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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, 26 September - 3 October 1984

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0.1. INTRODUCTION

0.1.1. Terms of reference

The Blue Whiting Assessment Working Group (Chairman: H í Jákupsstovu) met at ICES headquarters from 26 September to 3 October 1984 (C. Res. 1983/2:8:12) to:

(i) assess catch options inside safe biological limits for the blue whiting stock in 1985,

(ii) take into account the levels of predation mortality implied by the results of the stomach sampling project,

(iii) analyse the effect of changes in the data sets of weight at age and age at first maturity on the time series of stock and spawning stock biomass.

Further, NEAFC has asked ICES to provide comprehensive assessments of the blue whiting stock, including an assessment of the effect of an increase in the minimum mesh size to 40 mm.

0.1.2. Participants

H B Becker	The Netherlands
G Biais	France
S Ehrich	Federal Republic of Germany
H í Jákupsstovu (Chairman)	Faroe Islands
K Lehman	Greenland
T Monstad	Norway
A Paciorkowski	Poland
V Shleinik	USSR
N Schultz	German Democratic Republic
T Smolianova	USSR

0.2. LANDINGS

0.2.1. Landings in 1983

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

The total landings from all Northern blue whiting fisheries in 1983 were estimated at 541 467 tonnes compared to a total landing in 1982 of 544 919 tonnes.

There was an increase of about 14% in the total landings from the spawning fishery in 1983 compared to 1982, mainly due to larger landings of Faroe Islands, Norway and USSR.

The total landings from the Norwegian Sea fisheries decreased by about 50% compared to the 1982 landings, mainly due to a marked reduction of the USSR landings in 1983.

The total landings from the mixed industrial fisheries and from the directed fisheries were at the same level as in 1982.

The total landings from the Southern Area fishery were at the same level as in 1982.

0.2.2. Landings in 1984

Preliminary information on landings of blue whiting has been submitted by some countries reporting on ICES Data Form 5. Data up to and including July 1984 are presented in Table 2.7.

0.3. STOCK IDENTITY AND STOCK SEPARATION

The investigations on maturity curves started in 1982 in the area between 42° and 61°N (Ehrich and Robles, 1982) and were continued in 1983 (Giedz,1983 ; Ehrich and Schöne, 1983). The results of 1983 underscore the findings of Ehrich and Robles, that there is an increase in the mean lengt at maturity from the south to the north in the area west of the Britis Isles and Ireland. A comparison between fish from the Porcupine and Rockall Banks, using the otolith width and the diameter of the second growth zone as separation characters shows no significant differences (Giedz, 1984).

The Working Group reiterates the statement of last year, that population parameters like the size at maturity (L 50) or growth dependent characters like otolith width and ring diameters are very sensitive to extrinsic factors. They tend to characterize the environment occupied by a stock as well as the stock itself (Ihssen et al.,1981). Therefore only characters for stock separation should be used of which the phenotypic part could be excluded to a high degree.

Nevertheless, the occurrence of spawning and 0-group blue whiting in areas far away from each other (see Chapter 4) and the occurrence of a certain quantity of blue whiting on the Rockall Bank throughout the year see (Chapter 7.4), along the Norwegian shelfedge and the Norwegian fjords (Egidius and Monstad, 1982) indicate the existence of several populations in the North Atlantic.

0.4. AGEING OF BLUE WHITING

0.4.1. Otolith exchange program.

The Blue Whiting Assessment Working Group in 1983 (Anon 1984a) recommended that an international otolith exchange program was set up. This should serve as a control of the extent of consistency in ageing of blue whiting in various countries and appointed V.Shleinik as coordinator of th program. The program was initiated very soon after the Working Grou meeting but has unfortunately not been completed yet.

0.4.2. Interpretation of the first winter ring.

Since Bailey (1982) discussed this problem extensively, some additional information on the distribution and length composition of immature blue whiting during the summer has been collected.

During the 0-group surveys in August-September both in 1983 and 1984 (Anon 1983a,1984b) 0-group blue whiting were caught with a mean length of 6.6 cm and 5.8 cm respectively. In August 1983, during the Icelandic 0-group survey, immature blue whiting of two distinct length groups (av.l=8.9 cm and av.l= 15.3 cm) were caught in midwater over the continental slope west of Iceland and in the south eastern part of the Irminger Sea (Anon 1983b).Immature blue whiting were also caught on the bottom at several stations on the East Greenland -shelf in August 1983 (range 8.0-10.5 cm ,av.l=8.6 cm). On several cruises of the Federal

Republic of Germany research vessel "Walther Herwig", 0-group blue whiting have been caught (Ehrich pers. comm.). In June 1979 71 specimens (av.l= 6.5 cm) were caught at the bottom of the southeastern slope of the Lousy Bank. At the end of May 1983 23 specimens (av.l=7.4 cm) were caught over the western slope of the Porcupine Bank. In January 1983 1 specimen of 10.5 cm and a number of larger immature blue whiting (range 16.5-20.5 and av.l=18.9) were caught with bottom trawl. Similarly in July 1984 during a bottom trawl survey on the Rockall Bank one specimen of 7.5 cm was caught and a number of larger immature blue whiting (range 13.5-19.5 cm, av.l=15.5) were also obtained.

These new observations support the theory that blue whiting in their first year of life attain a length of approximately 10 cm and that they spend the first one and a half year in the upper midwater layers. In addition to the major spawning area of the northern stock component there exist some minor spawning areas where blue whiting have been reported to spawn at a later time of the year (Anon 1981 ,1983b). At least some of the small blue whiting mentioned above could originate from such late spawning.

At the moment the Working Group considers that these new observations are too inconclusive to allow any change in the age reading of the three important countries fishing for blue whiting (USSR, Norway and Faroes), which assume the blue whiting to attain a length of 20 cm in the first year. The Working Group, however, reiterates its previous recommendation that specific surveys are designed to study this question (See also section 13).

For the time being the Working Group strongly recommends that blue whiting from the Northern Area are age determined according to the recommendations made by the Blue Whiting Ageing Workshop (Anon. 1983d).

0.5. AGE COMPOSITON OF LANDINGS

Age composition of landings were revised for 1973-1980 and 1982 and new data were available for 1983.

The age readings brought to the Working Group meeting for 1983 followed the recommendations of the Ageing Workshop meeting in 1983 (Anon 1983d).

No attempt was made to standardize the age readings brought to the Working Group meeting for the earlier years, and the catch in number by age group (Tables 5.1 - 5.3) are as provided by the Working Group members.

For the directed fisheries in 1983, age composition data were provided by the USSR, Norway, the German Democratic Republic and the Faroe Islands. These data together accounted for 90% of the landings in the directed fisheries. Other landings from the Norwegian Sea fisheries were assumed to have the same relative age composition as those from the USSR in Division IIa.

Other landings from the spawning fishery were assumed to have the same relative age composition as that of Norway (from Divisions VIa-b,VIIb-c and VIIg-k), Faroes from Subareas Vb and VIa, USSR from Subarea Vb and Division XII and GDR from Division XII combined.

For landings of blue whiting taken in the mixed industrial fisheries data on age composition were available from Norwegian and Icelandic catches only. These accounted for 59% of the total industrial catches. Other countries' landings were assumed to have the same relative 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).

0.6. WEIGHT AT AGE

Mean weight at age data were presented by Norway, USSR and the German Democratic Republic by areas and months.

Mean weights for the spawning fishery, the Norwegian Sea fishery and the mixed industrial fishery were calculated, weighted by the monthly catches. An overall mean was calculated, weighted by the total landings in numbers from each country. The total catch landed in 1983 was compared against the sums of products (SOP's) of total numbers landed in 1983 and mean weight at age. The calculated SOP's were within 3% of the nominal landings. The mean weights at age used in the VPA runs are presented in Table 6.1.

0.7. STOCK SIZE ESTIMATES

0.7.1. Acoustic surveys in 1984

0.7.1.1. Surveys during the spawning season.

During the spawning season of 1984 three independent surveys on the blue whiting stock were conducted in the area west of the British Isles and Ireland, by USSR, Norway and Faroes.

The Norwegian survey (Monstad 1984), which took place from the end of March to mid-April, covered the area along the British shelf edge from Faroes and Shetland to the south of the Porcupine Bank and at the Rockall Bank.

Blue whiting were localized almost continuously along the slope between 61°30 N and 52°00 N. Extremely high concentrations of blue whiting were recorded within some narrow and limited localities. The distribution and relative abundance observed are shown in Fig. 7.1. Using a length dependent density coefficient (Anon 1982b) the biomass was estimated at 2.8 million tonnes. Of these 2.1 million tonnes were estimated to belong to the spawning stock (either maturing or spent gonads). The estimate broken down by areas is presented in Fig.7.2.

The Faroese survey took place in the first half of April (Jakupsstovu and Thomsen, 1984) from Faroes to the northern parts of the Porcupine Bank. Using the method described in Anon (1982) to convert the echo values to biomass, the spawning component was estimated at 2.2 million tonnes (fish 26 cm and larger). The estimated biomass split by areas is presented in Fig. 7.3.

Two separate estimates were made during the USSR survey (Ermolchev et al. 1984a), one in the second half of March the other in the first half of April. For the acoustic assessment the same method was used as for the corresponding survey in 1983 (Ermolchev et al. 1984b). In March, covering the area west of Ireland and the Porcupine Bank, the blue whiting biomass was estimated at 2.7 million tonnes of which 2.4 million tonnes consisted of fish 26 cm and larger. The distribution and relative densities recorded during this period are shown in Fig. 7.4. In April the shelf-edge from the north of Shetland (63° N) to the Porcupine Bank (53° N) was surveyed. Blue whiting was recorded along the entire shelf edge as far south as 56°20 N (Fig.7.5). The total blue whiting biomass during this part was estimated to be 3.4 million tonnes. Of this 2.7 million tonnes were fish 26 cm and larger.

In the text table below are given the different estimates (in million tonnes) obtained during the spawning season in 1984.

Country	Time period	Area	Imm.	Adults	Total
Faroes	31/3 - 17/4	60°30-54°00 N	0.2	2.2	2.4
USSR	17/3 - 31/3	56°20-51°00 N	0.3	2.4	2.7
USSR	9/4 - 20/4	63°00-53°00 N	0.7	2.7	3.4
Norway	26/3 - 17/4	61°30-52°00 N	0.7	2.1	2.8

The 1982 and 1983 year classes, dominated in the northern areas surveyed, while the 1982 year class and older fish made up the bulk of the biomass recorded further south.

0.7.1.2. Surveys in the feeding season

In August 1984, the third ICES-coordinated acoustic assessment survey was carried out in the Norwegian Sea with six research vessels from five different countries participating (Anon 1984c).

The area to cover and survey routes for each vessel were agreed upon by correspondence and telephone contact. The procedure of conveying data to the convener was as outlined by the Planning Group in 1983 (Anon 1983e).

The cruise tracks and stations are shown in Fig. 7.6. Because of of the participation of only six research vessels in 1984 compared to eight in 1983, the area covered was somewhat smaller than in 1983. Areas with high concentrations of blue whiting, however, were fully covered.

The distribution and relative abundance are shown in Fig. 7.7. Blue whiting was recorded scattered throughout most of the surveyed area.In the Norwegian Sea it was found on the warmer side of the polar front from the Norwegian Deep in the south to approximately 74°N. The distribution pattern was very similar to that recorded during the last three years (Anon 1982,1983f) with the highest concentrations located in the southern part of the investigated area. In 1984 dense recordings of blue whiting were found off the northern shelf of the Faroes , the southern shelf of Iceland and within a limited area west of Iceland.

Using the same methods for assessment as in the previous years (Anon 1982) the total stock was estimated at 3.8 million tonnes equivalent to 49.2*109 individuals. In Fig. 7.8 the total biomass estimate divided by areas is presented.

The total length distribution weighted by the abundance in the different areas is presented in Fig. 7.9. As the otoliths sampled during the survey had not been age determined by all countries by the time the Working Group met, the length distribution was broken down on age groups using probability paper (Harding 1949). Based on this method the total biomass was finally split into numbers and biomass by age groups. The results are shown in the text table below

Year class	Numbers (Billions)	Biomass (1000 t.)
1984	2.1	46.1
1983	30.6	1767.5
1982	14.6	1555.5
1981+	1.9	405.6
Total	49.2	3775.0

0.7.1.3. Discussion

The various estimates obtained in the spawning area and in the Norwegian Sea since 1981 in million tonnes are presented in the text table below (the adult component in brackets).

Area	1981	1982	1983	1984
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)
Norwegian Sea	4.9	4.6(4.1)	2.8(1.1*)	3.8(0.4*)

* The 1981 yearclass and older.

The three different spawning season surveys in 1984 covered slightly different areas. The USSR estimate in March (2.4 million tonnes of adults) is from the area off Ireland only and hence is an underestimate of the spawning stock. In April the USSR survey covered a much larger area and the estimate (2.7 million tonnes of adults) must be considered the most representative of the two. The Norwegian estimate (2.1 million tonnes of adults) was from a smaller area than the later USSR survey, but, however, from a larger area than the Faroese estimate (2.2 million tonnes of adults).

Taking into account the highly migratory behaviour of the blue whiting spawning stock and the slight differences in the timing of the three surveys, the similarity of the estimates obtained in 1984 should be noted.

The estimate of the spawning stock in 1982 must because of incomplete coverage be considered as an underestimate, but still the spawning stock surveys indicate a clear downward trend in the blue whiting spawning stock biomass. The trend is even more dramatic in the estimates of the 1981 yearclass and older fish from the Norwegian Sea surveys

The increase in the total stock estimate from the Norwegian Sea survey in 1984 compared to the 1983 estimate stems from the abundant 1982 and 1983 year classes.

As discussed by the Working Group in 1983 (Anon 1984a) the Norwegian Sea surveys in previous years have covered the most important areas of the blue whiting distribution fairly well. The effort was somewhat reduced in 1984, but the Working Group is of the opinion that it is unlikely that a major part of the blue whiting stock would be found outside the surveyed area.

The text table below gives the estimates in numbers of the 1981 yearclass and older and of the 1982 yearclass in August 1983 and 1984. Included in the table is also an estimate of the catch in numbers of the same age groups in the period between the two surveys. Applying a natural mortality coefficient of 0.2 the stock in numbers from August 1983 to August 1984 would have been reduced to the figures given in brackets.

Year classes (N*10-9)

	1981+	1982
August 1983	5.3	22.7
Catch (1983-1984)	1.4	2.4
August 1984	1.9 (3.0)	14.6 (16.3)

A similar calculation of the numbers estimated of the 1981 year class and older during the spawning surveys of 1983 and 1984 is presented below.

Yearclasses 1981+ (N*10-9)

April 1983	24
Catch 1983-1984	2
April 1984	15(16.3)

The acoustic estimates of the 1982 year class from the Norwegian Sea surveys in 1984 compare well with what should have been expected from the similar estimates obtained in 1983, taking into account the natural mortality (0.2) and the fishery in the period between the surveys. Similarly the estimates of the 1981 year class an older fish from the spring surveys in 1984 fit well with the expected values.The lower estimate of the 1981 and earlier year classes in the Norwegian Sea in 1984 compared to the one, expected from the 1983 survey, may be explained by the reduced survey effort in 1984. The two sets of acoustic surveys may thus be considered as valid indices of the stock size.

The great reduction in the biomass estimates from August 1982 to August 1983 which was not observed in the spawning area surveys might, however, indicate that the results from the August surveys in 1983 and 1984 are underestimates of the adult component of the stock.

In 1983 the Working Group discussed a number of plausible reasons which could explain an underestimate of the stock during the August survey compared to the spawning survey. The following reasons could explain the differences in the estimates.

1) The adult component of the stock was distributed in the northern and western part of the Norwegian Sea which was only partially surveyed.

2) A part of the adult component might have been distributed outside the areas surveyed e.g. the shelf edge west of the British Isles and Ireland and in the Barents Sea .

3) Blue whiting is a fast swimming species and a bias might have been introduced by the trawls relatively better catching the younger fish. Two of the vessels participating in the survey used only small trawls (vertical opening < 20 m) to identify the recordings. This could lead to an underestimate of the adult stock compared to the abundant 1982 and 1983 yearclasses.

4) The very low concentrations of adult fish found over the larger areas in the Norwegian Sea might occasionally have been below the integrator **threshold values.**

5) In the assessments the same value to convert echovalues to biomass is applied in the spawning and the feeding season. Any differences in the behaviour of the fish during these two seasons could affect the estimates significantly.

Based on the discussion above the Working Group concluded that the most likely estimates of the adult component in 1984 were those obtained during the spawning season (2.1 - 2.7 million tonnes). The Norwegian Sea survey in 1984 indicates the 1982 and 1983 yearclasses to be strong,and that the total stock biomass increased during the last year.

0.7.2. Virtual Population analysis (VPA)

The Working Group considered the acoustic estimates of the the adult component made during the spawning season in 1984 to be sufficiently reliabler to be used for the calibration of a VPA. The second survey of

USSR was chosen for the calibration as it covered the largest area and thus is expected to yield the most representative estimate of 3 years old and older fish. The VPA was started with the input fishing mortality for 1983 calculated from the 1983 catch in numbers, the stock size at the end of 1983 derived from the acoustic estimate chosen and the preliminary catch in number estimated by the Working Group for the first quarter of 1984 (Tables 7.1,7.2). These 1983 input F's were calculated for a fraction of 1984 and then for the whole of 1983.

The Working Group considered the . estimates for the 1982 and 1983 year classes from the 1984 August survey most likely to be somewhat overestimated For these yearclasses the Working Group therefore decided to use input F's corresponding to a recruitment of 20*109 individuals as 0-group (the average for the years with fairly good recruitment, 1970 - 1978).

0.7.2.1. VPA results

According to the VPA results, the total stock in No's decreased slowly from 10.3*109 in 1974 to 8.9*109 in 1978. These were reduced to 4.3*109 in 1981. There has been a slight increase in the stock in 1983 due to the recruitment of the 1982 and 1983 yearclasses.

0.7.2.2. Long Term Yield

The long term yield and spawning stock biomass per recruit have been calculated using the 1983 fishing pattern (tables 7.5 and 7.6). The yield per recruit curve (figure 7.11) is very flat above Fs above 0.2 and Fmax is consequently high (F= 0.34, F-factor of 2.4). F 0.1 equals 0.18, corresponding to a 1.3 times the fishing mortality in 1983.

0.7.2.3. Catch predictions

The catch predictions were run assuming a recruitment in 1984 and 1985 equal to the 1982-83 level (see section 7.2).The 1983 fishing pattern was used and three runs were selected corresponding to fishing mortality levels for 1984 to 1985 equal to the 1983 level, F0.1 and twice the 1983 level

0.7.3. Catch per unit of effort

Catch and effort data from the directed blue whiting fisheries for 1983 were submitted by 3 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 7.8 and 7.9.

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, which would imply an overall decline of the feeding stock biomass during that period by about 65% (Table 7.8). However, if the whole fishing season of the GDR fleet extending from May to October is taken into account (Table 7.9, second method of cpue calculation) the resulting decrease over the whole period does not exceed 43%. In addition, the GDR catch rates in 1983 were at about the same level as in 1982 which could indicate a certain degree of stabilization.

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 its 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 is very similar to that observed in the GDR and the USSR fisheries.

The USSR catch rates (GRT-class 2000-3999.9) in Division IIa averaged for the July-September and May-October seasons throughout the 1980-1983 period were not as consistent as the GDR data e.g. no decline was observed between 1981 and 1982 (Tables 7.8 and 7.9). On the other hand the cpue decreased by 51% from 1982 to 1983 for the May - October season (Table 7.9, second method) implying almost twice as big a decline (by 64%) over the whole time period 1980- 1983 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 USSR and Norwegian fisheries exploiting pre-spawning and post-spawning blue whiting in Division Vb do not show 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 7.8) but 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 of the GDR catch rates was observed from 1982 to 1983.

The Norwegian catch rates from the spawning fishery in Division VIa show almost a constant increase every year (Table 7.8).

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

0.7.4. Bottom trawl survey on the Rockall Bank

In July 1984 a Federal Republic of Germany bottom trawl survey aiming at estimating the minimum trawlable biomass of haddock, blue whiting and greater silver smelt took place on the Rockall Bank. A total of 66 hauls were made by the R.V. "Walther Herwig" on the plateau and on the slope of the Rockall Bank at depths down to 700 m. Using the swept area method (catchability coefficient = 1) the trawlable biomass of blue whiting was estimated to be 80 500 tonnes (+/-39%)(Ehrich, pers. comm.).

The density (t per nm2), the trawlable biomass and the confidence limits per depth range are listed in Table 7.10 and Figure 7.12 shows the length distribution of the total catch by sex.

Using the same method and equipment the trawlable biomass in January 1983 was estimated to be of nearly the same size (77 000 t +/-40%)(Ehrich 1983). Both surveys took place outside the spawning season of the big northern stock. The very similar sizes of the trawlable biomasses in January 1983 and July 1984 indicate the existence of a separate blue whiting stock on the Rockall Bank which does not migrate to the feeding areas further north.

0.8. MANAGEMENT CONSIDERATIONS

The acoustic surveys in 1984 in the same way as those in 1983 gave conflicting evidence on the size of the adult stock biomass . Both sets of surveys , however, indicate a downward trend in the adult stock biomass. As discussed in section 7.1.3, the Working Group considered the assessments from the Norwegian Sea as underestimates of the adult component of the stock and decided to calibrate the VPA against the largest estimate of the adult stock obtained during the spawning season 1984. The resulting stock size estimates from the VPA (section 7.2) presented below coincide to a large extent with the acoustic estimates of the adult stock obtained during the spawning seasons of 1981 and 1983.

Adult stock abundance (three years and older) estimated from acoustic surveys during the spawning season against estimates from the VPA calibrated against the 1984 survey (M=0.2).

Year	1981	1982	1983	1984
N*10-9				
Acoustic survey (1.April)	32.5	?	25	15
VPA (1.January)	33.1	25.3	19.7	16
Tonnes*10-6				
Acoustic survey	5.4	?	4.4	2.7
VPA	5.1	4.5	3.6	2.7

The cpue data (section 7.3) from the Norwegian Sea fishery on feeding blue whiting indicate a decrease of the stock in the period 1981-1983 of 43-65% compared to a decrease of 33% by the acoustic surveys. The difference may be explained by changes in availability in the Norwegian Sea due to differences in the hydrographic conditions.

Based on this the Working Group considers the VPA results and the catch predictions as usable basis for management considerations.

0.9. SOUTHERN AREA

0.9.1. Landings.

Landings of blue whiting from the Southern Area fishery were available to the Working Group from the Portuguese, Spanish and the Netherland fisheries.The Portuguese landings were also given as catch in number by length group. This, however, did not give the Working Group any possibilities to make an assessment of the southern blue whiting stock.

0.9.2. Acoustic Survey of the Gulf of Biscay.

In April - May 1984 an acoustic survey was conducted by the French research vessel "Thalassa" (Diner et al. 1984). The survey was mainly aimed at the anchovy stock in the southern parts of the Gulf of Biscay. However, during the period 8-15 May it was extended to include the edge of the continental shelf between 46 N and 48° N over depths ranging from 145-250 m. Blue whiting was recorded here mainly between 200 and 250 m. The blue whiting biomass in the area was estimated to be less than 10000 tonnes.

0.10. PREDATION

Blue whiting has not been investigated in the International Stomach Sampling Project 1981 neither as predator nor as prey (Anon 1984d). It is, therefore, not possible for the Working Group to present any predation parameters.

0.11. CHANGES IN THE DATA SET

0.11.1. Weight at age

The mean weight at age in the GDR catches increased by 25 % for the age groups 2 - 15+ from 1980 to 1983. The weight at age curves are given in Fig. 11.1. The weight-length relationships for the various years are given in Table 11.1. One explanation of the difference between the curve for 1982 and the other curves could be poorer sampling for the older agegroups in 1982. The increase in the weight at age seems to be density dependent and connected with the decrease of the blue whiting stock during that time. A similar trend can be observed in the mean weight at age in the total catches of blue whiting in the Northern Area from 1979 to 1983, except for 1982 (Table 6.1)

0.11.2. Age at maturity

The acoustic surveys during the spawning season in 1984 showed that at least a part of the 1982 year class matured in 1984 as 2 year olds (Ermolchev et al 1984a, Jakupsstovu and Thomsen 1984 and Monstad 1984).As a consequence the Working Group in the VPA changed the age range for the spawning stock from 5+ to 3+. There is the possibility that the changes in the age at maturity observed are density dependent and are connected with the decrease of the blue whiting stock in recent years.

0.12. SELECTIVITY

The minimum mesh size previously recommended by NEAFC for a directed blue whiting fishery in the North Atlantic is 16mm. Different mesh sizes are used by commercial vessels of Norway (36mm), France (45mm), Federal Republic of Germany (50mm) and USSR, Poland and German Democratic Republic (40mm).

Data on net selectivity of blue whiting are summarized in a paper by Robles et al. (1980). Using these data, which are based on very low catches, an increase of the L50% length with increasing mesh size from 40 to 80 mm is seen (Fig.12). No selectivity experiments were carried out with mesh sizes of less than 40mm.

At a mesh size of 40mm the L50% varies between 16 and 18 cm, which means that an increase of the mesh size from 16 to 40mm would only be a conservation measure for the 0-group and the 1-year old blue whiting in the beginning of the year. It should be pointed out that this conclusion cannot be applied to the major fishing areas of interest in the commercial fisheries.

Results of mesh selection for mackerel and horse mackerel, given by Eltink (1983), indicate that the implementation of a certain mesh size up to 80mm is not necessarily an effective protection due to the blocking effects of fish already in the net.

The Working Group presently sees no necessity to estimate the influence of a minimum mesh size of 40 mm as no countries apply mesh sizes less than

36 mm.

0.13. FUTURE RESEARCH RECOMMENDATIONS

13.1 Further investigations on stock separation and stock identity are recommended.

13.2 The results of cruises and investigations have shown evidence of a separate southern blue whiting stock. In order to manage this stock data series on age composition of landings are required and acoustic surveys are needed.

13.3 Special surveys to investigate the distribution of blue whiting in the first year of life are recommended. All the information on the occurrence of 0- and 1-group blue whiting should be reported very carefully.

13.4 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 are continued.

13.5 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 1981-1984 surveys have given valuable information about the trend in abundance of the blue whiting stock. The Working Group therefore considers it important to continue these surveys. This is also the only means by which an estimate of the recruiting yearclasses can be obtained. Furthermore the Working Group is of the opinion that not enough time has been available between the surveys and the Working Group meetings to analyse the results. The Working Group therefore recommends that prior to the coordinated acoustic survey in 1985 a Workshop (convenor T Monstad) should take place to review the 1982-84 surveys and to draw up plans for the 1985 survey.

13.6 In order to estimate the biomass of different components of the blue whiting stock (pre-spawning, spawning and post-spawning), it is recommended that data on maturity stages presently available should be compiled and presented to the next meeting of the Working Group.

0.14. REFERENCES

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Table 2.1 Landings (tonnes) of Blue Whiting from the main fisheries 1973-1983

Area	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983*
Norwegian Sea Fishery (Sub-areas I + II and Divisions Va, XIVa + XIVb)	878	146	6 746	3 336	56 999	236 226	741 042	766 798	520 738	110 685	55 511
Spawning Fishery (Divisions Vb, VIa, VIb and VIIb,c)	15 027	15 207	30 335	81 362	136 787	229 228	284 547	250 693	288 316	316 656	361 219
Icelandic Industrial Fishery (Division Va)	2 833	4 230	1 294	8 220	5 838	9 484	2 500	-	-	-	7 000
Industrial Mixed Fishery (Divisions IVa-c, IIIa)	56 826	62 197	41 955	36 024	38 389	99 874	63 333	75 129	61 754	117 578	117 737
Southern Fishery (Sub-areas VIII + IX, Divisions VIId,e + VIIg-k)	27 452	25 733	31 715	35 035	30 723	33 898	27 176	29 944	38 749	30 971	28 378
Total	103 016	107 513	112 045	163 977	268 736	608 710	1 118 598	1 122 564	909 557	575 890	569 845

* Preliminary

Table 2.2 Landings (tonnes) of Blue Whiting from the Norwegian Sea (Sub-areas I and II, Divisions Va,XIVa, and XIVb) fisheries 1973-1983, as estimated by the Working Group.

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983[1]
Denmark	-	-	-	-	-	-	-	-	-	473	-
Faroes	-	-	-	-	593	2 810	762	-	11 131	-	13 864
France	-	-	-	-	-	-	-	-	5 093	2 067	2 890
German Democratic Republic	-	-	-	90	2 031	7 301	22 502	14 234	15 607	3 042	5 553
Germany, Fed. Rep. of[2]	3	2	35	33	6 777	8 421	1 157	8 919	17 385	890	2
Iceland	60	119	3	569	4 768	17 756	12 428	4 562	4 808	-	-
Norway	-	20	31	737	-	-	33 588[3]	902	187	-	5 061
Poland	-	-	-	95	1 536	5 083	4 346	11 307	2 434	443	-
UK (England and Wales)	-	-	-	60	165	11	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-	-	-
USSR	815	5	6 677	1 752	41 129	194 844	666 259	726 874	464 093	103 770	28 141
Total	878	146	6 746	3 336	56 999	236 226	741 042	766 798	520 738	110 685	55 511

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) 1973-1983, as estimated by the Working Group

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983*
Denmark	-	-	-	-	18 745	23 498	21 200	19 272	11 361	23 164	28 680
Faroes	1 155	1 527	-	12 826	29 096	39 491	35 780	37 488	23 107	38 958	56 168
France	-	-	-	-	-	-	-	-	-	1 212	3 600
German Democratic Republic	-	-	-	4 971	1 094	1 714	172	181	6 562	7 771	3 284
Germany, Fed. Rep. of	-	2 655	-	85	3 260	6 363	3 304	709	935	701	825
Iceland	319	-	-	-	5 172	7 537	4 864	5 375	10 213	1 689	1 176
Ireland	-	-	-	160	-	-	-	-	-	-	-
Netherlands	-	-	-	-	-	1 172	154	-	222	200	150
Norway	2 445	3 247	7 301	24 853	38 214	116 815	186 737	133 754	166 168 1)	169 790 2)	185 646 3)
Poland	-	116	4 704	10 950	3 996	2 469	4 643	-	2 279	-	-
Spain	6 571	6 484	8 153	5 910	183	14	-	-	-	-	-
Sweden	-	-	-	-	6 391	6 260	-	3 185	-	-	-
UK (England and Wales)	-	-	455	341	1 475	5 287	4 136	3 878	6 000	-	-
UK (Scotland)	-	-	279	1 488	3 001	1 599	1 466	6 819	2 611	-	-
USSR	4 537	1 178	9 443	19 778	26 160	17 009	22 091	40 032	58 858	73 171	81 690
Total	15 027	15 207	30 335	81 362	136 787	229 228	284 547	250 693	288 316	316 656	361 219

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.

* Preliminary

Table 2.4 Landings (tonnes) of Blue Whiting from the Icelandic mixed industrial trawl fisheries Division Va 1972-1983

* Preliminary

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983*
Iceland	2 833	4 230	1 294	8 220	5 838	9 484	2 500	-	-	-	7 000

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), 1973-83, as estimated by the Working Group.

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983[1]
Denmark	-	-	-	-	16 071	54 804	28 932	49 947	35 066	34 463	38 290
Faroes	3 714	2 610	428	1 254	-	1 177	1 489	1 895	3 133	27 269	12 757
France	-	-	-	-	-	-	-	-	-	1 417	249
German Democratic Republic[2]	-	-	-	-	-	988	49	-	-	-	-
Germany, Fed. Rep. of[2]	-	-	-	-	76	1 514	13	252	-	93	-
Ireland	-	-	-	-	-	-	-	-	2 744	-	-
Norway	50 835	59 151	40 210	34 600	20 737	39 989	30 930	21 962[3]	18 627	47 856	62 591
Poland[2]	-	55	-	45	838	601	-	-	229	550	-
Spain	350	318	195	47	-	-	-	-	-	-	-
Sweden[4]	-	-	-	-	639	648	1 249	1 071	1 955	1 241	3 850
UK (England and Wales)[2]	-	-	-	-	3	+	-	-	-	4 689	-
UK (Scotland)	-	-	414	58	25	153	37	2	-	-	-
USSR[2]	1 927	63	708	20	-	-	634	-	-	-	-
Total	56 826	62 197	41 955	36 024	38 389	99 874	63 333	75 129	61 754	117 578	117 737

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 IX and Divisions VIIg-k and VIId,e) 1973-1983, as estimated by the Working Group

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983[1]
German Democratic Republic	-	-	-	-	-	-	-	-	-	-	-
Germany, Fed. Rep. of	-	-	-	-	-	25	-	-	-	-	-
Ireland	-	-	-	-	-	-	1	-	-	-	-
Netherlands	-	-	-	-	-	7	-	31	633	200	50
Poland	-	170	-	385	169	53	-	-	-	-	-
Portugal	-	-	-	-	1 557	2 381	2 096	6 051	7 388	3 271	4 328
Spain[2]	26 741	24 627	30 790	29 470	25 259	31 428	25 016	23 862	30 728	27 500	24 000
UK (England and Wales)	-	-	-	-	+	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	63	-	-	-	-
USSR	711	936	925	5 180	3 738	4	-	-	-	-	-
Total	27 452	25 733	31 715	35 035	30 723	33 898	27 176	29 944	38 749	30 971	28 378

[1] Preliminary.

[2] Significant quantities taken in Divisions VIIg-k not included in the Table are discarded every year.

Table 2.7. Preliminary returns on ICES Data Form 5 for 1984

Country	Area	January	February	March	April	May	June	July	Total
Faroes	Vb	1 813	1 598	0	0	329	0	188	3 928
	IV + VI	0	3 483	5 855	24 426	8 316	37	85	42 202*
German Democratic Republic	I + II*	-	-	-	-	-	291	430	721
	Vb**	-	-	-	-	351	1 585	3 494	5 430
Federal Republic of Germany	IV	-	2	-	246	-	93	324	665
	VIIg-k	-	-	-	-	-	-	247	247
Norway	IV	-	-	-	2 953	1 884	-	-	4 837***
	Vb	-	-	-	-	9 948	-	-	9 948
	VI	-	11 319	24 369	124 213	12 995	-	-	172 896
	VIIc	-	-	23 438	661	1 536	-	-	25 635
Sweden	IV	-	2	10	20	...	...	...	32
U.S.S.R.	I + II	-	54	18	353	11 584	25 504	14 717	52 230
	Vb	42	94	51	2 966	8 621	4 631	15 678	32 083

*Norwegian Economic Zone
**FZ Faroes
***Approximately 42 000 tonnes from the mixed industrial fisheries in IVa not included.

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, 1973-1983

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983*
0	2.2		1.9							1.2	2.5
1	4.4	0.6	2.2	4.5			69.9	55.1	4.0	1.7	290.4
2	3.4	5.5	5.0	13.1	44.0	63.6	165.0	319.5	40.1	48.6	239.1
3	6.1	4.6	28.7	24.1	87.5	69.0	320.9	362.0	322.8	123.1	164.1
4	8.9	15.1	26.7	54.6	164.8	345.8	457.5	399.1	225.3	371.0	194.1
5	11.6	20.2	25.2	26.4	184.9	436.9	468.3	478.3	501.5	212.6	411.4
6	11.1	16.2	34.3	52.3	154.3	483.1	569.0	530.9	539.0	251.0	284.4
7	14.8	14.4	32.8	69.1	137.6	527.9	743.2	725.3	448.5	250.7	274.0
8	6.6	14.7	27.0	57.6	176.7	474.3	904.8	779.2	618.3	259.3	283.5
9	9.5	3.6	27.6	65.2	120.1	364.8	826.4	604.5	573.2	278.7	219.9
10	8.1	4.3	13.8	73.0	132.0	307.6	797.0	1008.7	718.3	259.8	152.6
11	6.6	3.7	13.0	30.2	110.1	157.4	473.2	398.1	343.6	158.5	71.5
12	4.2	2.8	11.2	36.7	56.3	121.8	359.2	394.2	232.6	133.6	45.4
13	2.0	1.6	7.3	18.8	18.2	50.4	142.7	66.8	73.9	41.0	25.0
14	0.8	0.7	4.6	9.9	13.5	20.5	69.3	64.6	49.5	45.3	12.1
15+	0.7	1.0	3.5	6.3	6.9	16.1	39.0	4.7	30.6	28.0	10.0
TOTAL	101.0	109.0	264.8	541.8	1406.9	3439.2	6405.4	6191.0	4721.2	2464.1	2680.0
TONNES	15 905	15 353	37 081	84 698	193 786	465 454	1 025 589	1017 491	809 054	427 341	416 730

* Preliminary

Table 5.2. Catch in number (millions) by age group in the mixed industrial fisheries (Sub-area IV, Divisions IIIa and Va) 1973 - 1983

Age	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	1817.4	379.4	811.7	128.1	428.9	956.2	2.4	23.2		3450.1	336.3
1	349.5	480.1	221.2	760.7	467.5	1030.9	1849.0	276.1	65.1	43.3	1844.2
2	46.5	48.7	73.0	98.7	111.4	168.2	78.8	329.9	81.4	41.3	90.0
3	21.5	13.0	28.2	36.9	33.8	89.7	32.3	74.8	191.9	80.9	38.4
4	12.0	7.5	14.0	22.4	31.8	74.0	22.3	22.6	58.4	112.8	47.7
5							18.2	29.1	20.1	29.2	55.6
6							20.8	23.1	16.7	21.6	12.2
7							10.8	29.3	17.8	14.8	12.8
8							8.8	26.8	15.7	12.0	2.6
9							14.0	15.2	4.4	5.2	5.8
10							6.2	13.8	4.9	1.8	4.2
11							1.0	6.4	3.6		9.6
12							4.4	1.8	1.5	2.4	3.3
13								2.2	1.2	0.6	0.6
14								1.4	0.1	0.6	0.3
15+								0.4	0.2		
TOTAL	2246.9	928.7	1148.1	1046.8	1073.4	2319.0	2069.0	860.8	483.0	3816.6	2463.6
TONNES	59 659	66 427	43 249	44 244	44 227	109 358	94 995	75 129	61 754	117 578	124 737

Table 5.3 VIRTUAL POPULATION ANALYSIS

BLUE WHITING, NORTHERN AREA

CATCH IN NUMBERS UNIT: millions

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	379	814	128	429	956	2	25	0	3451	339
1	481	223	765	466	1031	1919	331	69	45	2135
2	54	78	112	155	232	244	649	122	90	329
3	18	57	61	121	159	353	437	315	204	203
4	23	41	77	197	420	480	422	284	484	242
5	20	25	26	185	437	467	507	522	242	467
6	16	34	52	154	483	590	554	556	273	297
7	14	33	69	136	528	754	755	460	266	287
8	15	27	58	177	474	914	806	634	271	286
9	4	28	65	120	365	840	620	578	264	226
10	4	14	73	132	308	805	1025	723	262	157
11	4	13	30	110	157	474	405	347	159	81
12	3	11	37	56	122	364	396	234	136	49
13	2	7	19	16	50	143	69	75	42	26
14	1	5	10	14	21	69	66	50	46	12
15+	1	4	6	7	16	39	5	31	28	10
TOTAL	1038	1413	1589	2480	5758	8474	7067	5206	6281	5144

Table 6.1 Virtual Population Analysis
BLUE WHITING, Northern Area
Mean Weight at Age of the Stock Unit : Kilogram

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0	0.032	0.032	0.032	0.032	0.032	0.032	0.027	0.032	0.018	0.018
1	0.030	0.030	0.030	0.030	0.030	0.030	0.036	0.063	0.046	0.046
2	0.084	0.084	0.084	0.084	0.084	0.084	0.079	0.092	0.094	0.094
3	0.105	0.105	0.105	0.105	0.105	0.105	0.107	0.118	0.136	0.136
4	0.109	0.109	0.109	0.109	0.109	0.109	0.122	0.135	0.152	0.152
5	0.129	0.129	0.129	0.129	0.129	0.129	0.135	0.145	0.162	0.162
6	0.147	0.147	0.147	0.147	0.147	0.147	0.149	0.155	0.178	0.178
7	0.160	0.160	0.160	0.160	0.160	0.160	0.165	0.170	0.195	0.195
8	0.170	0.170	0.170	0.170	0.170	0.170	0.176	0.178	0.200	0.200
9	0.177	0.177	0.177	0.177	0.177	0.177	0.186	0.187	0.204	0.204
10	0.188	0.188	0.188	0.188	0.188	0.188	0.199	0.199	0.213	0.213
11	0.193	0.193	0.193	0.193	0.193	0.193	0.202	0.208	0.234	0.234
12	0.199	0.199	0.199	0.199	0.199	0.199	0.207	0.228	0.228	0.228
13	0.200	0.200	0.200	0.200	0.200	0.200	0.207	0.234	0.258	0.258
14	0.200	0.200	0.200	0.200	0.200	0.200	0.207	0.249	0.242	0.242
15+	0.200	0.200	0.200	0.200	0.200	0.200	0.207	0.257	0.258	0.258

Table 7.1. BLUE WHITING
Catch in number during the first half of 1984 (in millions)

Year class	Spawning Jan-March	Fishery April-July	Mixed ind. fishery Jan-July	Norw. Sea fishery Jan-July	TOTAL Jan-July	TOTAL Jan-March
83	162.9	498.0	766.8	152.4	1 580.1	
82	404.7	1 237.7	191.7	109.5	1 943.6	
≤81	246.8	754.7	-	219.2	1 220.7	246.8
$\bar{\omega}$(g)	88.5	88.5	62.6	109.2		
Catch in tonnes	72 076	220 397	60 000	58 381		

Table 7.2. Calculation of Fishing Mortality in 1983

Year Class	Stock (10^9) 1 April 84	Catch (10^9) Jan-March 84	Fishing Mortality 84 Jan-March	Stock (10^9) 1 Jan 84	Catch (10^9) 1983	F_{83}
≤ 81	15.0	0.250	0.02	16.0	2.670	0.14
Year Class	**Stock (10^9) 1 Jan 82**	**Catch (10^9) 1982**	**F_{82}**	**Stock (10^9) 1 Jan 83**	**Catch (10^9) 1983**	**F_{83}**
82	20.0	3.451	0.21	13.268	2.134	0.19
83				20.0	0.339	0.02

Table 7.3 VIRTUAL POPULATION ANALYSIS

BLUE WHITING, NORTHERN AREA

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

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1979-81
0	0.02	0.05	0.01	0.04	0.06	0.00	0.01	0.00	0.21	0.02	0.00
1	0.03	0.01	0.05	0.04	0.12	0.17	0.06	0.03	0.01	0.19	0.09
2	0.00	0.01	0.01	0.01	0.03	0.04	0.08	0.04	0.05	0.14	0.05
3	0.00	0.01	0.01	0.01	0.02	0.05	0.09	0.08	0.09	0.14	0.07
4	0.00	0.00	0.01	0.02	0.05	0.07	0.08	0.07	0.11	0.14	0.07
5	0.00	0.00	0.00	0.03	0.06	0.08	0.10	0.14	0.08	0.14	0.10
6	0.00	0.01	0.01	0.02	0.09	0.11	0.13	0.14	0.10	0.14	0.13
7	0.01	0.01	0.02	0.02	0.11	0.19	0.20	0.15	0.09	0.14	0.18
8	0.01	0.01	0.02	0.05	0.11	0.27	0.31	0.26	0.12	0.14	0.28
9	0.00	0.02	0.04	0.04	0.14	0.30	0.30	0.36	0.18	0.14	0.32
10	0.01	0.01	0.06	0.10	0.15	0.54	0.71	0.67	0.30	0.14	0.64
11	0.01	0.03	0.04	0.12	0.16	0.35	0.57	0.56	0.30	0.14	0.50
12	0.01	0.03	0.10	0.10	0.19	0.68	0.50	0.79	0.45	0.14	0.67
13	0.00	0.02	0.05	0.07	0.12	0.36	0.26	0.19	0.31	0.14	0.27
14	0.00	0.01	0.03	0.05	0.10	0.24	0.28	0.30	0.17	0.14	0.27
15+	0.00	0.01	0.03	0.05	0.10	0.24	0.28	0.30	0.17	0.14	0.27
(2-12)U	0.00	0.01	0.03	0.05	0.10	0.24	0.28	0.30	0.17	0.14	

Table 7.4 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

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0	20724	20356	15254	12855	17616	5593	3375	4197	20366	18872	*******
1	19087	16624	15932	12373	10138	13560	4577	2743	3437	13568	15145
2	15138	15193	13409	12353	9709	7371	9373	3448	2183	2773	9186
3	13252	12345	12369	10878	9974	7739	5815	7088	2713	1706	1974
4	11375	10834	10056	10072	8796	8022	6018	4367	5339	2037	1214
5	7178	9293	8833	8163	8068	6823	6135	4546	3319	3935	1450
6	5937	5859	7585	7208	6517	6212	5147	4565	3252	2499	2601
7	2999	4847	4766	6163	5762	4900	4554	3715	3237	2417	1779
8	2103	2442	3938	3839	4922	4242	3332	3049	2621	2411	1720
9	1279	1709	1975	3172	2984	3602	2651	2004	1926	1902	1716
10	647	1044	1374	1558	2439	2114	2194	1614	1122	1321	1354
11	606	526	842	1059	1157	1761	1012	883	675	683	940
12	564	493	419	662	768	805	1016	466	412	410	486
13	625	459	393	310	491	519	334	477	173	216	292
14	773	510	369	305	237	357	297	212	323	104	154
15+	1104	388	235	156	186	201	23	131	197	84	134
TOTAL NO	103391	102921	97751	91128	89814	73820	55853	43506	51296	54938	
SPS NO	48442	50748	53155	53546	52351	47296	38527	33118	25310	19726	
TOT.BIOM	8852	9124	9227	9157	9002	7941	6765	5775	5240	4827	
SPS BIOM	6345	6697	7135	7336	7319	6736	5769	5151	4510	3603	

Table 7.5. List of input variables for the ICES prediction program

BLUE WHITING - NORTHERN STOCK

The reference F is the mean F for the age group range from 2 to 12

Proportion F (fishing mortality) effective before spawning: 0.0000
Proportion M (natural mortality) effective before spawning: 0.0000

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	0.02	0.20	0.00	0.018	0.018
1	0.19	0.20	0.00	0.046	0.046
2	0.14	0.20	0.00	0.094	0.094
3	0.14	0.20	1.00	0.136	0.136
4	0.14	0.20	1.00	0.152	0.152
5	0.14	0.20	1.00	0.162	0.162
6	0.14	0.20	1.00	0.178	0.178
7	0.14	0.20	1.00	0.195	0.195
8	0.14	0.20	1.00	0.200	0.200
9	0.14	0.20	1.00	0.204	0.204
10	0.14	0.20	1.00	0.213	0.213
11	0.14	0.20	1.00	0.234	0.234
12	0.14	0.20	1.00	0.228	0.228
13	0.14	0.20	1.00	0.258	0.258
14	0.14	0.20	1.00	0.242	0.242
15+	0.14	0.20	1.00	0.258	0.258

Table 7.6 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		At spawning time	
						Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
0.000	0.0000	0.0000	0.0000	5.5167	0.6772	3.0276	0.5585	3.0276	0.5585
0.200	0.0280	0.1101	0.0141	4.9681	0.5673	2.5099	0.4514	2.5099	0.4514
0.400	0.0560	0.1960	0.0238	4.5410	0.4848	2.1125	0.3715	2.1125	0.3715
0.600	0.0840	0.2648	0.0306	4.1993	0.4210	1.7993	0.3103	1.7993	0.3103
0.800	0.1120	0.3210	0.0354	3.9200	0.3706	1.5476	0.2623	1.5476	0.2623
1.000	0.1400	0.3679	0.0388	3.6877	0.3299	1.3418	0.2239	1.3418	0.2239
1.200	0.1680	0.4076	0.0412	3.4915	0.2965	1.1712	0.1927	1.1712	0.1927
1.400	0.1960	0.4416	0.0429	3.3239	0.2687	1.0282	0.1671	1.0282	0.1671
1.600	0.2240	0.4710	0.0441	3.1791	0.2453	0.9071	0.1458	0.9071	0.1458
1.800	0.2520	0.4967	0.0448	3.0529	0.2254	0.8038	0.1278	0.8038	0.1278
2.000	0.2800	0.5193	0.0453	2.9420	0.2082	0.7149	0.1127	0.7149	0.1127
2.200	0.3080	0.5394	0.0456	2.8438	0.1934	0.6380	0.0997	0.6380	0.0997
2.400	0.3360	0.5573	0.0457	2.7563	0.1805	0.5710	0.0885	0.5710	0.0885
2.600	0.3640	0.5734	0.0457	2.6780	0.1692	0.5125	0.0789	0.5125	0.0789

Slope of the yield curve at the origin based on a single recruit: 0.086

$F_{0.1}$ given by an F factor of 1.294, resulting in a reference F of 0.181

F_{max} given by an F factor of 2.444, resulting in a reference F of 0.342

<u>Table 7.7</u>. Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

BLUE WHITING - NORTHERN STOCK

Year 1984					Year 1985					Year 1986	
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	0.14	4934	2996	578	1.0	0.14	5246	3127	615	5547	3427
$= F_{83}$					1.3	0.18			783	5345	3280
					2.0	0.28			1148	4908	2979
1.3	0.18	4934	2996	736	1.0	0.14	5056	2998	592	5385	3271
$= F_{0.1}$					1.3	0.18			754	5189	3136
					2.0	0.28			1106	4767	2844
2.0	0.28	4934	2996	1079	1.0	0.14	4646	2718	543	5034	2935
					1.3	0.18			691	4854	2814
					2.0	0.28			1014	4463	2551

The data unit of the biomass and the catch is 1 000 tonnes.

The spawning stock biomass is given for 1 January.

The reference F is the mean F for the age group range from 2 to 12.

Table 7.8. Catch per unit effort in the directed Blue Whiting fisheries, 1976-83. (fishing gear: mid-water trawl)

Division	GRT-class	Country	Time period	Years								Units
				1976	1977	1978	1979	1980	1981	1982	1983	
IIa	2 000 – 3 999.9	German Dem.Rep.	July-Sept.	–[1]	–	1.99[2]	2.19	3.11	2.25	1.63	1.10	t/hour
		Poland	July-Aug.	–	–	14.0	17.8	24.0	19.7	4.5[8]	–	t/day
		USSR	July-Sept.	–	–	–	3.04	3.82	2.54	2.85	1.58[5]	t/hour
	1 000 – 1 999.9	USSR	Aug.-Oct.	–	2.38	2.79	–	–	–	–	0.87[6]	t/hour
Vb	2 000 – 3 999.9	German Dem.Rep.	June-July	–	1.38	1.77	2.20	–	3.88[3]	2.12[3]	2.08[3]	t/hour
		Poland	May-June	27.0	36.7	17.2	43.6[4]	–	–	–	–	t/day
		USSR	March-May	–	–	–	5.83	5.23	5.97	4.58	4.12	t/hour
	1 000 – 1 999.9	Norway	April-May	–	–	–	–	13.57	29.47	–	–	t/hour
		USSR	June-July	–	2.98	4.62	–	–	–	–	0.38[7]	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	April-May	–	–	21.35	20.29	18.14	18.94	4.88	–	t/hour
VIa	1 000 – 1 999.9	Norway	March-April	–	–	–	–	23.92	57.13	42.38	42.83	t/hour
	500 – 999.9	Faroes	April	–	17.4	19.8	21.4	16.4	–	–	–	t/hour
		Norway	March-April	–	–	24.93	30.27	26.56	34.96	36.30	49.04	t/hour
	100 – 499.9	Norway	March-April	–	–	–	24.93	13.53	23.59	31.00	41.84	t/hour
IVa	1 000 – 1 999.9	Norway	April-May	–	–	–	–	–	15.36	15.03	21.19	t/hour
	500 – 999.9	Norway	April-May	–	–	–	13.98	9.29	13.40	13.75	18.31	t/hour
	100 – 499.9	Norway	April-May	–	–	–	–	–	7.18	17.39	16.51	t/hour

1) Hyphen means no fishing.
2) Refers to June-July period.
3) Refers to January-May period.
4) Refers to April-May period.
5) Refers to May-July period.
6) Refers to May only.
7) Refers to May-June period.
8) Refers to July only.

Table 7.9. Catch per unit effort in the Blue Whiting directed fisheries in Sub-division IIa for 2 000 - 3 999.9 GRT, using mid-water trawls, 1979-1983

Month	Catch					Effort					C.P.U.E.				
	1979	1980	1981	1982	1983	1979	1980	1981	1982	1983	1979	1980	1981	1982	1983
	(tonnes)					(hours)					(tonnes/hour)				
German Dem.Rep.															
January															
February															
March															
April															
May	407	546	159	289	613	127	279	210	152	393	3.20	1,96	0.76	1.90	1.56
June	2 548	3 025	2 566	1 148	2 524	893	999	2 046	1 280	945	2,85	3.03	1.25	0.90	2.67
July	2 317	3 523	5 951	1 226	1 026	792	902	2 596	1 045	831	2.93	3.91	2.29	1.17	1.23
August	64	2 871	4 130		764	39	965	2 079		801	1.64	2.98	1.99		0.95
September	862	605	1 481	113		430	248	627		159	2.00	2.44	2.47	2.09	
October		1 128	55	266			424	53		73		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	2 281	4 322	7 611	2 649	3 202	2.71	3.20	1.88	1.15	1.73
May - (1)	6 198	11 698	14 310	3 042	4 917	2 281	3 817	7 611	2 970	3 202	2.72	3.06	1.88	1.15	1.66
Oct (2)											2,52	2,83	1.63	1.66	1.60
Poland	(tonnes)					(days)					(tonnes/hour)				
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	540	117	67		25.0	21.8	15.8	6.1	
May - (1)	4 324	9 754	1 676	411		173	438	107	67		25.0	22.3	15.6	6.1	
Oct (2)											27.1	19.8	16.9	6.9	
U.S.S.R.	(tonnes)					(hours)					(tonnes/hour)				
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	16 151	1 208	285		3.59	2.73	3.22	1.32	
April	3 382	36 284	45 645	618		1 933	16 119	12 666	256		1.74	2.25	3.60	2.41	
May	51 409	125 988	88 754	46 089	15 188	15 336	25 244	25 912	17 106	7 300	3.35	4.99	3.42	2.69	2.08
June	110 918	114 117	78 727	27 617	7 919	38 069	47 634	37 919	14 209	6 094	2.91	2.39	2.08	1.94	1.30
July	124 618	121 463	87 582	6 820	1 172	42 166	42 319	39 039	5 983	1 963	2.95	2.87	2.24	1.14	0.60
August	143 962	114 505	63 899			47 395	28 293	29 528			3.01	4 05	2.16		
September	106 606	79 504	37 960	2 921		33 755	17 499	11 745	640		3.16	4.54	3.23	4.56	
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	210 936	206 372	167 005	40 026	15 357	3.03	3.31	2.60	2.35	1.59
May - (1)	594 075	606 531	368 472	84 568	24 279	193 295	177 061	147 413	38 279	15 357	3.07	3.43	2.50	2.21	1.58
Oct (2)											3.14	3.67	2.78	2.72	1.33

(1) CPUE = Total catch/total effort

(2) CPUE = Σ(Monthly CPUE)/No of months

Table 7.10. Trawlable biomass of Blue Whiting per depth range on Rockall Bank in July 1984.

Depth Range (m)	$\bar{D}$ (t/nm^2)	TB (t)	CL (± %)	Hauls n
100 - 200	5.9	14 960	205	7
200 - 300	7.5	21 158	56	12
300 - 400	12.5	24 448	56	10
400 - 500	6.3	17 391	54	17
500 - 600	1.1	2 412	50	11
600 - 700	0.1	124	132	9
TOTAL		80 493	39	66

$\bar{D}$ = Relative mean density

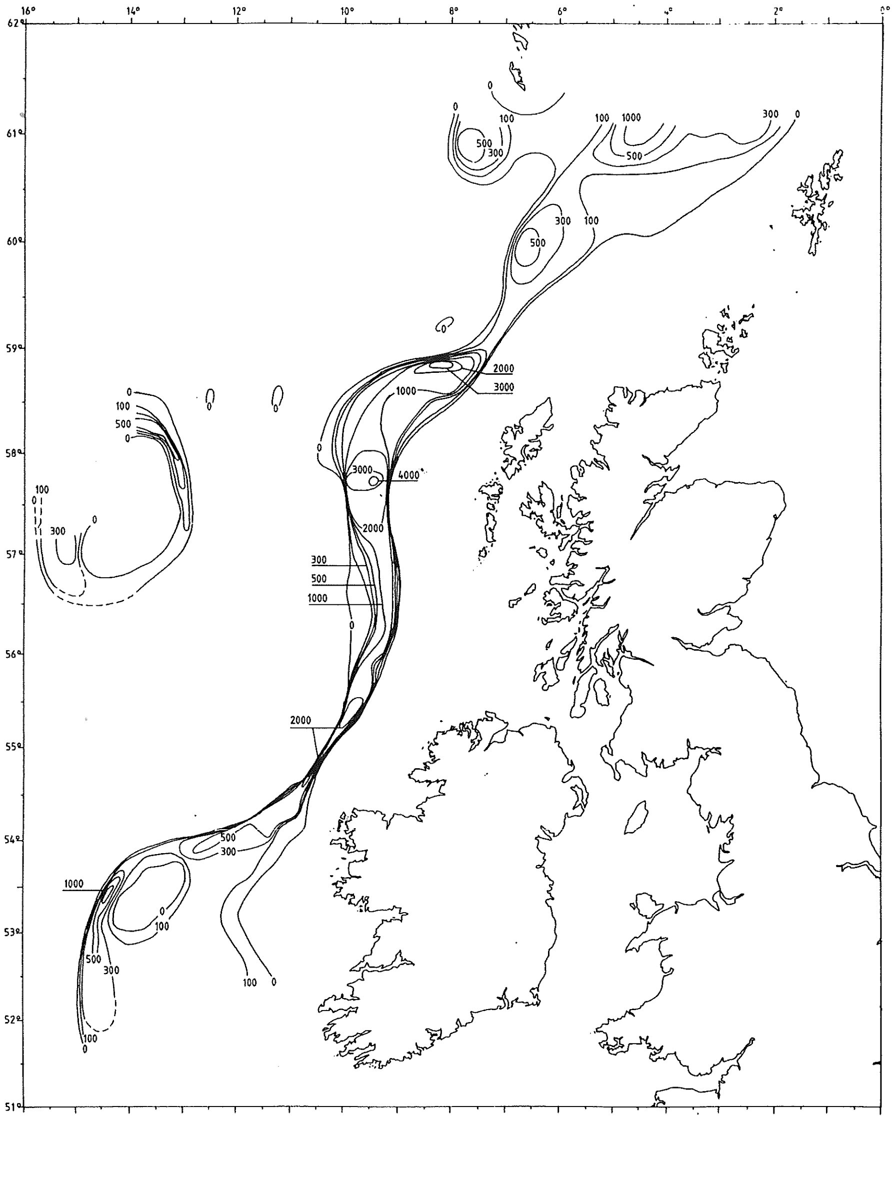
TB = Trawlable biomass

CL = Confidence limits (Confidence level = 95%)

Table 11.1. Parameters of weight at age curves (see Figure 11.1) in GDR catches

Year	1980	1981	1982	1983
a	66.67	91.24	56.76	80.85
b	0.438	0.344	0.572	0.450
r^2	0.853	0.790	0.790	0.830

Figure 7.1 Distribution and relative densities of BLUE WHITING March-April 1984 recorded during the Norwegian survey. Echo intensity in $m^2/n.m.^2 \times 10$.



<u>Figure 7.2</u> Biomass estimated of BLUE WHITING (1 000 tonnes) during the Norwegian survey, March-April 1984.

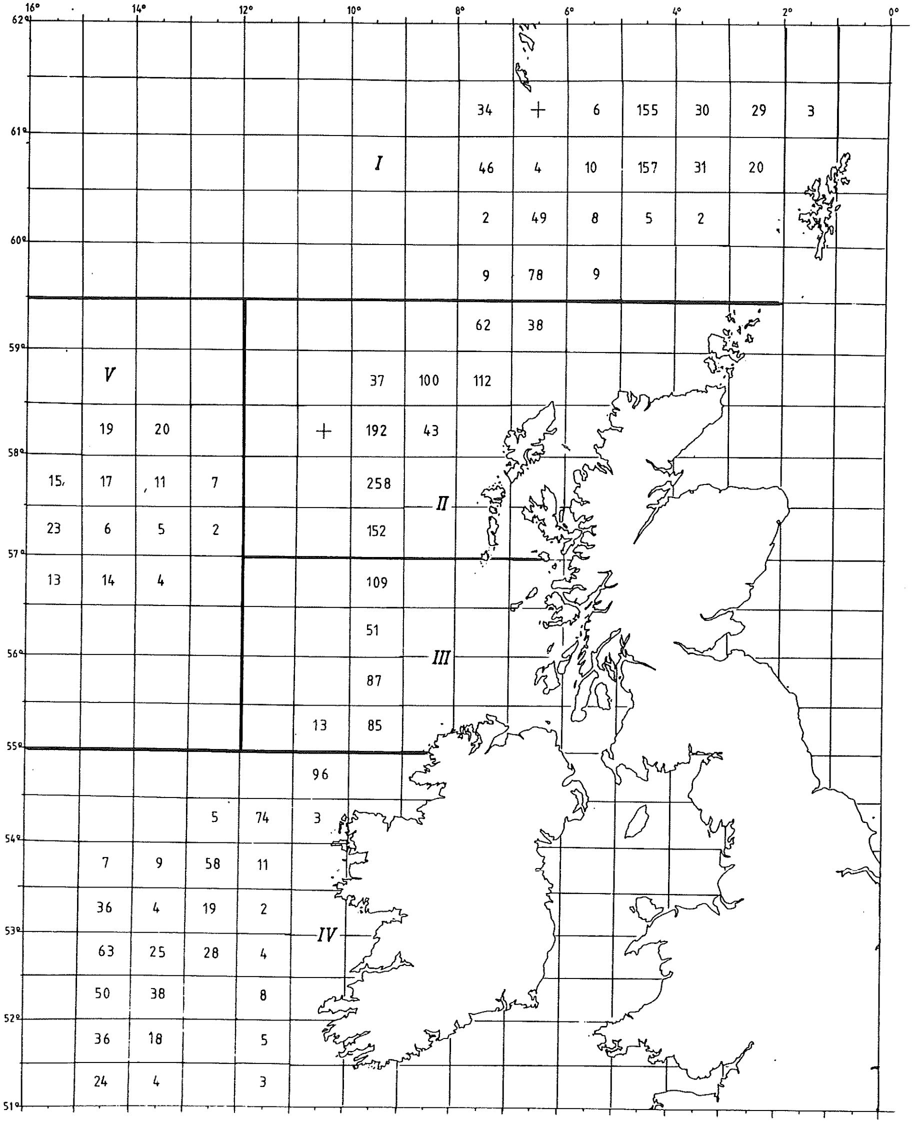


Figure 7.3 Biomass of BLUE WHITING by areas estimated during the Faroese survey, April 1984.

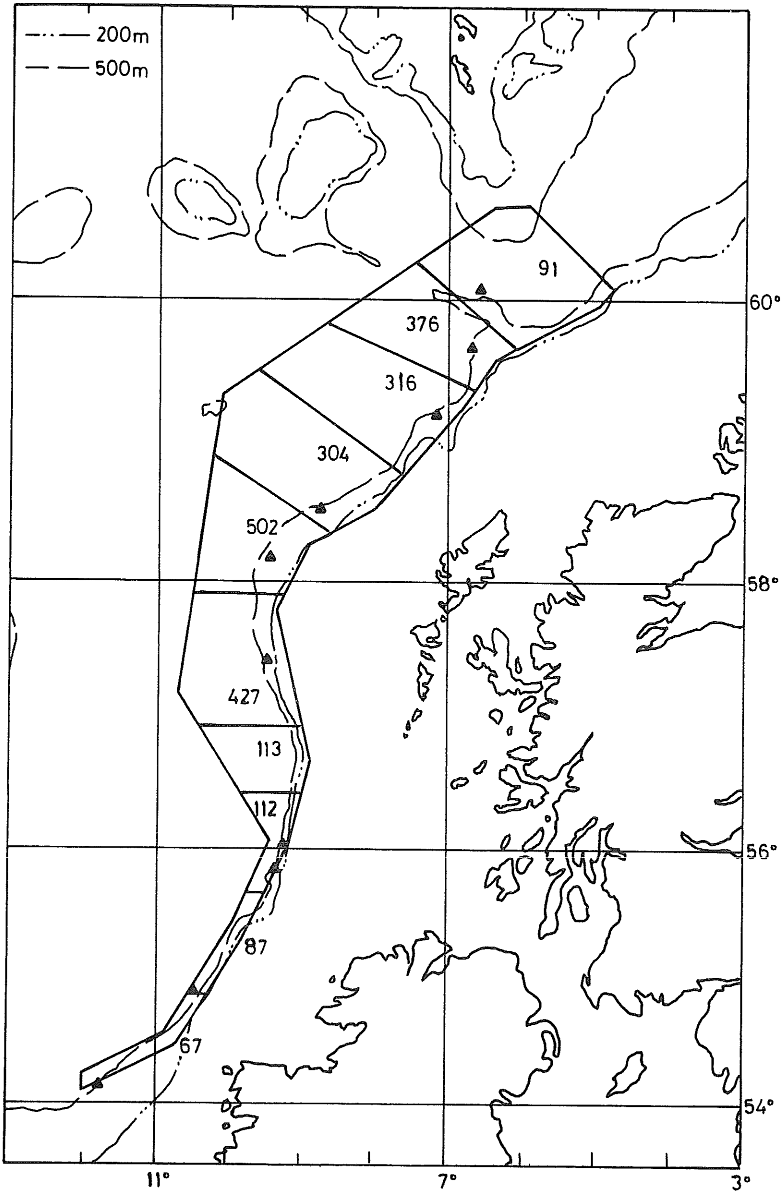


Figure 7.4 BLUE WHITING biomass (t/nm^2), estimated during the USSR in March 1984.

1 - < 75
2 - 75 - 300
3 - 300 - 750
4 - > 750

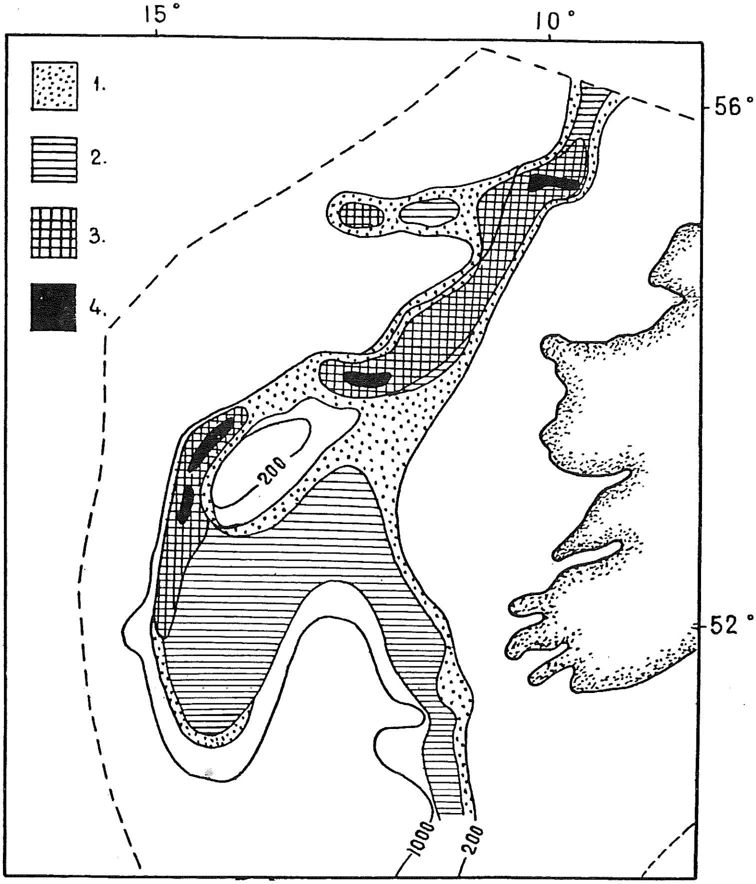


Figure 7.5 Density distribution of BLUE WHITING biomass ($t/n.m^2$) estimated during the USSR survey April 1984.
For legend - see Figure 7.4

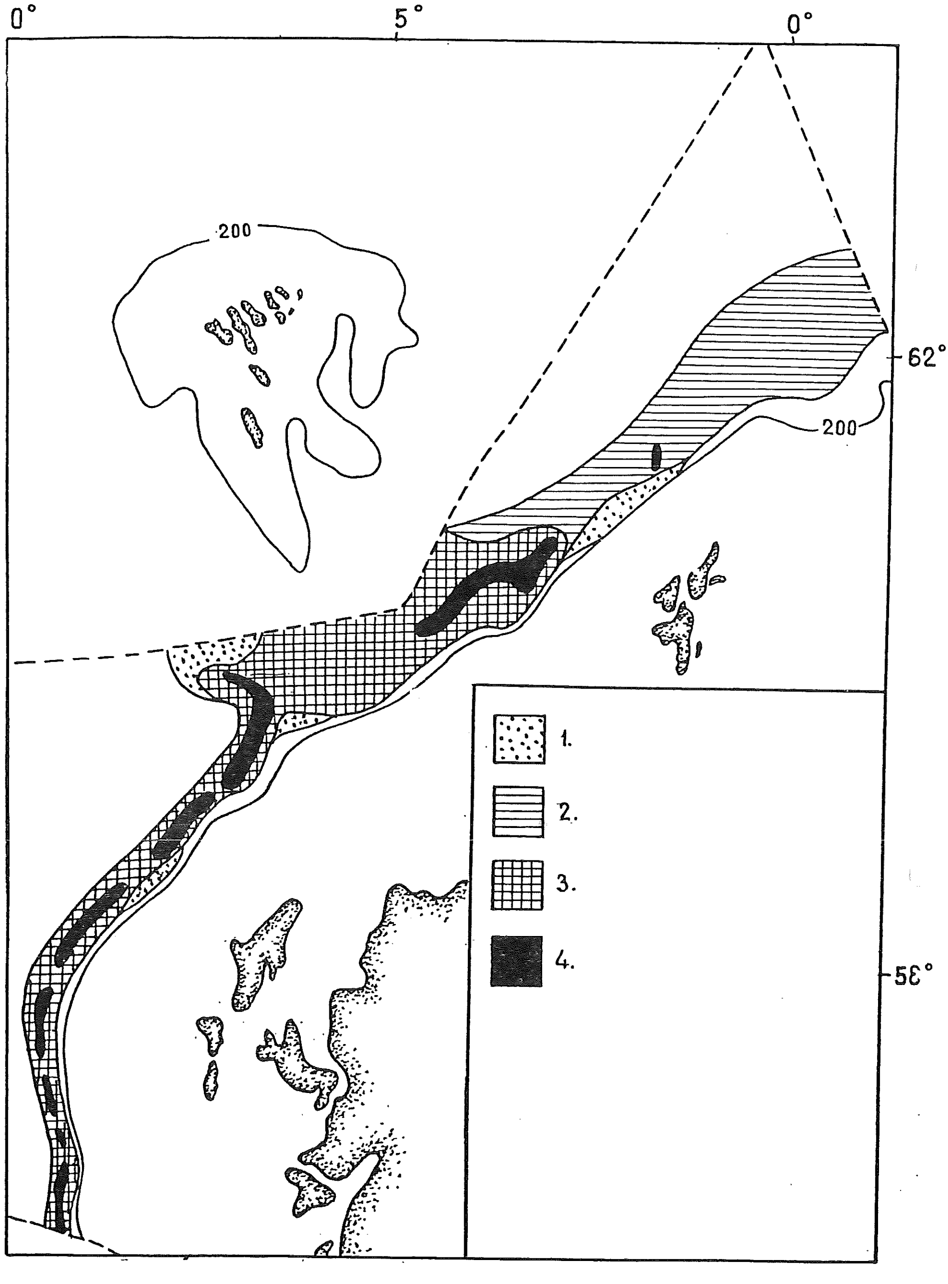
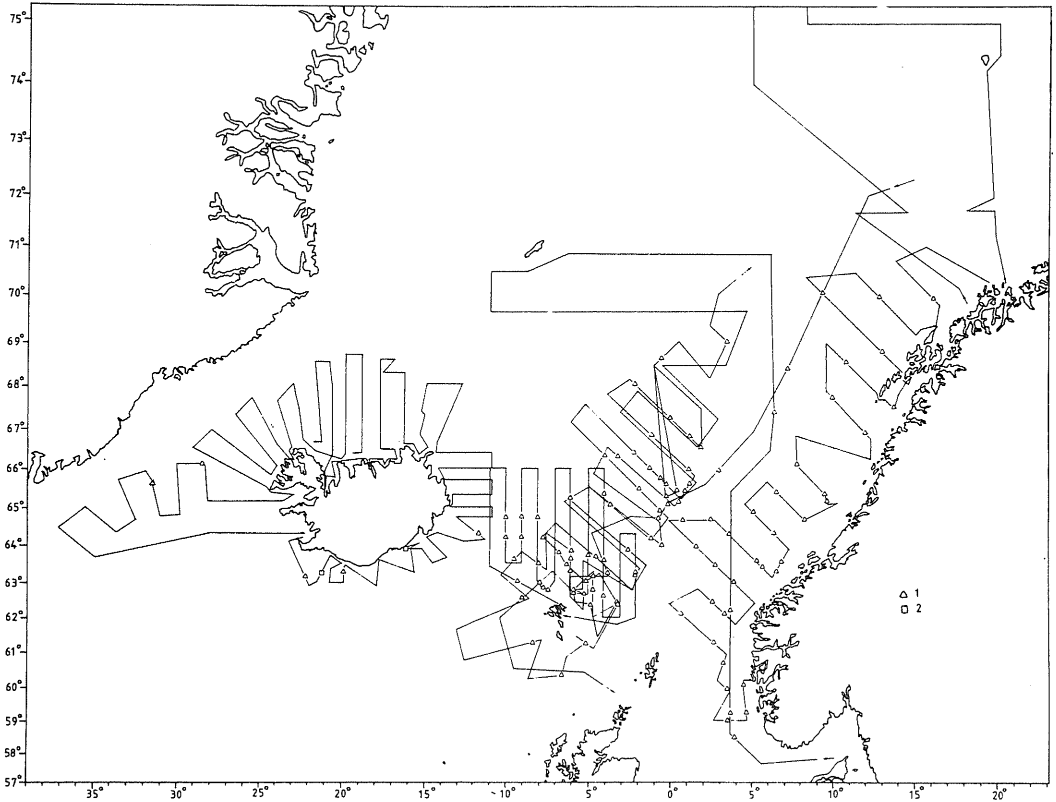


Figure 7.6 Cruise tracks and trawl stations of the six research vessels, August (26 July - 5 September 1984). 1 - Pelagic trawl; 2 - Bottom trawl.



<u>Figure 7.7</u> Distribution and abundance of BLUE WHITING. August 1984. Echo intensity m^2/n.mile)^2 x 10.

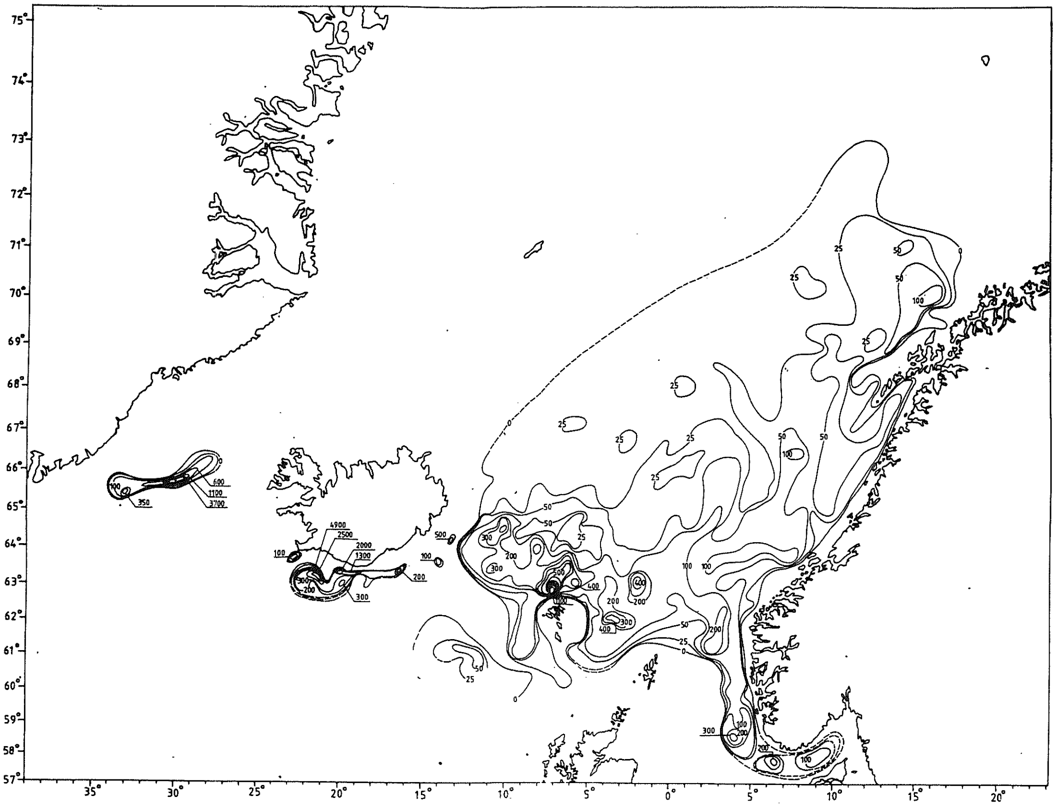
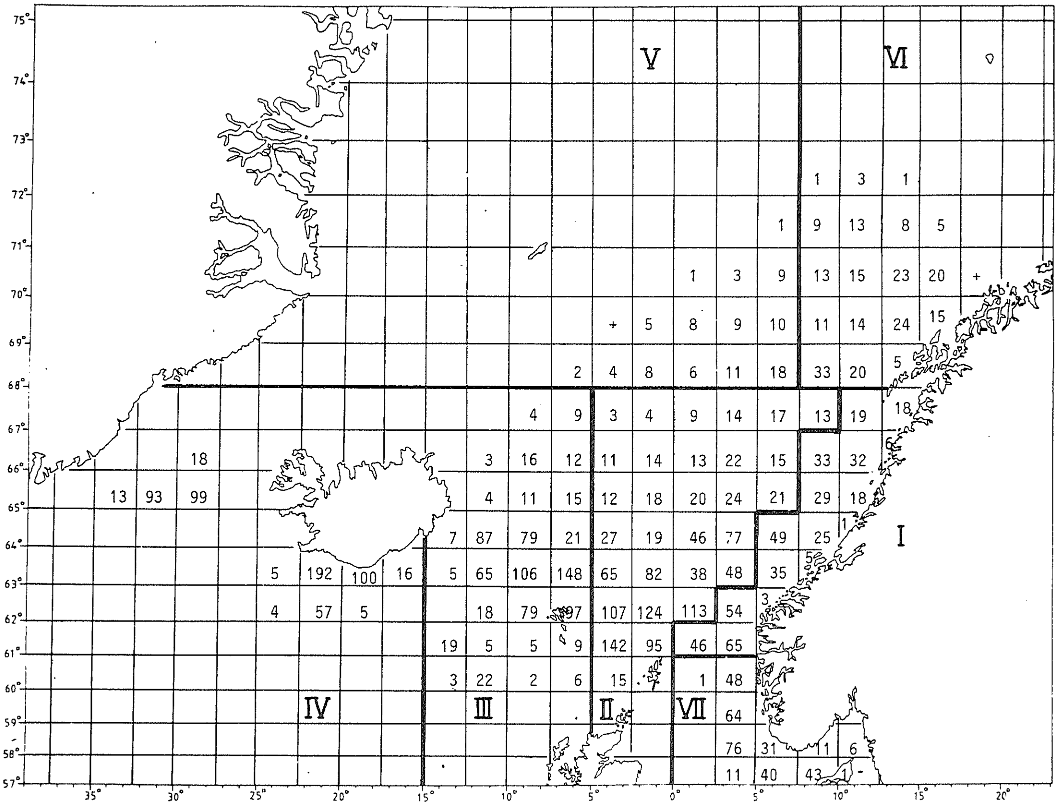
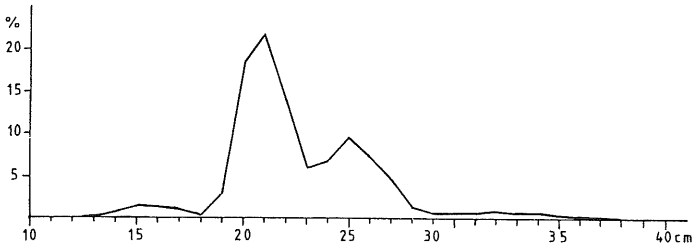


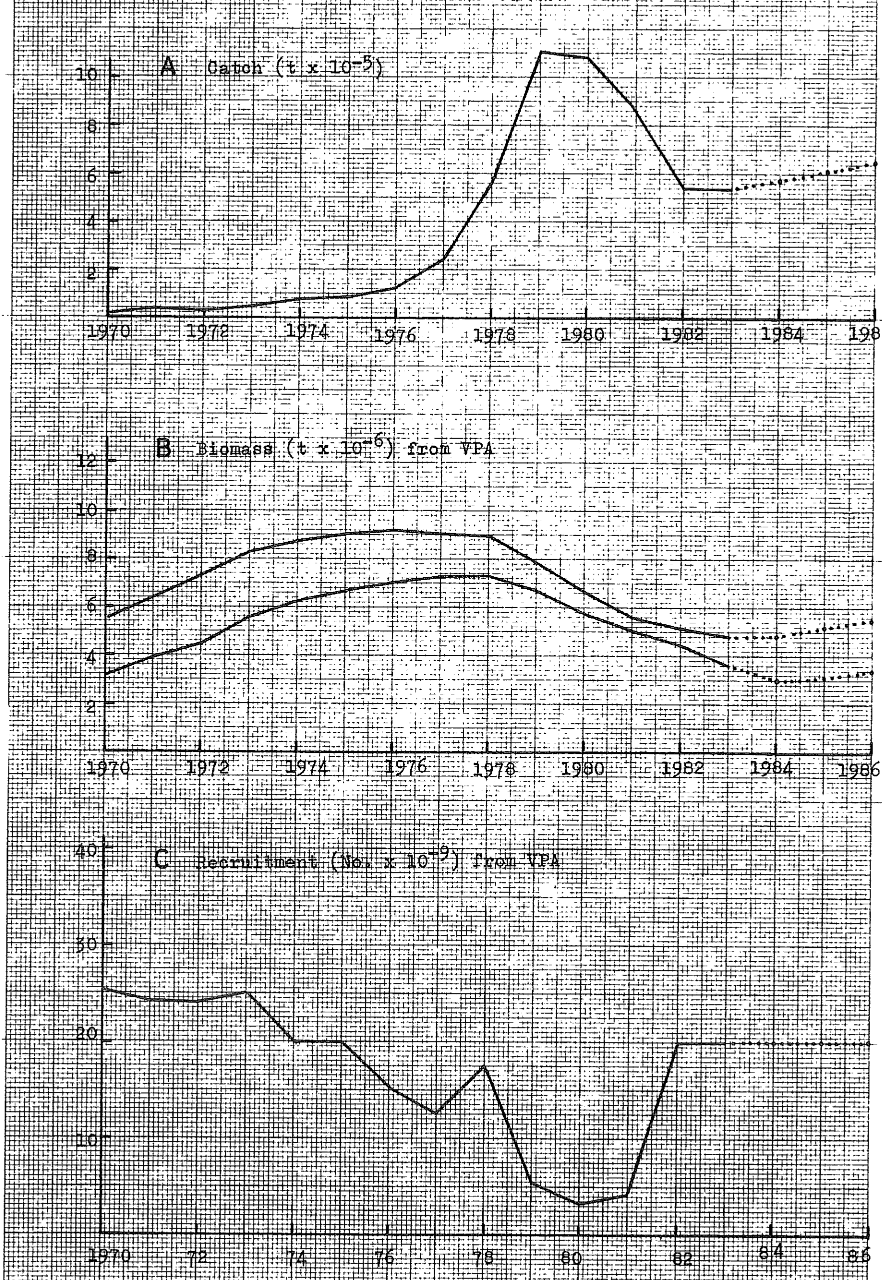
Figure 7.8. Estimated biomass of BLUE WHITING in 1 000 tonnes.





<u>Figure 7.9</u> Total length distribution (%) of BLUE WHITING weighted by abundance in the Norwegian Sea and adjacent waters, August 1984. N = 49.2×10^9.

Figure 7.10 BLUE WHITING. Northern area.



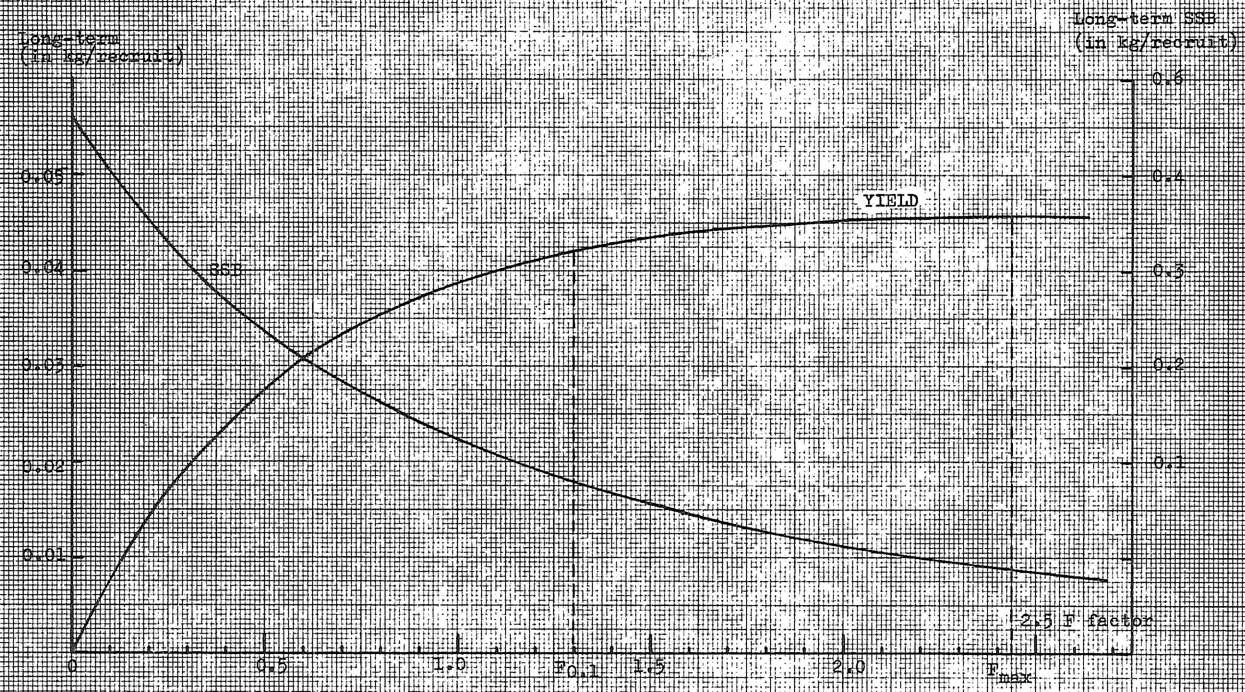


Figure 7.11 Long-term yield and spawning stock biomass per recruit.

Figure 7.12 Length distribution of the total catch in July 1984 (composed of 32 hauls) at Rockall Bank by the R/V "Walter Herwig".

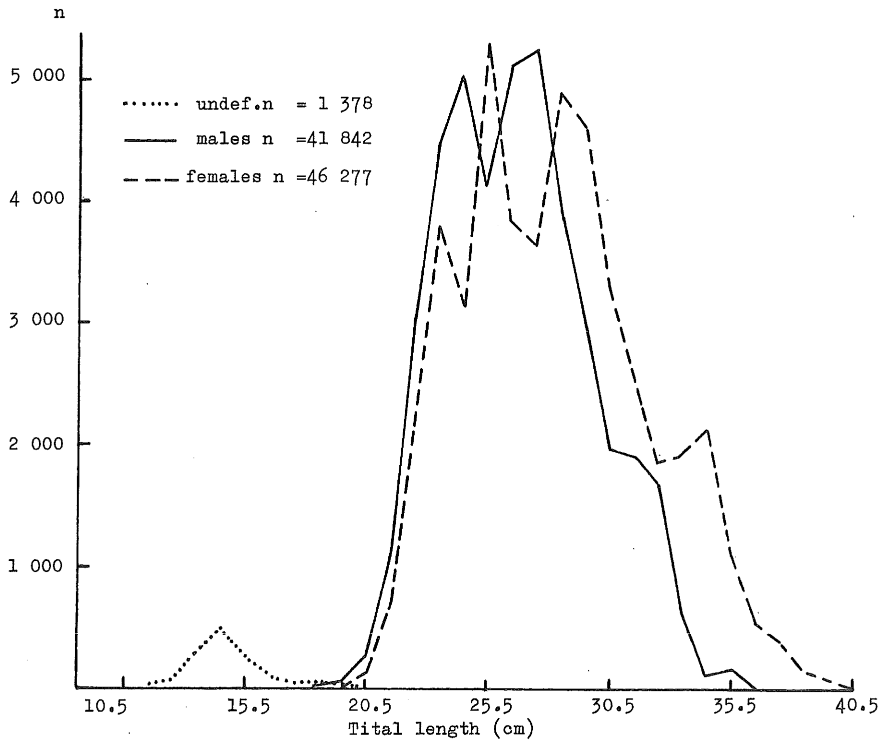


Figure 11.1 Weight at age in GDR catches from 1980-83.

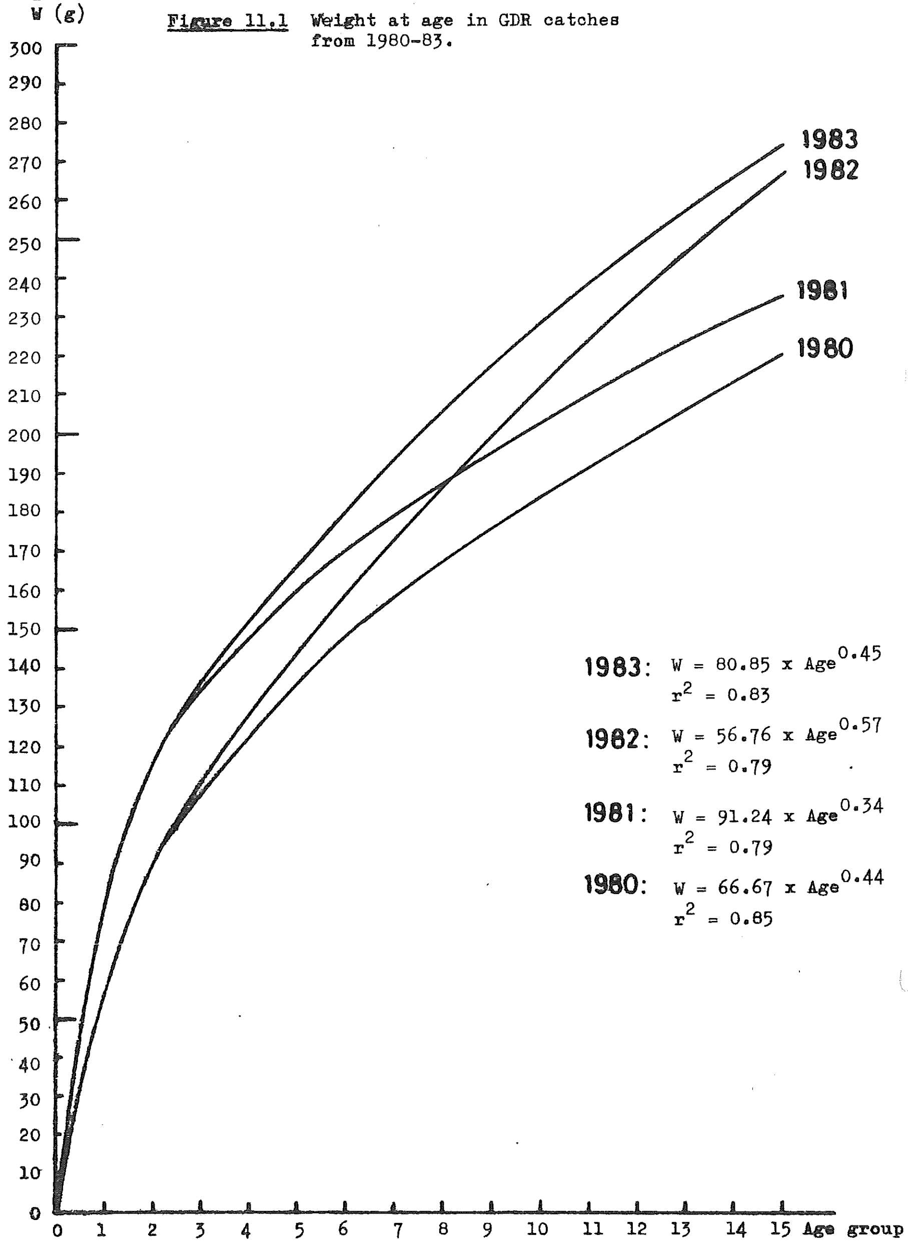


Figure 12.1 Selectivity data for BLUE WHITING.
(Robles *et al.*, 1980)