5	6	
1966	525	161	51	42	38	11 686
1967	871	217	42	11	11	14 332
1968	1 393	343	72	15	4	22 544
1969	1 383	576	128	28	6	28 445
1970	874	580	207	43	10	25 803
1971	785	371	219	72	17	22 396
1972	664	323	141	79	28	18 946
1973	768	264	124	54	31	17 898
1974	587	314	84	47	20	15 506
1975	968	225	83	28	15	17 060
1976	697	405	80	21	8	17 131
1977	539	272	107	14	5	13 463
1978	1 563	218	74	19	1	22 089
1979	2 688	642	66	20	5	41 031
1980	1 444	1 132	239	23	6	41 640
1981	1 001	585	347	68	6	31 099

Table 8.5.1. Lyme Bay area SPRAT.
Mean weight/age.

Season	Quarter	\multicolumn{7}{c}{Age Groups}	Overall Mean
		0/1	1/2	2/3	3/4	4/5	5/6	
1972-73	3	5.1	12.7	22.1	24.7	25.9	26.5	19.9
	4	5.3	11.3	21.9	24.9	26.5	27.2	20.3
	1	4.9	10.2	17.9	21.2	22.8	23.4	13.6
	Season	4.9	10.5	19.7	23.3	25.0	25.6	16.0
1973-74	3	6.4	15.6	18.2	23.5	24.7	25.1	19.5
	4	4.6	8.0	18.2	24.9	25.8	25.7	16.4
	1	6.2	10.0	15.5	23.3	24.4	24.4	15.0
	Season	4.8	9.2	17.3	24.2	25.2	25.2	16.5
1974-75	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
1975-76	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
1976-77	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
1977-78	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	18.1	22.4	28.7	9.8
	Season	6.4	6.2	16.7	22.3	25.5	31.3	17.5
1978-79	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	-	10.8
	Season	5.7	12.1	16.8	24.5	29.6	-	16.2
1979-80	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	31.0	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
1980-81	3	-	17.4	24.3	25.8	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	23.8	29.7	32.9	19.7
1981-82	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

Figure 3.5.1. Danish NORWAY POUT areas.
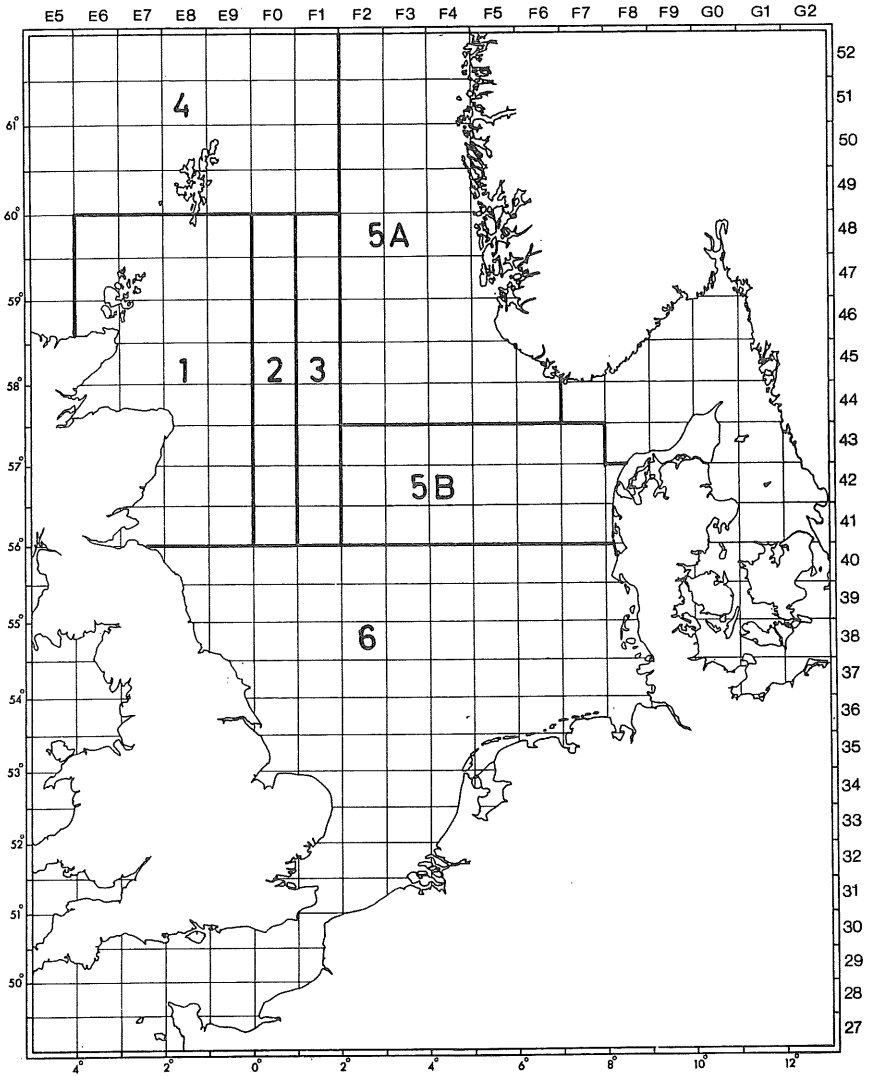
Figure 4.2.1. Norwegian cpue figures for the NORWAY POUT fishery (including by-catches) by quarters, 1972-1982.
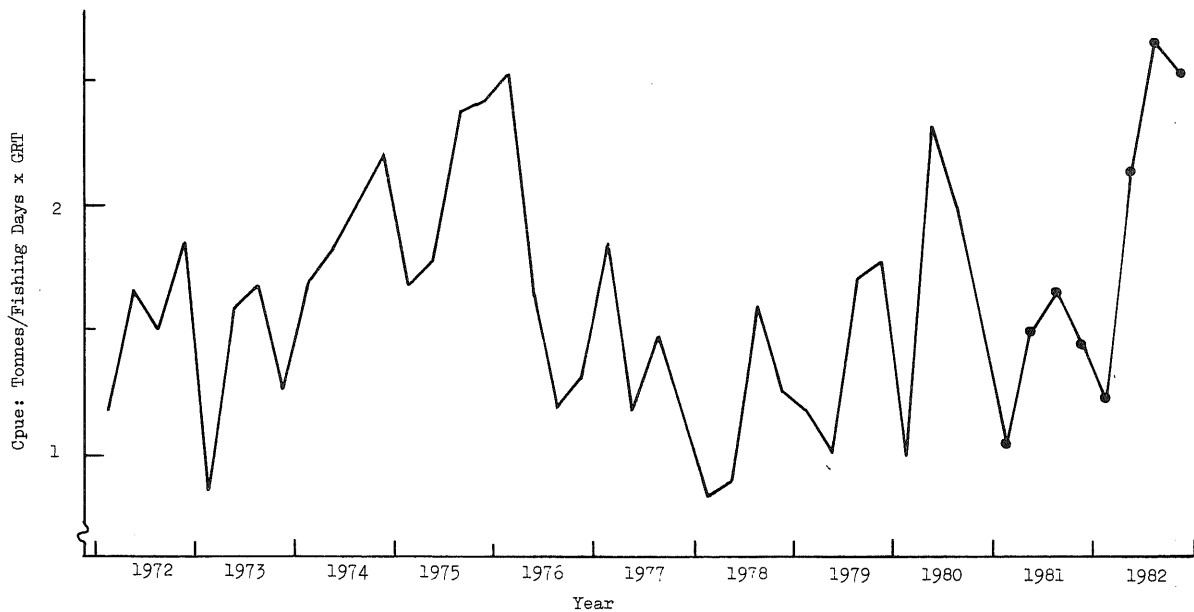
Figure 4.2.2 NORWAY POUT.
Relationship between an index of abundance I + II group Norway pout in IYFS (average catch in number per standard hauls per hour fishing) and catch of Norway pout per unit of effort (tonnes per days fishing per GRT in sampled part of the Norwegian fleet).
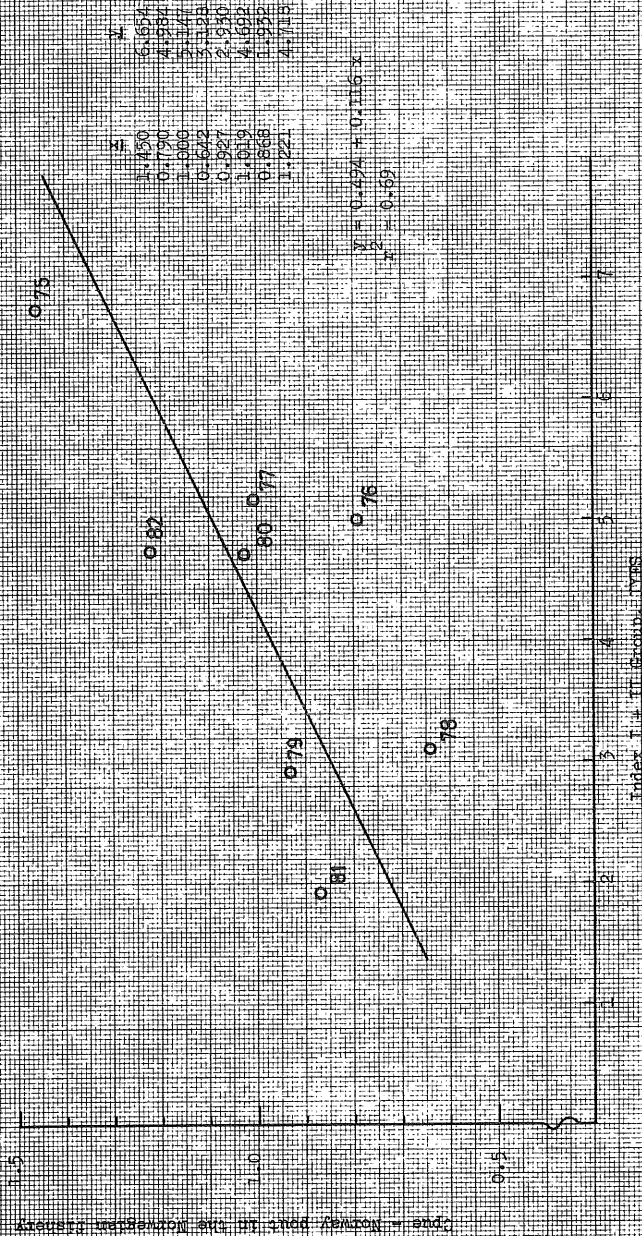
Figure 4.2.3. Faroese cpue data.
Target species NORWAY POUT in Division IVa.
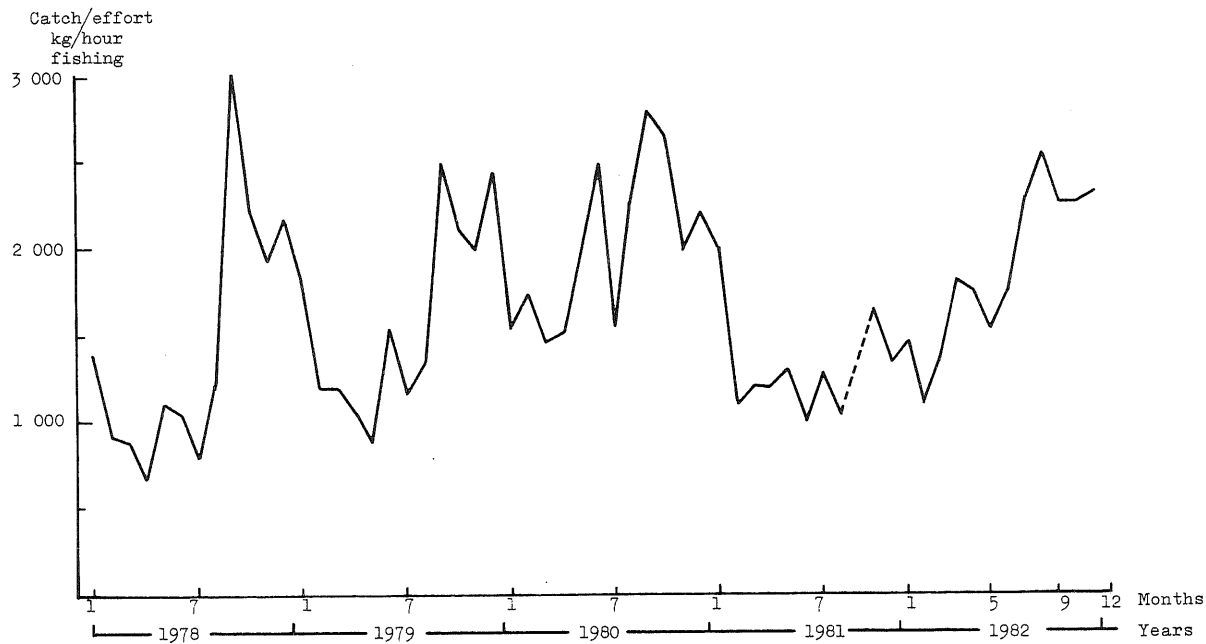
Figure 4.3.1. NORWAY POUT.
Stock biomass derived from VPA (Table 4.3.3) and:

Age Group	0			1				2				3				4
Quarter	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1
w (gms)	25	4	6	7	15	25	23	22	34	43	42	40	50	60	58	56

Annual catch(from Table 4.1.1)

Tonnes x 10⁻³
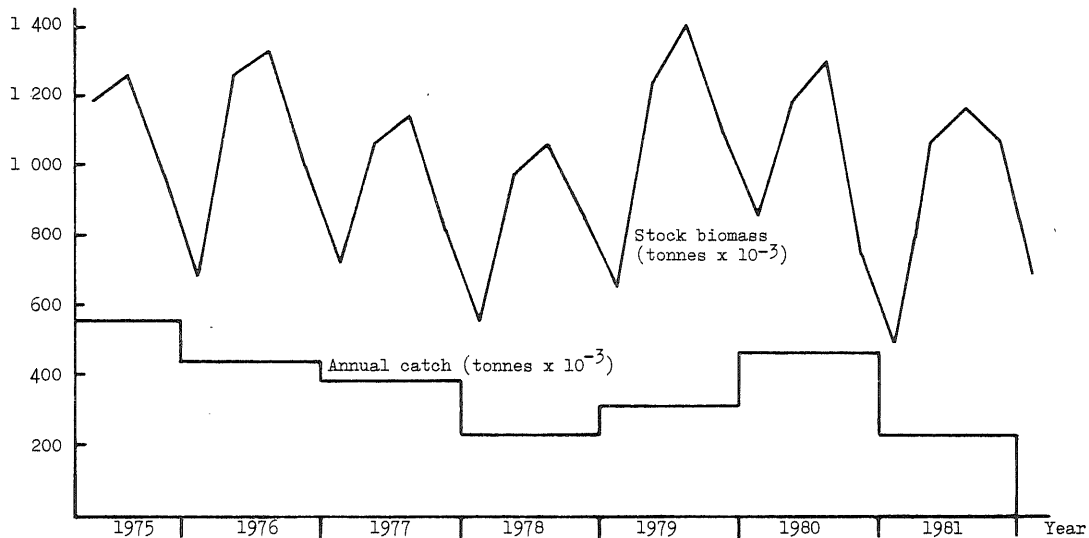
Figure 4.4.1. Sampling areas used for recruitment indices of NORWAY POUT shown in Table 4.5.1.
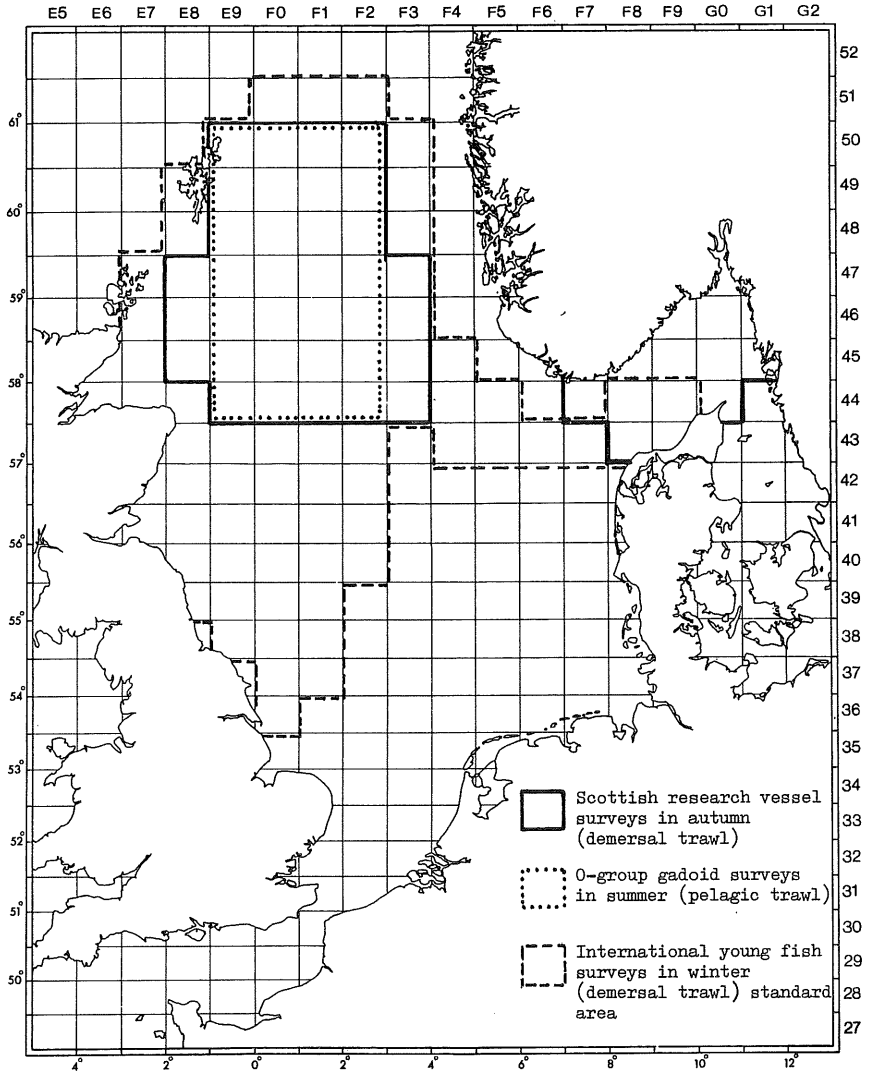
Figure 4.9.1. NORWAY POUT. Plot of survey indices of year class strength and landings in subsequent year.

Catch
('000 t)

1 - IYFS - 1 grp - 1st quarter
2 - Scottish survey - 0-grp - Autumn
3 - English survey - 0-grp - August
4 - English survey - 0-grp - Nov.

Figure 4.9.2. NORWAY POUT. Total catch vs IYFS index for 1 + 2 group in 1st quarter of each year.
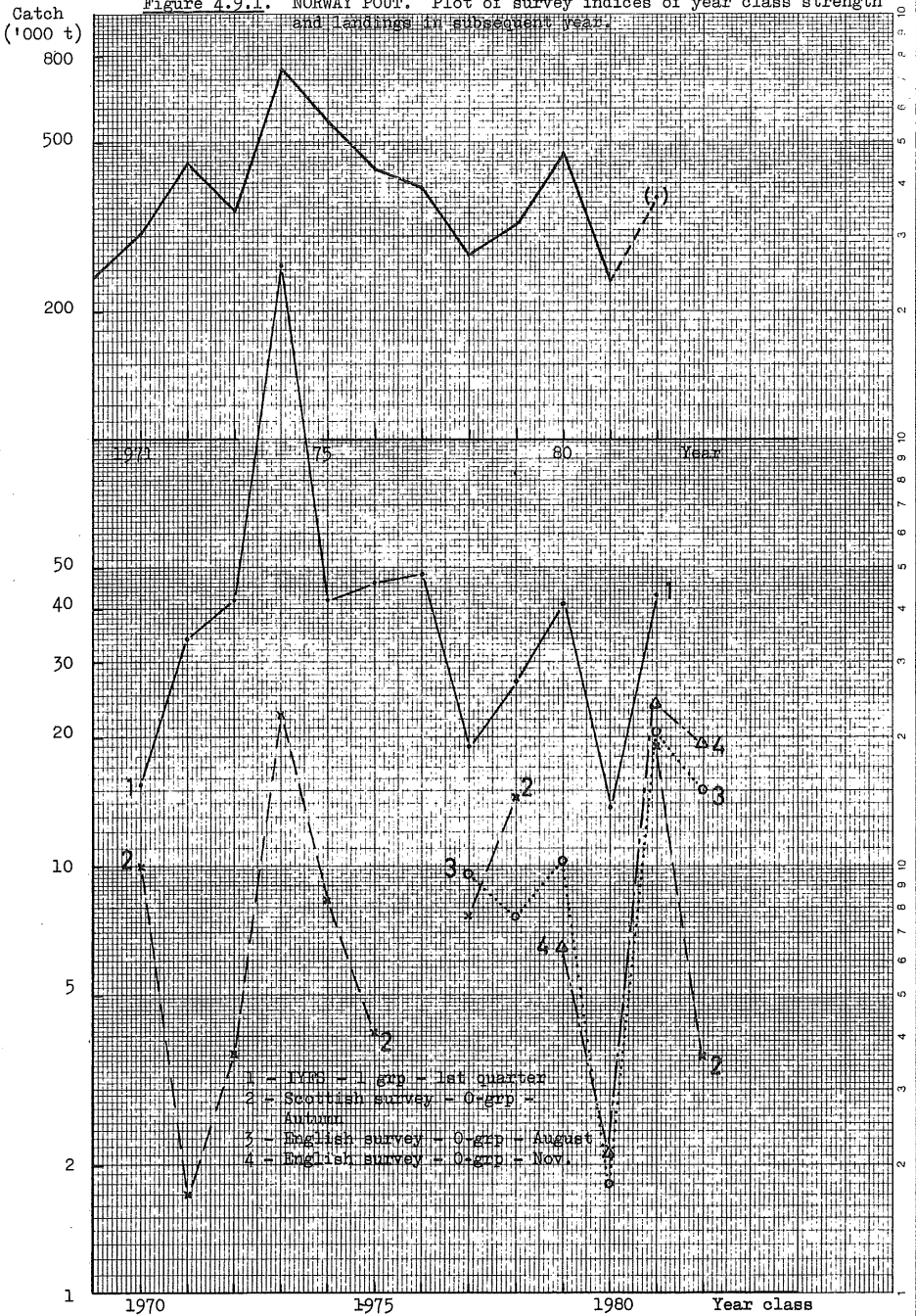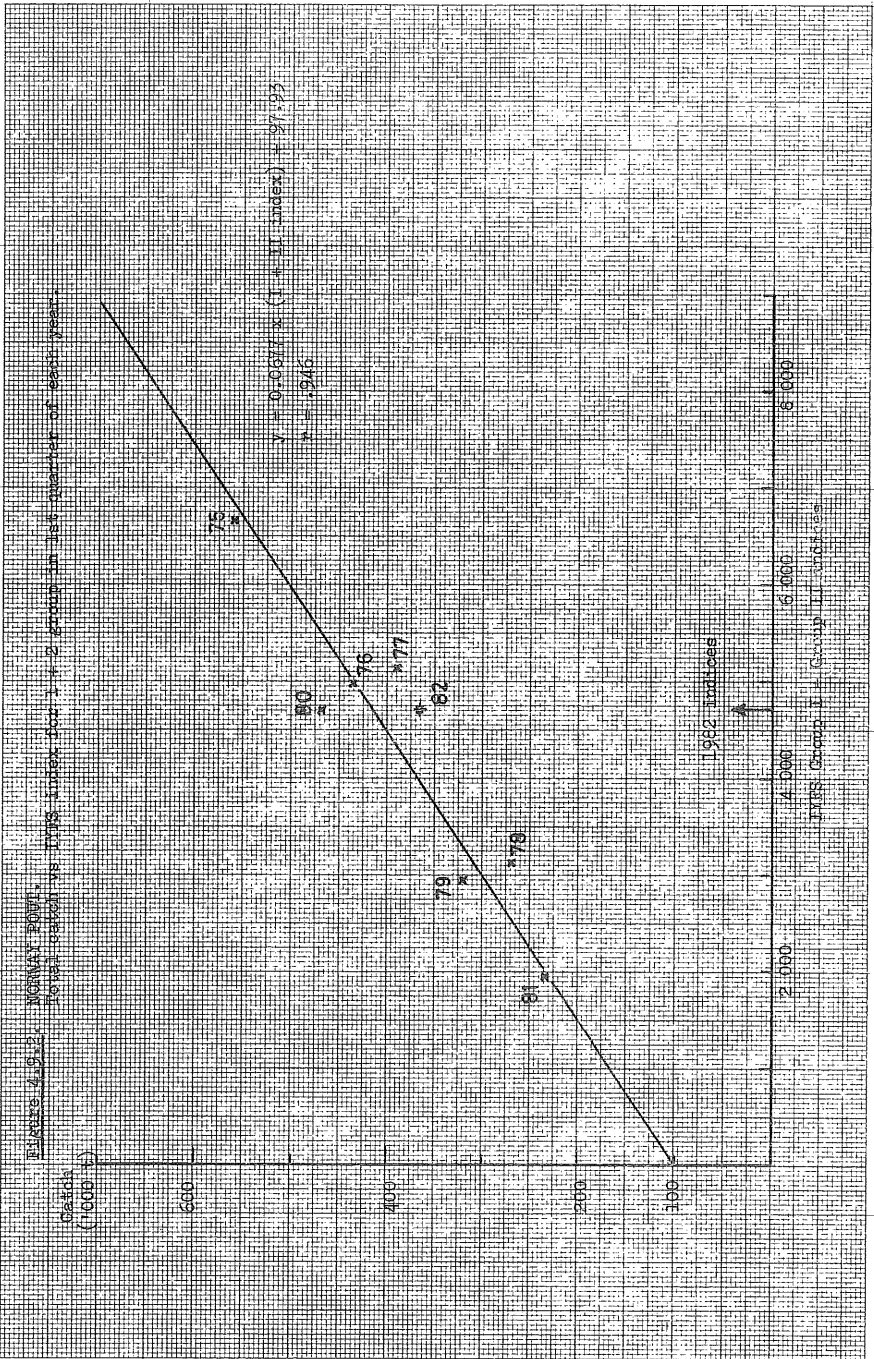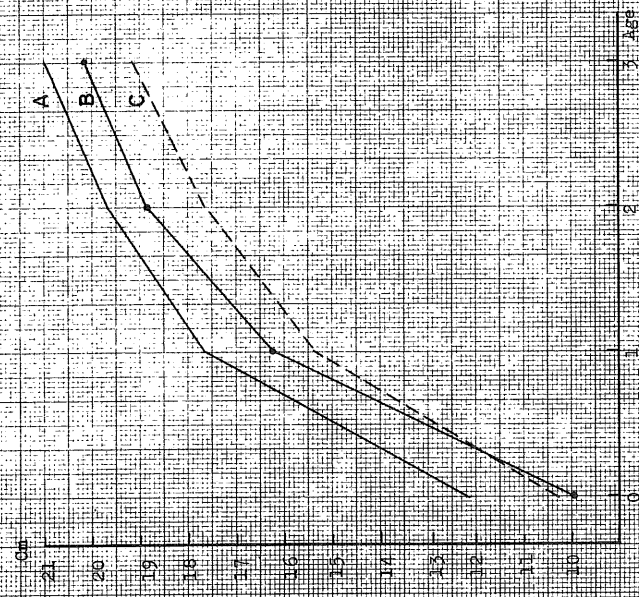
Figure 4.10.1. Length of Norway pout in the autumn, based on Scottish autumn surveys.

A: Year classes 1965-66
B: Year classes 1959-62
C: Year classes 1970-81
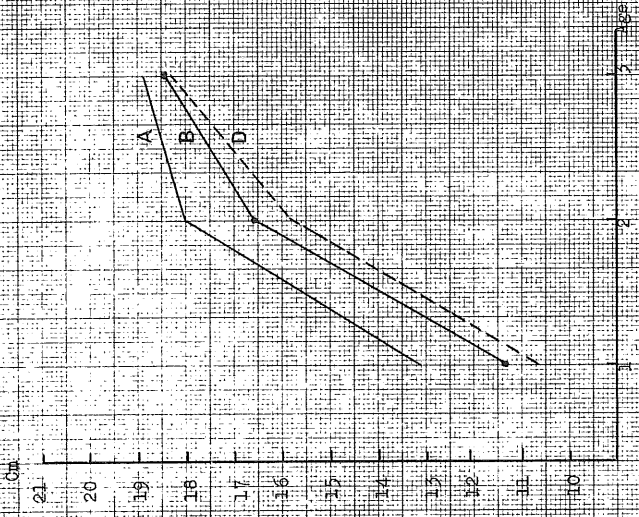
Figure 4.10.2. Length of Norway pout in the winter period (October-January).
A is mean for year classes 1963-66 in Scottish autumn and spring spawners. B is same for year classes 1959-62. D is mean for year classes 1973-76 in commercial catches during winter.
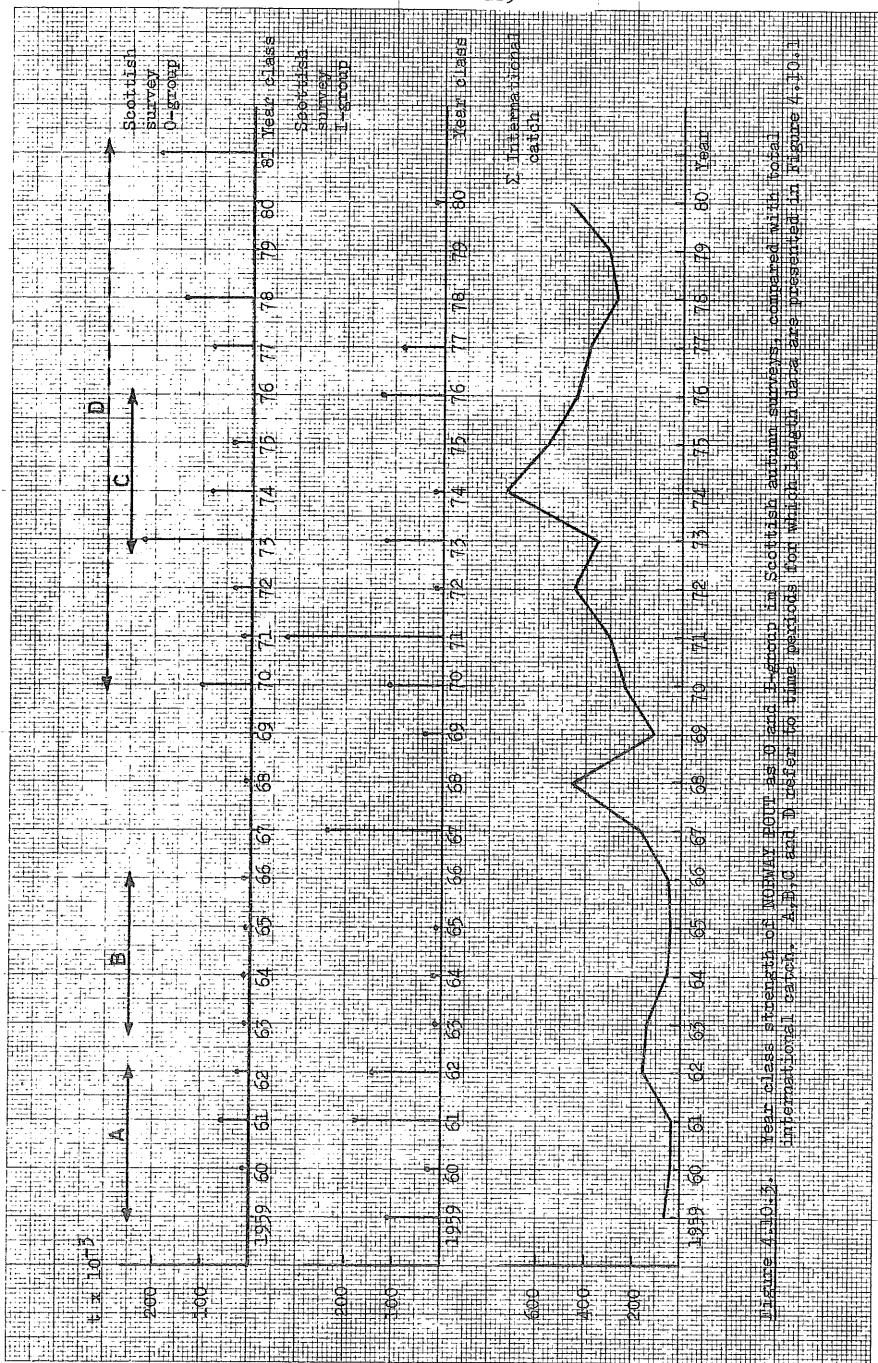
Figure 4.10.3. Year class strength of NORWAY POUT, as 0 and 1-group in Scottish autumn surveys, compared with total International catch. A,B,C and D refer to time periods for which length data are presented in figure 4.10.1.

Figure 5.1.1. Danish SANDEEL areas.
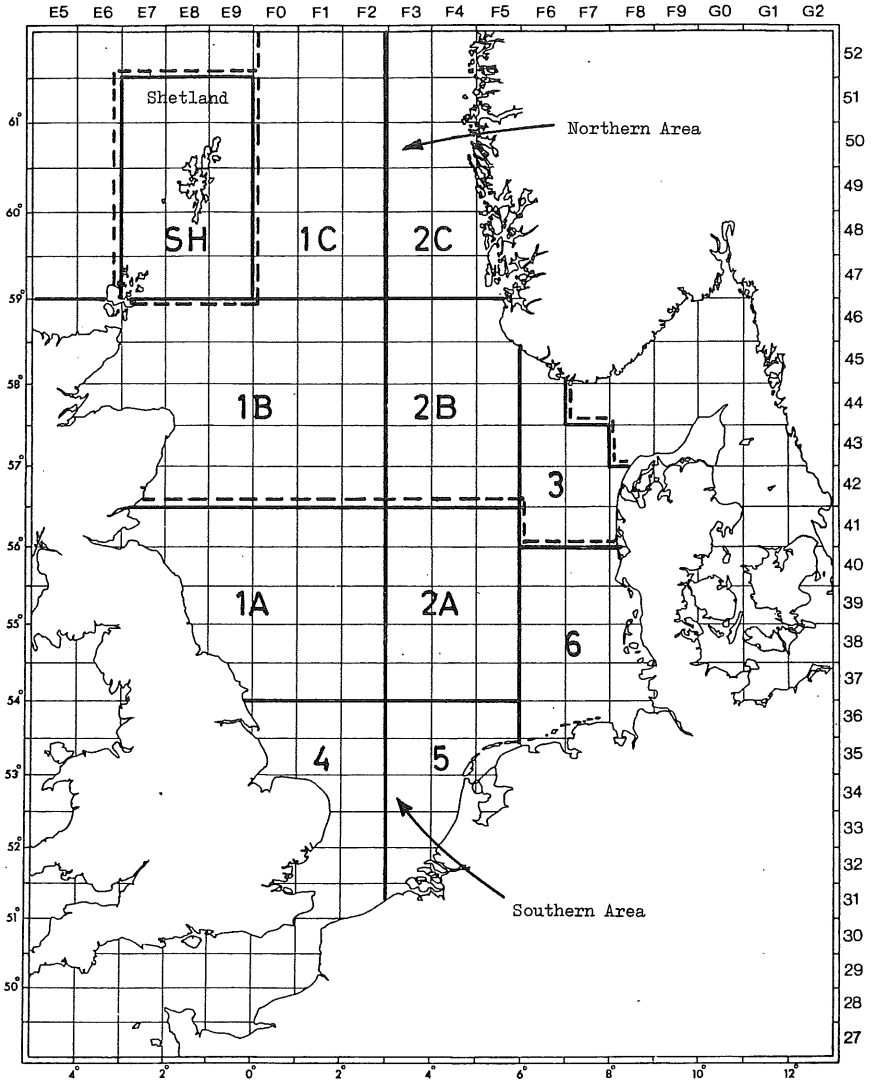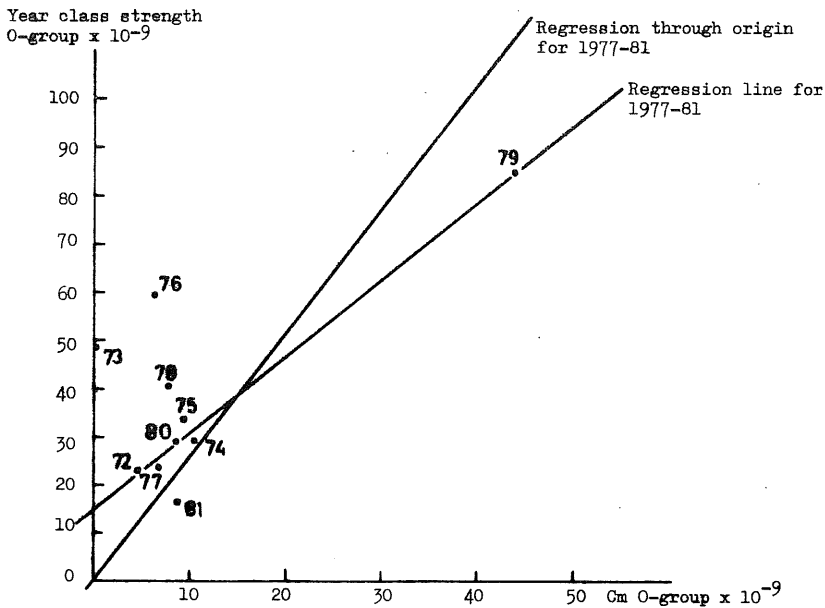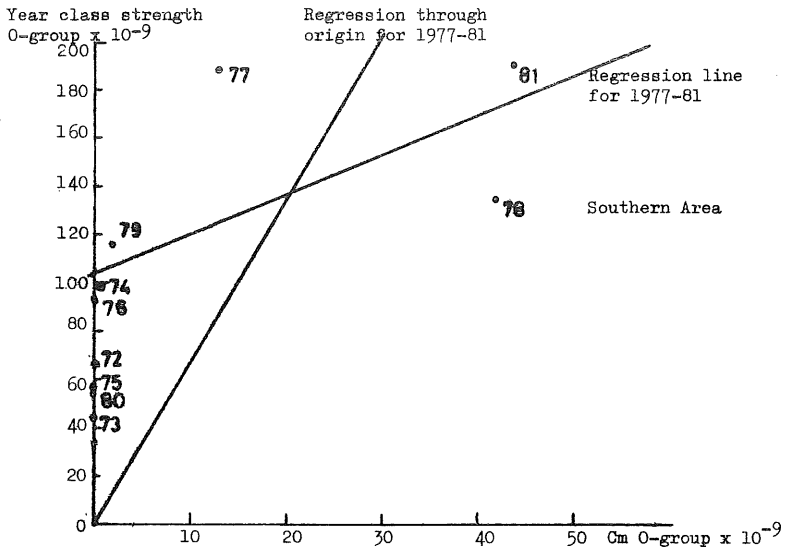
Figure 5.3.1. Year class strength of sandeels (No. of 0-group x 10^{-9}) plotted against catch of 0-group (No. x 10^{-9}).
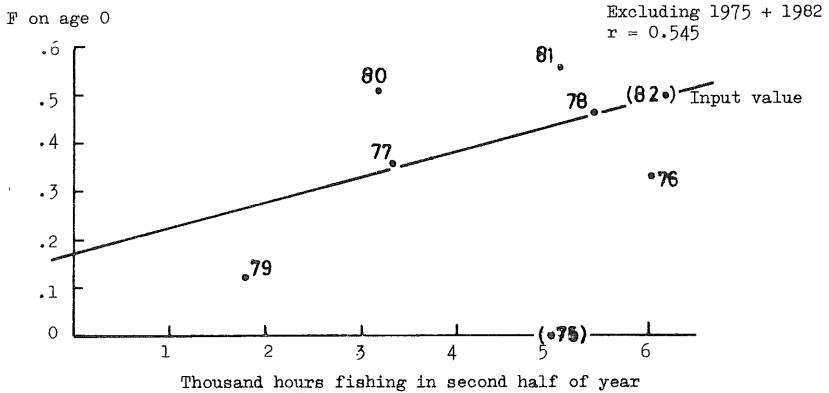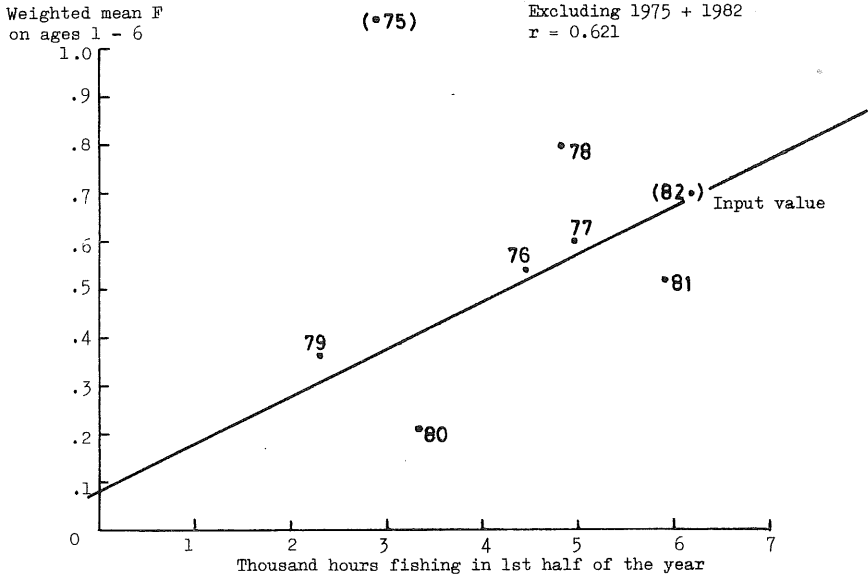
Figure 5.3.2. Correlation between F and fishing effort in the Shetland SANDEEL fishery.

Figure 5.8.1. Yield curves for North Sea SANDEELS.

North Sea (x 10⁻⁵ tonnes)
Div. IIIa (x 0.5 x 10⁻⁴ tonnes)
Baltic (x 10⁻⁴ tonnes)
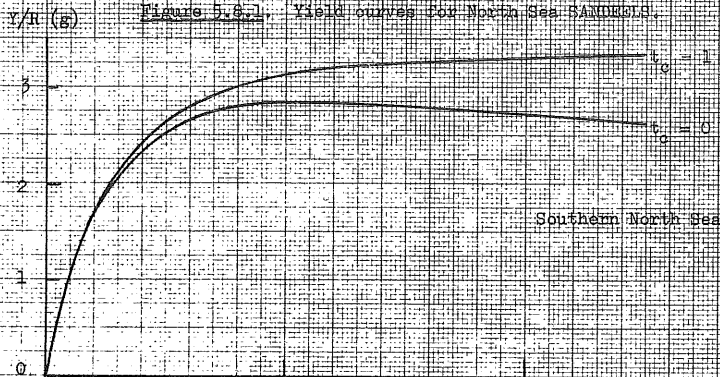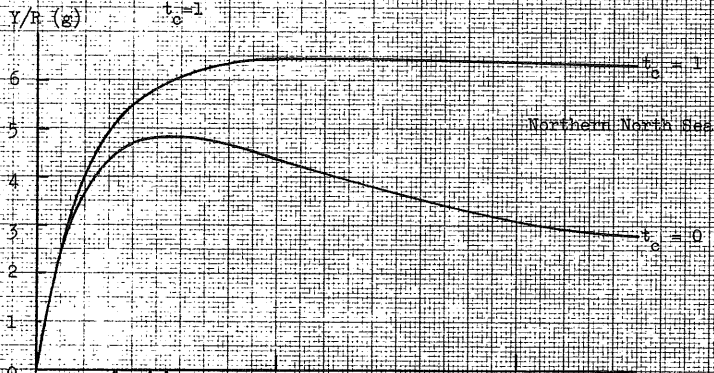
North Sea
Division IIIa
Sub-divisions 22-25
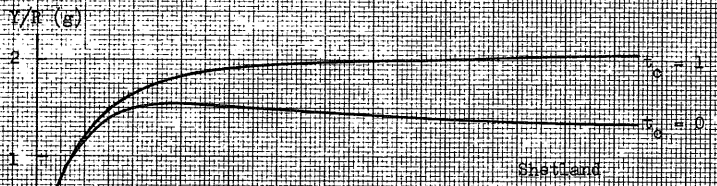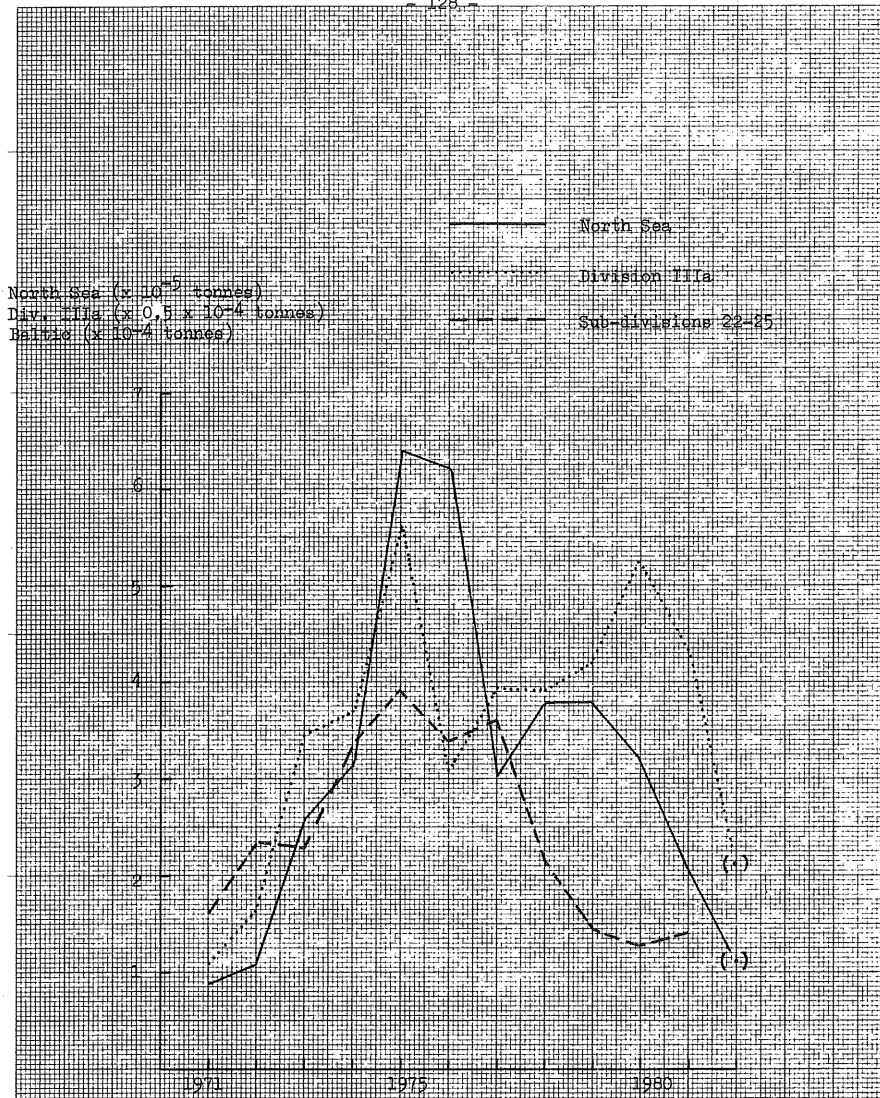
Figure 6.1.1. SPRAT.
Catch trends in the North Sea, Skagerrak-Kattegat
and in the western Baltic.

Figure 6.1.2. International SPRAT reporting areas.
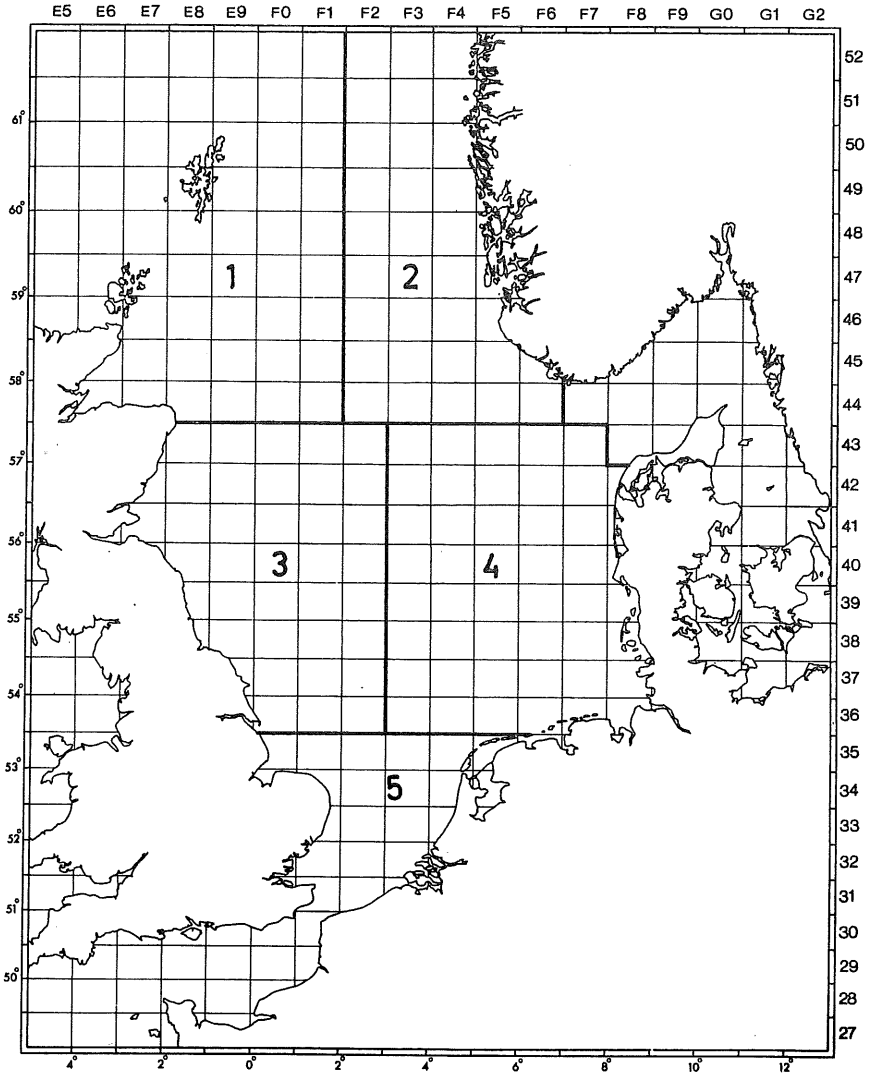
Figure 6.5.1. SPRAT in Division IIIa.
Mean weights per quarter averaged for 1975-79.
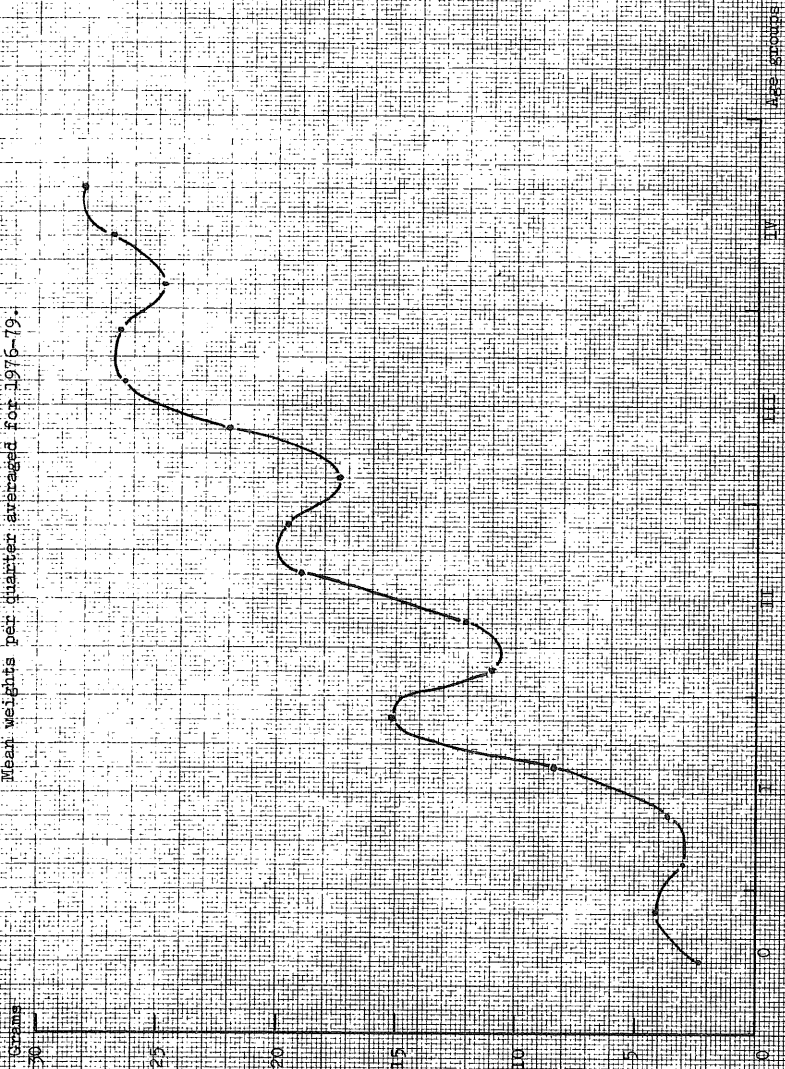
Figure 6.6.1. SPRAT in Division IIIa.
Fishing mortalities by quarters calculated by VPA, 1975-81.

Figure 7.4.1: Estimated biomass (t x 10⁻⁵) of SPRAT in each half statistical rectangle January 1983. Standardized with reference to target strength of -29dB kg-1.
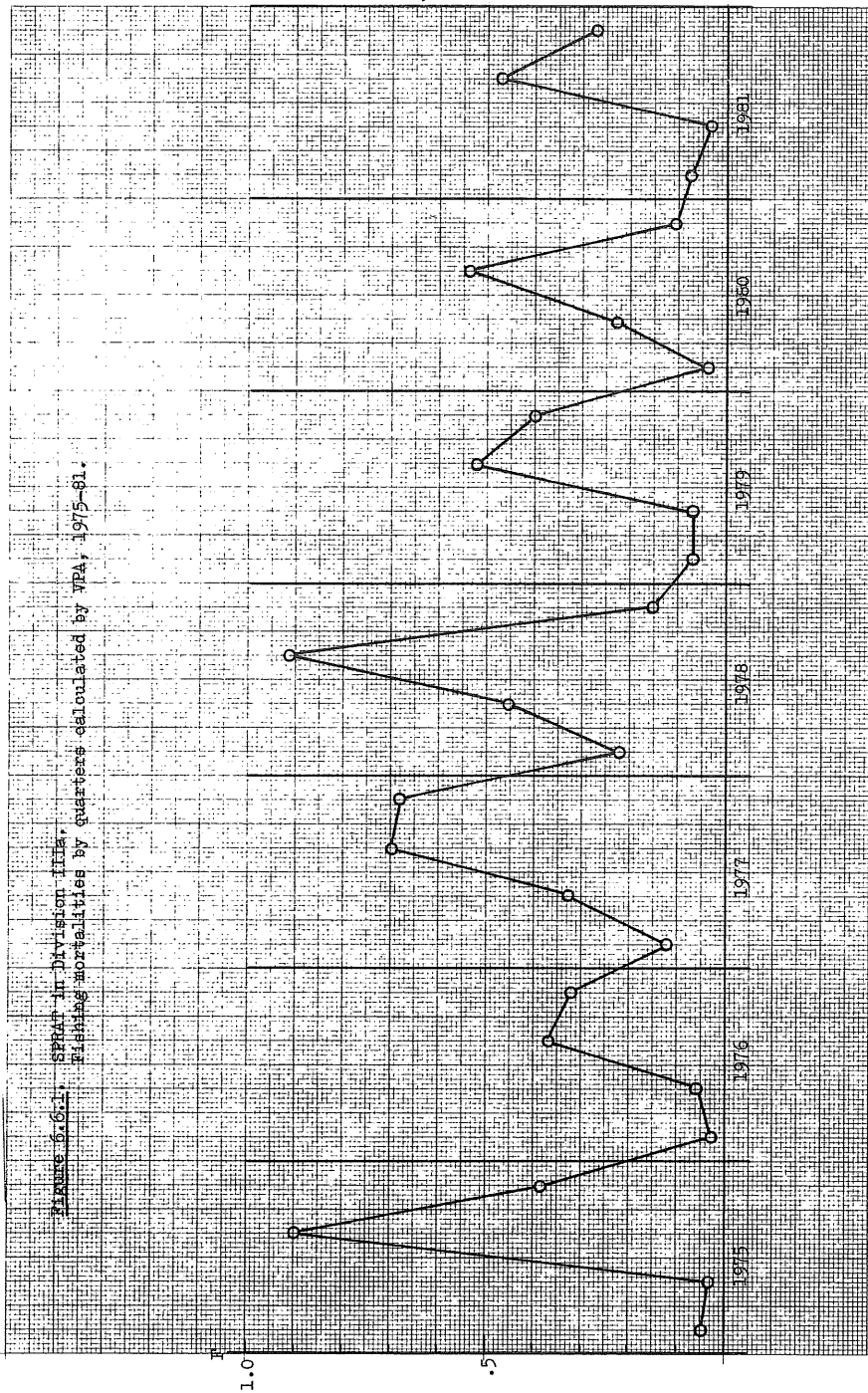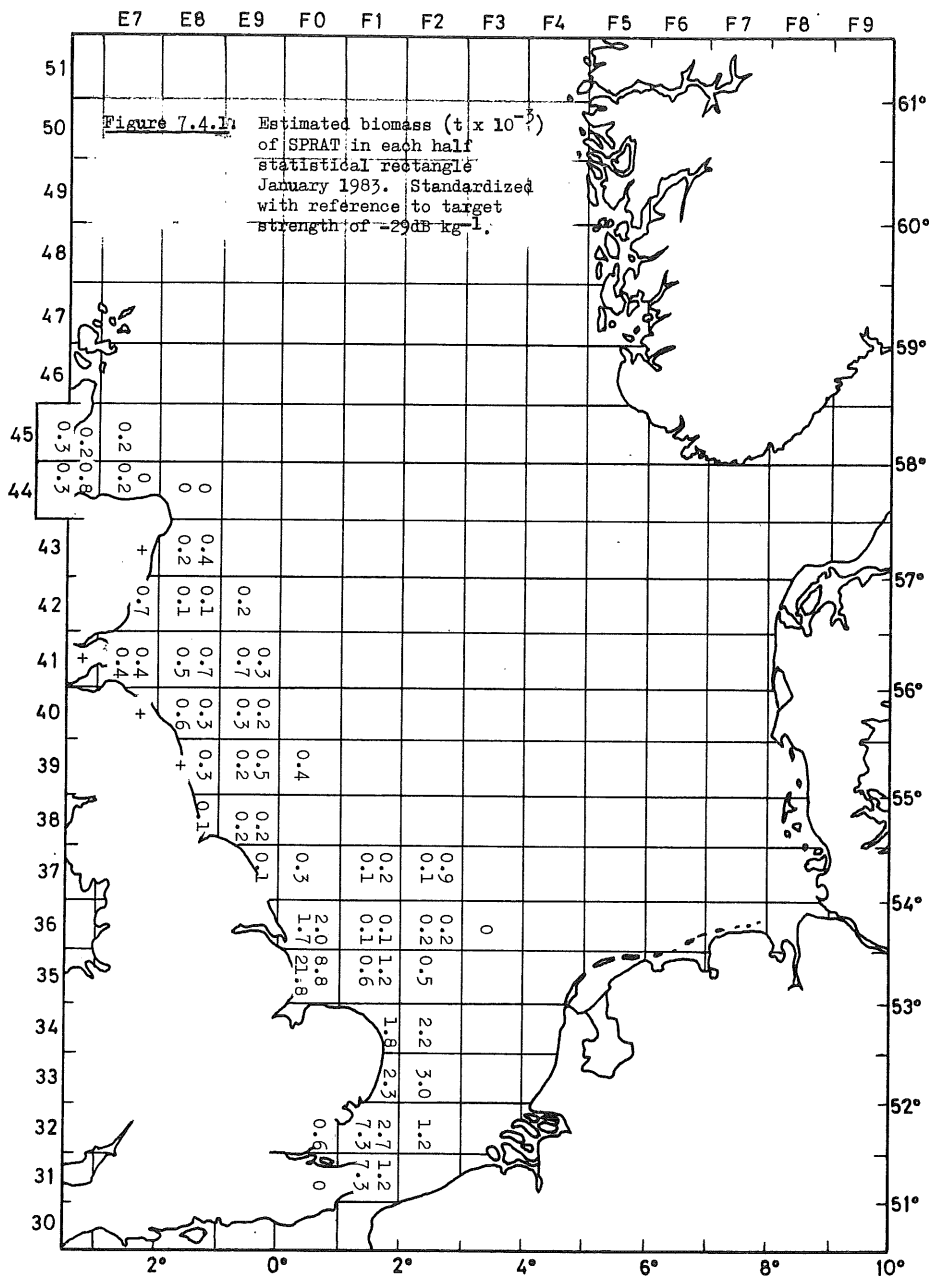
Figure 7.8.1.   North Sea SPRAT.
                 Logistic equilibrium lines fitted by two different methods.

Walters $B_t = \rho \left(\dfrac{Y_{t-1}}{B_{t-1}} \right)$

Gulland $B_t = \rho \left(\dfrac{Y_{t-1}/B_{t-1} + Y_{t-2}/B_{t-2}}{2} \right)$
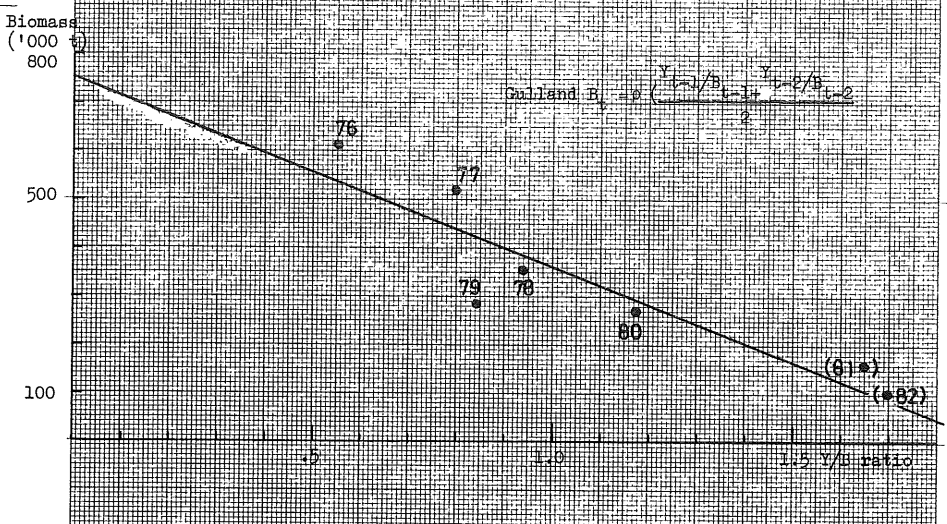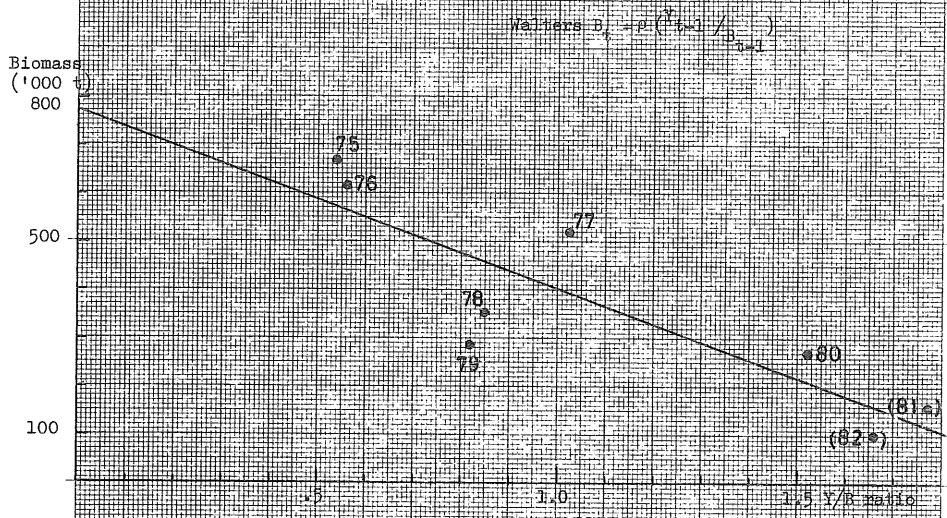
Figure 7.8.2. North Sea SPRAT. Logistic yield curves and observed landings plotted against catch to biomass ratios in the same season.
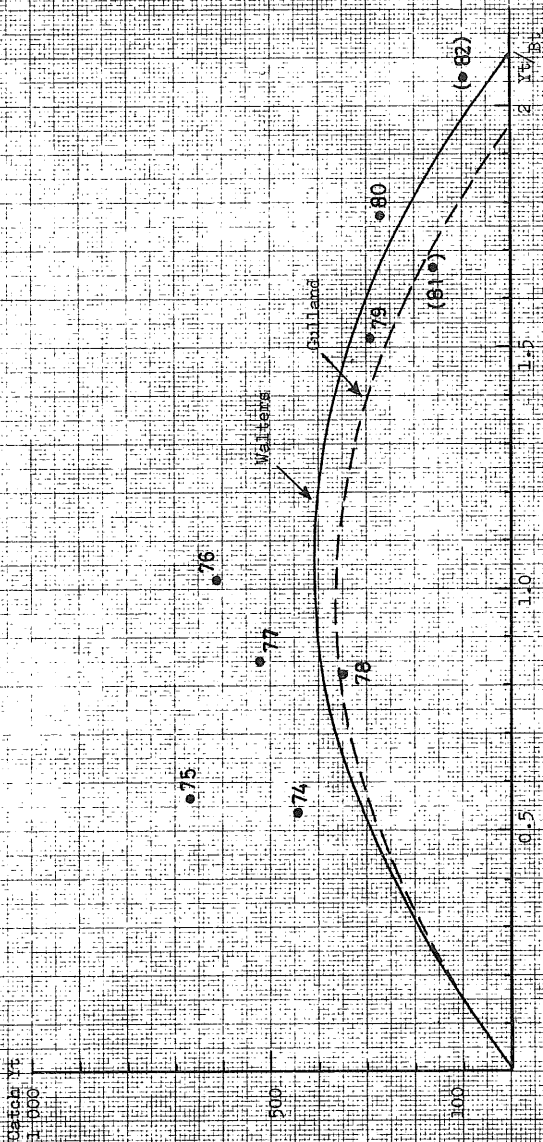
Figure 7.9.1. North Sea: SPRAT. Seasonal international catch vs. IYFS catches the following February.
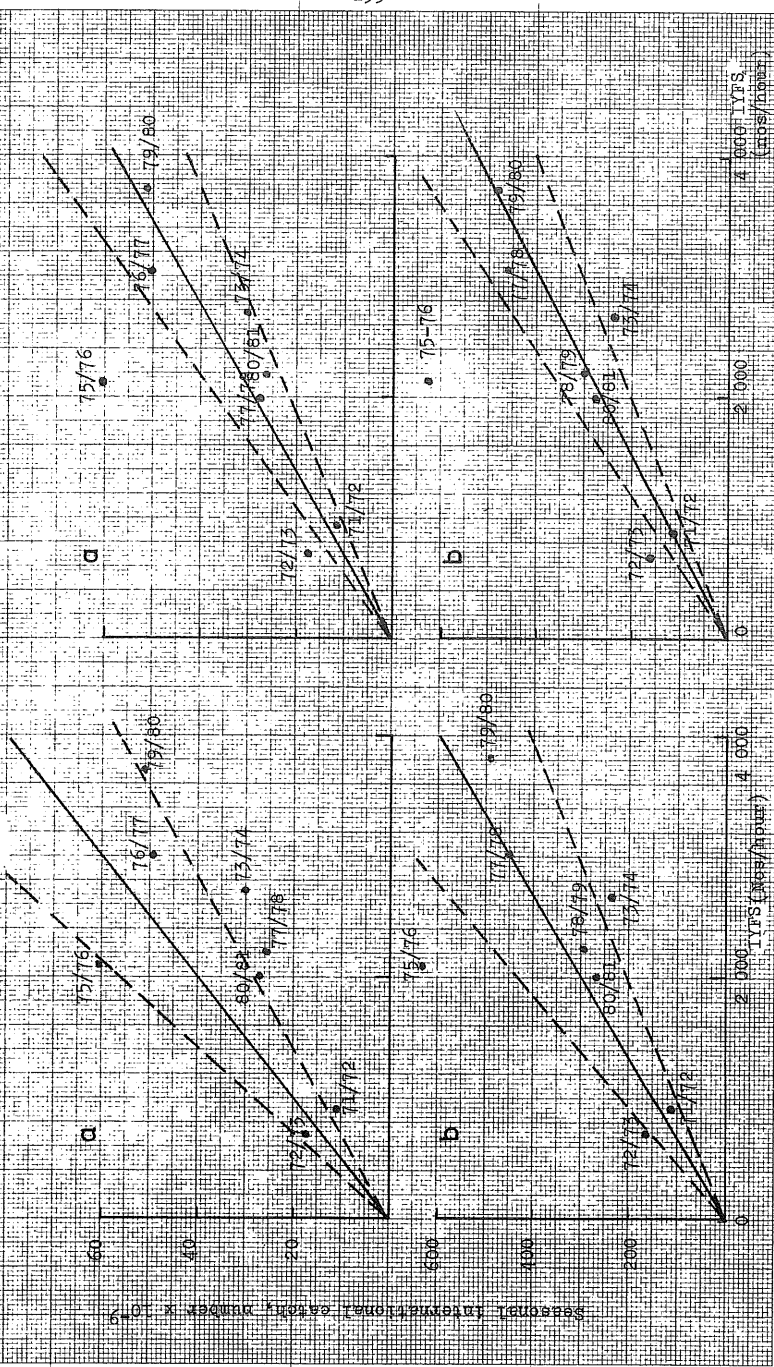
Figure 7.9.2 North Sea SPRAT. Parallel plot of survey indices and commercial catches in the subsequent year or season.

1. IYFS - Div.IVb 1-gr.
2. IYFS - Div.IVb E. IKMT 1-gr.
3. IYFS - Div.IVb E. Bottom trawl 1-gr.
4. Midwater survey - November. 0-gr.

Catches ('000 tonnes)
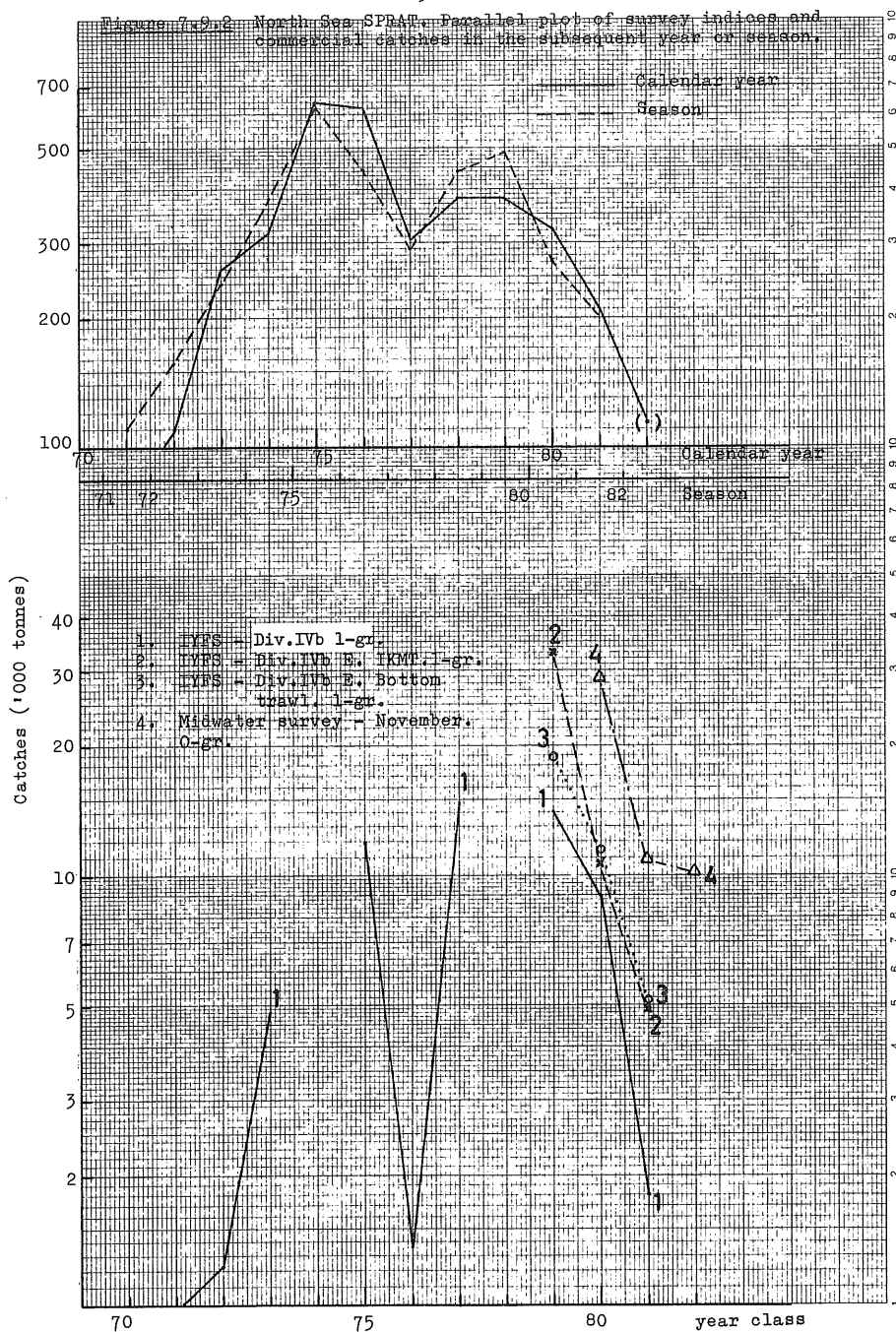
Figure 7.9.3   0-group SPRAT. No/hour.

1980
1981
1982

Figure 7.9.4

North Sea SPRAT: Landings
during fishing season vs IYFS
index at age 1.
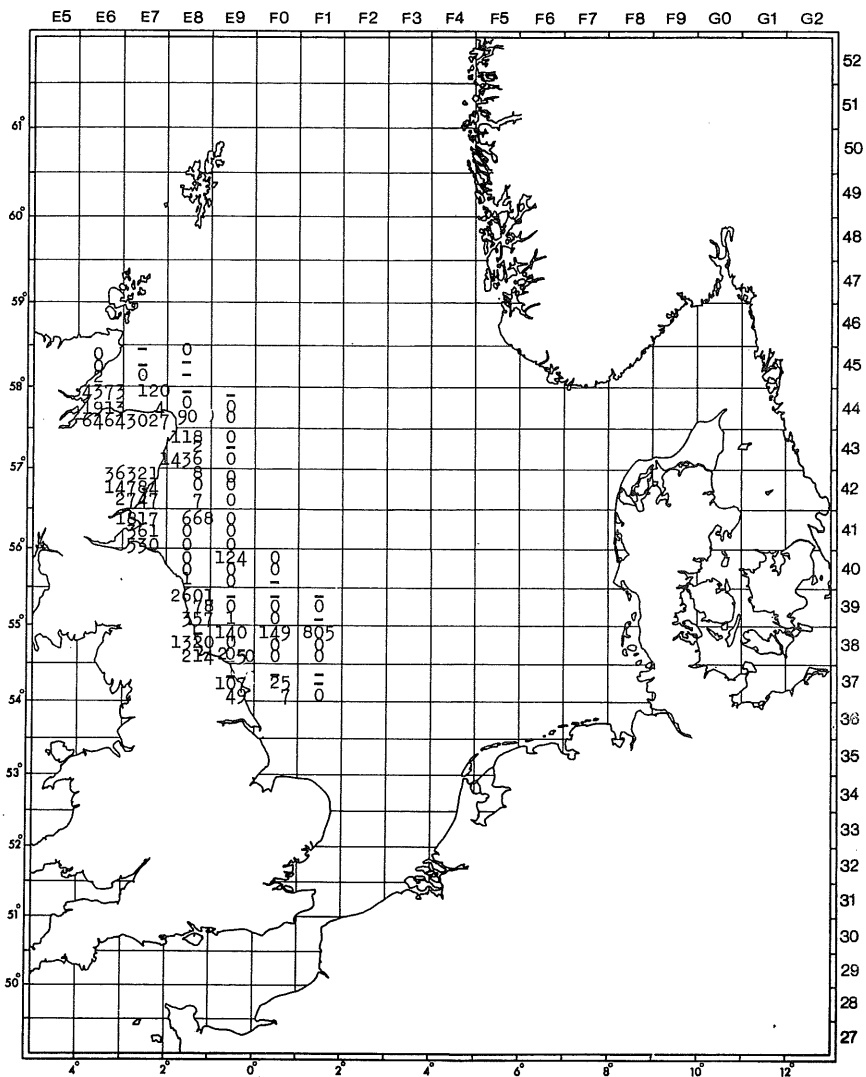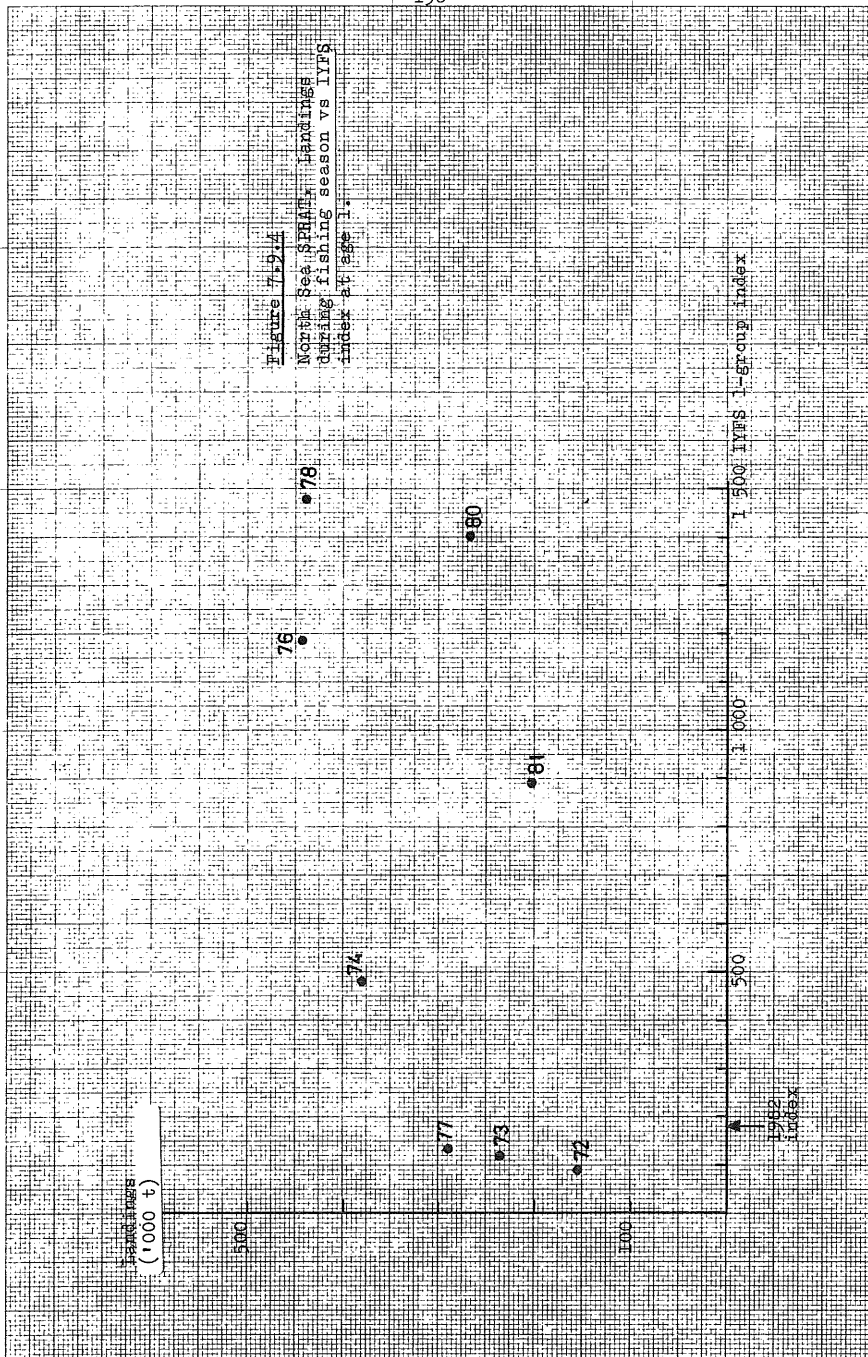
Figure 7.9.5 SPRAT. North Sea. Biomass (tonnes x 10³) at the beginning of the year, total stock and adult stock (age groups 2, 3, and 4) in relation to average annual fishing mortality on 1- and 2-groups.
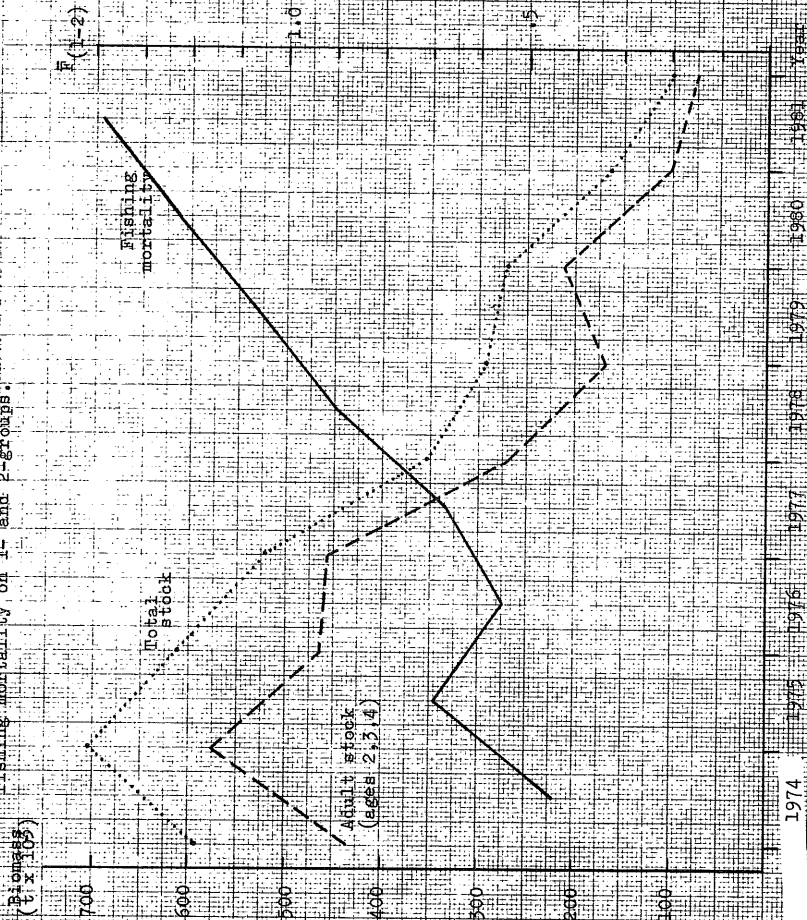
Figure 8.1.1 SPRAT — acoustic survey.

3·5

2·2

"Corella" 15/1981
2–12 December
Acoustic survey
SPRAT
Biomass estimates ('000 tonnes)

14·1

Approx. boundary of
sprat fishing area

40'

30'

20'

10'

50°

30'   3° W   30'
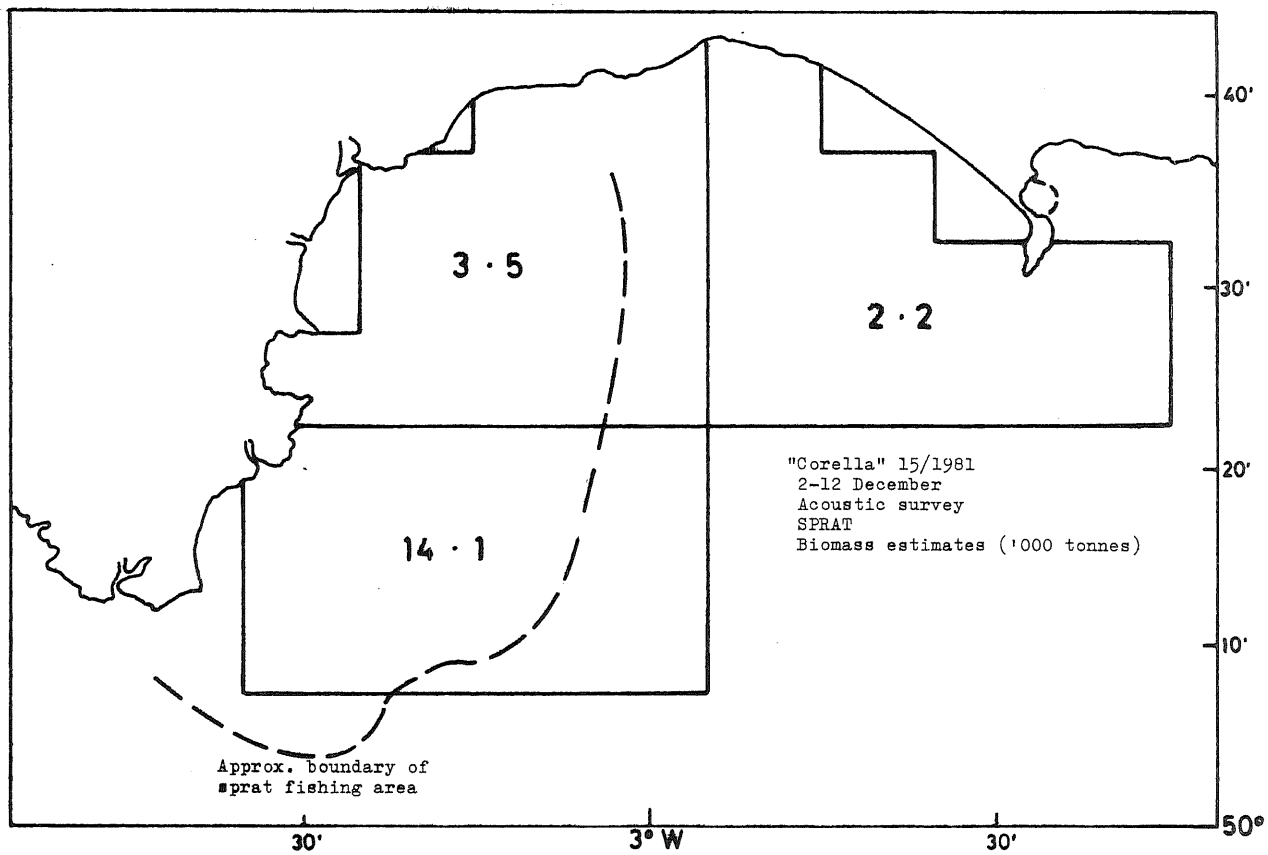
Figure 8.1.2   Lyme Bay SPRAT fishery: United Kingdom catch (tonnes)
distribution in September-March seasons: (A) 1973-74
(total 1 502 tonnes);   (B) 1980-81 (total 6 827 tonnes).
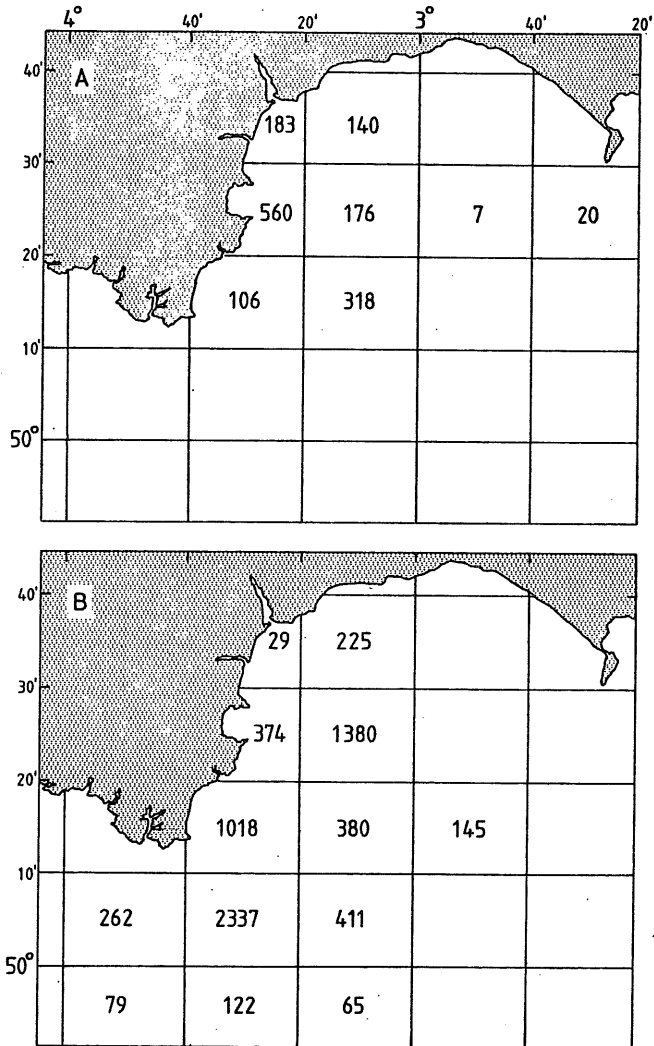
Figure 8.1.3   Lyme Bay area SPRAT – Seasonal catches by United Kingdom vessels.
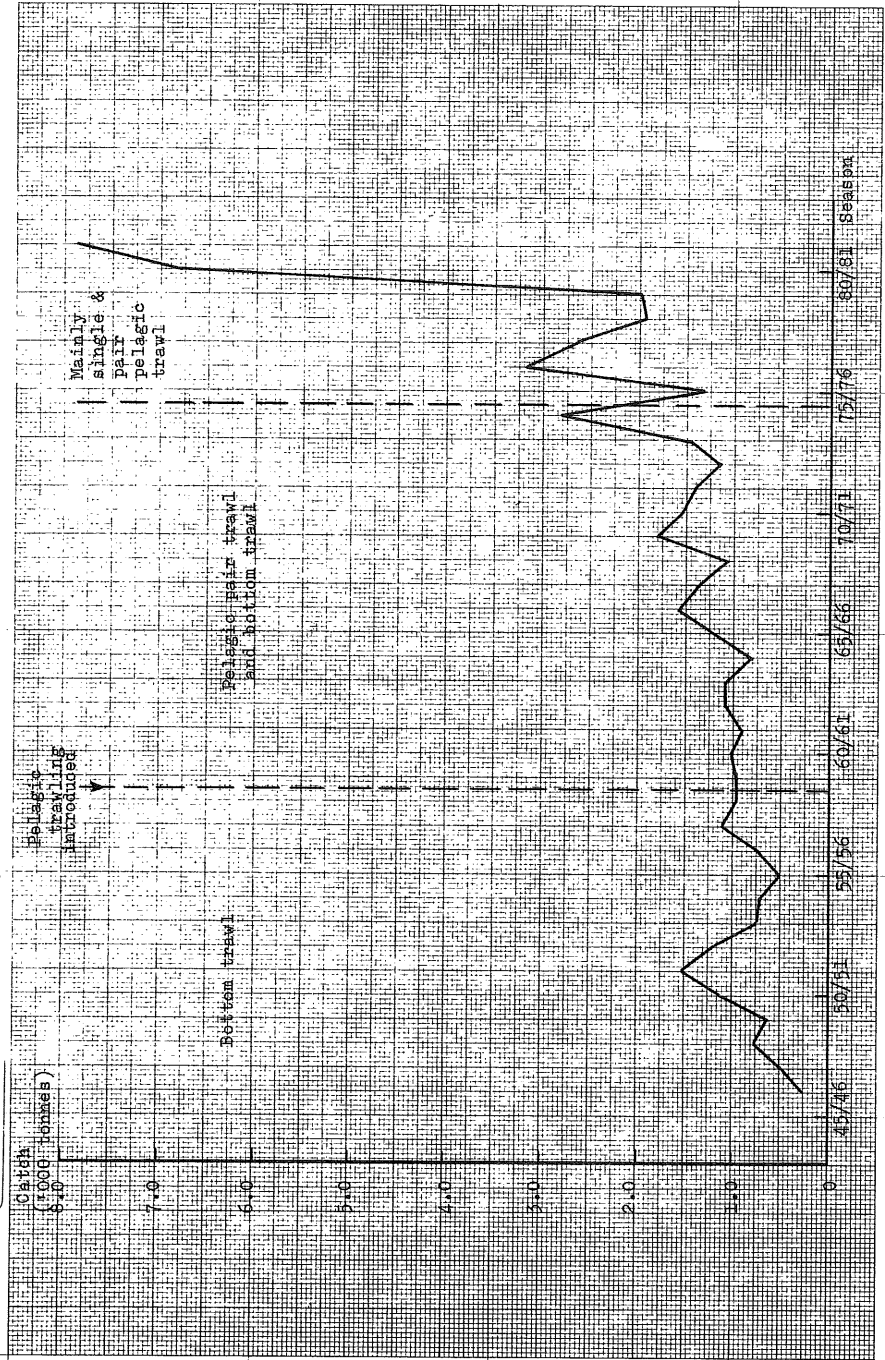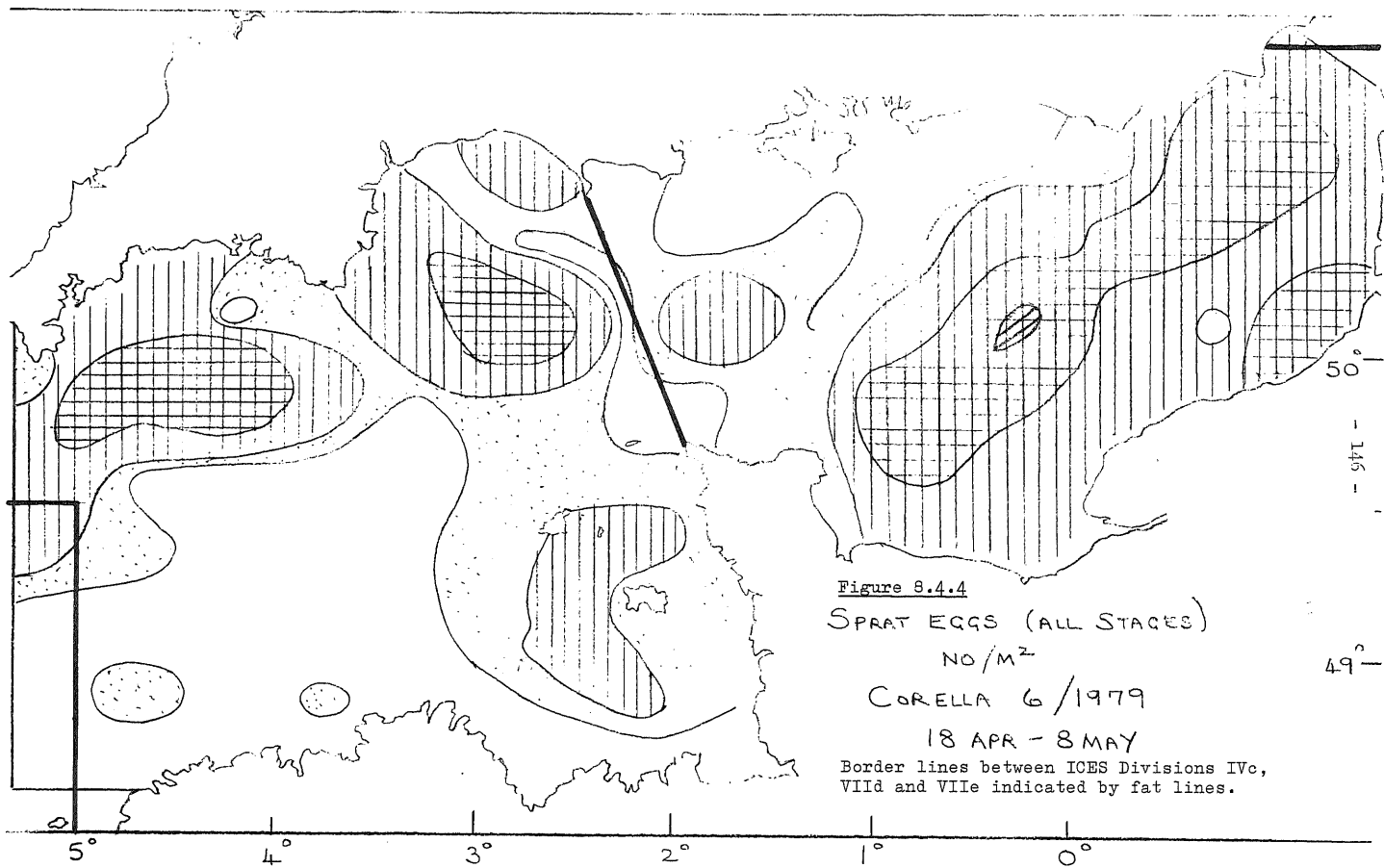
Figure B.3.1 : Lyme Bay area: SPRAT : Separable VPA (M = 0.5; F' = 0.130; S' = 0.02).
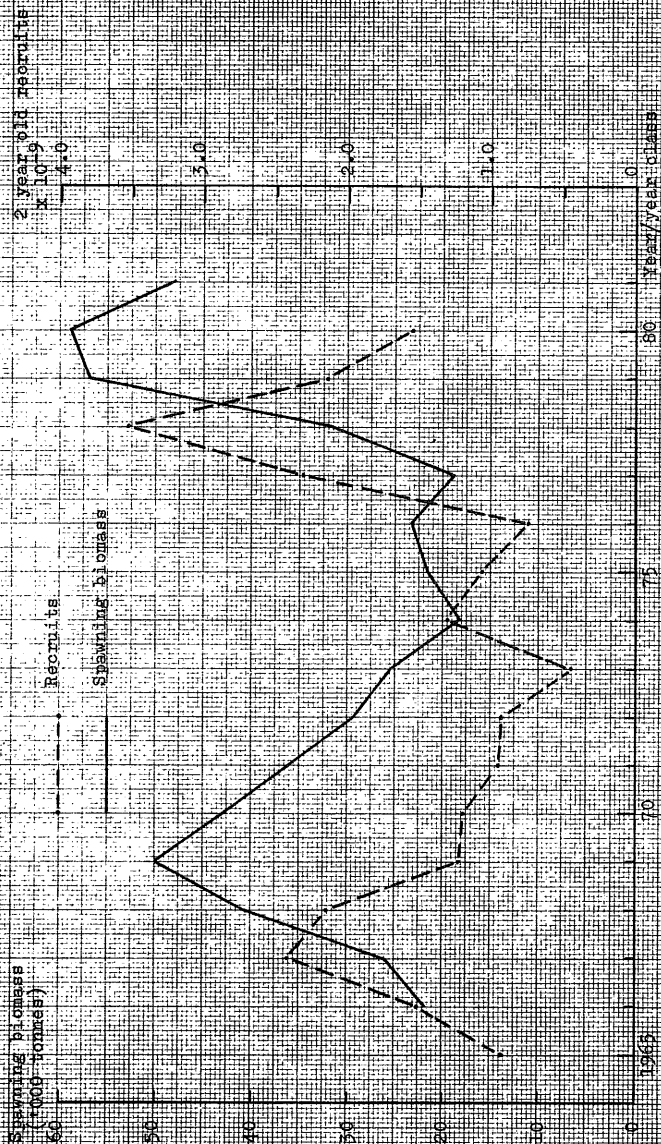
Figure 8.4.1 SPRAT egg surveys (Wallace and Pleasance, 1972).
Border lines between ICES Divisions IVc, VIId and
VIIe indicated by fat lines.

Sprattus sprattus eggs /m²
R.V. Ernest Holt 5/67 24·5·67 - 9·6·67

Contours

□ 0
▨ 1 - 9
▨ 10 - 99
▨ 100 - 999
■ 1000 - 2137
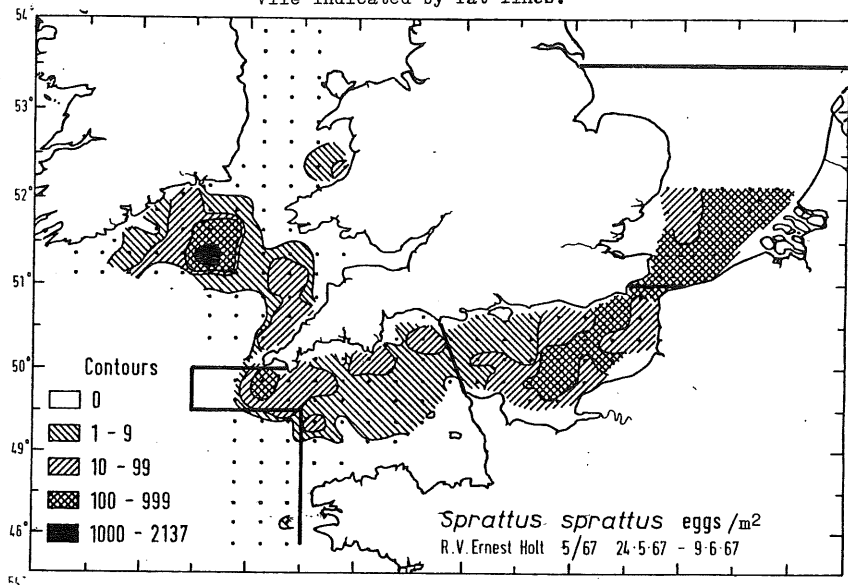
Figure 8.4.2 SPRAT. Border lines between ICES Divisions IVc, VIId
and VIIe indicated by fat lines.

Contours

□ 0
▨ 1 - 9
▨ 10 - 99
▨ 100

Sprattus sprattus eggs/m²
R.V. Corella 11/68 9-18·7·68

Figure 8.4.3
Border lines between ICES
Divisions IVc, VIId and VIIe
indicated by fat lines.

SPRAT EGGS (ALL STAGES)
No/M²
CORELLA 5/1978
30 MAR - 8 APR

Legend (No/M²):
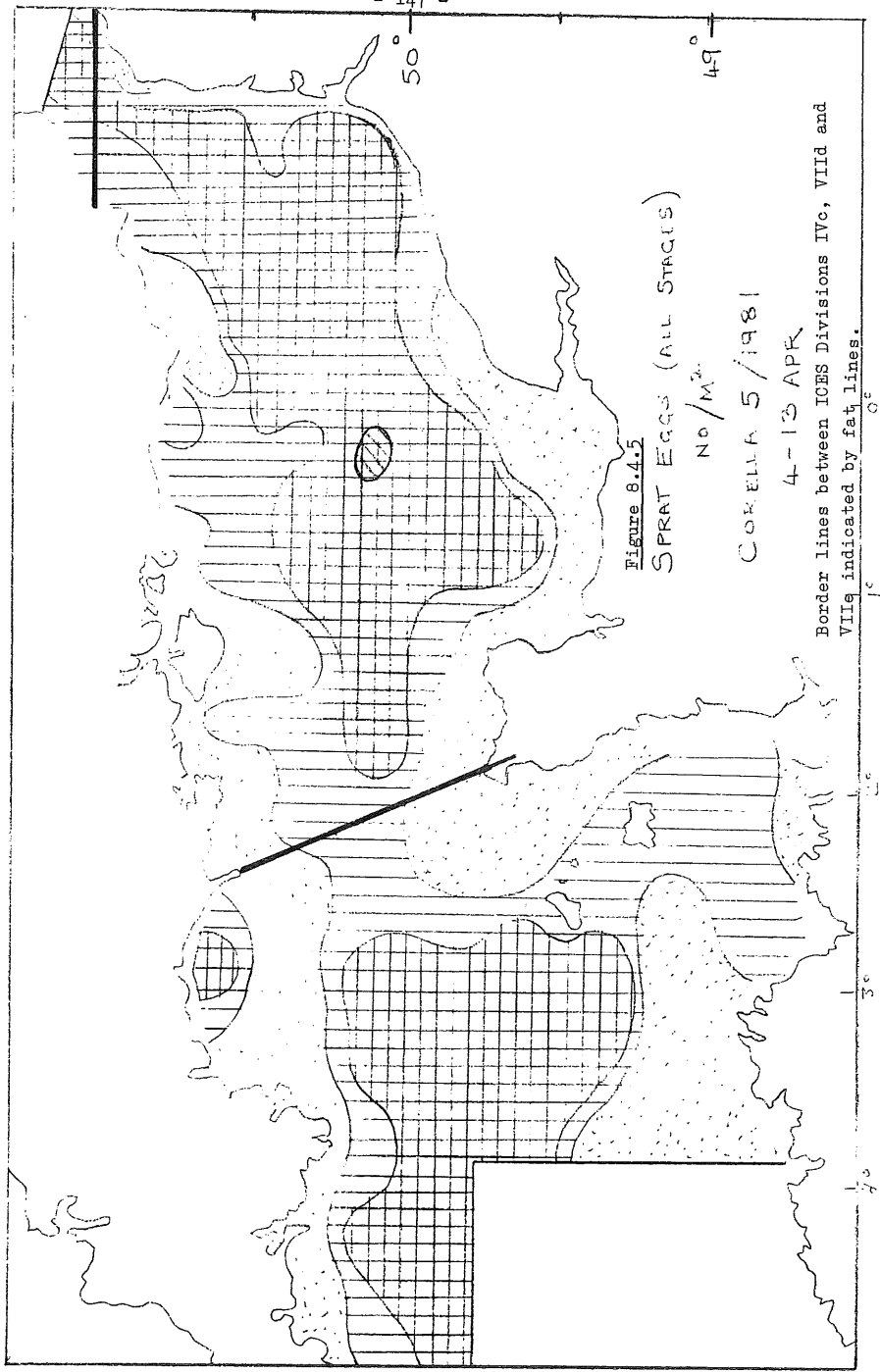- 1-10
- 11-100
- 101-300
- 301-600

Figure 8.4.4

SPRAT EGGS (ALL STAGES)

NO/M²

CORELLA 6/1979

18 APR - 8 MAY

Border lines between ICES Divisions IVc,
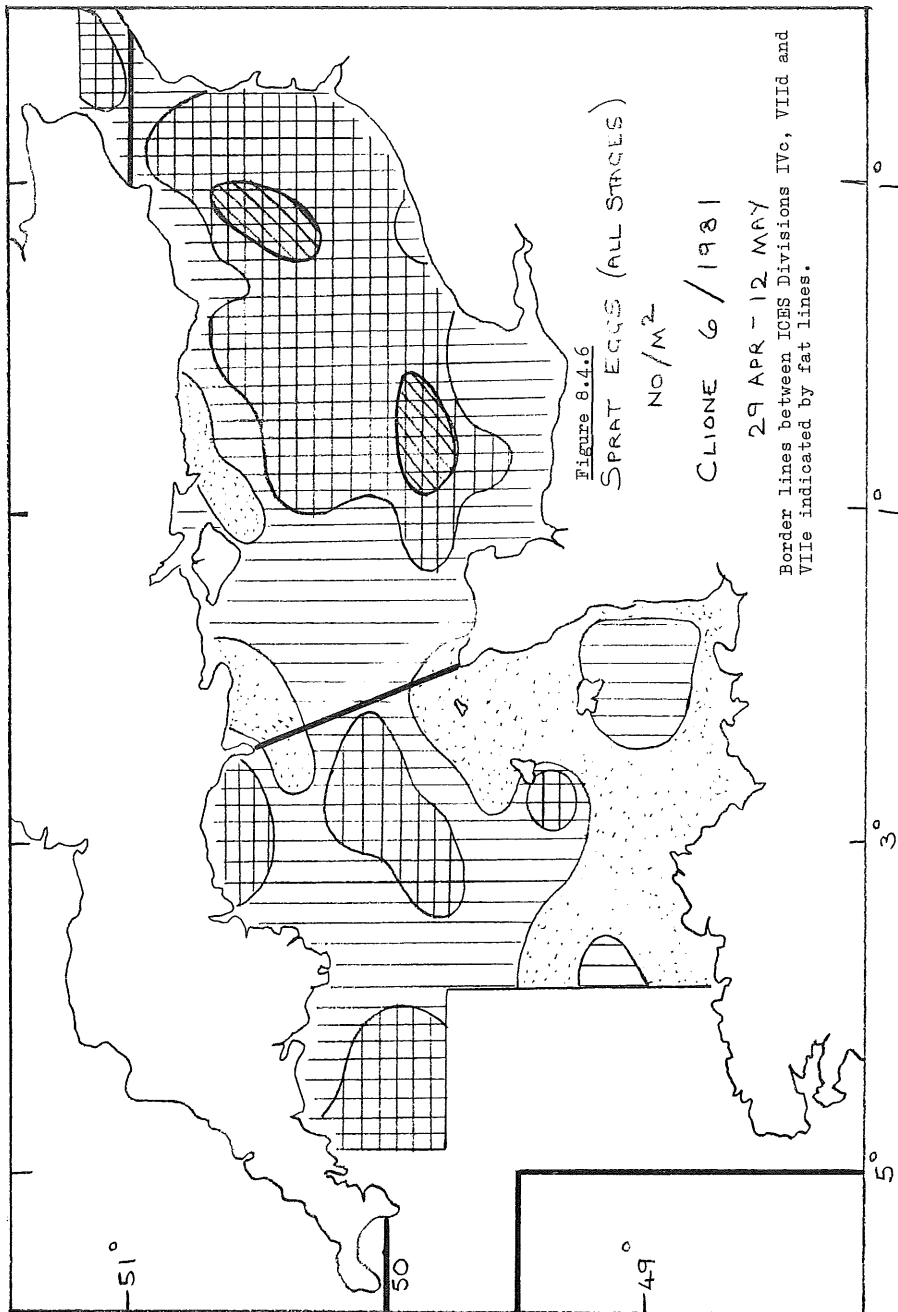VIId and VIIe indicated by fat lines.
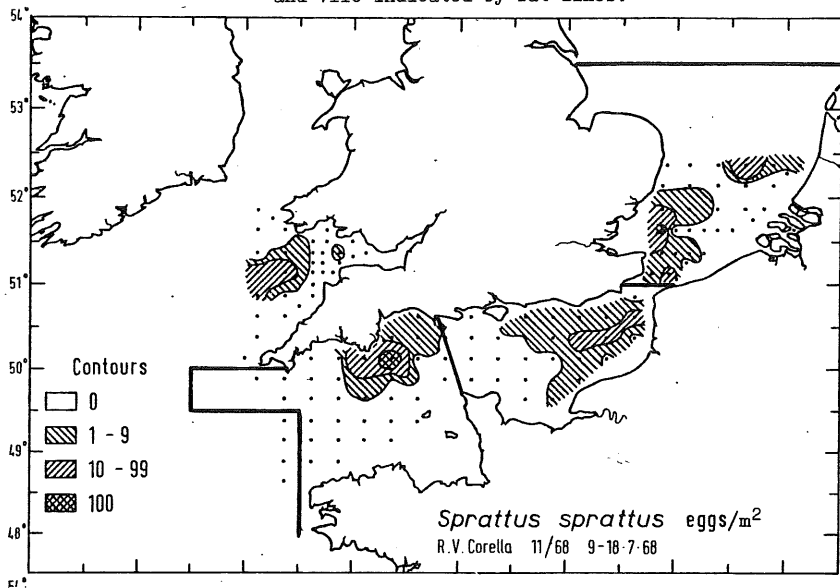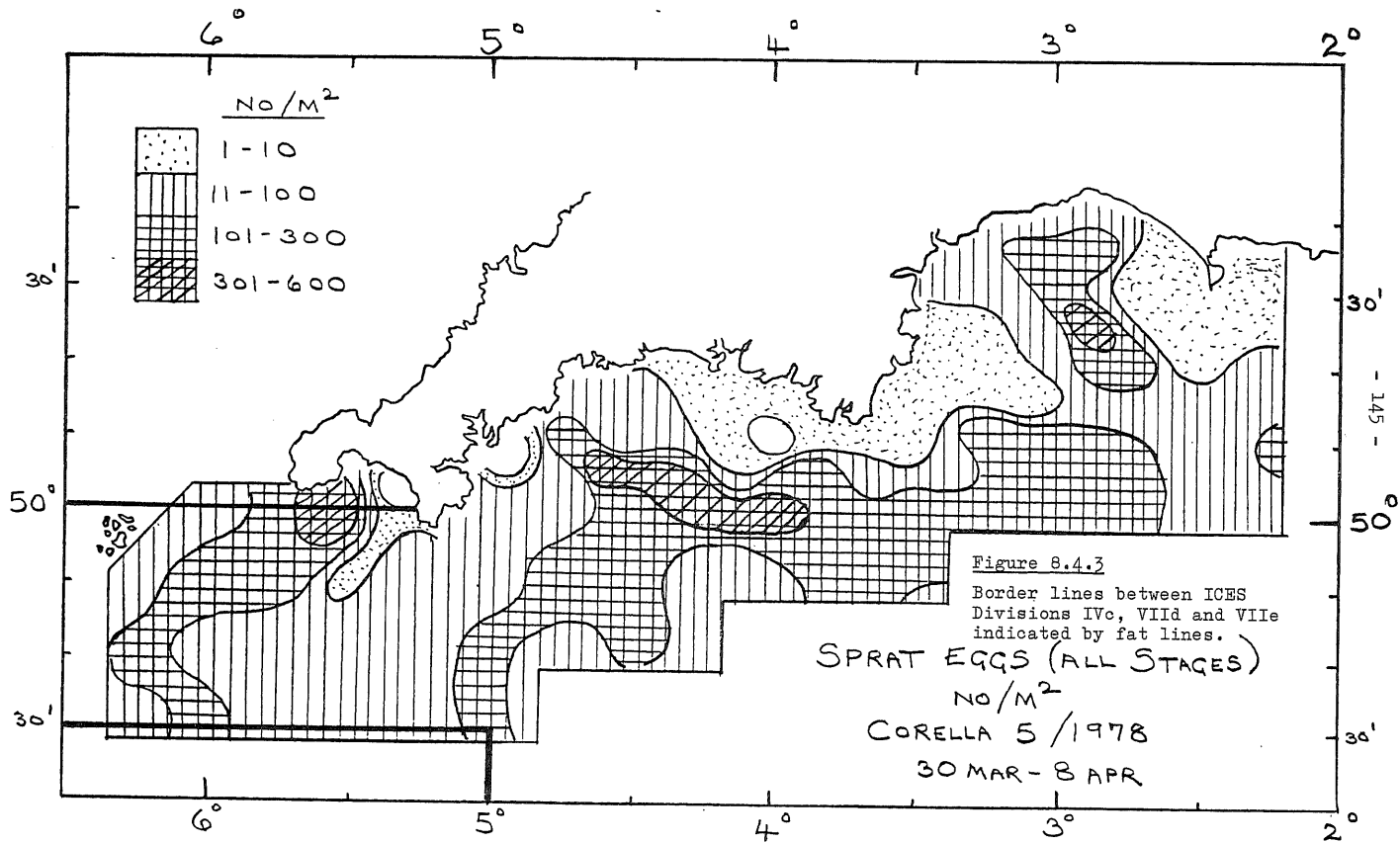
Figure 8.4.5

Sprat Eggs (All Stages)

No/m².

Corella 5/1981

4 - 13 Apr

Border lines between ICES Divisions IVc, VIId and
VIIe indicated by fat lines.

Figure 8.4.6

SPRAT EGGS (ALL STAGES)

NO/M²

CLIONE 6/1981

29 APR - 12 MAY

Border lines between ICES Divisions IVc, VIId and
VIIe indicated by fat lines.

- 149 -

Figure 8.4.7 Western Channel SPRAY (2 W/ = 6 cW).
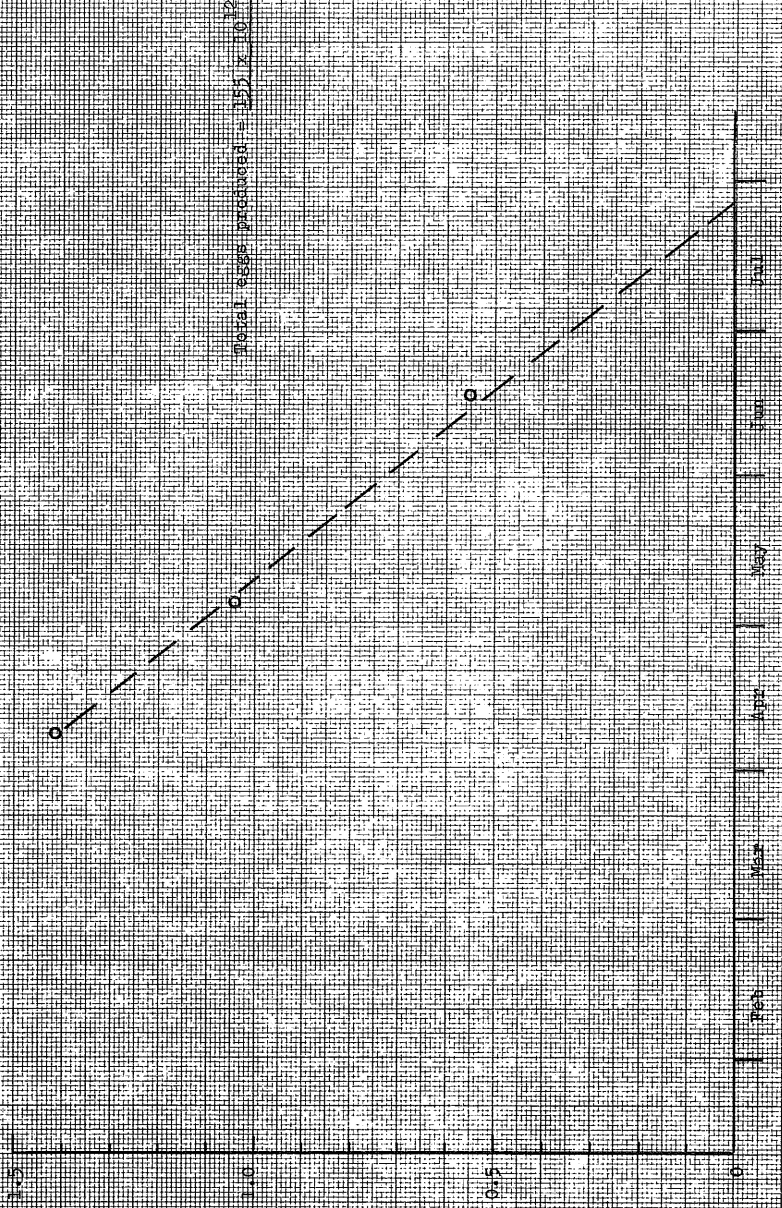Stage I egg production.

Total eggs produced = 151 x 10^12

Figure 8.5.1 Lyme Bay area SPRAT fishery.
Mean length and age distributions 1972/73 - 1978/79 seasons.
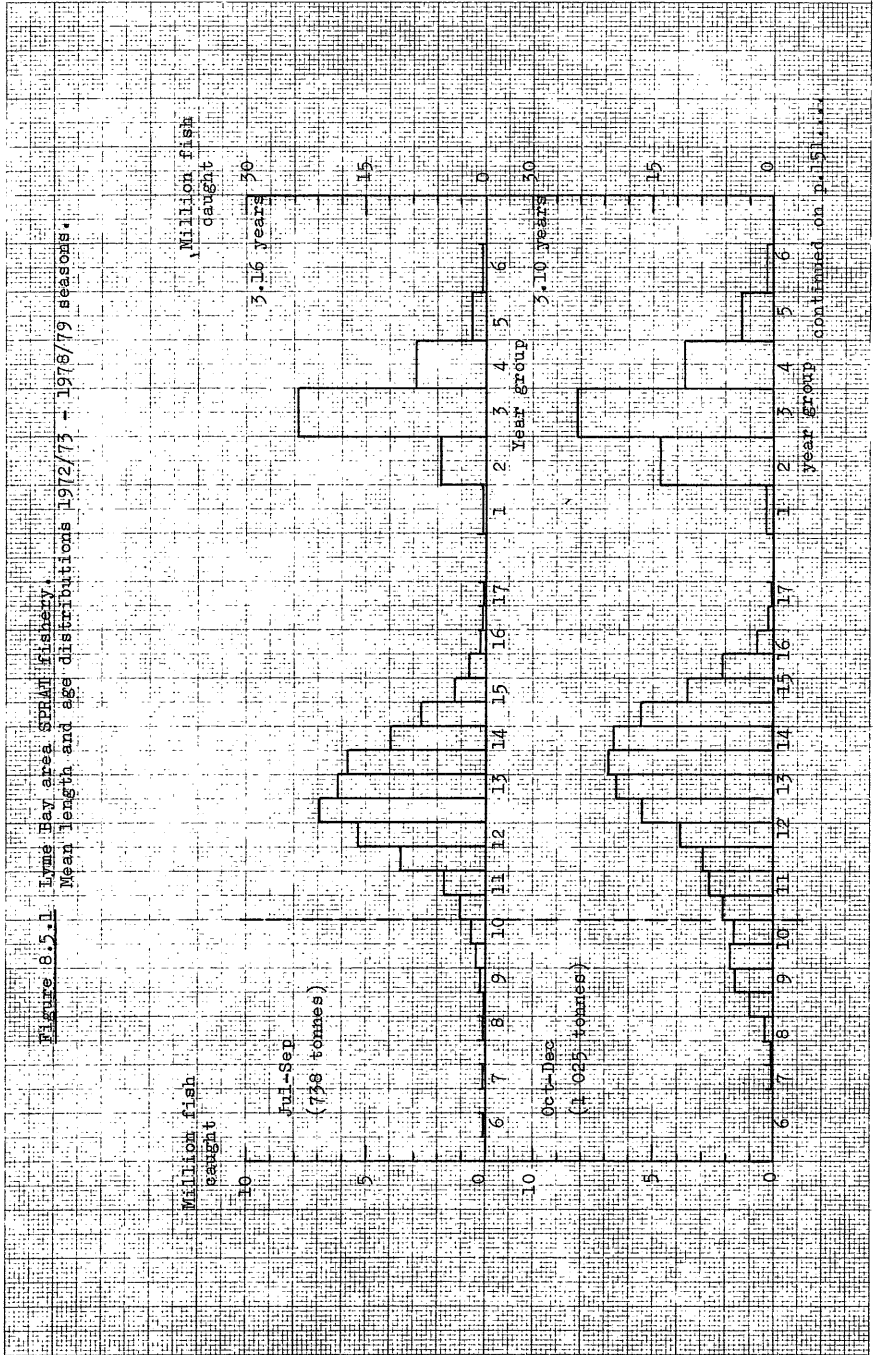
Table 8.5.1 (continued)

Million fish caught

2.67 years

3.04 years

Year group

Year group

Million fish caught

Jan-Mar
(436 tonnes)

Season
(2 1991 tonnes)