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REPORT OF THE BLUE WHITING ASSESSMENT WORKING GROUP

Copenhagen, 25 September - 2 October 1985

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REPORT OF THE BLUE WHITING ASSESSMENT WORKING GROUP

1. INTRODUCTION

1.1 Terms of Reference

The Blue Whiting Assessment Working Group (Chairman: Mr H í Jakupsstovu) met at ICES headquarters from 25 September to 2 October 1985 (C.Res.1984/2:4:19) to assess catch options inside safe biological limits for the Northern and Southern blue whiting stocks in 1986.

Further, NEAFC, at its meeting during 27-29 November 1984, requested ICES to present estimates of the distribution in time and space of catches and stock biomass of different life stages of blue whiting (Northern stock), within and beyond the areas under the fisheries jurisdiction of the contracting parties.

At the same meeting, the Portuguese Delegate requested that ICES should provide the Commission with information on the Southern stocks (ICES Divisions VIId and e and Sub-areas IX and X) of hake, sardine and blue whiting. It was suggested that ICES could provide advice on the seasonal distribution of the stocks and the level of each part of the catch over a period of years.

Finally, ACFM had the following comments to the Blue Whiting Assessment Working Group report of 1984: "The Group should have a closer look at the exploitation pattern assumed in the prediction. The Group did not comment on the industrial fishery with a 16-mm trawl mesh size, when discussing the effects of a 40-mm mesh size. The Group should assess the effect of the industrial small-mesh fisheries on the yield from the Blue Whiting stock". (Ulltang, 1985.)

1.2 Participants

H J L Heessen	Netherlands
H í Jakupsstovu (Chairman)	Faroe Islands
M Liwoch	Poland
T Monstad	Norway
V Shleinik	USSR
S Sveinbjörnsson	Iceland

2. LANDINGS

2.1 Landings in 1984

Estimates of total landings by countries from the various fisheries are given in Tables 2.2-2.6 and summarised in Table 2.1.

The total landings from all Northern blue whiting fisheries in 1984 were estimated at 586,504 tonnes compared to a total in 1983 of 539,235 tonnes.

There was an increase of about 10% in the total landings from the spawning fishery in 1984 compared to 1983, mainly due to larger landings by USSR, Norway and the Faroe Islands.

In some landings from the spawning fishery in Division VIa, greater silver smelt (*Argentina silus*) constituted a significant by-catch. No estimate of the magnitude of this by-catch was presented to the Working Group, but based on information from Norwegian observers, this could be in the order of 10% of the

Norwegian landings. The landing figures given in Tables 2.1 and 2.3 have not been corrected for this.

The total landings from the Norwegian Sea fisheries increased by about 20% compared to the 1983 landings, mainly due to larger landings by the USSR in 1984.

The total landings from the mixed industrial fisheries and from the directed fisheries were at the same level as in 1983.

The total landings from the Southern area fishery increased about 29% in 1984 compared to 1983.

2.2 Landings in 1985

Preliminary information on landings of blue whiting submitted by Working Group members and by some countries reporting on ICES Data Form 5 are presented in Table 2.7.

3. STOCK IDENTITY AND STOCK SEPARATION

No further investigations on stock identity and stock separation of the blue whiting stocks were reported to the Working Group.

4. OTOLITH EXCHANGE PROGRAM

The Blue Whiting Assessment Working Group in 1983 (Anon., 1984a) recommended that an international otolith exchange program be set up to achieve and maintain consistency in the ageing of blue whiting in various countries. V Shleinik (USSR) was appointed coordinator of the program. The program was initiated very soon after the Working Group meeting, but has unfortunately not yet been completed, due to delays by several countries in reading the circulating otoliths. The Working Group recommends that the program should be completed and reported to the next meeting of the Working Group.

5. AGE COMPOSITION OF LANDINGS

The age composition of the landings in 1983 was slightly revised and new data were made available for 1984.

For the directed fisheries in 1984, age composition data were provided by the Faroe Islands, the German Democratic Republic, Norway and the USSR. These data together accounted for 94% of the landings in the directed fisheries. Other landings from the spawning fishery were assumed to have the same relative age composition as the part that was sampled. Data from the Norwegian Sea fishery (fishery on feeding fish) were treated separately. The age composition of the catches in the directed fisheries is given in Table 5.1.

For landings of blue whiting taken in the mixed industrial fisheries, data on age composition were only available for Norwegian catches, which accounted for not more than 45% of the total industrial catches. Landings from other countries, mainly from Denmark, were assumed to have the same age composition as those of Norway (Table 5.2).

The raised age compositions for the directed fisheries and the mixed industrial fisheries were summed to give the total age composition in the Northern Area (Table 5.3).

6. WEIGHT AT AGE

Mean-weight-at-age data for 1984 were presented by the Faroe Islands, the German Democratic Republic, Norway and the USSR. Weighted mean weights for the spawning fishery, the feeding fishery and the mixed industrial fishery were calculated.

An overall mean was calculated, weighted by the total landings in numbers in each fishery. The total catch landed in 1984 was compared to the sum of products (SOP) of total numbers landed in 1984 and mean-weight-at-age. The calculated SOP was within 1% of the nominal landings. The mean-weights-at-age used in the VPA runs are shown in Table 6.1.

7. AGE AT MATURITY

The acoustic survey during the spawning season in 1984 showed that 40% of the 1982 year class in numbers matured at age 2 (Ermolchev et al., 1985). In 1985, a considerably higher number of the same year class was mature (80%)(Belikov et al., 1985). Based on this, the Working Group decided to change the age at maturity used for calculation of the spawning stock from knife-edge maturity at age 3 to the one shown in Table 8.4. There is, however, the possibility that the changes in the age at maturity observed are density-dependent and are connected with the decrease in the spawning stock observed in recent years up to 1984.

8. STOCK ESTIMATES

8.1 Acoustic Surveys in 1985

8.1.1 Surveys during the spawning season

During the spawning season of 1985, two independent surveys on the blue whiting stock were conducted in the area west of the British Isles by the Faroes and USSR.

The Faroese survey (Jakupsstovu and Thomsen, 1985) took place from 29 March to 16 April and covered the shelf edge from the Faroe Islands to the Porcupine Bank. Blue whiting were recorded over a rather wide area, compared to 1984, along the entire shelf area. The best concentrations were recorded in the southern part of the area surveyed, especially between 55°20'N and 57°20'N (Figure 8.1). The total biomass of blue whiting within the area surveyed was estimated to be 6.4 million tonnes, equivalent to 75,600 million individuals. Based on preliminary age determinations (Figure 8.2), the 1982 year class was estimated at 45,200 million, the 1983 year class at 11,000 million and the 1981 and older year classes at 19,400 million. Based on the length distribution (< 28 cm), the biomass of the recruiting year classes, i.e. 1982 and younger year classes, was estimated at 4.7 million tonnes and the 1981 and older year classes at 1.7 million tonnes.

The USSR survey took place from 21-29 April north and west of the British Isles (Belikov et al., 1985). For the acoustic assessment, the same method was used as in 1984 (Ermolchev et al., 1985). The most dense concentrations were observed in a narrow area along the shelf edge between 58° and 61°N (Figure 8.3).

The biomass of blue whiting was estimated to be 2.8 million tonnes, equivalent to 23,100 million individuals, within the area surveyed. Of this amount, the adults ($\geq$ 26 cm) constituted 2.7 million tonnes and 21,500 million individuals. The bulk of the concentration consisted of the 1982 and older year classes.

The results from the two different surveys are listed in the text table below:

Country	Time of survey	Area	Biomass in million tonnes		
			Young	Adult	Total
Faroes	29/3 - 16/4	61°00'-53°40'N	4.7	1.7*	6.4
USSR	21 - 29/4	64°00'-55°00'N	.1	2.7**	2.8

* $\geq$ 28 cm
** $\geq$ 26 cm

In Figure 8.4, the length and age composition of blue whiting in samples collected from commercial catches by Norwegian vessels west of the British Isles is shown by month and area. The catches consisted of both young and old fish. In Division VIa in February, old fish (1979 and older year classes) together with the strong 1982 year class made up the bulk of the catches. In March, the contribution of the youngest year classes increased, and in the south in the Porcupine Bank area (Divisions VIIb,c), the 1982 year class constituted more than 80% in number of the catches (Monstad, 1985a). During a Norwegian survey in April along the shelf edge from Bergen to the Lofoten (Monstad, 1985b), blue whiting were recorded along the entire shelf edge. Rather good recordings were made at three localities: 63°20'N, 66°N and at 67°N (Figure 8.5). Young fish (1982 and younger year classes) predominated in the samples. While the 1982 year class was most numerous in the north, the 1984 year class was most abundant in the south. The 1983 year class was more evenly distributed. Large blue whiting ($\geq$30 cm) were found in the samples only to a very limited extent.

8.1.2 Surveys in the feeding season

In August 1985, the fourth ICES Coordinated Acoustic Survey was carried out in the Norwegian Sea with seven vessels from five countries taking part (Anon., 1985b and 1985c).

The cruise tracks and trawl stations are shown in Figure 8.6, and the distribution of blue whiting and its relative abundance in Figure 8.7. The distribution pattern was very similar to the distribution during the last three years, with the highest concentrations in the southern part of the investigated area (Anon., 1982, 1983b and 1984b). High concentrations were especially found around the Faroe Islands, west of Iceland and along the western Norwegian coast. The zero line of blue whiting distribution was not defined either in the north or in the south.

Using the same methods for assessment as in previous years (Anon., 1982), the total biomass of blue whiting was estimated to be 4.9 million tonnes, which is equivalent to 47,200 million individuals. The total biomass estimate divided into rectangles and areas is presented in Figure 8.8. The total age composition estimated from the weighted length distribution (Figure 8.9) by area and age/length keys established from otolith analysis of samples from the Norwegian vessels is shown in Figure 8.10 and in the text table below.

Year class	Number (100 million)	Biomass (1,000 tonnes)
1985	2.2	26.8
1984	6.0	470.6
1983	24.0	2,404.9
1982	12.5	1,583.4
1981	2.4	462.4
Total	47.1	4,948.1

8.1.3 Discussion

In the following text table, the various estimates (million tonnes) obtained in the spawning area and in the Norwegian Sea since 1981 are listed (the adult component is given in brackets):

Area	1981	1982	1983	1984	1985
Spawning area	6.1 (5.4)	2.5	4.7 (4.4) 3.6 (3.6)	2.7 (2.4) 3.4 (2.7)* 2.8 (2.1) 2.4 (2.2)*	6.4 (1.7)* 2.8 (2.7)**
Norwegian Sea	4.9	4.6 (4.1)	2.8 (1.1)*	3.8 (0.4)*	4.9 (0.5)*

* 1981 and older year classes
** 1982 and older year classes

Due to the difference in timing of the two surveys in the spawning areas west of the British Isles in the spring of 1985, it is difficult to compare the estimates obtained. The USSR survey took place at a time when a significant part of the main spawning stock had began the northward migration, and the spawning stock is probably underestimated by this survey. Due to incomplete coverage, especially in the Rockall Channel, the estimate obtained during the Faroese survey also,to a certain extent, might be considered an underestimate.

Since the age determination of the Faroese samples was not finalized, the Working Group considered the estimate in numbers to be unreliable for calibration of the VPA. The age determination, however, indicated that most of the fish less than 28 cm belonged to the 1982 and younger year classes and that fish larger than 28 cm were from the older age groups. This gave a biomass estimate for the 1981 and older year classes of 1.7 million tonnes. Due to the underestimate mentioned above, the Working Group assumed the biomass for the 1981 and older year classes to be 1.9 million tonnes for the calibration of the VPA.

The Norwegian Sea survey in 1985 must also be considered an underestimate. The area from 60° to 71°N was covered between Norway and Greenland, but the zero line of the blue whiting distribution was not defined in either the north or the south.

In the north, during a bottom trawl survey to the Spitsbergen and Bear Island area in July-August 1985, large blue whiting (peak length at 36 cm) were caught along the entire shelf edge from 73° to 78°N. At some stations northwest and southwest of Bear Island, the numbers were quite significant (Anon., 1985c). Blue whiting might thus have been distributed further north than the area covered during the acoustic survey, but nothing can be said about the age composition.

In the south, during a survey in the Norwegian Deep in the second half of July 1985, blue whiting were recorded south to 58°N and were found to be at the same level of abundance as during a similar survey in 1984, i.e. in quite noticeable concentrations (Bergstad, pers.comm.). The Working Group made the assumption that the total underestimate in the Norwegian Deep and Skagerrak was of the order of 175,000 tonnes.

The area northwest of Scotland, where minor concentrations of blue whiting are recorded throughout the year, was not surveyed either.

The estimated total biomass of 4.9 million tonnes within the area surveyed in August 1985 is an increase of 1.1 million tonnes since 1984 and 2.1 million tonnes since 1983. The increase is mainly caused by the strong 1982 and 1983 year classes. Using the compensating figure from the Norwegian Deep, the total amounts to 5.2 million tonnes.

Of the estimate in numbers, 51% were from the 1983 year class, 27% from the 1982 year class and 22% from the older year classes.

Compared to the spawning surveys, the estimates of the adult component in the Norwegian Sea have been seriously underestimated since 1983. This applies also for the 1985 survey. The reason for this was discussed in last year's report (Anon., 1985a) and at the workshop in 1985 (Anon., 1985b). With regard to the 1982 and 1983 year classes, however, the time series obtained since 1983 shows a great deal of consistency when natural and fishing mortality are taken into account. The Working Group was not able to check whether the summer surveys are estimating the absolute abundance of these year classes or a constant fraction of them (ref. the preliminary figures from the Faroese survey in the spring of 1985 estimating 45,200 million in the 1982 year class).

According to the summer surveys, however, these year classes are of the same order of magnitude as the good year classes of the early 1970s, whereas the Faroese survey estimated the recent year classes to be 3 - 5 times larger. The Working Group, therefore, decided to use the raised estimates of the 1982 and 1983 year classes from the Norwegian Sea survey in 1985 to calibrate the VPA.

8.2 Virtual Population Analysis (VPA)

The Working Group concluded that the 1982 and 1983 year classes were underestimated in the acoustic survey in the Norwegian Sea in August 1985. The numbers of both year classes were adjusted to compensate for the incomplete coverage (see Section 8.1.3). From the preliminary landings for the first seven months of 1985 (Table 2.7), the numbers at age were calculated using Norwegian data for Norwegian, Faroese and Danish landings and using USSR data for landings by USSR and GDR (Table 8.1). Based on this information from the summer survey and from the landings in the first half of 1985, the expected numbers in the 1982 and 1983 year classes at 1 January 1985 were calculated. Given the catch in number of these year classes in 1984 and assuming a natural mortality of 0.2, the input F for 1984 was calculated which would result in these year class sizes on 1 January 1985.

To calibrate the VPA for the older year classes (1981 and older), the raised estimate of the Faroese survey was considered to be sufficiently reliable (see Section 8.1.3). Since information was not available to estimate an input F for the 0-group, the value of 0.05 was used, which was approximately the average of the last two years.

8.2.1 VPA results (Tables 8.2 and 8.3)

From 1974 to 1981, there was a decrease in total stock numbers from 93,000 million to 43,000 million (Table 8.3). The total number increased when the strong 1982 and 1983 year classes recruited. The 1983 year class is the largest on record and about twice as large as the strong year classes in the early 1970s. The 1984 year class so far appears to be weak and thus the total stock number decreased in 1984.

Spawning stock biomass is plotted in Figure 8.11. It should be noted that this plot is not comparable with that in last year's report (Anon., 1985a) because the maturity ogive has been changed (see Section 7). Spawning stock biomass increased from 1970 to a maximum of approximately 6.8 million tonnes in 1976-77. Since then, it has continuously decreased to a value of 3.3 million tonnes in 1984.

8.2.2 Long-term yield

Yield per recruit and spawning stock biomass per recruit have been calculated using the fishing pattern assumed for 1984 in the VPA run (Tables 8.4 and 8.5). The Y/R curve (Figure 8.11) is very flat for Fs above 0.2. F_{max} is consequently high and will change considerably with slight changes in the assumption on the input Fs on the younger age groups. $F_{0.1}$ is 0.21 corresponding to a level 1.3 times the fishing mortality in 1984.

8.2.3 Catch prediction

Several factors were considered by the Working Group for the catch prediction. In the mixed industrial fisheries, the vessels participating will concentrate their effort relative to the availability of the main species fished. When the strong 1982 year class recruited to the fishery, the fleet, to a large extent, concentrated its effort on this year class resulting in an increase in the Fs on ages 0 and 1 in 1982 and 1983, respectively.

The Working Group assumed the same fishing mortality in 1985 as in 1984 for ages 0 and 1.

It is likely that the effort in directed fisheries by the USSR in 1986 will decrease somewhat due to diversion to other fisheries, whereas they will be at the same level in 1985 as in 1984. In 1984, Norwegian vessels started a fishery in November and December on adult blue whiting in Division Vb. It is expected that they will increase this effort in 1985. The Working Group was unable to quantify the expected changes and the same values of F for ages 2 and older were used in the prediction as in the VPA for 1984.

For recruitment, the average for the period 1970-81 was used. The 1984 values for weight-at-age in the catch and in the stock were used. The input values for the catch prediction are given in Table 8.4 and results in Table 8.6.

8.3 Catch per Unit of Effort

Catch and effort data from the directed blue whiting fisheries for 1984 were submitted by three countries, i.e. the German Democratic Republic, Norway and USSR. These countries presented their data broken down by vessel tonnage, area and month.

Comparative time series of CPUE data for Divisions IIa, Vb, VIa and IVa, which may be indicative of changes in stock abundance, are compiled in Tables 8.7 and 8.8.

The German Democratic Republic catch rates (GRT-class 2000-3999.9) in the Norwegian Sea (Division IIa) for the period July-September decreased from 1980 to 1983 at an average rate of 30% per year, and more than doubled in 1984 (234%) compared to 1983. This would imply an overall decline in the feeding stock biomass in the period 1980-83 by about 65% (Table 8.7) and good recruitment to the stock in 1984 (1982-83 year classes). However, if the whole fishing season for the GDR fleet extending from May to October is taken into account (Table 8.8, second method of CPUE calculation), the resulting decrease over the whole period does not exceed 43%. The GDR catch rates in the period 1981-83 were at about the same level as in 1982, which could indicate a certain degree of stabilization. In 1984, the catch rates using the second method increased by 78% compared to 1983.

The Polish catch and effort statistics in the same area are less conclusive. The fleet did not take part in the fishery in 1983 and 1984, and the effort exerted in 1982 was relatively insignificant compared with that of the GDR and USSR fleets. Nevertheless, the drop in catch rate between 1980 and 1981 was very similar to that observed in the GDR and the USSR fisheries.

The USSR catch rates in Division IIa, averaged for July-September throughout the 1980-83 period, were not as consistent as the GDR data. No decline was observed between 1981 and 1982 (Table 8.7), and the catch rates in 1984 were at the same level as in 1982. The lowest catch rates were observed in 1982, but the data from this year are not comparable with other years. On the other hand, the CPUE decreased by 51% from 1982 to 1983 for the May-October season (Table 8.8, second method) and increased by 212% in 1984 compared to 1983. This would imply almost twice as large a decline (64%) over the whole time period 1980-83 as that suggested by the GDR data. A similar picture can be derived from GDR and USSR catch rates in Division Vb from fisheries based on aggregations of feeding blue whiting in June-July.

According to Shevchenko (1984), the decrease noted in catch rates in the Norwegian Sea results from both a reduction of the adult stock biomass and a change in the distribution pattern of the fish caused by anomalous hydrological conditions. The increase in the catch rates in 1984 was caused by the recruitment of the 1982 and 1983 year classes.

The USSR and Norwegian fisheries exploiting pre-spawning and post-spawning blue whiting in Division Vb do not exhibit the same decline in CPUE as that observed during the feeding season. A decrease in catch rates which started here in most cases in 1978 (Table 8.7) ended in 1981 when all fleets were able to increase their fishing efficiency. A further downward trend in 1982 and 1983 is seen in the USSR data (GRT-class 2000-3999.9 tonnes) averaged over the March-May period. The overall decline indicated by the latter USSR CPUE time series between 1979 and 1983 equals 29%, but no change in the GDR catch rates was observed from 1982 to 1984.

In all the fisheries mentioned above, an increase in the catch rates was observed in 1984 compared to 1983.

The Norwegian catch rates from the fishery on spawning fish in Division VIa show almost a constant increase every year (Table 8.7) up to 1983. In 1984, however, a decrease was observed for all GRT-classes (33-53%) which does not correspond with the observed increase in the spawning stock (Sections 8.1 and 8.2).

The Working Group noted the usefulness of the CPUE data and recommends that they are also collected in the future by as many countries as possible.

9. MANAGEMENT CONSIDERATIONS

The acoustic survey in 1985, as well as those in 1983 and 1984, gave conflicting evidence on the size of the adult stock biomass. In Section 8.1.3, the interpretation of the Working Group of the various estimates is discussed, together with the basis for calibrating the VPA. From this, it appears that it is still difficult to assess the size of the large 1982 and 1983 year classes.

The available evidence indicates that the effort in the blue whiting fisheries in 1984 was at the same level as in 1983. With an increasing stock, this should result in a reduced F as shown by the VPA. Based on this, the Working Group considers the VPA results and the catch predictions as a usable basis for the management considerations.

10. SOUTHERN AREA

10.1 Landings

Data on landings of blue whiting from the Southern Area were available to the Working Group from the Portuguese, Spanish and the GDR fisheries (Table 2.6).

In 1983, above-average landings of blue whiting were reportedly taken by vessels from the Netherlands in the Southern Area (8,299 tonnes). It was assumed by the Working Group that these landings were incorrectly attributed to the blue whiting fisheries and were, therefore, excluded from the landings in Table 2.6.

The Portuguese landings were also given as monthly landings by trawlers and coastal fisheries (Table 10.1) and as catch in number by length group (Table 10.2). This, however, did not give the Working Group a sufficient data base to perform an assessment of the Southern blue whiting stock.

10.2 Acoustic Survey off Cantabria and Galicia

During an acoustic survey of the sardine stock off Cantabrian and Galician waters in 1984 (Pastor *et al.*, 1985), the biomass within the surveyed area was estimated (preliminary) to be 133,000 tonnes. Since the survey did not cover the entire area in which blue whiting were distributed (Figure 10.1), this must be considered an underestimate.

11. DISTRIBUTION IN TIME AND SPACE OF DIFFERENT LIFE STAGES OF BLUE WHITING (NORTHERN STOCK)

The information presented in this section was obtained from a number of scientific papers by different authors, and it is not possible to refer to each one. The available knowledge is summarised, however, in two extensive papers by Bailey (1982) and Zilanov (1984) which include most of the references to earlier studies. New information can also be found in the reports of the Blue Whiting Assessment Working Group (Anon., 1981, 1983a, 1984a, 1985a).

11.1 Spawning Areas (Figure 11.1)

The main spawning area of the blue whiting extends from west of Ireland northwards along the continental slope west of the British Isles and along the slope of Rockall Bank. In addition, some other spawning areas of less importance are known, mainly around the Faroe Islands, at the west coast of Norway and the south-southwest coast of Iceland.

The spawning stock in the main spawning area has been monitored acoustically every year since 1972 during March-April, in most years only by Norwegian vessels but also in some years by Scottish Faroese and USSR vessels. No such abundance estimates have been made of the spawning stocks in other areas.

From the information available on the spawning distribution, it can be concluded that the main bulk of the stock spawns in March-April to the west of the British Isles inside the fisheries jurisdictions of the EEC and Rockall. Any spawning outside of this area is thought to be of only minor importance.

11.2 Nursery Areas (Figure 11.2)

The planktonic drift of blue whiting eggs and larvae is not fully understood, but it seems likely that most larvae from the major spawning area are carried north and northeast in the North Atlantic Drift Current.

There are numerous records in the literature of the O-group after metamorphosis, but surveys at the appropriate time and of sufficient scope have not been undertaken to provide a clear picture of the distribution of the fish at that stage in its life.

In June and July, the most numerous records of O-group blue whiting are from the area west of Scotland, the Faroes and the northern North Sea.

In 1961 and 1979, small O-group blue whiting were caught off northwestern Norway in significant numbers. In 1983 and 1984, O-group blue whiting were recorded over a wider area in the Barents Sea during the O-group surveys than previously (Anon., 1983d and 1984d).

The O-group blue whiting recorded in the northern North Sea in June-July and around the Faroe Islands in July are probably originating from the main spawning grounds west of the British Isles. On the other hand, the fish recorded to the west of Iceland and off northwest and northern Norway are more likely to stem from a spawning area north of the main area.

In the industrial bottom trawl fishery in the northern North Sea, immature blue whiting (mostly ages 0 and 1) make up a considerable proportion of the fish caught. The same is the case with a similar fishery off the west coast of Norway, north and northwest coast of Scotland, south coast of Iceland and in a newly started fishery at the Faroe Islands.

A considerable amount of valuable information on the quantitative distribution of immature blue whiting and year class strength has come from the international blue whiting acoustic surveys in August in the Norwegian Sea and adjacent waters initiated in 1982. In these surveys, the main concentrations were found in the southern Norwegian Sea, around the Faroe Islands, south and west of Iceland, in the Norwegian Deep and along the west coast of Norway. During Icelandic surveys in 1983-85 in June in the area between southeast Iceland and the Faroes, immature blue whiting were recorded in considerable quantities, especially over the Faroe-Iceland Ridge; there is some evidence that the immature fish stay in this area throughout the year (Sveinbjörnsson et al., 1984). Similarly, during a Norwegian survey off the west coast of Norway in April 1985, immature blue whiting (ages 1-3) were found dominant throughout the area (Monstad, 1985b). Furthermore, during a bottom trawl survey in March 1985 for demersal fish species in Icelandic waters, immature blue whiting (mainly age 2) were caught on the outer part of the continental shelf from southeast to northwest Iceland (Sveinbjörnsson, 1985).

It seems clear from the different records that the nursery areas for blue whiting extend through a number of national zones, but it is difficult at present to quantify the importance of each zone. In addition, the proportion of any year class in any nursery area will most certainly depend on the prevailing current regime during the egg and larval drift.

11.3 Adult Distribution and Migration (Figure 11.3)

11.3.1 Spawning season

During the spawning season in February-May, adult blue whiting congregate to the west of the British Isles, the largest concentrations being found along the edge of the continental shelf and around the slopes of the Porcupine Bank and to a lesser extent the slopes of Rockall Bank.

The period of peak abundance in the area west of Scotland extends from late March to mid-April, with some evidence that older fish reach the spawning grounds before the younger ones. By early May, the spent fish have largely migrated from the area west of the British Isles and during the remainder of the year, the residual population consists largely of immature fish in that area.

11.3.2 Post-spawning and pre-spawning migrations

There is a massive migration of post-spawning fish from the main spawning area west of the British Isles in early to mid-May through the Faroese and EEC zone.

In the late 1970s and until 1981 in late April and early May, large concentrations of post-spawning blue whiting were found southwest and west of the Faroes indicating that this was the main route taken then during the post-spawning migration. In later years, however, the main route has been through the Faroe-Shetland Channel. North of the Faroe Islands, these concentrations disperse over the entire Norwegian Sea and into the Norwegian Deep for feeding. The main directions and extent of this feeding migration are most probably governed by the hydrographical conditions, available food and the stock structure. In June-July, post-spawning concentrations are regularly recorded east of Iceland, but the magnitude may vary considerably. These concentrations are sometimes known to move inside the continental shelf where they stay during the summer, such as during 1972-79. A successful blue whiting fishery took place in July-August 1977-79 at the northern east coast of Iceland. Since 1979, no post-spawning migration has been recorded to the east coast of Iceland. From June to August, large concentrations have been found north and northeast of Iceland and, in the same season, records have been made of fish west of Spitsbergen (80°N) and in some years as far north as 45°E in the Barents Sea. In September and October, the distribution in the Norwegian Sea appears to be very wide. The most likely interpretation of the available evidence is that the summer dispersal from the main spawning ground takes place over the entire Norwegian Sea with some local aggregations depending on the environmental conditions.

In August 1980 and 1981, Norwegian research vessels covered a major part of the Norwegian Sea during an acoustic survey of the blue whiting stock.

International acoustic surveys coordinated by ICES since 1982 have taken place in the Norwegian Sea and adjacent waters in the same period (See Section 8.1.2). In the text table below, the percentages of the total biomass estimates during these surveys are shown within and beyond the areas of national fisheries jurisdiction of the NEAFC contracting parties (Figure 11.4).

Area/Year	1980	1981	1982	1983	1984	1985
Internat.	18.9	26.0	14.7	5.6	4.8	8.2
Svalbard*	5.4	2.0	1.1	1.1	0.1	-
Jan Mayen	16.8	8.8	5.9	3.4	0.6	2.5
Norway	40.7	38.7	45.9	38.2	39.2	22.7
Iceland	8.6	14.2	10.8	25.0	18.4	13.7
Greenland	0.1	-	-	-	-	0.9
Faroes	4.7	8.3	16.9	19.4	25.9	37.4
EEC	4.8	2.0	7.7	7.2	11.1	14.7

* Spitsbergen, Bear Island and Hopen Island

During these surveys, the area covered has varied quite extensively and the figures given in the table should, therefore be treated with caution. In some years, such as 1980, the Svalbard area was surveyed adequately giving a fairly reasonable percentage, whereas in other years, the coverage was not adequate and resulted in extremely low percentages. Similarly, the Faroe zone was surveyed well in 1985 giving a high percentage, whereas in 1980, it was only partly surveyed. The same applies for all the other zones. During 1980-85, however, great changes have taken place both with the stock structure and with the hydrography of the Norwegian Sea which have affected the distribution of blue whiting significantly.

The available evidence indicates clearly that the largest fish have a more northern distribution in the summer, compared to the smaller fish (see Section 8.1.2).

From 1980 to 1981, the stock consisted mainly of older fish with a more northerly distribution, whereas during 1983-85, the stock has been dominated by the young 1982 and 1983 year classes with a more southerly distribution.

By October, a reverse migration begins with concentrations forming in the Faroe-Iceland region; in winter, they are distributed over wide areas of the southern Norwegian Sea, especially in the area between the Faroe Islands and Iceland. In November-December, pre-spawners begin to move into the Faroe zone in fishable concentrations and by late January and early February, they are found as far south as the Faroe-Shetland Channel. From surveys and the fishery, it appears that the most regular route of the pre-spawning migration is east of the Faroe Islands, although there are some recent records of concentrations west of the Faroes in February.

During its life history,the adult population disperses from the EEC zone into the Faroese, Icelandic, Norwegian zones and later further north also into the international, Jan Mayen and the Svalbard zones, and then returns through the Faroese zone into the EEC zone to spawn.

11.3.3 Residual populations

Although the major part of the adult population spawns west of the British Isles and migrates to the feeding areas further north, there are residual populations in much of the area of distribution throughout the year, such as west and southwest of Ireland, over the Rockall Bank, over the Faroe-Iceland Ridge, along the Norwegian coast and in the Barents Sea. This indicates a considerable degree of complexity in the stock structure of blue whiting.

Considerable quantities of adult and immature fish have been found in the Irminger Sea between Iceland and Greenland, and there is a record of blue whiting spawning over the Reykjanes Ridge southwest of Iceland. The relationship between these groups and the main stock is not clear and the pattern of distribution throughout the year is not well known.

Most records from East Greenland and the Irminger Sea area (Dohrn Bank) are from May to September, and a decrease in catch rates has been reported in the Dohrn Bank area between September and November, indicating a movement of the fish out of the area.

11.3.4 Distribution of catches of blue whiting (Figure 11.5)

The main fishing areas for the different blue whiting fisheries (Tables 2.2, 2.3, 2.4 and 2.5) are shown in Figure 11.5. In Table 11.1, the total landings during 1978-84 are divided into national fishery zones. The table was derived from data brought by the Working Group members and some assumptions had to be made. For this reason, the totals for each year deviate somewhat from the official total.

12. SEASONAL DISTRIBUTION OF THE SOUTHERN BLUE WHITING STOCK

The available information on the seasonal distribution of the southern blue whiting stock is very limited. The Working Group was not, therefore, able to present a valid seasonal distribution pattern. The Working Group also reiterated its recommendations from previous years that acoustic surveys be undertaken in the southern areas aimed at widening our knowledge of the seasonal distribution and the general biology of blue whiting in this area.

The landings of blue whiting in the Southern area are, to a large extent, from by-catches in bottom trawl fisheries aimed at other species and are not from directed blue whiting fisheries. Since only Spain and Portugal record these catches, it is difficult to get a clear picture of the seasonality in the blue whiting fishery in this area.

13. SELECTIVITY

13.1 Mesh Selection (16 mm)

Although the minimum mesh size previously recommended by NEAFC for a directed blue whiting fishery in the North-east Atlantic is 16 mm, larger mesh sizes are used by the various nations participating in the fishery (36-50 mm).

In the mixed industrial fishery in the North Sea, mesh sizes of 22 mm (Norway and Denmark) and 24 mm (Faroes) are used.

Data on net selectivity of blue whiting are summarised and a new selection factor is given in a paper by Robles et al. (1980).

In the text table below, the 50% retention lengths (L_{50})(cm) for three different mesh sizes are given based on the selection factors obtained by Robles et al. (1980) and also on the other selection factors from other sources cited in that paper.

Selection factor	Mesh size (mm)		
	16	22	40
4.84*	7.7	10.6	19.3
3.9-4.4**	6.2-7.0	8.6-9.7	15.6-17.6

* Robles et al. (1980)
** Other sources

13.2 Effects on the Yield per Recruit from the Mixed Industrial Fishery

In all mixed industrial fisheries, the blue whiting catch consists mainly of age 0-1 fish with a length distribution of 12-24 cm.

A change in mesh size to 40 mm in these fisheries would, therefore, represent a considerable conservation measure.

In Figure 8.11, yield per recruit and spawning stock biomass per recruit are plotted assuming no fishing on ages 0 and 1 and assuming the same exploitation pattern for the older age groups as used for 1984 in the VPA (Tables 13.1 and 13.2). It is evident that little would be gained when the fishing mortality is low on ages 0-1. However, with higher Fs, the benefit might be significant. In these calculations, natural mortality of 0.2 has been assumed, which could be questioned. Such conservation measures may also not be very effective due to the blocking effect of fish already in the net (Eltink, 1983).

14. FUTURE RESEARCH RECOMMENDATIONS

1) The results of surveys and investigations have provided evidence of a separate Southern blue whiting stock. In order to assess and manage this stock, data series on age composition of landings are required and acoustic surveys are needed (see Section 12).

2) The Working Group considers it very important that the Northern blue whiting stock is monitored continuously. The surveys of the spawning stock during spring have proved to be very valuable and the Working Group recommends that they be continued.

3) Although it is difficult at present to indicate the precision of the stock estimates obtained by the acoustic surveys in the Norwegian Sea, the indices from the 1981-85 surveys have given valuable information about the trend

3) ctd. in abundance of the blue whiting stock. This is also the only means by which an estimate of the recruiting year classes can be obtained.

The Working Group considers it important to continue these surveys and, therefore, recommends that a coordinated acoustic survey takes place in August 1986 with Mr T Monstad as Convenor.

4) The Working Group recommends that investigations be performed on selectivity of blue whiting using mesh sizes used in the mixed industrial fisheries and the directed fisheries in the Northern Area.

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Table 2.1. Landings (tonnes) of BLUE WHITING from the main fisheries 1974-84

Area	1974	1975	1976	1977	1978	1979
Norwegian Sea Fishery (Sub-areas I+II and Divisions Va, XIVa+XIVb)	146	6,746	3,336	56,999	236,226	741,042
Spawning Fishery (Divisions Vb, VIa, VIb and VIIb + VIIc)	15,207	30,335	81,362	136,787	229,228	284,547
Icelandic Industrial Fishery (Division Va)	4,230	1,294	8,220	5,838	9,484	2,500
Industrial Mixed Fishery (Divisions IVa-c, IIIa)	62,197	41,955	36,024	38,389	99,874	63,333
Southern Fishery (Sub-areas VIII + IX, Divisions VIId,e + VIIg-k)	25,733	31,715	35,035	30,723	33,898	27,176
Total	107,513	112,045	163,977	268,736	608,710	1,118,598

Area	1980	1981	1982	1983	1984*
Norwegian Sea Fishery (Sub-areas I+II and Divisions Va, XIVa+XIVb)	766,798	520,738	110,685	52,961	65,932
Spawning Fishery (Divisions Vb, VIa, VIb and VIIb + VIIc)	250,693	288,316	361,656	361,537	403,680
Icelandic Industrial Fishery (Division Va)	-	-	-	7,000	-
Industrial Mixed Fishery (Divisions IVa-c, IIIa)	75,129	61,754	117,578	117,737	116,892
Southern Fishery (Sub-areas VIII + IX, Divisions VIId,e + VIIg-k)	29,944	38,749	30,971	28,798	37,044
Total	1,122,564	909,557	620,890	568,033	623,548

*Preliminary

Table 2.2. Landings (tonnes) of BLUE WHITING from the Norwegian Sea (Sub-areas I and II, Divisions Va, XIVa and XIVb) fisheries 1974-84, as estimated by the Working Group

Country	1974	1975	1976	1977	1978	1979
Denmark	-	-	-	-	-	-
Faroes	-	-	-	593	2,810	762
France	-	-	-	-	-	-
German Democratic Republic	-	-	90	2,031	7,301	22,502
Federal Republic[2] of Germany	2	35	33	6,777	8,421	1,157
Iceland	119	3	569	4,768	17,756	12,428
Norway	20	31	737	-	-	33,588[3]
Poland	-	-	95	1,536	5,083	4,346
United Kingdom (England and Wales)	-	-	60	165	11	-
United Kingdom (Scotland)	-	-	-	-	-	-
USSR	5	6,677	1,752	41,129	194,844	666,259
Total	146	6,746	3,336	56,999	236,226	741,042

Country	1980	1981	1982	1983	1984[1]
Denmark	-	-	473	-	93
Faroes	-	11,131	-	11,316	-
France	-	5,093	2,067	2,890	-
German Democratic Republic	14,234	15,607	3,042	5,553	8,193
Federal Republic[2] of Germany	8,919	17,385	890	2	35
Iceland	4,562	4,808	-	-	105
Norway	902	187	-	5,061	689
Poland	11,307	2,434	443	-	-
United Kingdom (England and Wales)	-	-	-	-	-
United Kingdom (Scotland)	-	-	-	-	-
USSR	726,874	464,093	103,770	28,141	56,817
Total	766,798	520,738	110,685	52,961	65,932

[1] Preliminary.

[2] Including catches off East Greenland (Division XIVb) (327 tonnes in 1977, 896 tonnes in 1978, 204 tonnes in 1979, and 8,757 tonnes in 1980).

[3] Including purse-seine catches of 29,162 tonnes of juvenile blue whiting

Table 2.3 Landings (tonnes) of the BLUE WHITING from the spawning fishery (Divisions Vb, VIa,b and VIIb,c) 1974-84 as estimated by the Working Group

Country	1974	1975	1976	1977	1978	1979
Denmark	-	-	-	18,745	23,498	21,200
Faroes	1,527	-	12,826	29,096	39,491	35,780
France	-	-	-	-	-	-
German Dem. Rep.	-	-	4,971	1,094	1,714	172
Germany, Fed.Rep.	2,655	-	85	3,260	6,363	3,304
Iceland	-	-	-	5,172	7,537	4,864
Ireland	-	-	160	-	-	-
Netherlands	-	-	-	-	1,172	154
Norway	3,247	7,301	24,853	38,214	116,815	186,737
Poland	116	4,704	10,950	3,996	2,469	4,643
Spain	6,484	8,153	5,910	183	14	-
Sweden	-	-	-	6,391	6,260	-
UK (England & Wales)	-	455	341	1,475	5,287	4,136
UK (Scotland)	-	279	1,488	3,001	1,599	1,466
USSR	1,178	9,443	19,778	26,160	17,009	22,091
Total	15,207	30,335	81,362	136,787	229,228	284,547

Country	1980	1981	1982	1983	1984*
Denmark	19,272	11,361	23,164	28,680	24,229
Faroes	37,488	23,107	38,958	56,168	60,022
France	-	-	1,212	3,600	3,882
German Dem. Rep.	181	6,562	7,771	3,284	1,171
Germany, Fed.Rep.	709	935	701	825	640
Iceland	5,375	10,213	1,689	1,176	-
Ireland	-	-	-	-	-
Netherlands	-	222	200	150	-
Norway	133,754	166,168[1)]	169,790[2)]	185,646[3)]	205,024
Poland	-	2,279	-	-	-
Spain	-	-	-	318	-
Sweden	3,185	-	-	-	-
UK (England & Wales)	3,878	6,000	-	-	-
UK (Scotland)	6,819	2,611	-	-	-
USSR	40,032	58,858	73,171	81,690	108,712
Total	250,693	288,316	316,656	361,537	403,680

*Preliminary
1) Including 28,466 tonnes from directed fisheries in Division IVa
2) Including 35,001 tonnes from directed fisheries in Division IVa
3) Including 32,043 tonnes from directed fisheries in Division IVa

Table 2.4 Landings (tonnes) of BLUE WHITING from the Icelandic mixed industrial trawl fisheries in Division Va 1974-84

Country	1974	1975	1976	1977	1978	1979
Iceland	4,230	1,294	8,220	5,838	9,484	2,500

Country	1980	1981	1982	1983	1984*
Iceland	-	-	-	7,000	-

*Preliminary

Table 2.5 Landings (tonnes) of BLUE WHITING from the mixed industrial fisheries and caught as by-catch in ordinary fisheries in the North Sea (Divisions IVa-c and IIa), 1974-84, as estimated by the Working Group

Country	1974	1975	1976	1977	1978	1979
Denmark	-	-	-	16,071	54,804	28,932
Faroes	2,610	428	1,254	-	1,177	1,489
France	-	-	-	-	-	-
German Dem. Rep.[2)]	-	-	-	-	988	49
Germany, Fed. Rep.[2)]	-	-	-	76	1,514	13
Ireland	-	-	-	-	-	-
Norway	59,151	40,210	34,600	20,737	39,989	30,930
Poland[2)]	55	-	45	838	601	-
Spain	318	195	47	-	-	-
Sweden[4)]	-	-	-	639	648	1,249
UK (England & Wales)[2)]	-	-	-	3	+	-
UK (Scotland)	-	414	58	25	153	37
USSR[2)]	63	708	20	-	-	634
Total	62,197	41,955	36,024	38,389	99,874	63,333

Country	1980	1981	1982	1983	1984*
Denmark	49,947	35,066	34,463	38,290	54,376
Faroes	1,895	3,133	27,269	12,757	9,740
France	-	-	1,417	249	-
German Dem. Rep.[2)]	-	-	-	-	-
Germany, Fed. Rep.[2)]	252	-	93	-	-
Ireland	-	2,744	-	-	-
Norway	21,962[3)]	18,627	47,856	62,591	52,776
Poland[2)]	-	229	550	-	-
Spain	-	-	-	-	-
Sweden[4)]	1,071	1,955	1,241	3,850	-
UK (England & Wales)[2)]	-	-	4,689	-	-
UK (Scotland)	2	-	-	-	-
USSR[2)]	-	-	-	-	-
Total	75,129	61,754	117,578	117,737	116,892

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 (tonnes) of BLUE WHITING from the Southern Areas (Sub-areas VIII and IC and Divisions VIIg-k and VIId,e) 1974-84 as estimated by the Working Group

Country	1974	1975	1976	1977	1978	1979
German Dem. Rep.	-	-	-	-	-	-
Germany, Fed. Rep.	-	-	-	-	25	-
Ireland	-	-	-	-	-	1
Netherlands	-	-	-	-	7	-
Poland	170	-	385	169	53	-
Portugal	-	-	-	1,557	2,381	2,096
Spain[1)]	24,627	30,790	29,470	25,259	31,428	25,016
UK (England & Wales)	-	-	-	+	-	-
UK (Scotland)	-	-	-	-	-	63
USSR	936	925	5,180	3,738	4	-
Total	25,733	31,715	35,035	30,723	33,898	27,176

Country	1980	1981	1982	1983	1984*
German Dem. Rep.	-	-	-	-	301
Germany, Fed. Rep.	-	-	-	50	-
Ireland	-	-	-	-	-
Netherlands	31	633	200	-	-
Poland	-	-	-	-	-
Portugal	6,051	7,387	3,890	4,748	5,252
Spain[1)]	23,862	30,728	27,500	24,000	25,900
UK (England & Wales)	-	-	-	-	-
UK (Scotland)	-	-	-	-	-
USSR	-	-	-	-	5,591
Total	29,944	38,748	31,590	28,798	37,044

*Preliminary

1)Significant quantities taken in Divisions VIIg-k not included in the Table are discarded every year.

Table 2.7 Preliminary data on landings of BLUE WHITING in 1985 based on returns on ICES Data Form 5 for 1985 and information from Working Group members.

Country	Area	January	February	March	April	May	June	July	August	Total
Faroe Islands	Vb	-	-	-	-	-	-	-	-	60,719[b]
	IV + VI	-	-	-	-	-	-	-	-	-
German Democratic Republic	I + II	-	-	-	-	-	393	642	-	1,035
	Vb[a)]	1,097	740	95	491	1,186	1,129	-	-	4,738
	VI	-	-	-	-	468	-	-	-	468
	VIIg-k	-	-	-	-	413	-	-	-	413
	XII	-	-	-	-	347	-	-	-	347
	XIV	-	-	-	-	53	-	-	-	53
Federal Republic of Germany	IV	-	-	-	-	-	-	-	7	7
	Vb	-	-	-	-	-	-	324	-	324
	VI	-	-	-	-	-	-	-	210	210
Norway	IV	729	290	859	8,139	12,141	-	-	-	22,165
	Vb	5,947	515	-	-	16,976	-	-	-	23,438
	VI	-	10,229	34,926	89,781	11,914	-	-	-	146,850
	VIIc	-	-	29,327	9,827	-	-	-	-	39,154
Sweden	IV	-	4	4	17	12	5	-	-	42
U.S.S.R.	I + II	291	1,667	-	126	8,390	24,636	31,871	9,164	76,145
	Vb	5,977	3,151	540	13,957	18,801	21,220	8,496	22,321	94,463

a) Fishery Zone Faroes

b) Areas Vb and VI

BLUE WHITING.

Table 5.1 Catch in number (millions) by age group in the directed fisheries (Sub-areas I and II, Divisions Va, XIVa and XIVb, Vb, VIa and VIb, VIIb,c and VIIg,h,j,k, 1974-84

Age	1974	1975	1976	1977	1978	1979
0	-	1.9	-	-	-	-
1	0.6	2.2	4.5	-	-	-
2	5.5	5.0	13.1	44.0	63.6	69.9
3	4.6	28.7	24.1	87.5	69.0	165.0
4	15.1	26.7	54.6	164.8	345.8	457.5
5	20.2	25.2	26.4	184.9	436.9	468.3
6	16.2	34.3	52.3	154.3	483.1	569.0
7	14.4	32.8	69.1	137.6	527.9	743.2
8	14.7	27.0	57.6	176.7	474.3	904.8
9	3.6	27.6	65.2	120.1	364.8	826.4
10	4.3	13.8	73.0	132.0	307.6	797.0
11	3.7	13.0	30.2	110.1	157.4	473.2
12	2.8	11.2	36.7	56.3	121.8	359.2
13	1.6	7.3	18.8	18.2	50.4	142.7
14	0.7	4.6	9.9	13.5	20.5	69.3
15+	1.0	3.5	6.3	6.9	16.1	39.0
Total	109.0	264.8	541.8	1,406.9	3,439.2	6,405.4
Tonnes	15,353	37,081	84,698	193,786	465,454	1,025,589

Age	1980	1981	1982	1983	1984*
0	-	-	1.2	2.5	62.0
1	55.1	4.0	1.7	290.4	407.0
2	319.5	40.1	48.6	239.1	1,358.7
3	362.0	322.8	123.1	164.1	270.8
4	399.1	225.3	371.0	194.1	206.5
5	478.3	501.5	212.6	411.4	252.6
6	530.9	539.0	251.0	284.4	409.5
7	725.3	448.5	250.7	274.0	246.7
8	779.2	618.3	259.3	283.5	185.5
9	604.5	573.2	278.7	219.9	147.7
10	1,008.7	718.3	259.8	152.6	110.9
11	398.1	343.6	158.5	71.5	56.3
12	394.2	232.6	133.6	45.4	48.8
13	66.8	73.9	41.0	25.0	14.6
14	64.6	49.5	45.3	12.1	7.9
15+	4.7	30.6	28.0	10.0	6.6
Total	6,191.0	4,721.2	2,464.1	2,680.0	3,791.9
Tonnes	1,017,491	809,054	427,341	416,730	469,612

*Preliminary

BLUE WHITING.

Table 5.2 Catch in number (millions) by age group in the mixed industrial fisheries (Sub-area IV, Divisions IIIa and Va) 1974-1984

Age	1974	1975	1976	1977	1978	1979
0	379.4	811.7	128.1	428.9	956.2	2.4
1	480.1	221.2	760.7	467.5	1,030.9	1,849.0
2	48.7	73.0	98.7	111.4	168.2	78.8
3	13.0	28.2	36.9	33.8	89.7	32.3
4	7.5	14.0	22.4	31.8	74.0	22.3
5	-	-	-	-	-	18.2
6	-	-	-	-	-	20.8
7	-	-	-	-	-	10.8
8	-	-	-	-	-	8.8
9	-	-	-	-	-	14.0
10	-	-	-	-	-	6.2
11	-	-	-	-	-	1.0
12	-	-	-	-	-	4.4
13	-	-	-	-	-	-
14	-	-	-	-	-	-
15+	-	-	-	-	-	-
Total	928.7	1,148.1	1,046.8	1,073.4	2,319.0	2,069.0
Tonnes	66,427	43,249	44,244	44,227	109,358	94,995

Age	1980	1981	1982	1983	1984*
0	23.2	-	3,450.1	336.3	200.1
1	276.1	65.1	45.3	1,844.2	1,352.0
2	329.9	81.4	41.3	90.0	657.8
3	74.8	191.9	80.9	38.4	79.1
4	22.6	58.4	112.8	47.7	10.1
5	29.1	20.1	29.2	55.6	14.2
6	23.1	16.7	21.6	12.2	11.6
7	29.3	17.8	14.8	12.8	4.3
8	26.8	15.7	12.0	2.6	2.5
9	15.2	4.4	5.2	5.8	0.3
10	13.8	4.9	1.8	4.2	1.0
11	6.4	3.6	-	9.6	0.5
12	1.8	1.5	2.4	3.3	0.5
13	2.2	1.2	0.6	0.6	0.5
14	1.4	0.1	0.6	0.3	0.2
15+	0.4	0.2	-	-	-
Total	876.1	483.0	3,816.6	2,463.6	2,334.6
Tonnes	75,129	61,754	117,578	124,737	116,892

*Preliminary

Table 5.3 VIRTUAL POPULATION ANALYSIS

BLUE WHITING, NORTHERN AREA

CATCH IN NUMBERS UNIT: millions

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	0	17	1067	1820	379	814	128	429	956	2	23	0
1	0	11	99	354	431	223	765	468	1051	1919	331	69
2	15	18	54	50	54	78	112	155	232	244	649	122
3	20	55	19	28	18	57	61	121	159	353	437	515
4	25	75	24	21	23	41	77	197	420	430	422	284
5	29	88	28	12	20	25	26	185	437	487	507	522
6	18	74	28	11	16	34	52	154	483	590	554	556
7	12	59	21	15	14	33	69	138	528	754	755	466
8	7	37	19	7	15	27	58	177	474	914	806	634
9	5	20	6	10	4	28	65	120	365	840	620	578
10	2	13	3	8	4	14	73	132	308	803	1023	723
11	0	5	1	7	4	13	30	110	157	474	405	347
12	0	2	0	4	3	11	37	56	122	364	396	234
13	0	1	0	2	2	7	19	18	50	143	69	75
14	0	0	0	1	1	5	10	14	21	69	66	50
15+	0	0	0	1	1	4	6	7	16	39	5	31
TOTAL	132	472	1370	2348	1038	1413	1589	2480	5758	8474	7067	5206

	1982	1983	1984
0	3451	339	262
1	45	2133	1759
2	90	328	2016
3	204	202	350
4	484	241	217
5	242	465	267
6	273	295	421
7	266	285	251
8	271	285	188
9	284	225	148
10	262	156	112
11	159	81	57
12	136	49	49
13	42	26	15
14	46	12	8
15+	28	10	7
TOTAL	6281	5132	6127

Table 6.1 VIRTUAL POPULATION ANALYSIS

BLUE WHITING, NORTHERN AREA

MEAN WEIGHT AT AGE OF THE STOCK UNIT: kilogram

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	.032	.032	.032	.032	.032	.032	.032	.032	.032	.032	.027	.032
1	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030	.036	.063
2	.084	.084	.084	.084	.084	.084	.084	.084	.084	.084	.079	.092
3	.105	.105	.105	.105	.105	.105	.105	.105	.105	.105	.107	.118
4	.109	.109	.109	.109	.109	.109	.109	.109	.109	.109	.122	.135
5	.129	.129	.129	.129	.129	.129	.129	.129	.129	.129	.135	.145
6	.147	.147	.147	.147	.147	.147	.147	.147	.147	.147	.149	.155
7	.160	.160	.160	.160	.160	.160	.160	.160	.160	.160	.165	.170
8	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.176	.178
9	.177	.177	.177	.177	.177	.177	.177	.177	.177	.177	.186	.187
10	.188	.188	.188	.188	.188	.188	.188	.188	.188	.188	.199	.199
11	.193	.193	.193	.193	.193	.193	.193	.193	.193	.193	.202	.208
12	.199	.199	.199	.199	.199	.199	.199	.199	.199	.199	.207	.228
13	.200	.200	.200	.200	.200	.200	.200	.200	.200	.200	.207	.234
14	.200	.200	.200	.200	.200	.200	.200	.200	.200	.200	.207	.249
15+	.200	.200	.200	.200	.200	.200	.200	.200	.200	.200	.207	.257

	1982	1983	1984
0	.018	.018	.032
1	.046	.046	.040
2	.094	.094	.083
3	.136	.136	.103
4	.152	.152	.141
5	.162	.162	.157
6	.178	.178	.165
7	.195	.195	.175
8	.200	.200	.189
9	.204	.204	.186
10	.213	.213	.197
11	.234	.234	.201
12	.228	.228	.194
13	.258	.258	.226
14	.242	.242	.224
15+	.258	.258	.2[illegible]

Table 8.1. Catch of BLUE WHITING, Northern Area January-July 1985.

Year class	Directed fish Jan-Jul ($N \times 10^{-6}$)	Mixed ind.fish Jan-Jul ($N \times 10^{-6}$)	Total ($N \times 10^{-6}$)	$\overline{w}$ kg	Total ($t \times 10^{-3}$)
1984	46.1	401.6	447.7	.040	17.9
1983	606.9	671.1	1,278.0	.083	106.1
1982	925.4	79.2	1,004.6	.103	103.4
1981	62.1	11.6	73.7	.141	10.4
1980	187.2	-	187.2	.157	29.4
1979	221.5	-	221.5	.165	36.5
1978	216.1	-	216.1	.175	37.8
1977	246.4	-	246.4	.189	46.6
1976	216.9	-	216.9	.186	40.3
1975	200.2	-	200.2	.197	39.4
1974	126.6	-	126.6	.201	25.4
1973	89.6	-	89.6	.194	17.4
1972	34.6	-	34.6	.226	7.8
1971	17.3	-	17.3	.224	3.9
1970	17.3	-	17.3	.242	4.2
Total	3,214.2	1,163.5	4,377.7		
	415.5	96.	511.5		526.5

Table 8.2 Virtual Population Analysis. BLUE WHITING, northern area.

FISHING MORTALITY COEFFICIENT   UNIT: Year-1   NATURAL MORTALITY COEFFICIENT = .20

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	.00	.00	.05	.10	.03	.06	.01	.04	.06	.00	.01	.00
1	.00	.00	.01	.02	.04	.02	.07	.05	.12	.16	.07	.02
2	.00	.00	.00	.00	.00	.01	.01	.02	.03	.04	.07	.03
3	.00	.01	.00	.00	.00	.01	.01	.02	.02	.06	.08	.08
4	.01	.01	.00	.00	.00	.00	.01	.03	.07	.09	.09	.07
5	.01	.02	.01	.00	.00	.00	.00	.03	.08	.10	.12	.16
6	.01	.03	.01	.00	.00	.01	.01	.03	.09	.15	.17	.20
7	.01	.05	.01	.01	.01	.01	.02	.03	.12	.20	.28	.20
8	.01	.04	.02	.00	.01	.01	.02	.05	.12	.31	.34	.40
9	.00	.02	.01	.01	.00	.02	.04	.04	.15	.32	.36	.44
10	.00	.01	.00	.01	.01	.01	.06	.10	.15	.54	.83	.95
11	.00	.00	.00	.01	.01	.03	.04	.12	.16	.35	.58	.76
12	.00	.00	.00	.01	.01	.03	.10	.10	.19	.68	.56	.80
13	.00	.34	.00	.00	.00	.02	.05	.07	.12	.36	.26	.19
14	.00	.00	.00	.00	.00	.01	.03	.05	.10	.24	.28	.30
15+	.00	.00	.00	.00	.00	.01	.03	.05	.10	.24	.28	.30
(1- 3)U	.00	.00	.00	.01	.01	.01	.03	.03	.06	.08	.07	.04
(3-12)U	.01	.02	.01	.01	.00	.01	.03	.05	.11	.28	.34	.41

	1982	1983	1984	1980-82
0	.10	.01	.05	.04
1	.01	.09	.06	.03
2	.04	.11	.11	.05
3	.07	.11	.16	.08
4	.10	.10	.16	.09
5	.08	.13	.16	.12
6	.11	.13	.16	.16
7	.13	.17	.16	.21
8	.18	.21	.16	.31
9	.31	.22	.16	.37
10	.36	.29	.16	.71
11	.56	.18	.16	.63
12	.79	.33	.16	.72
13	.31	.33	.16	.25
14	.17	.14	.16	.25
15+	.17	.14	.16	.25
(1- 3)U	.04	.10	.11	
(3-12)U	.27	.19	.16	

Table 8.3 VIRTUAL POPULATION ANALYSIS

BLUE WHITING, NORTHERN AREA

STOCK SIZE IN NUMBERS UNIT: millions

BIOMASS TOTALS UNIT: thousand tonnes

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
0	23896	21912	22883	20631	16869	16626	13655	15212	18715	7051	4266	5346
1	16026	19564	17925	17772	15250	13469	12879	11064	10430	14460	5771	3472
2	13566	13121	16008	14586	14231	12052	10825	9854	8637	7010	10110	4426
3	6867	10930	10726	13057	11397	11662	9797	8762	7928	6862	6010	7691
4	4902	5603	8899	8765	10066	9725	9446	7966	7064	6347	5299	4527
5	3025	3991	4520	7265	7157	8712	7925	7066	6344	5405	4764	3958
6	1590	2451	5186	5675	5937	5841	7110	6465	6109	4800	3986	3443
7	1438	1286	1940	2585	2999	4846	4752	5774	5154	4566	3399	2765
8	1308	1166	999	1569	2103	2442	3936	3628	4603	3743	3060	2104
9	1423	1064	922	801	1279	1709	1975	3172	2975	3341	2244	1781
10	1733	1161	853	749	647	1044	1574	1558	2489	2107	1980	1281
11	1612	1417	939	696	606	526	842	1059	1157	1761	1006	710
12	2	1320	1156	768	564	453	419	662	708	605	1016	461
13	1	2	1079	946	625	459	393	310	491	519	334	477
14	1	1	1	883	773	510	369	305	237	357	297	212
15+	1	1	1	773	1104	388	235	156	186	201	23	131
TOTAL NO	77190	84991	92041	95522	92707	90446	85936	81813	83287	69935	55564	42785
SPS NO	29478	35412	41275	47533	51195	52145	52237	50979	48417	43951	36836	30121
TOT.BIOM	5590	6371	7194	7993	6315	8376	8342	8229	8117	7184	6108	5307
SPS BIOM	3574	4251	4946	5844	6397	6623	6806	6827	6634	6040	5198	4513

	1982	1983	1984	1985
0	38469	41038	5922	0
1	4377	28384	33295	4612
2	2730	3543	21315	25670
3	3513	2195	2605	15633
4	5833	2693	1615	1817
5	3450	4339	1967	1127
6	2770	2606	3133	1386
7	2318	2023	1868	2186
8	1844	1659	1399	1303
9	1154	1265	1101	976
10	940	689	834	768
11	405	535	424	582
12	272	190	365	296
13	169	101	112	254
14	323	101	60	78
15+	197	84	52	78
TOTAL NO	68815	91445	76084	
SPS NO	24036	22297	26889	
TOT.BIOM	5157	5624	5783	
SPS BIOM	4031	3451	3280	

Table 8.4 List of input variables for the ICES prediction program.

PREDICTION BLUE WHITING 1985-87
The reference F is the maximum value in the F at age array (age 15).

The number of recruits per year is as follows:

Year	Recruitment
1985	15400.0
1986	15400.0
1987	15400.0

Proportion of F (fishing mortality) effective before spawning: .0000
Proportion of M (natural mortality) effective before spawning: .0000

Data are printed in the following units:

Number of fish: millions
Weight by age group in the catch: kilogram
Weight by age group in the stock: kilogram
Stock biomass: thousand tonnes
Catch weight: thousand tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
0	15400.0	.05	.20	.00	.032	.032
1	11994.0	.06	.20	.10	.040	.040
2	25670.0	.11	.20	.40	.083	.083
3	15633.0	.16	.20	.80	.103	.103
4	1817.0	.16	.20	1.00	.141	.141
5	1127.0	.16	.20	1.00	.157	.157
6	1386.0	.16	.20	1.00	.165	.165
7	2186.0	.16	.20	1.00	.175	.175
8	1303.0	.16	.20	1.00	.189	.189
9	976.0	.16	.20	1.00	.186	.186
10	768.0	.16	.20	1.00	.197	.197
11	582.0	.16	.20	1.00	.201	.201
12	296.0	.16	.20	1.00	.194	.194
13	254.0	.16	.20	1.00	.226	.226
14	78.0	.16	.20	1.00	.224	.224
15+	78.0	.16	.20	1.00	.242	.242

Table 8.5 BLUE WHITING. Yield and spawning stock biomass per recruit.

F factor	reference F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
.000	.0000	.0000	.0000	5.5167	.6232	3.2678	.5170	3.2678	.5170
.100	.0160	.0553	.0074	5.2412	.5710	3.0029	.4656	3.0029	.4656
.200	.0320	.1032	.0134	5.0028	.5267	2.7748	.4221	2.7748	.4221
.400	.0640	.1821	.0224	4.6100	.4560	2.4024	.3528	2.4024	.3528
.600	.0960	.2446	.0287	4.2992	.4022	2.1114	.3004	2.1114	.3004
.800	.1280	.2955	.0332	4.0463	.3600	1.8780	.2596	1.8780	.2596
1.000	.1600	.3379	.0364	3.8361	.3261	1.6868	.2271	1.6868	.2271
1.200	.1920	.3739	.0388	3.6581	.2983	1.5274	.2006	1.5274	.2006
1.400	.2240	.4048	.0405	3.5051	.2752	1.3927	.1788	1.3927	.1788
1.600	.2560	.4317	.0418	3.3719	.2556	1.2773	.1605	1.2773	.1605
1.800	.2880	.4555	.0427	3.2547	.2389	1.1774	.1450	1.1774	.1450
2.000	.3200	.4766	.0433	3.1505	.2245	1.0903	.1317	1.0903	.1317
2.200	.3520	.4956	.0438	3.0570	.2118	1.0135	.1203	1.0135	.1203
2.400	.3840	.5127	.0440	2.9727	.2007	.9455	.1103	.9455	.1103
2.600	.4160	.5283	.0442	2.8960	.1908	.8849	.1015	.8849	.1015
2.800	.4480	.5426	.0443	2.8259	.1820	.8305	.0938	.8305	.0938
3.000	.4800	.5558	.0443	2.7615	.1741	.7814	.0869	.7814	.0869
3.200	.5120	.5679	.0442	2.7020	.1670	.7370	.0808	.7370	.0808
3.400	.5440	.5792	.0441	2.6469	.1605	.6966	.0753	.6966	.0753

Slope of the yield curve at the origin based on a single recruit: .082
F-0.1 given by an F factor of 1.334, resulting in a reference F of .213
F-max given by an F factor of 2.875, resulting in a reference F of .460

Table 8.6

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

PREDICTION BLUE WHITING 1985-87

Year 1985					Year 1986					Year 1987	
factor	ref. F	stock biomass	sp.stock biomass	catch	factor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
1.0	.16	6605	4080	719	.0	.00	6606	4833	0	7347	5755
					.1	.02			82	7255	5671
					.2	.03			164	7165	5587
					.4	.06			323	6989	5425
					.6	.10			477	6818	5267
					.8	.13			628	6652	5114
					1.0	.16			774	6490	4966
					1.2	.19			915	6334	4822
					1.4	.22			1053	6181	4682
					1.6	.26			1187	6034	4547
					1.8	.29			1317	5890	4415
					2.0	.32			1444	5750	4288
					2.2	.35			1567	5615	4165
					2.4	.38			1686	5483	4045
					2.6	.42			1803	5355	3928
					2.8	.45			1916	5231	3816
					3.0	.48			2025	5110	3706
					3.2	.51			2132	4993	3600
					3.4	.54			2236	4879	3497

The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for 1 January.
The reference F is the maximum value in the F at age array (age 15).

Table 8.7 Catch per unit effort in the directed BLUE WHITING fisheries, 1977-84
(Fishing gear: mid-water trawl)

Division	GRT-class	Country	Time period	1977	1978	1979	1980	1981	1982	1983	1984	Units
				Year								
IIa	2,000 - 3,999.9	German Dem.Rep.	May-Jun	- 1)	3.43 5)	2.90	2.79	1.21	1.00	2.35	1.40	t/hour
			Jul-Sep	-	1.99 10)	2.19	3.11	2.25	1.21	1.10	2.57	t/hour
			Oct-Dec	-	-	-	3.51	1.04 13)	2.25 13)	2.70 15)	-	t/hour
		Poland	May-Jun	-	-	21.9	8.0 5)	16.1 5)	6.5 5)	-	-	t/day
			Jul-Aug	-	14.0	17.8	24.0	19.7	4.5 6)	-	-	t/day
			Sep-Nov				21.4	13.3 14)	7.9 12)	-	-	t/day
		USSR	Feb	-	-	2.70	6.35	-	-	-	-	t/hour
			Mar-Apr	-	-	2.57	2.38	3.57	1.84	-	7.8	t/hour
			May-Jun	-	-	3.04	3.30	2.62	2.35	1.73	3.06	t/hour
			Jul-Sep	-	-	3.04	3.82	2.54	2.85	0.60 6)	2.85	t/hour
			Oct-Dec	-	-	3.03	3.14	3.01	2.99 14)	-	-	t/hour
	1,000 - 1,999.9	USSR	Aug-Oct	2.38	2.79	-	-	-	-	0.87 4)	-	t/hour
	500 - 999.9	Norway	Nov	-	-	-	-	-	-	-	8.00 2)	t/hour
Vb	2,000 - 3,999.9	German Dem.Rep.	Jan-May	-	-	-	-	3.88	2.12	2.08	-	t/hour
			Jun-Jul	1.38	1.77	2.20	-	-	-	-	-	t/hour
			Nov-Dec	-	-	-	-	-	-	-	2.20	t/hour
		Poland	May-Jun	36.7	17.2	43.6 7)	-	-	-	-	-	t/day
		USSR	Jan-Feb	-	-	1.64 3)	6.83	6.71	5.16	3.05 3)	1.74 3)	t/hour
			Mar-May	-	-	5.83	5.23	5.97	4.58	4.12	4.57 7)	t/hour
			Jun-Aug	-	-	5.29 10)	-	3.75 5)	3.03	3.16	4.29	t/hour
			Sep-Dec	-	-	-	-	2.72 11)	-	2.77 12)	3.70	t/hour
	1,000 - 1,999.9	Norway	Apr-May	-	-	-	13.57	29.47	-	-	-	t/hour
		USSR	Jun-Jul	2.98	4.62	-	-	-	-	0.38 8)	-	t/hour
	500 - 999.9	Faroes	May	17.6	13.6	10.6	6.2	9.6	-	-	-	t/hour
		Iceland	May	55.6	57.5	33.8	43.3	79.2	-	-	-	t/day
		Norway	Apr-May	-	21.35	20.29	18.14	18.94	4.88	-	12.40	t/hour
			Nov-Dec	-	-	-	-	-	-	-	25.08	t/hour

(cont'd)

Table 8.7 (cont'd)

Division	GRT-class	Country	Time period	1977	1978	1979	1980	1981	1982	1983	1984	Units
				Year								
VIa	2,000 - 3,999.9	USSR	Mar	-	-	-	-	-	-	-	3.92	t/hour
	1,000 - 1,999.9	Norway	Mar-Apr	-	-	-	23.92	57.13	42.38	42.83	28.78	t/hour
	500 - 999.9	Faroes	Apr	17.4	19.8	21.4	16.4	-	-	-	-	t/hour
		Norway	Mar-Apr	-	24.93	30.27	26.56	34.96	36.30	49.04	25.21	t/hour
	100 - 499.9	Norway	Feb	-	-	-	-	-	-	-	31.35	t/hour
			Mar-Apr	-	-	24.93	13.53	23.59	31.00	41.84	19.89	t/hour
IVa	1,000 - 1,999.9	Norway	Apr-May	-	-	-	-	15.36	15.03	21.19	-	t/hour
	500 - 999.9	Norway	Apr-May	-	-	13.98	9.29	13.40	13.75	18.31	7.03[4)]	t/hour
			Nov	-	-	-	-	-	-	-	4.50[2)]	t/hour
	100 - 499.9	Norway	Apr-May					7.18	17.39	16.51	8.68[4)]	t/hour
VIIb,c	2,000 - 3,999.9	USSR	Feb-Mar	-	-	-	-	-	-	-	4.72	t/hour
	1,000 - 1,999.9	Norway	Mar	-	-	-	-	-	-	-	8.00[2)]	
	500 - 999.9	Norway	Mar	-	-	-	-	-	-	-	27.74	t/hour
	100 - 499.9	Norway	Mar	-	-	-	-	-	-	-	21.08	t/hour
VIIg-k	2,000 - 3,999.9	USSR	Feb-Mar	-	-	-	-	-	-	-	3.85	t/hour
	500 - 999.9	Norway	Mar	-	-	-	-	-	-	-	14.58	t/hour

1) Hyphen means no fishing
2) One trawl only
3) Refers to February only
4) Refers to May only
5) Refers to June only
6) Refers to July only
7) Refers to April-May period
8) Refers to May-June period
9) Refers to May-July period
10) Refers to June-July period
11) Refers to September-November period
12) Refers to September-October period
13) Refers to October only
14) Refers to October-November period
15) Refers to November-December period

Table 8.8 Catch per unit effort in the BLUE WHITING directed fisheries in Division IIa for 2,000 - 3,999.9 GRT, using mid-water trawls, 1980-84

Month	Catch (tonnes)						Effort (hours)						C.P.U.E. (tonnes/hour)					
	1979	1980	1981	1982	1983	1984	1979	1980	1981	1982	1983	1984	1979	1980	1981	1982	1983	1984
German Dem.Rep.																		
January	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
February	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
March	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
April	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
May	407	546	159	289	613	351	127	279	210	152	393	219	3.21	1.96	0.76	1.90	1.56	1.60
June	2,548	3,025	2,566	1,148	2,524	1,876	893	999	2,046	1,280	945	1,371	2.85	3.03	1.25	0.90	2.67	1.37
July	2,317	3,523	5,951	1,226	1,026	3,947	792	902	2,596	1,045	831	1,596	2.93	3.91	2.29	1.17	1.23	2.47
August	64	2,871	4,130	-	764	1,779	39	965	2,079	-	801	598	1.64	2.98	1.99	-	0.95	2.97
September	862	605	1,481	113	-	240	430	248	627	54	-	128	2.01	2.44	2.36	2.09	-	1.88
October	-	1,128	55	266	-	-	-	424	53	118	-	-	-	2.66	1.04	2.25	-	-
November	-	1,380	-	-	494	-	-	275	-	-	159	-	-	5.02	-	-	3.11	-
December	-	754	-	-	132	-	-	230	-	-	73	-	-	3.28	-	-	1.81	-
All months	6,198	13,832	14,310	3,042	5,553	8,193	2,281	4,322	7,611	2,649	3,202	3,912	2.72	3.20	1.88	1.15	1.73	2.09
May – Oct (1)	6,198	11,698	14,310	3,042	4,917	8,193	2,281	3,817	7,611	2,649	2,970	3,912	2.72	3.06	1.88	1.15	1.66	2.09
(2)	–	–	–	–	–	–	–	–	–	–	–	–	2.53	2.83	1.62	1.66	1.61	2.06

Same as last year May – (1)
Oct (2)

(cont'd)

Table 8.8 (cont'd)

Month	Catch						Effort						C.P.U.E.					
	1979	1980	1981	1982	1983	1984	1979	1980	1981	1982	1983	1984	1979	1980	1981	1982	1983	1984
	(tonnes)						(days)						(tonnes/days)					
Poland																		
January	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
February	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
March	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
April	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
May	948	–	–	–	–	–	21	–	–	–	–	–	45.1	–	–	–	–	–
June	2,216	200	210	163	–	–	80	25	13	25	–	–	27.7	8.0	16.1	6.5	–	–
July	896	1,405	369	113	–	–	59	62	30	25	–	–	15.2	22.7	12.3	4.5	–	–
August	264	3,269	569	–	–	–	13	130	21	–	–	–	20.3	25.2	27.1	–	–	–
September	–	3,123	–	99	–	–	–	128	–	13	–	–	–	24.4	–	7.6	–	–
October	–	1,757	526	36	–	–	–	93	43	4	–	–	–	18.9	12.2	9.0	–	–
November	–	1,383	178	–	–	–	–	72	10	–	–	–	–	19.2	17.8	–	–	–
December	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
All months	4,324	11,137	1,852	411	–	–	173	510	117	67	–	–	–	21.8	15.8	6.1	–	–
May - (1)	4,324	9,754	1,676	411	–	–	173	438	107	67	–	–	–	22.3	15.6	6.1	–	–
Oct (2)	–	–	–	–	–	–	–	–	–	–	–	–	–	19.8	16.9	6.9	–	–

(cont'd)

Table 8.8 (cont'd)

Month	Catch						Effort						C.P.U.E.					
	1979	1980	1981	1982	1983	1984	1979	1980	1981	1982	1983	1984	1979	1980	1981	1982	1983	1984
	(tonnes)						(hours)						(tonnes/hours)					
U.S.S.R.																		
January	8,992	2,927	–	8,003	–	–	–	–	–	1,045	–	–	–	–	–	7.66	–	–
February	4,959	2,153	–	–	–	–	1,833	339	–	–	–	–	2.70	6.35	–	–	–	–
March	5,520	16,811	3,886	375	–	–	1,538	6,151	1,208	285	–	–	3.59	2.73	3.22	1.32	–	–
April	3,382	36,284	45,645	618	–	1,782	1,933	16,119	12,666	256	–	222	1.74	2.25	3.60	2.41	–	8.01
May	51,409	125,988	88,754	46,089	15,188	6,131	15,336	25,244	25,912	17,106	7,300	2,247	3.35	4.99	3.42	2.69	2.08	2.73
June	110,918	114,117	78,727	27,617	7,919	16,564	38,069	47,634	37,919	14,209	6,094	5,160	2.91	2.39	2.08	1.94	1.30	3.21
July	124,618	121.463	87,582	6,820	1,172	11,842	42,166	42,319	39,039	5,983	1,963	4,315	2.95	2.87	2.24	1.14	0.60	2.74
August	142,962	114,505	63,889	–	–	15,609	47,395	28,293	29,528	–	–	5,292	3.01	4.05	2.16	–	–	2.95
September	106,606	79,504	37,960	2,921	–	492	33,755	17,499	11,745	640	–	194	3.16	4.54	3.23	4.56	–	2.54
October	57,562	50,954	11,560	1,121	–	–	16,574	16,072	3,270	341	–	–	3.47	3.17	3.53	3.29	–	–
November	16,317	17,543	4,778	379	–	–	6,841	5,710	1,455	161	–	–	2.39	3.07	3.28	2.35	–	–
December	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	93,943	24,279	52,420	210,936	206,372	167,005	40,026	15,357	17,430	3.03	3.31	2.60	2.35	1.58	3.01
May - (1)	594,075	606,531	368,472	84,568	24,279	50,638	193,295	177,061	147,413	38,279	15,357	17,208	3.07	3.43	2.50	2.21	1.58	2.94
Oct (2)	–	–	–	–	–	–	–	–	–	–	–	–	3.14	3.67	2.78	2.72	1.33	2.83

(1) CPUE = Total catch/total effort
(2) CPUE = Σ (Monthly CPUE)/No. of months

Table 10.1. Monthly landings of BLUE WHITING during 1984 from the Portuguese fisheries (in tonnes)

Month	Trawlers	Artisanal
January	364.4	20.4
February	584.2	37.3
March	748.1	18.5
April	305.9	13.7
May	285.3	5.7
June	412.0	6.3
July	323.7	8.0
August	355.4	9.9
September	478.1	10.1
October	444.0	17.7
November	523.9	12.5
December	427.3	12.1

Table 10.2. Length composition of landings of BLUE WHITING in the Portuguese fisheries for 1984.

Length (cm)	Number (thousands)
11	3
12	41
13	276
14	757
15	4,274
16	37,176
17	49,869
18	36,285
19	25,972
20	12,202
21	6,792
22	3,321
23	1,681
24	1,048
25	619
26	255
27	156
28	39
29	46
30	10
31	14
32	5
33	3
34	3
35	1
36	0
37	0
Total	180,859
Tonnes	5,252
Mean weight (g)	29.0

Table 11.1. Total catches of BLUE WHITING divided into areas within and beyond areas of national fisheries jurisdiction of NEAFC contracting parties. Percentage in ( ).

Year	International	Svalbard	Jan Mayer	Norway	Iceland	Greenland	Faroes	EEC	Total (t)	Total from off. data (t)	%
1978	136,504 (25.52)	-	-	67,391 (12.60	26,444 (4.94)	6,580 (1.23)	195,361 (36.53)	102,523 (19.17)	534,803	574,812	93.0
1979	614,734 (56.18)	-	-	75,545 (6.90)	15,117 (1.38)	204 (0.02)	224,201 (20.49)	164,388 (15.02)	1,094,189	1,091,422	100.3
1980	567,693 (55.23)	-	-	152,095 (14.80)	4,562 (0.44)	8,757 (0.85)	164,342 (15.99)	130,417 (12.69)	1,027,866	1,092,620	94.1
1981	168,681 (19.76)	-	123,000 (14.41)	215,004 (25.18)	7,751 (0.91)	-	174,801 (20.48)	164,475 (19.27)	853,712	870,808	98.0
1982	22,993 (4.32)	-	-	130,435 (24.51)	5,797 (1.09)	-	125,072 (23.50)	247,884 (46.58)	532,181	544,919	97.7
1983	15,203 (2.93)	-	-	109,675 (21.15)	7,000 (1.35)	-	91,804 (17.70)	294,981 (56.87)	518,663	539,235	96.2
1984	18,407 (3.19)	-	-	150,603 (26.13)	105 (0.02)	-	124,905 (21.67)	282,418 (48.99)	576,438	586,504	98.3

Table 13.1 List of input variables for the ICES prediction program under the assumption of no catch of age 0 and 1 fish.

PREDICTION BLUE WHITING 1985-87
The reference F is the maximum value in the F at age array (age 15).

Proportion of F (fishing mortality) effective before spawning: .0000
Proportion of M (natural mortality) effective before spawning: .0000

Data are printed in the following units:

Total yield and weight by age group in the catch: kilogram
Total biomass and weight by age group in the stock: kilogram

age	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
0	.00	.20	.00	.032	.032
1	.00	.20	.10	.040	.040
2	.11	.20	.40	.083	.083
3	.16	.20	.80	.103	.103
4	.16	.20	1.00	.141	.141
5	.16	.20	1.00	.157	.157
6	.16	.20	1.00	.165	.165
7	.16	.20	1.00	.175	.175
8	.16	.20	1.00	.189	.189
9	.16	.20	1.00	.186	.186
10	.16	.20	1.00	.197	.197
11	.16	.20	1.00	.201	.201
12	.16	.20	1.00	.194	.194
13	.16	.20	1.00	.226	.226
14	.16	.20	1.00	.224	.224
15+	.16	.20	1.00	.242	.242

Table 13.2 BLUE WHITING. Yield and spawning stock biomass per recruit under the assumption of no catch of age 0 and 1 fish.

F factor	reference F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January sp.stock size	at 1 January sp.stock biomass	at spawning time sp.stock size	at spawning time sp.stock biomass
.000	.0000	.0000	.0000	5.5167	.6232	3.2678	.5170	3.2678	.5170
.100	.0160	.0469	.0071	5.2832	.5767	3.0356	.4707	3.0356	.4707
.200	.0320	.0873	.0130	5.0819	.5373	2.8355	.4314	2.8355	.4314
.400	.0640	.1535	.0221	4.7525	.4743	2.5084	.3686	2.5084	.3686
.600	.0960	.2055	.0286	4.4943	.4262	2.2525	.3208	2.2525	.3208
.800	.1280	.2474	.0335	4.2863	.3885	2.0467	.2833	2.0467	.2833
1.000	.1600	.2819	.0372	4.1153	.3582	1.8779	.2533	1.8779	.2533
1.200	.1920	.3109	.0401	3.9721	.3335	1.7369	.2287	1.7369	.2287
1.400	.2240	.3355	.0423	3.8505	.3128	1.6173	.2083	1.6173	.2083
1.600	.2560	.3567	.0441	3.7459	.2954	1.5148	.1911	1.5148	.1911
1.800	.2880	.3752	.0456	3.6550	.2805	1.4259	.1764	1.4259	.1764
2.000	.3200	.3915	.0467	3.5753	.2676	1.3481	.1637	1.3481	.1637
2.200	.3520	.4059	.0477	3.5047	.2565	1.2795	.1527	1.2795	.1527
2.400	.3840	.4187	.0485	3.4419	.2466	1.2185	.1431	1.2185	.1431
2.600	.4160	.4303	.0491	3.3856	.2379	1.1640	.1346	1.1640	.1346
2.800	.4480	.4407	.0496	3.3348	.2302	1.1151	.1270	1.1151	.1270
3.000	.4800	.4502	.0501	3.2887	.2232	1.0708	.1202	1.0708	.1202
3.200	.5120	.4589	.0504	3.2468	.2170	1.0306	.1142	1.0306	.1142
3.400	.5440	.4668	.0507	3.2085	.2113	.9940	.1087	.9940	.1087

$$
$$

Slope of the yield curve at the origin based on a single recruit: .078
F-0.1 given by an F factor of 1.618, resulting in a reference F of .259
F-max given by an F factor of 7.305, resulting in a reference F of 1.169

$$
$$

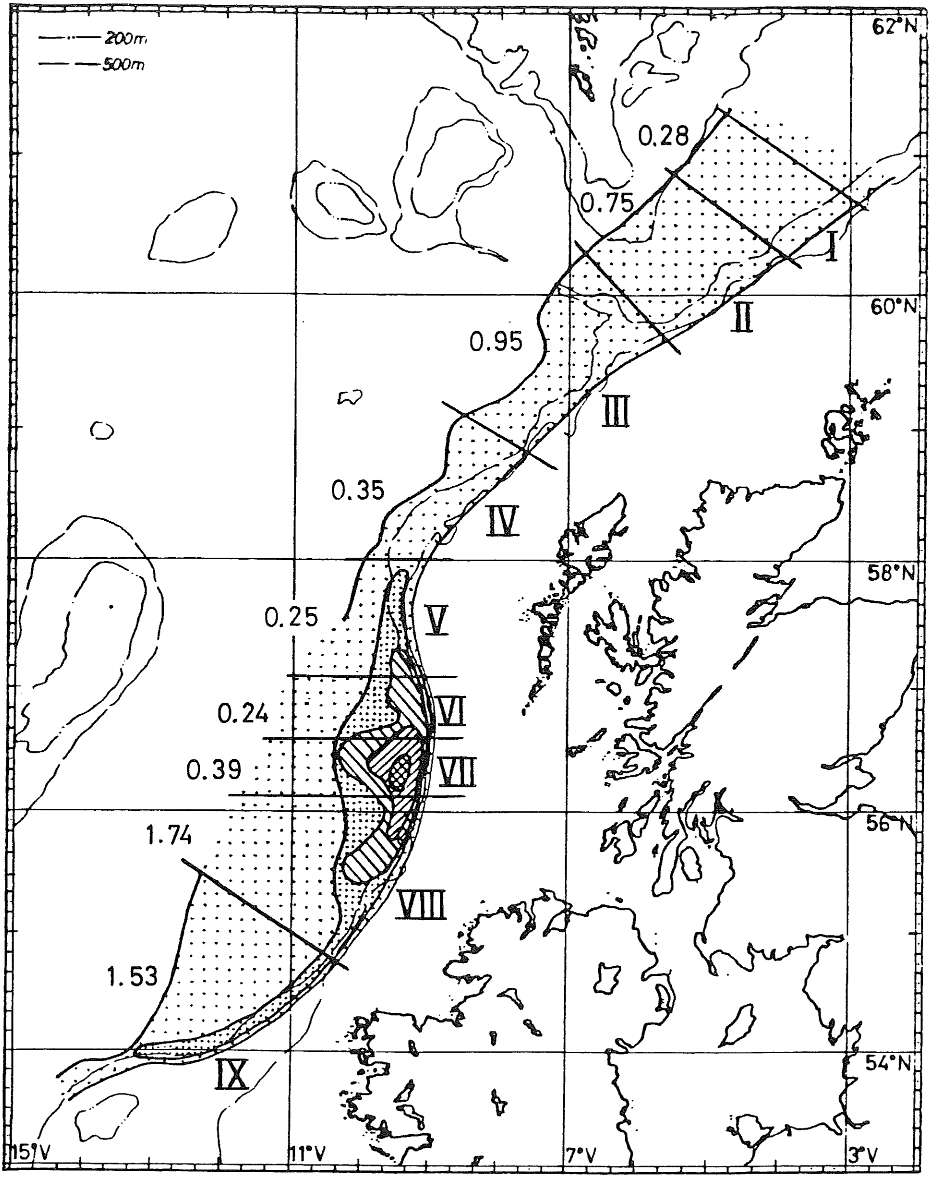


Figure 8.1. Distribution and relative abundance of blue whiting. Magnus Heinason March-April 1985.

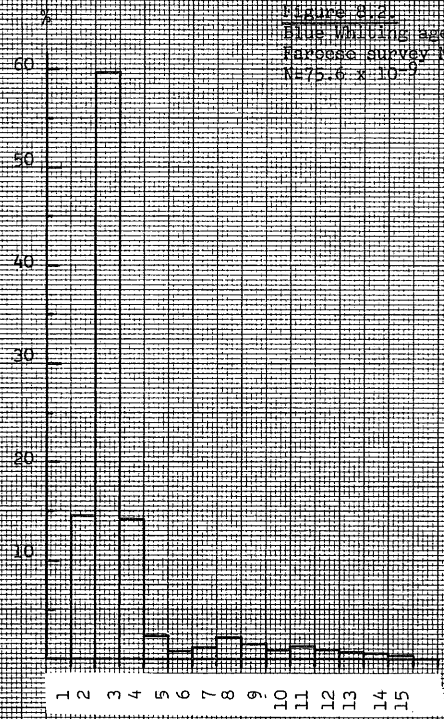


Figure 8.2.
Blue Whiting age composition
Faroese survey March-April 1985
$N=75.6 \times 10^{-9}$

Figure 8.3.

Biomass (1,000 tonnes) of Blue Whiting by rectangle estimated during the Soviet survey, April 1985.

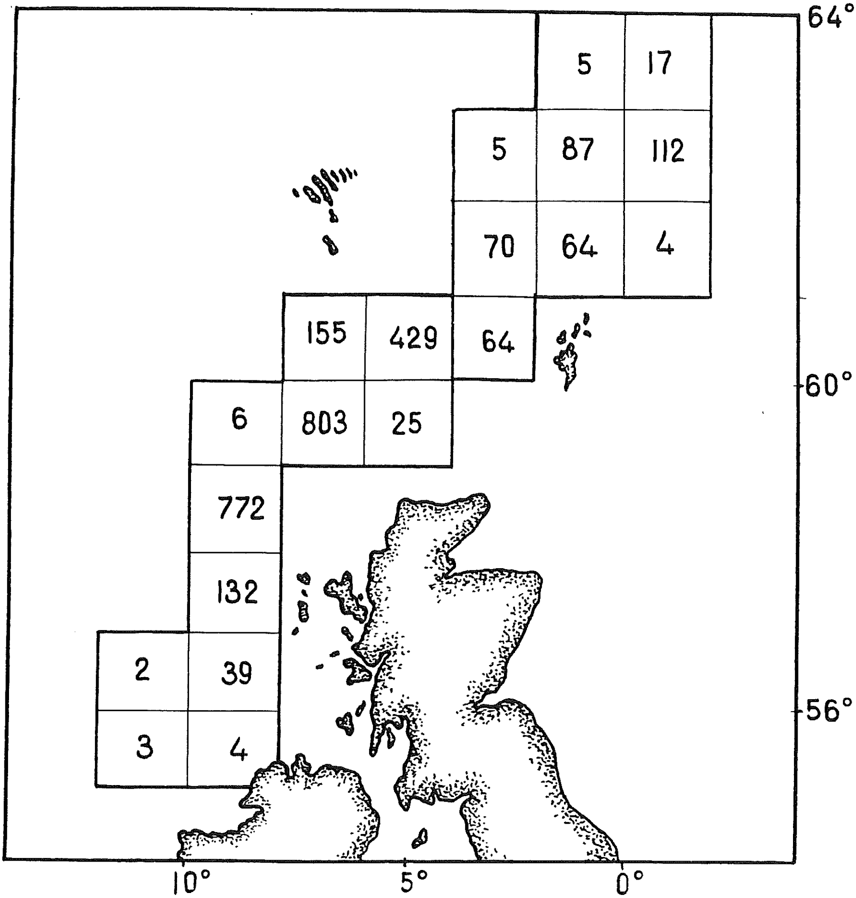
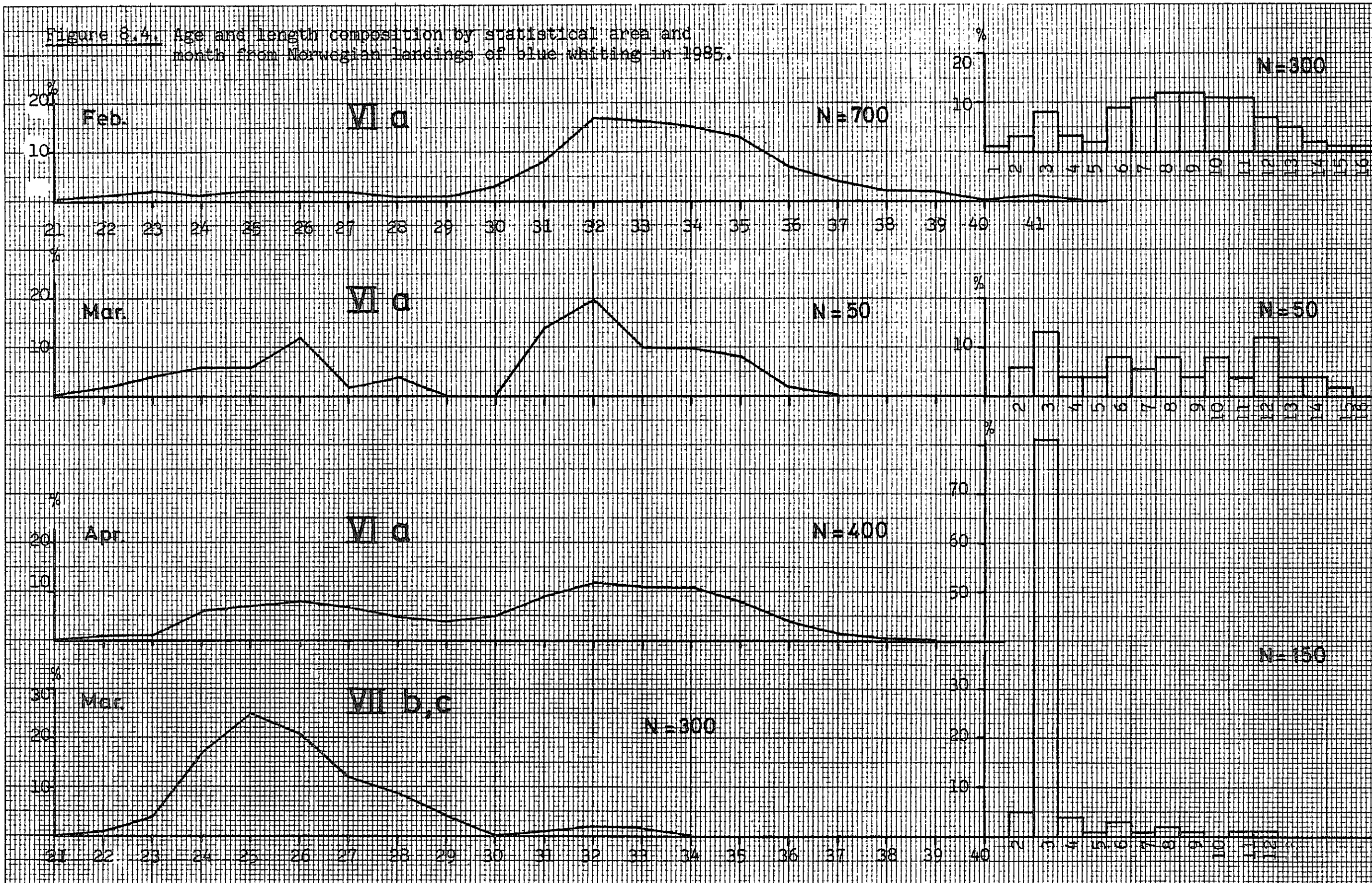


Figure 8.4. Age and length composition by statistical area and month from Norwegian landings of blue whiting in 1985.



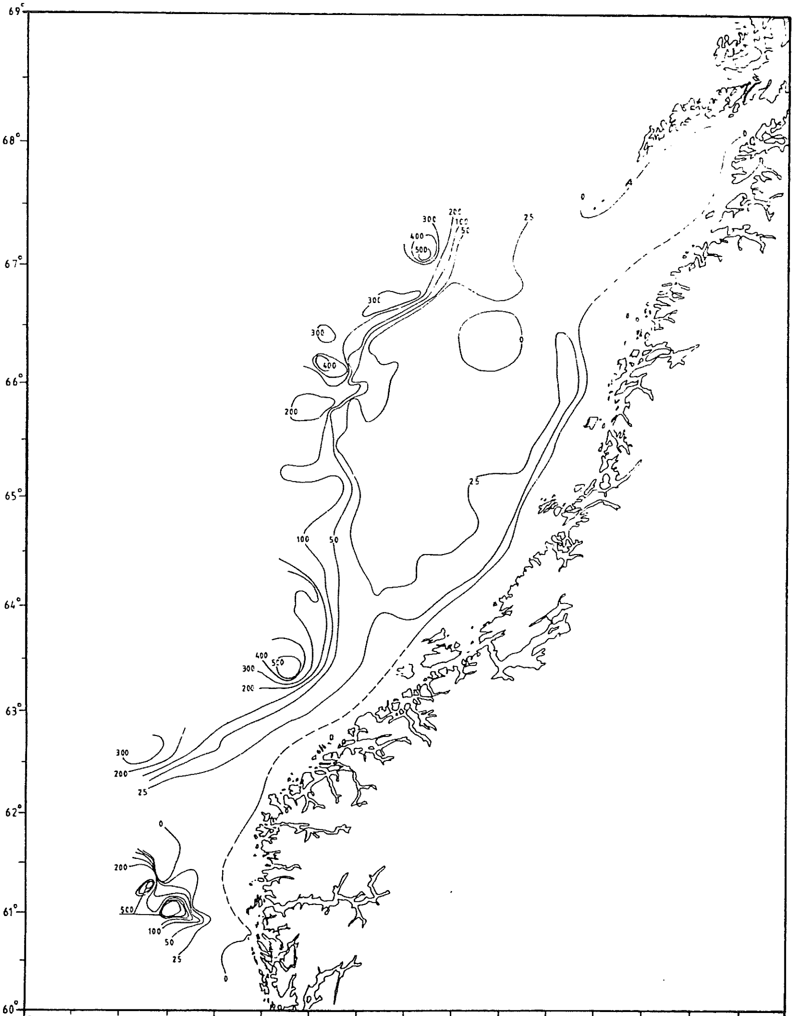


Figure 8.5 Relative abundance of Blue Whiting recorded in April 1985. Echo intensity in m^2/n. mile^2 * 10.

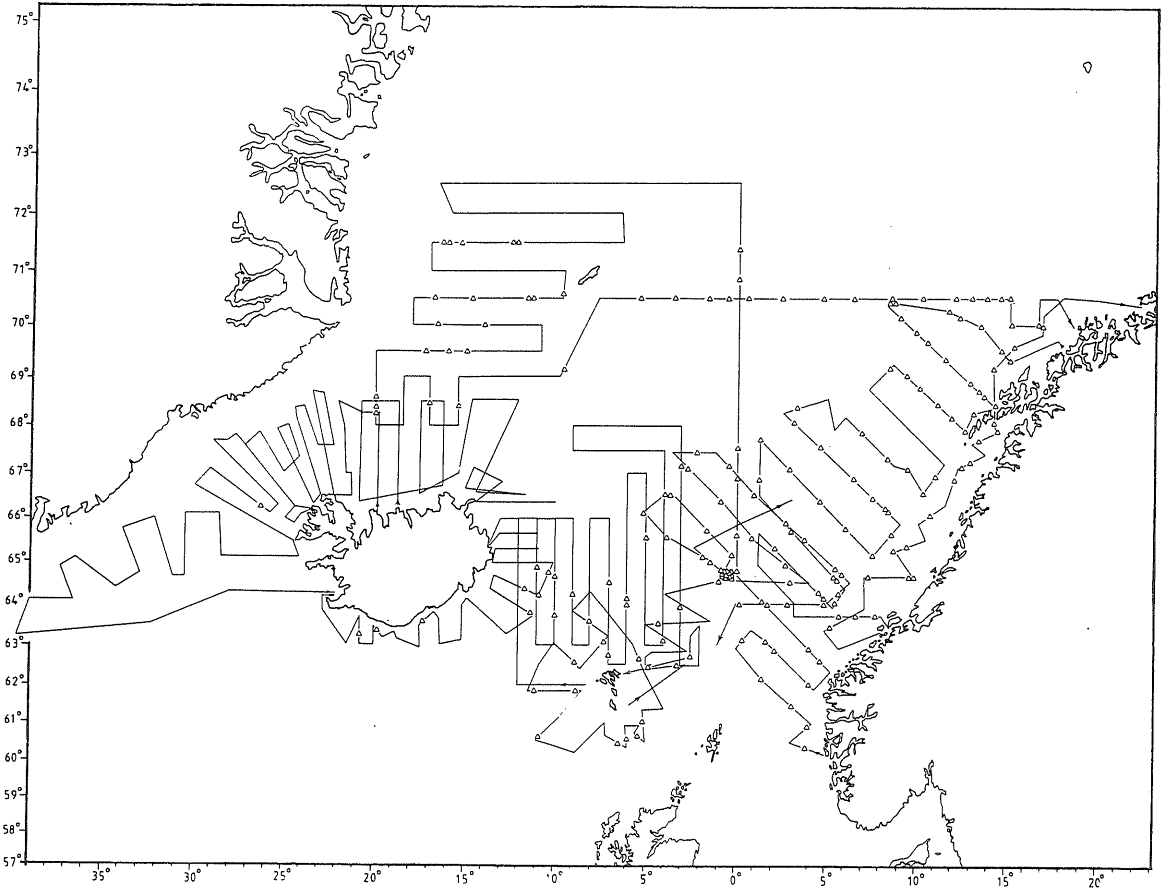


Figure 8.6 Cruise tracks and trawl stations of the seven research vessels, August (27 July - 5 September) 1985. Triangel : Pelagic trawl station.

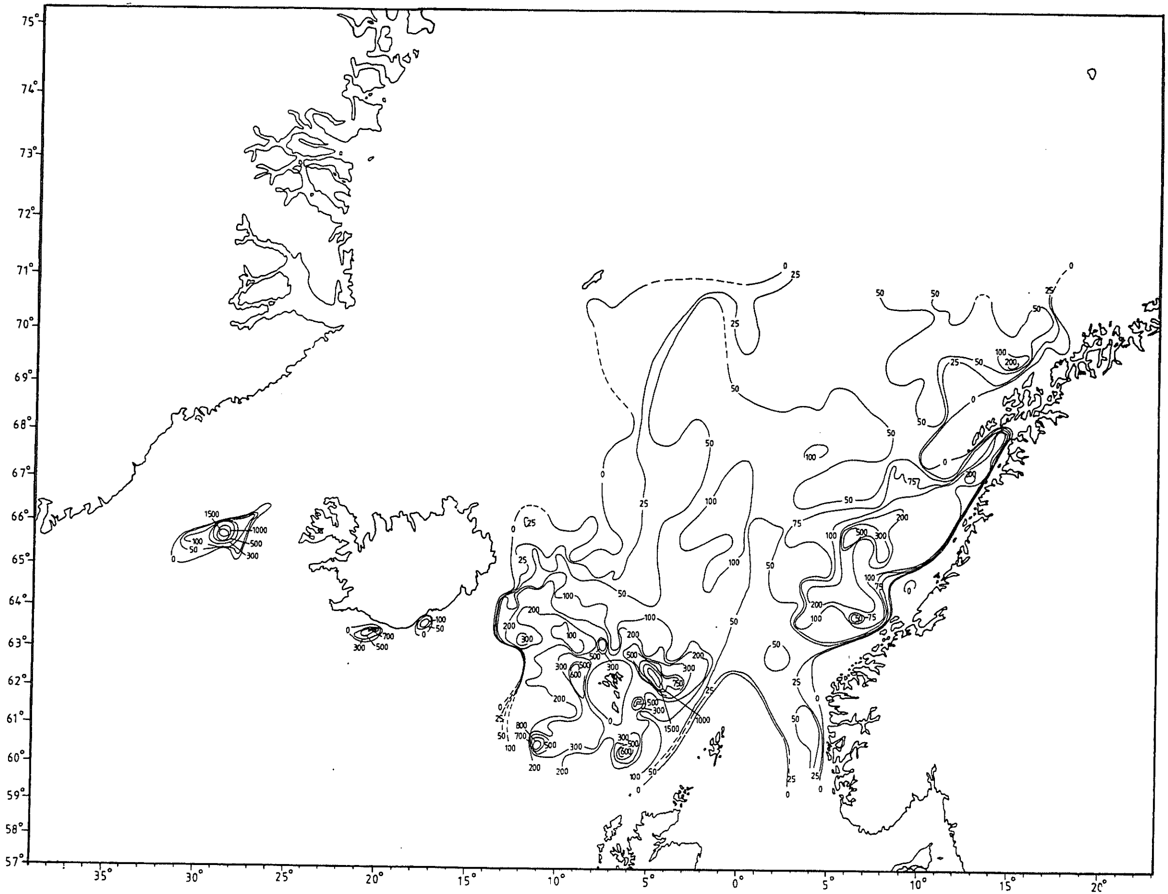


Figure 8.7 Distribution and relative abundance of blue whiting, August 1985. Echo intensity in $m^2/(n.mile)^2 .4\pi$

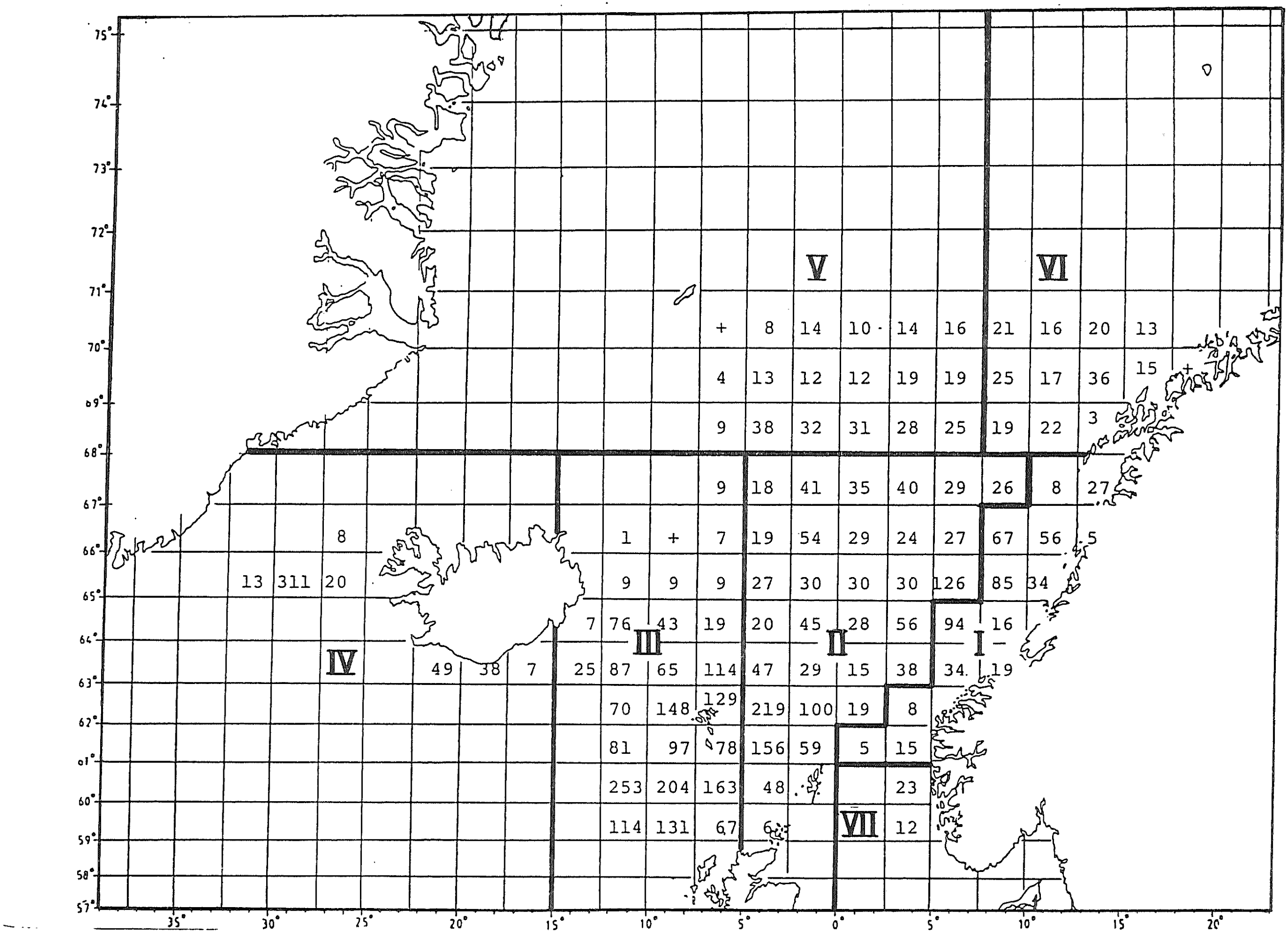


Figure 8.8. Biomass of blue whiting (in 1,000 tonnes), August 1985.
Markings of sub-areas I-V

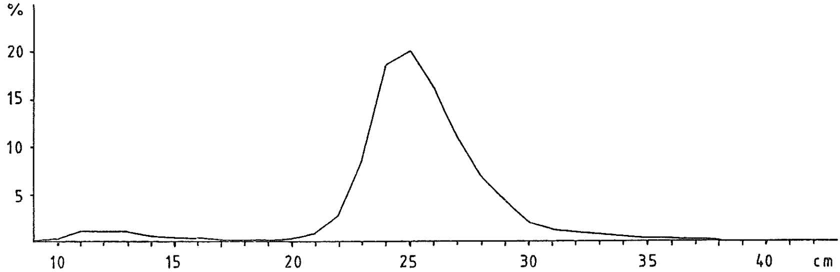


Fig. 8.9 Total length distribution of blue whiting weighted by abundance, Norwegian Sea, August 1985. N: 47.2 · 10^9 specimens.

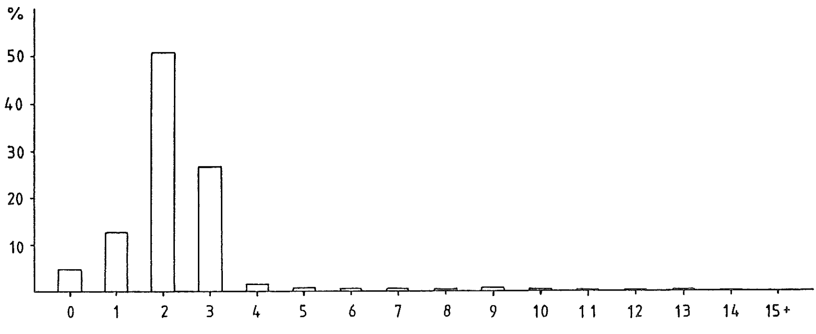
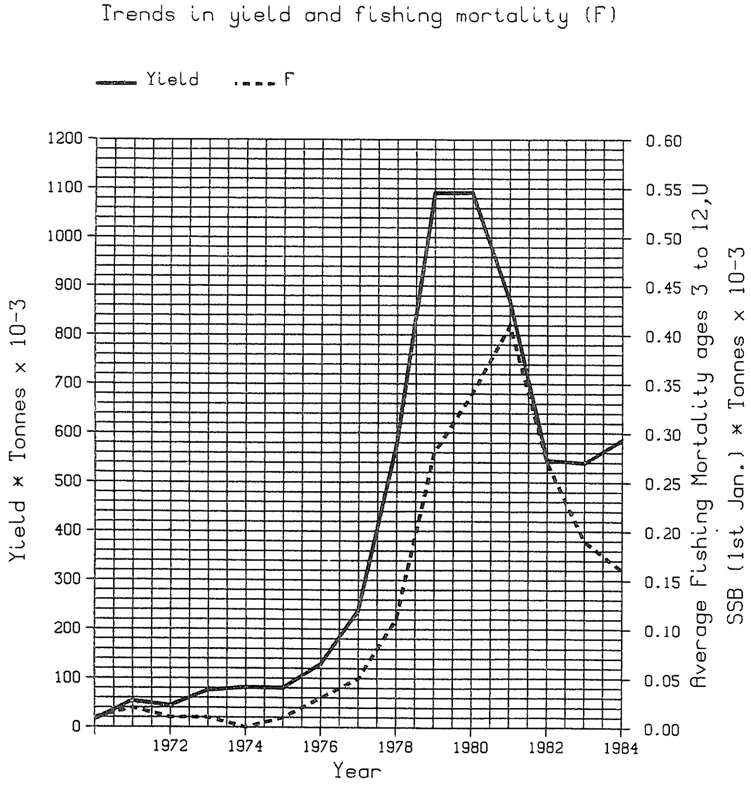


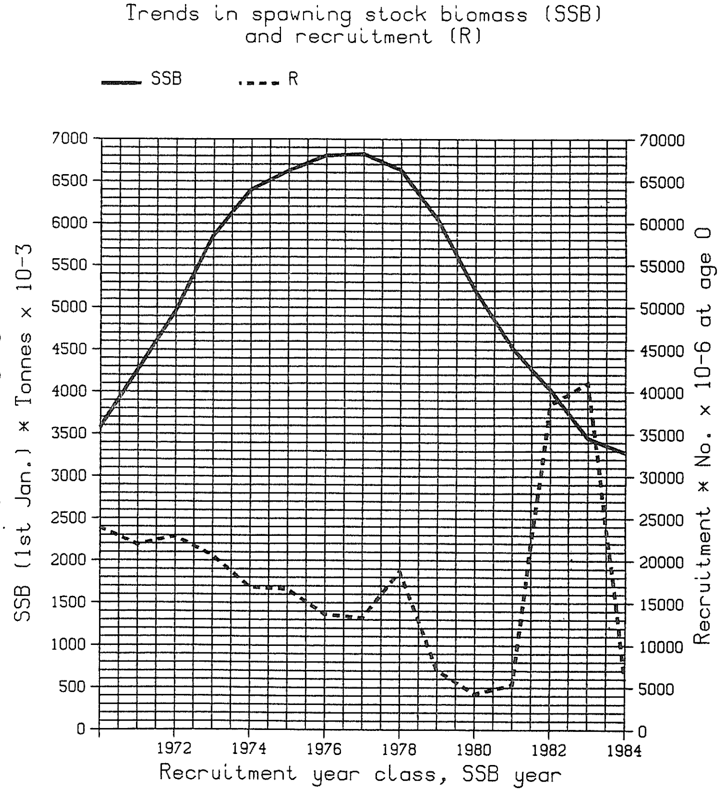
Fig. 8.10 Total age composition of blue whiting, Norwegian Sea, August 1985. N: 47.2 · 10^9 specimens.

Figure 8.11 A-B

FISH STOCK SUMMARY
STOCK: BLUE WHITING - NORTHERN
10-10-1985



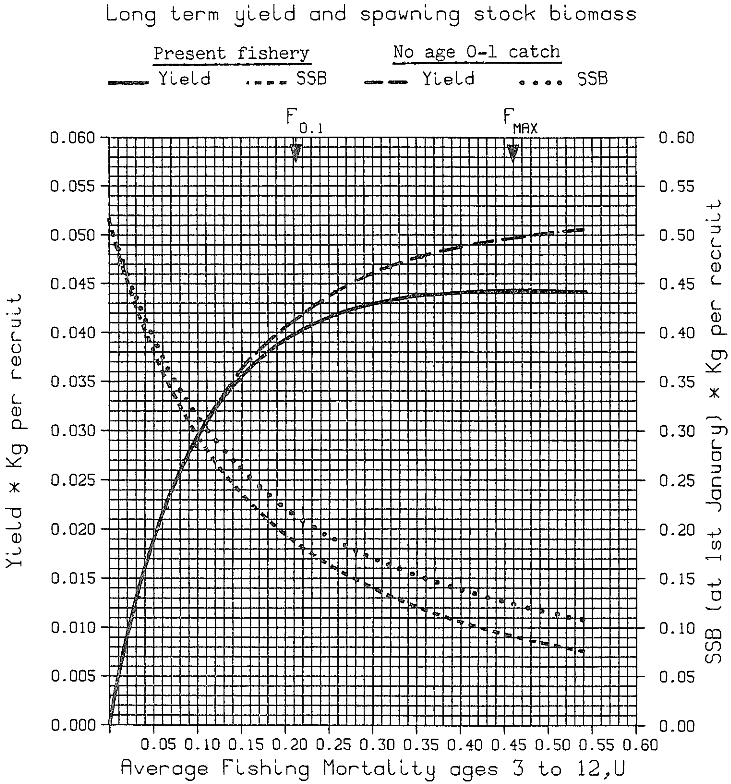
A



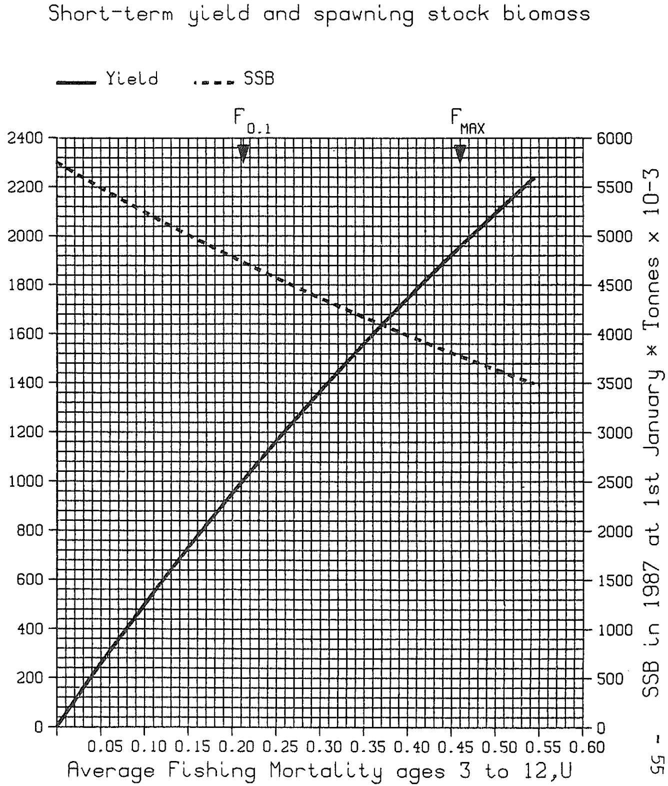
B

Figure 8.11 C-D

FISH STOCK SUMMARY
STOCK: BLUE WHITING - NORTHERN
10-10-1985



C



D

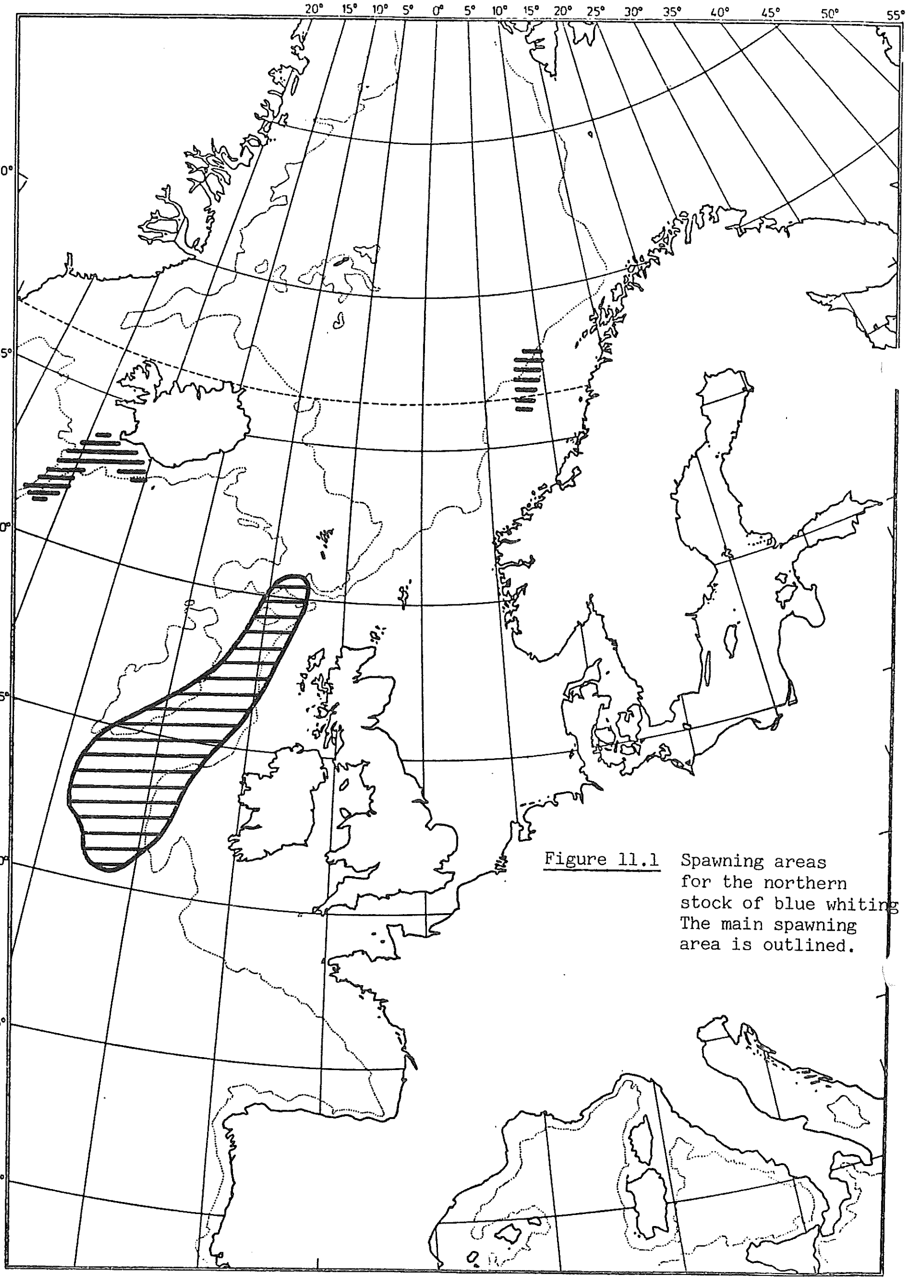


Figure 11.1 Spawning areas for the northern stock of blue whiting The main spawning area is outlined.

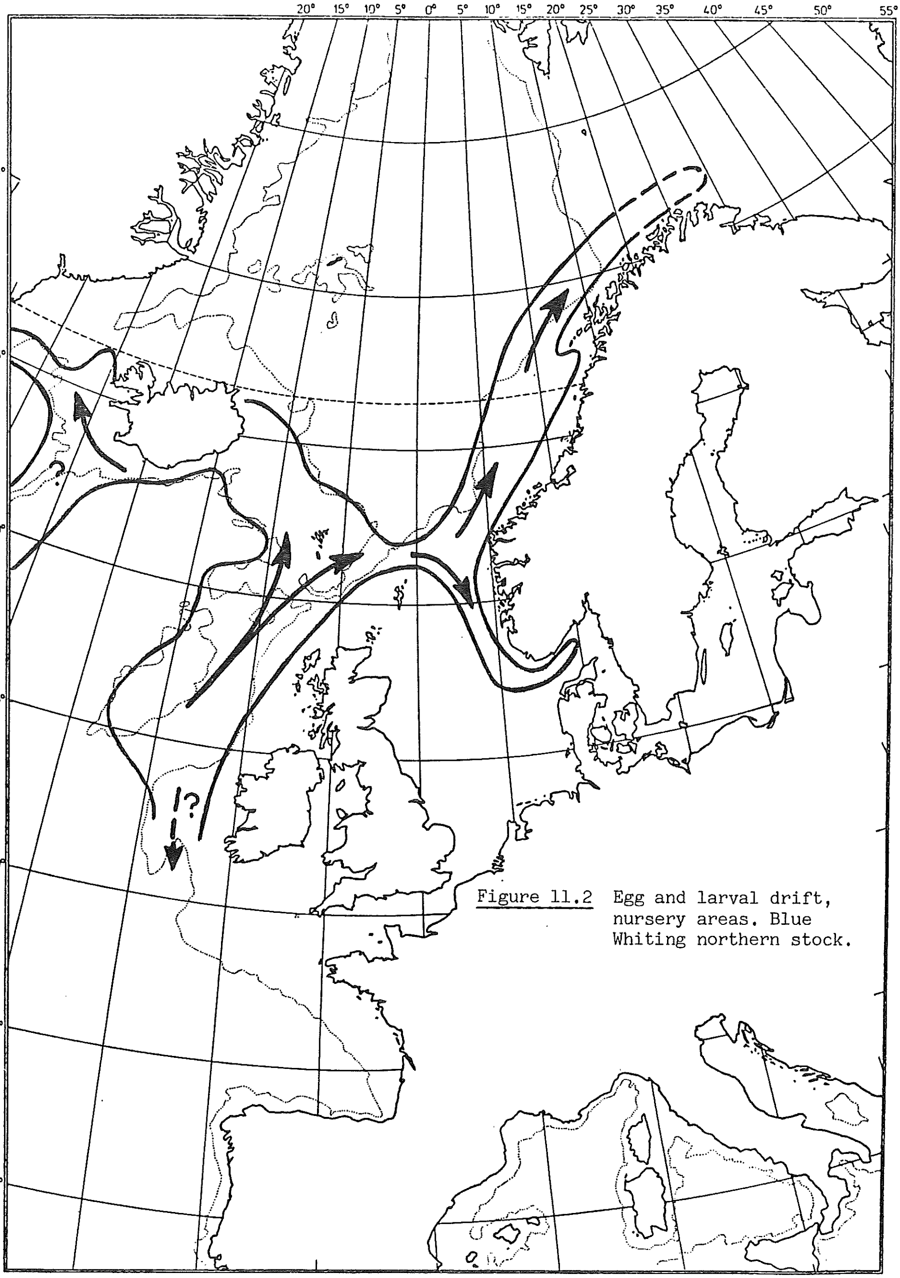


Figure 11.2 Egg and larval drift, nursery areas. Blue Whiting northern stock.

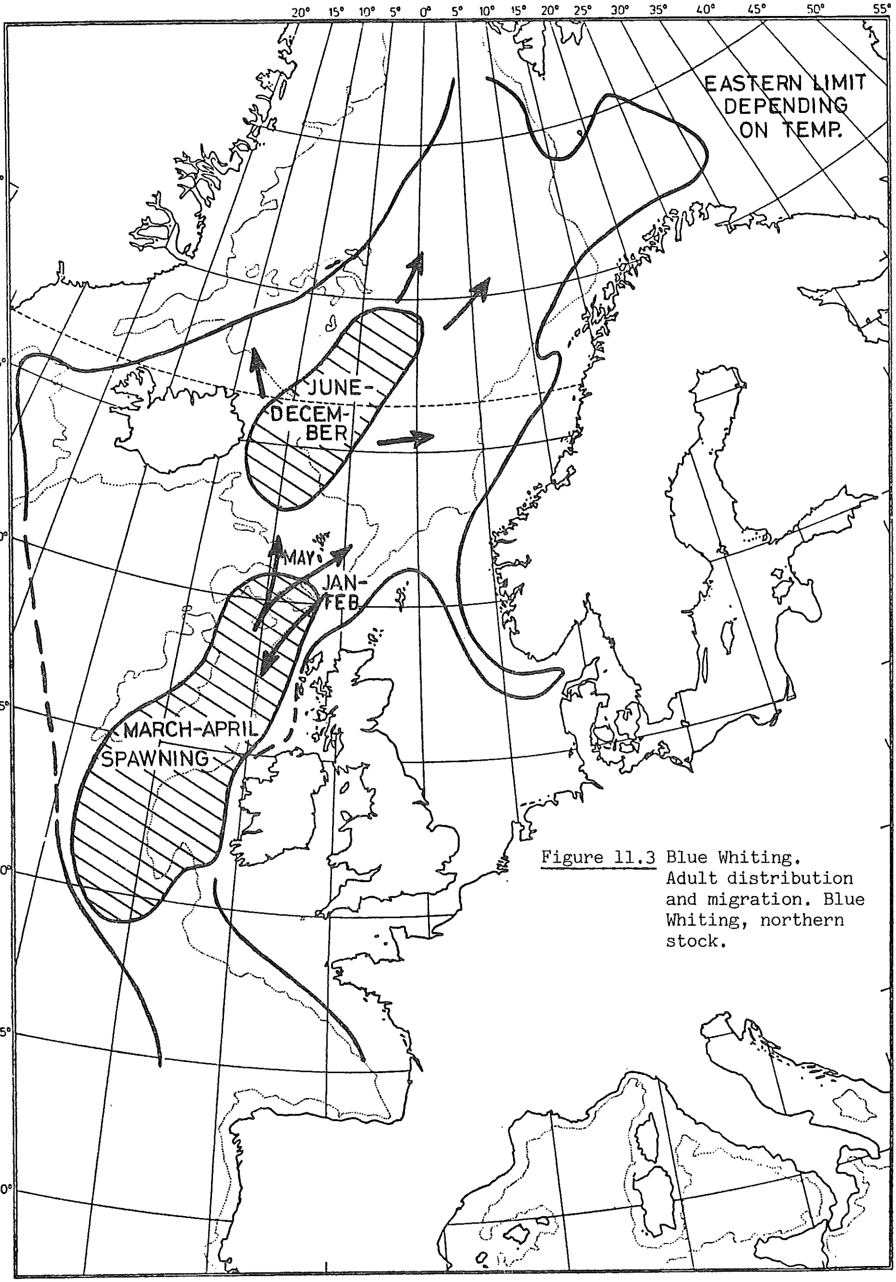
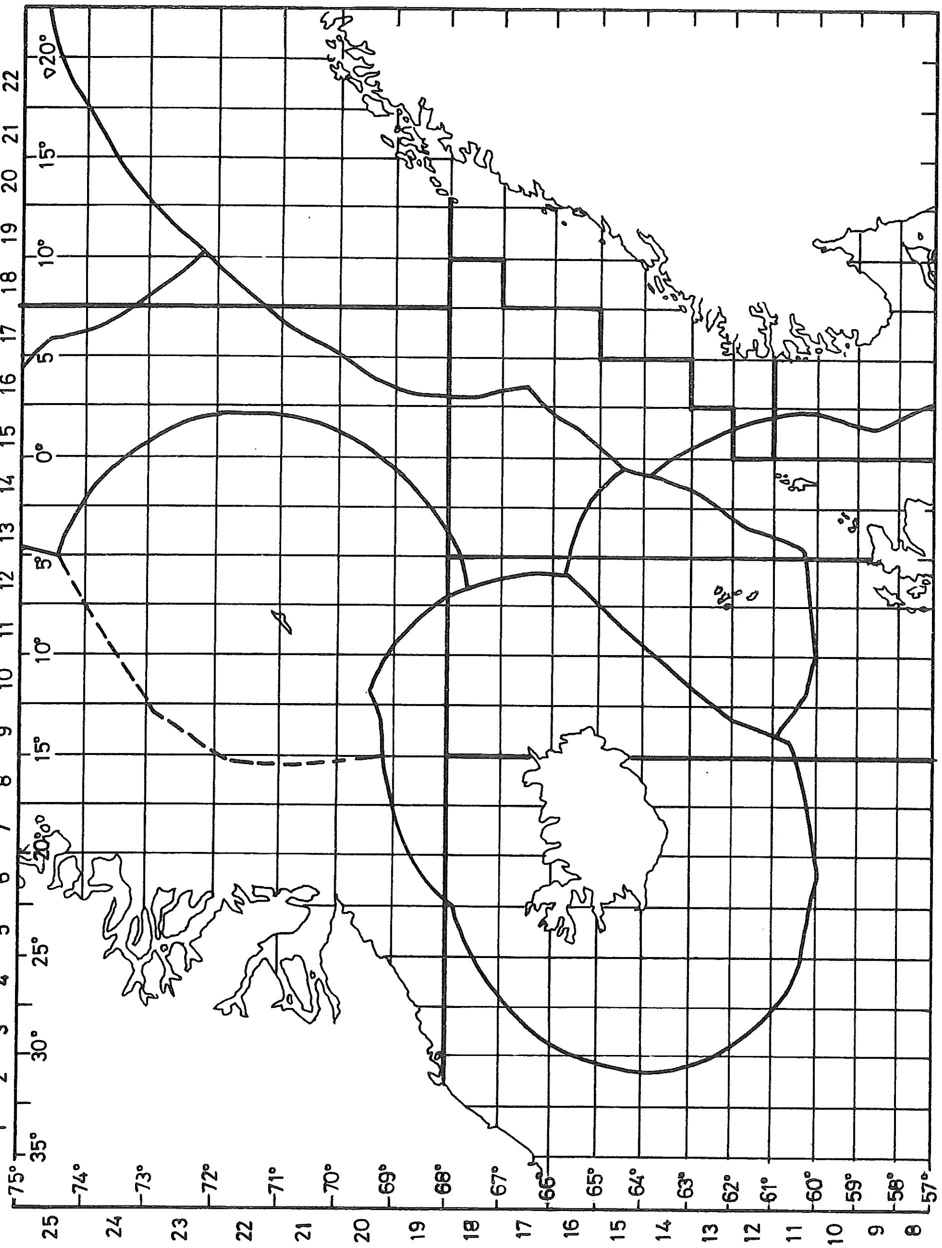


Figure 11.3 Blue Whiting. Adult distribution and migration. Blue Whiting, northern stock.

Figure 11.4 Areas of national fisheries jurisdiction of NEAFC contracting parties.



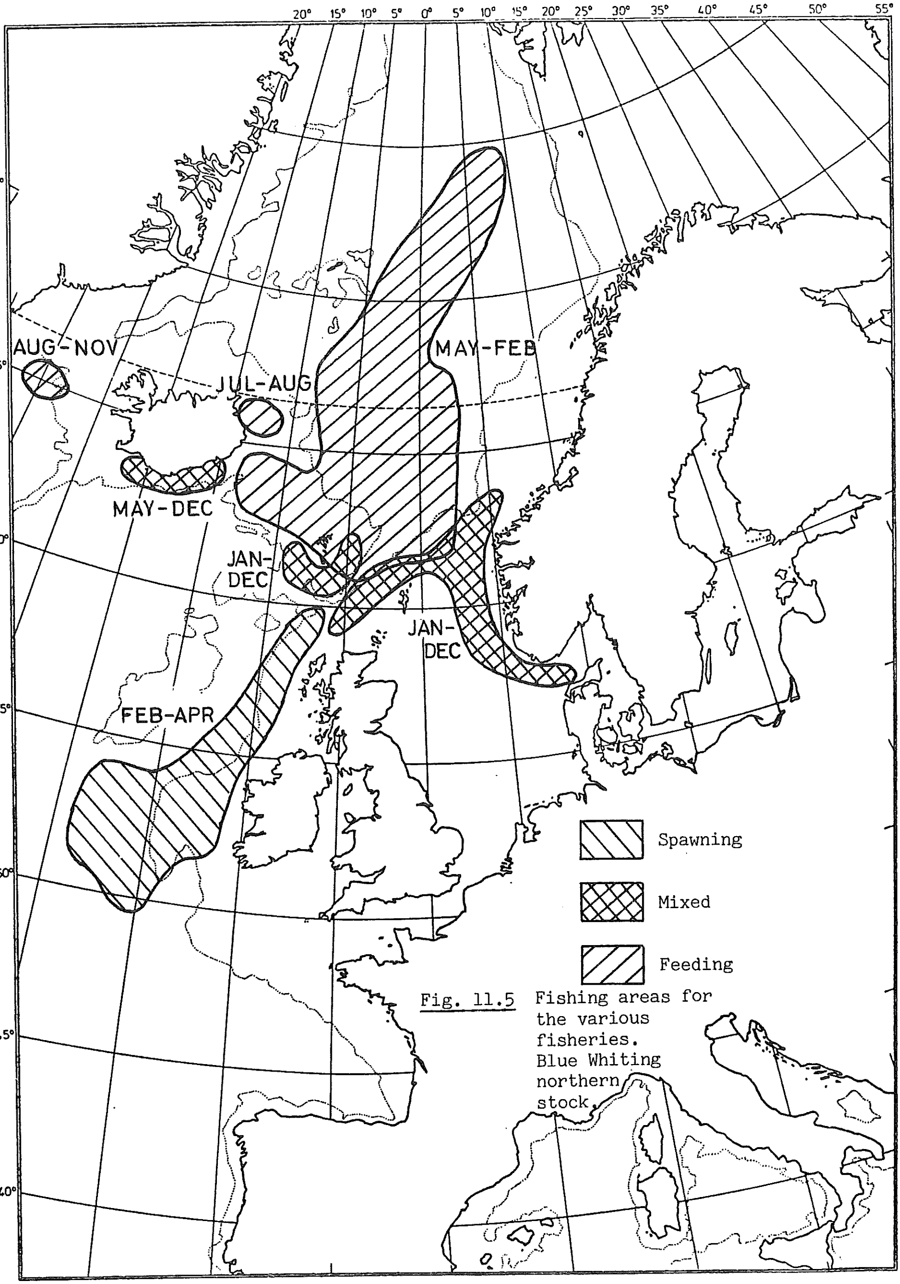


Fig. 11.5 Fishing areas for the various fisheries. Blue Whiting northern stock.

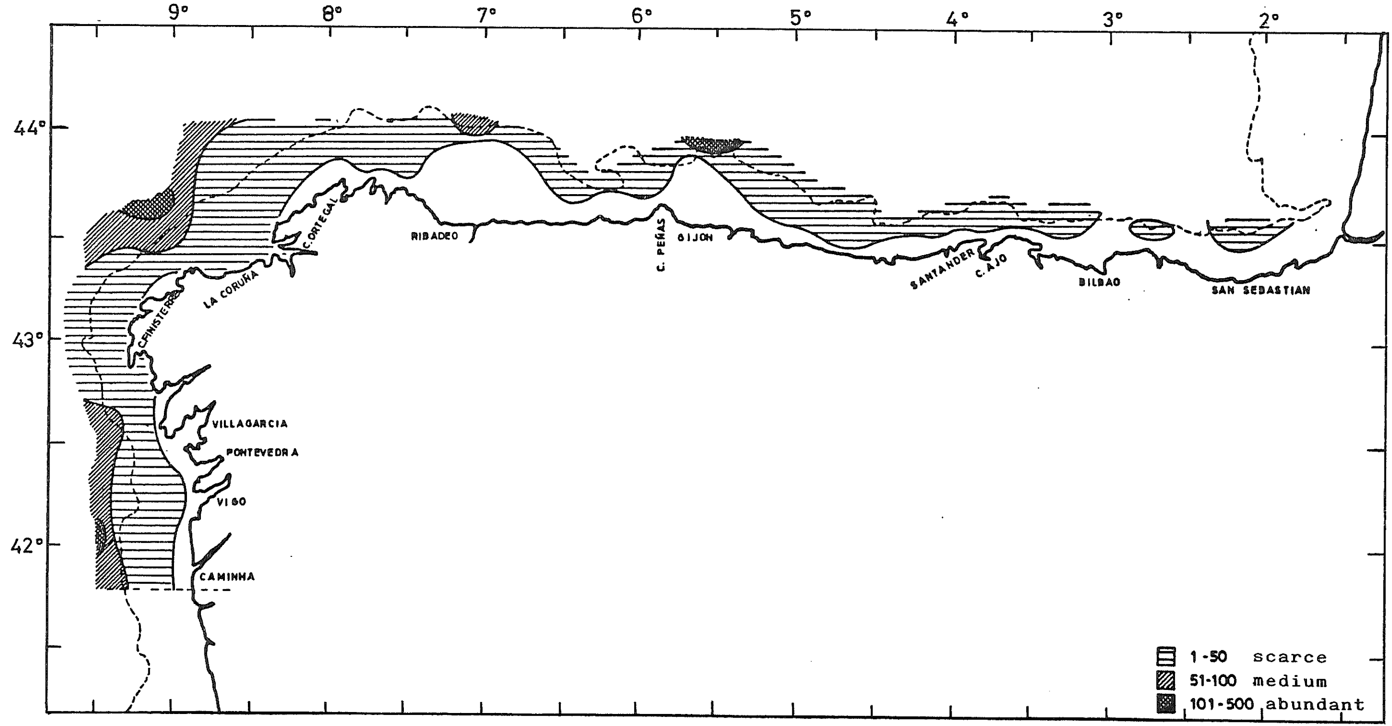


Figure 10.1 Distribution and abundance of Blue Whiting off Cantrabian and Galician waters during a survey in 1984. (Pastor et al, 1985).

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