

This Report not to be cited without prior reference to the Council<sup>\*)</sup>

International Council for the  
Exploration of the Sea

C.M.1981/H:12  
Pelagic Fish Committee

BLUE WHITING ASSESSMENT WORKING GROUP REPORT

Copenhagen, 6-12 May 1981

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 without consultation with the General Secretary.

---

<sup>\*)</sup> General Secretary,  
ICES,  
Palægade 2-4,  
DK-1261 Copenhagen K,  
DENMARK.



TABLE OF CONTENTS

Page

1. INTRODUCTION .....	1
2. THE FISHERY IN 1980 .....	1
3. STOCK DISTRIBUTION AND STOCK SEPARATION .....	2
4. CATCH COMPOSITION .....	3
4.1. Age Determination .....	3
4.2. Age Compositions of Landings .....	4
5. WEIGHT AT AGE .....	4
5.1. Spawning Area .....	5
5.2. Norwegian Sea .....	5
5.3. Mixed Fishery (North Sea) .....	5
6. NATURAL MORTALITY .....	5
7. STOCK SIZE ESTIMATES .....	6
7.1. Acoustic Stock Size Estimates .....	6
7.2. Virtual Population Analysis (VPA) .....	9
7.3. Catch per Unit Effort .....	10
8. YIELD AND SPAWNING STOCK PER RECRUIT .....	11
9. SURVEY PLANS FOR 1980 AND 1981 .....	11
10. SOUTHERN AREA .....	11
11. MANAGEMENT CONSIDERATIONS .....	13
12. FUTURE RESEARCH RECOMMENDATIONS .....	14
References .....	15
Tables 2.1 - 10.6 .....	16 - 40
Figures 7.1.a - 7.6 .....	41 - 47



## BLUE WHITING ASSESSMENT WORKING GROUP REPORT

### 1. INTRODUCTION

The Blue Whiting Assessment Working Group met at the ICES headquarters, Copenhagen, 6-12 May 1981. The terms of reference were set by the Council's resolution passed at its 68th Statutory Meeting (C.Res.1980/2:6/8): to

- (i) assess the current exploitation rate of the blue whiting stocks and advise on the biological need for and form of any regulatory action,
- (ii) promote and coordinate further biological research on blue whiting in accordance with the recommendations presented in document C.M.1980/H:5.

#### 1.1. Participants

R.S. Bailey	United Kingdom (Scotland)
H. Hovgård Hansen	Denmark
H.f. Jakupsstovu (Chairman)	Faroe Islands
B.W. Jones	United Kingdom (England)
T. Monstad	Norway
A. Paciorkowski	Poland
R. Robles	Spain
V. Ryzhov	USSR
N. Schultz	German Democratic Republic
R. Schöne	Federal Republic of Germany
S. Sveinbjörnsson	Iceland
V. Shleinik	USSR
A.M. Tavares	Portugal
M.E. Vasconcelos	Portugal

### 2. THE FISHERY IN 1980

The total landings of blue whiting in 1980 (Table 2.1) were almost the same as in 1979 and this is the first time that the catches have not increased significantly since 1975.

The fishery is distributed over a vast area of the Northeast Atlantic extending from Sub-area IX in the south to Sub-areas I and II in the north. The following fisheries can be defined:

- a) In the Norwegian Sea (Table 2.2). This fishery is mainly based on feeding, post-spawning blue whiting. By far the greatest catches are taken by vessels from the USSR (approximately 666 250 tonnes in 1979 and 726 900 tonnes in 1980, which is about 97% of the total catch in this area).
- b) A spawning fishery based on the spawning stock in the spawning area (Divisions VIa, b and VIIb,c) and at the Faroes (Division Vb) on fish migrating to and from the spawning area (Table 2.3).

The greatest part (144 000 tonnes in 1980) is landed by Norwegian vessels followed by USSR (40 000 tonnes), Faroese and Danish vessels. The total catch in this area was about 258 000 tonnes which was about 30 000 tonnes less than in 1979.

- c) The industrial fishery for Norway pout had stopped in 1980 by the time the juvenile blue whiting normally appear in the catches (Table 2.4). However, some blue whiting are always caught and discarded in the Nephrops fishery at the south coast of Iceland.
- d) An industrial fishery for Norway pout and juvenile blue whiting in the North Sea (Divisions IVa-c and IIIa, Table 2.5). Catches in this fishery increased to 82 000 tonnes in 1980 compared to 63 000 tonnes in 1979. The main landings of blue whiting were made by Denmark (48 000 tonnes) and Norway (30 000 tonnes) which together accounted for about 95% of the total catch.
- e) A southern fishery (Sub-areas VIII and IX and Division VIIg-k, Table 2.6). The main landings in this fishery were made by Spanish vessels (24 000 tonnes of a total of 30 000 tonnes) taken partly in a directed fishery for blue whiting and partly as a by-catch in other fisheries. Most of the fish landed were young immature blue whiting.
- f) In the Greenland/Dohrn Bank area (Division XIVb) the catches of the Federal Republic of Germany increased considerably due to directed fishing for human consumption. These have been included in Table 2.2.

### 3. STOCK DISTRIBUTION AND STOCK SEPARATION

At its 1980 meeting, the Working Group decided to treat the entire Northeast Atlantic as a single assessment unit except for the Southern area (Division VIIg-k, Sub-area VIII and Division IXa).

Data presented to the 1981 meeting indicate that blue whiting caught along the Spanish and Portuguese coasts (Sub-area VIII and Division IXa) are rather different from those found further north (see Section 10). Length at age is much lower and maturation appears to be complete at a much lower age and size than in the Northern stock. This indicates the likelihood that blue whiting in these areas belong to a separate stock. For this reason, a separate assessment was made for this Southern area.

The Working Group, however, was not able to provide any new data from which to decide the appropriate boundary for the Southern stock. In last year's report, all catches south of Porcupine Bank were excluded from the Northern assessment. It is possible that the boundary between the stocks should be drawn further south than this, but the Working Group considered that it would be unwise to fix a definite boundary until better data are available, especially for the Celtic Sea and the Bay of Biscay.

In the Northern area, new data were presented for the area west of Iceland which might indicate the existence of a separate stock in this area also. On the Dohrn Bank, fish ranging in length from 20-48 cm have been found at all times of the year in considerable quantities. The conclusions to

be drawn from this evidence, however, are not clear because the fish are in all cases at very low stages of maturation (either immature or resting), and it is not certain which spawning area they originate from.

The acoustic surveys of the spawning area to the west of the British Isles are thought to cover the major proportion of the Northern stock. At its previous meeting, however, the Working Group acknowledged the fact that spawning occurs in other areas. Further evidence from the Norwegian Sea was obtained by Norwegian vessels.

In July 1979, 0-group blue whiting were observed by R.V. "MICHAEL SARS" in the Norwegian Sea. Using a pelagic trawl in the upper water layers, rather large numbers (up to 13 000 specimens/hour) with a mean length of 3.5 cm were caught in an area on the Norwegian shelf between 64° and 69°N. This is similar to observations made by Zilantov (1968) of large larvae in the Lofoten area. In addition, blue whiting ranging from 7-8 cm in length were found in small numbers in an area northeast of Shetland. The specimens observed in the latter area may originate from the main spawning west of the British Isles in March/April, while the 0-groups found further north, however, most probably originated from a later spawning somewhere in the southern part of the Norwegian Sea.

In August 1980, three vessels covered the greater part of the Norwegian Sea, making frequent pelagic trawl hauls in the upper water layers. Only very small numbers of blue whiting were found, i.e., at one station northeast of Iceland, at one station off western Norway and at three stations off northern Norway.

A survey in the fjords of western Norway in June 1980 gave evidence that spawning also takes place there to a minor extent. In the fjords between 60° and 62°N, 77 plankton-net stations were worked. In 37 of these, either blue whiting eggs or larvae were observed. In addition, a total of 63 specimens of 0-group blue whiting were caught with pelagic trawl (15 stations), indicating that spawning takes place over an extended time period.

#### 4. CATCH COMPOSITION

##### 4.1. Age Determination

The otolith exchange programme initiated by the Blue Whiting Planning Group in 1979 is now complete and the results were presented to the Working Group.

The material consists of age readings by 11 readers on the same sample of 100 blue whiting otoliths. In addition, when reading the otoliths, 7 readers have marked on photos of a sub-sample of 31 otoliths which zones were interpreted as annual and consequently counted in the age determination.

Taking the readings at face value, the variability in interpretation is quite unacceptable (Table 4.1). There is no complete agreement on any of the otoliths. The difference between highest and lowest age interpretation is up to 10 years and is mainly between 3 and 8 years. The mean age in the sample calculated by readers varies from 6.3 to 10.6 years (Table 4.2).

Scrutinizing the marking of the zones on the photographs revealed that all combinations of interpretation of the edge and the first year's growth existed between readers, although the readers seemed to be quite consistent in their own interpretations. Standardizing the age readings for this reduced the variation between readers to some extent (Table 4.3). Of the 7 readers who had marked the photographs, 5 after standardizing obtained a mean age between 7.4 and 8.2 years, while one obtained a lower mean age (6.6 years) and one a higher (9.1 years).

From Table 4.2, it appears that there are 2.9 years' difference in mean age calculated for the sample between reader No.9 (Norway) and reader No.12 (USSR) when taken at face value. It is therefore reasonable to conclude that the catch in number by age groups provided by these countries is biased in the same way in relation to each other. As the catch taken by these countries amounted to 83% of the total catch in 1980 this will greatly affect any calculation based on the catch in numbers by age groups.

The Group felt, however, that it was not possible at this stage to standardize age readings brought to the Working Group meeting. In Table 4.4, the catch in numbers by age group are as provided by the Working Group members.

#### 4.2. Age Compositions of Landings

Age compositions of landings from the Northern areas were revised for 1979 and new data were made available for 1980. For the directed fisheries in 1980, age composition data were provided by the Faroes, the German Democratic Republic, Iceland, Norway, Poland, Scotland and USSR. These countries together accounted for 96% of the landings in the directed fisheries. Landings by other countries were caught mainly in the spawning fishery and were assumed to have the same relative age compositions as Norwegian landings (Table 4.4).

For landings of blue whiting taken in the mixed industrial fisheries, age compositions were available for Norway only (38% of total industrial landings). Other countries' landings were assumed to have the same relative age compositions as those of Norway (Table 4.5).

The raised age compositions for the directed fisheries and the mixed industrial fisheries were summed to give the total age composition for the Northern area (Table 4.6). It should be noted that all age compositions were used as submitted by the representatives of the countries concerned and no attempt was made to correct for any bias or differences in otolith interpretation between the different otolith readers (see Section 4.1).

No age composition data were available for the landings from the Southern area.

#### 5. WEIGHT AT AGE

Mean weight at age has been calculated for several countries regarding the different areas and quarters. These data are shown in Table 5.1.



The differences in mean weight at age in the same areas and quarters may be due to both the different fishing areas and month of sampling as well as to different interpretations of the otoliths zones during ageing (see Section 4).

In order to get an overall weighted mean value at age, mean values were calculated for the spawning area, the Norwegian Sea and the mixed fishery in the North Sea separately, and summarized by weighting these values by the relevant catch in numbers in those areas (Table 5.2). Checks of sums of products (SOPs) of total numbers landed x mean weight at each age were made for 1979 and 1980 using for 1979 the weight at age data given in last year's report and for 1980 the data given in Table 5.2. The calculated SOPs were within 2% of the nominal landings.

#### 5.1. Spawning Area

Weight at age data were available from the Faroes, the Federal Republic of Germany, Norway, Scotland and the USSR. Summarized mean weight at age data for the spawning fishery are given in Table 5.2. These values were calculated by weighting the Norwegian and Faroese mean weights at age for the second quarter by the total catch from the directed fisheries by these nations. The combined catches of these two countries account for approximately 80% of the total fishing in the spawning area.

#### 5.2. Norwegian Sea

Data from this area were supplied by the German Democratic Republic, Poland, Norway and the USSR. The USSR weight at age data for the 2nd and 3rd quarter, which represent more than 85% of the USSR catch and approximately 80% of the total catch in the area, were used as representing the mean weight at age in the Norwegian Sea (Table 5.2).

#### 5.3. Mixed Fishery (North Sea)

Weight at age data for the industrial mixed fisheries in the North Sea were available for all quarters from Norway. Mean weight data for that fishery for the total year were calculated from data by quarters weighted by the total catch in numbers from the Norwegian fishery.

### 6. NATURAL MORTALITY

Based on catch curve analysis of Scottish and Norwegian research vessel samples of blue whiting, the Working Group in 1980 concluded that natural mortality could be in the range of 0.2 - 0.3. Warburton (1981) in a working paper to the Working Group based on biological data on blue whiting from the main spawning areas sent to him (see Blue Whiting Working Group Report 1980, recommendation No.4 (C.M.1980/H:5)) indicates that the combined data would suggest M to be slightly higher than that adopted by the Working Group, perhaps 0.25 - 0.4 compared to 0.2 - 0.3

In view of the difficulties in the ageing, especially of older fish, the estimates of natural mortality based on catch curves may be biased. If ages of the older fish are underestimated, this will lead to an overestimate of the natural mortality. The effect of this possible bias requires further investigation.

## 7. STOCK SIZE ESTIMATES

### 7.1. Acoustic Stock Size Estimates

#### 7.1.1. Spawning season

A coordinated acoustic survey was carried out by Norwegian and Scottish research vessels during March-April 1981 in the area extending from Porcupine Bank (52°30'N) to the Norwegian Sea (65°N). The Norwegian cruise of "G.O. SARS" took place from 9 March - 4 April, the period up to 20 March in the northern part of the area and the remaining period in the area west of Scotland (Figure 7.1.a). Blue whiting were recorded over almost the entire area surveyed, the highest concentrations being found west of the Hebrides. The Scottish survey on "SCOTIA" took place from 25 March - 14 April (Figure 7.1.b). The first half of the survey covered the area from the Hebrides to Porcupine Bank, while the second half covered the area from northwest of Ireland to the Faroe-Shetland Channel extending west to Rockall Bank. During this survey, blue whiting were recorded in the highest densities in a rather narrow strip along the edge of the Continental Shelf with the highest concentrations northwest of Ireland and just north of the Wyville-Thompson Ridge.

The Norwegian acoustic data were converted to biomass estimates using the same method as in 1980. At two trawl stations, in situ target strength (TS) measurements were made on single blue whiting echoes. The results indicate the median recorded TS value to be -39dB. The corresponding median fish length in the trawl hauls was 32 cm. This value fits closely with TS values for cod of the same length given by Nakken and Olsen (1977), and the length-dependent conversion factor (C-value) for blue whiting appropriate for "G.O. SARS" was that calculated for cod:

$$C = 5.25 \times 10^6 \times l^{-2.18}$$

where  $l$  is the fish length in cm, and the C-value is expressed in numbers of fish per mm of integrator deflection per square nautical mile. This formula was used in conjunction with the mean length and mean weight from trawl haul data to estimate the blue whiting biomass in each statistical rectangle surveyed.

The biomass estimates for each statistical rectangle surveyed by the Norwegian vessel are given in Figure 7.2. The total for the area surveyed is 6.9 million tonnes. Owing to the time difference between the surveys in the north and south of the area when blue whiting were still moving south, it is possible that part of the stock may have been measured twice. If so, the above figure may be a slight overestimate.

The Scottish survey estimates were calculated by referring the echo-intensities to standard targets of known target strength (table tennis balls). Two calibrations were carried out during the cruise. To convert the values obtained to levels comparable with the Norwegian estimates, some assumption had to be made about the TS values used on the Norwegian survey. While these were based on a length-dependent TS function, the modal length of blue whiting in Norwegian trawl hauls in the Scottish survey area was 32 cm. The target strength corresponding to this length is -39dB and using a weight per individual of 186 g this is equivalent to a TS of -32dB/kg.

There is, however, a further factor to be taken into account. Recent research has shown that the absorption coefficient of sound in seawater used in the time-varied-gain function (TVG) in the acoustic equipment used on these surveys may not be correct. Furthermore, there is a difference of approximately 2dB/km between the values of this coefficient used on the Scottish and Norwegian ships. In relatively shallow water this difference will have little effect, but at the depths at which blue whiting are found in this area (here assumed to be 400 m on average), there will be a significant difference. The Norwegian equipment has used a higher absorption coefficient than the Scottish equipment and has therefore used a higher compensation value in the TVG.

To correct for the differences between the equipment, the Scottish values were recalculated to correspond to a target strength of -32dB/kg, and to allow for the differences in absorption coefficient. The resultant biomass estimates for each statistical rectangle are given in Figure 7.3. The total estimate for the area surveyed by the Scottish vessel is 5.3 million tonnes.

To combine the results of the two surveys, the mean of the values has been used for those rectangles covered by both ships. The resulting total for the entire area surveyed is 9.7 million tonnes. However, if the lower absorption coefficient is used in biomass calculations for both surveys, then the overall biomass estimate is 6.7 million tonnes. Since no information was available to the Working Group to decide which of the two absorption coefficients is correct, it is only possible to express the results as a range of values, i.e. 6.7 - 9.7 million tonnes, with a mean of 8.2 million tonnes.

The equivalent biomass in that part of the area surveyed by both ships was 4.0 million tonnes by the Norwegian vessel and 3.5 million tonnes by the Scottish vessel. In addition, an intercalibration experiment was carried out west of the Hebrides. Even when the Scottish values obtained during this experiment had been corrected to refer to the same target strength and the same absorption coefficient as the Norwegian values, the slope of the regression line between the two sets of values still indicated a factor of 1.6 difference between the two vessels. Since the experiment was carried out in unfavourable weather which resulted in considerable amounts of noise in the acoustic recordings, the results of the intercalibration may not be reliable and were therefore not used to correct the biomass estimates of either ship.

Although the Working Group were aware of the potential sources of error in the estimate, they considered that the figure of 8.2 million tonnes represented the best estimate of the biomass in the area surveyed. According to the analysis of the Norwegian trawl samples, the immature part of this estimate accounted for about 1 million tonnes. This gives a minimum estimate of the spawning stock biomasses in the range of 5.7 - 8.7 million tonnes, with a mean of 7.2 million tonnes.

#### 7.1.2. Post-spawning migration

From 22 April to 5 May 1980, the Soviet R.V. "POISK" carried out an acoustic survey for blue whiting in the Faroe Islands area and in the southeastern Norwegian Sea (Figure 7.4). In the southeastern Norwegian Sea, blue whiting were distributed over the area from 62°50' to 64°00'N and from 00°30' and 02°00'E. In the daytime, fish were observed in depths of 300-500 m, but at night they were more dispersed.

In the area surveyed, the main blue whiting concentrations were observed in the area south of 63°N. Blue whiting were distributed in depths of 400-500 m during the day and the vertical extent of the shoals was 20-40 m.

In the southeastern Norwegian Sea, 54.2% of blue whiting caught were 28-31 cm long and from their gonad condition would not have taken part in spawning that year. Post-spawning blue whiting did not exceed 11% of the fish analysed. Fish from 5-10 years of age predominated in the catches (80%).

The smallest blue whiting were found in the area west of the Faroe Islands. The mean length of fish in this area was 25 cm, varying between 17 and 32 cm in different samples. Immature blue whiting in the first maturity stages prevailed in the area (75.7% at stage II).

Blue whiting 24-38 cm long and at an age of 5-15 years (Table 7.1) were caught to the east of the Faroe Islands. Post-spawning specimens made up 34.9% of the number of fish analysed.

The biomass of blue whiting in the area surveyed from 22 April to 5 May 1980 was estimated to be 812 000 tonnes, including 697 000 tonnes in the Faroe Islands area (Table 7.2). The length-dependent conversion factors used were described by Zaferman *et al* (1980).

This estimate would suggest that most of the spawning population was distributed to the south and east of the area surveyed.

#### 7.1.3. The summer feeding period

From 4 August to 11 September 1980, the three Norwegian research vessels "G.O. SARS", "MICHAEL SARS" and "JOHAN HJORT" carried out a combined survey of the area from Shetland to Spitsbergen and between Greenland and Hope Island in the Barents Sea. In Figure 7.5, the cruise tracks are shown together with hydrographic and pelagic trawl stations.

The purpose of the cruise was to investigate the distribution and density of blue whiting and 0-group fish. In the Iceland/Jan Mayen area, the objective was also to investigate capelin distribution. In the Svalbard and Barents Sea area, the blue whiting recordings were obtained from the annual international 0-group fish survey, which took place immediately after the survey further south.

The distribution and relative densities of blue whiting are shown in Figure 7.6. They were found scattered over most of the area covered. The western limit of the distribution was located more or less along the polar front which followed a line from Iceland to the west of Jan Mayen and northeast and north to the west of Spitsbergen. In the east, blue whiting were recorded to the area east of Bear Island.

The results of the survey provide information on blue whiting distribution over a large area which was covered within a fairly short time period. As this is considered to be a pilot survey, no stock estimate is given. It nevertheless shows the feasibility of future acoustic assessment surveys on the stock during the feeding season.

#### 7.1.4. Acoustic assessment surveys

Acoustic assessment surveys in the spawning area in the years 1972-79 have resulted in a great variation of spawning stock size estimates (Anon., 1980). The coordinated surveys in 1980 and 1981, however, in which intercalibration between ships was carried out, resulted in spawning stock size estimates of a similar magnitude when the data for the ships participating were combined. At least this would indicate that, by continuing acoustic assessment surveys in the same way as in 1980 and 1981, the relative spawning stock size could be monitored, especially if all aspects of the calibration procedure were standardized.

The acoustic assessment survey of blue whiting with 3 Norwegian vessels in the Norwegian Sea in July/August 1980 reveals that acoustic assessment of the stock feeding in the Norwegian Sea is quite feasible. Despite the large area which has to be surveyed, this approach has many advantages compared to assessing the spawning stock. The weather conditions are likely to be better on average, the fish are supposedly more stationary or are migrating less rapidly compared to the spawning period, the scattered concentrations are easier to survey and the fish are generally found in shallower water yielding better target strength measurements. Finally, a survey in the Norwegian Sea in the summer/autumn period would cover a major part of the total stock, in contrast to surveys during the spawning period, when only the major part of the spawning stock is found to the west of the British Isles.

The best time to do acoustic assessment surveys of blue whiting in the Norwegian Sea is when the northward migration is completed and before the southward migration starts, presumably in the period August to September. At this time, however, most research vessels likely to be able to take part in such an effort are occupied on annual 0-group surveys and the blue whiting would most likely have to take place before or after this period.

Owing to the advantages of a survey in the feeding period, however, the Working Group felt that an acoustic assessment of the blue whiting stock in the Norwegian Sea should be carried out in July-August 1982, with vessels participating from as many countries as possible. In order to achieve this, an ad hoc planning group should be established to coordinate the surveys and to standardize survey procedures including between-ship calibration.

As this would be a new approach with unknown problems, the Working Group recommends that the coordinated acoustic surveys of the spawning stock west of the British Isles should also be conducted in 1982.

#### 7.2. Virtual Population Analysis (VPA)

Catch age composition data were available for the period from 1970 and these were used by the Group to perform some trial VPA calculations. It was hoped that it might be possible to obtain estimates of fishing mortality in the last year or two. However, on examining the results, it was concluded that this could not be done with any reliability due to uncertainties relating to the input data. The catch age composition data are known to be subject to error and/or bias due to differences in interpretation of age between readers. It is not known what value of the natural mortality coefficient is appropriate for blue whiting, although limits of a probable range of values could be given (see Section 6). Furthermore, there was very little information to indicate

appropriate input values for fishing mortality on the oldest age group and for the most recent year. One possibility considered by the Group was to use F values for 1980 which would give a stock biomass estimate in 1981 consistent with that determined by the acoustic survey. However, the difficulties with this approach were knowing what proportion of the total stock biomass was represented in the acoustic survey estimate. The best estimate of biomass from the acoustic survey in early 1981 is 8.2 million tonnes. Although the surveys covered the main part of the known spawning area, it is known that some spawning occurs outside the area surveyed. There was no means of knowing what proportion of the spawning stock was included in the survey. On the other hand, trawl samples taken during the survey indicated, particularly in the northern part of the area, that a proportion of immature fish will have been included in the stock surveyed. The shape of the maturity ogive is also uncertain. As a result of these uncertainties, the Working Group concluded that no reliable estimate either of the current exploitation pattern or of the level of fishing mortality could be given.

### 7.3. Catch per Unit Effort

The data on catch per unit effort were available from 7 countries, i.e. Faroes, German Democratic Republic, Iceland, Norway, Poland, United Kingdom (Scotland), and Soviet Union for 1-5 recent years. In accordance with a request from ACFM, the reported data were broken down by vessel tonnage classes, gear types and area. Some countries provided data on monthly and Sub-area or Division basis, which may enable a more detailed examination in the future.

The observed trends do not allow any definite conclusions to be drawn at present on stock density. Cpue of Faroese 500-999.9 GRT class (MWT) indicate a declining availability of post-spawning blue whiting in the fishery on the Faroe Plateau in May when catch per hour decreased annually from 17.6 tonnes in 1977 to 6.2 tonnes in 1980 (Table 7.3).

The catch rates of Icelandic trawlers of the same tonnage class also fishing at the Faroes in May showed a rapid decline from 1978 to 1979 but a considerable increase (by 25%) in 1980. The results of Polish vessels from the same Division fluctuated widely from year to year and were highest in 1979. A constant increase from 1977 to 1979 on the other hand, and an abrupt decrease in 1980, were shown by Faroese data from Division VIa in April, for example. After a discussion, it was concluded that the observed decline in cpue of Faroese vessels may reflect the changes in availability of blue whiting due to periodic changes of the current system around the Faroes which influences the migration pattern and thus the density of blue whiting concentrations in that area. The blue whiting density changes in Division Va may also be dependent on environmental factors such as water temperature and strength of the East Icelandic current. However, no environmental explanation can be given for the considerable decline in Icelandic catches and catch rates in that Division in 1980. Cpue in all the above-mentioned areas could fluctuate due to the influence of such factors as stock abundance changes, the time when a fishery takes place, fleet structure within a GRT class etc. In that context, a clear separation of the observed density changes within these Divisions into those resulting from environmental reasons and those from other factors is difficult at present.

The cpue data of the fishing fleets exploiting the feeding concentrations of blue whiting in the Norwegian Sea reveal a similar degree of variability, but it is believed that the real density changes may be masked or altered by such factors as learning, fishing gear improvements (more common usage of high opening rope trawls), and an increasing proportion of more powerful and better equipped vessels within the same tonnage class etc. The stability of cpue by USSR vessels which account for about 70% of the total blue whiting catch in 1979 and 1980 (Table 7.3) could indicate, however, that no substantial changes in stock abundance have taken place during the last two years in that area.

Taking into account the future needs for blue whiting stock assessments and the conclusions of the Working Group on the Use of Effort Data, the Blue Whiting Working Group recommends that all countries involved in the blue whiting fishery should report their catch and effort statistics on the blue whiting by GRT class, gear type, division and month. In addition, age compositions made available for each fishery should be accompanied by associated effort data. Countries which have such statistics but have not supplied them for previous years are requested to do so before the next Working Group meeting.

8. YIELD AND SPAWNING STOCK PER RECRUIT

Graphs showing the yield and spawning stock per recruit at various levels of fishing mortality for the Northern stock of blue whiting were given in the 1980 Working Group report, with a qualification that they should be interpreted with great caution. No improvement in age determination has occurred since then, and the Working Group were not able to revise the previous curves. The statement made in the 1980 report, however, needs to be reiterated - that errors in the assumed exploitation pattern and in the age composition could have major effects on the shape of these curves and on any estimated values of the optimal fishing mortality such as  $F_{0.1}$ .

9. SURVEY PLANS FOR 1980 AND 1981

The blue whiting surveys in 1980, with their cruise dates, main objectives and areas, are summarized in Table 9.1 as reported to the Working Group. It was felt that the results of individual cruises should not be presented in this year's Working Group report, since they are usually published elsewhere.

Cruises for 1981 already completed and proposed cruises for the remainder of the year, with their cruise dates, main objectives and areas, are given in Table 9.2.

10. SOUTHERN AREA

Concerning Recommendation 2 of last year's Working Group report, the material collected for this area came from England, the Federal Republic of Germany, Spain and Portugal. The former two countries presented data collected on several research vessel cruises, and Spain and Portugal presented a compilation of their data.

Length distributions and age/length keys for 1976, 1978, 1979 and 1980 for blue whiting caught by different research vessels and chartered trawlers in Division VIIg-k and Division VIIa,b were provided by England.

The Federal Republic of Germany presented data on length/weight relationships in Sub-area VIII for the years 1975, 1976, 1977 and 1980 obtained from research vessel cruises.

Spain and Portugal submitted data on commercial fishery and biological data coming from research vessel cruises for Divisions VIIIc and IXa.

#### Division VIIg-k

Table 10.1 gives average lengths at age from the English research catches of blue whiting in this ICES Division. These indicate lower average lengths at age than those found in areas further north. Only small differences in growth could be observed between ICES Divisions VIIg-k and VIIIa,b. For comparison, age-length data from the Federal Republic of Germany in ICES Division VIa are also given. Possible differences in sampling time and age determination need to be further investigated.

#### Sub-area VIII and Division IXa

Blue whiting is a common species which is caught as by-catch in the bottom trawl fishery for hake. In addition, some Spanish pair trawlers have a directed fishery on it, on grounds ranging from 100-500 m in depth. From time to time, the Spanish purse-seine fishery for sardines catches small quantities of small blue whiting in shallow water.

Fleet - The Spanish bottom trawl fleet in these areas is composed of 287 boats with a mean of 516 HP and 169 GRT. The Portuguese fleet has 119 boats with a mean of 682 HP and 166 GRT.

Landings - In Table 10.2, data from 1966-1980 for Spain and from 1977-80 for Portugal are provided. Portuguese landings of this species were not separated from the "other fish" category until 1977. In addition to the landings, significant quantities are discarded at sea.

Length compositions - Spain presented data from 1977 to 1980 and Portugal for 1980 (Table 10.3). It can be seen that more than 96% of the landings in number are individuals below 25 cm in length. Whether this reflects a lower growth rate than in the northern area or indicates that bigger individuals are not available to the bottom trawl gear on the grounds fished requires separate investigation.

Length/weight relationship - Separate data for females and males were presented by Portugal and Spain. No significant differences were observed between sexes and the data for both sexes were combined, and these gave a calculated length/weight relationship of  $w = 0.0039 l^{3.126}$ , where  $w$  is weight in g and  $l$  is length in cm. The Federal Republic of Germany presented a further relationship derived from research vessel catches taken in Sub-area VIII ( $w = 0.0045 l^{3.063}$ ).

Age - In Divisions VIIIa,b, English research vessel data for 1976-1978 and 1980 are available. These age determinations show lower average lengths at age than in the northern area (Table 10.1). Whether this is the result of different oceanographic conditions or indicates that there is a different stock in this area requires further investigation.

For Divisions VIIIa and IXa, no age determinations have been carried out. In order to have a very rough idea of the growth parameters, an attempt



was made to apply the Cassie method to the length frequency distributions obtained on several Spanish and Portuguese cruises. These gave very provisional estimates of  $L_{\infty}$  and  $K$  (39.1 cm and .225, respectively) that were further used in a trial cohort-by-length analysis.

Maturation - New data indicate the presence of mature fish in the area from January to March. Portuguese and Spanish data presented for the month of March 1981 show that a major proportion of the fish samples (17-25 cm) were ripening or spent fish (Table 10.4). This supports the idea of a possible separation from the stock further north, in which maturation is not completed until a larger size is reached.

Sex ratio - Information presented demonstrates that the proportion of females increases with length as in other areas. Practically all the fish above 33 cm are females.

Trawl surveys - Groundfish surveys along the Portuguese coast were carried out by the Portuguese research vessel "NORUEGA" in June and October 1979, March, May/June and October 1980 and in March 1981. On these surveys, the area was stratified by zone and depth and trawl hauls were made at random within each stratum. Table 10.5 shows the mean catch of blue whiting per hour within each stratum with its standard deviation. The results of the surveys show that the greatest catch rates were in the 200-500 m depth stratum.

Assessments - With the data available at present, it is impossible to make a reliable assessment. Nevertheless, to give a tentative assessment of the state of the stock (as has been previously done for hake in these waters), a cohort-by-length analysis (Jones, 1974) was attempted using the mean length distributions from 1977 to 1980, or a kind of "synthetic" cohort simulating an equilibrium situation.

The input values assumed were  $E = .5$  (that implies  $F = M$ ) and  $M = .2, .3$  and  $.4$ . The results are given in Table 10.6. For  $M = .2, .3$  and  $.4$ , the rough stock biomass estimates, obtained by multiplying the number at length by the mean weight at length, are in the range of 160 000 - 300 000 tonnes, respectively.

## 11. MANAGEMENT CONSIDERATIONS

The coordinated acoustic assessment surveys in 1981 indicate an adult stock size spawning west of the British Isles in the range of 5.7 - 8.7 million tonnes compared to 6 million tonnes in 1980. In addition to this, there is some spawning along the southern shelf edge of Porcupine Bank, southwest of Iceland, probably in some years in the southern part of the Norwegian Sea and also in the Norwegian fjords. There is no quantitative information to indicate the size of the spawning stock in these other areas but it is felt that if added it would not significantly change the present spawning stock size estimate.

The catch and effort data provided to the meeting give conflicting evidence on the stock size fluctuations. In the Norwegian Sea fisheries, the Polish and German Democratic Republic's large vessel class (2 000 - 3 999.9 GRT) have slightly increased cpue from 1978-1980 and so have the same USSR ships in the same class from 1979 to 1980. On the other hand, the Faroese vessels fishing at the Faroes in May have had a continuous declining catch rate from 17.6 tonnes/hour in 1977 to 6.2 tonnes/hour in 1980. The same trend, however, was not experienced by the same vessels fishing in Divison VIa in April in the same years.

During the period with escalating catches (1975-1979), there has probably been a learning factor involved with regard to behaviour of the fish, migration pattern, trawling speed, in addition to improvements in the gears, which to a certain extent might have masked any reduction of the availability of blue whiting. The Working Group felt, however, that any major decrease in the availability or stock abundance should have been apparent in the acoustic stock size estimates and more consistently in the cpue data. This is consistent with the conclusion from acoustic surveys that the stock size has not changed significantly from 1980-1981.

As stated earlier, the variation in age readings and other considerations make any estimate of the exploitation pattern very difficult and various VPA runs calibrated to a certain spawning stock size will result in a variety of total stock size estimates depending on what exploitation pattern was assumed. A consequence of this is that it is not possible to calculate yield per recruit curves with any confidence. Consequently, the Working Group can only at present, as last year, advise caution as far as any expansion of this fishery is concerned. Furthermore, as last year, the Working Group draws attention to the similarities between this fishery and the fishery for Atlanto-Scandian herring. It is also a fact that no fishery on a single long-lived pelagic stock unit in the Northeast Atlantic has been sustained for any prolonged period with annual catches significantly in excess of 1 million tonnes.

Until better data are available, the Working Group therefore recommends that the fishery should be stabilized at the present level.

## 12. FUTURE RESEARCH RECOMMENDATIONS

1. Since no acoustic survey of the blue whiting population in the Southern area has been carried out since the last meeting, there is still a need for such a survey. It is therefore recommended that a survey of Division VIIg-k and Sub-areas VIII and IX should be carried out during the period January-March to determine the size of the spawning population in these areas. During the survey, material should be collected to determine whether this population constitutes a separate stock from that in areas further north.
2. As discussed in Section 7.1.4, an ICES-coordinated acoustic survey should be carried out in the Norwegian Sea in the period July-August 1982. For this purpose, an organising committee should be formed under the convenership of T. Monstad.
3. A coordinated acoustic survey should be carried out in the spawning area west of the British Isles during the period March-April 1982 to estimate the spawning stock biomass. This survey should be supplemented by surveys in other likely spawning areas.
4. Since the recent otolith exchange has shown a low level of agreement between readers, no reliability can be placed on any assessments dependent on age composition data. For this reason, it is essential that a further meeting of otolith readers should take place.

5. To provide an additional basis for assessment of the blue whiting stock in future, as set out in the report of the Working Group on the Use of Effort Data, the Blue Whiting Assessment Working Group recommends that all countries involved in blue whiting fisheries should supplement their catch age composition data for each fishery with associated effort data.

#### REFERENCES

- ANON, 1980. Report of the Blue Whiting Assessment Working Group. ICES, C.M.1980/H:5.
- JONES, R., 1974. Assessing the long-term effects of changes in fishing effort and mesh size from length composition data. ICES, C.M.1974/F:33.
- NAKKEN, O. and OLSEN, K., 1977. Target strength measurements of fish. Rapp.p.-v.Réun.Cons.int.Explor.Mer, 170:52-69.
- ZAFERMAN, M.L., ZILANOV, V.K., ISAEV, N.A., KUZNETSOV, V.N. and SCHLEINIK, V.N., 1980. Assessment of blue whiting stocks and prospects of their fishery in the Norwegian Sea. ICES, C.M.1980/H:18.
- ZILANOV, V.K., 1968. Occurrence of Micromesistius poutassou (Risso) larvae in the Norwegian Sea in June 1961. Rapp.p.-v.Réun.Cons.int. Explor.Mer., 158:122-125.

Table 2.1 Landings (t) of blue whiting from the main fisheries 1970-1980

Area	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980*
Norwegian Sea Fishery (Sub-Areas I+II and Divisions Va, XIVa + XIVb)	14 807	35 219	625	878	146	6 746	3 436	57 250	236 124	737 546	767 224
Spawning Fishery, (Divisions Vb, VIa, VIb and VIIb,c)	354	18 394	15 396	15 027	15 207	30 335	81 200	135 364	227 382	287 674	257 944
Icelandic Industrial Fishery (Division Va)			12	2 833	4 230	1 294	8 220	5 838	9 484	2 500	-
Industrial Mixed Fishery (Divisions IVa-c, IIIa)	-	600	27 959	56 826	62 197	39 765	28 251	37 945	97 145	62 623	81 815
Southern Fishery (Sub-areas VIII+IX, Divisions VIId, e + VIIg-k)	22 788	21 386	33 503	27 452	25 733	31 715	35 035	30 264	32 974	26 215	29 944
Total	37 949	75 599	77 495	103 016	107 513	109 855	156 142	266 661	603 109	116 558	1 136 927

\*Preliminary.

Table 2.2 Landings (t) of Blue Whiting from the Norwegian Sea (Sub-areas I and II, Divisions Va, XIVa and XIVb) fisheries 1970-80

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 <sup>1)</sup>
Faroes	-	-	-	-	-	-	-	593	2810	762	482
German Dem. Rep.	-	-	3	-	-	-	90	2031	7301	22502	14294
Germany, Fed. Rep. of <sup>2)</sup>	-	-	-	3	2	35	33	7028	9319	1157	9079
Iceland	-	-	622	60	119	3	569	4768	17756	12428	4562
Norway	-	-	-	-	20	31	837	-	-	30060 <sup>3)</sup>	626
Poland	-	-	-	-	-	-	95	1536	5083	4346	11307
UK, (England & Wales)	-	-	-	-	-	-	60	165	11	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-	32	-
USSR	14807	35219	-	815	5	6677	1752	41129	193844	666259	726874
Total	14807	35219	625	878	146	6746	3436	57250	236124	737546	767224

1) Preliminary

2) Including catches off the south-east coast of East Greenland (Division XIVb), (327 t in 1977, 897 t in 1978, 204 t in 1979 and 8784 t in 1980).

3) Including purse seine catches of 29162 tonnes of juvenile Blue Whiting.

Table 2.3 Landings (t) of the blue whiting from the Spawning Fishery  
(Divisions Vb, VIa, b, and VIIb, c.) 1970-80.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 <sup>1)</sup>
Denmark	-	-	-	-	-	-	-	18745	23498	21200	19242
Faroes	-	-	-	1155	1527	-	12826	29096	39491	38907	35082
German Dem. Rep.	-	-	-	-	-	-	4971	1094	1714	172	181
Germany, Fed. Rep. of	-	-	-	-	2655	-	85	3260	6363	3304	633
Iceland	-	-	-	319	-	-	-	5172	7537	4864	5375
Ireland	-	-	-	-	-	-	160	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	1172	154	-
Norway	-	-	651	2445	3247	7301	24691	36791	114969	186737	143697
Poland	-	-	-	-	116	4704	10950	3996	2469	4643	-
Spain	-	-	6955	6571	6484	8153	5910	183	14	-	-
Sweden	-	-	-	-	-	-	-	6391	6260	-	3005
UK (England & Wales)	-	-	-	-	-	455	341	1475	5287	4136	3878
UK (Scotland)	-	-	-	-	-	279	1488	3001	1599	1466	6819
USSR	354	18394	7790	4537	1178	9443	19778	26160	17009	22091	40032
Total	354	18394	15396	15027	15207	30335	81200	135364	227382	287674	257944

1) Preliminary.

Table 2.4 Landings (t) of blue whiting from the Icelandic mixed industrial trawl  
fisheries Division Va 1970-79.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Iceland	-	-	12	2833	4230	1294	8220	5838	9484	2500	-

Table 2.5 Landings (t) of blue whiting from the Mixed Industrial Fisheries and caught as by catch in ordinary fisheries in the North Sea (Divisions IV a-c and IIIa).

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 <sup>1)</sup>
Denmark	-	-	-	-	-	-	-	16071	54804	28932	48159
Faroes	-	-	-	3714	2610	428	1254	-	1177	1489	1925
German Dem.Rep. <sup>2)</sup>	-	-	-	-	-	-	-	-	988	49	-
Germany, Fed. Rep. of <sup>2)</sup>	-	-	-	-	-	-	-	76	1514	13	400
Norway	-	-	27609	50835	59151	38020	26827	20293	37260	30220	30428 <sup>3)</sup>
Poland <sup>2)</sup>	-	-	-	-	55	-	45	838	601	-	-
Spain <sup>2)</sup>	-	-	350	350	318	195	47	-	-	-	-
Sweden <sup>4)</sup>	-	-	-	-	-	-	-	639	648	1249	901
UK (England & Wales) <sup>2)</sup>	-	-	-	-	-	-	-	3	+	-	-
UK (Scotland)	-	-	-	-	-	414	58	25	153	37	2
USSR <sup>2)</sup>	-	600	-	1927	63	708	20	-	-	634	-
Total	-	600	27959	56826	62197	39408	28251	37945	97145	62623	81815

1) Preliminary.

2) Reported landings in human consumption fisheries.

3) Including mixed industrial fishery in the Norwegian Sea.

4) Reported landings assumed to be from human consumption fisheries.

Table 2.6 Landings (t) of blue whiting from the Southern Areas. (Sub-areas VIII and IX and Division VII g-k and VII d, e.)

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980 <sup>1)</sup>
German, Dem. Rep.	-	78	-	-	-	-	-	-	-	-	-
Germany, Fed. Rep. of	-	-	-	-	-	-	-	-	25	-	-
Ireland	-	-	-	-	-	-	-	-	-	1	-
Netherlands	-	-	-	-	-	-	-	-	7	-	31
Poland	-	-	-	-	170	-	385	169	53	-	-
Portugal	-	-	-	-	-	-	-	1557	2381	2096	6051
Spain <sup>2)</sup>	16360	11800	28090	26741	24627	30790	29470	24800	30504	24055	23862
UK (England & Wales)	-	-	-	-	-	-	-	+	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-	63	-
USSR	6428	9508	5413	711	936	925	5180	3738	4	-	-
Total	22788	21386	33503	27452	25733	31715	35035	30264	32974	26215	29944

1) Preliminary.

2) Significant quantities taken in Division VII g-k not included in the Table are discarded every year.



Table 4.1 Distribution of differences between highest and lowest age determination of the same otolith in the otolith exchange programme

Difference No. of years	0	1	2	3	4	5	6	7	8	9	10	Total
No. of otoliths	0	0	4	9	16	22	19	13	13	3	1	100

Table 4.2 Calculated mean age in the otolith sample used in the otolith exchange programme by reader

Reader No.	1	2	3	4	5	6	7	9	10	11	12
Mean age	7.9	10.1	8.6	9.4	10.6	7.0	8.4	6.3	9.7	8.1	9.2*

\* only the photographed otoliths

Table 4.3 Calculated mean age in the otolith sample after standardizing for interpretation of the nucleus and the edge

Reader No.	1	2	3	6	7	9	12
Photographs	8.0	9.1	7.5	7.4	7.9	6.6	8.2
All otoliths	7.9	9.1	7.6	7.0	8.4	6.3	

Table 4.4 Catch in number (millions) by age group in the adult fisheries

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980*
0		16.5	0.7	3.0		2.0					
1	0.4	11.3	0.4	6.0	0.6	2.3	4.8			68.1	58.4
2	14.6	17.5	5.8	4.6	6.0	5.3	13.9	45.0	63.5	160.3	334.4
3	20.3	54.8	13.5	8.2	5.0	30.3	25.6	89.1	69.1	312.3	370.1
4	24.5	75.1	22.0	12.0	16.4	28.2	57.9	167.4	346.0	445.6	404.6
5	28.5	87.8	28.4	15.7	22.1	26.6	28.5	188.0	437.9	457.1	487.1
6	17.5	73.6	27.8	15.0	17.6	36.2	55.6	156.8	484.9	554.9	539.5
7	11.9	59.0	21.2	20.0	15.7	34.8	73.4	140.1	530.4	721.8	734.9
8	7.3	36.8	19.1	9.0	16.0	28.5	61.2	180.0	476.5	874.5	784.6
9	4.7	19.8	6.0	12.8	3.9	29.2	69.3	122.6	366.5	796.3	606.9
10	1.7	12.7	2.7	11.0	4.7	14.6	77.5	135.1	308.7	769.3	1009.3
11	0.4	4.7	1.3	8.9	4.0	13.7	32.1	112.4	157.9	456.5	398.6
12		1.9	0.5	5.7	3.0	11.8	39.0	57.6	122.1	346.1	394.6
13		0.5		2.7	1.7	7.7	20.0	18.6	50.5	137.9	66.7
14				1.1	0.8	4.9	10.4	13.8	20.6	67.2	64.6
15+				1.0	1.1	3.7	6.6	7.0	16.1	38.4	4.6
Total	131.8	472.0	149.4	136.7	118.6	279.8	575.8	1433.5	3450.7	6206.2	6259.0
Tonnes	15162	63721	21814	21517	16730	39183	89928	197402	466262	995503	1026461

\* Preliminary

**Table 4.5** Catch in number (millions) by age group in the mixed industrial fisheries.  
Sub-area IV and Division Va.

Age	1972	1973	1974	1975	1976	1977	1978	1979 <sup>1)</sup>	1980*
0	1066.4	1748.0	376.9	746.3	102.7	408.5	870.3	2.3	24.9
1	98.7	336.2	476.9	206.4	682.8	448.5	950.6	1795.2	295.8
2	48.2	44.7	48.4	67.0	79.1	106.1	153.2	76.1	353.5
3	5.7	20.7	12.9	25.9	29.6	32.3	81.6	31.2	80.2
4 +	1.7	11.5	7.5	12.9	18.0	30.3	67.3	21.5	24.2
5								17.5	31.2
6								20.1	24.7
7								10.5	31.5
8								8.5	28.7
9								13.5	16.3
10								6.0	14.8
11								1.0	6.9
12								4.2	2.0
13									2.4
14									1.6
15 +									0.4
Total	1220.7	2161.1	922.6	1058.5	912.2	1025.7	2123.0	2007.6	939.1
Tonnes	27621	57382	65991	39796	37075	42202	102725	92174	80508

\*Preliminary.

1) Includes purse seine catches of 29162 tonnes of juvenile blue whiting taken in the southern Norwegian Sea (see Table 2.2).

Table 4.6 Catch in number (millions) of blue whiting in the Norwegian Sea, Spawning fishery and Industrial fishery (grand total)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980*
0		16.5	1067.2	1751.0	376.9	748.4	102.6	408.5	870.3	2.3	24.9
1	0.4	11.3	99.2	342.2	477.5	208.7	687.6	448.5	950.6	1863.3	354.2
2	14.6	17.5	54.0	49.4	54.4	72.3	93.0	151.1	216.7	236.4	687.9
3	20.3	54.8	19.1	28.9	18.0	56.2	55.1	121.4	150.7	343.5	450.3
4	24.5	75.0	23.7	23.5	23.9	41.0	75.9	197.7	413.3	467.2	428.8
5	28.5	87.8	28.4	15.6	22.1	26.6	28.5	188.0	437.9	474.6	518.3
6	17.5	73.6	27.8	15.0	17.6	36.2	55.6	156.8	484.9	575.0	564.2
7	11.9	59.1	21.2	20.1	15.7	34.8	73.4	140.1	530.4	732.2	766.4
8	7.3	36.8	19.1	9.0	16.0	28.5	61.2	180.0	476.5	883.0	813.3
9	4.7	19.8	6.0	12.8	3.9	29.2	69.3	122.6	366.5	809.8	623.2
10	1.7	12.7	2.7	11.0	4.7	14.6	77.5	135.1	308.7	775.3	1024.1
11	0.4	4.7	1.3	8.9	4.0	13.7	32.1	112.4	157.9	457.5	405.5
12		1.9	0.4	5.7	3.0	11.8	39.0	57.6	122.1	350.4	396.6
13		0.5		2.7	1.7	7.7	20.0	18.6	50.4	137.9	69.1
14				1.1	0.8	4.9	10.5	13.8	20.6	67.2	66.2
15+				1.0	1.1	3.7	6.7	7.0	16.2	38.4	5.1
Total	131.8	472.0	1370.1	2297.9	1041.3	1338.3	1488.0	2459.2	5573.7	8213.9	7198.1
Tonnes	15162	63721	49435	78899	82721	78979	127003	239604	568987	1087677	1106843

\*Preliminary.

Table 5.1 Mean weights at age (g) by country, ICES Division and quarters of the year for 1980.

Norwegian Sea Fisheries

Country	USSR	POLAND	GDR	NORWAY	USSR	POLAND	GDR	NORWAY	USSR	USSR	NORWAY	USSR	NORWAY	NORWAY	NORWAY	NORWAY	FRG	NORWAY
ICES Div.	IIa	IIa	IIa	IIa	IIa	IIa	IIa	IIa	IIa	IIb	IIb	IIb	IIb	Va	Va	XIV	XIV	XIV
Quarters of the year	I	II	II	II	III	III	III	III	IV	II	III	IV	IV	IV	III	III	III	IV
0																		
1	79	80	65	83	116	96	71	85	121	135	138	113	200	83	135	152	137	152
2	75	90	87	107	136	120	118	135	129	153	174	113	200	135	155	171	152	183
3	77	105	108	138	142	137	140	169	153	188	209	164	209	155	188	181	193	189
4	101	111	132	141	147	156	164	179	196	119	225	157	239	185	241	206	226	188
5	143	136	142	161	163	174	176	182	228	-	220	-	242	203	239	205	245	201
6	154	153	151	161	180	185	188	192	232	167	222	246	239	225	266	220	263	190
7	167	172	162	168	186	192	186	191	248	203	231	261	232	241	268	223	284	191
8	174	178	163	192	196	201	179	203	264	201	242	234	234	241	254	229	300	195
9	191	200	172	173	200	212	189	203	282	226	245	256	253	273	255	224	295	168
10	97	207	165	206	201	218	168	192	253	212	210	256	263	261	-	280	354	205
11	251	216	190	204	202	236	211	191	270	195	283	287	289	240	245	220		
12+																		

continued...

Table 5.1 (continued)

## Mixed industrial fisheries

Country	NORWAY			
	IIIIa	IV	IV	IV
ICES Div.				
Quarters of the year	I	II	III	IV
0	-	-	26	29
1	26	35	67	64
2	78	75	125	98
3	108	102	149	136
4	141	129	173	169
5	145	137	187	237
6	162	156	190	230
7	239	173	201	224
8	275	180	194	247
9	269	189	208	245
10	283	201	196	239
11	192	205	188	272
12	-	184	188	279

## Spawning area

Country	USSR	FRG	NORWAY	USSR	SCOTLAND	FAROEES
ICES Div.	Vb	Vb+Vla	Vb, VI, VIIb,c	Vb	Vb, VIa	Vb
Quarters of the year	I Jan.	I March	II Apr.-May	II Apr.	II Apr.-May	II Apr.-May
0	-	-	-	-	-	-
1	-	-	40	-	34	-
2	-	101	74	-	70	71
3	90	115	99	-	98	82
4	81	148	118	-	111	98
5	117	165	141	121	125	128
6	173	169	150	104	132	125
7	159	183	158	128	140	137
8	180	187	164	149	138	136
9	200	197	175	151	159	147
10	216	204	179	162	135	152
11	289	220	193	167	159	156
12	239	-	201	200	146	178

Table 5.2 Overall mean weight at age (g) for 1980

Age	Spawning Area	Norwegian Sea	North Sea Mixed fishery	Weighted mean
0	-	-	27	027
1	40	-	35	036
2	74	100	79	079
3	95	115	107	107
4	115	125	141	122
5	139	131	149	135
6	144	151	167	149
7	154	168	182	165
8	157	180	189	176
9	168	188	199	186
10	168	200	206	199
11	179	204	202	202
12+	190	208	197	207
Weighted mean	126	182	85	154

Table 7.1 Age composition in numbers in two samples of BLUE WHITING taken in April-May 1980 on the USSR survey.

Area	Age, Years														No. of specimens
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
South-eastern Norwegian Sea	2	7	8	19	7	18	14	12	10	2	1	-	-	-	100
East of Faroe Islands	-	-	-	2	1	10	7	13	37	14	9	4	2	1	100



Table 7.2 Abundance and biomass estimates of BLUE WHITING  
in April-May 1980 on the USSR survey.

Area	Sq. miles	Number of Spec., x 10 <sup>-6</sup>	Mean weight g	Biomass t
South-eastern Norwegian Sea	473.5	918.73	126.3	115 760
West of the Faroe Islands	3 614.5	2 547.58	86.2	219.602
East of the Faroe Islands	4 123.0	3 050.0	156.5	477 324
TOTAL	8 211.0	6 516.31		812 686

Table 7.3 Catch per unit effort in the BLUE WHITING fisheries, 1976-1980. (Fishing gear: midwater trawl).

Country	GRT class	Division Sub-division	Time period	Y E A R										Effort units
				1976		1977		1978		1979		1980		
				Catch Effort	CPUE	Catch Effort	CPUE	Catch Effort	CPUE	Catch Effort	CPUE	Catch Effort	CPUE	
Faroes	500- 999.9	V1a	April			$\frac{1\ 149}{66}$	17.4	$\frac{4\ 980}{252}$	19.8	$\frac{10\ 194}{477}$	21.4	$\frac{12\ 055}{737}$	16.4	hours
		Vb	May			$\frac{8\ 346}{474}$	17.6	$\frac{7\ 060}{523}$	13.4	$\frac{12\ 553}{1\ 187}$	10.6	$\frac{3\ 525}{565}$	6.2	hours
Iceland	500- 999.9	Vb <sub>1</sub>	May			$\frac{5\ 172}{93}$	55.6	$\frac{7\ 537}{131}$	57.5	$\frac{4\ 798}{142}$	33.8	$\frac{5\ 875}{124}$	43.3	days
		Va	Jul-Aug			$\frac{4\ 197}{54}$	77.7	$\frac{16\ 523}{186}$	88.9	$\frac{12\ 428}{202}$	61.5	$\frac{4\ 361}{153}$	28.5	days
Poland	2 000- 3 999.9	Vb	Mar-Jul	$\frac{5\ 519}{201}$	27.5	$\frac{1\ 742}{48}$	36.3	$\frac{591}{31}$	19.1	$\frac{2\ 250}{44}$	51.1			days
		IIa	May-Dec					$\frac{4\ 763}{303}$	15.7	$\frac{4\ 324}{173}$	25.0	$\frac{11\ 137}{510}$	21.8	days
German Dem.Rep	2 000- 3 999.9	IIa	Jun-Nov					$\frac{903}{347}$	2.60	$\frac{6\ 198}{2\ 281}$	2.71	$\frac{13\ 832}{4\ 322}$	3.20	hours
USSR	2 000- 3 999.9	IIa, Vb	Jan-Dec							$\frac{665\ 453}{16\ 310}$	40.8	$\frac{730\ 689}{17\ 608}$	41.5	days
										211 254	3.15	214 375	3.41	hours

Table 9.1 BLUE WHITING cruises in 1980.

Period	Ship	Nationality	Area	Main objective
10.1 - 10.3 March*)	Chartered vessels "Noruega"	Faroes	Faroeese waters	Explor.fishing, acoustic surveys
13.3 - 11.4*)	"Anton Dohrn"	Portugal	Southern area (IXa)	Demersal fish survey
2.4 - 22.4	"Scotia"	Germany, Fed.Rep.	W of the Br. Isles, SW of Ireland	Ground fish survey, egg and larval survey
8.4 - 14.5	"G O Sars"	United Kingdom	W of the Br. Isles	Acoustic survey (spawning stock)
10.4 - 1.6	"J C Svabo"	Norway	W of the Br. Isles	Acoustic survey of the spawning stock
20.4 - 5.5	"Poisk"	Faroes	Faroes	Acoustic survey (post-spawning migration)
30.4 - 22.5 May-June*)	"Eisbär"	USSR	Faroes, SW Norwegian Sea	Acoustic survey, biol. sampling
1.5 - 15.5	"Noruega"	German Dem.Rep.	Norwegian Sea	Acoustic survey, biol. invest.
18.5 - 15.6	"Michael Sars"	Portugal	Southern area	Demersal fish survey
8.6 - 20.6	"B Uhse", "W Bredal"	Norway	Northern Norway, Bear Island	Acoustic survey, groundfish and blue whiting
15.5 - 19.7*)	Chartered vessel	German Dem.Rep.	Norwegian Sea	Expl. fishing, acoustic survey
20.5 - 6.7*)	"Akill"	Norway	Fjords of W. Norway	Eggs, larvae and O-group survey
June	"Andromeda"	USSR	Norwegian Sea	Oceanographic survey
9.6 - 4.10	"A Fridriksson"	USSR	Norwegian Sea	Oceanographic survey
1.8 - 15.8	"Pegaz"	Iceland	E-Icelandic waters	Acoustic survey
4.8 - 11.9*)	"Poisk"	Poland	Norwegian Sea	Expl.fishing, biol. invest.
28.8 - 27.10	"G O Sars", "Michael Sars" and "Johan Hjort"	USSR	NE-Norwegian Sea	Acoustic survey, biol. sampling
	Chartered trawler	Norway	Norwegian Sea, Iceland, E-Greenland Barents Sea	O-group survey
		Germany, Fed.Rep.	W of the Br. Isles SW of Ireland	Expl. fishing, biol. invest.

cont'd.

Table 9.1 (continued)

Period	Ship	Nationality	Area	Main objective
Sept. - Oct.	"Hafthor"	Iceland	SE of Iceland Dohrn Bank	Expl. fishing, biol. invest.
10.9 - 9.10	"Michael Sars"	Norway	Spitsbergen Bear Island	Acoustic survey, groundfish, blue whiting
4.10 - 3.11*)	"Cornide de Saavedra"	Spain	Southern area	Demersal fish survey
October*)	"Noruega"	Portugal	Southern area	Demersal fish survey
1.11 - 14.11	"Michael Sars"	Norway	Norwegian Shelf from 62° - 68°N	Acoustic survey
5.11 - 28.11*)	"G O Sars"	Norway	North Sea	Acoustic survey, O-group
20.11 - 30.12	"Slavgorod"	USSR	Norwegian Sea	Behaviour and biol. sampling

\*) Blue whiting as subsidiary objective

Table 9.4 BLUE WHITING cruises in 1981.

Period	Ship	Nationality	Area	Main objective
Jan-Mar	Chartered vessels	Faroese	Faroese waters	Expl. fishing
Feb-Mar	"Walther Herwig"	Germany, Fed.Rep.	W of the Br. Isles Bay of Biscay	Bil.invest.
March*)	"Cornide de Saavedra"	Spain	Southern area	Biol.invest.
Mar-Apr	"Walther Herwig"	Germany, Fed.Rep.	East Greenland, SW of Iceland	Biol. invest., fish processing
March*)	"Noruega"	Portugal	Southern area	Demersal Fish survey
9.3 - 4.4	"G O Sars"	Norway	W of Scotland, Faroes	Acoustic survey
16.3 - 15.4	"Michael Sars"	Norway	W of the Br. Isles	Acoustic survey
25.3 - 14.4	"Scotia"	United Kingdom	W of the Br. Isles	Acoustic survey
1.4 - 10.5	"Perseus III"	USSR	Faroes, Norwegian Sea	Acoustic survey, biol. sampling
15.4 - 30.6	"Korwin"	Poland	W of the Br. Isles	Expl. fishing, biol. invest.
20.4 - 30.6	"Rybak Morski"	Poland	W of the Br. Isles	Expl. fishing, biol. invest.
22.4 - 2.5	"G O Sars"	Norway	W of Norway from 62° - 70° N	Acoustic survey
15.5 - 10.7*)	"Ahill"	USSR	Norwegian Sea	Oceanographic survey
20.5 - 5.7*)	"Andromeda"	USSR	Norwegian Sea	Oceanographic survey
June*)	"Noruega"	Portugal	Southern area	Demersal fish survey
July	"Hafthor"	Iceland	E Iceland	Expl. fishing, biol. invest.
1.7 - 20.8	"Eisbär"	German Dem.Rep.	Norwegian Sea	Acoustic survey, biol. invest.
1.7 - 30.7	"Perseus III"	USSR	Norwegian Sea	Acoustic survey, biol. sampling
13.7 - 29.7*)	"G O Sars"	Norway	North Sea	O-group fish survey
31.7 - 19.8	"G O Sars"	Norway	Norwegian Sea	Acoustic survey
2.8 - 19.8	"Michael Sars"	Norway	Norwegian Sea	Acoustic survey

cont'd.

Table 9.2 (cont'd.)

Period	Ship	Nationality	Area	Main objective
21.8 - 6.9*)	"Michael Sars"	Norway	Spitsbergen, Barents Sea	O-group fish survey
21.8 - 6.9*	"G O Sars"	Norway	Spitsbergen, Barents Sea	O-group fish survey
Autumn	"Magnus Heinason"	Faroes	Norwegian Sea	Acoustic assessment
September *)	"Cornide de Saavedra"	Spain	Southern area	Biol. invest.
Sep-Oct	"Hafthor"	Iceland	Dohrn Bank	Expl. fishing, biol. invest.
7.9 - 11.10*)	"Michael Sars"	Norway	Spitsbergen, Barents Sea	Groundfish, blue whiting
October*)	"Noruega"	Portugal	Southern area	Demersal fish survey
13.10 - 14.11*)	"Michael Sars"	Norway	Norwegian coast from 62° - 70° N	Acoustic survey
4.11 - 2.12*)	"G O Sars"	Norway	North Sea	Acoustic survey
December*)	"Noruega"	Portugal	Southern area	Demersal fish survey

\*) Blue whiting as subsidiary objective.

Table 10.1 Average lengths at age of BLUE WHITING research vessel catches.

Age \ $\bar{L}$ (cm)	Division VIIg-k England (1980)	Division VIII England (1980)	Division VIa Germany, Fed.Rep.(1977)
1	-	15.19	16.53
2	17.33	17.33	22.28
3	20.43	19.50	27.34
4	22.69	20.61	28.68
5	23.36	21.90	31.69
6	28.44*	26.39*	31.66
7			33.26
8			33.89
9			35.28
10+			36.76

\* It is 6+

Table 10.2 Landings (tonnes) in Divisions VIIIc and IXa  
by countries 1966 - 1980.

Year	Spain	Portugal	Total: Divisions VIIIc + IXa
1966	20 648	-	-
1967	21 140	-	-
1968	20 756	-	-
1969	10 300	-	-
1970	16 875	-	-
1971	12 402	-	-
1972	19 916	-	-
1973	18 936	-	-
1974	17 741	-	-
1975	22 272	-	-
1976	18 199	-	-
1977	25 259*	1 557	26 816
1978	30 490*	2 381	32 871
1979	24 055*	2 096	26 151
1980	23 862*	6 051	29 913

\*Data from Vigo I.E.O.



Table 10.3 Length compositions of the landings (Nos.  $\times 10^{-3}$ ) from 1977-1980 for Spain and 1980 for Portugal.

Length (cm)	Divisions VIIIc + IXa						Average 1977-80
	1977 Spain	1978 Spain	1979 Spain	1980			
				Spain	Portugal	Total	
10					307	307	77
11				70	606	676	169
12	0.2		55		140	140	49
13	1 369	11 683	621	112	---	112	3 446
14	10 701	55 459	3 082	922	127	1 049	17 573
15	54 513	128 556	22 664	24 022	1 687	25 709	57 861
16	154 387	198 184	51 523	61 960	5 711	67 671	117 941
17	110 226	225 169	81 850	78 479	14 356	92 835	127 520
18	12 119	162 479	127 911	108 909	29 904	138 813	110 330
19	14 815	82 186	124 803	111 811	27 191	139 002	90 202
20	29 709	43 835	80 588	81 741	23 835	105 576	64 927
21	36 601	21 186	44 919	38 922	15 260	54 182	39 222
22	22 277	10 109	17 526	19 114	4 256	23 370	18 321
23	18 105	9 302	7 808	6 411	1 392	7 803	10 754
24	16 104	3 888	4 524	1 662	562	2 224	6 685
25	9 141	2 817	2 797	1 019	443	1 462	4 054
26	5 486	1 577	1 602	813	239	1 052	2 430
27	1 718	1 205	573	490	263	753	1 062
28	1 137	491	517	493	237	730	719
29	767	304	460	274	185	459	498
30	581	137	302	231	190	421	360
31	105	123	216	97	365	462	227
32	105	8	88	87	505	592	198
33	41	36	62	106	458	564	176
34	---		58	50	458	267	81
35	41		42	43	217	142	56
36			27	44	99	145	43
37			11	16	101	59	18
38			5	23	43	23	7
39			1	11		11	3
40			1	6		6	2
41			-				0
42			0.1				0
No. total ( $\times 10^{-3}$ )	500 048	958 734	574 636	537 938	128 679	666 617	675 011
Total weight (t)	25 259	30 499	24 055	23 862	6 051	29 913	27 000
Average weight (kg)	0.051	0. 033	0.044	0.044	0.047	0.045	0.040

Table 10.4 BLUE WHITING. Length maturity stage distribution (March, 1981).  
Divisions VIIIC and IXa.

Maturity stages Length (cm)	Females								Males							
	I	II	III	IV	V	VI	VII	Total	I	II	III	IV	V	VI	VII	Total
17		1	1	6	4	5		17							20	20
18		13	9	19	22	13		76		18					68	86
19	1	27	24	38	57	32		179	1	57			1		170	229
20	1	32	37	58	56	31	3	218		26	5			4	134	169
21		15	19	28	30	18	13	123	1	5	1			2	74	83
22		4	5	14	15	10	12	60							9	9
23		2	7	3	1	3	2	18							2	2
24			1	1	2	1	2	7							2	2
25				1	1		2	4								
Total	2	94	103	168	188	113	34	702	2	106	6		1	6	479	600

Table 10.5 Catch per hour and its standard deviation on N/I Noruega cruises in random hauls within each stratum along the Portuguese coast.

Month Year	Depth Zone	20 - 100 m		100 - 200 m		200 - 500 m	
		Mean catch rate (kg/h)	Standard deviation	Mean catch rate (kg/h)	Standard deviation	Mean catch rate (kg/h)	Standard deviation
Jun 79 May-Jun 80 Oct 79 Oct 80 Mar 80 Mar 81	41°50'N-40°50'N	.1 .4 .7 4.5 - 0	.06 .25 .42 4.5 - 0	26.8 7.5 23.7 16.3 - .9	21.3 4.0 23.4 13.8 - .9	33.5 236.0 38.5 57.5 - 84.0	.2 174.0 19.0 41.0 - 5.5
Jun 79 May-Jun 80 Oct 79 Oct 80 Mar 80 Mar 81	40°50'N-39°50'N	0 0 0 10.0 - 0	0 0 0 10.0 - 0	74.0 1.0 4.0 11.9 - 10.1	68.0 .4 1.3 8.3 - .6	1.5 3.5 0 22.2 - 2.4	.1 3.5 0 21.6 - .9
Jun 79 May-Jun 80 Oct 79 Oct 80 Mar 80 Mar 81	39°50'N-37°50'N	.6 3.0 16.5 0 0 0	.6 2.7 16.5 0 0 0	7.8 6.0 33.9 10.3 278.7 9.0	5.4 3.7 18.5 8.3 270.9 9.0	30.1 5.1 50.5 654.7 8.7 314.2	26.6 .7 13.5 477.5 1.3 247.2
Jun 79 May-Jun 80 Oct 79 Oct 80 Mar 80 Mar 81	37°50'N-8°45'W	- 0 - 0 0 0	- 0 - 0 0 0	- .1 1.0 0 0 0	- .1 1.0 0 0 0	186.9 69.3 196.2 1010.1 1.5 59.1	96.4 41.4 123.5 752.2 .5 33.2
Jun 79 May-Jun 80 Oct 79 Oct 80 Mar 80 Mar 81	8°45'W-7°25'W	0 0 0 0 0 0	0 0 0 0 0 0	2.4 6.0 0 4.0 0 324.3	2.4 4.5 0 4.0 0 324.3	105.1 42.9 27.2 30.8 .9 100.8	77.0 22.3 4.2 25.3 .9 89.2

Table 10.6 BLUE WHITING in Divisions VIIIc and IXa.  
Cohort analysis by length (Jones, 1974).

Length (cm)	M = 0.2	E = 0.5	M = 0.3	E = 0.5	M = 0.4	E = 0.5
	Numbers in stock ( $\times 10^6$ )	Biomass ( $\text{tx}10^{-3}$ )	Numbers in stock ( $\times 10^6$ )	Biomass ( $\text{tx}10^{-3}$ )	Numbers in stock ( $\times 10^6$ )	Biomass ( $\text{tx}10^{-3}$ )
10	931	7.1	1 105	8.4	1 498	11.5
11	902	9.0	1 055	10.5	1 407	14.0
12	873	11.1	1 005	12.7	1 319	16.7
13	845	13.4	956	15.1	1 234	19.5
14	812	15.8	904	17.6	1 149	22.4
15	766	18.1	840	19.8	1 051	24.8
16	681	19.2	737	20.8	919	25.9
17	539	18.0	580	19.4	736	24.6
18	393	15.4	422	16.6	556	21.8
19	268	12.3	289	13.2	404	18.5
20	168	8.9	183	9.7	283	14.9
21	97	5.9	107	6.5	195	11.8
22	54	3.7	62	4.3	139	9.6
23	33	2.6	40	3.1	108	8.5
24	21	1.9	26	2.3	86	7.6
25	13	1.3	18	1.8	69	6.8
26	8	0.8	12	1.3	57	6.3
27	6	0.6	9	1.1	47	5.8
28	4	0.5	7	1.0	40	5.5
29	3	0.5	5	0.8	33	5.0
30	2	0.3	4	0.7	27	4.5
31	2	0.4	3	0.6	22	4.1
32	1	0.2	3	0.6	17	3.4
33+	2	0.4	5	1.6	34	9.1
Total	7 424	167.4	8 377	189.5	11 430	302.6

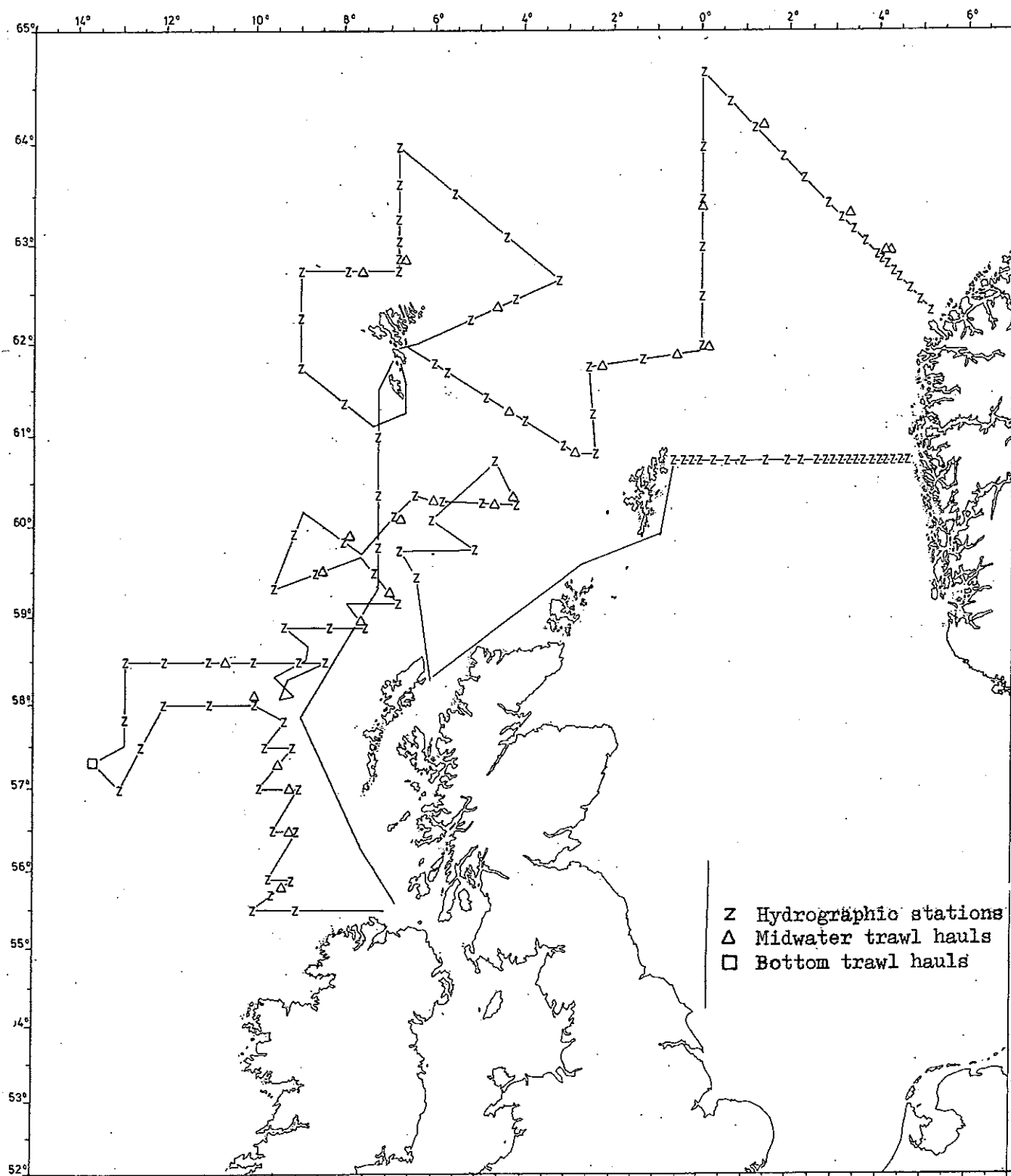


Figure 7.1.a. Cruise track of Norwegian research vessel "G.O. SARS"  
9 March - 4 April 1981.

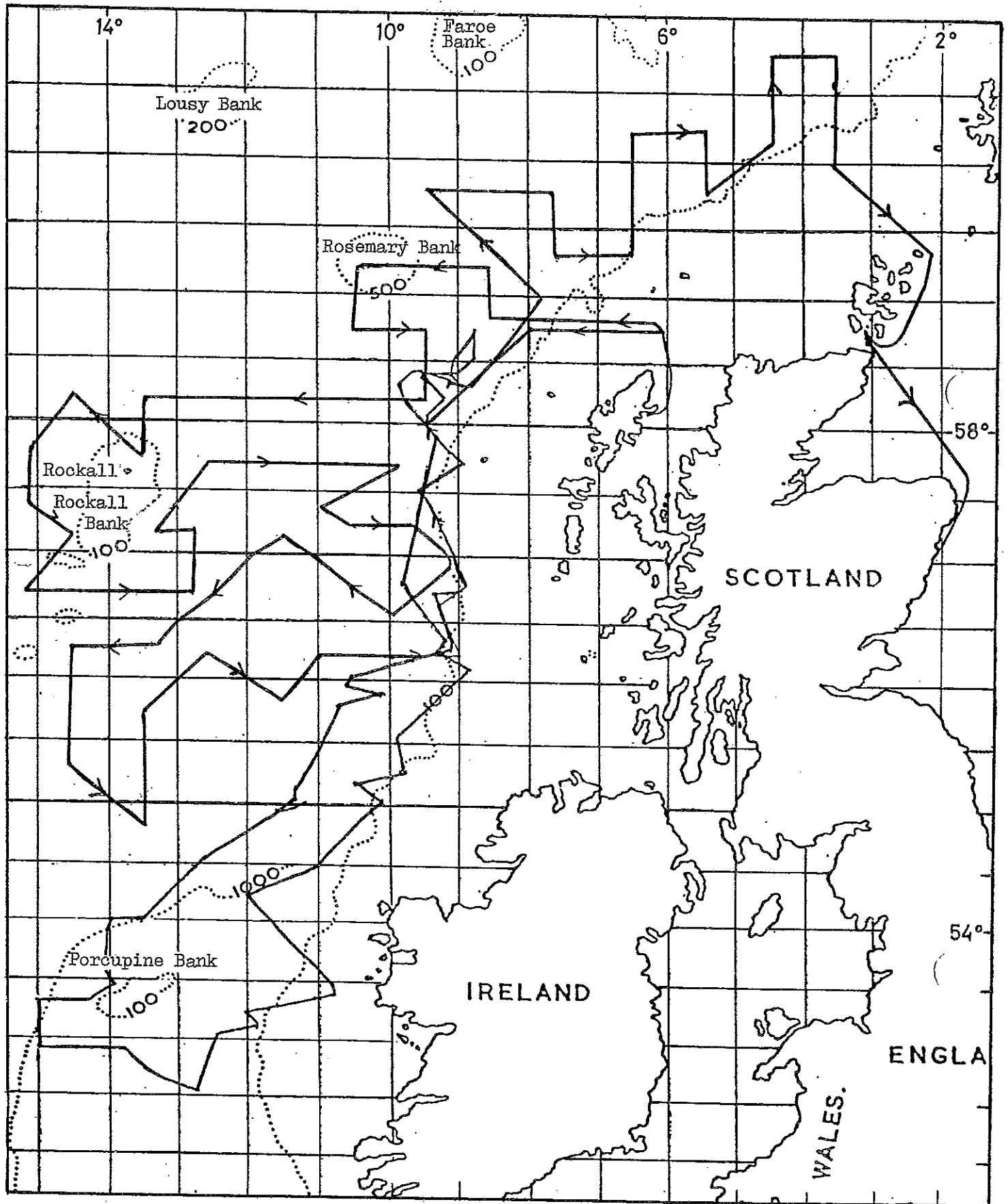
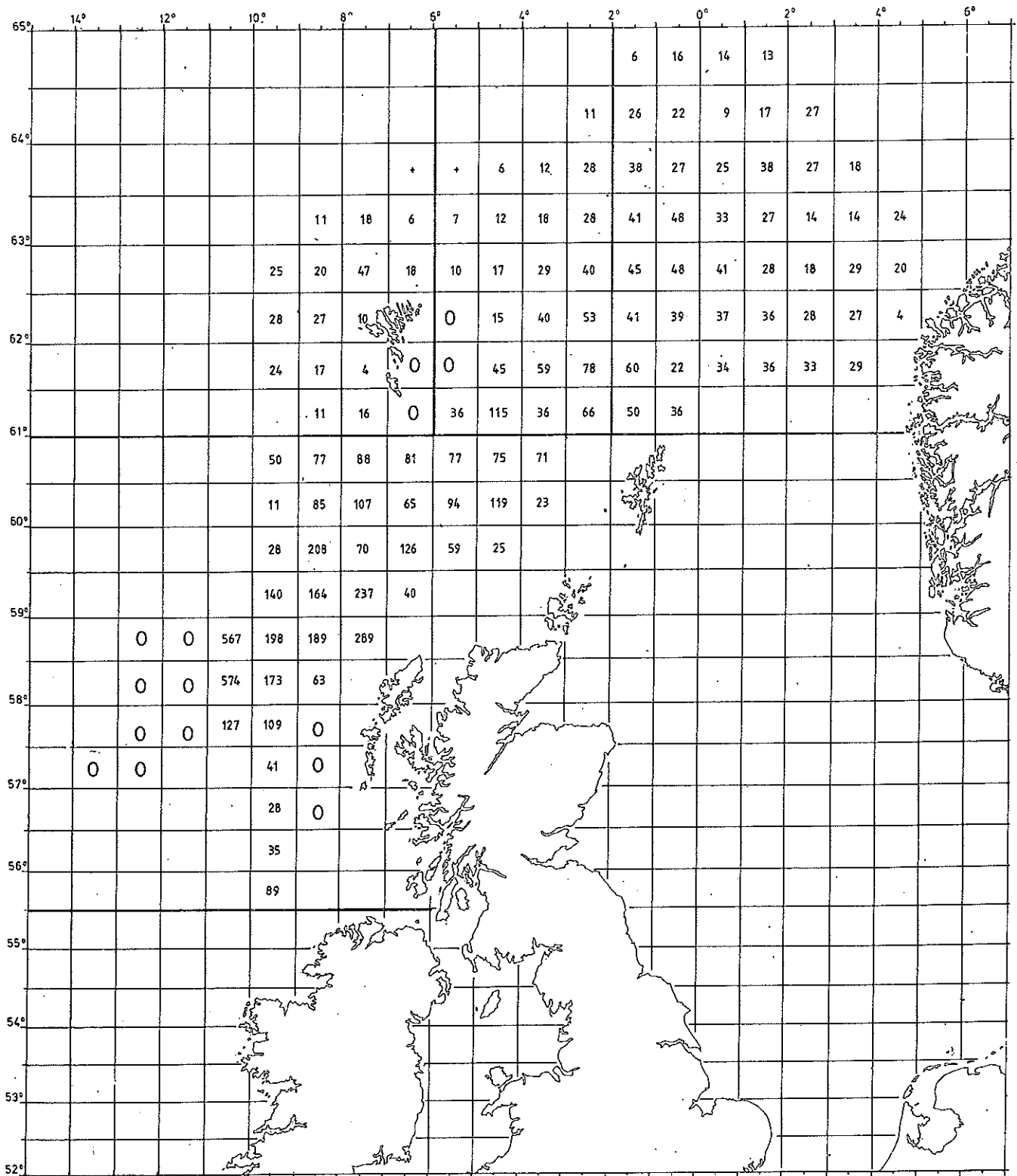


Figure 7.1.b. Cruise track of Scottish research vessel "SCOTIA" 25 March - 14 April 1981.



**Figure 7.2.** Estimated BLUE WHITING biomass ('000 tonnes) in each statistical rectangle on Norwegian survey, 9 March - 4 April 1981.

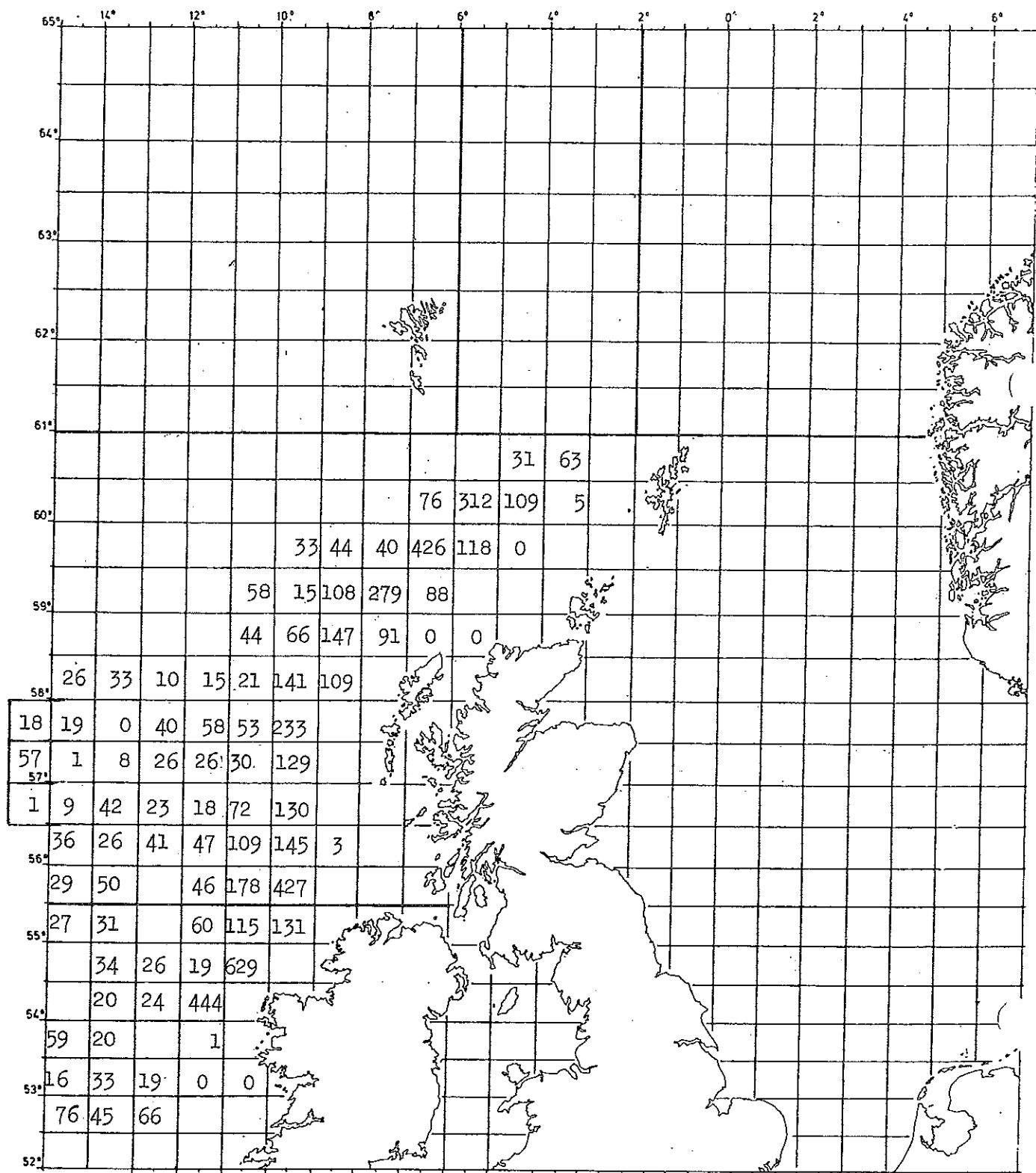


Figure 7.3. Estimated BLUE WHITING biomass ('000 tonnes) in each statistical rectangle on Scottish survey, 25 March - 14 April 1981. (Values corrected refer to target strength and absorption coefficient used on Norwegian survey.)



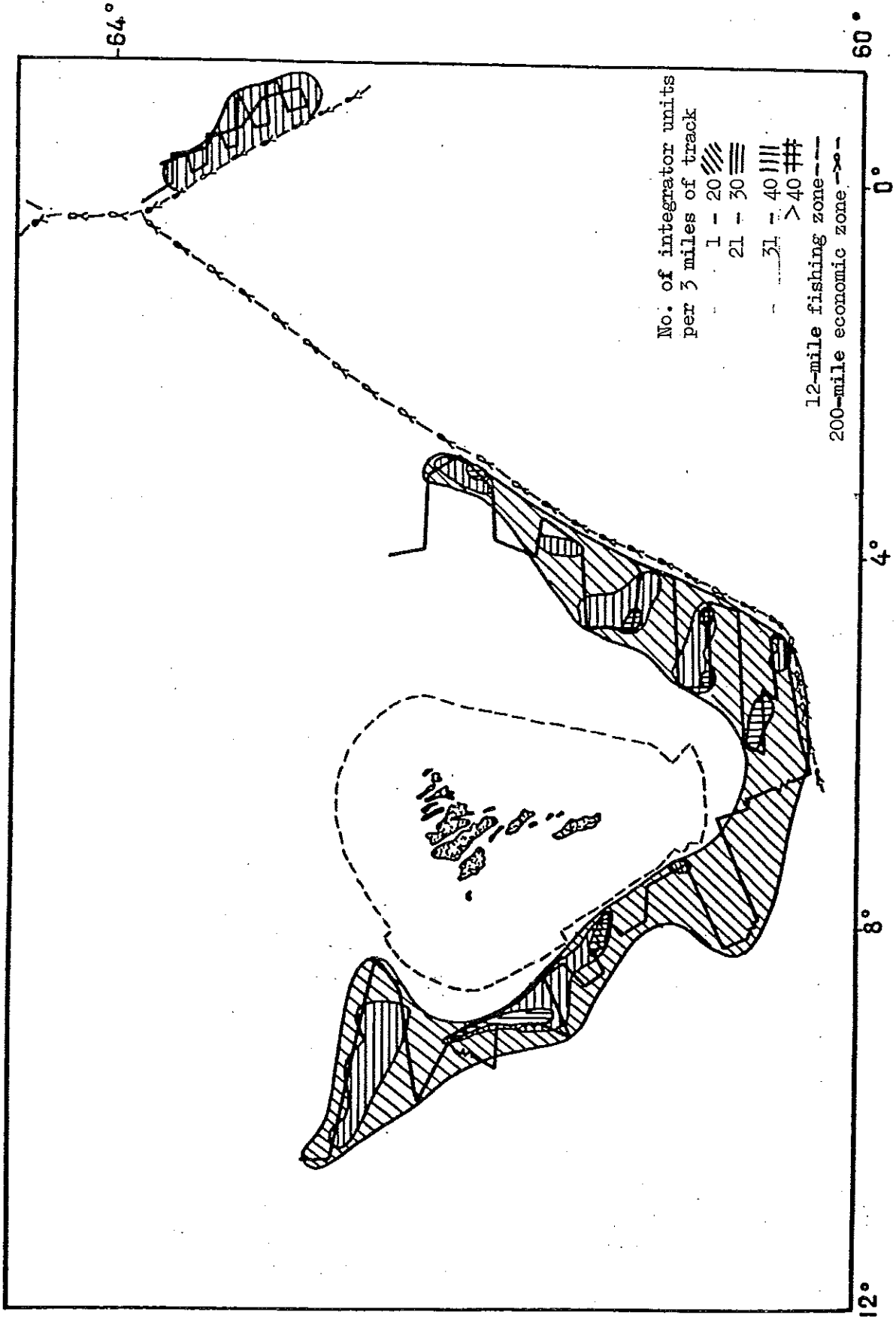
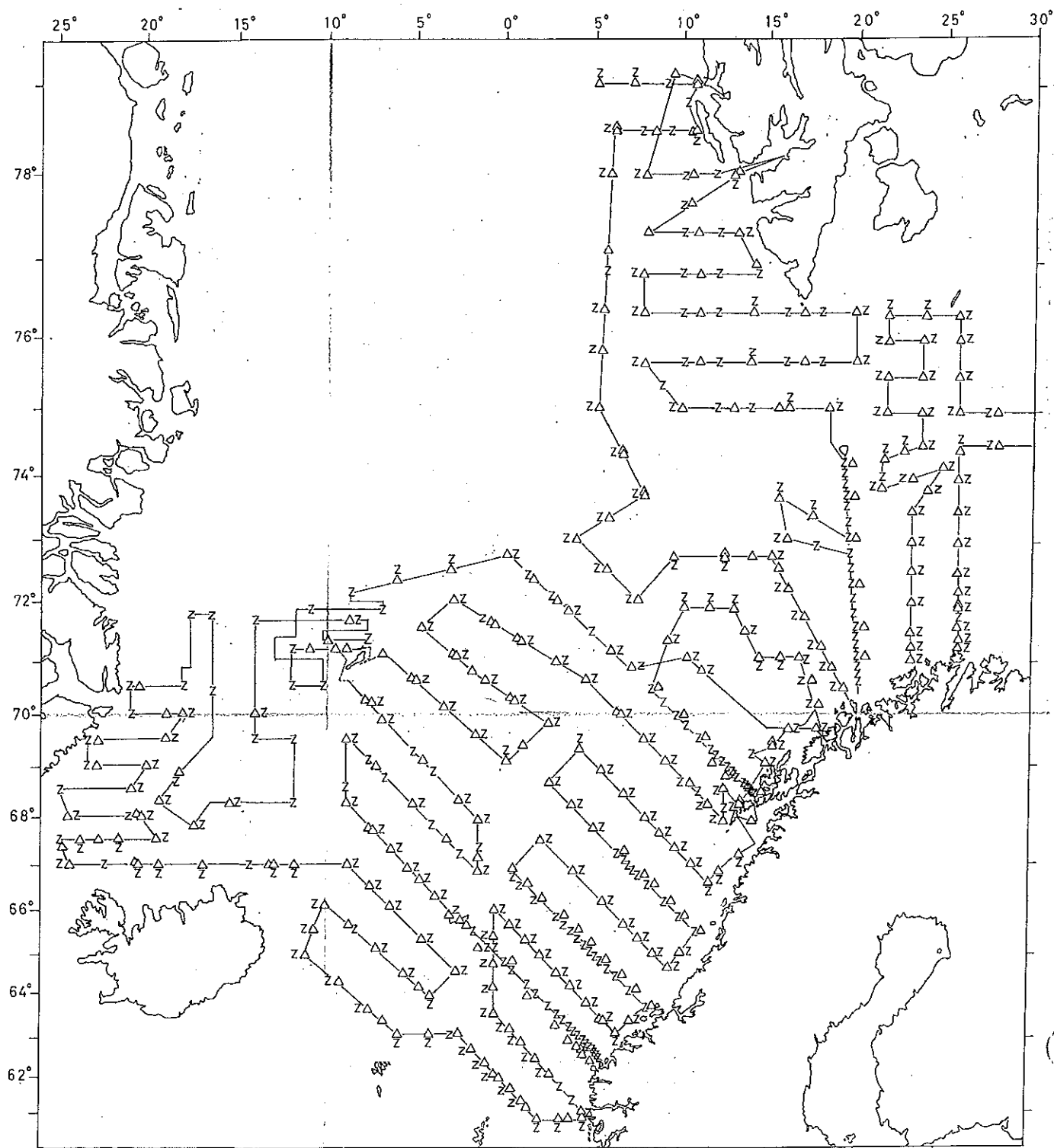


Figure 7.4. Survey track and relative echointegrator densities of BLUE WHITING recorded by the USSR "R.V. POISK", 22 April - 5 May 1980.



Δ Pelagic trawl station  
Z CTD (hydrographic) station

**Figure 7.5.** Cruise tracks and station positions from 4 August - 11 September 1980, R.V. "G.O. SARS", "JOHAN HJORT" and "MICHAEL SARS".

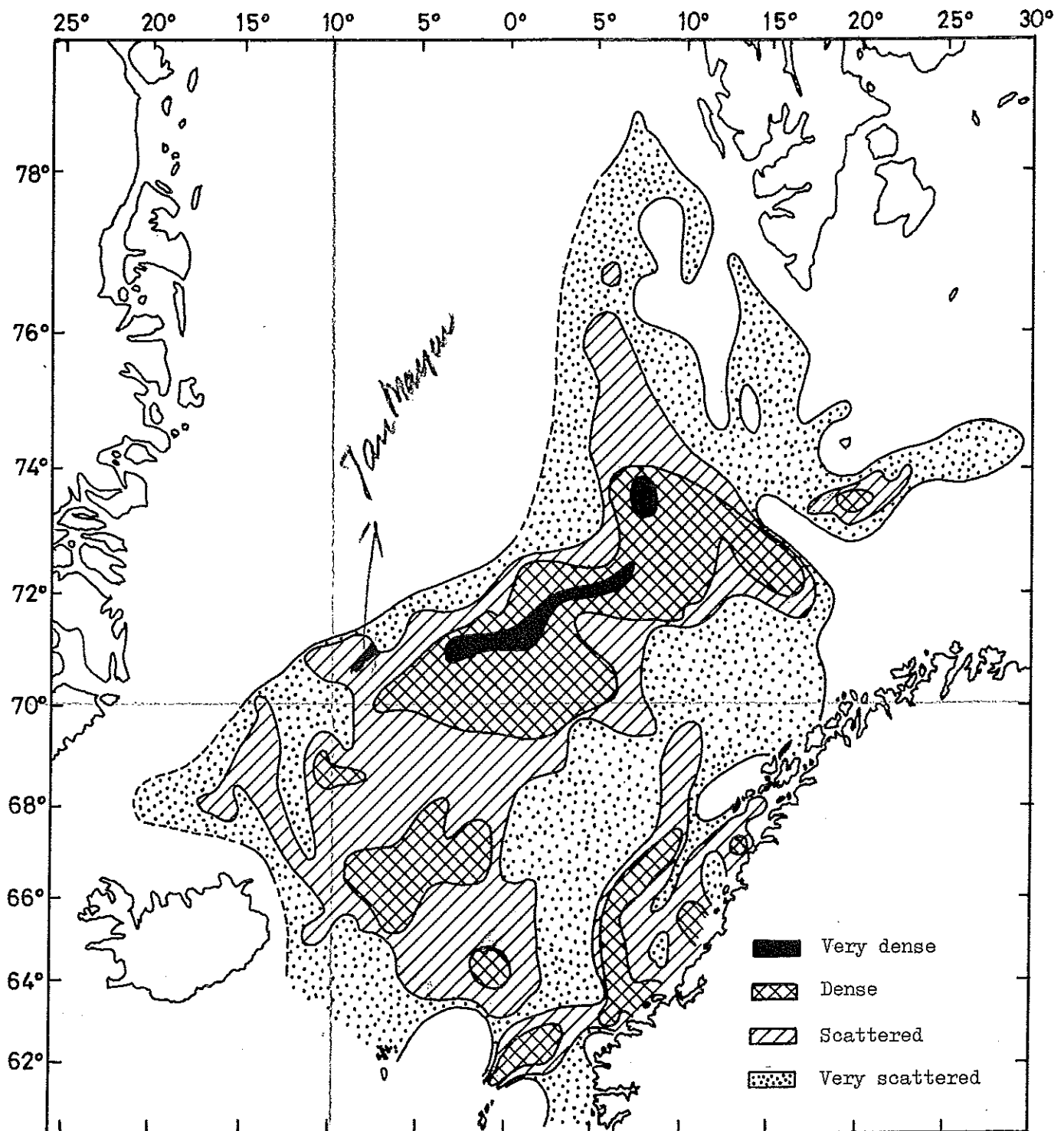


Figure 7.6. Distribution and relative densities of BLUE WHITING recorded from 4 August - 11 September 1980 by three Norwegian research vessels.

