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International Council for the
Exploration of the Sea

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**Report of
the Blue Whiting
Assessment Working Group**

Copenhagen, 15-21 September 1982

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1. INTRODUCTION

1.1. Terms of Reference

The Blue Whiting Assessment Working Group met at ICES headquarters, Copenhagen, 15-21 September 1982. The terms of reference were set by the Council's resolution, passed at its 69th Statutory Meeting (C.Res.1981/2:27:8):

'It was decided that the Blue Whiting Assessment Working Group (Chairman: Mr H í Jákupsstovu) should meet at ICES headquarters 15-21 September 1982 to:

- (i) assess the current exploitation rate and the state of the blue whiting stocks and advise on catch options for 1983,
- (ii) specify deficiencies in data required for assessments.'

1.2. Participants

R S Bailey
H B Becker
H í Jákupsstovu (Chairman)
T Monstad
A Paciorkowski
R Robles
V Ryzhov
V Shleinik
N Schultz
R Schöne
S Sveinbjørnsson

United Kingdom (Scotland)
The Netherlands
Faroe Islands
Norway
Poland
Spain
USSR
USSR
German Democratic Republic
Federal Republic of Germany
Iceland

Mr W van den Broek, New Zealand, participated as an observer and Mr K. Hoydal participated in his capacity as Secretary to ACFM.

2. LANDINGS

2.1. Landings in 1981

Total landings by countries in the various blue whiting fisheries are presented in Tables 2.2. to 2.6., and summarised in Table 2.1.

There was a significant decrease in total landings of blue whiting in 1981 compared to 1980. The major part of this decrease is accounted for by a reduction in the USSR landings from the Norwegian Sea. The landings from the Southern Areas increased in 1981. In the other fisheries the changes were only minor ones.

2.2. Landings in 1982

Preliminary information on landings of blue whiting have been submitted by some countries reporting on Data Form 5. Data up to and including July 1982 are presented in Table 2.7.

3. STOCK IDENTITY AND STOCK SEPARATION

- 3.1. No investigations on stock identity and stock separation of blue whiting were carried out in 1981. In February and March 1982 during a cruise by the Federal Republic of Germany research vessel 'Walther Herwig', investigations on the maturity of blue whiting were carried out between 42 degrees and 61 degrees N (Ehrich and Robles, 1982). Analysis of maturity curves indicates the possible existence of different populations in the area of investigation (Table 3.1).
- 3.2. The results suggest that one population occupies the area between northern Spain and the Great Sole Bank. The maturity data from different areas in this region showed no significant differences and were therefore combined. They indicate the 50 percent maturation length (L₅₀) to be 18-20 cm. During the cruise, fish in spawning condition were caught in several areas along the continental slope of the southern area. Although the survey extended beyond the continental slope, the only blue whiting observed were close to the bottom in depths of less than 400 m.
- 3.3. Another population is considered to occur along the continental slope and on the northern oceanic banks in ICES Divisions VIa and Vb. In

these areas, the L 50 was much higher (28 cm in females). The survey, however, was carried out over a month before peak spawning is normal in this area, and the number of fish less than 28 cm sampled was very small. For these reasons, this estimate should be treated as a provisional one.

- 3.4. In the area of Porcupine Bank, the L 50 of females was intermediate between the estimates for the northern and southern areas (23.5 cm), and this may indicate the existence of a separate population in this area. This is, to a certain extent, supported by comparative studies on the blue whiting otolith width distributions in samples from the Porcupine Bank (March) and fishing grounds off the Faroes (March), Jan Mayen (July) and Bear Island (June), collected in 1979 and 1980 (Giedz, 1982). On the basis of the Wilcoxon signed rank test, significant differences were found between the otoliths of fish below 26-32 cm total length from the Porcupine Bank and those from other areas. The results may indicate that at least the younger age groups of blue whiting occurring on Porcupine Bank in early spring do not migrate northward into the areas sampled in summer.
- 3.5. The blue whiting sampled on Rockall Bank, during the 'Walther Herwig' cruise, show a complex mixture of maturation stages. While males and females of 23-26 cm were almost all mature (L 50 of females = 22.7 cm), fish larger than 27 cm included a significant proportion of fish of the size of 28-34 cm which were not mature. The reason for this is not clear. There are also indications that part of the blue whiting population spawning at Rockall Bank remains in this area throughout the year. Scottish (Bailey, 1972) and Federal Republic of Germany investigations show that some quantities of blue whiting are available especially by bottom trawling over the whole year. These findings may indicate that there is a separate population at Rockall Bank.
- 3.6. Another separate blue whiting stock may occur in the waters between SW and W Iceland and East Greenland, spawning mainly in May SW of Iceland (Magnússon, 1978; Sveinbjörnsson, 1982; Kosswig and Schöne, 1979; Schöne, 1982). In addition, a single ripe fish and small numbers of spent blue whiting were caught on Dohrn Bank at the beginning of August 1982 (Schöne, 1982). Further indications of a possible separate blue whiting stock in this area are the different growth rate in relation to other areas (Sahrhage and Schöne, 1980), and the fact that most of these blue whiting are not infected with parasites (Wirtz &

Schreiber, 1981).

- 3.7. The results of several Norwegian surveys in 1981 show that blue whiting are distributed along the Norwegian Shelf and in Norwegian coastal waters throughout the year. Scattered spawning was observed in the late spring along the slope and nearer to the coast, but further investigations are required to establish whether this indicates a separate stock or not.

Egidius and Monstad (1982) reported that of the blue whiting examined from the Norwegian Shelf between 63 degrees and 68 degrees north 10.7 percent had pseudo-branchial tumours. It is not clear at present whether the prevalence of these tumours in blue whiting can be used as an additional evidence for stock separation.

4. CATCH COMPOSITION

4.1. Age Determination

Some improvements have been made in the standardization of age readings of blue whiting in the Southern area. In March and June, two short meetings were held in Vigo with the participation of Portuguese, Spanish and USA scientists. Of 40 otoliths studied, using sections through the nucleus, agreement was reached on 77 %. For the Northern area no new comparisons between readers have been made last year. It was not possible to standardize age readings brought to the Working Group meeting. But as the Working Group considered that it is very important to do so, it recommends that the age determination should be done by all countries by the method recommended by the Blue Whiting Planning Group in 1979 (Anon., 1979).

4.2. Age Composition of Landings

Age compositions of landings from the Northern area were revised for 1972, 1975-80 and new data were made available for 1981.

Since it was not possible to standardize age readings brought to the Working Group meeting, the catch in numbers by age group (Tables 4.1-4.3) are as provided by the Working Group members.

For the directed fisheries in 1981, age composition data were provided

by Faroe Islands (only Division Vb), German Democratic Republic, Iceland (only Division IIa), Norway and USSR. These countries together accounted for 92 % of the landings in the directed fisheries. Landings by other countries were assumed to have the same relative age compositions as Norwegian landings in the spawning fishery or as the USSR landings in Norwegian Sea fishery (Table 4.1).

For landings of blue whiting taken in the mixed industrial fisheries age compositions were available for Norway only (30 % of total industrial landings). Other countries' landings were assumed to have the same relative age compositions as those of Norway (Table 4.2.).

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 4.3). A comparison of the age compositions in the different fisheries is shown in Figure 4.1.

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

5. WEIGHT AT AGE

Mean weight at age data were presented by several countries for different areas and quarters. Any differences in these data may be due to variations by countries in interpretation of ages from the otoliths. Weighted mean values at age were calculated for the mixed industrial fishery, the spawning fishery and the Norwegian Sea fishery (Table 5.1.). A mean was then determined for the spawning fishery and Norwegian Sea fishery combined, by weighting the weights at age by the total catch in each area. An overall mean was calculated by further combining these values with those for the mixed industrial fishery and weighting by the total catch in numbers at age.

The total catch landed in 1981 for the whole area was compared against the sums of products (SOPs) of total numbers landed in 1981 and mean weights at age. The calculated SOPs were within 2 % of nominal landings.

6. STOCK SIZE ESTIMATES

6.1. Acoustic Surveys

6.1.1. Surveys during the spawning season

An acoustic survey of the spawning area west of the British Isles was carried out by vessels from the United Kingdom (Scotland) and the Faroes in March-April 1982. The results of the Scottish survey are reported by Forbes et al. (1982). To compare the results with those of previous years, it is necessary to ensure that a number of parameters used in the calculation of biomass are the same.

Firstly, the acoustic equipment must be calibrated against a known standard either by direct calibration using a target of known backscattering cross section or by intercalibration against another ship. On the Scottish survey in 1982 direct calibrations were carried out using a tungsten carbide sphere. In addition, an intercalibration was carried out between the Scottish and Faroese vessels.

Secondly, the mean backscattering cross section or target-strength (\bar{TS}) of blue whiting must be known. In situ measurements reported by Monstad and Midttun (1981) indicated that the \bar{TS} of blue whiting is very similar to that of cod of the same size. Accordingly, a length-dependent relationship based on juvenile cod (given in Appendix to Doc. C.M.1982/H:5) has been used by the Working Group to calculate the \bar{TS} of blue whiting:

$$\frac{1}{\bar{\sigma}^{b.s.}} = 1.87 \times 10^7 \times l^{-2.18}$$
$$\bar{TS} = 10 \log \bar{\sigma}^{b.s.}$$

where l = length in cm; $\bar{\sigma}^{b.s.}$ = mean backscattering cross section of the fish; \bar{TS} target strength (dB) of one fish.

To be comparable, results must also be made assuming the same absorption (attenuation) coefficient in the Time Varied Gain (TVG) function. In the spawning area where the mean depth of blue whiting is 400 m, the two alternative values of this coefficient that have been used in the last few years (8 and 10.5 dB/km) imply a difference of

2.5 dB \times 0.8 at a depth of 400 m (because absorption occurs during downward and upward transmission), which is equivalent to a factor of 1.58 in biomass estimates. Since the value of this coefficient currently in use is 8 dB/km, the Working Group corrected the results of previous surveys to correspond to this value. Finally, because the target strength of blue whiting depends on length of fish, it is necessary to use biological data collected during the surveys in the calculation of biomass in each area. In-so-far as the data available to the Working Group allowed, the results of previous surveys have been corrected to correspond to the parameter values given above.

6.1.2. Results of previous surveys

The results of previous surveys of the spawning area corrected to the parameter values given above are as follows:

Year	Survey	Biomass (t \times 10 ⁻⁶)	Mean weight (g)	Number of fish (\times 10 ⁻⁹)
1979	Norwegian survey	5.0	129	38.7
1979	Scottish survey	10.6	114	92.8
1980	Combined survey	3.8	129	29.5
1981	Norwegian survey	4.4	186	23.4
1981	Scottish survey	4.2	186 ^{a)}	22.4
1981	Combined	6.1	186	33.0

^{a)} Adopted from the Norwegian Survey.

The results of these surveys have been commented on in previous reports of the Working Group. To summarize, the 1979 surveys did not cover the area south of 55 degrees 30 N (most of Ireland and Porcupine Bank) and in that year the Norwegian survey was carried out in late April, when the distribution of the fish indicated that some had already moved out of the area surveyed.

In 1980 the surveys were carried out in April and there was some evidence that spawning was rather early. There is, therefore, some possibility that part of the spawning stock had already left the area by the time of the survey (Warburton and Hutcheon, 1980; Monstad and

Midttun, 1980).

The 1981 survey extended much further to the north than in previous years, and it is the results of the Scottish survey that provide the most comparable estimate. The combined results in that year, however, indicate that only a relatively small part of the spawning stock is still in the area north of 61 degrees N during April, and in fact a higher proportion of the blue whiting found in that area was immature. Of the total of 6.1 million tonnes in that year it was estimated that 12 % were immature (1981 Working Group Report), so the spawning stock estimate in 1981 is 5.4 million tonnes.

6.1.3. The 1982 survey

The survey in March-April 1982 covered only part of the area surveyed in 1981. The Scottish biomass estimates for blocks of four rectangles given by Forbes et al. (1982) were based on an assumed target strength of -34 dB/kg and an absorption coefficient of 8 dB/km. To be comparable with the results of previous surveys, values corresponding to parameter values given in this report are given in Figure 6.1. The estimated total biomass in the area surveyed is 2.48×10^6 tonnes, which, converted to number of fish on an area basis, is equivalent to 16.2×10^9 fish.

The 1981 estimate for the same area as that covered in 1982 is 4.36×10^6 tonnes equivalent to 23.5×10^9 fish. The two surveys therefore provide some evidence of a decrease in spawning stock size between 1981 and 1982. The 1982 survey, however, was carried out about a week earlier than the 1981 survey, and the area covered extended only as far north as 61 degrees N. In 1981, an estimated 27 % of the total stock in the combined survey area was in the area to the north of the 1982 survey area. With a slightly earlier survey in 1982 it is possible that a larger percentage of the total had not yet migrated into the spawning area. What evidence there is on this is somewhat conflicting. The Faroese survey, which took place in early April recorded low densities of blue whiting in the Faroe-Shetland Channel slightly to the north of the Scottish survey area, which suggests that there were no major concentrations about to migrate into the spawning area. There was, however, some fishing by the Soviet Union fleet north of 61 degrees N in the first half of April and the blue whiting caught were pre-spawning. It thus appears likely that part of the blue whiting spawning stock was not present in the main spawning area at the time

of the 1982 survey, but there are no data from which this can be quantified.

6.1.4. Acoustic surveys in the Norwegian Sea

From 1 to 19 August 1981, the two Norwegian research vessels 'G O SARS' AND 'MICHAEL SARS' conducted a coordinated acoustic survey on blue whiting in the Norwegian Sea. In addition, information on blue whiting in the western Barents Sea and Spitsbergen area was obtained during the following survey during late August and early September. The cruise tracks and area covered are shown in Fig. 6.2.

The two vessels carried out an intercalibration of the acoustic instruments, and the integrator values were expressed in G O SARS-standards.

Fig. 6.3. shows the distribution and relative densities of blue whiting expressed as mm deflection per nautical mile. Blue whiting were found scattered over the major part of the area investigated. The densest recordings were obtained around position 68 degrees N at the Greenwich meridian and between the Faroes and Iceland.

The estimate of blue whiting biomass was calculated to be 4.9 million tonnes. Using the estimated mean weight during the survey of 203 g, this is equivalent to 24.1×10^9 fish.

For the similar survey in 1980, the biomass was not estimated (Anon., 1981). However, comparing the distribution of fish on the two surveys, the largest concentrations were further south in 1981.

In 1982, a coordinated acoustic survey was carried out in the Norwegian Sea in August in accordance with Council Recommendation 1981/C.Res.2:23. Five countries participated with eight vessels altogether, i.e., Faroe Islands, German Democratic Republic, Iceland, Norway and USSR.

The area covered was the same as in 1980 and 1981, i.e., from the Faroes to south of Bear Island, but in addition the areas around Iceland were surveyed, extending westwards to Dohrn Bank (Fig. 6.4.).

Seven of the eight participating vessels were equipped with integrators. Their acoustic instruments were calibrated against a standard target (Coppersphere of 60 mm dia) and the echo intensity recorded by each of the vessels converted into numbers of square meters reflected per square nautical mile. The method used in this conversion is described in Anon. (1982).

The results are shown as relative densities in Fig. 6.5. The estimated biomass in each statistical rectangle is given in Anon (1982). Blue whiting were found dispersed over most of the Norwegian Sea between Iceland and Norway from Shetland/Faroes to 75 degrees 45 minutes N in the Bear Island area. In the area integrated up to 74 degrees N, the highest concentrations were found in the southern part of the area investigated.

The blue whiting biomass was estimated to be in the order of 4.6 million tonnes. The overall mean weight of blue whiting in the survey area was estimated to be 192 g, and the total number of fish was therefore 24.7×10^9 . The estimate of 4.6 mill tonnes distributed over the Norwegian Sea in 1982, is considered to represent the major part of the Northern stock. Blue whiting, however, inhabit other areas also, as mentioned under the stock distribution section. Taking this into consideration, the total stock of 5.5 mill tonnes should be at a realistic level.

Considering the 1981 and 1982 surveys in the Norwegian Sea, the resulting biomass estimates are at the same level. The area of distribution in 1982 was very much the same as in 1981, although in 1981 the distribution extended a little further north and northeast to southern Spitsbergen and the western Barents Sea. These northern areas, however, had very low densities of blue whiting.

In the area east of Iceland, the coverage was much better in 1982 than in 1981. The limit of distribution in both years occurred in relation to the location of the polar front. In 1982 several vessels surveyed these waters at slightly different times, showing that the location of the blue whiting concentrations varied from day to day within the area.

6.1.5. Trends in stock size

Acoustic estimates of stock size (million tonnes) corrected to the standard parameter values are as follows:

Year	Spring survey in spawning area	August survey in Norwegian Sea
1979	7.8*	
1980	3.8	
1981	5.4**	4.9
1982	2.5	4.6

* *Mean of Norwegian and Scottish surveys*

** *Excluding immatures*

6.2. Virtual Population Analysis (VPA)

In its 1981 report, the Blue Whiting Working Group decided that the results of a VPA were unreliable because of the lack of independent information on the level of fishing mortality in the last year for which catch data were available. The spring acoustic survey in 1981 provided an estimate of spawning stock size, but no data were available to judge what percentage of the spawning stock was distributed outside the area surveyed. Furthermore, since the maturity-at-age ogive has not been adequately described, it was impossible to estimate what proportions of each of the younger ages were estimated by the acoustic survey.

It was partly for the reasons given above that the Working Group recommended that an acoustic survey should be carried out in 1982 in an area and at a time where the total stock might be found. This survey, carried out over the entire Norwegian Sea in August 1982, provided an estimate of 4.6 million tonnes of all age groups, while a Norwegian survey in August 1981 gave an estimate for a larger area of 4.9 million tonnes. From the results of previous work it was known that even the large area covered on these surveys did not contain the entire stock, and that a proportion could be found in the Norwegian Deeps and along the edge of the continental shelf to the north of the British Isles (Walsh et al. (1978), Jákupsstovu (1974), Schulz and Verch (1982)). Making some allowance for these additional areas, the Working Group used 5.5 million tonnes as its best estimate of the total stock in 1981. A virtual population analysis was repeated using different values of input F, until the calculated total stock biomass approximately matched this estimate.

In the previous reports the Working Group was not able to obtain a reliable estimate of natural mortality M , but indicated the likely range. Accordingly, three alternative values — 0.2, 0.25 and 0.3 were used in the VPA.

To obtain an exploitation pattern to be used as input to the VPA, a trial run was carried out ($M = 0.2$; input- $F = 0.3$ on age 3 and older). The estimates of F at age obtained for the years 1976-80 were divided into the components due to the adult and mixed industrial fisheries on the basis of the proportions of the catch at each age made by these fisheries in the respective years, then, taking the mean values of F at each age over the period 1976-80 for the two fisheries separately, it was possible to quantify the recent exploitation pattern. In the adult fisheries the values of F were rather similar over the age groups 3-9, while those for ages 10-13 were higher. All ages from 3 years upwards were assumed to have the same value of input F in the VPA. The proportional values of F on younger age groups were $F(0) = 0$; $F(1) = 0.1$; $F(2) = 0.5$. For the mixed industrial fishery, the values of F at age from 1976-80 were rather stable with means of $F(1) = 0.20$; $F(2) = 0.05$; $F(3) = 0.02$; $F(\geq 4) = 0$. Since no information was available to the Working Group to indicate if the level of effort in these fisheries changed in 1981, these absolute values were used for the industrial fishery in all runs of the VPA by adding them to the F values used for the adult fishery.

6.2.1. Results from the Virtual Population Analysis

The catch in number data used in the VPA are given in Table 4.3. Runs of the VPA that match the results of the acoustic survey using an M of 0.2-0.3 were those with an input F on the fully exploited age groups of 0.15-0.3. The trends in total stock size estimated for nine combinations of M and input F values are given in Table 6.1. In all cases it is evident that the stock has decreased progressively since the mid-1970s, because recruitment in recent years has been at a lower level than in the early 1970s. Runs of the VPA based on the higher values of M indicate the steepest decrease from levels of stock size in the mid-1970s which seems unrealistic. The acoustic estimates of stock size in those years were in some cases higher than in 1981 and 1982, but not by a factor of 5. The VPA that most closely matched the 1981 Norwegian Sea acoustic survey, and that gave a less dramatic decrease in total stock (i.e. $M = 0.2$; input F -adult = 0.18) is given in Tables 6.2. and 6.3. for fishing mortality and stock in numbers respectively. It indicates that

recent values of F increased sharply up to 1980. In 1981 there appears to have been a further small increase in F despite the decrease in catch. According to the VPA runs recruitment has decreased almost every year since 1972.

6.3. Catch per Unit Effort

- 6.3.1. Data on catch and effort for the year 1981 were presented by 6 countries, i.e. Faroes, German Democratic Republic, Iceland, Norway, Poland and USSR. All these countries, apart from Iceland, presented their data broken down by vessel tonnage, gear types and area and month. Iceland presented the CPUE data from the fishery at the Faroes during the period April-May, but in fact most of the Icelandic catch was taken in May.

The Norwegian statistics for 1981 for the various fishing areas included the catch per hour only. A few countries have submitted their preliminary catch and effort statistics for the period January-July 1982 as well.

- 6.3.2. Comparable time series of CPUE data for Divisions IIa, Vb, VIa and IVa, which may be indicative of changes in stock abundance, are compiled in Table 6.4. A variety of vessel-tonnage classes and gear types have been used by different countries in the blue whiting fishery. Data on CPUE vary with respect to months and Divisions fished and not all of them can be used for stock assessment purposes. The data have been filed until a longer time series within each category is available.
- 6.3.4. Changes of the total stock biomass seem to be best reflected by abundance indices from the Norwegian Sea fishery during the period from July to September, when the blue whiting are dispersed in relatively small, mobile shoals over the largest area and when almost all age groups (besides ages 1-3) are present.

Using data for this area and season, the catch rates of the USSR vessels (GRT-class 1000-1999.9 and 2000-3999.9) in that area provide the most representative time series for the period 1977-1981, taking into account the effort exerted by that fleet in comparison with other countries' vessels. The USSR catch rates of GRT-class 1000-1999.9 increased by 17 % from 1977 to 1978 (Table 6.4.). An increase by about 26 % for the GRT-class 2000-3999.9 was observed between 1979 and 1980, when

the catch rates were at the highest level. Similar trends were observed in the GDR and Polish blue whiting fisheries (Table 6.5.).

- 6.3.5. The learning factor and increased efficiency connected with probable fishing gear improvements, better fish searching equipment, higher towing speed due to more powerful engines is beyond doubt at least part of the explanation of the increased catch rates for all fleets from 1977 to 1980. In 1981 catch rates of all fleets for which data are available have decreased, in the case of the USSR fleet by 34 %, of the GDR fleet by 28 % and of the Polish fleet by 18 %. The decrease in the CPUE was accompanied by a decrease in fishing effort (in the case of the USSR fleet by 19 %) and a consequent decrease in total landings (Figure 6.6.). It is, however, difficult to estimate to what extent the decrease in CPUE has been influenced by changes in availability.

7. MANAGEMENT CONSIDERATIONS

7.1. General Picture from the various Assessments

The results of the assessments made by the Working Group are subject to major reservations because of the doubts about the reliability of the age composition and of the acoustic surveys. There is, however, a measure of agreement between the VPA, the acoustic surveys and the CPUEs.

- a) The acoustic survey in spring 1982 indicated a lower spawning stock than in any of the previous three years;
- b) The acoustic surveys in August 1981 and 1982 indicated that the total stock is not greater than about 5-6 million tonnes, which is lower than that estimated in previous years;
- c) Catch per unit effort data from the largest component of the fishing fleets exploiting the stock (large trawlers from the Soviet Union) indicate a decrease in abundance in the Norwegian Sea in 1981;
- d) The results of the VPA carried out over a range of values of natural mortality and input fishing mortality indicate a steady decrease in the stock from about 1974-75 to 1981.

There is thus some evidence that the size of the stock is lower than at any time during the last ten years, although the extent of the decrease may be questionable.

The VPA is now based on data from five years during which the fishery has been significant. During this period a major component of the age data has been provided by the USSR with the result that a certain amount of consistency is built in the data base.

7.2. Indications of Declining Recruitment

Nevertheless, there are some problems in the interpretation of recent recruitment, which depend to a considerable extent on data from the mixed industrial fisheries. Results of the Norwegian Sea acoustic surveys in 1980 and 1981, brought to the 1982 Working Group meeting, gave no indication of any substantial recruiting year classes, thus supporting the low estimates of low recruitments in the VPA. In 1982, the survey indicated the possibility of a larger incoming year class in some areas. The age composition data provided by Norway for the mixed industrial fishery in the North Sea (Table 4.2) indicate that the last reasonable year class was that of 1978 and that more recent ones have been very poor. It must be recognised that the sampling of these fisheries covers only 30 % of the landings and there is therefore some doubt about their validity. Even if the age composition is biased, however, and the true proportion of 1 year olds in 1981, for example, was higher, the resulting estimate of recruitment of this age group in 1981 would still have been lower than the estimates for the early 1970s.

7.3. Tentative Predictions

Using the results of the VPA run given in Table 6.2 and as a starting point (input values in Table 7.1), a stock and catch prediction was made, assuming that the F in 1982 will be the same as in 1981 (giving a catch of 650 000 tonnes). Resulting levels of catch and stock in 1983 and 1984 respectively are shown in Figure 7.1 D. For the prediction it was also assumed that the exploitation pattern will remain the same as in 1981, and that recruitment of the 1-group in 1982 and 1983 will be 4 765 mill., i.e., the mean of 1979 and 1980 values. As discussed above, the 1982 year class recruiting as 1-group in 1983 may be better than the recent average, but in a fishery exploiting many age groups, this will not have a large influence on the predictions.

7.4. Yield per Recruit Calculations

Using the same input values as in the prediction (Table 7.1), yield per recruit and spawning stock biomass per recruit curves have been calculated for values of M of 0.2 and 0.3. Values of $F_{0.1}$ values obtained for the two curves are 0.20 and 0.31 respectively.

8. SOUTHERN AREA

8.1. The Fishery in 1981

The total landings of blue whiting in the Southern Area (38 506 tonnes) increased by 29 % compared with 1980 (29 944 tonnes). Almost the entire catch came from Divisions VIIIc and IXa where the Spanish and Portuguese fleets operate. Portugal took about 7 400 tonnes in Division IXa and Spain caught about 9 000 tonnes in Division IXa and approx. 20 000 tonnes in Div VIIIc, only about 1 000 tonnes were caught by Spanish vessels in other divisions.

8.2. Catch Composition

8.2.1. Length composition of the landings

Table 8.1 provides the results for Spain and Portugal during 1980 and 1981. In 1981 the major percentage of fish were between 17 and 24 cm with a mode of 20 cm. The level of sampling in Portuguese landings was considerably improved in 1981 in relation to 1980.

8.3. Catch per Unit Effort

A short series of CPUE data has been collected from Portuguese and Spanish fleets (Table 8.2). Portugal presented data from 1977 in tonnes per vessel and in kg per hour fishing. Spain provided only data for the last two years in tonnes per vessel by the whole fleet but presented also a better set of data from 1978 in kg per HP \times days fishing $\times 10^{-2}$ taken only from the port of La Coruna which accounts for approximately half the total landings.

In the case of the Spanish fleets, which took 80 % of the total catch in 1981, the effort dropped in both 1980 and 1981. The increase in

landings and CPUE in 1981 may therefore be explained by an increase in abundance, although there may also have been a decrease in the extent of discarding, owing to an increase in the price of blue whiting.

8.4. Other Data

8.4.1. Maturation

As described in Section 3, the length at first maturation seems to be very similar in all the areas sampled within the Southern area except Divisions VIIc-k (Porcupine Bank).

From the length composition of the landings (Table 8.2) and using the maturity length data summarized in Section 3, approximately 80 % of the total landings in 1981 consisted of mature fish, compared with approximately 50 % in 1980. In both years, the proportion of mature fish appears to have been higher than reported for 1980 in the 1981 Working Group report.

8.4.2. Length/weight relationships

Equations based on fresh samples from Portugal and Spain were

$$W = .0030 L^{3.20}$$

and

$$W = .0028 L^{3.24}$$

respectively. The use of frozen samples appears to have a significant effect on this relationship (Vasconcelos, 1982).

8.4.3. Trawl surveys

Five surveys were conducted in this area during 1981, none of them devoted specifically to blue whiting although many data on this species were collected. The small numbers of fish caught in depths less than 100 m in June (Figure 8.1) were clearly the young ranging from 7 to 17 cm which escape through the meshes currently used by the commercial fleet in these areas. Catch per hour indices from the Portuguese R/V 'Noruega' indicate greater concentrations in March and June 1981 than in previous years (Table 8.3.).

8.5. Assessments

Although a small number of blue whiting up to a maximum of 40 cm are caught every year in this area (see Table 8.1), the greater part of the landings consists of small blue whiting of modal length 19-20 cm (see Section 8.2.1). Since these small fish are found to contain a high percentage of mature individuals, and since the 'Walther Herwig' survey in February 1982 provided no evidence of concentrations of large blue whiting in the Southern area, it seems likely that the spawning stock in this area has a completely different size structure compared to that in the Northern area.

The small number of otoliths read this year indicate that growth parameters obtained last year by applying the Cassie method (Anon., 1981) may not be reliable. Until more reliable information on age determination is collected, it seems inappropriate to attempt to make an assessment of the effect of the fishery on this stock.

9. DATA DEFICIENCIES

- 9.1. A major problem in assessing the state of the Northern stock of blue whiting has been the short period during which it has been exploited and the length of the data series available. Assessment methods that depend on several years' data (e.g. VPA) or correlation techniques are as a result not very useful. This problem diminishes every year, but there are nevertheless other deficiencies in the information about blue whiting that will prevent a proper interpretation of the recorded events in the fisheries.
- 9.2. Some of the deficiencies are related to major biological problems (e.g. age determination, stock separation, extent of stock distribution, target strength estimation) which, in the case of blue whiting, have not yet received adequate attention. Some of these form the basis for future research recommendations in Section 10. Others are deficiencies in sampling, which are recognised as the responsibility of those countries exploiting the stock concerned.
- 9.3. Catch reporting is in general adequate. In the Southern area discarding is known to take place. There are no estimates of the amount of blue whiting discarded, or perhaps landed unreported, even in areas where this species is known from surveys to be one of, if not the, most abundant species of fish.

- 9.4. Biological sampling is also adequate for a large part of the catch, although there are important exceptions. Approximately 70 % of the landings in the mixed industrial fishery are apparently completely unsampled. This is an important deficiency, because landings of the youngest three or four age classes form the only available information on recruitment. Similarly length, weight, age and maturation at age data are required to improve the reliability of the VPA in these age groups and to estimate essential biological parameters of the stock (weight at age, the maturation ogive, etc.). In the Southern area the major deficiency is age data. At present no information on catch at age has been presented to the Working Group for the Southern area.
- 9.5. Recruitment indices could also be obtained from research vessel surveys, but the surveys for other species do not cover the main areas of juvenile blue whiting distribution, i.e., the continental shelf edge and the oceanic banks. Since the distribution of juveniles is not fully known, furthermore, it would be difficult to design a survey for this purpose. It is therefore important that better sampling of commercial landings by the mixed industrial fishery are carried out and that effort data are provided. Since juvenile blue whiting occur mainly in the deeper parts of the North Sea, the catch and effort data should be broken down by statistical rectangle, or, if this is not possible, at least by depth strata. At the present state of knowledge, these fisheries are the most promising source of data on recruitment trends in the blue whiting stock.

10. FUTURE RESEARCH RECOMMENDATIONS

- 10.1. There is good evidence of the existence of a separate Southern blue whiting stock, which the results of cruises and investigations in 1981 had shown. However, more investigations are needed especially in age determination and acoustic estimates of the stock. This will provide for better management of blue whiting in the Southern area in the future.
- 10.2. Further investigations on stock separation have to be done in the entire distribution area. More information on meristic characters, growth rates and maturation length data, as well as parasite infestation rates and other diseases, have to be enforced.
- 10.3. All information on the occurrence of 0- and 1- age group blue whiting should be reported very carefully, and special searching should be carried out during future research cruises.

- 10.4. The coordinated acoustic survey in August 1982 in the Norwegian Sea gave very valuable information of the stock abundance in the Northern area. While there are indications of a possible decline in the Northern blue whiting stock, it is very important to continue the supervision of it. Therefore it is recommended that a similar coordinated acoustic survey should be carried out in August 1983. In connection with this, meetings of members from participating countries should be arranged before and after the survey.
- 10.5. In addition to this, the surveying of the spawning stock during spring-time should be continued.
- 10.6. A meeting of the otolith readers, as recommended in last year's report, did not take place. There is still a need for better agreement in age determination and, therefore, it is recommended again that such a meeting should be arranged in 1983.

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Table 2.1 Landings (t) of blue whiting from the main fisheries 1970-1981

Area	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
Norwegian Sea Fishery (Sub-Areas I + II and Divisions Va, XIVa + XIVb)	14 808	35 219	625	878	146	6 746	3 336	56 999	235 226	741 074	766 858	515 645
Spawning Fishery, (Divisions Vb, VIa, VIb and VIId,c)	354	18 394	15 426	15 027	15 207	30 335	81 362	136 787	229 228	284 541	250 693	253 983
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	41 955	36 024	38 389	99 874	63 333	75 129	80 189
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	30 723	32 898	7 176	29 944	38 749
TOTAL	37 950	75 599	77 525	103 016	107 513	112 045	163 977	268 736	607 710	1 118 624	1 122 624	888 566

* 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	1981 ¹⁾
Faroes	-	-	-	-	-	-	-	593	2810	762	0	11131
German Dem. Rep.	-	-	3	-	-	-	90	2031	7301	22502	14294	15607
Germany, Fed.Rep.of ²⁾	-	-	-	3	2	35	33	6777	8421	1157	8919	17385
Iceland	-	-	622	60	119	3	569	4768	17756	12428	4562	4808
Norway	-	-	-	-	20	31	737	-	-	33588 ³⁾	902	187
Poland	-	-	-	-	-	-	95	1536	5083	4346	11307	2434
UK, (England & Wales)	-	-	-	-	-	-	60	165	11	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-	32	-	-
USSR	14808	35219	-	815	5	6677	1752	41129	193844	666259	726874	464093
Total	14808	35219	625	878	146	6746	3336	56999	235226	741074	766858	515645

1) Preliminary

2) Including catches off the south-east coast of East Greenland (Division XIVb). (327 t in 1977, 896 t in 1978, 204 t in 1979 and 8784 t in 1980). (ICES 8757 t).

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.) 1970-81.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981 ¹⁾
Denmark	-	-	-	-	-	-	-	18745	23498	21200	19272	11361
Faroes	-	-	-	1155	1527	-	12826	29096	39491	35780	37488	23107
German Dem. Rep.	-	-	-	-	-	-	4971	1094	1714	172	181	6562
Germany, Fed. Rep. of	-	-	-	-	2655	-	85	3260	6363	3304	709	935
Iceland	-	-	-	319	-	-	-	5172	7537	4864	5375	10213
Ireland	-	-	-	-	-	-	160	-	-	-	-	-
Netherlands	-	-	-	-	-	-	-	-	1172	154	-	222
Norway	-	-	651	2445	3247	7301	24853	38214	116815	186737	133754	131835
Poland	-	-	-	-	116	4704	10950	3996	2469	4643	-	2279
Spain	-	-	6955	6571	6484	8153	5910	183	14	-	-	-
Sweden	-	-	-	-	-	-	-	6391	6260	-	3185	-
UK (England & Wales)	-	-	-	-	-	455	341	1475	5287	4136	3878	6000 ²⁾
UK (Scotland) ³⁾	-	-	-	-	-	279	1488	3001	1599	1466	6819	2611
USSR	354	18394	7820	4537	1178	9443	19778	26160	17009	22091	40032	58858
Total	354	18394	15426	15027	15207	30335	81362	136787	229228	284541	250693	253983

1) Preliminary. 2) Assumed that the catches are from Divisions VIa and VIb. 3) Including estimated by-catch in industrial fishery in Division VIa.

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), 1970-81.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981 ¹⁾
Denmark	-	-	-	-	-	-	-	16071	54804	28932	49947	35066
Faroese	-	-	-	3714	2610	428	1254	-	1177	1489	1895	3133
German Dem.Rep. ²⁾	-	-	-	-	-	-	-	-	988	49	-	-
German, Fed. Rep. ²⁾	-	-	-	-	-	-	-	76	1514	13	252	-
Ireland	-	-	-	-	-	-	-	-	-	-	-	2744
Norway	-	-	27609	58035	59151	40210	34600	20737	39989	30930	21962 ³⁾	37602 ⁵⁾
Poland ²⁾	-	-	-	-	55	-	45	838	601	-	-	229
Spain ²⁾	-	-	350	350	318	195	47	-	-	-	-	-
Sweden ⁴⁾	-	-	-	-	-	-	-	639	648	1249	1071	1955
UK (England and Wales) ²⁾	-	-	-	-	-	-	-	3	+	-	-	-
UK (Scotland)	-	-	-	-	-	414	58	25	153	37	2	-
USSR ²⁾	-	600	-	1927	63	708	20	-	-	634	-	-
Total	-	600	27959	56826	62197	41955	36024	38389	99874	63333	75129	80189

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

5) Including 19 002 tonnes from directed fisheries in Division IVa

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.) 1970-81.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981 ¹⁾
German, Dem. Rep.	-	78	-	-	-	-	-	-	-	-	-	-
Germany, Fed. Rep. of	-	-	-	-	-	-	-	-	25	-	-	-
Ireland	-	-	-	-	-	-	-	-	-	1	-	-
Netherlands	-	-	-	-	-	-	-	-	7	-	31	633
Poland	-	-	-	-	170	-	385	169	53	-	-	-
Portugal	-	-	-	-	-	-	-	1557	2381	2096	6051	7388
Spain ²⁾	16360	11800	28090	26741	24627	30790	29470	5259	1428	25016	23862	30728
UK (England & Wales)	-	-	-	-	-	-	-	+	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-	63	-	-
USSR	6428	9508	5413	711	936	925	5180	3738	4	-	-	-
Total	22788	21386	33503	27452	25733	31715	35035	30723	33898	27176	29944	38749

1) Preliminary.

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

Table 2.7 Preliminary returns on ICES data
Form 5 for 1982

Country	Jan	Feb	Mar	Apr	May	Jun	Jul	Total ¹⁾
German Democratic Republic Vb	708	758	-	-	-	-	-	1 466
Norway Vb,	-	-	-	-	1 575	-	-	1 575
IV	-	-	-	7 219	26 836	-	-	34 110
VI	-	-	-	84 135	22 626	-	-	106 457
VIIg-k	-	-	-	28 501	-	-	-	28 501
Poland IIa	-	-	-	-	-	163	145	308
IV	-	-	-	-	8	542	-	550
USSR IIa	4 659	2 482	535	4 478	47 548	26 332	2 458	88 492
Vb	8 247	5 308	9 364	11 167	13 081	5 328	10 781	63 276

1) The total is the revised total, not necessarily the sum of the monthly reports

Table 3.1 50% and 95% maturation length by sex and area (from Ehrlich and Robles, 1982).

	Northern Spain IXa+VIIIc	Southern France VIIIb	Northern France VIIIa	Great Sole Bank VIIj	N. Spain-Gr. S. Bank IXa-VIIj	Porcupine Bank VIIc+VIK	Rockall Bank VIb	Northern Rockall Trough VIa+Vb
L _{50%} ♂	18.2	18.5	18.0	-	18.2	-	-	-
L _{50%} ♀	18.2	19.9	19.4	19.4	19.4	23.5	22.7	28.2
L _{95%} ♂	20.5	20.9	21.0	19.5	20.5	21.7	23.0	29.7
L _{95%} ♀	23.1	21.7	21.8	22.4	22.5	23.9	24.4	34.0
Pawson et al. 1975 (from 52°N to 64°N, March to May) (Porcupine → Northern Rockall Trough)								
	♂ ~ 23 cm ----- ♀ ~ 24.5 cm ----- ♂ ~ 26.5 cm ----- ♀ ~ 27.5 cm -----							
	L _{50%} ♂ ----- L _{50%} ♀ ----- L _{95%} ♂ ----- L _{95%} ♀							

Table 4.1 Catch in number (millions) by age group in the adult fisheries (Sub-areas I and II, Divisions Va, XIVa and XIVb, Vb, VIa and VIb and VIIb,c), 1970-81.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981*
0	0.4	16.5	0.7	3.0	0.6	2.0	4.8	45.2	64.1	67.9	55.1	3.6
1	14.6	11.3	0.4	6.0	6.0	2.3	13.9	89.8	69.6	160.2	319.5	32.1
2	20.3	17.5	5.8	4.6	5.0	5.3	25.6	169.2	348.6	311.6	362.0	282.3
3	24.5	54.8	13.5	8.2	16.4	30.3	58.0	189.9	440.4	444.2	397.1	220.4
4	28.5	75.1	22.0	12.0	22.1	28.2	28.5	158.4	487.0	454.7	478.4	486.5
5	17.5	87.8	28.5	15.7	17.6	26.6	55.6	141.3	532.2	552.5	531.0	533.8
6	11.9	73.6	27.9	15.0	15.7	36.2	73.4	181.5	478.1	721.6	725.4	439.8
7	7.3	59.0	21.3	20.0	15.7	34.8	61.2	123.3	367.8	802.4	779.3	609.2
8	4.7	36.8	19.2	9.0	16.0	28.5	69.3	135.5	310.1	773.9	604.6	563.7
9	1.7	19.8	6.0	12.8	3.9	29.2	77.6	113.1	158.7	1008.8	398.1	710.0
10	1.7	12.7	2.7	11.0	4.7	14.6	32.1	57.8	122.8	394.2	394.2	338.4
11	0.4	4.7	1.3	8.9	3.0	13.7	39.0	18.7	50.8	138.6	66.8	72.1
12		1.9	0.4	2.7	1.7	7.7	20.0	13.9	20.7	67.3	64.6	48.3
13		0.5		1.1	0.8	4.9	10.5	7.1	16.2	37.9	4.7	29.6
14				1.0	1.1	3.7	6.7					
15+												
Total	131.8	472.0	149.7	136.7	118.6	279.8	576.2	1444.7	3467.1	6219.6	6189.6	4598.9
Tonnes	15 162	63 721	21 844	21 517	16 730	39 183	89 990	199 004	468 215	995 838	1 017 630	789 263

* Preliminary

Table 4.2 Catch in number (millions) by age group in the mixed industrial fisheries
(Sub-area IV, Divisions IIIa and Va), 1972-81.

Age	1972	1973	1974	1975	1976	1977	1978	1979 ¹⁾	1980	1981 [#]
0	1066.4	1748.0	376.9	788.8	127.6	413.6	895.8	2.3	22.8	64.6
1	98.7	336.2	476.9	214.7	757.8	450.8	965.8	1811.1	271.2	80.7
2	48.2	44.7	48.4	70.9	98.3	107.4	157.6	77.2	324.1	189.4
3	5.7	20.7	12.9	27.4	36.8	32.6	84.0	31.6	73.5	57.9
4+	1.7	11.5	7.5	13.6	22.3	30.7	69.3	21.8	22.2	19.9
5								17.8	28.6	16.5
6								20.4	22.7	17.6
7								10.6	28.8	15.5
8								8.6	26.3	4.4
9								13.7	14.9	4.8
10								6.1	13.6	3.6
11								1.0	6.3	1.5
12								4.3	1.8	1.2
13									2.2	0.1
14									1.4	0.2
15+									0.4	
Total	1220.7	2161.1	922.6	1115.4	1042.8	1035.1	2172.5	2026.5	860.8	477.9
Tonnes	27 621	57 382	65 991	41 986	44 074	42 646	102 454	93 050	73 804	61 187

Preliminary.

1) Includes purse-seine catches of 29 162 tonnes of juvenile blue whiting taken in the southern Norwegian Sea (see Table 2.2).

Table 4.3 Catch in numbers (millions) of BLUE WHITING in the Northern Area.

	1970	1971	1972	1973	1974	1975	1976	1977	1978
1	0	11	99	342	473	217	763	451	966
2	15	18	54	49	54	76	112	153	222
3	20	55	19	29	18	58	62	122	154
4	25	75	24	24	24	42	30	200	418
5	29	88	28	16	22	27	29	190	440
6	18	74	28	15	18	36	56	158	487
7	12	59	21	20	16	35	73	141	532
8	7	37	19	9	16	29	61	182	478
9	5	20	6	13	4	29	69	123	368
10	2	13	3	11	5	15	78	136	310
11	0	5	1	9	4	14	32	113	159
12	0	2	0	6	3	12	39	58	123
13	0	1	0	3	2	8	20	19	51
14	0	0	0	1	1	5	10	14	21
15+	0	0	0	1	1	4	7	7	16
TOTAL	132	455	303	547	664	604	1491	2066	4744
NOMINAL (tonnes)	15162	63721	49435	78899	82721	81169	134064	241650	573669

	1979	1980	1981
1	1879	326	68
2	237	644	115
3	343	436	472
4	466	419	278
5	472	507	506
6	573	554	550
7	732	754	457
8	887	806	625
9	816	620	568
10	780	1022	715
11	461	404	342
12	353	396	231
13	139	69	73
14	67	66	48
15+	38	5	30
TOTAL	8244	7028	5077
NOMINAL (tonnes)	1063413	1091434	850450

Table 5.1 Overall mean weight at age (g) for 1981.

Age	Spawning area	Norwegian Sea	North Sea Mixed fishery	Weighted mean
1		38	64	63
2	84	103	90	92
3	103	133	111	118
4	125	141	131	135
5	139	148	140	145
6	150	157	187	155
7	166	169	231	170
8	176	177	234	178
9	185	188	249	187
10	269	194	233	199
11	265	207	376	208
12	250	217	215	228
13	253	221	402	234
14	227	261	245	249
15	248	260	450	257
Weighted mean				170

Table 6.1 Estimates of total stock biomass from VPA runs assuming different natural mortalities and different fishing mortalities on the adults.

Year	M = 0.2			M = 0.25			M = 0.3		
	F _{ad} =0.15	F _{ad} =0.2	F _{ad} =0.3	F _{ad} =0.15	F _{ad} =0.2	F _{ad} =0.3	F _{ad} =0.15	F _{ad} =0.2	F _{ad} =0.3
1970	4.5	4.2	3.6	7.7	6.7	5.7	12.4	10.7	9.1
1971	6.7	5.8	5.0	10.4	9.0	7.6	16.3	14.0	11.8
1972	8.8	7.6	6.4	13.4	11.4	9.5	20.4	17.3	14.3
1973	11.0	9.3	7.8	16.0	13.5	11.1	23.3	19.6	16.0
1974	12.2	10.4	8.5	17.0	14.3	11.7	23.8	20.7	16.1
1975	12.8	10.8	8.8	17.0	14.2	11.5	22.7	18.9	15.2
1976	12.8	10.8	8.8	16.3	13.6	11.0	20.7	17.2	13.8
1977	12.4	10.4	8.4	15.1	12.6	10.0	18.3	15.2	12.0
1978	11.6	9.7	7.7	13.4	11.1	8.8	15.6	12.9	10.1
1979	10.2	8.4	6.6	11.4	9.3	7.3	12.6	10.3	8.0
1980	8.5	6.8	5.1	9.1	7.2	5.4	9.7	7.8	6.0
1981	6.7	5.2	3.7	7.0	5.3	3.8	7.1	5.5	3.8
1982	5.4	4.0	2.6	5.3	3.9	2.6	5.2	3.9	2.5

Table 6.2 BLUE WHITING, Northern area.
Fishing mortalities from VPA. M = 0.20

UNIT: Year-1		NATURAL MORTALITY COEFFICIENT = 0.20									
FISHING MORTALITY COEFFICIENT											

		1974	1975	1976	1977	1978	1979	1980	1981		
1		0.023	0.017	0.064	0.052	0.215	0.338	0.269	0.218		
2		0.003	0.004	0.011	0.016	0.033	0.075	0.184	0.140		
3		0.001	0.003	0.004	0.015	0.021	0.065	0.191	0.200		
4		0.002	0.002	0.006	0.018	0.063	0.080	0.106	0.180		
5		0.002	0.002	0.002	0.017	0.049	0.094	0.117	0.180		
6		0.003	0.004	0.005	0.012	0.057	0.084	0.151	0.180		
7		0.005	0.008	0.011	0.017	0.052	0.113	0.151	0.180		
8		0.007	0.011	0.017	0.033	0.073	0.116	0.175	0.180		
9		0.003	0.015	0.034	0.044	0.086	0.172	0.111	0.180		
10		0.012	0.013	0.052	0.087	0.147	0.264	0.338	0.180		
11		0.020	0.044	0.035	0.099	0.139	0.337	0.212	0.180		
12		0.017	0.076	0.170	0.083	0.149	0.514	0.545	0.180		
13		0.014	0.056	0.177	0.115	0.097	0.249	0.176	0.180		
14		0.050	0.050	0.100	0.180	0.180	0.180	0.180	0.180		
15+		0.050	0.050	0.100	0.180	0.180	0.180	0.180	0.180		
F(4-14),U		0.012	0.026	0.055	0.064	0.099	0.200	0.206	0.180		
F(4-14),W		0.003	0.005	0.010	0.024	0.068	0.138	0.171	0.180		

Table 6.3 BLUE WHITING, Northern area.
Stock size in numbers (millions) at 1 January.
Biomass unit: thousand tonnes.

	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	23604	14387	13466	9728	5482	7195	1519	383*	*****
2	22364	18694	11583	10337	7557	3619	4203	950	252
3	26024	18261	15400	9382	8325	5987	2749	2861	676
4	17035	21291	14899	12552	7571	6678	4592	1858	1918
5	11510	13925	17394	12126	10097	5821	5047	3382	1271
6	5972	9403	11377	14215	9756	7869	4340	3675	2313
7	3444	4873	7066	9264	11495	7548	5926	3054	2513
8	2590	2806	3958	6210	7458	8931	5520	4172	2089
9	1538	2106	2272	3186	4920	5674	6512	3793	2853
10	433	1256	1698	1797	2497	3697	3911	4773	2594
11	222	350	1015	1320	1349	1765	2325	2283	3264
12	195	178	274	802	979	962	1031	1540	1562
13	138	157	135	189	605	691	471	490	1053
14	18	111	121	93	138	449	441	323	335
15+	25	83	77	47	108	253	34	199	358
TOTAL	115111	108032	101336	91249	78337	67139	48621	33739	
SSB	26084	35249	45988	49250	49402	43660	35558	27686	
TOTAL BION	11001	11474	11472	11087	10308	9020	7387	5754	
SSB-BION	3825	5218	6854	7574	7809	7144	6146	5053	

Table 6.4 Catch per unit effort¹⁾ in the BLUE WHITING fisheries, 1976-82 (fishing gear: mid-water trawl).

Division	GRT-class	Country	Time period	Years							Units
				1976	1977	1978	1979	1980	1981	1982	
IIa	2000-3999.9	German Dem.Rep. Poland USSR USSR	Jul-Sep	- ²⁾	-	1.99 ⁴⁾	2.19	3.11	2.25	....³⁾	c/hour
			Jul-Aug	-	-	14.0	17.8	24.0	19.7	....	c/day
			Jul-Sep	-	-	-	3.04	3.82	2.54	....	c/hour
			Jul-Sep	-	2.31	2.70	-	-	-	-	c/hour
Vb	2000-3999.9	German Dem.Rep. Poland USSR USSR	Jun-Jul	-	1.38	1.77	2.20	-	3.88 ⁵⁾	c/hour
			May-Jun	27.0	36.7	17.2	43.66)	-	-	-	c/day
			Mar-May	-	-	-	5.83	5.23	5.97	....	c/hour
			Jun-Jul	-	2.98	4.62	-	-	-	-	c/hour
	1000-1999.9	Faroes Iceland	May	-	17.6	13.6	10.6	6.2	9.6	-	c/hour
			May	-	55.6	57.5	33.8	43.3	79.2	-	c/day
VIa	500-999.9	Faroes Norway	April Mar-Apr	-	17.4	19.8	21.4	16.4	-	-	c/hour
				....	....	....	....	....	42.9	50.2	c/hour
IVa	500-999.9	Norway	Apr-May	....	....	....	....	....	13.2	19.5	c/hour

1) Calculated as Σ of monthly cpue/no. of months.

2) Hyphen means: no fishing.

3) Dots mean the data not yet available.

4) Refers to June-July period.

5) Refers to January-May period.

6) Refers to April-May period.

Table 6.5 Catch per unit of effort in the BLUE WHITING fisheries in Sub-division IIA for 2 000 - 3 999.9 GRT class, using mid-water trawls, 1978 - 1981.

Month	Catch				Effort				C.P.U.E.				Ratio 80/81
	1978	1979	1980	1981	1978	1979	1980	1981	1978	1979	1980	1981	
	(tonnes)				(hours)				(tonnes/hour)				
<u>German Dem. Rep.</u>													
Jan													
Feb													
Mar													
Apr													
May		407	546	159		127	279	210		3.20	1.96	0.76	
Jun	848	2 548	3 025	2 566	247	893	999	2 046	3.43	2.85	3.03	1.25	
Jul	55	2 317	3 523	5 951	100	792	902	2 596	0.55	2.93	3.91	2.29	
Aug		64	2 871	4 130		39	965	2 079		1.64	2.98	1.99	
Sep		862	605	1 481		430	248	627		2.00	2.44	2.47	
Oct			1 128	55			424	53			2.66	1.04	
Nov			1 380				275				5.02		
Dec			754				230				3.28		
All months	903	6 198	13 832	14 310	347	2 281	4 322	7 611	2.60	2.71	3.20	1.88	
Jul 1) - Sep 2)	-	3 243	6 999	11 540	-	1 261	2 115	5 302	-	2.57 2.19	3.31 5.11	2.18 2.25	0.66 0.12
<u>Poland</u>													
Jan													
Feb													
Mar													
Apr													
May		948				21				45.1			
Jun		2 216	200	210		80	25	13		27.7	8.0	16.1	
Jul	129	896	1 405	369	13	59	62	30	9.9	15.2	22.7	12.3	
Aug	2 269	264	3 268	569	126	13	130	21	18.0	20.3	25.2	27.1	
Sep	1 393		3 123		113		128		12.3		24.4		
Oct	554		1 757	526	34		93	43	16.3		18.9	12.2	
Nov			1 383	178			72	10			19.2	17.8	
Dec													
All months	4 763	4 324	11 137	1 852	303	173	510	117	15.7	25.0	21.8	15.8	
Jul 1) - Aug 2)	2 398	1 160	4 674	938	139	72	192	51	17.3 14.0	16.1 17.8	24.3 24.0	18.4 19.7	0.76 0.82
<u>U.S.S.R.</u>													
Jan		8 992	2 927										
Feb		4 959	2 153			1 833	339			2.70	6.35		
Mar		5 520	16 811	3 886		1 538	6 151	1 208		3.59	2.73	3.22	
Apr		3 382	36 284	45 645		1 933	16 119	12 666		1.74	2.25	3.60	
May		51 409	125 988	88 754		15 336	25 244	25 912		3.35	4.99	3.42	
Jun		110 918	114 117	78 727		38 069	47 634	37 919		2.91	2.39	2.08	
Jul		124 618	121 463	87 582		42 166	42 319	39 039		2.95	2.87	2.24	
Aug		142 962	114 505	63 889		47 395	28 293	29 528		3.01	4.05	2.16	
Sep		106 606	79 504	37 960		33 755	17 499	11 745		3.16	4.54	3.23	
Oct		57 562	50 954	11 560		16 574	16 072	3 270		3.47	3.17	3.53	
Nov		16 317	17 543	4 778		6 841	5 710	1 455		2.39	3.07	3.28	
Dec		5 830	1 292	10 704		2 867	413	4 263		2.03	3.13	2.51	
All months		639 129	683 541	433 485		210 936	206 372	167 005		3.03	3.31	2.60	
Jul 1) - Sep 2)		314 186	315 472	189 431		123 316	88 111	80 312		3.03 3.04	3.58 3.82	2.36 2.54	0.66 0.66

1) CPUE = Total catch/total effort

2) CPUE = \sum Monthly CPUE/Nb of months

Table 7.1 BLUE WHITING, Northern area.
Input data for catch predictions.

FIRST YEAR: 82
LAST YEAR: 85

THE LAST AGE GROUP IS A PLUS GROUP

LIST OF RECRUITMENT BY YEAR:

YEAR	RECRUITMENT
82	4765000.
83	4765000.
84	4765000.
85	4765000.

LIST OF INPUT VARIABLES BY AGE GROUP:

AGE	STOCK SIZE	F-PATTERN	M	MATURITY OGIVE	WEIGHT IN THE CATCH	WEIGHT IN THE STOCK
1	4765000.00	0.2180	0.200	0.0000	0.0630	0.0630
2	252000.00	0.1400	0.200	0.0000	0.0920	0.0920
3	676000.00	0.2000	0.200	0.0000	0.1180	0.1180
4	1918000.00	0.1800	0.200	0.0000	0.1350	0.1350
5	1271000.00	0.1300	0.200	1.0000	0.1450	0.1450
6	2313000.00	0.1800	0.200	1.0000	0.1550	0.1550
7	2513000.00	0.1800	0.200	1.0000	0.1700	0.1700
8	2089000.00	0.1800	0.200	1.0000	0.1780	0.1780
9	2853000.00	0.1800	0.200	1.0000	0.1870	0.1870
10	2594000.00	0.1800	0.200	1.0000	0.1990	0.1990
11	3264000.00	0.1800	0.200	1.0000	0.2080	0.2080
12	1562000.00	0.1800	0.200	1.0000	0.2280	0.2280
13	1053000.00	0.1800	0.200	1.0000	0.2340	0.2340
14	535000.00	0.1800	0.200	1.0000	0.2490	0.2490
15+	3580000.00	0.1800	0.200	1.0000	0.2570	0.2570

Table 8.1 Length composition of the landings from the Portuguese and Spanish fleets in the southern area (Divisions VIIIc and IXa).

Length (cm)	VIIIc + IXa ICES					
	1980			1981		
	Portugal	Spain	TOTAL	Portugal	Spain	TOTAL
8	0	0	0	19	0	19
9	0	0	0	7	0	7
10	307	0	307	19	0	19
11	606	70	676	3	0	3
12	140	0	140	0	0	0
13	0	112	112	40	0	40
14	127	922	1 049	136	86	222
15	1 687	24 022	25 709	212	4 257	4 469
16	5 711	61 960	67 671	281	9 443	9 724
17	14 356	78 479	92 835	1 835	39 668	41 503
18	29 904	108 909	138 813	12 408	79 470	91 878
19	27 191	111 811	139 002	38 226	118 125	156 351
20	23 835	81 741	105 576	41 136	136 686	177 822
21	15 260	38 922	54 182	32 973	111 216	144 189
22	4 256	19 114	23 370	17 720	61 780	79 500
23	1 392	6 411	7 803	5 597	23 994	29 591
24	562	1 662	2 224	1 540	8 517	10 057
25	443	1 019	1 462	562	3 317	3 879
26	239	813	1 052	341	1 396	1 737
27	263	490	753	198	713	911
28	237	493	730	66	409	475
29	185	274	459	68	141	209
30	118	231	349	32	71	103
31	183	97	280	16	50	66
32	234	87	321	14	73	87
33	168	106	274	1	47	48
34	90	50	140	1	35	36
35	44	43	87	1	27	28
36	37	44	81	1	25	26
37	15	16	31	0	20	20
38	0	23	23	0	3	3
39	0	11	11	0	1	1
40	0	6	6	0	0	0
Total number	127 590	537 938	665 528	153 453	599 570	753 023
Total weight (tonnes)	6 051	23 862	29 913	7 387	30 728	38 115
Average weight (g)	47	44	45	48	51	51

Table 8.2 Data on landings, effort and catch per unit effort of the Portuguese and Spanish fleets in Divisions VIIIc and IXa of the southern area.

Landings				Effort				Year	c.p.u.e.			
Year	Spain	Portugal	Total VIIIc+IXa	Year	Spain	Portu- gal	Spain [#] 3)		Portugal (hours)	(t/boat)	Portugal (t/boat)	Spain [#] 3)	Portu- gal kg/hr
1966	20 648			1966		69		174 142				
1967	21 140			1967		71		206 137				
1968	20 756			1968		80		217 121				
1969	10 300			1969		79		232 179				
1970	16 875			1970		87		257 172				
1971	11 800			1971		89		289 972				
1972	28 090			1972		93		280 943				
1973	26 741			1973		104		369 300				
1974	24 627			1974		104		340 000 ²⁾				
1975	30 790			1975		101		350 000 ²⁾				
1976	29 470			1976		111		340 000 ²⁾				
1977	25 259 ¹⁾	1 557	26 816	1977		116		374 000 ²⁾		13.42		4.16
1978	31 428 ¹⁾	2 381	33 809	1978		109	53 447	270 000 ²⁾		21.84	296	8.82
1979	25 016 ¹⁾	2 096	27 112	1979		117	53 340	294 000 ²⁾		17.91	256	7.13
1980	23 862 ¹⁾	6 051	29 913	1980	287	119	42 947	313 000 ²⁾	83.14	50.85	283	19.33
1981	30 728 ¹⁾	7 388	38 116	1981	261	114	39 845	260 000 ²⁾	119.56	64.81	414	27.51

#) Port of la Coruña only

2) Estimated.

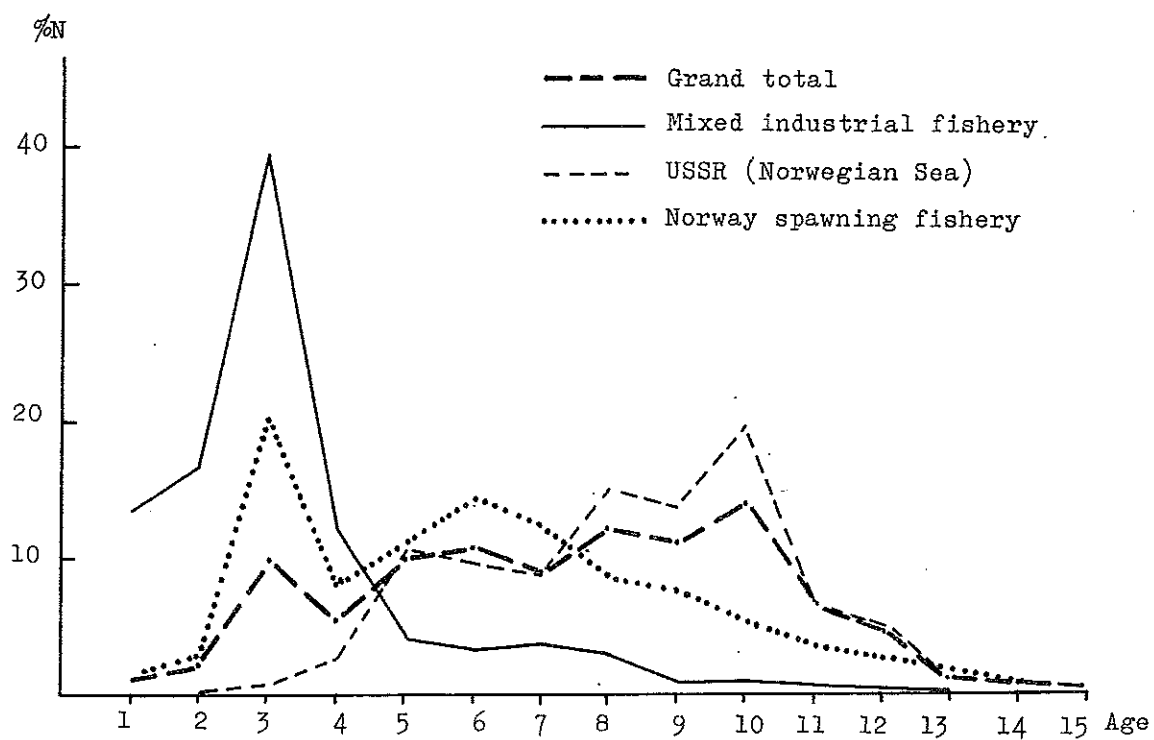
1) Data from IEO

3) kg/HP x days fishing x 10⁻²

Table 8.3 Catch per hour and its standard deviation on R/V "Noruega" in random hauls with each stratum along the Portuguese coast.

Month	Year	Depth Zone	20-100 m		100-200 m		200-500 m	
			Mean catch rate kg/hr	Standard deviation	Mean catch rate kg/hr	Standard deviation	Mean catch rate kg/hr	Standard deviation
Jun	1979	41°50'N	.1	.06	26.8	21.3	33.5	.2
May-Jun	1980		.4	.25	7.5	4.0	236.0	174.0
Jun	1981		0	0	13.4	7.9	398.8	80.4
Oct	1979	40°50'N	.7	.42	23.7	23.4	38.5	19.0
Oct	1980		4.5	4.5	16.3	13.8	57.5	41.0
Mar	1980		-	-	-	-	-	-
Mar	1981		0	0	.9	.9	84.0	5.5
Jun	1979	40°50'N	0	0	74.0	68.0	1.5	.1
May-Jun	1980		0	0	1.0	.4	3.5	3.5
Jun	1981		0	0	0	0	105.5	64.2
Oct	1979	39°50'N	0	0	4.0	1.3	0	0
Oct	1980		10.0	10.0	11.9	8.3	22.2	21.6
Mar	1980		-	-	-	-	-	-
Mar	1981		0	0	10.1	.6	2.4	.9
Jun	1979	39°50'N	.6	.6	7.8	5.4	30.1	26.6
May-Jun	1980		3.0	2.7	6.0	3.7	5.1	.7
Jun	1981		.1	.1	3.2	0	116.4	25.1
Oct	1979	37°50'N	16.5	16.5	33.9	18.5	50.5	13.5
Oct	1980		0	0	10.3	8.3	654.7	477.5
Mar	1980		0	0	278.7	270.9	8.7	1.3
Mar	1981		0	0	9.0	9.0	314.2	247.2
Jun	1979	37°50'N	-	-	-	-	186.9	96.4
May-Jun	1980		0	0	.1	.1	69.3	41.4
Jun	1981		0	0	0	0	179.5	33.1
Oct	1979	8°45'W	-	-	1.0	1.0	196.2	123.5
Oct	1980		0	0	0	0	1010.1	752.2
Mar	1980		0	0	0	0	1.5	.5
Mar	1981		0	0	0	0	59.1	33.2
Jun	1979	8°45'W	0	0	2.4	2.4	105.1	77.0
May-Jun	1980		0	0	6.0	4.5	42.9	22.3
Jun	1981		0	0	14.1	14.1	327.8	163.5
Oct	1979	7°25'W	0	0	0	0	27.2	4.2
Oct	1980		0	0	4.0	4.0	30.8	25.3
Mar	1980		0	0	0	0	.9	.9
Mar	1981		0	0	324.3	324.3	100.8	89.2

Figure 4.1 Percentage age composition of BLUE WHITING
in various fisheries in the northern areas in 1981.



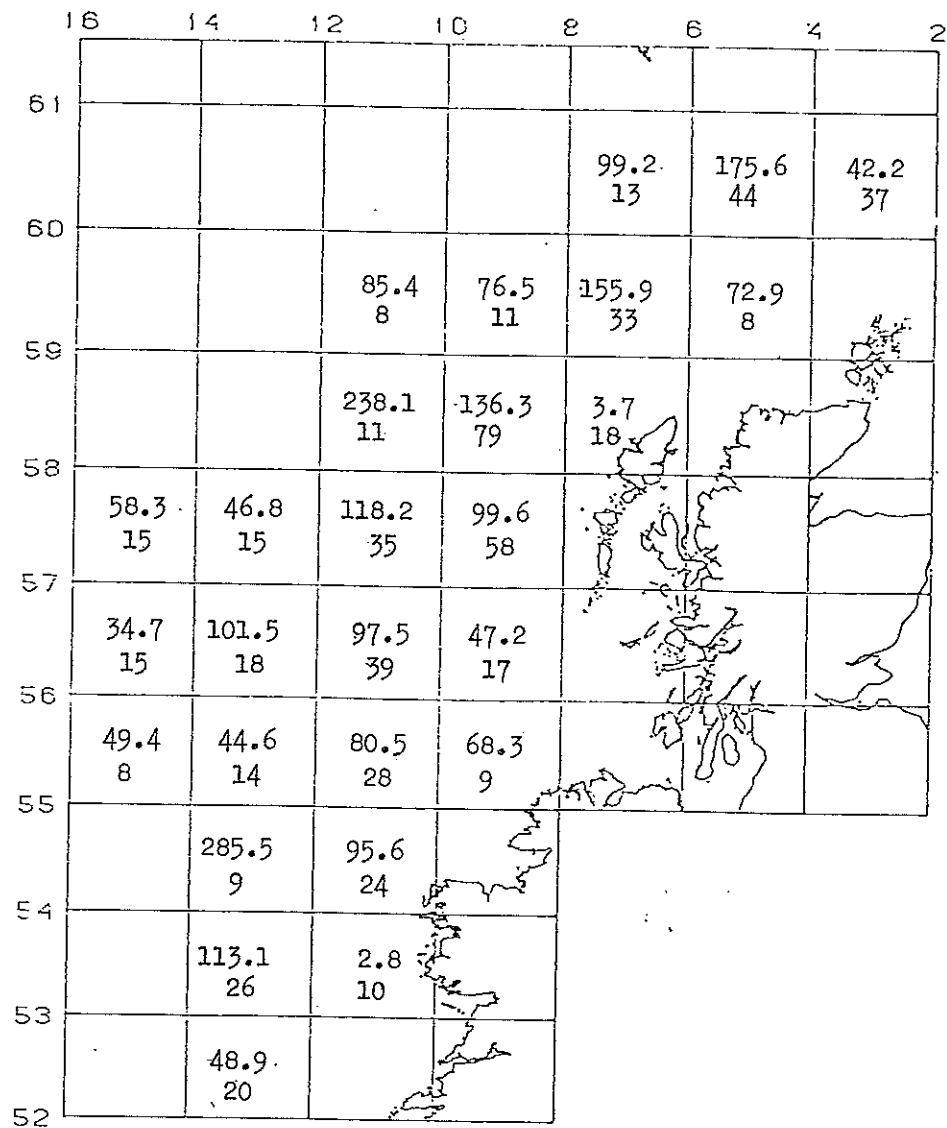


Figure 6.1 Estimated biomass of BLUE WHITING in 1° by 2° rectangles 18 March - 4 April 1982.
Upper figure = estimate in '000 tonnes.
Lower figure = number of observations.

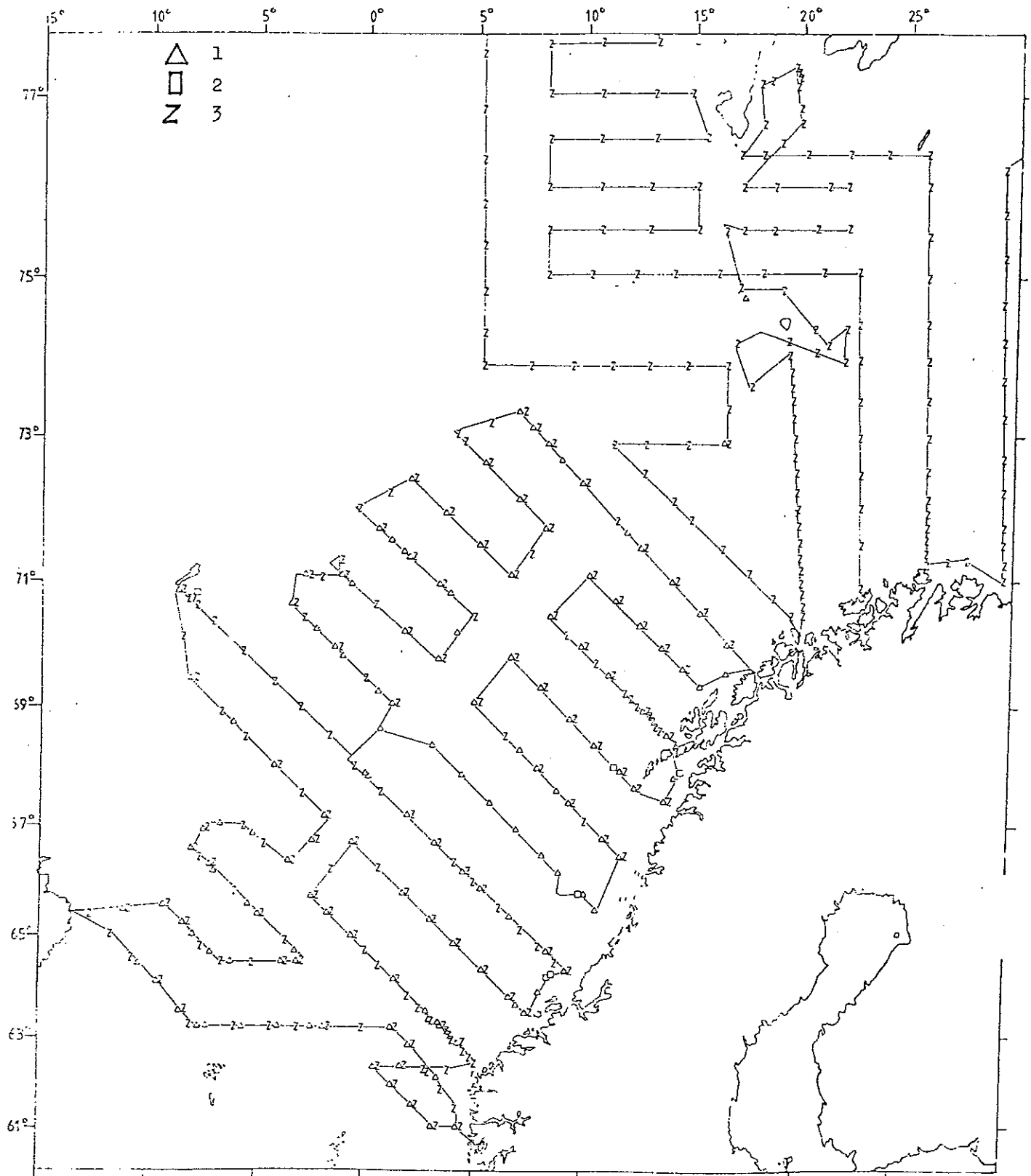


Figure 6.2 Cruise tracks and stations worked with R/V "G O Sars" and "Michael Sars" August/September 1981.
1) Pelagic trawl; 2) bottom trawl; 3) CTD-sonde.

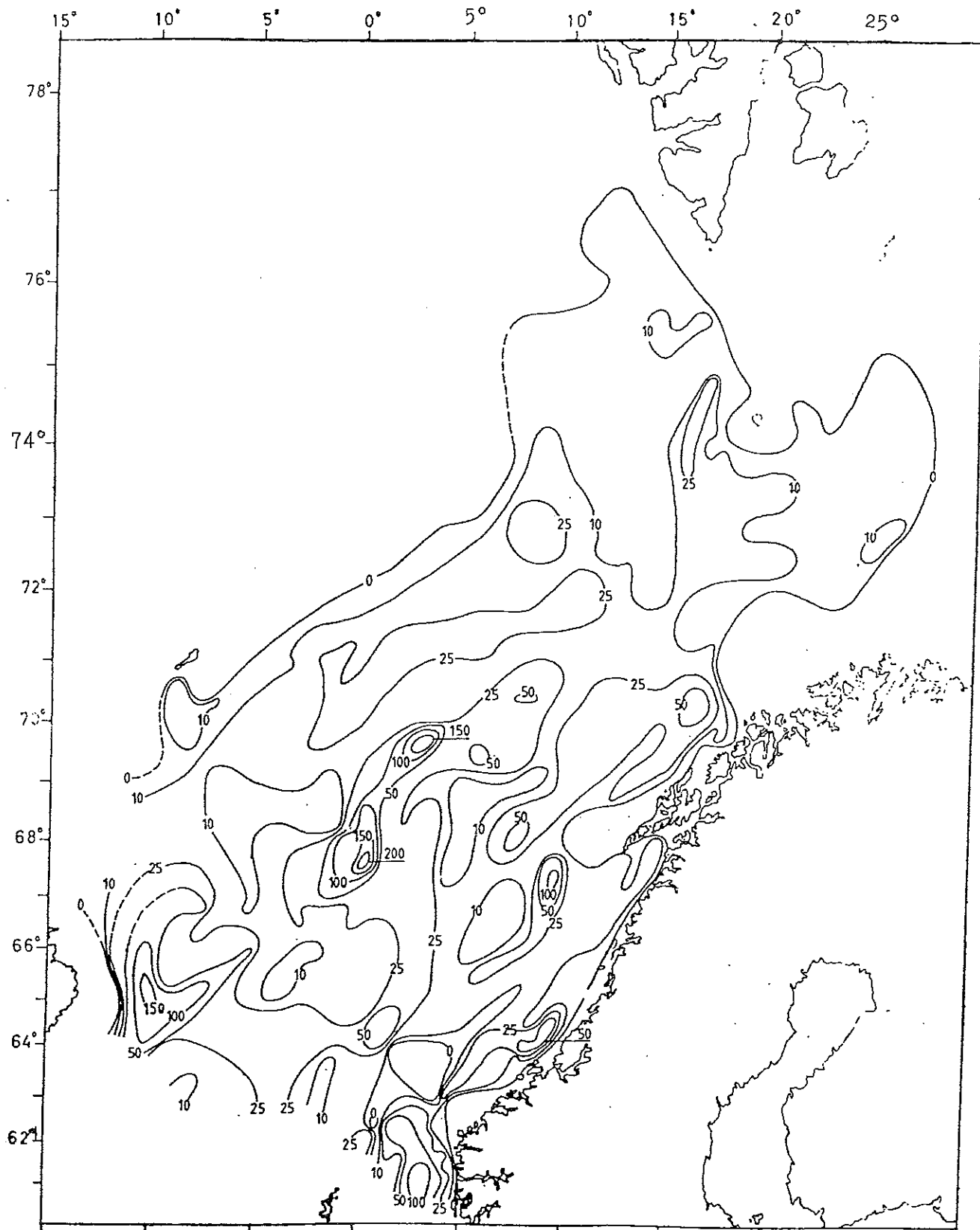


Figure 6.3 Distribution and relative densities of Blue Whiting in August/September 1981. Echo-intensity expressed in mm deflection per nautical mile.

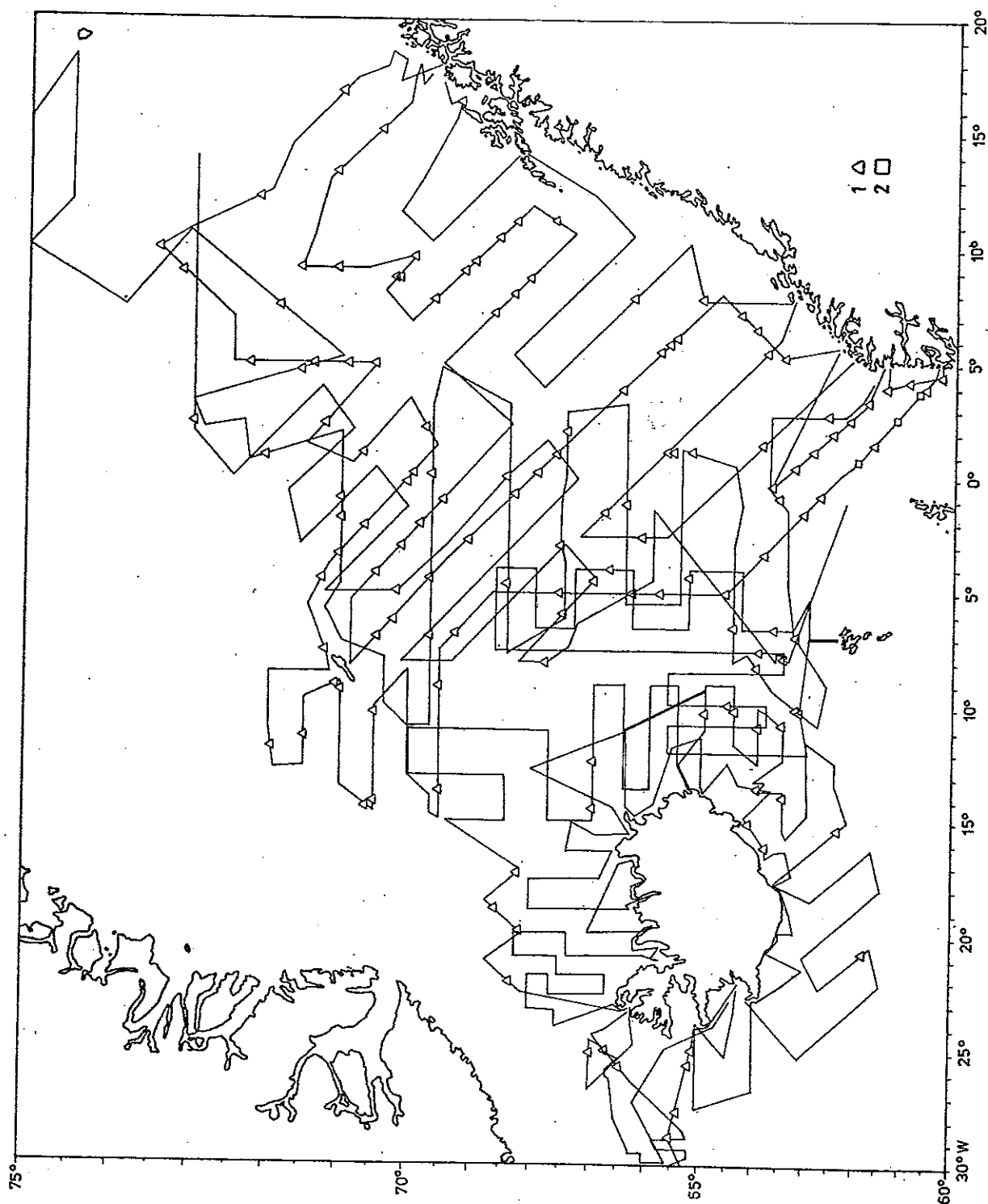


Figure 6.4 Cruise tracks and trawl stations with R/V "G O Sars", "Johan Hjort", "Michael Sars", "Arni Fridriksson", "Bjarni Samundsson", "Magnus Heinason", "Eisbär", in August 1982.
1. Pelagic trawl. 2. Bottom trawl.

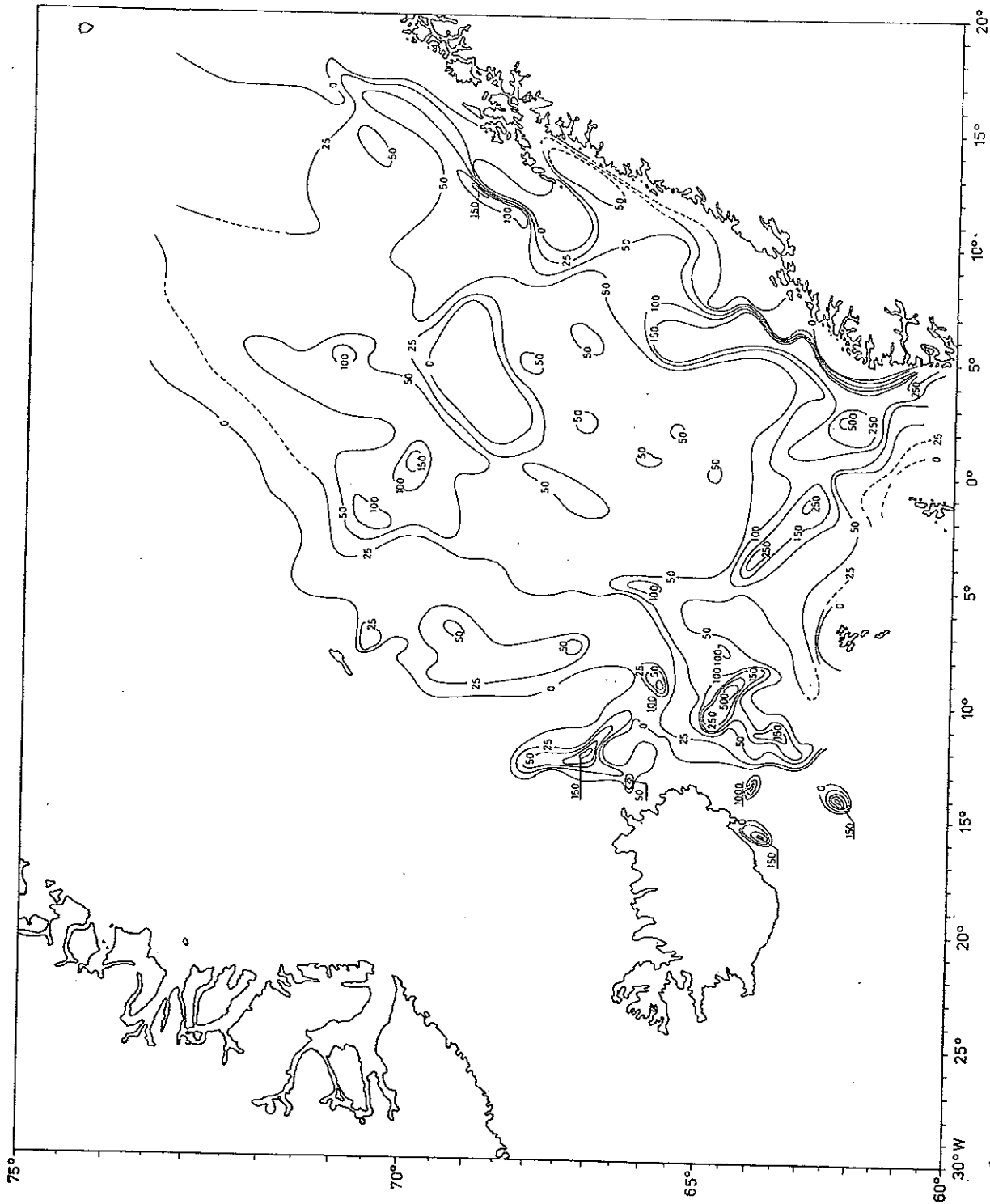


Figure 6.5 Distribution and relative densities of Blue Whiting in August 1982. Echo-intensity expressed as square meter reflected per square nautical mile x 10.

Figure 6.6 Catch, effort, and catch per unit effort by month for the USSR GRN 2000-3999.9 + vessel class in Division 11a, 1979-81.

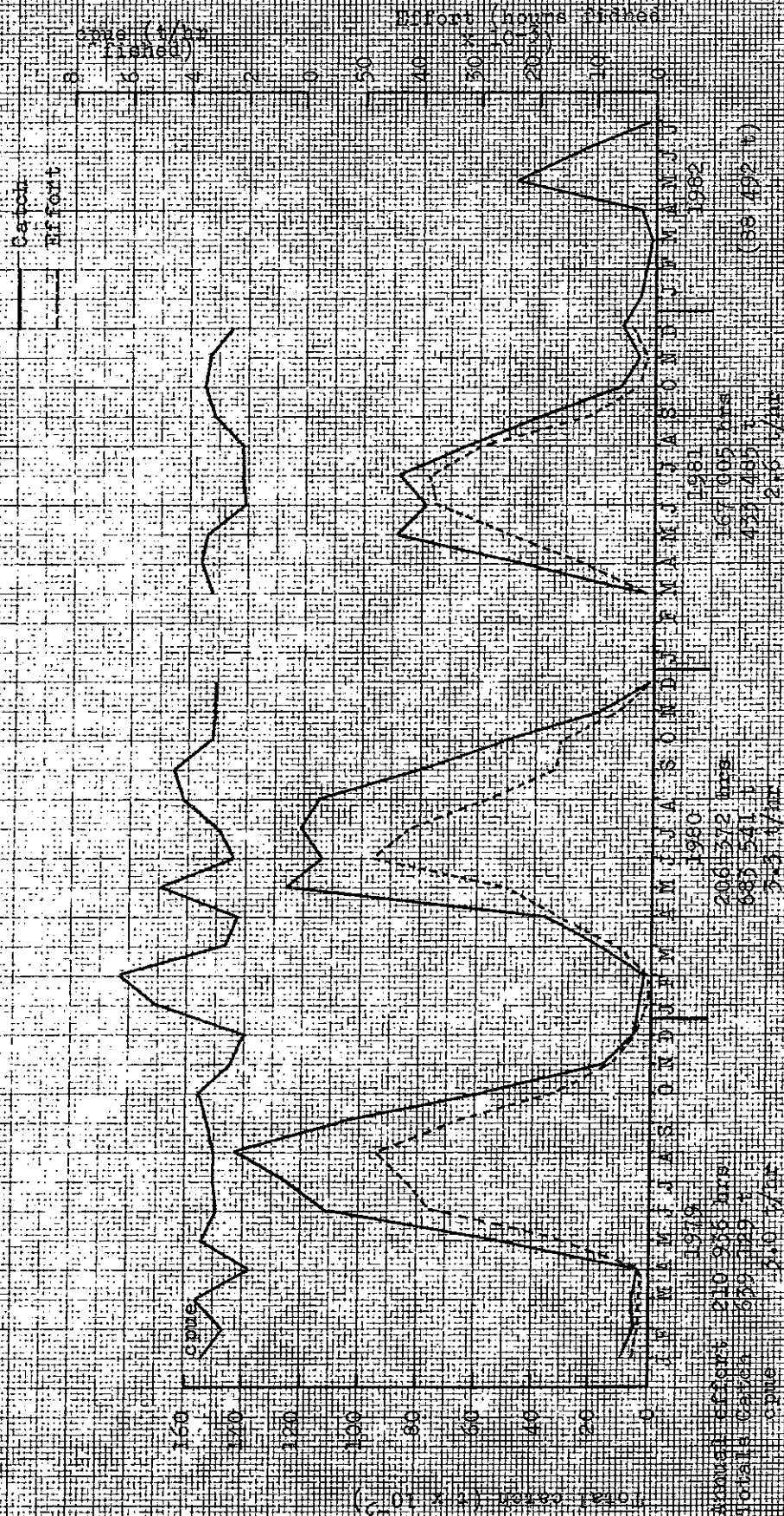
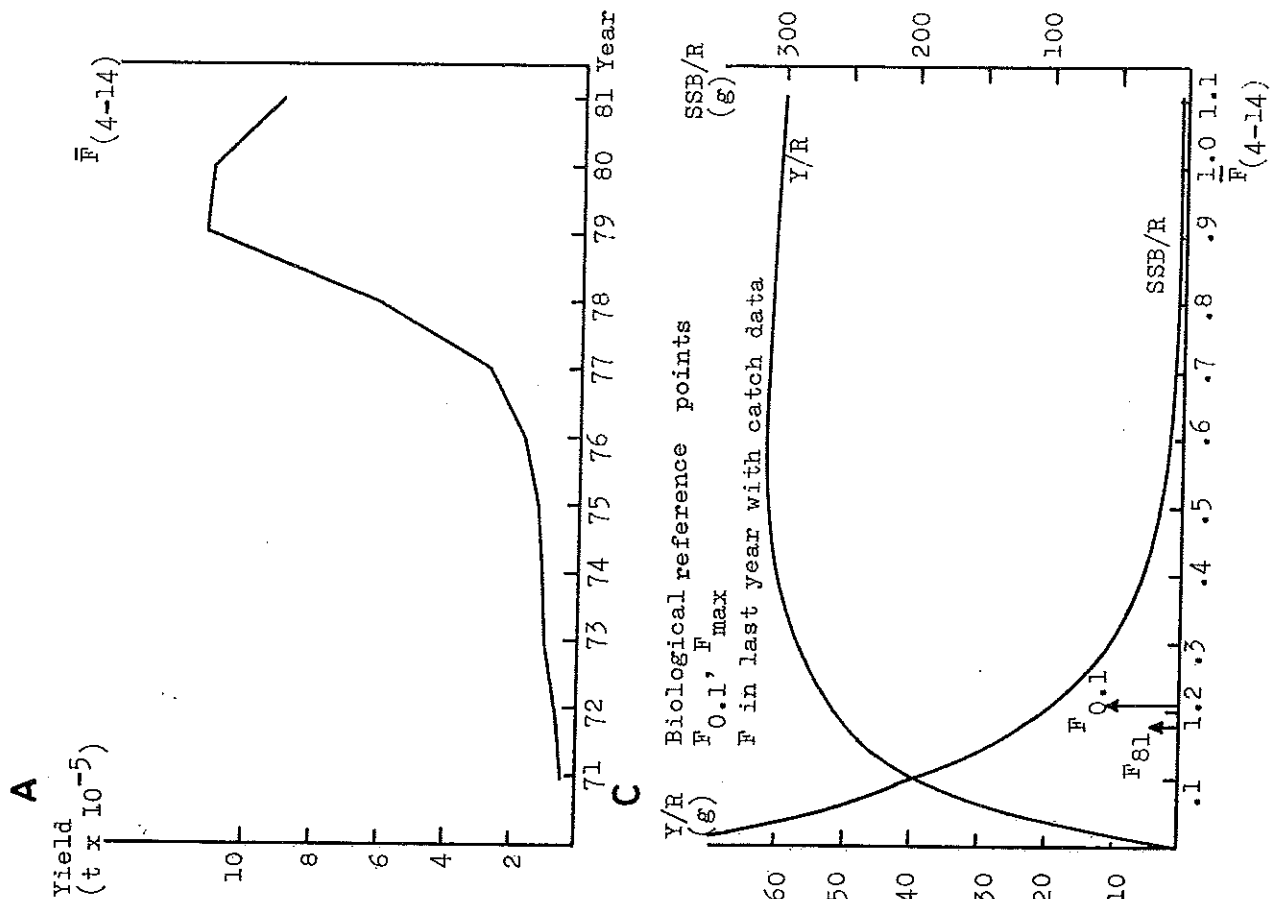


Figure 7.1 BLUE WHITING, NORTHERN AREA.



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(4-14)

Figure 8.1 Length distributions of BLUE WHITING in the different depth strata during the cruise of R/V "Noruega" in June 1981.

