Advisory Committee on Fisheries Management **ICES CM 2000/ACFM:16**

REPORT OF THE

NORTHERN PALAGIC AND BLUE WHITING FISHERIES WORKING GROUP

ICES Headquarters
26 April–4 May 2000

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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TABLE OF CONTENTS

Section		Page

1 INTRODUCTION

1.1 Terms of Reference

The **Northern Pelagic and Blue Whiting Fisheries Working Group** [WGNPBW] (Chair: Dr J. Carscadden, Canada) will meet at ICES Headquarters from 26 April to 4 May 2000 to:

a) assess the status of and provide catch options for 2001 for the Norwegian spring-spawning herring stock;
b) assess the status of and provide catch options for the 2000–2001 season for the Icelandic summer-spawning herring stocks;
c) assess the status of capelin in Sub-areas V and XIV and provide catch options for the summer/autumn 2000 and winter 2001 seasons;
d) assess the status of and provide catch options for capelin in Sub-areas I and II (excluding Division IIa west of 5°W) in 2001;
e) assess the status of and provide catch options for 2001 and 2002 for the blue whiting stock;
f) identify major deficiencies in the assessments.

The above Terms of Reference are set up to provide ACFM with the information required for responding to requests for advice/information from NEAFC and EC DGXIV Fisheries. (Further items may be added on receipt of the requests for advice).

g) NEAFC letter 06.04.2000: During the meeting of the Blue Whiting Working Group of NEAFC on 5 and 6 April 2000, Russia presented a scientific paper dealing with the distribution of Blue Whiting in the Barents Sea. In order to further discussion on the management of the Blue Whiting stock within NEAFC, ICES (as the advisory body of NEAFC) is requested to validate this information at its forthcoming ACFM meeting, and return the advice to NEAFC as soon as possible.

h) FAROE ISLANDS letter 01.02.2000: The coastal states of the Norwegian Spring Spawning Herring (Atlanto-Scandian Herring) (European Union, Faroe Islands, Iceland, Norway and Russia) have agreed to request ICES to provide information about the stock development in accordance with the Annex of the Memorandum of Understanding with NEAFC. Furthermore, it should provide catch options for 2001 based on fishing mortalities in the range F=0.08 to 0.15. ICES should evaluate the probability that the SSB will fall below Bpa of 5 000 000 t and blim of 2 500 000 t in a 5 and 10-year period at various levels of constant fishing mortalities while the SSB is above Bpa, including values in the range of F=0.05, 0.08, 0.10, 0.125, 0.15. ICES should evaluate the strategies that would ensure a probability in the range of 50 to 80% of restoring the SSB to above BPA within 2 to 5 years, in a case where SSB is below Bpa. For each of these combinations, evaluate the expected average percentage change in catches from year to year and the expected average catches over the same ten year period.

i) NASCO has requested, with respect to Atlantic Salmon in the North-East Atlantic Commission area, that an estimate of the by-catch of salmon post-smolts in pelagic fisheries be provided.

WGNPBW will report to ACFM at its May 2000 meeting.

1.2 Participants

Jim Carscadden (Chair)	Canada
Sergei Belikov	Russia
Bjarte Bogstad	Norway
Are Dommasnes	Norway
Petter Fossum	Norway
Harald Gjøsæter	Norway
Susana Godinho	Portugal
Asta Gudmundsdottir	Iceland
Kjellrun Hiis Hauge	Norway
Jan Arge Jacobsen	Faroe Islands
Per Kanneworff	Denmark
Michael Keatinge	Ireland
Alexander Krysov	Russia
Manuel Meixide	Spain

Webjørn Melle	Norway
Brian Nakashima	Canada
Ingolf Røttingen	Norway
Sveinn Sveinbjornsson	Iceland
Sigurd Tjelmeland	Norway
Dmitri Vasilyev	Russia
Hjalmar Vilhjalmsson	Iceland
Jonathan White	Ireland

2 ECOLOGICAL CONSIDERATIONS

2.1 Barents Sea

2.1.1 Climate

The Barents Sea is characterised by large year-to-year fluctuations in heat content and ice coverage caused by variations in heat influx from Atlantic water. There was a period of warming up in the western Barents Sea from 1989 to 1995 (Figure 2.1.1.1). This period was followed by cooling in 1996-1997. In winter and spring 1998 the temperature increased to the long-term mean, however, during autumn 1998 there was a strong increase in temperature, and in January 1999 the temperature was 1^0C above the long-term mean, the highest temperature measured in January since 1983. During winter the temperature decreased somewhat, but was still 0.87 degrees above the long-term mean in March 1999. During spring 1999 the temperature decreased to 0.36 degrees above the long-term mean in April 1999 and then declined further to 0.3 degrees above the long-term mean in summer 1999. During autumn 1999 there was a significant increase in temperature and in January 2000 the temperature was 1.1 degrees above the long-term mean, again the highest temperature recorded since January 1983.

The warm periods during the winters of 1999 and 2000 may be looked upon as warming events where pulses of warm Atlantic water flow into the Barents Sea. This pulse of warm water is expected to continue into the central parts of the Barents Sea in 2000 as it did in 1999 resulting in temperatures 0.5 degree above the long-term mean in the central parts and 0.2-0.3 degree above the long-term mean in the eastern part of the sea. A temperature forecast for the Kola section (WD by Ottersen), predicts a temperature of 5.3 ^{0}C in September 2000, 0.4 degree above the long-term mean. Such high temperatures are creating basis for good feeding conditions for capelin, herring and 0-group fish. An example of this is the large growth of the 0-group fish that was measured on the joint 0-group survey in autumn 1999.

In 1999 the ice coverage was significantly less than previous years. The ice edge was north of 75^0N in some areas in the winter. There was also a strong melting process going on during summer resulting in very little ice in the autumn 1999.

Conclusions:

- Temperatures above the long-term mean are predicted for the whole Barents Sea in 2000.
- A temperature forecast at the Kola section for September 2000 predicts a temperature 0.4 degrees above the long-term mean with an error of 0.34 .

2.1.2 Zooplankton

The standing stock of zooplankton has been monitored in the Barents Sea from the early eighties in connection with the joint 0-group and capelin surveys in August-October. At this time of the year most of the production has taken place and zooplankton biomass can be seen as an expression of the size of the coming overwintering population of zooplankton. The samples are taken with dip nets and Mocness oblique hauls and are subdivided into three different size categories: 180-1000µm, 1000-2000µm and above 2000 µm. The mean values for zooplankton for the whole Barents Sea from 1994 are shown in Figure 2.1.2.1. In Figure 2.1.2.2 the mean values of zooplankton in 7 different areas are shown back to 1987, and this figure shows that there was a marked increase in zooplankton biomass during the period 1991-94. After this period the biomass of zooplankton decreased in all parts of the sea except from the eastern part where the biomass of zooplankton has been constant. In the period 1998-99 the same development has continued with a small decrease in all parts of the sea. Expected temperatures above the long-term mean in 2000 together with slightly reduced overwintering zooplankton biomass will create the basis for somewhat reduced zooplankton production and feeding conditions for capelin, herring and juvenile fish in the Barents Sea in 2000 compared to 1999.

Conclusions:

- Somewhat reduced abundance of zooplankton biomass and thus feeding conditions for capelin, Norwegian spring-spawning herring and other juvenile fish in the Barents Sea in 2000 compared to 1999.

2.1.3 Consumption of capelin and herring by cod, harp seals and minke whales

Bogstad *et al.* (2000) reviewed the consumption of fish in the Barents Sea by various predators. The three most important predator species are cod, harp seal and minke whale. The consumption by cod of various prey species for the period 1984-1999 is given in Table 2.1.3.1, using the same method as described by Bogstad and Mehl (1997). The consumption by minke whale (Folkow *et al.* 2000) and by harp seal (Nilssen *et al.* 2000) is given in Table 2.1.3.2. These consumption estimates are based on stock size estimates of 85 000 minke whales in the Barents Sea and Norwegian coastal waters (Schweder *et al.*, 1997) and of 2 223 000 harp seals in the Barents Sea (ICES 1999/ACFM:7). The consumption by harp seal is calculated both for situations with high and low capelin stock, while the consumption by minke whale is calculated for a situation with a high herring stock and a low capelin stock. It is worth noting that the abundance estimate of harp seals was revised considerably upwards in 1998 (ICES 1999/ACFM:7), which also increased estimates of the consumption by harp seals correspondingly. The food consumption of harp seals and minke whales combined is now at about the same level as the food consumption by cod, and the predation by these two species needs to be considered when calculating the mortality of capelin and young herring in the Barents Sea.

According to Bogstad *et al.* (2000), the total consumption of capelin by these three predators is higher than both the acoustic abundance estimates of capelin and the calculated MOB (M-output-biomass, i.e. the biomass output through natural mortality, see (Gjøsæter, 1997)) in several of the years with low capelin abundance. However, the total consumption of herring by the three main predators is much lower than the MOB (based on M=0.9 on ages 1 and 2) in those years. These discrepancies merit consideration in the assessment of the capelin and herring stocks in the Barents Sea.

The consumption estimates in Table 2.1.3.1 do not include the consumption by mature cod in the period when it is outside the Barents Sea (assumed to be 3 months during the first half of the year). During this period it may consume significant amounts of adult herring (Bogstad and Mehl 1997).

2.2 Norwegian Sea

2.2.1 Hydrography and climate

The Nordic Seas (Figure 2.2.1.1) during the last decades have been characterized by increased input of Arctic waters. The Arctic waters to the Norwegian Sea are mainly carried by the East Icelandic Current and also to some extent by the Jan Mayen Current. During periods of increased Arctic water input, the western extension of Atlantic water is moved eastward. As a result, over the last 25 years the southern and western Norwegian Sea has become colder and fresher while the eastern Norwegian Sea is warmed. Atmospheric forcing drives this trend. Since the mid 1960’s the North Atlantic Oscillation index (NAO) has increased (Figure 2.2.1.2). NAO as it is used here is the normalised air pressure difference at sea level between Lisbon, Portugal and Reykjavik, Iceland and is an indicator of the strength of the westerly winds into the Norwegian Sea. A high NAO index (i.e. stronger westerly winds) will force Atlantic and Arctic waters more eastward.

The Institute of Marine Research, Norway, has measured temperature and salinity in three standard sections in the Norwegian Sea almost regularly since 1978. The sections are 1) the Svinøy section which runs NW from 62.37^{o} N at the Norwegian coast, 2) the Gimsøy section which also runs NW from the Lofoten Islands and 3) the Sørkapp section which is a zonal section at 76.33^{o} N just south of Svalbard (Figure 2.2.1.1).

Figure 2.2.1.3 shows the time series of summer (July-August) temperature and salinity from 1978 to 1999 in the three sections: Svinøy, Gimsøy and Sørkapp. The values are averaged vertically between 50 and 200 m and horizontally over 3 stations in the core of Atlantic water. The trends for all three sections are similar. The temperatures are increasing while the salinities are decreasing. The largest temperature increase is in the Sørkapp section. In 1999 the temperature decreased in the southernmost sections while it increased slightly in the Sørkapp section.

Figure 2.2.1.4 shows time series of temperature and salinity during the spring in the Svinøy and Gimsøy sections from 1978 to 2000 and from 1978 to 1999, respectively. The values are calculated using the same procedure as mentioned above. The low salinities in 1978 and 1979 are a result of the Great Salinity Anomaly during the 1970’s. In 1994 a large salinity anomaly comparable with the anomaly in 1978 and 1979 was seen. The temperature was also a minimum that year. The 1994 anomaly was a result of increased influence of Arctic water from the East Icelandic Current. There is a small increase in temperature and salinity in the core of the Atlantic water in year 2000 compared with year 1999.

Conclusions:

- The trend in temperature and salinity in the standard sections since 1970 has been towards higher temperatures and lower salinities.
- Temperatures in July-August dropped in 1999 in the southernmost sections.
- Temperature and salinity in the Svinøy section in March-April 2000 increased compared with 1999.
- The high winter NAO in 1999 coincided with a further eastward movement of the Arctic front and increased dominance of cold low salinity water masses in the western and central Norwegian Sea.
- An even higher winter NAO in 2000 (preliminary data) suggests a continuation in the eastward movement of the Arctic front.

2.2.2 Phytoplankton

The development of phytoplankton in the Atlantic water is closely related to the increase of incoming solar irradiance during March and to the development of stratification in the upper mixed layer due to warming. The Institute of Marine Research, Norway, started in 1990 a long-term study of the mechanisms controlling the development of phytoplankton at Ocean Weather Station Mike situated at 66°N, 2°E.

Figure 2.2.2.1 shows the development of the phytoplankton bloom for 1997,1998 and 1999, years with a strong difference in the time where the spring bloom reached its maximum. While in 1997 the spring bloom reached its maximum 20 May (day of the year 140), in 1998 this was achieved about one month earlier 18 April (day of the year 108). The timing of the bloom in 1999 was similar to that in 1998, but did not show the same high maximum in chlorophyll. This may be related to the weekly measurements in 1999, as opposed to daily measurements in 1997 and 1998. On the other hand, weekly measurements prior to 1997 have revealed pronounced maxima in chlorophyll, suggesting that early and strong grazing from a large over-wintered zooplankton stock may have kept the algal biomass at a low level in 1999. The same figure shows two distinct phases, similar for all the years since 1990, in the development of phytoplankton prior to the spring bloom. The first phase from day 1 to about day 50 is characterised by extremely low phytoplankton biomass expressed as chlorophyll *a*. This is the winter season where phytoplankton growth is mainly limited by the low incoming irradiance typical of this period. The second phase from about day 50 to day 100 is characterised by a gradual increase of phytoplankton biomass but without reaching bloom conditions. This is the pre-bloom phase where the increase in biomass is related to the increase in incoming irradiance during the spring equinox and the lack of a bloom in this period is due to a still deep upper mixed layer.

Figure 2.2.2.2 shows the extension in time for these two phases in addition to the time of the spring bloom for the period 1991-1999. In a "normal" year the winter season extends to about March 2. The pre-bloom phase extended on average from the March 2 to April 16. The spring bloom itself starts normally on April 16 and reaches its maximum on May 21, but the year-to-year variations are much larger than those of the previous phases. A trend from 1991, with the spring bloom taking place earlier for each year, was broken in 1996. Thereafter year-to-year variability in the timing of the bloom has been greater.

Conclusions:

- The phytoplankton bloom in 1999 developed similar to that in 1998 and earlier than in 1997.
- Chlorophyll concentrations did not peak in May 1999 as we have observed in previous years.

2.2.3 Zooplankton

Zooplankton biomass distribution in the Norwegian and Icelandic Seas has been mapped annually in May (since 1995) and in July (since 1994). Zooplankton samples for biomass estimation were collected by vertical net hauls (WP2) or oblique net hauls (MOCNESS). In the present report results based on samples from the upper 200 m are analysed. Total zooplankton biomass (g dry weight m^{-2}) in May was averaged over sampling stations within three water masses, Atlantic water (salinity >35), Arctic water (salinity <35, west of 1.4°E) and Coastal water (salinity <35, east of 1.4°E), at 20 m depths (Figure 2.2.3.1). In Atlantic water masses zooplankton biomass decreased from 1995 to 1997 and increased again in 1998 and remained at the same level in 1999. In Arctic water the interannual variation in zooplankton biomass was similar. In the Coastal water masses, which includes the Norwegian continental shelf and slope waters influenced by Norwegian coastal water, the trend was different with generally low biomass from 1995 to 1997 and a marked increase in 1998 followed by a decrease in 1999.

In July the total zooplankton biomass (g dry weight m^{-2}) in the upper 200 m was calculated by integrating biomass at sampling stations over a selected area in the central and eastern Norwegian Sea, which was visited every year. In May the major part of the zooplankton biomass in the 0-200 m depth layer is *Calanus finmarchicus*, and this depth layer also includes the main feeding depths of the herring at that time. In July most *C. finmarchicus* have descended from the upper 200 m towards their wintering depths. The biomass left may still be representative for the total population, and is the best estimate for the overwintering population available for the time being.

Interannual zooplankton biomass variations in July were different from those observed in May (Figure 2.2.3.2). Zooplankton biomass was highest in 1994, 1997 and 1999. The low biomass in May 1997 was followed by high biomass in July the same year. The high biomass in 1999 was largely confined to the Arctic water mass in the western Norwegian Sea (Holst *et al.* 1999).

Conclusions:

- Average zooplankton biomass in Atlantic water masses of the Norwegian Sea in May 1999 was similar to that in 1998.
- Zooplankton biomass in July 1999 was the same level as in 1997.

2.2.4 Herring growth and food availability

Individual growth of the Norwegian spring spawning herring, as measured by condition or length specific weight after the summer feeding period in the Norwegian Sea, has been characterised by large fluctuations during the 1990's (Fig 2.2.4.1). During 1991 and 1993 individual condition was good, but from 1994 on the condition of the herring started to decline and by 1997 it had reached the lowest level during the 1990's. The level observed in 1997 corresponds with the absolute long-term low level observed during the period 1935 – 1994 (Holst 1996). After 1997 the condition of the herring in the Norwegian Sea improved, but is still well below the maximum observed during the first four years of the decade.

Comparing the feeding migration patterns of the herring during the period after 1995 leaves us with few clues in the search for explanations for the varying growth. The recent years have been characterised by a rather stable migration pattern and migration distances have not varied considerably, although, a somewhat northerly extension of the feeding area has been observed over the last two years.

Since 1994, when the large-scale migration pattern of the herring have been mapped during two annual cruises, May and July-August, the herring have been feeding most heavily in Atlantic water of the central Norwegian Sea. It has been found that the herring condition index obtained after the feeding period in the Norwegian Sea is related to average zooplankton biomass of Atlantic water (Figure 2.2.4.2). This indicates that variations in the production of zooplankton, constituting the food of the herring, may be the main reason for the observed variability in herring growth. The high herring condition index in 1999 when zooplankton biomass was moderate, suggests that food concentrations within Atlantic water may not be the only important factor governing herring growth, or that our index to zooplankton biomass may not reflect the actual food supply for the herring.

Conclusions:

- Herring condition improved from 1998 to 1999.
- There is a direct relationship between zooplankton biomass in May and herring condition in the autumn during the years 1995-1998.
- High herring condition after the 1999-feeding season when zooplankton biomass was moderate, encourages further investigations on this subject.

2.2.5 Predictions for zooplankton biomass and herring feeding conditions

A factor possibly governing zooplankton biomass is the size of the zooplankton spawning stock, or the size of the over-wintering population. Zooplankton biomass in July may represent the over-wintering population, and a linear regression of the biomass in July on the biomass in May the following year explains 61% of the total variation (Figure 2.2.5.1). The time series is short and the variability is large, but the high biomass in July 1999 suggests that zooplankton biomass in May 2000 will be high, 13-14 g m^{-2} (Figure 2.2.5.1). According to Figure 2.2.4.2, showing the relationship between biomass in May and herring condition in the autumn the same year, a high herring condition index can be expected for the autumn 2000.

The North Atlantic Oscillation index (NAO), is a proxy for the strength and duration of south-westerly winds, and is correlated with the inflow of Atlantic water to the Norwegian Sea. In the Norwegian Sea the winter NAO (December to March) was correlated with zooplankton biomass in May, not within the same year but the following year (Figure 2.2.5.1). We believe this to be related to the influence of Atlantic inflow on the production of over-winterers to become the spawning stock next year. The relationship suggests that high zooplankton biomass in May follows a winter with high NAO the previous year. Knowing that the NAO during the winter 1998-1999 was rather high, a high zooplankton biomass may be expected in May 2000, 13-14 g m^{-2} (Figure 2.2.5.1). The winter NAO for the winter 1999-2000 was even higher than the previous year, ~4, and would predict a very high zooplankton biomass for May 2001.

Based on the major trends in the long-term herring growth data (Holst 1996), 5 to 6 years are typically needed to move from periods of low growth to periods of high growth. Based on the long-term series of condition in the herring stock and the recent development we are probably now entering a new period of above average growth. A reasonable prediction would be that condition after the 2000 feeding season would lie somewhere between 0.85 and 0.91, when no other data then the individual herring condition time series is taken into account.

The correlations we revealed between zooplankton biomass and herring growth and between zooplankton biomass and the NAO suggested that a relationship between the herring condition index and the NAO might exist. For both indices the available time series are much longer than the zooplankton biomass time series, which is limited to the years after 1994. The time series for the herring condition index was recalculated for the period from 1991 to 1999 (this index is now being reconstructed back to the 1930's). A regression of the herring condition index on the winter NAO the previous year explained more than 80% of the variation in the data, if the year 1996 was excluded from the data set (Figure 2.2.5.2). The reason why herring condition in 1996 appeared to be lower than predicted from the NAO is not clear, but also the zooplankton production this year was lower than what could be predicted from the NAO. The winter NAO is known at the end of March, possibly even earlier, and offers the opportunity to predict the herring condition in the autumn of the following year (18 months). Thus, the herring condition index for 2000 is predicted to be 0.87 in 2000, and assuming that the winter NAO for 2000 was 4, the condition index for 2001 will be 0.90.

Conclusions:

- A direct relationship between zooplankton biomass in July and the zooplankton biomass in May the following year is suggested by the time series from 1994 to 1999.
- The relationship predicts herring feeding conditions (zooplankton biomass in May) to be good in 2000, and the herring condition in the autumn 2000 to be high.
- The winter NAO is directly related to zooplankton biomass in May and herring condition the following year.
- The winter NAO predicts zooplankton biomass between 13 and 14 g m^{-2} in May 2000 and herring condition index to be 0.87 in the autumn 2000.
- The winter NAO predicts herring condition index to be 0.90, close to the maximum for the years available, in the autumn 2001.

2.3 Icelandic Waters

2.3.1 Hydrography and climate

Due to the proximity of the oceanic Polar Front in the northern North Atlantic, hydrographic conditions in the sea north of Iceland are highly variable. Changes in intensity of the influx of Atlantic water and/or variable admixture of polar water to the surface layers north of Iceland may lead to marked fluctuations in temperatures and salinities, both in space and time. Off the south and west coasts, where Atlantic water predominates, fluctuations are much smaller.

Climatic conditions in the North Atlantic improved greatly around 1920 and remained good until the mid-1960s when they deteriorated suddenly. In the area north and east of Iceland temperature and salinity declined sharply in 1965 and these severely cold conditions lasted until 1971. After that, climatic conditions of the area north and east of Iceland improved again but have been variable and warm years have alternated with cold years.

During the last 3 years, there has been a pronounced increase in the intensity of the Irminger Current south and west of Iceland, resulting in temperatures and salinities similar to those recorded in these waters in the 1950s and the early 1960s. There were no signs of a reduction of this flow of warm water off South and West Iceland throughout 1999. In spring 1999, an inflow of Atlantic water to the north Icelandic area was quite pronounced and the cold East Icelandic Current was weaker and farther offshore than at any time since 1964. This situation still prevailed during the quarterly surveys for monitoring environmental conditions of Icelandic waters in August and November 1999 and in February

2000. The February 2000 survey also recorded considerable amounts of Atlantic water north of Iceland, which is unusual for that time of the year. The present situation will probably persist throughout 2000 since this large current system is quite stable with changes normally taking months or years.

Nevertheless, there can be large variations of temperature and salinity in the area north and east of Iceland, due mainly to variability in cloud cover and the prevailing wind direction. Such variations mainly effect the uppermost 50-100 m of the water column and may to a large extent mask the beneficial effects of the warm water inflow from the south and west.

Average values for temperature and salinity in May/June from a standard section (Siglunes) off the central north coast of Iceland are shown for the period 1952-1999 in Figure 2.3.1a and b respectively.

2.3.2 Phytoplankton

The fresh surface layer reduced the positive effects of the warm Atlantic water north of Iceland considerably in 1997 and to a lesser extent in 1998. This layer was, however, pushed northward by the larger warm water influx in 1999 and in February 2000 there still was mixed water of high salinity in the area north of Iceland. Experience shows that such mixed water makes for quicker renewal of nutrients and increases primary production during the growth season. Therefore, a high nutrient content and phytoplankton production is expected in the area north of Iceland in spring and summer of 2000.

2.3.3 Zooplankton

In the area north of Iceland, zooplankton biomass is significantly higher during years with a strong inflow of Atlantic water than in years when Atlantic inflow is weak and salinity lowered in the surface layer. The continued strong inflow of Atlantic water to the north Icelandic area therefore indicates that zooplankton biomass will be above average in spring and summer 2000.

Long-term changes of zooplankton biomass north of Iceland are shown in Figure 2.3.1c. The values represent averages of all stations on the Siglunes section. In north Icelandic waters, the high values of zooplankton in the beginning of the series dropped drastically with the onset of the Great Salinity Anomaly of the 1960s. Since then zooplankton biomass has been highly variable.

2.3.4 Herring migrations

Prior to the cold period which began in the mid-1960s, the shelf waters north and east of Iceland as well as the oceanic area between Iceland and Jan Mayen constituted a major part of the feeding grounds of adult Norwegian spring spawning herring. The low temperature of Icelandic waters, the Iceland Sea and adjacent areas in the late 1960s, made them inaccessible to these herring and displaced their feeding grounds eastwards into the Northwestern Norwegian Sea and, finally, northeast to the area west of Bear Island and Spitzbergen. Concurrently, the exploitation rate of the herring stock increased greatly and the stock collapsed (Dragesund *et al.* 1980).

During the 1970s and most of the 1980s, stock abundance was low and the Norwegian Spring spawning herring had no need for extensive feeding migrations to fulfill their food requirements. However, with the maturation of the large 1983 year class and its descendants from 1991-1993, stock abundance increased rapidly in the late 1980s and the 1990s (cf. Figure 3.5.6.1b).

Although the Norwegian spring spawning herring resumed their feeding migrations westward into the Norwegian Sea around 1990, these migrations did not reach as far to the west as during the warm period prior to the mid-1960s. During the early 1990s, on approaching the eastern boundary of the cold East Icelandic Current in May, the herring generally turned north and northeast and arrived in the area northwest of Lofoten in August-September.

However, with the improvement of the marine climate north and northeast of Iceland since 1996, Norwegian spring spawning herring have begun to reappear in the waters east, northeast and even north of Iceland. Thus, some herring schools were located north of Melrakkaslétta (NE-Iceland) where a catch of 130 t was taken in July 1997 (Vilhjalmsson *et al.* 1997), and in 1998 a fishery was conducted off NE-Iceland as well as the eastern northcoast in June and early July (Holst *et al.* 1998). In June 1999 part of the stock, consisting of old and large herring, migrated west at approximately 68°N. In early July these herring were located between 14°30’W and 16°W and fished upon by Faroese vessels for a short period (cf. Figure 3.1.2.2.1). Furthermore, a few Norwegian spring spawning herring were taken as bycatch in the capelin fishery near 68°N, 18°W around mid-July.

It seems therefore that, due to the improvement of the marine climate in the last three years, the herring have been able to migrate considerably farther west and enter the area to the northeast and north of Iceland. However, it is equally clear that the herring only stayed in these waters over a short period and then migrated northeast just south of the Polar Front (Holst *et al*. 1999).

2.3.5 General summary

The increased intensity, heat content and salinity of the Irminger Current has, through its eastern branch, resulted in an improvement of the ocean climate north and east of Iceland. The simultaneous increase in the intensity of the very cold, south flowing East Greenland Current in 1997 and 1998 apparently hindered to some extent the eastward flow of Atlantic water off the north coast of Iceland, thereby augmenting the branch flowing west across the northern Irminger Sea towards Greenland. Furthermore, this situation caused periodic fluxes of cold, low salinity water into the near-surface layer over the shelf north and east of Iceland. However, in 1997 and 1998 the temperatures of the East Icelandic Current were higher, its southern and western boundary east of Iceland located farther offshore and to the north as compared to most recent years. On the other hand, Atlantic water predominated in the shelf area north of Iceland during spring, summer and autumn of 1999 and this situation still prevailed in February 2000.

Although the zooplankton biomass north of Iceland in the spring of recent years has not reached the pre-1965 levels, the increase is substantial as compared to most years in the period 1965-1990.

Improvements of the marine climate to the east, northeast and north of Iceland in 1997-1999 have enabled the Norwegian spring spawning herring to migrate farther west than they had during more than three decades.

Table 2.1.3.1 The Northeast Arctic cod stock's consumption in 1000 tonnes of main prey species in 1984–1999.

Year	Prey species										
	Amphipod	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	Others	Total
1984	27	114	443	735	80	15	22	51	370	512	2369
1985	172	58	157	1640	185	3	32	47	227	1173	3695
1986	1232	109	143	844	135	142	83	110	316	670	3784
1987	1064	66	189	226	32	202	25	4	318	668	2794
1988	1228	316	128	334	8	90	9	3	220	406	2743
1989	816	243	133	585	3	32	8	11	234	733	2797
1990	137	83	193	1594	7	6	19	15	241	1571	3866
1991	66	76	188	2894	8	12	26	20	309	1098	4697
1992	103	159	376	2463	331	97	54	106	188	1041	4920
1993	254	720	317	3058	165	278	285	72	100	790	6039
1994	579	725	532	1115	150	604	235	50	80	691	4761
1995	981	519	368	638	115	256	393	117	194	861	4441
1996	637	1181	349	555	48	106	552	70	98	676	4272
1997	391	537	324	950	6	120	360	43	38	528	3298
1998	377	463	338	775	96	160	187	37	13	491	2936
1999	154	284	242	1407	153	168	96	38	22	670	3234

Table 2.1.3.2 Annual consumption (1000 tonnes) by minke whales and harp seals in the Barents Sea. The minke whale calculations are based on data from 1992–1995, while those for harp seals are from 1990–1996. For harp seals, the most conservative estimates in Nilssen *et al.* (2000) are used.

Prey	Minke whale consumption	Harp seal consumption (low capelin stock)	Harp seal consumption (high capelin stock)
Capelin	142	23	812
Herring	633	394	213
Cod	256	298	101
Haddock	128	47	*
Krill	602	550	605
Amphipods	0	304	313**
Shrimp	0	*	*
Polar cod	*	880	608
Other fish	55	622	406
Other crustaceans	0	356	312
Total	1817	3491	3371

* indicates that the prey species is included in the 'other' group for this predator.

** only Themisto.

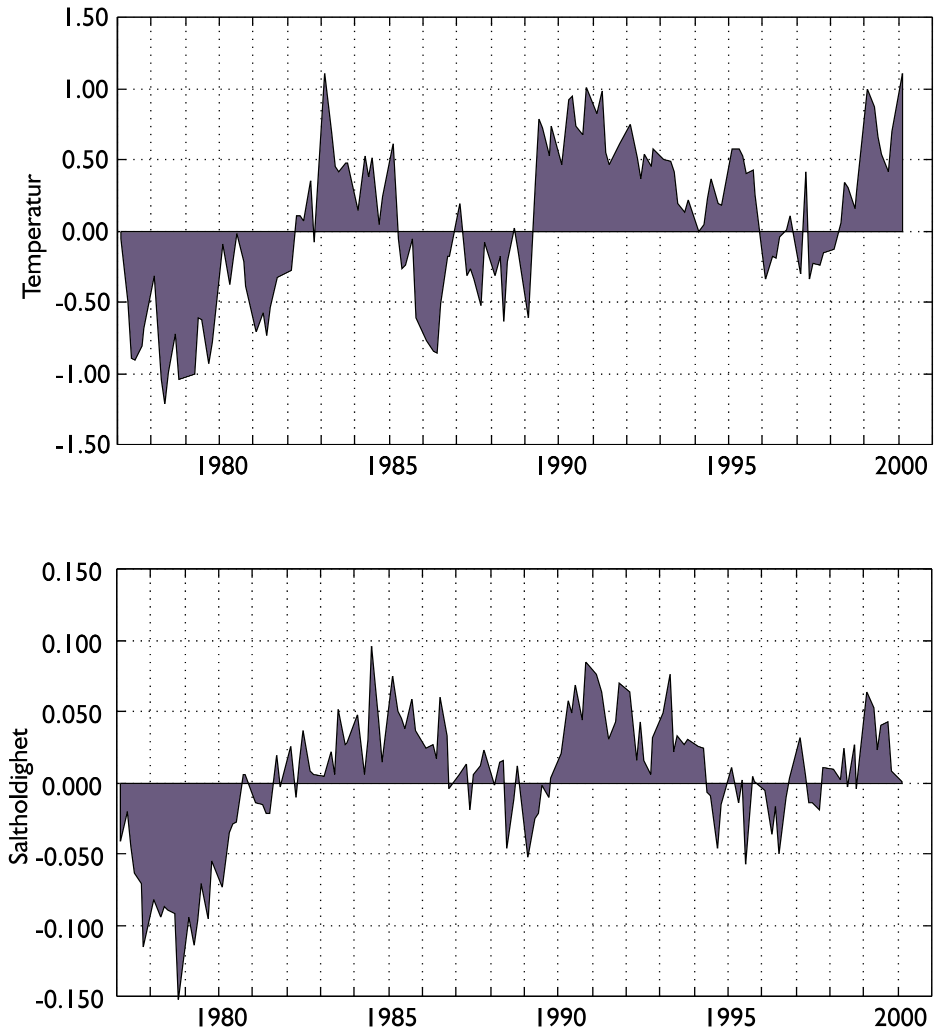


Figure 2.1.1.1. Temperature and salinity anomalies in the Norway-Bear Island section during the period 1977-2000.

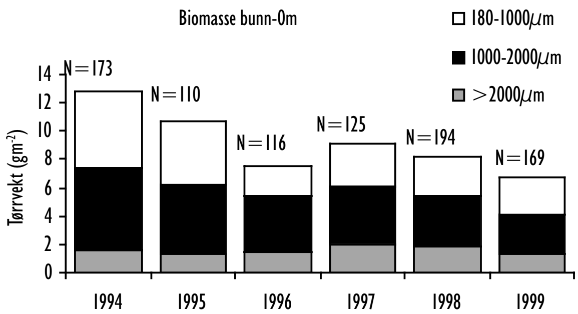


Figure 2.1.2.1. Size separated zooplankton biomass, gm^{-2}, from bottom-0 m, mean values for the whole Barents Sea, from 1994-99.

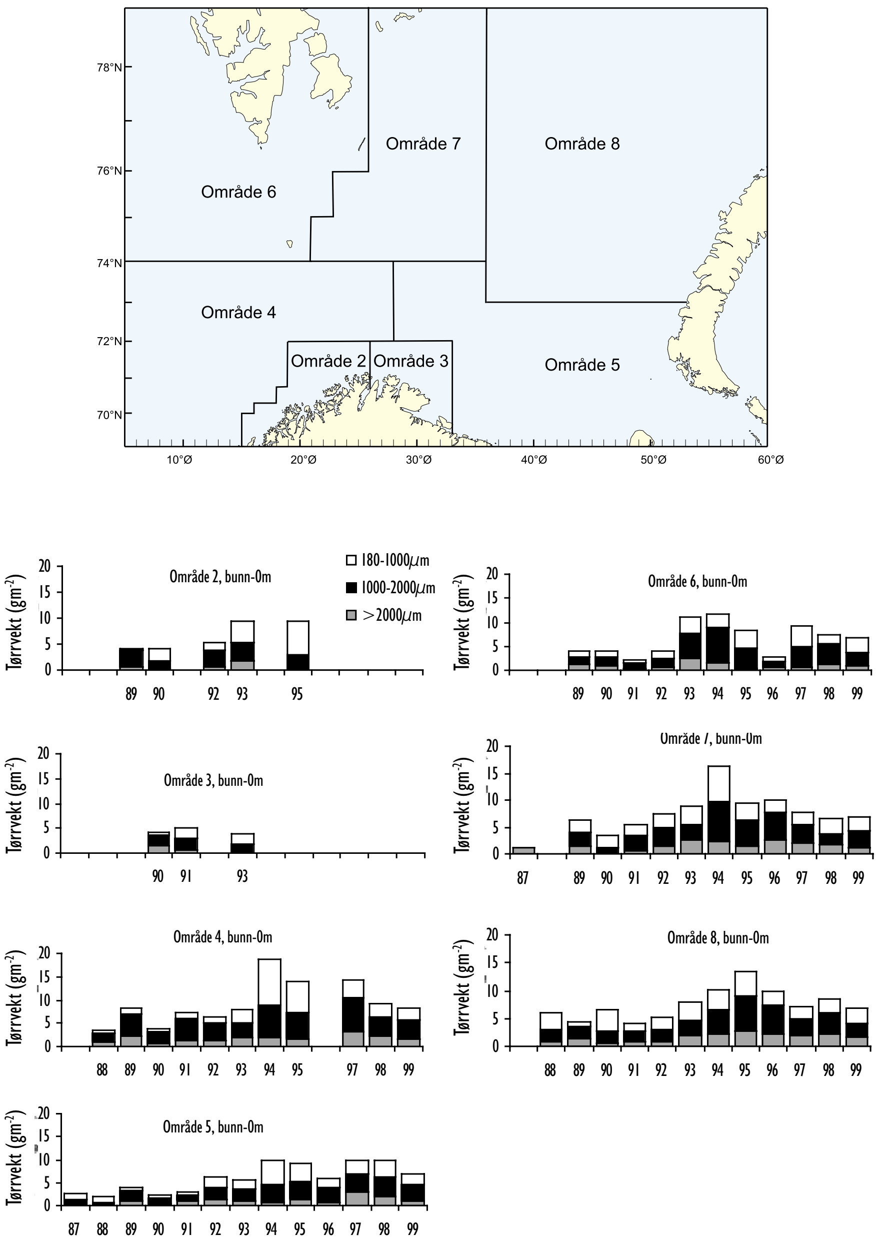


Figure 2.1.2.2. Mean values of size separated zooplankton biomass, gm^{-2}, from bottom-0 m in the regions 2-8 during the period 1987-1999.

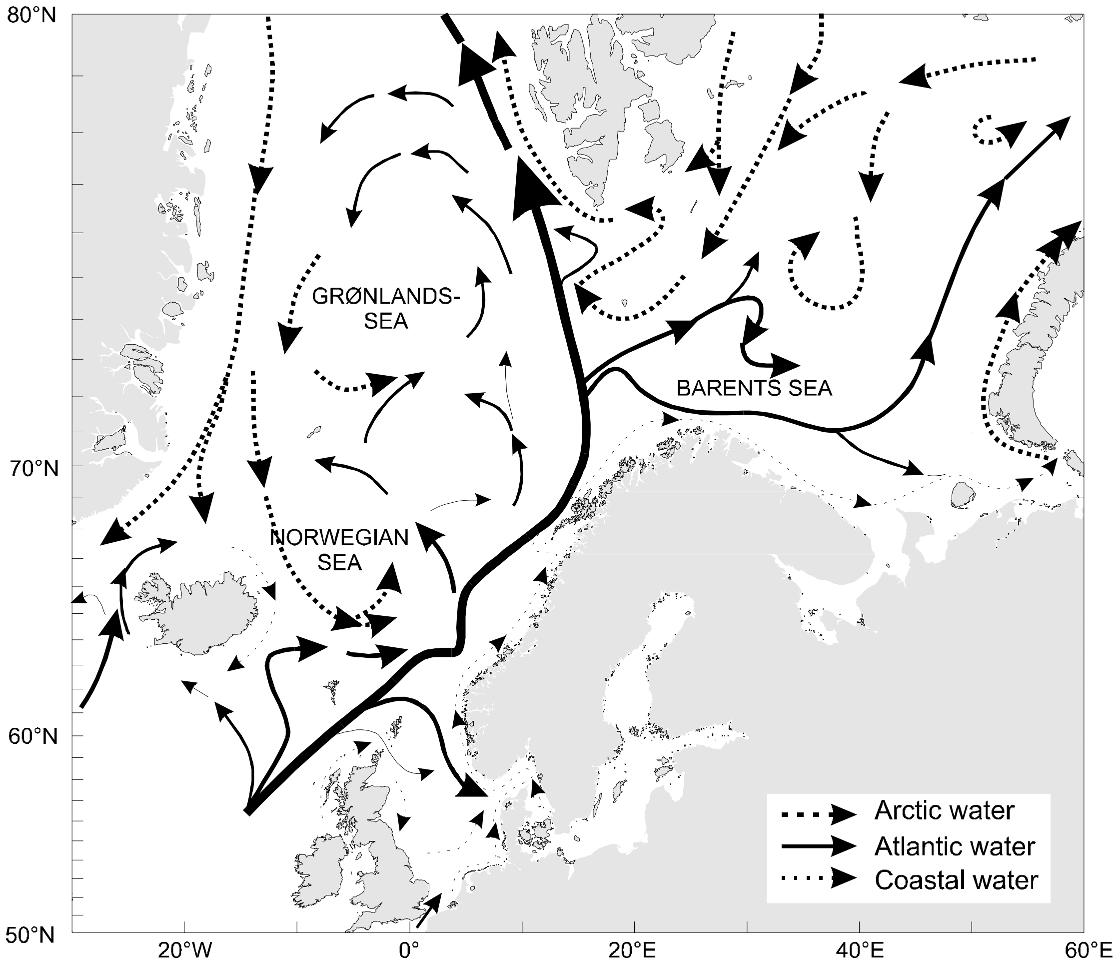


Figure 2.2.1.1. Main surface currents of the Nordic and Barents Seas. Standard sections A: Svinøy NW, B: Gimsøy NW, C: Sørkapp, D: Fugløy-Bear Island, E: Vardø N, F: Kola.

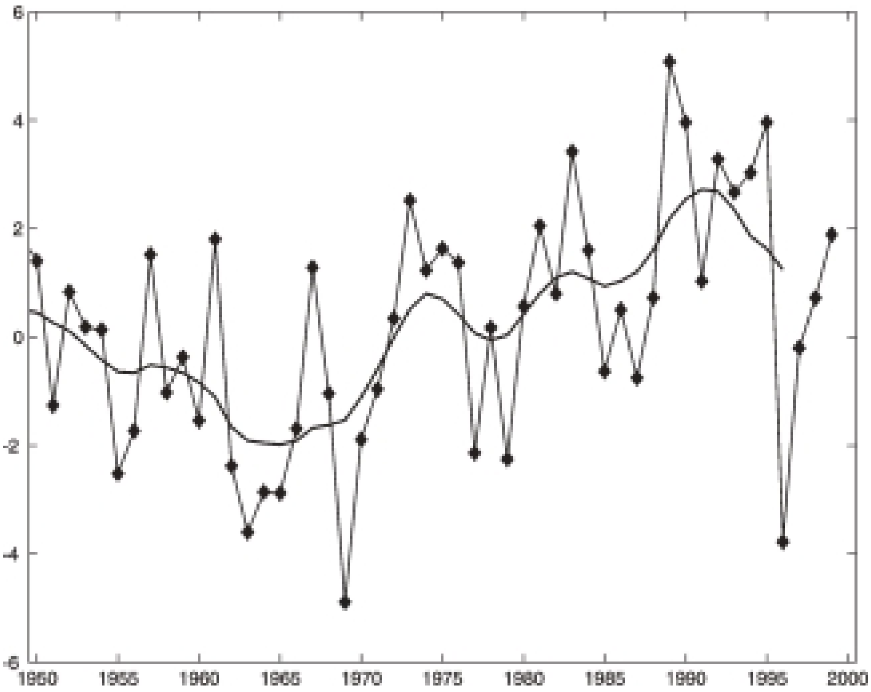


Figure 2.2.1.2. Winter (December-March) North Atlantic Oscillation index (NAO).

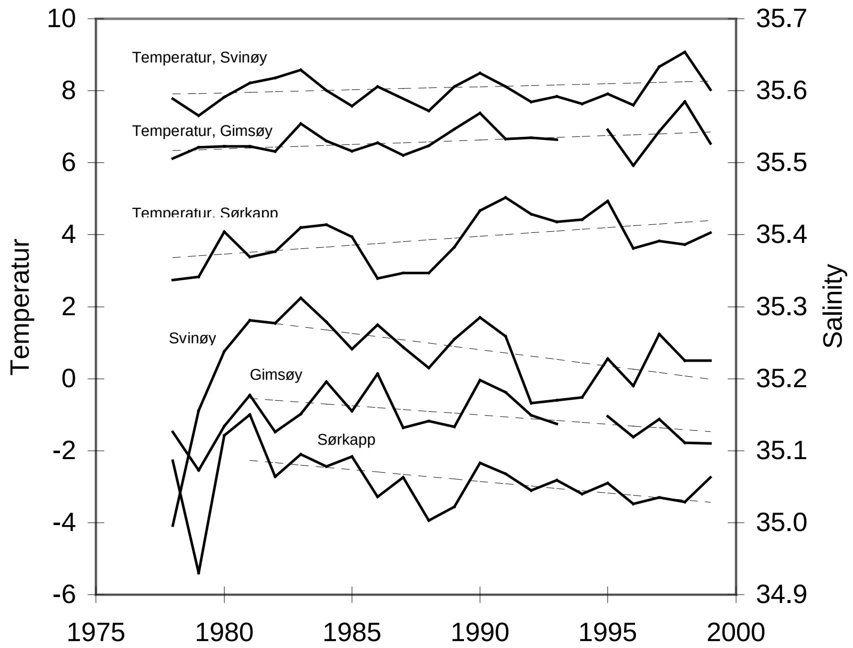
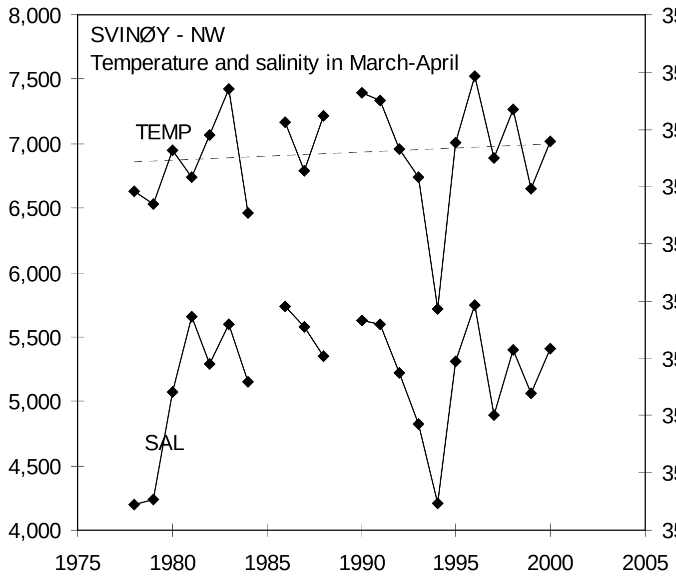


Figure 2.2.1.3. Temperature (ºC) and salinity observed during July/August, in the core of Atlantic Water beyond the shelf edge in the sections Svinøy - NW, Gimsøy - NW and Sørkapp - W, averaged between 50 and 200 m depth and horizontally over three stations across the core.



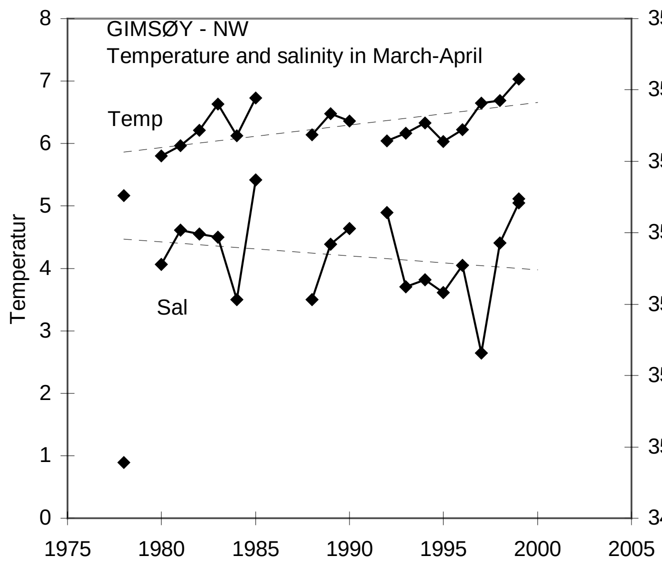


Figure 2.2.1.4. Temperature and salinity in the sections Svinøy – NW and Gimsøy - NW, observed during March/April, in the core of Atlantic Water near the shelf edge, averaged between 50 and 200 m depth and horizontally over three stations across the core.

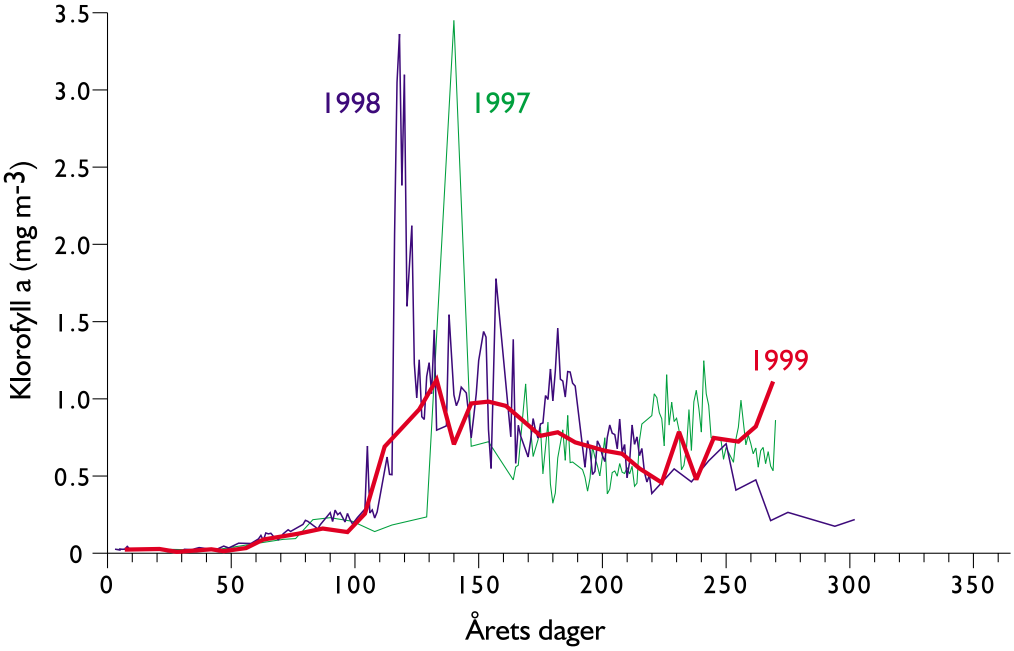


Figure 2.2.2.1. Distribution of chlorophyll *a* at 10 m depth during the year at Weather Station Mike in 1997, 1998 and 1999.

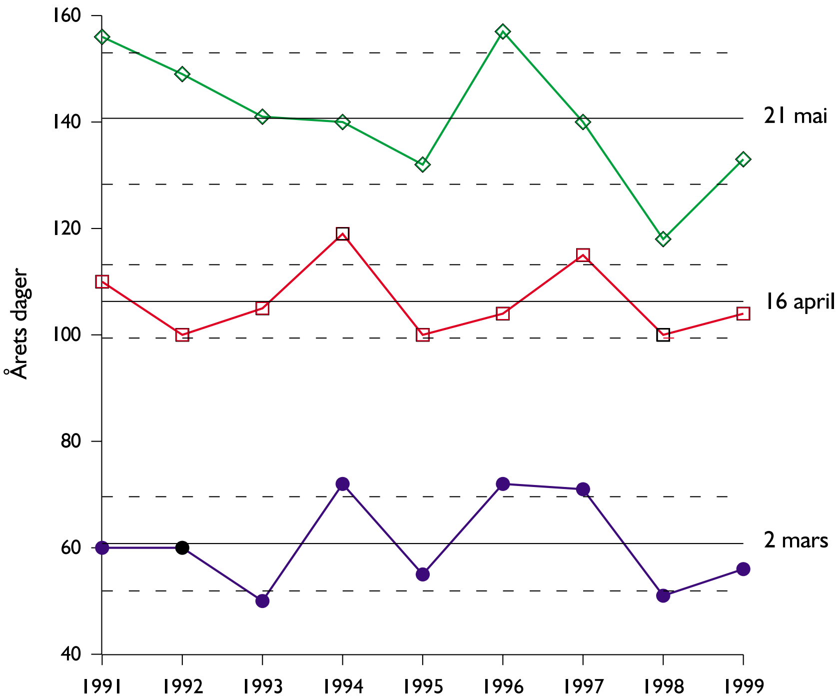


Figure 2.2.2.2. Year to year variation in the different phases of the development of phytoplankton at Weather Station Mike in the period 1991 to 1999. Circles: winter phase; squares: pre-bloom phase; diamonds: spring bloom. Continuous lines represent the average for each period. Broken lines represent one standard deviation for each period.

Figure 2.2.3.1. Zooplankton biomass (dry weight) in the upper 200 m in May. A: Arctic influenced water (salinity <35, west of 1.4ºE). B: Atlantic water (salinity >35). B: Norwegian Coastal water (salinity <35, west of 1.4ºE). Error bars: 95% confidence limits.

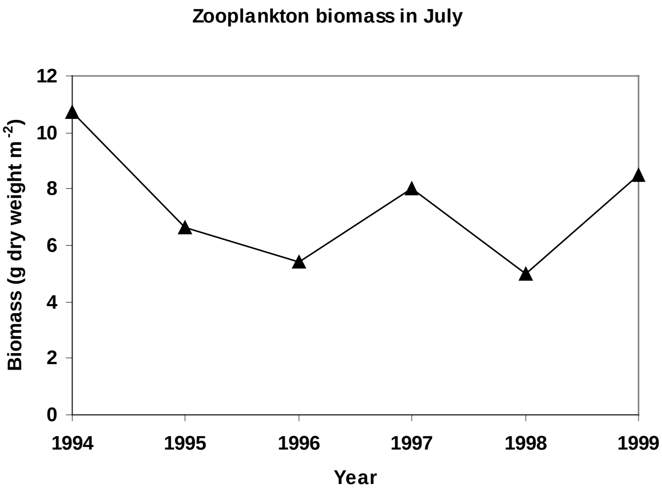


Figure 2.2.3.2. Zooplankton biomass in July-August in the eastern Norwegian Sea (0-200 m). Integrated biomass within a fixed geographical region divided by its area.

Figure 2.2.4.1. Individual weight to length ratio (herring condition index) for Norwegian spring spawning herring. Data from September, October, and November, for herring 30-35 cm body length. Error bars: 95% confidence limits.

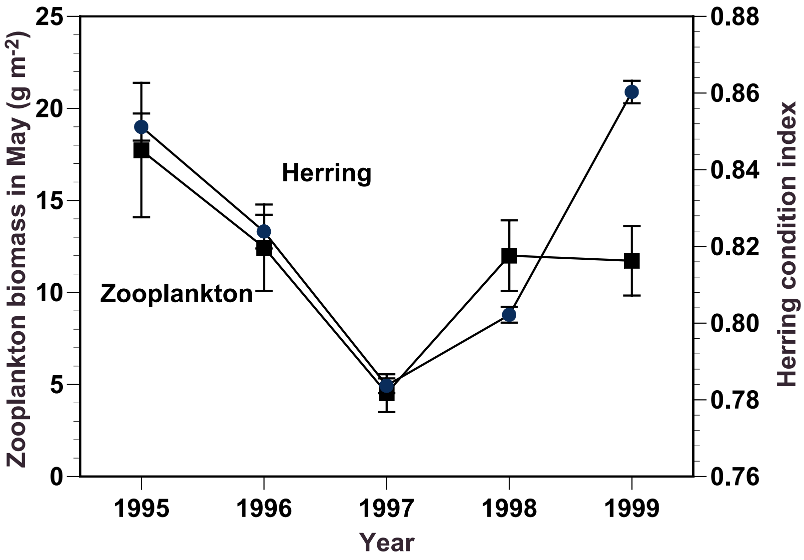


Figure 2.2.4.2. Zooplankton biomass (dry weight) in Atlantic water in the Norwegian Sea in May (0-200 m) and herring condition index (individual weight and length ratio, September-November, 30-35 cm). Error bars: 95% confidence limits.

Figure 2.2.5.1. Upper panel: Zooplankton biomass in July (year n) vs. zooplankton biomass in May (year n+1) (squares). Prediction of biomass May 2000 from biomass in July 1999 (circle) using estimated linear relationship. Lower panel: Winter (December-March) North Atlantic oscillation index (NAO) (year n) vs. zooplankton biomass in May (year n+1) (squares). Prediction of biomass May 2000 from NAO during December 1998 to March 1999 (circle) using estimated linear relationship.

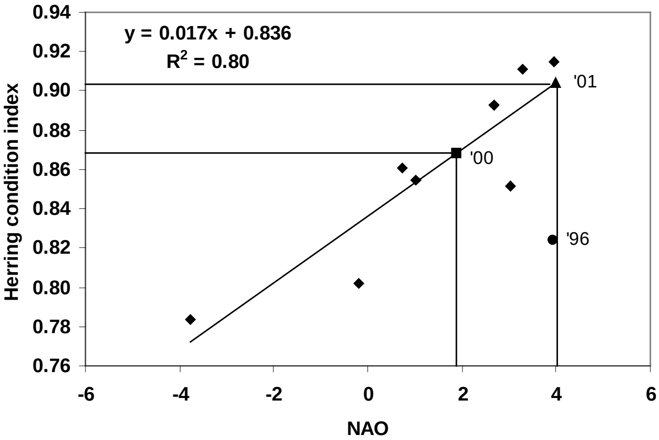


Figure 2.2.5.2. Herring condition index (year n+1) vs. winter NAO (year n). The 1996 was considered an outlier and excluded from the data set prior to estimation of the linear relationship. Prediction of herring condition in the autumn 2000 and 2001 from NAO during winter 1999 (square) and 2000 (diamond), respectively.

3 NORWEGIAN SPRING-SPAWNING HERRING

3.1 TAC and Fisheries

3.1.1 TAC agreements for 1999 and 2000

At a meeting in Reykjavik in October 1998 the Regional Management (Coastal states European Union, Faroe Islands, Iceland, Norway and Russia) Organization agreed to limit their catches to 1.3 million t in 1999.

At the corresponding annual meeting in Torshavn in October 1999 the Parties agreed to limit their catches to 1.25 million t in 2000.

3.1.2 The Fisheries

3.1.2.1 Description of the fisheries in 1999

Denmark: No information was received on the Danish fishery.

The Faroes: The Faroese fishery started in late February in the Norwegian zone (outside the Møre area from 62°N to 63°N). In May the catches were taken in the central part of the Norwegian Sea and later during the summer the fishery moved northwards into the Jan Mayen area. In August the catches were taken in international area and later the fishery continued in the area west of Lofoten, northern Norway. A new element in the 1999 fishery was the occurrence of herring in the northern part of the Icelandic zone in July as far west as 18°W, where approximately 6 000 t were caught.

France: There was no information of a French fishery in 1999.

Germany: There was no information of a German fishery in 1999.

Iceland: The fishery started in the second week of May in international waters near 68°N, between 1°E and 1°W. During the following two weeks, the fishery followed this component of the stock migrating slowly in a south-westerly direction. Generally, the schools were unstable and stayed at depths between 150 and 300 m, except for a few hours around midnight when some of them ascended to the near surface layer. For these reasons, catch rates were low and by about 25 May this phase of the fishery ended in international waters near 66°30'N, 2°W. In the last week of May, large fishable herring concentrations were located in the area from 68°N and 68°30'N, between about 1°W and 3°W, mainly in the Jan Mayen EEZ. Of the May catch of about 55 000 t, some 47 000 t were taken north of 68°N, the largest part of that in the Jan Mayen EEZ. The remainder was taken in international waters. From the end of May until 10-15 June the fishery followed these herring, as they migrated, first to the southwest and then north-westwards, mainly in the southernmost part of the Jan Mayen EEZ. Around mid-June, large herring concentrations were located approximately 30 nautical miles southeast of Jan Mayen. The fishery soon shifted to this area and then followed these herring as they migrated quickly to the northeast. The Icelandic fishery ended in late June at approximately 73°N, 4°E. The total catch in June was about 148 000 t. Of this about 2 700 t were taken within the Icelandic EEZ, just south of 68°N, and about 9 000 t in international waters north of 72°30'N. Thus, the total Icelandic catch in May-June 1999 amounted to some 203 000 t which corresponds to the Icelandic share of the total TAC set for the 1999 fishing season.

Ireland: The Irish fishery was carried out in the Norwegian Sea. Only two vessels using midwater trawls took part in the fishery. All the catches were taken in May, and the total catches were 2 412 t.

Netherlands: The Dutch fishery occurred in May-June in international waters.

Norway: By far the larger part of the Norwegian fishery takes place in Norwegian coastal waters where the herring winters in the period from September until March. The herring occurs in concentrations that are easily available to the fishery. The fishery is carried out by many size categories of vessels. In 1999 approximately 160 000 t were caught in the wintering area in Northern Norway, and 90 000 t in the spawning season. Approximately 10 000 t were caught in the spring/summer fishery in the Norwegian Sea, and the remaining part of the Norwegian quota (approximately 480 000 t) were taken in the period September-December on the herring migrating to, and wintering in, the wintering areas in Northern Norway.

Russia: In 1999 the Russian vessels started fishing of the herring within the shelf region of the Norwegian EEZ, near Sklinna and Halten Bank (approximately 65° N) and Langrunnen Bank (approximately 62° N) in the beginning of

February. In March the fishing occurred in the same regions. In February and March the catch was 72 404 t. In May-June two vessels conducted fishing in the northern part of the international area in the Norwegian Sea in region of the Polar Front. In May-June the catch was 7 911 t. In July one vessel caught herring in the Norwegian EEZ near the Fugløy Bank and to the northeast of the EEZ of Iceland. In mid August the fishery started in the eastern part of the international area in the Norwegian Sea, near the boundary of the zone of Spitsbergen. At the end of this month Russian vessels followed the southward migrating fish and transferred their fishery to the Norwegian EEZ. In September the fishery of the herring was prolonged in the EEZ of Norway. The herring migrated on a southwest, along the depths of the continental sloop. The basic group of vessels conducted fishery to the west off Lofoten islands. The herring now migrated rapidly to the region southwest of the Vestfjord. In August and September the catch was 76 870 t. The entire Russian catch was utilized for human consumption.

Sweden: No information was received on the Swedish fishery.

UK (Scotland): The UK fishery increased from 15 978 t in 1998, to 19 207 t in 1999.

Catches by ICES rectangles and quarters for the Russian, Norwegian, Faroese and Icelandic fisheries are shown in Figures 3.1.2.1.1 - 3.1.2.1.4, and Figure 3.1.2.1.5 shows the general distribution of the fisheries and the migrations of the adult stock in 1999.

3.2 Catch Statistics

The total annual catches of Norwegian spring-spawning herring for the period 1973–1999 (1999 preliminary) are presented in Tables 3.2.1 (by fishery) and 3.2.2 (by country).

The Working Group noted, with frustration, that very few of the nine nations participating in the international fishery for Norwegian spring-spawning herring in 1999 seem to have carried out an adequate sampling of their fishery (Table 3.2.3). This situation lowers the quality of the catch at age data for Norwegian spring-spawning herring.

The Working Group noted that in this fishery an additional mortality caused by fishing operations probably exists. In general, it was not possible to assess the magnitude of these extra removals from the stock, and taking into account the large catches taken in recent years, the relative importance of such additional mortality is probably low. Therefore no extra amount to account for these factors have been added in 1994 and later years. In previous years, when the stock and the quotas were much smaller, an estimated amount of fish was added to the catches (Table 3.2.1).

The combination of national catch-at-age and weight-at-age data for 1999 to obtain the total international catch-at-age and weight-at-age was done using the computer programme described in a WD by Patterson. The official catch, sampled catch and catch as used by the Working Group, together with number of samples, catch-at-age and weight-at-age for each fishery are given in Tables 3.2.3 and 3.2.4. The allocation of catches for which no samples were taken and the final catch-at-age and weight-at-age by ICES area is given in Table 3.2.5. This was in general a difficult task, since no information on time; area etc. was available for several of the non-sampled fisheries.

Russia and Faroe Islands presented some samples of their catches. However, these were few and not systematically sampled throughout the year and from different fishing areas. It was therefore decided not to use these samples in calculating the catch in number.

In general it was decided to use the Icelandic age distribution and weights for all the unsampled fisheries in the Norwegian Sea in period 2, and to use the Norwegian age distributions and weight keys for un-sampled fisheries for the rest of the year. An exception from this is the Faroese catch in areas Vb and XIVa. Here age distribution and weights from a biological sample taken by an Icelandic research vessel operating in the same area was used.

Netherlands provided age distributions with a younger plus-group (9+) than used by the Working Group. The Dutch catches were distributed on older age groups according to the age distribution found from the Icelandic age distribution and weight keys from the Icelandic fisheries in the Norwegian Sea.

In addition to the sampling described in Table 3.2.3, size group information is used to calculate the Norwegian catch in number. A major part of the Norwegian catches (2 629 samples representing 440 594 t or 60% of the total Norwegian catch in 1999) which are used for consumption, are divided into 5 size groups as follows:

Group	Weight (g)
1	> 333
2	200–333
3	125–200
4	83–125
5	< 83

The percentage of the total catch in kg is calculated for each size group, by taking out sub-samples of the catch during the production process. These percentages are registered by the sales organisation. The age composition within each size group is from the age-sampled catches, and the total catch in number calculated.

3.3 Surveys

3.3.1 Spawning areas

An acoustic survey was carried out in the spawning area in the time period 15.02-26.03 2000 (WD by Slotte and Dommasnes). The abundance estimate is given in Table 3.3.1.1. The spawning area in 1999 stretched along the Norwegian coast from 58^{o}N to approximately 69^{o}N.

3.3.2 Wintering areas

The wintering area was surveyed acoustically in December 1999 (WD by Røttingen). The abundance estimate obtained during this survey is given in Table 3.3.2.1. There was no acoustic survey of the wintering area in January 2000 (Table 3.3.2.2).

3.3.3 Feeding areas

The feeding area in the Norwegian Sea was surveyed acoustically during the ICES co-ordinated herring survey in 23.04 - 02.06 1999 (Holst *et al.* 1999). The abundance estimate is given in Table 3.3.3.1.

3.3.4 Nursery area

The nursery area of the Norwegian spring-spawning herring is Norwegian fjord and coastal areas, and in the Barents Sea. Since 1988, when the 1983 year class spawned for the first time, the latter area has increased in importance as a nursery area for the herring.

Results from the Russian acoustic survey in the Barents Sea in June 1999 (WD by Krysov) are given in Table 3.3.4.1.

The results from the 0-group herring survey in Norwegian Fjords and Coastal areas are given in Table 3.3.4.2 and the results from the joint Norwegian-Russian 0-group survey in the Barents Sea are given in Table 3.3.4.3.

3.3.5 Herring larval survey 2000

The larval survey in 2000 started on the inner stations of the Fugløya-Bjørnøya section the 13th of April (WD by Fossum). Herring larvae were found from the start of the survey (Figure 3.3.5.1). Between 10 to 1000*m^{-2} were found on the banks outside Senja, Vesterålen and at the Røstbank. These larvae were in the later yolksac stages, and in the first post yolksac stage. Farther south there was an area without larvae (66^{0}-68^{0}N), and in contrast to the period 1993-1994 few larvae were found between 64^{0}-66^{0}N. The larvae in this area were large and in the first post yolksac stages, when the yolksac is resorbed and the dorsal fin starts to develop. At this stage they have started to grow and are beyond the most critical stage for starvation.

In 2000 the main distribution of herring larvae were found farther south than what has been observed during the period 1993-1999, and most larvae were found between Stad and the Frøyabank (62^{0}-64^{0}N) similar to the period before 1993. These were also relatively large larvae in the first post yolksac stage. The index (index 1) estimated for the area 60^{0}-68^{0}N is shown in Table 3.3.5.1 and was calculated to be 19.8×10^{12}, which is close to what was found in 1999, but much lower than in 1997 and 1998. The mean size of the larvae was 13.5 mm (standard length), the highest recorded since the start of monitoring in 1985, which is a very positive signal for the recruitment of NSS-herring in 2000.

The larval production index (index 2) is the estimated backcalculated number of newly hatched larvae. The backcalculation is based upon the age of the larvae estimated from their developmental stages and 10% daily mortality.

3.4 Tagging Experiments

No herring were tagged in 1999, but 29 350 herring were tagged in March-April 2000. Recovery of tags from supervised detector plants has continued, as well as recovery from the standard magnets in the production line of fish processing plants and from individuals (WD by Dommasnes).

During the tagging process, the total length of the herring is measured. For each purse seine catch that is used for tagging, a sample of 100 fish is taken to determine the age distribution within each length group. The age composition in this batch of tagged herring is then estimated from the age distribution in the sample.

If it is later found, from the age composition or other criteria, that a batch of tagged herring may have contained herring from one of the local stocks in the fjords, this batch is not used for stock assessment.

Recoveries are made from commercial catches passing through tag detectors installed at fish processing factories.

For stock assessment purposes, tags are used only from supervised factories where detector efficiency has been tested, and where it is known that the detectors have been working as intended. Two factories filled these criteria in 1998, and a total of 59.355 million herring (18 077 tonnes) were screened at these factories. Magnet efficiency in 1999 has been 100% except for two catches where the efficiencies were 70% and 80%, respectively. For these two catches the number of herring screened was reduced corresponding to the efficiency before being included in the total. The numbers of fish screened given in Table 3.4.1 are thus corrected for efficiency.

All tagged herring which were recovered were measured, weighed, and aged.

In 1999, 51 tags were recovered from the year classes 1983+, 1986-89, 1990, 1991 and 1992 that filled the criteria above.

Tables of tagging data updated with recoveries in 1999 are given in Table 3.4.1 for year classes 1983+ aggregated and year classes 1986-1989 aggregated, as well as for the year classes 1990-1993.

In the 1999 Working Group a number of corrections were made in the data files, as a result of efforts to find and correct errors in the raw data. The intention was that this would be a onetime effort, and that no further corrections were to be done in data that were already entered in the files. However, work with the data this year has brought to light new errors in the data , which have been corrected. The errors are listed below, and data that have been corrected are indicated with grey background in Table 3.4.1 in this report.

1) With reference to Table 3.4.1 in the 1999 WG report, in the table with heading "Tagging data for the 1986-89 year classes" a block of data was repeated from the corresponding table above ("Tagging data for the 1983+ year class"). This was due to faulty references in a spreadsheet.
2) With reference to Table 3.4.1 in the 1999 WG report, in the table with heading "Tagging data for the 1983+ year class" the number of recoveries in 1997 from the 1989 release should be corrected from 2 to 1.
3) With reference to Table 3.4.1 in the 1999 WG report, in the table with heading "Tagging data for the 1991 year class", the number tagged in 1995 should be corrected from 33 995 to 21 528.

3.5 Stock assessment

3.5.1 Models for stock assessment

The model used for tuning the historic abundance by age to survey observations and tag data is essentially the same as the model used during the 1999 meeting. The survey observations are assumed gamma distributed with a constant CV and the probability of tag returns is assumed to follow the Poisson distribution. However, one important modification to the software was made. It is observed that the 1985 year class is much weaker than the 1983 year class before age 13, after which it increases markedly relative to the 1983 year class. The most likely reason for this is the problem distinguishing age rings when the fish are older (WD by Tjelmeland). Therefore, fish older than 13 years were pooled both in the survey and in the VPA before the calculation of terms in the likelihood function was carried out. The age reading difficulty also affects the catch data. In the year the 1983 year class was 13 years old, the ratio between the catch of the 1983 year class and the catch of the 1985 year class was calculated and applied to older ages in the same cohorts to redistribute the catch. The tagging data for the 1984 and 1985 year classes were added to the 1983 year class for consistency.

Assuming the same shape for the distribution of all survey data is unsatisfactory because the real uncertainty will depend on the biological sampling and density of cruise tracks for each particular cruise. Also, as was pointed out last year (ICES CM 1999/ACFM:18), year to year environmental effects may influence the surveys. These specifics should be accounted for in the observation model. Co-operation between IMR and Norwegian Computing Centre has resulted in a statistical model for the cruises in Vestfjorden, that is based on parametric bootstrap of biological data and acoustical data (WD by Høst *et al*). This work is premature for including in the assessment at the moment because presumably other important effects such as day-night asymmetry are not yet are included. But the WG considered this approach a promising step towards removing as many subjective assumptions from the assessment as possible.

3.5.2 Input data

The year and age range, natural mortality and handling of missing data in the catch at age matrix were unchanged from last year.

The analysis was run for ages 0 to 15 with a 16+ group. Historic populations in the plus-group were calculated independently of the VPA populations based on the catch equation, the fishing mortality on the last true age and the estimated catch at age in the plus-group in the conventional fashion. M is set equal to 0.15 for ages 3 and older and 0.9 for ages 0 to 2 in all years. The proportion of F and M before spawning is set to 0.1.

The catch at age, weight at age in the stock and in the catch and maturity ogive for the period 1950-1998 are given in Tables 3.5.2.1-3.5.2.4.

3.5.2.1 Survey data

The same surveys as used at previous WG meetings were used also this year, i.e. the Barents Sea surveys in May-June were not included (Tables 3.3.1.1, 3.3.2.1, 3.3.2.2, 3.3.3.1 and 3.3.4.1). The age groups included in the tuning are age 4 and older in the December survey and age 5 and older in the other surveys. During the 1997 meeting of this WG (ICES 1997/Assess:14) age 4 in the December survey in 1996 and the observations of the 1991 year class in January 1996 and in the survey on the spawning stock in 1996 were perceived as outliers because of the noise they generated in the assessment and were consequently excluded from the analysis. These points were excluded also in 1998, 1999 and at the present meeting. Also, acoustic data earlier than 1991 were excluded in 1998 because the WG then felt that the different acoustic equipment before 1991 made the earlier points incomparable to those from 1991 and later years. An exploratory run not listed in this section shows, however, that the effect of the outliers is relatively small this year. This is probably due to more data points added after the 1998 or generally more stability in the tuning.

3.5.2.2 Tagging data

In addition to the tagging data that were used at the WG meeting in 1999, data for the 1992 and 1993 year classes were included in the likelihood function (data in Table 3.4.1). The first recoveries used were those obtained three years after release, in contrast to 1999 assessment, where the first tagging data used were two years after release for the 1983 year class and three years after release for younger fish. Independent analyses showed that using tag returns from the first time three years after release generally gives a better fit to expected returns than using the data for the first time two years after release (ICES 1998/ACFM:18). Data for the 1984 and 1985 year classes were also included this year, and the 1983, 1984 and 1985 year classes were treated as a group.

3.5.2.3 Larval indices

The larval index considered by the WG last year was included in the tuning this year. In addition, a larval production index was considered (Table 3.3.5.1).

3.5.3 Implementation of acoustic surveys and tagging data in the assessment model

3.5.3.1 Survey structural relationship and inclusion of data in the likelihood function

The survey structural relationship is unchanged from last year. Also this year only terminal F-values for the most abundant year classes were included among the free parameters to be estimated, and only these year classes (1983,1990,1991 and 1992) were included in the likelihood function. However, the 1993 year class was added to the tuning this year. Also for this assessment the terminal F-values for the non-tuned year classes were linearly interpolated between the terminal F-values for the year classes included in the tuning.

The reason for including only the larger tuned year classes in the likelihood is that the larger relative error for the catch at age of small year classes may unduly influence the assessment. After this amendment was made the assessment became more stable than it was at the 1997 meeting. The WG wants, however, to investigate this more thoroughly and formally, for which there was no time at the meeting. This work will be undertaken intersessionally by two of the WG members.

3.5.3.2 Probability of tag recovery

The assumption that the probability of tag return follows the Poisson distribution used last year was assumed also for this meeting.

3.5.4 Stock assessment

The equations for fitting the VPA to the survey data and tagging data were described in the report from the 1998 meeting of this WG (ICES 1998/ACFM:18). Eight exploratory runs were made.

The parameters estimated in the run considered the most appropriate by the WG were:

Catchability of the survey on the spawning grounds
Catchability of the December survey in Ofoten
Catchability of the January survey in Ofoten
Catchability of the international survey in the Norwegian Sea
CV of the survey probability distributions
Catchability of the larval survey index
F in the last year of catch data for the 1983 year class not being in the plus-group (1998)
F in the last year of catch data for the 1990 year class
F in the last year of catch data for the 1991 year class
F in the last year of catch data for the 1992 year class
F in the last year of catch data for the 1993 year class
Survival of tagged fish in the tagging year

Altogether 12 parameters were estimated.

The following exploratory runs were made:

Run 1. The 1983 and 1985 year classes were pooled as described in Section 3.5.1. The first year the tag return data were used was two years after release. The year classes 1983, 1990, 1991, 1992 and 1993 were included in the tuning.

Run 2. With respect to Run 1 the 1993 year class was not used in the tuning.

Run 3. With respect to Run 1 the first year for using tagging data was three years after release.

Run 4. With respect to Run 1 the larval production index was used in the tuning.

Run 5. With respect to Run 1 the larval index was used in the tuning.

Run 6. Combining Run 3 and Run 5.

Run 7. Previous year, not using tagging data. The 1983 and 1985 year classes were pooled.

Run 8. Previous year, not using tagging data. The 1983 and 1985 year classes were not pooled.

These runs are summarized in Table 3.5.4.1. The differences in estimates of the spawning stock size in 2000 among runs are quite small compared to past assessments, which gives some confidence regarding the robustness of the model. To give a feel for the uncertainty connected to the various data sources the summed log-likelihood divided by the number of terms together with the number of terms is tabulated. The variance would not be as informative because it does not have a direct bearing on how the data affect the likelihood since gamma and Poisson distributions are used, not the normal distribution. The difference between Run 7 and Run 8 shows the effect of pooling the 1983 and 1985 year class.

The WG considered Run 6 which combines leaving the tagged fish one year more in the sea with the larval index to be the most appropriate. Leaving tags three years in the sea provides for a better blending of tagged fish with the total population which may be the reason for the better fit (higher likelihood). The extra year of larval data makes the trend in the larval index in the later years more in accordance with the trend in the spawning stock. The WG considered it very valuable to include more independent information into the assessment. Figure 3.5.1 shows the larvae indices together with the fitted spawning stock from Run 4 and Run 5.

Figure 3.5.2 shows a scatterplot of the cumulative density points when all the survey data and all the tagging data have been pooled separately. If the distribution of the data comply with the distributional assumption made the distribution should be uniform in each point on the x-axis. This is reasonably well achived, except there is a narrowing of the distribution for larger expected values. The tagging data seem uniformly distributed for tag returns of 10 and less while it is shifted towards higher CDF values for larger number of tag returns. The chosen distributional assumptions seem to work reasonably well, although there seem to be some room for improvement. The choice of distributional function was addressed by this WG last year (ICES CM 1998/ACFM:18) where it was concluded that the gamma distribution with constant CV was preferable to the gamma distribution with constant variance or the log-normal function. However, this question might be considered further as more data points are obtained.

3.5.4.1 Retrospective analysis

Using the same assumptions as used in Run 6 the assessment year was set to 2000, 1999, 1998, 1997, 1996 and 1995. Year classes that were younger than 7 years in the assessment year were deleted from the tuning, in accordance with the assessments made in 1999 and 2000. Figure 3.5.3 shows the resulting retrospective plot. It should be born in mind that the younger age groups that are assessed with the RCT3 program are not included in the analysis.

The stock has been lowered by the present assessment with respect to a similar assessment made in 1999 but increased with respect to similar assessments made earlier than 1999. Since acoustic data are used only from 1991 the data support for the model becomes poor when going some years back, which may be the reason for the deviating historic values for similar assessment that would have been made in 1997 and 1996.

3.5.4.2 Stock assessment by ISVPA

Being nonseparable, the model presently used for stock assessment produces the solution for terminal years mostly on the basis of auxiliary information. In the ISVPA model (described in more details in section 6.4.5) only catch-at-age data are used and its solution is based on robust procedures. In the assessment catches for age groups older than 13 were pooled. The procedure of stock assessment is similar to described in section 6.4.5, except that preliminary filtering of catch-at-age matrix was not used because the loss function revealed a distinct minimum just for initial data. (Figure 3.5.4.2.1).

The results of stock assessment since 1991 are given in Table 3.5.4.2.1. The spawning stock estimate for 1999 is 8.7 million tonnes. This estimate is rather close to estimates of spawning stock for this year obtained earlier by the WG (ICES 1999/Assess:18). The WG express interest in trying different methods and encourages the inclusion of auxiliary information into ISVPA, as well as, possibly, separability of the model presently used for Norwegian spring spawning herring stock assessment.

Year	B(2+) th.t.	SSB th.t.	F mean (5-12)
1981	1388.9	1189.1	0.097
1982	1215.1	1079.3	0.06
1983	1161.8	1056.9	0.146
1984	967.3	872.4	0.176
1985	4084.9	656.1	0.609
1986	3729.7	652.1	0.961
1987	7114.7	2120.9	0.479
1988	7385.4	6424.5	0.508
1989	7290.2	6449.1	0.108
1990	7324.1	6261.3	0.123
1991	6564.5	6155.9	0.045
1992	6721.8	5816.8	0.045
1993	7843.6	5092.6	0.022
1994	10515.5	5221.3	0.069
1995	11918.6	5037.4	0.110
1996	12578.8	5799.2	0.148
1997	11728.8	10423.5	0.317
1998	10165.0	9495.3	0.261
1999	9397.4	8738.6	0.207

Table 3.5.4.2.1. Norwegian Spring-Spawning Herring.
Results of stock assessment by means of ISVPA

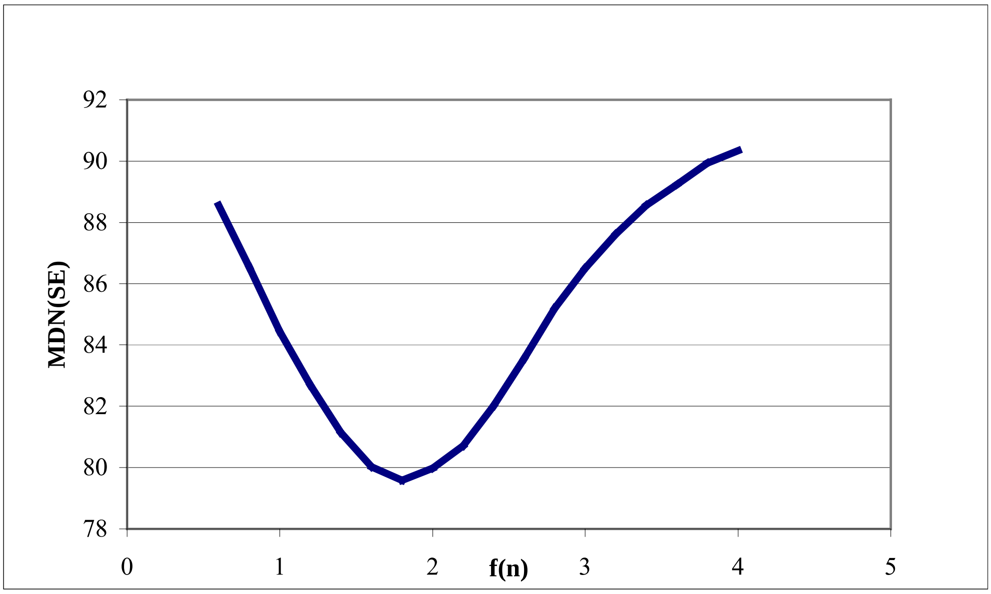


Figure 3.5.4.2.1. Profile of ISVPA loss function as function of terminal effort factor for Norwegian spring spawning herring

3.5.5 Assessment of the 1994 and younger year classes

The RCT3 program was used for predicting the abundance of the 1994–1999 year classes, which were not predicted by the assessment model above.

The following survey estimates were used in the RCT3 program:

Acoustic survey of the spawning stock in February-March, age 4 (Table 3.3.1.1)

Acoustic survey in the wintering areas in December, age 3 (Table 3.3.2.1)

Acoustic survey in the wintering areas in January, age 4 (Table 3.3.2.2)

Acoustic survey in the Barents Sea in May-June, ages 1 and 2 (Table 3.3.4.1)

International 0-group survey in the Barents Sea in August-September (Table 3.3.4.3)

As last year, the acoustic survey of 0-group in Norwegian coastal waters in November-December (Table 3.3.4.2) was excluded from the RCT3 analysis. The default settings in the RCT3 program were used. The input data are given in Table 3.5.5.1 and the results of the analysis are given in Table 3.5.5.2. The year class strength of the 1994–1999 year classes at age 3 (billion) is given in the text table below, together with the estimates of those year classes made by last year's Working Group.

Year class	2000 WG	1999 WG
1994	2.143	2.905
1995	1.400	1.561
1996	6.238	5.144
1997	4.619	3.655
1998	13.171	5.908
1999	3.679	-

Data from acoustic surveys in 1990 and earlier years were excluded from the analysis, as discussed in Section 3.3.4. Given the highly variable recruitment in this stock, the Working Group considered that using the RCT3 estimates would be preferable to using the assumption of a mean value for forthcoming recruitment.

3.5.6 The final VPA

The final VPA was run using the values of terminal F in 1999 from the Working Group's best estimate (Run 6) described in Section 3.5.4 for the 1993 and older year classes. The fishing mortality on the 1983 year class in 1998 was set equal to that of the 1985 year class in the same year. The fishing mortalities for the 1994–1997 year classes in 1999 were adjusted so that the abundance at age 3 of those year classes are the same as those predicted by RCT3. The fishing mortalities and stock numbers are given in Tables 3.5.6.1–3.5.6.2, while the stock biomass at age and spawning stock biomass at age are given in Tables 3.5.6.3–3.5.6.4. A summary of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment is given in Tables 3.5.6.5 and 3.5.6.6, for recruitment at age 0 and 3 respectively, and Figure 3.5.6.1. Plots of recruitment at age 0 and age 3 vs. spawning stock biomass are given in Figure 3.5.6.2 and 3.5.6.3. Following the advice given by ACFM at its November 1995 meeting, it was decided to use $F_{5\text{-}14}$ weighted by the population number (hereafter denoted as $F_{5\text{-}14,w}$) as the reference F for this stock. The $F_{5\text{-}14,w}$ is given in Table 3.5.6.6.

3.5.7 Yield-per-recruit analysis

The yield per recruit analysis using the fishing pattern and stock parameters for 2000 (Table 3.6.1.1) gave an estimate of $F_{0.1}$=0.22 (based on ages 3-16+), while F_{max} was not defined. Yield per recruit vs. F is plotted in Figure 3.5.7.1.

3.5.8 Extension of the time series back to 1907

Toresen and Østvedt (2000) present a VPA back to 1907. The Working Group regards this as an important step in the process of extending the time-series on the biological data for the Norwegian spring-spawning herring stock. Attempts to include these data in the time series presented here failed due to technical problems with IFAP. Also, the new data need to be evaluated by the Working Group before they are used to change the weight at age in the catch or to update the stock/recruitment relation with pre-1950 data as a basis for the medium-term projections.

3.6 Short-term Prediction

3.6.1 Input data to the short-term prediction

These data are given in Table 3.6.1.1. The number at age at January 1, 2000, was taken from the final VPA for the year classes 1997 and older. For the 1998 and 1999 year classes, values corresponding to the RCT3 estimate of year class strength at age 3 were used. The weight at age in the stock in 2000 was set equal to the weight at age obtained from biological samples taken during December 1999 and January 2000. The maturity at age in all years was set equal to that observed for 1998 during the December 1997 survey. The weight at age in the stock in 2001 and 2002 was set equal to the 2000 value, while the weight at age in the catch in 2000 and later years was set equal to the 1999 values. This is in accordance with the prognosis of the development of the condition factor of herring, as given in Section 2.2.5. The natural mortality was set to the same values as used in the assessment, i.e. 0.15 on ages 3 and older. The exploitation pattern in 2000 and later years was set equal to 1999 exploitation pattern.

3.6.2 Results of the short-term prediction

Assuming that the internationally agreed TAC of 1 250 000 t in 2000 is taken, this will cause the fishing mortality ($F_{5\text{-}14,u}$) to increase from 0.19 in 1999 to 0.21 in 2000. The effects of different levels of $F_{5\text{-}14,u}$ on the catch in 2001 and on the stock and SSB in 2002 are presented in Table 3.6.2.1. Unweighted fishing mortalities are considered in the following discussions.

The assessment shows that the spawning stock biomass decreased from 9.0 million tonnes in 1997 to 6.9 million tonnes in 2000, and will decrease further to 6.1 million tonnes in 2001. From 2001 to 2002, the spawning stock biomass will decrease for values of F above 0.16. The fishing mortality in 1999 of 0.19 is higher than the value of 0.12 obtained in last year’s assessment. The agreed F of 0.125 will in 2001 correspond to a catch of 753 000 t.

3.7 Assessment of uncertainty

Since there are no informative priors available and since the use of uninformative priors might give biased assessments (WD by Schweder) the WG did not attempt to make a Bayesian analysis of the Norwegian spring spawning herring. A bootstrap analysis (WD by Tjelmeland) has been performed where the survey data and the tagging data were resampled from the distributions used in the tuning with applying the parameters as obtained using the original data. The uncertainty in the catch data were perceived equal to the uncertainty in one large random sample from a perfectly mixed population with 30 tagged fish per 1000 tonnes. This is a too optimistic assumption since the average number of tags per 1000 tonnes turned out to be 15 (Table 3.2.3). Also the uncertainty connected to using samples from one area for distribution of catch from other areas on age due to inferior sampling by many countries was neglected. The bootstrap distribution which resampled only the tag returns was badly biased towards high values. The reason for this must be investigated further before resampling tags is used in a full-fledged bootstrap analysis of the stock.

The WG failed at the meeting to produce a new uncertainty analysis of the estimate based on bootstrapping and Run 6 due to time constraints and lack of adequate computing power. The CV for the spawning stock calculated from bootstrapping only survey data prior to the meeting is 0.17 (Figure 3.7.1). If the uncertainty in the estimate represented by the uncertainty in the surveys is not small compared to the uncertainty represented by the uncertainty in tagging and catch, the WG feels that a CV on 0.4 for the estimate as used in the previous WG meeting might be to high. Furthermore, this number was based on the subjective feeling for the uncertainty generated by the large deviation among assessments made with different assumptions at the 1997 WG meeting. At present time the assessment seems more stable, as indicated by the small deviation among the different runs in Table 3.5.4.1.

3.8 Long-term Management Plan and Precautionary Reference Points

At the meeting in Torshavn in October 1999 (Section 3.1.1), the Regional Management (European Union, Faroe Islands, Iceland, Norway and Russia) Organization for Norwegian spring-spawning herring agreed to implement a long-term management plan consisting of the following elements:

1) Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the critical level (Blim) of 2 500 000 t.
2) For the year 2001 and subsequent years, the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of less than 0.125 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of this fishing mortality rate.
3) Should the SSB fall below a reference point of 5 000 000 tonnes (Bpa), the fishing mortality rate, referred under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adoptions shall ensure a safe and rapid recovery of the SSB to a level in excess of 5 000 000 t.
4) The parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.

Item 2) was interpreted by the Working Group as a signal on maximum level of the precautionary fishing mortality, thus the Regional (Coastal states European Union, Faroe Islands, Iceland, Norway and Russia) Management Organization has agreed upon the following reference points for the stock of Norwegian spring-spawning herring:

Blim = 2.5 million t
Bpa = 5.0 million t
Fpa= 0.125

These values are within the framework of precautionary reference points proposed by ICES.

3.9 Harvest control rule

3.9.1 Request on adoptions of F in case of SSB below B_{pa}

Item 3) in the agreement on long time management (Section 3.8) considers management action in case the SSB falls below the agreed B_{pa} of 5 000 000 t. A possible basis for the implementation of management action may be found in the request to ICES from the Management Organization. It is stated in the request to ICES from the Management Organisation (Ref 1.1):

"ICES should evaluate strategies that would ensure a probability in the range of 50 to 80% of restoring the SSB to above B_{pa} within 2 to 5 years, in case where the SSB is below Bpa."

The Working Group discussed this request from the Management Organization. This was regarded as a request within the process of evolving management strategies to rebuild SSB within a time constraint to levels above B_{pa} after it has fallen below that level. The request was regarded as relevant by the present Working Group, but it was pointed out that this type of rebuilding approach may not be useful as a general rule for all stocks, including the stock of Norwegian spring-spawning herring which shows a highly variable recruitment. There may be situations when the SSB is fairly low while strong year classes contributing to the SSB in the short and medium-term have been demonstrated. Vice versa there may be situations when SSB is expected to decline in the short and medium-term to levels below Bpa since no strong year classes have been observed among the recruiting year classes. In the latter case it may not be possible to restore the SSB to levels above B_{pa} within 2 to 5 years even if the fishery is stopped. The situation for the Norwegian spring-spawning herring in 2000 is that the spawning stock has declined since 1997 and is at present at a level approximately 7 million t. The year class 1998 seems to be moderately strong (approximately 13 billion individuals as 3 year old, Table 3.5.5.2) and will recruit to the spawning stock mainly in 2003.

3.9.2 Modifications of F at SSB below B_{pa} implemented in the medium-term projections

Due to time constraints it did not prove possible to obtain the probability of restoring the SSB to above B_{pa} in 2 to 5 years for different harvest control rules. However, the number of years the SSB is below B_{pa} within the period 2001-2010 for different strategies was included for illustrative purposes. In addition, the following runs were made in the medium-term projection to illustrate elements in the request from the Management Organization (Table 3.10.1):

- To illustrate the effect of stopping the fishery a medium-term was run with F= 0.0.
- Several medium-term projections were run without modifications of F below B_{pa}.

The default medium projections were run with the same type of continuous reduction of F below B_{pa} as last year (ICES 1999/ACFM:18). That is a linear reduction in F from F=0.125 (or other relevant levels) at B_{pa} to F=0.05 at B_{lim} and lower.

3.10 Medium-term projections

The framework for the range of values for the biological parameters in the medium-term projections is the request from the coastal states of the Norwegian spring-spawning herring (Section 1.1). This request and the projections that have been carried out in order to fulfil it is described in the text table below.

Parameter	Request from coastal states	Technical performance values
Fishing mortality for SSB above B_{pa}	0.05, 0.08, 0.10, 0.125, 0.15	As requested, in addition a medium-term including no fishing (F=0) was run for illustrative purposes
Catch ceiling	None	1.5 million t
Value of B_{pa}	5.0 million t	As requested
Value of B_{lim}	2.5 million t	As requested
Time range	5 and 10 years	As requested
Fishing mortality for F below B_{pa}	Ensure a probability in the range of 50 to 80% of restoring the SSB to above B_{pa} within 2 to 5 years in case where the SSB is below B_{pa}	Linear decrease in F from 0.125 at B_{pa} to 0.05 at B_{lim} (ACFM 1999) (similar decreases were also made with other requested F's (0.05, 0.08, 0.10, 0.15)). Alternatively run for F=0.125 with no reductions in F below B_{pa}
Measure of stability of catches	average percentage change in catches from year to year	As requested
Yield	average catches over the same ten year period	Average annual yield (tonnes) of the time range for the simulation run (5 or 10 years).
Risk	Probability that SSB will fall below B_{pa} and Blim in a 5 and 10 year period	As requested, risk to fall below B_{pa} and B_{lim} within the time range for the simulation run (5 or 10 years).

Medium-term projection of stock and catch were carried out using a simple spreadsheet model. Here, the same input data were used as in the short-term prediction based on Run 6 (Table 3.6.1.1).

As last year, future recruitment was generated from a Beverton-Holt model with a CV (or log-scale standard error) of 1.9. The model was parameterised from VPA data with age 3 as the youngest age, and scaled to age 0 using a total mortality of 2.7. The obtained parameters were 23.9 for the slope at the origin and 1.05 for the spawning stock that yields a slope half of this. An upper bound on recruitment of 1000 billion at age 0, which is somewhat above the size of the 1950 year class (747 billion fish at age 0) is used. Uncertainty in current stock size was assumed to be adequately reflected by a standard error of 0.3 on a log scale for ages 4 and older in 2000, with support from the bootstrap runs described in Section 3.7. This value was used also during the simulations to account for future assessment errors. Uncertainty in younger ages was interpolated linearly from 1.8 at age -1 down to 0.3 at age 4. Note that the current and future assessment error is assumed to be uncorrelated between age groups.

The projections started at January 1 2000 and the allocated catch for 2000 was implemented using an F of 0.21. The F by age applied during the simulations is the F-value in the harvest control rule multiplied by the exploitation pattern given in Table 3.6.1.1 and divided by the average over ages 5–14 of these numbers.

2000 simulations were performed for each harvest control rule. For various harvest control rule parameters, the average yields and probabilities for the SSB to fall below B_{pa} and B_{lim} for the 5-year period 2001-2005 and 10-year period 2001-2010 is given in Table 3.10.1. The average percentage change over the 10-year period is also given.

In order to investigate the effect of various strategies for reducing F when the SSB falls below B_{pa}, it was also attempted to keep the fishing mortality constant for all SSB values. This was only done for F=0.125, and is also given in Table 3.10.1. According to the table the following conclusions can be drawn:

1) Continued fishing at F=0.125 and a reduction in F below B_{pa} as described in Section 3.9 , and with a catch ceiling of 1.5 million t, gives a high probability of the stock falling below B_{pa} in the medium-term (5 years).

2) Even the no fishing case gives a probability of 10-20% of falling below Bpa in the medium-term (10 years).

3) The probability of SSB falling below B_{lim}= 2.5 million tonnes in the coming 10-year period is almost doubled when a reduction in F at SSB levels below B_{pa}=5.0 million tonnes is not applied. Probability of falling below B_{lim} in the medium-term (10 year) period is less than 20% for all the strategies investigated.

4) The mean catch in the medium-term period is below 1.0 million tonnes.

Figures 3.10.1 and 3.10.2 show the development of SSB and yield for F=0.125 above B_{pa} =5.0 million tonnes with a linear reduction to F=0.05 at B_{lim}= 2.5 million tonnes and a catch ceiling of 1.5 million tonnes, Fig 3.10.3 gives the development of the SSB in a no fishing case. 5, 25, 50, 75 and 95 percentiles are given to illustrate the uncertainty in the prognosis.

Table 3.10.1 Average yield, probability of falling below Bpa/Blim and average annual percentage change in catch, 5 and 10 year periods.

Strategy above Bpa	Strategy below Bpa	CV	P (SSB < Blim, during 5 years)	P(SSB < Blim, during 10 years)	P(SSB< Bpa, during 5 years)	P(SSB < Bpa, during 10 years)	Yield (average in first 5 years)	Yield (average in first 10 years)	Average no. years with SSB < Bpa	Av % annual change, 10 years
F=0	F=0	0.3	0.00	0.00	0.14	0.22	0.00	0.00	0.5	38
F=0.05	F=0.05	0.3	0.00	0.01	0.25	0.49	0.33	0.35	1.5	38
F=0.08	Linear red. to F=0.05 at Blim	0.3	0.00	0.04	0.38	0.64	0.50	0.50	2.3	38
F=0.10	Linear red. to F=0.05 at Blim	0.3	0.00	0.05	0.46	0.71	0.60	0.58	2.8	38
F=0.125	Linear red. to F=0.05 at Blim	0.3	0.00	0.10	0.55	0.79	0.71	0.66	3.3	39
F=0.125	Linear red. to F=0.05 at Blim	0.4	0.00	0.11	0.58	0.80	0.71	0.66	3.6	51
F=0.15	Linear red. to F=0.05 at Blim	0.3	0.00	0.14	0.65	0.85	0.80	0.72	3.9	39
F=0.125	F=0.125	0.3	0.00	0.20	0.56	0.79	0.72	0.69	3.4	37

3.11 Management considerations

The immatures and adults of this stock form a central part of the ecosystem in the Barent Sea and Norwegian Seas, respectively. The herring has an important role as a transformer of the production of zooplankton biomass and energy to a form that is available to organisms at a higher level of the food chain.

The Regional (coastal states European Union, Faroe Islands, Iceland, Norway and Russia) Management organisation have agreed on a long-term management plan and on precautionary reference point for this stock.

The current stock assessment indicates a spawning stock of approximately 7 million t in 2000, declining from 9 million t in 1997. Since last year a larvae index series has been included in the tuning process. Further, the 1983 and 1985 year classes have been pooled due to problems with age reading of old fish.

The future prospects for this stock indicate relatively stable levels just above or at B_{pa}. A plan for reduction in F at levels below B_{pa} should be included in the management plan.

Table 3.2.1 Catches of Norwegian spring spawning herring (tonnes) since 1972.

Year	A	B[1]	C	D	Total	Total catch as used by the Working Group
1972	-	9.895	3,266[2]	-	13,161	13,161
1973	139	6,602	276	-	7,017	7,017
1974	906	6,093	620	-	7,619	7,619
1975	53	3,372	288	-	3,713	13,713
1976	-	247	189	-	436	10,436
1977	374	11,834	498	-	12,706	22,706
1978	484	9,151	189	-	9,824	19,824
1979	691	1,866	307	-	2,864	12,864
1980	878	7,634	65	-	8,577	18,577
1981	844	7,814	78	-	8,736	13,736
1982	983	10,447	225	-	11,655	16,655
1983	3,857	13,290	907	-	18,054	23,054
1984	18,730	29,463	339	-	48,532	53,532
1985	29,363	37,187	197	4,300	71,047	169,872
1986	71,122[3]	55,507	156	-	126,785	225,256
1987	62,910	49,798	181	-	112,899	127,306
1988	78,592	46,582	127	-	125,301	135,301
1989	52,003	41,770	57	-	93,830	103,830
1990	48,633	29,770	8	-	78,411	86,411
1991	48,353	31,280	50	-	79,683	84,683
1992	43,688	55,737	23	-	99,448	104,448
1993	117,195	110,212	50	-	227,457	232,457
1994	288,581	190,643	4	-	479,228	479,228
1995	320,731	581,495	0	-	902,226	902,226
1996	462,248	758,035	0	-	1,220,283	1,220,283
1997[5]			0	-	1,426,507	1,426,507
1998[6]			0	-	1,223,131	1,223,131
1999[6]			0	-	1,235,433	1,235,433

A = catches of adult herring in winter
B = mixed herring fishery in remaining part of the year
C = by-catches of 0- and 1-group herring in the sprat fishery
D = USSR-Norway by-catch in the capelin fishery (2-group)

1 Includes also by-catches of adult herring in other fisheries
2 In 1972, there was also a directed herring 0-group fishery
3 Includes 26,000 t of immature herring (1983 year class) fished by USSR in the Barents Sea
4 Preliminary, as provided by Working Group members
5 Details of distribution of 1997 and catches by fishery and ICES area given in ICES 1999
6 Details of distribution of 1999 catches by fishery and ICES area given in Tables 3.2.3-3.2.5

Table 3.2.2 Total catch of Norwegian spring spawning herring (tonnes) since 1972. Data provided by Working Group members.

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Nether- lands	Greenland	UK	Germany	France	Sweden	Total
1972	13,161	-	-	-	-	-	-	-	-	-	-	-	13,161
1973	7,017	-	-	-	-	-	-	-	-	-	-	-	7,017
1974	7,619	-	-	-	-	-	-	-	-	-	-	-	7,619
1975	13,713	-	-	-	-	-	-	-	-	-	-	-	13,713
1976	10,436	-	-	-	-	-	-	-	-	-	-	-	10,436
1977	22,706	-	-	-	-	-	-	-	-	-	-	-	22,706
1978	19,824	-	-	-	-	-	-	-	-	-	-	-	19,824
1979	12,864	-	-	-	-	-	-	-	-	-	-	-	12,864
1980	18,577	-	-	-	-	-	-	-	-	-	-	-	18,577
1981	13,736	-	-	-	-	-	-	-	-	-	-	-	13,736
1982	16,655	-	-	-	-	-	-	-	-	-	-	-	16,655
1983	23,054	-	-	-	-	-	-	-	-	-	-	-	23,054
1984	53,532	-	-	-	-	-	-	-	-	-	-	-	53,532
1985	167,272	2,600	-	-	-	-	-	-	-	-	-	-	169,872
1986	199,256	26,000	-	-	-	-	-	-	-	-	-	-	225,256
1987	108,417	18,889	-	-	-	-	-	-	-	-	-	-	127,306
1988	115,076	20,225	-	-	-	-	-	-	-	-	-	-	135,301
1989	88,707	15,123	-	-	-	-	-	-	-	-	-	-	103,830
1990	74,604	11,807	-	-	-	-	-	-	-	-	-	-	86,411
1991	73,683	11,000	-	-	-	-	-	-	-	-	-	-	84,683
1992	91,111	13,337	-	-	-	-	-	-	-	-	-	-	104,448
1993	199,771	32,645	-	-	-	-	-	-	-	-	-	-	232,457
1994	380,771	74,400	-	2,911	21,146	-	-	-	-	-	-	-	479,228
1995	529,838	101,987	30,577	57,084	174,109	-	7,969	2,500	881	556	-	-	905,501
1996	699,161	119,290	60,681	52,788	164,957	19,541	19,664	-	46,131	11,978	-	22,424	1,220,283
1997	860,963	168,900	44,292	59,987	220,154	11,179	8,694	-	25,149	6,190	1,500	19,499	1,426,507
1998	743,925	124,049	35,519	68,136	197,789	2,437	12,827	-	15,9711	7,003	605	14,863	1,223,131
1999[1]	740,640	157,328	37,010	55,527	203,381	2,412	5,871	-	9,207	-	-	14,057	1,235,433

[1] Preliminary, as provided by Working Group members.

Table 3.2.3

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12	CN 13	CN 14	CN 15	CN 16
Transfer Norwegian		0	16	1999																						
1	Norway	1	IIa	232731	203958	203958	138	5847	9665	0	0	109	9950	3782	38936	108649	385449	220112	53671	18739	2880	1389	0	9596	0	16036
2	Norway	2	IIa	11983	11943	11943	39	2286	2546	0	0	240	908	259	1091	3745	17876	10299	3118	1727	15	494	0	2069	0	2192
3	Norway	3	IIa	105056	105026	105026	52	892	3793	0	0	1385	33826	6720	11627	39905	132484	83632	13542	4673	668	668	0	4099	0	6022
4	Norway	4	IIa	390870	390853	390853	61	3103	7999	0	0	1194	50868	15848	49766	145491	524004	356381	80730	25474	1462	2198	0	15379	0	8803
5	Norway	1	IVa	0	28773	28773	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Norway	2	IVa	0	40	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Norway	3	IVa	0	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Norway	4	IVa	0	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Russia	1	IIa	0	72404	72404	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Russia	2	IIa	0	7096	7096	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Russia	3	IIa	0	76870	76870	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Russia	4	IIa	0	143	143	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Russia	2	IVa	0	16	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Russia	2	Vb	0	799	799	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Denmark	2	IIa	0	33491	33491	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Denmark	2	IIb	0	3519	3519	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Iceland	2	IIa	203381	203381	203381	66	2616	2806	0	0	0	0	0	3061	32113	169079	227809	75593	29606	5935	23924	5542	34327	0	7460
18	Sweden	2	IIa	0	14057	14057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Germany	2	IIa	0	6996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Netherland	1	IIa	0	380	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Netherland	2	IIa	5871	6149	5871	2	50	50	0	0	0	0	0	372	0	5204	6691	2619	1026	206	829	192	1189	0	258
22	Netherland	3	IIa	0	7528	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	UK(Scot)	1	IIa	0	1214	1214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	UK(Scot)	2	IIa	0	1031	1031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	UK(Scot)	3	IIa	0	16962	16962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	UK(Scot)	4	IIa	0	1529	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Ireland	2	IIa	0	2412	2412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Faroes	1	IIa	0	9704	9704	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Faroes	2	IIa	0	19909	19909	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Faroes	3	IIa	0	18517	18517	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Faroes	4	IIa	0	1023	1023	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	Faroes	3	IIb	0	395	395	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Faroes	2	Va	0	286	286	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Faroes	3	Va	0	418	418	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Faroes	3	XIVa	5979	5275	5275	1	85	85	0	0	0	0	0	0	0	1794	4893	652	978	0	1794	0	0	0	3751

Table 3.2.4

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7	CW 8	CW 9	CW 10	CW 11	CW 12	CW 13	CW 14	CW 15	CW 16
Transfe Norwegian	0	16	1999																							
1	Norway	1	IIa	232731	203958	203958	138	5847	9665	0.000	0.000	0.094	0.110	0.179	0.233	0.237	0.263	0.277	0.309	0.330	0.351	0.369	0.000	0.372	0.000	0.376
2	Norway	2	IIa	11983	11943	11943	39	2286	2546	0.000	0.000	0.078	0.143	0.205	0.243	0.243	0.255	0.273	0.295	0.321	0.298	0.361	0.000	0.364	0.000	0.377
3	Norway	3	IIa	105056	105026	105026	52	892	3793	0.000	0.000	0.091	0.182	0.238	0.288	0.305	0.320	0.320	0.369	0.388	0.437	0.440	0.000	0.421	0.000	0.428
4	Norway	4	IIa	390870	390853	390853	61	3103	7999	0.000	0.000	0.120	0.179	0.237	0.280	0.290	0.305	0.316	0.343	0.390	0.379	0.379	0.000	0.424	0.000	0.428
5	Norway	1	IVa	0	28773	28773	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	Norway	2	IVa	0	40	40	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Norway	3	IVa	0	30	30	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Norway	4	IVa	0	17	17	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	Russia	1	IIa	0	72404	72404	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	Russia	2	IIa	0	7096	7096	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	Russia	3	IIa	0	76870	76870	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	Russia	4	IIa	0	143	143	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	Russia	2	IVa	0	16	16	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	Russia	2	Vb	0	799	799	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	Denmark	2	IIa	0	33491	33491	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	Denmark	2	IIb	0	3519	3519	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Iceland	2	IIa	203381	203381	203381	66	2616	2806	0.000	0.000	0.000	0.000	0.000	0.282	0.301	0.307	0.323	0.343	0.361	0.368	0.396	0.396	0.402	0.000	0.412
18	Sweden	2	IIa	0	14057	14057	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	Germany	2	IIa	0	6996	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	Netherland	1	IIa	0	380	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Netherland	2	IIa	5871	6149	5871	2	50	50	0.000	0.000	0.000	0.000	0.000	0.309	0.000	0.285	0.304	0.343	0.361	0.368	0.396	0.396	0.402	0.000	0.412
22	Netherland	3	IIa	0	7528	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.310	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	UK(Scot)	1	IIa	0	1214	1214	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	UK(Scot)	2	IIa	0	1031	1031	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	UK(Scot)	3	IIa	0	16962	16962	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	UK(Scot)	4	IIa	0	1529	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	Ireland	2	IIa	0	2412	2412	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	Faroes	1	IIa	0	9704	9704	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	Faroes	2	IIa	0	19909	19909	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	Faroes	3	IIa	0	18517	18517	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	Faroes	4	IIa	0	1023	1023	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	Faroes	3	IIb	0	395	395	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	Faroes	2	Va	0	286	286	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	Faroes	3	Va	0	418	418	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	Faroes	3	XIVa	5979	5275	5275	1	85	85	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.349	0.408	0.423	0.466	0.000	0.503	0.000	0.000	0.000	0.459

Table 3.2.5

Summary of Sampling by Country

AREA : IIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	33491.00	0	0	0	0.00
Faroes	0.00	49153.00	0	0	0	0.00
Germany	0.00	6996.00	0	0	0	0.00
Iceland	203381.00	203381.00	66	2806	2616	99.99
Ireland	0.00	2412.00	0	0	0	0.00
Netherlands	5871.00	14057.00	2	50	50	101.61
Norway	740640.00	711780.00	290	24003	12128	99.91
Russia	0.00	156513.00	0	0	0	0.00
Sweden	0.00	14057.00	0	0	0	0.00
UK(Scot)	0.00	20736.00	0	0	0	0.00
Total IIa	949892.00	1212576.00	358	26859	14794	99.94

Sum of Offical Catches : 1212576.00
Unallocated Catch : -16711.00
Working Group Catch : 1195865.00

AREA : IIb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	3519.00	0	0	0	0.00
Faroes	0.00	395.00	0	0	0	0.00
Total IIb	0.00	3914.00	0	0	0	0.00

Sum of Offical Catches : 3914.00
Unallocated Catch : 0.00
Working Group Catch : 3914.00

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	0.00	28860.00	0	0	0	0.00
Russia	0.00	16.00	0	0	0	0.00
Total IVa	0.00	28876.00	0	0	0	0.00

Sum of Offical Catches : 28876.00
Unallocated Catch : 0.00
Working Group Catch : 28876.00

AREA : Va

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	704.00	0	0	0	0.00
Total Va	0.00	704.00	0	0	0	0.00

Sum of Offical Catches : 704.00
Unallocated Catch : 0.00
Working Group Catch : 704.00

AREA : Vb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Russia	0.00	799.00	0	0	0	0.00
Total Vb	0.00	799.00	0	0	0	0.00

Sum of Offical Catches : 799.00
Unallocated Catch : 0.00
Working Group Catch : 799.00

Table 3.2.5 (Continued)

AREA : XIVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	5979.00	5275.00	1	85	85	99.98
Total XIVa	5979.00	5275.00	1	85	85	99.98

Sum of Offical Catches : 5275.00
Unallocated Catch : 0.00
Working Group Catch : 5275.00

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	9704.00	0	0	0	0.00
Netherlands	0.00	380.00	0	0	0	0.00
Norway	232731.00	232731.00	138	9665	5847	100.05
Russia	0.00	72404.00	0	0	0	0.00
UK(Scot)	0.00	1214.00	0	0	0	0.00
Period Total	232731.00	316433.00	138	9665	5847	100.05

Sum of Offical Catches : 316433.00
Unallocated Catch : -380.00
Working Group Catch : 316053.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	37010.00	0	0	0	0.00
Faroes	0.00	20195.00	0	0	0	0.00
Germany	0.00	6996.00	0	0	0	0.00
Iceland	203381.00	203381.00	66	2806	2616	99.99
Ireland	0.00	2412.00	0	0	0	0.00
Netherlands	5871.00	6149.00	2	50	50	101.61
Norway	11983.00	11983.00	39	2546	2286	100.00
Russia	0.00	7911.00	0	0	0	0.00
Sweden	0.00	14057.00	0	0	0	0.00
UK(Scot)	0.00	1031.00	0	0	0	0.00
Period Total	221235.00	311125.00	107	5402	4952	100.03

Sum of Offical Catches : 311125.00
Unallocated Catch : -7274.00
Working Group Catch : 303851.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	5979.00	24605.00	1	85	85	99.98
Netherlands	0.00	7528.00	0	0	0	0.00
Norway	105056.00	105056.00	52	3793	892	99.24
Russia	0.00	76870.00	0	0	0	0.00
UK(Scot)	0.00	16962.00	0	0	0	0.00
Period Total	111035.00	231021.00	53	3878	977	99.28

Sum of Offical Catches : 231021.00
Unallocated Catch : -7528.00
Working Group Catch : 223493.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	1023.00	0	0	0	0.00
Norway	390870.00	390870.00	61	7999	3103	100.07
Russia	0.00	143.00	0	0	0	0.00
UK(Scot)	0.00	1529.00	0	0	0	0.00
Period Total	390870.00	393565.00	61	7999	3103	100.06

Sum of Offical Catches : 393565.00
Unallocated Catch : -1529.00
Working Group Catch : 392036.00

Table 3.2.5 (Continued)

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	37010.00	0	0	0	0.00
Faroes	5979.00	55527.00	1	85	85	99.98
Germany	0.00	6996.00	0	0	0	0.00
Iceland	203381.00	203381.00	66	2806	2616	99.99
Ireland	0.00	2412.00	0	0	0	0.00
Netherlands	5871.00	14057.00	2	50	50	101.61
Norway	740640.00	740640.00	290	24003	12128	99.91
Russia	0.00	157328.00	0	0	0	0.00
Sweden	0.00	14057.00	0	0	0	0.00
UK(Scot)	0.00	20736.00	0	0	0	0.00
Total for Stock	955871.00	1252144.00	359	26944	14879	99.94

```
      Sum of Offical Catches :     1252144.00
      Unallocated Catch :           -16711.00
      Working Group Catch :        1235433.00
```

DETAILS OF DATA FILLING-IN

```
  Filling-in for record : (  5)   Norway                 1 IVa
Using Only
  >>  (  1)  Norway                 1 IIa

  Filling-in for record : (  6)   Norway                 2 IVa
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : (  7)   Norway                 3 IVa
Using Only
  >>  (  3)  Norway                 3 IIa

  Filling-in for record : (  8)   Norway                 4 IVa
Using Only
  >>  (  4)  Norway                 4 IIa

  Filling-in for record : (  9)   Russia                 1 IIa
Using Only
  >>  (  1)  Norway                 1 IIa

  Filling-in for record : ( 10)   Russia                 2 IIa
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : ( 11)   Russia                 3 IIa
Using Only
  >>  (  3)  Norway                 3 IIa

  Filling-in for record : ( 12)   Russia                 4 IIa
Using Only
  >>  (  4)  Norway                 4 IIa

  Filling-in for record : ( 13)   Russia                 2 IVa
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : ( 14)   Russia                 2 Vb
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : ( 15)   Denmark                2 IIa
Using Only
  >>  ( 17)  Iceland                2 IIa

  Filling-in for record : ( 16)   Denmark                2 IIb
Using Only
  >>  ( 17)  Iceland                2 IIa

  Filling-in for record : ( 18)   Sweden                 2 IIa
Using Only
  >>  ( 17)  Iceland                2 IIa

  Filling-in for record : ( 19)   Germany                2 IIa
Using Only
  >>  ( 17)  Iceland                2 IIa
```

Table 3.2.5 (Continued)

```
  Filling-in for record : ( 20)   Netherlands            1 IIa
Using Only
  >>  ( 21)  Netherlands           2 IIa

  Filling-in for record : ( 22)   Netherlands            3 IIa
Using Only
  >>  ( 21)  Netherlands           2 IIa

  Filling-in for record : ( 23)   UK(Scot)               1 IIa
Using Only
  >>  (  1)  Norway                1 IIa

  Filling-in for record : ( 24)   UK(Scot)               2 IIa
Using Only
  >>  (  2)  Norway                2 IIa

  Filling-in for record : ( 25)   UK(Scot)               3 IIa
Using Only
  >>  (  3)  Norway                3 IIa

  Filling-in for record : ( 26)   UK(Scot)               4 IIa
Using Only
  >>  (  4)  Norway                4 IIa

  Filling-in for record : ( 27)   Ireland                2 IIa
Using Only
  >>  ( 17)  Iceland               2 IIa

  Filling-in for record : ( 28)   Faroes                 1 IIa
Using Only
  >>  (  1)  Norway                1 IIa

  Filling-in for record : ( 29)   Faroes                 2 IIa
Using Only
  >>  (  2)  Norway                2 IIa

  Filling-in for record : ( 30)   Faroes                 3 IIa
Using Only
  >>  (  3)  Norway                3 IIa

  Filling-in for record : ( 31)   Faroes                 4 IIa
Using Only
  >>  (  4)  Norway                4 IIa

  Filling-in for record : ( 32)   Faroes                 3 IIb
Using Only
  >>  ( 17)  Iceland               2 IIa

  Filling-in for record : ( 33)   Faroes                 2 Va
Using Only
  >>  ( 35)  Faroes                3 XIVa

  Filling-in for record : ( 34)   Faroes                 3 Va
Using Only
  >>  ( 35)  Faroes                3 XIVa
```

Catch Numbers at Age by Area

Ages	IIa	IIb	IVa	Va	Vb	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	4998.52	0.00	15.04	0.00	16.00	0.00	5029.57
3	136319.59	0.00	1246.25	0.00	60.54	0.00	137626.41
4	35331.73	0.00	471.39	0.00	17.27	0.00	35820.39
5	129857.02	58.91	4824.32	0.00	72.75	0.00	134813.00
6	415098.34	618.00	13467.72	0.00	249.71	0.00	429433.78
7	1550921.38	3253.87	47797.99	211.24	1191.93	1582.76	1604959.13
8	1126999.13	4384.11	27300.40	576.13	686.71	4316.87	1164263.38
9	282422.16	1454.76	6657.40	76.77	207.90	575.23	291394.22
10	102015.55	569.76	2327.25	115.16	115.15	862.84	106005.73
11	14052.47	114.22	356.38	0.00	1.00	0.00	14524.08
12	37579.21	460.41	174.32	211.24	32.94	1582.76	40040.88
13	7095.38	106.65	0.00	0.00	0.00	0.00	7202.03
14	86601.92	660.61	1197.88	0.00	137.96	0.00	88598.38
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	57947.55	143.57	1994.91	441.66	146.16	3309.34	63983.18

Table 3.2.5 (Continued)

Mean Weight at Age by Area (Kg)

Ages	IIa	IIb	IVa	Va	Vb	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0959	0.0000	0.0928	0.0000	0.0780	0.0000	0.0959
3	0.1735	0.0000	0.1108	0.0000	0.1430	0.0000	0.1729
4	0.2289	0.0000	0.1794	0.0000	0.2050	0.0000	0.2283
5	0.2632	0.2820	0.2331	0.0000	0.2430	0.0000	0.2621
6	0.2755	0.3010	0.2371	0.0000	0.2430	0.0000	0.2743
7	0.2930	0.3070	0.2631	0.3490	0.2550	0.3490	0.2922
8	0.3076	0.3230	0.2771	0.4080	0.2730	0.4080	0.3073
9	0.3358	0.3430	0.3090	0.4230	0.2950	0.4230	0.3354
10	0.3615	0.3610	0.3300	0.4660	0.3210	0.4660	0.3618
11	0.3714	0.3680	0.3510	0.0000	0.2980	0.0000	0.3709
12	0.3939	0.3960	0.3690	0.5030	0.3610	0.5030	0.3986
13	0.3960	0.3960	0.0000	0.0000	0.0000	0.0000	0.3960
14	0.4006	0.4020	0.3720	0.0000	0.3640	0.0000	0.4002
15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16	0.4012	0.4120	0.3761	0.4590	0.3770	0.4590	0.4037

Table 3.3.1.1 Norwegian Spring Spawning herring. Estimates obtained on the acoustic surveys on the spawning stock in February-March. Numbers in millions.

Year Age	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
2		101	183	44			16		407			106	1516
3	255	5	187	59			128	1792	231			1366	690
4	146	373	0	54			676	7621	7638		381	337	1996
5	6805	103	345	12			1375	3807	11243		1905	1286	164
6	202	5402	112	354			476	2151	2586		10640	2979	592
7		182	4489	122			63	322	957		6708	11791	1997
8			146	4148			13	20	471		1280	7534	7714
9				102			140	1	0		434	1912	4240
10							35	124	0		130	568	553
11							1820	63	165		39	132	71
12								2573	0		0	0	3
13									2024		175	0	0
14											0	392	6
15+											804	437	361
Total	7408	6166	5462	4895	-	-	4742	18474	25756	-	22496	28840	19903

In 1992, 1993 and 1997 there was no estimate due to poor weather conditions.

Table 3.3.2.1 Norwegian Spring Spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in December. Numbers in millions.

Year Age	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
1		72		380		9	65	74
2	36	1518	16	183	1465	73	1207	159
3	1247	2389	3708	5133	3008	661	441	2425
4	1317	3287	4124	5274	13180	1480	1833	296
5	173	1267	2593	1839	5637	6110	3869	837
6	16	13	1096	1040	994	4458	12052	2066
7	208	13	34	308	552	1843	8242	6601
8	139	158	25	19	92	743	2068	4168
9	3742	26	196	13	0	66	629	755
10	69	4435	29	111	7	0	111	212
11			3239	39	41	0	14	0
12				907	15	126	0	15
13					393	0	392	0
14+						842	221	146
Total	6947	13178	15209	15246	25384	16411	31144	17754

Table 3.3.2.2 Norwegian Spring Spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in January. Numbers in millions.

Year Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	90			73				214	0	
3	220	410	61	642	47	315		267	1358	
4	70	820	1905	3431	3781	10442		1938	199	
5	20	260	2048	4847	4013	13557		4162	1455	
6	180	60	256	1503	2445	4312		9647	4452	
7	150	510	27	102	1215	1271		6974	12971	
8	5500	120	269	29	42	290		1518	7226	
9	440	4690	182	161	24	22		743	1876	
10		30	5691	131	267	25		16	499	
11			128	3679	29	200		4	16	
12					4326	58		0	16	
13						1146		181	0	
14								7	156	
15+								314	220	
Total	6670	6900	10567	14598	16189	31638	-	25985	30444	-

In 1997 there was no estimate due to poor weather conditions.
In 2000 there was no estimate due to technical problems.

Table 3.3.3.1 Norwegian spring spawning herring. Estimates obtained in the international acoustic surveys on the feeding areas in the Norwegian Sea in May. Numbers in millions.

Year Age	1996	1997	1998	1999
3	4114	1169	367	2191
4	22461	3599	1099	322
5	13244	18867	4410	965
6	4916	13546	16378	3067
7	2045	2473	10160	11763
8	424	1771	2059	6077
9	14	178	804	853
10	7	77	183	258
11	155	288	0	5
12	0	415	0	14
13	3134	60	112	0
14		2472	0	158
15+			415	128
Total	50504	44915	35987	25801

Table 3.3.4.1 Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in May/June. 1990-1995, Norwegian estimates, for later years, see footnotes.

Year Age	1990	1991	1992	1993	1994	1995	1996[1]	1997[2]	1998[3]	1999[3]
1	4.4	24.3	32.6	102.7	6.6	0.5	0.1	2.6	9.5	49.5
2		5.2	14.0	25.8	59.2	7.7	0.25	0.04	4.7	4.9
3			5.7	1.5	18.0	8.0	1.8	0.4	0.01	0.00
4					1.7	1.1	0.6	0.35	0.01	0.00
5							0.03	0.05	0.00	0.00

[1] Average of Norwegian and Russian estimates
[2] Combination of Norwegian and Russian estimates as described in 1998 WG report.
[3] Russian estimate

Table 3.3.4.2 Norwegian spring spawners. Acoustic abundance (TS = 20 logL - 71.9) of 0-group herring in Norwegian coastal waters in 1975–1999 (numbers in millions).

Year	Area				Total
	South of 62°N	62°N-65°N	65°N-68°N	North of 68°30'	
1975		164	346	28	538
1976		208	1 305	375	1 888
1977		35	153	19	207
1978		151	256	196	603
1979		455	1 130	144	1 729
1980		6	2	109	117
1981		132	1	1	134
1982		32	286	1 151	1 469
1983		162	2 276	4 432	6 866
1984		2	234	465	701
1985		221	177	104	502
1986		5	72	127	204
1987		327	26	57	410
1988		14	552	708	1 274
1989		575	263	2 052	2 890
1990		75	146	788	1 009
1991		80	299	2 428	2 807
1992		73	1 993	621	2 891
1993	290	109	140	288	827
1994	157	452	323	6 168	7 101
1995	0	27	2	0	29
1996	0	20	114	8 800	8 934
1997	208	69	544	5 244	6 065
1998	424	273	442	11 640	12 779
1999	121	658	271	6 329	7 379

Table 3.3.4.3 Norwegian spring-spawning herring. Abundance indices for 0-group herring in the Barents Sea, 1973-1999.

Year	Log index	Year	Log index
1973	0.05	1987	0.00
1974	0.01	1988	0.30
1975	0.00	1989	0.58
1976	0.00	1990	0.31
1977	0.01	1991	1.19
1978	0.02	1992	1.05
1979	0.09	1993	0.75
1980	0.00	1994	0.28
1981	0.00	1995	0.16
1982	0.00	1996	0.65
1983	1.77	1997	0.39
1984	0.34	1998	0.59
1985	0.23	1999	0.41
1986	0.00		

Table 3.3.5.1 The indices for herring larvae for the period 1981-2000 ($N*10^{-12}$)

Year	Index 1	Index 2	Year	Index 1	Index 2
1981	0.3		1991	8.6	23.5
1982	0.7		1992	6.3	27.8
1983	2.5		1993	24.7	78.0
1984	1.4		1994	19.5	48.6
1985	2.3		1995	18.2	36.3
1986	1.0		1996	27.7	81.7
1987	1.3	4.0	1997	66.6	147.5
1988	9.2	25.5	1998	42.4	138.6
1989	13.4	28.7	1999	19.9	73.0
1990	18.3	29.2	2000	19.8	127.5

Table 3.4.1. Tagging data for the year classes 1983+ and 1986-89 aggregated, and for the year classes 1990 - 1993.

Tagging data for the 1983+ year class

Year	Screened billion	Number tagged	Recaptured 87 release	88 release	89 release	90 release	91 release	92 release	93 release	94 release	95 release	96 release	97 release
1987		33067											
1988		38152											
1989	0.010695	20620	12										
1990	0.005489	24585	4	10									
1991	0.005545	12558	1	7	5								
1992	0.001737	15262	4	0	2	2							
1993	0.009372	15839	6	13	6	12	9						
1994	0.009474	5364	2	10	7	8	4	11					
1995	0.011554	859	6	10	5	15	6	9	7				
1996	0.004038	2879	3	2	6	10	2	1	4	3			
1997	0.003867	2266	0	3	1	3	2	3	0	0	0		
1998	0.000509		1	3	1	1	2	2	0	0	0	1	
1999	0.000379		0	0	1	1	0	0	1	0	0	0	1

Tagging data for the 1986 - 89 year classes

Year	Screened billion	Number tagged	Recaptured 93 release	94 release	95 release	96 release	97 release
1993		14472					
1994		16917					
1995	0.013386	3416	5				
1996	0.005947	7492	5	7			
1997	0.004547	6193	2	7	0		
1998	0.001339		0	1	0	1	
1999	0.001272		1	0	0	1	1

Tagging data for the 1990 year class

Year	Screened billion	Number tagged	Recaptured 94 release	95 release	96 release	97 release
1994		10784				
1995		3868				
1996	0.009009	6171	9			
1997	0.009830	4057	7	3		
1998	0.002828		1	1	1	
1999	0.003402		1	2	2	1

Tagging data for the 1991 year class

Year	Screened billion	Number tagged	Recaptured 95 release	96 release	97 release
1995		21528			
1996		25683			
1997	0.030952	7129	21		
1998	0.012459		8	6	
1999	0.014968		7	14	4

Tagging data for the 1992 year class

Year	Screened billion	Number tagged	Recaptured 96 release	97 release
1996		8417		
1997		8353		
1998	0.020695		7	
1999	0.023790		4	9

Tagging data for the 1993 year class

Year	Screened billion	Number tagged	Recapt. 97 release
1997		976	
1998			
1999	0.008046		0

Table 3.5.2.1

Run title : Herring spring-spawn (run: SVPBJA12/V12) t 2/05/2000 18:23

Table 1 Catch numbers at age Numbers*10**-4

YEAR	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
AGE										
0	511260	163550	1372160	569720	1067600	517560	536390	500190	966700	1789630
1	200000	760770	914970	505500	707110	287110	202370	329080	279810	198530
2	60000	40000	123290	58130	85540	51010	62710	21950	66640	32550
3	27620	660	3930	74010	26630	9300	11650	2330	1750	1510
4	18480	38380	6050	4660	143550	27640	25160	37330	1790	2680
5	18550	17240	60230	10090	14290	204510	31420	15380	11090	2590
6	54700	16440	13630	35560	23600	11430	255510	22850	8930	14660
7	62860	51560	20450	8190	49030	18960	11000	198530	19440	11480
8	7950	60200	38020	11090	12810	27470	20390	7200	97350	24070
9	8860	7710	37790	31410	19980	8530	26420	12730	7070	110380
10	10950	8270	7920	39490	44040	19340	13070	18250	12300	8860
11	8690	10310	8570	6170	46070	29560	19830	8840	20090	12430
12	19450	10760	10770	9120	8840	20320	27280	12120	9870	19800
13	36830	25350	10680	9410	10060	5870	16330	14930	7740	8850
14	6640	34800	18650	9880	13300	8460	6300	13160	7090	7740
15	10700	4740	25630	21550	12680	10360	8890	3370	6940	8520
+gp	23730	30510	30810	51490	67640	47700	47620	24770	18620	15070
TOTALNUM	1087270	1281250	2703550	1455470	2352770	1305130	1322340	1243010	1543220	2269350
TONSLAND	933000	1278400	1254800	1090600	1644500	1359800	1659400	1319500	986600	1111100
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-4

YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
AGE										
0	1288430	620750	369320	480700	361300	230300	392650	42680	178360	56120
1	1358080	1607560	408110	211920	272830	378090	66280	987710	43700	50710
2	39250	288480	104130	204530	22030	285360	167800	7040	38830	14190
3	12170	3120	184380	76040	11460	8990	204870	139230	9910	18820
4	1820	810	800	83580	39900	25620	2690	325400	188050	80
5	2810	410	310	530	204580	57110	46660	2660	138740	880
6	2440	1500	720	180	1370	219970	130600	42130	1420	470
7	9620	1940	2020	360	150	1950	288450	113200	9400	70
8	7330	6160	1190	1830	300	1490	3790	172080	13410	1170
9	20390	4920	5910	930	2490	740	1430	890	34510	3360
10	116300	13610	5260	10770	2930	1910	1740	570	200	3600
11	8520	72810	11700	9250	9560	4000	2620	350	110	30
12	12970	4970	81350	17410	8240	10050	1100	850	80	20
13	15350	4500	4420	92370	15300	10780	6910	890	250	20
14	5670	6300	5470	7960	77280	13870	7210	1750	260	20
15	4720	2170	6560	6040	4580	70400	9670	1430	180	40
+gp	12170	3840	8670	12490	29100	17910	46000	9010	1520	200
TOTALNUM	2918040	2643850	1200320	1216890	1063400	1338540	1380470	1847870	658930	149800
TONSLAND	1101800	830100	848600	984500	1281800	1547700	1955000	1677200	712200	67800
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Run title : Herring spring-spawn (run: SVPBJA12/V12) At 2/05/2000 18:23

Table 1 Catch numbers at age Numbers*10**-4

	YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
	AGE										
	0	11930	3050	34710	2930	6590	3060	2010	4300	2010	3260
	1	52940	4290	4100	350	780	360	240	620	240	380
	2	3320	8510	2040	170	390	180	120	310	120	190
	3	630	182	3538	239	10	327	2325	2210	302	635
	4	1860	102	348	2520	24	13	544	2360	1216	187
	5	60	124	358	65	2451	91	0	34	2032	687
	6	330	36	248	151	26	3067	0	0	87	1122
	7	330	111	69	28	20	1	1309	42	0	33
	8	100	113	149	18	0	0	0	1077	62	0
	9	1340	36	20	0	0	0	0	0	503	0
	10	2620	441	0	0	0	0	0	0	0	253
	11	2810	691	49	0	0	0	0	0	0	0
	12	30	545	59	0	0	0	0	0	0	0
	13	10	0	59	0	0	0	0	0	0	0
	14	20	2	0	18	0	0	0	0	0	0
	15	10	12	0	0	0	0	0	0	0	0
	+gp	190	0	0	0	0	0	0	0	0	0
0	TOTALNUM	78530	18245	45748	6489	10291	7099	6548	10953	6572	747
	TONSLAND	62300	21100	13161	7017	7619	13713	10436	22706	19824	12864
	SOPCOF %	100	100	99	100	101	100	100	100	100	100

Table 3.5.2.1 (continued)

Table 1 Catch numbers at age Numbers*10**-4

	YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
	AGE										
	0	690	830	2260	12700	3386	2857	1381	1385	1549	712
	1	80	110	110	468	170	1315	138	633	279	193
	2	40	1190	20	168	249	20722	309	3577	911	2520
	3	641	417	1382	318	448	2150	53979	1978	6292	289
	4	581	459	789	2119	539	1550	1759	50139	2506	362
	5	228	860	451	952	6154	1650	1450	1867	55037	565
	6	817	220	626	618	1820	13000	1550	350	945	2429
	7	1584	451	196	682	1264	5900	10500	706	368	347
	8	44	828	508	129	1561	5500	7500	2800	596	80
	9	1	35	605	460	722	6300	4200	1200	1458	68
	10	0	10	12	733	1634	1000	7700	950	887	330
	11	269	11	4	14	648	3100	1947	450	282	138
	12	0	96	4	4	0	5000	6600	783	336	68
	13	0	0	12	14	0	0	8000	650	268	32
	14	0	0	0	86	0	0	0	700	157	26
	15	0	0	0	0	165	0	0	45	54	0
	+gp	0	0	0	0	0	264	247	0	0	0
0	TOTALNUM	4975	5518	6978	19466	18760	70309	107260	68213	71925	8158
	TONSLAND	18577	13736	16655	23054	53532	169872	225256	127306	135301	103830
	SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-4

	YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	AGE										
	0	102	10	163	657	43	0	0	0	0	0
	1	40	337	15	13	2	0	0	0	0	0
	2	1554	333	134	724	810	113	3014	2182	8289	503
	3	1863	844	1259	2841	3250	5759	3437	13045	7032	13763
	4	266	278	3310	10687	11009	34646	71363	27095	24237	3582
	5	1188	141	498	8727	36392	62281	157100	179578	36831	13481
	6	1085	1470	119	863	16480	63784	94058	199362	176032	42943
	7	22628	887	1198	365	1558	23109	40628	76121	126375	160496
	8	129	21885	575	2960	814	1551	10341	32649	38148	116426
	9	152	250	22568	1863	3733	1585	568	6087	12997	29139
	10	204	46	248	41011	3566	6975	737	2002	4250	10601
	11	242	9	64	0	64541	8374	6609	3241	2534	1452
	12	65	69	25	0	283	91188	1757	9052	348	4004
	13	18	10	124	0	46	407	83655	1912	11260	720
	14	59	26	0	0	10	25	0	37033	563	8860
	15	17	53	0	0	207	0	0	30	10852	0
	+gp	31	1	0	0	0	45	0	0	0	6398
0	TOTALNUM	29641	26648	30300	70711	142742	299842	473266	589388	459749	412369
	TONSLAND	86411	84683	104448	232457	479228	905501	1220283	1426507	1223131	1235433
	SOPCOF %	100	100	100	100	102	100	101	100	100	100

1

Table 3.5.2.2

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 2/05/2000 18:23

Table 2 Catch weights at age (kg)

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,
AGE										
0,	.0070,	.0090,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0090,	.0090,
1,	.0250,	.0290,	.0260,	.0270,	.0260,	.0270,	.0280,	.0280,	.0300,	.0300,
2,	.0580,	.0680,	.0610,	.0630,	.0620,	.0630,	.0660,	.0660,	.0700,	.0710,
3,	.1100,	.1300,	.1150,	.1200,	.1170,	.1190,	.1260,	.1270,	.1330,	.1350,
4,	.1880,	.2220,	.1970,	.2050,	.2010,	.2040,	.2150,	.2160,	.2270,	.2310,
5,	.2110,	.2490,	.2210,	.2300,	.2250,	.2290,	.2410,	.2430,	.2550,	.2590,
6,	.2340,	.2760,	.2450,	.2550,	.2500,	.2540,	.2680,	.2690,	.2830,	.2870,
7,	.2530,	.2980,	.2650,	.2750,	.2690,	.2740,	.2890,	.2900,	.3050,	.3100,
8,	.2660,	.3140,	.2790,	.2900,	.2840,	.2890,	.3040,	.3060,	.3210,	.3270,
9,	.2800,	.3300,	.2930,	.3050,	.2990,	.3040,	.3200,	.3220,	.3380,	.3440,
10,	.2940,	.3460,	.3080,	.3200,	.3130,	.3180,	.3360,	.3380,	.3550,	.3600,
11,	.3030,	.3570,	.3170,	.3300,	.3230,	.3280,	.3460,	.3480,	.3660,	.3720,
12,	.3120,	.3680,	.3270,	.3400,	.3330,	.3380,	.3570,	.3590,	.3770,	.3830,
13,	.3200,	.3770,	.3350,	.3470,	.3410,	.3460,	.3650,	.3670,	.3860,	.3920,
14,	.3230,	.3810,	.3390,	.3510,	.3450,	.3500,	.3690,	.3710,	.3900,	.3970,
15,	.3310,	.3900,	.3460,	.3590,	.3520,	.3580,	.3780,	.3800,	.3990,	.4060,
+gp,	.3350,	.3950,	.3510,	.3640,	.3570,	.3630,	.3830,	.3850,	.4040,	.4110,
0 SOPCOFAC,	1.0019,	1.0009,	.9963,	.9994,	1.0006,	.9995,	1.0013,	1.0030,	.9985,	1.0004,

Table 2 Catch weights at age (kg)

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
AGE										
0,	.0060,	.0060,	.0090,	.0080,	.0090,	.0090,	.0080,	.0090,	.0100,	.0090,
1,	.0110,	.0100,	.0230,	.0260,	.0240,	.0160,	.0170,	.0150,	.0270,	.0210,
2,	.0740,	.0450,	.0550,	.0470,	.0590,	.0480,	.0400,	.0360,	.0490,	.0470,
3,	.1190,	.0870,	.0850,	.0980,	.1390,	.0890,	.0630,	.0660,	.0750,	.0720,
4,	.1880,	.1590,	.1480,	.1710,	.2190,	.2170,	.2460,	.0930,	.1080,	.1050,
5,	.2770,	.2760,	.2880,	.2750,	.2390,	.2340,	.2600,	.3050,	.1580,	.1520,
6,	.3370,	.3220,	.3330,	.2680,	.2980,	.2620,	.2650,	.3050,	.3750,	.2960,
7,	.3180,	.3720,	.3600,	.3230,	.2950,	.3310,	.3010,	.3100,	.3830,	.3760,
8,	.3630,	.3630,	.3520,	.3290,	.3390,	.3600,	.4100,	.3330,	.3640,	.3290,
9,	.3790,	.3930,	.3500,	.3360,	.3500,	.3670,	.4250,	.3590,	.3820,	.3290,
10,	.3600,	.4070,	.3740,	.3410,	.3580,	.3860,	.4560,	.4130,	.4410,	.3410,
11,	.4200,	.3970,	.3840,	.3580,	.3510,	.3950,	.4600,	.4460,	.4100,	.3630,
12,	.4110,	.4220,	.3740,	.3850,	.3670,	.3930,	.4670,	.4010,	.4420,	.3850,
13,	.4390,	.4470,	.3940,	.3530,	.3750,	.4040,	.4460,	.4080,	.5170,	.3770,
14,	.4500,	.4650,	.3990,	.3810,	.3720,	.4010,	.4590,	.4390,	.4910,	.4510,
15,	.4440,	.4520,	.4110,	.3860,	.4270,	.4290,	.4650,	.4270,	.4640,	.4230,
+gp,	.4480,	.4520,	.4160,	.3860,	.4340,	.4370,	.4740,	.4310,	.4870,	.4290,
0 SOPCOFAC,	1.0014,	1.0017,	.9997,	1.0003,	.9995,	.9995,	1.0001,	1.0005,	.9991,	1.0036,

1

Run title : Herring spring-spawn (run: SVPBJA12/V12)

At 2/05/2000 18:23

Table 2 Catch weights at age (kg)

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
0,	.0080,	.0110,	.0110,	.0060,	.0060,	.0090,	.0070,	.0110,	.0120,	.0100,
1,	.0580,	.0530,	.0290,	.0530,	.0550,	.0790,	.0620,	.0910,	.1000,	.0880,
2,	.0850,	.1210,	.0620,	.1060,	.1170,	.1690,	.1320,	.1930,	.2100,	.1810,
3,	.1050,	.1770,	.1030,	.1610,	.1680,	.2410,	.1890,	.3160,	.2740,	.2930,
4,	.1710,	.2160,	.1540,	.2130,	.2220,	.3180,	.2500,	.3500,	.4240,	.3590,
5,	.2560,	.2500,	.2150,	.2390,	.2490,	.3580,	.2800,	.3980,	.4540,	.4160,
6,	.2160,	.2770,	.2580,	.2550,	.2650,	.3810,	.2980,	.4390,	.4950,	.4360,
7,	.2770,	.3050,	.2950,	.2770,	.2880,	.4130,	.3230,	.4950,	.5240,	.4820,
8,	.2980,	.3330,	.3220,	.2870,	.2990,	.4290,	.3360,	.5110,	.5960,	.4820,
9,	.3040,	.3530,	.3410,	.3240,	.3370,	.4840,	.3790,	.5580,	.6130,	.5390,
10,	.3050,	.3660,	.3540,	.3380,	.3520,	.5060,	.3960,	.5830,	.6500,	.5530,
11,	.3090,	.3770,	.3650,	.2570,	.2670,	.3840,	.3000,	.5370,	.5900,	.5180,
12,	.3570,	.3880,	.3760,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,
13,	.3480,	.3990,	.3870,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,
14,	.3570,	.4190,	.4060,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,
15,	.3670,	.4440,	.4300,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,
+gp,	.3760,	.4440,	.4300,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,
0 SOPCOFAC,	1.0030,	1.0001,	.9935,	1.0011,	1.0051,	1.0002,	1.0004,	.9991,	.9998,	1.0016,

Table 3.5.2.2 (continued)

Table 2 Catch weights at age (kg)

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
0	.0120	.0100	.0100	.0110	.0090	.0090	.0070	.0100	.0080	.0100
1	.1010	.0820	.0870	.0900	.0470	.0220	.0770	.0750	.0620	.0600
2	.2020	.1630	.1590	.1650	.1450	.0220	.0970	.0910	.0750	.2040
3	.2660	.1960	.2560	.2170	.2180	.2140	.0550	.1240	.1240	.1880
4	.3990	.2910	.3120	.2650	.2620	.2770	.2490	.1730	.1540	.2640
5	.4490	.3410	.3780	.3370	.3250	.2950	.2940	.2530	.1940	.2600
6	.4600	.3680	.4150	.3780	.3460	.3380	.3120	.2320	.2410	.2820
7	.4850	.3800	.4350	.4100	.3810	.3600	.3520	.3120	.2650	.3060
8	.4720	.3970	.4490	.4260	.4000	.3810	.3740	.3280	.3040	.3090
9	.6180	.4360	.4480	.4350	.4130	.3970	.3980	.3490	.3050	.3910
10	.6450	.4500	.5060	.4440	.4050	.4090	.4020	.3530	.3170	.4220
11	.6080	.4920	.4930	.4680	.4260	.4170	.4010	.3700	.3080	.3640
12	.5940	.4810	.4990	.4610	.4150	.4350	.4100	.3850	.3340	.4290
13	.5940	.4810	.4990	.4610	.4150	.4350	.4100	.3850	.3340	.4290
14	.5940	.4810	.4990	.4610	.4150	.4350	.4100	.3850	.3340	.4290
15	.5940	.4810	.4990	.4610	.4150	.4350	.4100	.3850	.3340	.4290
+gp	.5940	.4810	.4990	.4610	.4150	.4350	.4100	.3850	.3340	.4290
0 SOPCOFAC	.9999	1.0007	1.0001	.9981	.9999	.9997	1.0010	.9979	.9998	1.0007

Table 2 Catch weights at age (kg)

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
0	.0070	.0070	.0070	.0070	.0070	.0070	.0070	.0070	.0070	.0070
1	.0780	.0150	.0750	.0300	.0630	.0630	.0630	.0630	.0630	.0630
2	.1020	.1040	.1030	.1060	.1020	.1020	.1360	.0890	.1110	.0960
3	.2300	.2080	.1910	.1530	.1940	.1530	.1360	.1670	.1500	.1730
4	.2390	.2500	.2330	.2430	.2390	.1920	.1680	.1840	.2160	.2280
5	.2660	.2880	.3040	.2820	.2800	.2340	.2060	.2070	.2210	.2620
6	.3050	.3120	.3370	.3200	.3170	.2830	.2620	.2320	.2490	.2740
7	.3080	.3160	.3650	.3300	.3280	.3280	.3090	.2770	.2770	.2920
8	.3760	.3300	.3610	.3650	.3560	.3490	.3370	.3050	.3160	.3070
9	.4070	.3440	.3710	.3730	.3720	.3560	.3660	.3310	.3380	.3350
10	.4120	.3720	.4030	.3790	.3900	.3740	.3600	.3280	.3740	.3620
11	.4240	.3540	.3650	.3800	.3790	.3660	.3610	.3440	.3720	.3710
12	.4280	.3980	.3940	.3850	.3990	.3930	.3670	.3430	.3660	.3990
13	.4280	.3980	.4040	.3900	.4030	.3870	.3790	.3970	.3960	.3960
14	.4280	.3980	.4060	.3950	.4050	.4000	.3790	.3570	.3770	.4000
15	.4280	.3980	.4080	.4000	.4070	.4000	.3790	.5100	.4060	.4000
+gp	.4280	.3980	.4100	.4050	.4050	.4000	.3790	.5100	.4060	.4040
0 SOPCOFAC	.9992	1.0015	1.0024	.9981	1.0192	1.0000	1.0075	.9996	.9995	1.0020

Table 3.5.2.3

Run title : Herring spring-spawn (run: SVPBJA12/V12)

At 2/05/2000 18:23

Table 3 Stock weights at age (kg)

YEAR	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
AGE										
0	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010
1	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
2	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470	.0470
3	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
4	.2040	.2040	.2040	.2040	.2040	.1950	.2050	.1360	.2040	.2040
5	.2300	.2300	.2300	.2300	.2300	.2130	.2300	.2280	.2420	.2520
6	.2550	.2550	.2550	.2550	.2550	.2600	.2490	.2550	.2920	.2600
7	.2750	.2750	.2750	.2750	.2750	.2750	.2750	.2620	.2950	.2900
8	.2900	.2900	.2900	.2900	.2900	.2900	.2900	.2900	.2930	.3000
9	.3050	.3050	.3050	.3050	.3050	.3050	.3050	.3050	.3050	.3050
10	.3150	.3150	.3150	.3150	.3150	.3150	.3150	.3150	.3150	.3150
11	.3250	.3250	.3250	.3250	.3250	.3250	.3250	.3250	.3300	.3250
12	.3300	.3300	.3300	.3300	.3300	.3300	.3300	.3300	.3400	.3300
13	.3400	.3400	.3400	.3400	.3400	.3400	.3400	.3400	.3450	.3400
14	.3450	.3450	.3450	.3450	.3450	.3450	.3450	.3450	.3520	.3450
15	.3620	.3620	.3620	.3620	.3620	.3620	.3620	.3620	.3600	.3550
+gp	.3650	.3650	.3650	.3650	.3650	.3650	.3650	.3650	.3650	.3600

Table 3.5.2.3 (Continued)

Table 3 Stock weights at age (kg)

AGE	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,
2,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,
3,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.2040,	.2320,	.2190,	.1850,	.1940,	.1860,	.1850,	.1800,	.1150,	.1150,
5,	.2700,	.2500,	.2910,	.2530,	.2130,	.1990,	.2190,	.2280,	.2060,	.1450,
6,	.2910,	.2920,	.3000,	.2940,	.2640,	.2360,	.2220,	.2690,	.2660,	.2700,
7,	.2930,	.3020,	.3160,	.3120,	.3170,	.2600,	.2490,	.2700,	.2750,	.3000,
8,	.3210,	.3040,	.3240,	.3290,	.3630,	.3630,	.3060,	.2940,	.2740,	.3060,
9,	.3180,	.3230,	.3260,	.3270,	.3530,	.3500,	.3540,	.3240,	.2850,	.3080,
10,	.3200,	.3220,	.3350,	.3340,	.3490,	.3700,	.3770,	.4200,	.3500,	.3180,
11,	.3440,	.3210,	.3380,	.3410,	.3540,	.3600,	.3910,	.4300,	.3250,	.3400,
12,	.3490,	.3440,	.3340,	.3490,	.3570,	.3780,	.3790,	.3660,	.3630,	.3680,
13,	.3700,	.3570,	.3470,	.3410,	.3590,	.3870,	.3780,	.3680,	.4080,	.3600,
14,	.3790,	.3630,	.3540,	.3580,	.3650,	.3900,	.3610,	.4330,	.3880,	.3930,
15,	.3750,	.3650,	.3580,	.3750,	.4020,	.3940,	.3830,	.4140,	.3780,	.3970,
+gp,	.3800,	.3700,	.3580,	.3750,	.4020,	.3940,	.3830,	.4140,	.3780,	.3970,

Run title : Herring spring-spawn (run: SVPBJA12/V12)

At 2/05/2000 18:23

Table 3 Stock weights at age (kg)

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0150,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
2,	.0470,	.0800,	.0700,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,
3,	.1000,	.1000,	.1500,	.1700,	.1700,	.1810,	.1810,	.1810,	.1800,	.1780,
4,	.2090,	.1900,	.1500,	.2590,	.2590,	.2590,	.2590,	.2590,	.2940,	.2320,
5,	.2720,	.2250,	.1400,	.3420,	.3420,	.3420,	.3420,	.3430,	.3260,	.3590,
6,	.2300,	.2500,	.2100,	.3840,	.3840,	.3840,	.3840,	.3840,	.3710,	.3850,
7,	.2950,	.2750,	.2400,	.4090,	.4090,	.4090,	.4090,	.4090,	.4090,	.4200,
8,	.3170,	.2900,	.2700,	.4040,	.4440,	.4440,	.4440,	.4440,	.4610,	.4440,
9,	.3230,	.3100,	.3000,	.4610,	.4610,	.4610,	.4610,	.4610,	.4760,	.5050,
10,	.3250,	.3250,	.3250,	.5200,	.5200,	.5200,	.5200,	.5200,	.5200,	.5200,
11,	.3290,	.3350,	.3350,	.5340,	.5430,	.5430,	.5430,	.5430,	.5430,	.5510,
12,	.3800,	.3450,	.3450,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,
13,	.3700,	.3550,	.3550,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,
14,	.3800,	.3650,	.3650,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,
15,	.3910,	.3900,	.3900,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,
+gp,	.3910,	.3900,	.3900,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,

Table 3 Stock weights at age (kg)

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0150,	.0150,
2,	.0850,	.0850,	.0850,	.0850,	.0850,	.0230,	.0850,	.0550,	.0500,	.1000,
3,	.1750,	.1700,	.1700,	.1550,	.1400,	.1480,	.0540,	.0900,	.0980,	.1540,
4,	.2830,	.2240,	.2040,	.2490,	.2040,	.2340,	.2060,	.1430,	.1350,	.1750,
5,	.3470,	.3360,	.3030,	.3040,	.2950,	.2650,	.2650,	.2410,	.1970,	.2090,
6,	.4020,	.3780,	.3550,	.3680,	.3380,	.3120,	.2890,	.2790,	.2770,	.2520,
7,	.4210,	.3870,	.3830,	.4040,	.3760,	.3460,	.3390,	.2990,	.3150,	.3050,
8,	.4650,	.4080,	.3950,	.4240,	.3950,	.3700,	.3680,	.3160,	.3390,	.3670,
9,	.4650,	.3970,	.4130,	.4370,	.4070,	.3950,	.3910,	.3420,	.3430,	.3770,
10,	.5200,	.5200,	.4530,	.4360,	.4130,	.3970,	.3820,	.3430,	.3590,	.3590,
11,	.5340,	.5430,	.4680,	.4930,	.4220,	.4280,	.3880,	.3620,	.3650,	.3950,
12,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,
13,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,
14,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,
15,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,
+gp,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,

Table 3.5.2.3 (continued)

Table 3 Stock weights at age (kg)

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0110,	.0070,	.0080,	.0100,	.0180,	.0180,	.0180,	.0180,	.0180,
2,	.0480,	.0370,	.0300,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,
3,	.2190,	.1470,	.1280,	.0810,	.0750,	.0660,	.0760,	.0960,	.0740,	.1020,
4,	.1980,	.2100,	.2240,	.2010,	.1510,	.1380,	.1180,	.1180,	.1470,	.1500,
5,	.2580,	.2440,	.2960,	.2650,	.2540,	.2300,	.1880,	.1740,	.1740,	.2230,
6,	.2880,	.3000,	.3270,	.3230,	.3180,	.2960,	.2610,	.2290,	.2170,	.2400,
7,	.3090,	.3240,	.3550,	.3540,	.3710,	.3460,	.3160,	.2860,	.2420,	.2640,
8,	.4280,	.3360,	.3450,	.3580,	.3470,	.3880,	.3460,	.3230,	.2780,	.2830,
9,	.3700,	.3430,	.3670,	.3810,	.4120,	.3630,	.3740,	.3700,	.3040,	.3150,
10,	.4030,	.3820,	.3410,	.3690,	.3820,	.4090,	.3900,	.3780,	.3100,	.3450,
11,	.3870,	.3660,	.3610,	.3960,	.4070,	.4140,	.3900,	.3860,	.3590,	.3860,
12,	.4400,	.4250,	.4300,	.3930,	.4100,	.4220,	.3840,	.3600,	.3400,	.3860,
13,	.4400,	.4250,	.4700,	.3740,	.4100,	.4100,	.3980,	.3930,	.3440,	.3860,
14,	.4400,	.4250,	.4700,	.4030,	.4100,	.4100,	.3980,	.3910,	.3850,	.3820,
15,	.4400,	.4250,	.4700,	.4000,	.4100,	.4050,	.3980,	.3910,	.3630,	.3820,
+gp,	.4400,	.4250,	.4500,	.4000,	.4100,	.4470,	.3980,	.3910,	.3750,	.4070,

Table 3.5.2.4

Run title : Herring spring-spawn (run: SVPBJA12/V12)

At 2/05/2000 18:23

Table 5 Proportion mature at age

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0800,	.0800,	.0000,	.0800,	.0800,
4,	.1000,	.1000,	.1000,	.1000,	.1000,	.2200,	.2200,	.0000,	.2200,	.2200,
5,	.3000,	.3000,	.3000,	.3000,	.3000,	.3700,	.3700,	.5000,	.3700,	.3700,
6,	.6000,	.6000,	.6000,	.6000,	.6000,	.8500,	.8500,	.6000,	.8500,	.8500,
7,	.9000,	.9000,	.9000,	.9000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
3,	.0800,	.0400,	.0000,	.0400,	.0200,	.0000,	.0100,	.0000,	.0000,	.6200,
4,	.2200,	.3500,	.1100,	.0300,	.0600,	.3400,	.1500,	.0100,	.0000,	.8900,
5,	.3700,	.6800,	.6700,	.3200,	.2800,	.3500,	1.0000,	.2300,	.0100,	.9500,
6,	.8500,	.9400,	1.0000,	.9000,	.3200,	.7600,	.9600,	1.0000,	.7600,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

1

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 2/05/2000 18:23

Table 5 Proportion mature at age

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.1000,	.1000,	.1000,	.1000,	.0000,	.0000,	.0000,
3,	.0600,	.1000,	.0000,	.5000,	.5000,	.5000,	.5000,	.7300,	.1300,	.1000,
4,	.1300,	.2500,	.1000,	.9000,	.9000,	1.0000,	.9000,	.8900,	.9000,	.6200,
5,	.3100,	.6000,	.2500,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9500,
6,	.1700,	.9000,	.6000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 3.5.2.4 (continued)

Table 5 Proportion mature at age

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
3	.2500	.3000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
4	.5000	.5000	.4800	.5000	.5000	.5000	.2000	.3000	.3000	.3000
5	.9700	.9000	.7000	.6900	.9000	.9000	.9000	.9000	.9000	.9000
6	1.0000	1.0000	1.0000	.7100	.9500	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5 Proportion mature at age

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
3	.4000	.1000	.1000	.0100	.0100	.0000	.0000	.0000	.0000	.0000
4	.8000	.7000	.2000	.3000	.3000	.0100	.0100	.3000	.3000	.3000
5	.9000	1.0000	.8000	.8000	.8000	.8000	.4500	.9000	.9000	.9000
6	.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

1

Table 3.5.4.1. Exploratory tuning series - Norwegian spring spawning

Run number	Explanation
1	Pooling older than 13, tags 2 years in sea,
2	No tuning 1993 yearclass,
3	One extra year of tag mixing,
4	Larvae production index,
5	Larvae index,
6	One extra year of tag mixing, larvae index,
7	Previous year, present model, no tagging,
8	Previous year, previous model, no tagging,

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8
SSB 2000	6.46	5.81	6.66	6.85	6.64	6.85		
SSB 1999	7.13	6.56	7.33	7.49	7.31	7.51	8.94	10.45
SSB 1998	8.13	7.61	8.34	8.50	8.32	8.53	8.72	10.03
SSB 1997	8.84	8.43	9.04	9.16	9.03	9.22	9.47	10.73
SSB 1996	5.01	4.82	5.04	5.11	5.09	5.12	5.24	5.91
Total log-likelihood	-334.68	-322.33	-314.95	-396.43	-384.62	-364.81	-100.27	-96.41
Log-likelihood acoustics per term	-1.66	-1.68	-1.66	-1.66	-1.66	-1.66	-1.67	-1.61
Number acoustic terms	79.00	71.00	79.00	79.00	79.00	79.00	60.00	60.00
Log-likelihood tags per term	-2.01	-2.01	-1.94	-2.02	-2.01	-1.94		
Number tag terms	101.00	101.00	95.00	101.00	101.00	95.00	0.00	0.00
Log-likelihood larvae per term				-4.40	-2.93	-2.93		
Number larvae terms	0.00	0.00	0.00	14.00	17.00	17.00	0.00	0.00
Catchability spawning grounds	0.74	0.80	0.74	0.74	0.74	0.74	0.72	0.63
Catchability Ofoten December	0.49	0.49	0.49	0.48	0.48	0.48	0.46	0.41
Catchability Ofoten January	0.80	0.84	0.79	0.78	0.78	0.78	0.74	0.65
Catchability Norwegian Sea	0.94	1.05	0.93	0.91	0.92	0.91	0.99	0.86
TerminalF83	0.26	0.30	0.26	0.25	0.25	0.25	0.21	0.14
TerminalF90	0.21	0.22	0.21	0.20	0.20	0.20	0.18	0.15
TerminalF91	0.19	0.20	0.18	0.18	0.19	0.18	0.14	0.12
TerminalF92	0.16	0.17	0.15	0.15	0.15	0.15	0.11	0.10
TerminalF93	0.12		0.12	0.11	0.12	0.12		
CV surveys	0.43	0.44	0.43	0.43	0.43	0.43	0.40	0.37
Catchability larvae production				11.43				
Catchability larvae index					3.83	3.81		
TaggingSurvival	0.50	0.48	0.49	0.50	0.50	0.50		

Table 3.5.5.1

NORWEGIAN SPRING-SPAWNING HERRING recruits as 3-year-olds

6,27,2

1973	848	5	-11	-11	-11	-11	-11
1974	563	1	-11	-11	-11	-11	-11
1975	192	0.25	-11	-11	-11	-11	-11
1976	669	0.25	-11	-11	-11	-11	-11
1977	333	1	-11	-11	-11	-11	-11
1978	409	2	-11	-11	-11	-11	-11
1979	807	9	-11	-11	-11	-11	-11
1980	102	0.25	-11	-11	-11	-11	-11
1981	71	0.25	-11	-11	-11	-11	-11
1982	152	0.25	-11	-11	-11	-11	-11
1983	21258	177	-11	-11	-11	-11	-11
1984	758	34	-11	-11	-11	-11	-11
1985	4013	23	-11	-11	-11	-11	-11
1986	398	0.25	-11	-11	-11	-11	-11
1987	1104	0.25	-11	-11	54	-11	70
1988	1696	3	-11	-11	-11	-11	820
1989	5342	58	-11	5200	-11	1247	1905
1990	9189	31	24300	14000	676	2389	3431
1991	24919	119	32600	25800	7621	3708	3781
1992	29790	105	102700	59200	7638	5133	10442
1993	6351	75	6600	7700	-11	3008	-11
1994	-11	28	500	250	381	661	1938
1995	-11	16	100	40	337	441	199
1996	-11	65	2600	4700	1996	2425	-11
1997	-11	39	9500	4900	-11	-11	-11
1998	-11	59	49500	-11	-11	-11	-11
1999	-11	41	-11	-11	-11	-11	-11

BS 0-gr (log index*100)
BS 1-gr (million)
BS 2-gr (million)
Spawn 4 (million)
Dec 3 (million)
Jan 4 (million)

Table 3.5.5.2

Analysis by RCT3 ver3.1 of data from file :

c:\npel99\nssh\recruit\nsshrcrt.txt

NORWEGIAN SPRING-SPAWNING HERRING recruits as 3-year-olds

Data for 6 surveys over 26 years : 1973 - 1998

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Year class = 1993

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression---------I					I-----------Prediction---------I			
BS 0-g	.05	5.84	1.68	.624	20	75.00	9.39	1.940	.020
BS 1-g	1.10	-1.68	.74	.612	3	8.79	8.01	2.690	.010
BS 2-g	.87	1.21	.28	.932	4	8.95	9.00	.493	.303
Spawn									
Dec 3	1.44	-1.62	.21	.961	4	8.01	9.88	.337	.650
Jan 4									
					VPA Mean =		7.81	2.060	.017

Year class = 1994

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression---------I					I-----------Prediction---------I			
BS 0-g	.05	5.90	1.68	.622	20	28.00	7.21	1.941	.030
BS 1-g	1.10	-1.67	.74	.612	3	6.22	5.18	5.567	.004
BS 2-g	.87	1.21	.29	.932	4	5.53	6.02	1.090	.097
Spawn	.72	4.20	.40	.962	4	5.95	8.47	.668	.258
Dec 3	1.44	-1.63	.21	.961	4	6.50	7.70	.531	.407
Jan 4	.89	2.44	.60	.875	6	7.57	9.14	.805	.177
					VPA Mean =		7.93	2.042	.028

Year class = 1995

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression---------I					I-----------Prediction---------I			
BS 0-g	.05	5.99	1.66	.623	20	16.00	6.72	1.970	.038
BS 1-g	1.10	-1.65	.75	.611	3	4.62	3.42	7.581	.003
BS 2-g	.87	1.21	.29	.931	4	3.71	4.44	1.511	.065
Spawn	.72	4.21	.41	.962	4	5.82	8.38	.689	.314
Dec 3	1.44	-1.63	.21	.961	4	6.09	7.12	.637	.367
Jan 4	.89	2.41	.61	.874	6	5.30	7.12	.922	.175
					VPA Mean =		8.07	2.012	.037

Table 3.5.5.2 (Continued)

Year class = 1996

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
BS 0-g	.04	6.10	1.62	.627	20	65.00	9.02	1.947	.074
BS 1-g	1.10	-1.62	.76	.611	3	7.86	7.00	3.910	.018
BS 2-g	.87	1.21	.29	.931	4	8.46	8.57	.581	.835
Spawn									
Dec 3									
Jan 4									
					VPA Mean =		8.22	1.970	.073

Year class = 1997

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
BS 0-g	.04	6.23	1.56	.637	20	39.00	7.93	1.911	.397
BS 1-g	1.09	-1.58	.78	.611	3	9.16	8.43	2.650	.207
BS 2-g									
Spawn									
Dec 3									
Jan 4									
					VPA Mean =		8.36	1.915	.396

Year class = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
BS 0-g	.04	6.39	1.48	.653	20	59.00	8.86	1.863	.497
BS 1-g									
BS 2-g									
Spawn									
Dec 3									
Jan 4									
					VPA Mean =		8.52	1.852	.503

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1993	14010	9.55	.27	.25	.82		
1994	2905	7.97	.34	.35	1.09		
1995	1561	7.35	.39	.41	1.11		
1996	5144	8.55	.53	.15	.08		
1997	3655	8.20	1.20	.16	.02		
1998	5908	8.68	1.31	.17	.02		

Table 3.5.6.1

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 2/05/2000 18:23
Traditional vpa using screen input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,
AGE										
0,	.0104,	.0174,	.2455,	.1082,	.4996,	.3874,	.3408,	.3741,	.6958,	.0689,
1,	.1217,	.0390,	.2699,	.2894,	.4172,	.5567,	.5949,	.8901,	.9181,	.7079,
2,	.0658,	.0661,	.0160,	.0505,	.1521,	.0987,	.5132,	.2514,	1.2040,	.5811,
3,	.0278,	.0013,	.0118,	.0171,	.0424,	.0320,	.0426,	.0462,	.0414,	.1058,
4,	.0508,	.0465,	.0141,	.0165,	.0396,	.0537,	.1079,	.1763,	.0431,	.0781,
5,	.0410,	.0581,	.0908,	.0279,	.0612,	.0692,	.0756,	.0844,	.0689,	.0769,
6,	.0709,	.0440,	.0565,	.0674,	.0799,	.0605,	.1097,	.0687,	.0612,	.1160,
7,	.0884,	.0839,	.0673,	.0415,	.1184,	.0808,	.0723,	.1105,	.0728,	.0990,
8,	.0446,	.1085,	.0779,	.0448,	.0800,	.0854,	.1111,	.0587,	.0689,	.1150,
9,	.0346,	.0527,	.0873,	.0810,	.1009,	.0666,	.1049,	.0891,	.0714,	.0987,
10,	.0375,	.0390,	.0668,	.1173,	.1476,	.1270,	.1307,	.0930,	.1105,	.1140,
11,	.0369,	.0427,	.0490,	.0645,	.1846,	.1325,	.1759,	.1163,	.1330,	.1475,
12,	.0379,	.0556,	.0544,	.0641,	.1175,	.1098,	.1647,	.1469,	.1741,	.1777,
13,	.0666,	.0602,	.0682,	.0584,	.0886,	.1012,	.1147,	.1209,	.1249,	.2207,
14,	.0780,	.0787,	.0545,	.0789,	.1039,	.0949,	.1424,	.1208,	.0736,	.1678,
15,	.0459,	.0697,	.0726,	.0782,	.1304,	.1044,	.1295,	.1000,	.0820,	.1127,
+gp,	.0459,	.0697,	.0726,	.0782,	.1304,	.1044,	.1295,	.1000,	.0820,	.1127,
0 FBAR 5-14,	.0536,	.0623,	.0673,	.0646,	.1083,	.0928,	.1202,	.1009,	.0960,	.1333,

Table 8 Fishing mortality (F) at age

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
AGE										
0,	.1068,	.1360,	.3679,	.0451,	.0621,	.5500,	.1392,	.1961,	.7997,	.0921,
1,	.1421,	.4130,	.2658,	.9250,	.0665,	.1786,	.7192,	1.7622,	.7439,	1.6597,
2,	.6955,	.0835,	.0871,	.4621,	.5117,	.1927,	.2389,	.3323,	.6937,	1.7485,
3,	.7587,	.1583,	.1028,	.1240,	.0612,	.6737,	.3137,	.5034,	3.2066,	2.0406,
4,	.1698,	.0927,	.0525,	.0588,	.0840,	.1789,	.4085,	1.1192,	4.5599,	.2604,
5,	.1041,	.0497,	.0442,	.0424,	.1886,	.1573,	.5321,	.8593,	4.7169,	.7590,
6,	.0916,	.0705,	.1097,	.0310,	.1391,	.2997,	.5982,	1.3102,	1.8048,	.6023,
7,	.0985,	.0928,	.1213,	.0698,	.0309,	.2829,	.7536,	1.6834,	1.2122,	.3507,
8,	.0804,	.0802,	.0718,	.1458,	.0725,	.4469,	1.3073,	1.4826,	.9377,	.4226,
9,	.1278,	.0675,	.0976,	.0700,	.2847,	.2423,	.9790,	1.3296,	1.5726,	.6056,
10,	.1357,	.1117,	.0907,	.2443,	.3074,	.3472,	1.3436,	1.4501,	1.2945,	.6310,
11,	.1449,	.1118,	.1256,	.2153,	.3356,	.8375,	1.0666,	1.0905,	1.3198,	.6261,
12,	.2138,	.1117,	.1666,	.2626,	.2856,	.6639,	.5451,	1.2609,	.7483,	.8732,
13,	.1925,	.1012,	.1302,	.2729,	.3657,	.6932,	1.3723,	1.1286,	1.9490,	.3927,
14,	.2032,	.1069,	.1628,	.3429,	.3634,	.6227,	1.4701,	1.9718,	1.2342,	.8364,
15,	.1387,	.1057,	.1466,	.2569,	.3195,	.6204,	1.1880,	1.4777,	1.3620,	.5776,
+gp,	.1387,	.1057,	.1466,	.2569,	.3195,	.6204,	1.1880,	1.4777,	1.3620,	.5776,
0 FBAR 5-14,	.1393,	.0904,	.1121,	.1697,	.2374,	.4594,	.9968,	1.3567,	1.6790,	.6100,

Run title : Herring spring-spawn (run: SVPBJA12/V12)

At 2/05/2000 18:23
Traditional vpa using screen input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
0,	.3347,	.2441,	.7939,	.0035,	.0118,	.0159,	.0030,	.0130,	.0050,	.0040,
1,	.2501,	.4295,	1.7489,	.0323,	.0023,	.0016,	.0031,	.0023,	.0018,	.0023,
2,	1.2205,	.1204,	.9309,	.7288,	.0937,	.0013,	.0013,	.0099,	.0011,	.0035,
3,	.5307,	.2855,	.0983,	.4069,	.1233,	.1561,	.0300,	.0432,	.0171,	.0103,
4,	1.4843,	.1419,	1.2887,	.0893,	.0609,	.2243,	.3938,	.0365,	.0286,	.0124,
5,	.2998,	.3119,	.9578,	.8552,	.1115,	.3212,	.0022,	.0354,	.0379,	.0192,
6,	.6842,	.2794,	1.8090,	1.5110,	.9654,	.1880,	.0005,	.0026,	.1147,	.0251,
7,	1.1086,	.4857,	1.2502,	1.1078,	.7734,	.0379,	.1083,	.2687,	.0030,	.0544,
8,	1.1726,	1.6241,	2.9486,	1.3527,	.0086,	.0141,	.0090,	.1158,	.7485,	.0035,
9,	1.1825,	2.5238,	1.7610,	.0147,	.0192,	.0101,	.0083,	.0106,	.0690,	.0021,
10,	1.3751,	1.9510,	.0388,	.0293,	.0174,	.0228,	.0119,	.0097,	.0124,	.0427,
11,	1.5563,	2.2737,	1.5553,	.0471,	.0351,	.0206,	.0271,	.0140,	.0114,	.0146,
12,	3.9033,	1.8357,	2.0473,	.0090,	.0576,	.0424,	.0244,	.0325,	.0165,	.0134,
13,	1.6255,	.2170,	1.1132,	.0136,	.0105,	.0714,	.0517,	.0291,	.0391,	.0195,
14,	.8120,	2.7742,	.3301,	1.2442,	.0161,	.0124,	.0899,	.0636,	.0350,	.0474,
15,	1.4061,	2.0280,	2.1062,	.6032,	.0165,	.0190,	.0146,	.1157,	.0793,	.0422,
+gp,	1.4061,	2.0280,	2.1062,	.6032,	.0165,	.0190,	.0146,	.1157,	.0793,	.0422,
0 FBAR 5-14,	1.3720,	1.4276,	1.3812,	.6185,	.2015,	.0741,	.0333,	.0582,	.1088,	.0242,

Table 3.5.6.1 (continued)

Table 8 Fishing mortality (F) at age

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
0,	.0068,	.0116,	.0148,	.0006,	.0045,	.0007,	.0035,	.0013,	.0009,	.0001,
1,	.0002,	.0027,	.0038,	.0076,	.0000,	.0043,	.0001,	.0039,	.0006,	.0003,
2,	.0006,	.0089,	.0012,	.0144,	.0101,	.0060,	.0025,	.0055,	.0140,	.0140,
3,	.0210,	.0110,	.0182,	.0340,	.0701,	.1654,	.0277,	.0285,	.0170,	.0078,
4,	.0110,	.0178,	.0247,	.0333,	.0705,	.3436,	.1875,	.0308,	.0435,	.0011,
5,	.0179,	.0193,	.0207,	.0357,	.1211,	.3000,	.5875,	.2929,	.0407,	.0117,
6,	.0272,	.0205,	.0166,	.0339,	.0841,	.3781,	.4797,	.2553,	.2236,	.0289,
7,	.0426,	.0179,	.0216,	.0214,	.0853,	.3991,	.5624,	.3946,	.4372,	.1131,
8,	.0920,	.0268,	.0238,	.0169,	.0592,	.5933,	1.2624,	.2676,	.6414,	.1497,
9,	.0333,	.0916,	.0233,	.0257,	.1171,	.3356,	1.2486,	.6434,	.2055,	.1275,
10,	.0025,	.6964,	.0399,	.0338,	.1136,	.2228,	.8276,	1.0630,	1.4616,	.0619,
11,	.0553,	.3917,	.5462,	.0575,	.0359,	.3073,	.8219,	.0924,	1.0588,	.9170,
12,	.0173,	.0240,	.1999,	2.2586,	.0005,	.3953,	2.0562,	.9048,	.0876,	.7529,
13,	.0158,	.0205,	.0035,	3.2773,	.2937,	.0006,	2.1502,	1.5336,	.8806,	.0102,
14,	.0232,	.0186,	.0243,	.0298,	.2407,	.5035,	.0007,	1.4985,	4.7159,	.1734,
15,	.0581,	.0276,	.0221,	.0290,	.0698,	.3792,	1.3962,	.4168,	.3809,	.0897,
+gp,	.0581,	.0276,	.0221,	.0290,	.0698,	.3792,	1.3962,	.4168,	.3809,	.0897,
0 FBAR 5-14,	.0327,	.1327,	.0920,	.5791,	.1151,	.3436,	.9997,	.6946,	.9753,	.2346,

Table 8 Fishing mortality (F) at age

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	FBAR 97-99
AGE											
0,	.0000,	.0000,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0056,	.0004,	.0001,	.0002,	.0002,	.0001,	.0086,	.0096,	.0081,	.0007,	.0061,
3,	.0183,	.0054,	.0025,	.0033,	.0014,	.0021,	.0050,	.0674,	.0556,	.0240,	.0490,
4,	.0084,	.0032,	.0248,	.0254,	.0152,	.0176,	.0305,	.0466,	.1629,	.0344,	.0813,
5,	.0044,	.0052,	.0067,	.0801,	.1072,	.1056,	.0979,	.0948,	.0783,	.1215,	.0982,
6,	.0266,	.0063,	.0052,	.0137,	.2018,	.2615,	.2172,	.1644,	.1201,	.1168,	.1338,
7,	.0240,	.0260,	.0060,	.0186,	.0293,	.4514,	.2500,	.2587,	.1411,	.1452,	.1817,
8,	.0531,	.0277,	.0200,	.0176,	.0500,	.0350,	.3523,	.3078,	.1888,	.1769,	.2245,
9,	.4384,	.1310,	.0342,	.0791,	.0263,	.1230,	.0153,	.3409,	.1827,	.2038,	.2425,
10,	.6363,	.2163,	.1762,	.0763,	.2019,	.0596,	.0733,	.0650,	.3995,	.2106,	.2250,
11,	.0559,	.0455,	.4904,	.0001,	.1565,	.9287,	.0700,	.4893,	.1040,	.2174,	.2702,
12,	1.6749,	.0193,	.1664,	.0012,	.3500,	.3249,	.4707,	.1224,	.0824,	.2242,	.1430,
13,	.4237,	1.6296,	.0413,	.0009,	.9446,	1.1850,	.5246,	1.3926,	.2083,	.2310,	.6106,
14,	.0220,	1.9531,	.0483,	.0000,	.1000,	4.0282,	.0007,	.4387,	6.9098,	.2378,	2.5288,
15,	.1527,	.0238,	.0286,	.0592,	.1000,	.0000,	.3033,	.2616,	.2083,	.2446,	.2382,
+gp,	.1527,	.0238,	.0286,	.0592,	.1000,	.0000,	.3033,	.2616,	.2083,	.2446,	
FBAR 5-14,	.3359,	.4060,	.0995,	.0288,	.2168,	.7503,	.2072,	.3675,	.8415,	.1885,	

Table 3.5.6.2

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 2/05/2000 18:23
Traditional vpa using screen input for terminal F
Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,
AGE										
0,	7473747,	1439079,	938988,	835771,	397029,	237538,	274748,	236506,	278105,	4053427,
1,	262358,	3007097,	575014,	298670,	304949,	97946,	65556,	79447,	66148,	56387,
2,	142205,	94445,	1175817,	178474,	90917,	81693,	22821,	14702,	13263,	10738,
3,	108558,	54134,	35944,	470458,	68991,	31748,	30092,	5554,	4649,	1618,
4,	40165,	90878,	46533,	30573,	398069,	56914,	26464,	24821,	4564,	3839,
5,	49706,	32858,	74664,	39490,	25883,	329322,	46426,	20449,	17911,	3763,
6,	85994,	41064,	26685,	58688,	33055,	20954,	264511,	37050,	16177,	14389,
7,	79923,	68950,	33821,	21705,	47220,	26265,	16977,	204017,	29773,	13096,
8,	19630,	62971,	54572,	27216,	17923,	36105,	20851,	13593,	157223,	23826,
9,	28024,	16159,	48627,	43450,	22398,	14241,	28532,	16060,	11033,	126308,
10,	32020,	23300,	13194,	38355,	34489,	17428,	11467,	22112,	12644,	8841,
11,	25817,	26545,	19288,	10623,	29358,	25611,	13211,	8660,	17343,	9744,
12,	56309,	21416,	21893,	15808,	8572,	21008,	19308,	9537,	6636,	13068,
13,	61467,	46664,	17436,	17846,	12761,	6559,	16201,	14095,	7087,	4799,
14,	9515,	49494,	37816,	14018,	14488,	10052,	5102,	12433,	10750,	5384,
15,	25669,	7575,	39378,	30821,	11151,	11239,	7869,	3809,	9483,	8596,
+gp,	56929,	48758,	47336,	73642,	59483,	51748,	42150,	27995,	25443,	15205,
0 TOTAL,	8558036,	5131387,	3207006,	2205608,	1576735,	1076372,	912286,	750839,	688233,	4373027,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,
AGE										
0,	1913386,	732827,	177124,	1646402,	905560,	79326,	453493,	35822,	46386,	96073,
1,	1538204,	699104,	260052,	49847,	639834,	345996,	18608,	160413,	11970,	8476,
2,	11294,	542521,	188063,	81052,	8036,	243395,	117663,	3686,	11196,	2313,
3,	2442,	2291,	202893,	70081,	20760,	1959,	81610,	37672,	1075,	2275,
4,	1253,	984,	1683,	157564,	53282,	16807,	859,	51327,	19600,	37,
5,	3056,	910,	772,	1374,	127875,	42166,	12097,	492,	14426,	177,
6,	2999,	2370,	745,	636,	1134,	91146,	31010,	6115,	179,	111,
7,	11028,	2355,	1901,	575,	531,	849,	58137,	14675,	1420,	25,
8,	10209,	8601,	1847,	1450,	461,	443,	551,	23551,	2346,	364,
9,	18279,	8109,	6833,	1480,	1078,	369,	244,	128,	4602,	791,
10,	98496,	13846,	6524,	5334,	1188,	698,	249,	79,	29,	822,
11,	6790,	74015,	10658,	5128,	3596,	752,	425,	56,	16,	7,
12,	7237,	5056,	56966,	8091,	3559,	2213,	280,	126,	16,	4,
13,	9416,	5030,	3892,	41507,	5355,	2302,	980,	140,	31,	7,
14,	3312,	6686,	3913,	2940,	27193,	3198,	991,	214,	39,	4,
15,	3918,	2327,	5171,	2862,	1796,	16274,	1476,	196,	26,	10,
+gp,	10102,	4117,	6834,	5918,	11413,	4140,	7024,	1235,	216,	49,
0 TOTAL,	3651422,	2111147,	935871,	2082239,	1812651,	852033,	785697,	335927,	113573,	111544,

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Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 2/05/2000 18:23

Traditional vpa using screen input for terminal F
Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,
AGE										
0,	6207,	2098,	9074,	127017,	85007,	29426,	100187,	50393,	61332,	124347,
1,	35624,	1806,	668,	1668,	51461,	34155,	11775,	40609,	20224,	24812,
2,	655,	11279,	478,	47,	657,	20874,	13864,	4773,	16472,	8207,
3,	164,	79,	4065,	77,	9,	243,	8476,	5629,	1921,	6690,
4,	254,	83,	51,	3172,	44,	7,	179,	7080,	4641,	1626,
5,	25,	50,	62,	12,	2497,	36,	5,	104,	5875,	3881,
6,	71,	16,	31,	20,	4,	1922,	22,	4,	86,	4868,
7,	52,	31,	10,	4,	4,	1,	1371,	19,	4,	66,
8,	15,	15,	16,	3,	1,	2,	1,	1059,	13,	3,
9,	205,	4,	3,	1,	1,	1,	1,	1,	812,	5,
10,	371,	54,	0,	0,	1,	0,	1,	1,	1,	652,
11,	376,	81,	7,	0,	0,	1,	0,	1,	1,	1,
12,	3,	68,	7,	1,	0,	0,	0,	0,	1,	1,
13,	1,	0,	9,	1,	1,	0,	0,	0,	0,	1,
14,	4,	0,	0,	3,	1,	1,	0,	0,	0,	0,
15,	1,	1,	0,	0,	1,	1,	1,	0,	0,	0,
+gp,	27,	0,	0,	0,	1,	1,	1,	0,	0,	0,
0 TOTAL,	44057,	15664,	14482,	132026,	139688,	86671,	135886,	109675,	111382,	175161,

Table 3.5.6.2 (continued)

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
0	15393	10919	23297	3184150	114033	600835	60562	166920	254118	795332
1	50355	6216	4388	9333	1293797	46154	244105	24538	67779	103221
2	10064	20468	2520	1777	3766	526008	18684	99237	9937	27540
3	3325	4089	8248	1024	712	1516	212582	7577	40126	3984
4	5699	2803	3481	6971	851	572	1106	177969	6339	33954
5	1382	4851	2370	2923	5804	683	349	789	148534	5223
6	3277	1168	4096	1998	2428	4426	435	167	507	122746
7	4086	2745	985	3467	1662	1921	2610	232	111	349
8	54	3370	2321	830	2921	1314	1109	1280	135	62
9	3	42	2824	1951	702	2370	625	270	843	61
10	4	2	33	2375	1636	538	1458	154	122	591
11	538	4	1	28	1976	1257	370	549	46	24
12	1	438	2	0	22	1641	796	140	431	14
13	1	1	368	2	0	19	951	88	49	339
14	0	1	0	316	0	0	17	95	16	17
15	0	0	0	0	264	0	0	14	18	0
+gp	0	0	0	0	0	90	35	0	0	0
0 TOTAL	94183	57118	54937	3217144	1430576	1189342	545793	480020	529111	1093458

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	GMST	AMST
AGE									50-97	50-97			
0	1367503	3708531	4433418	1113236	323168	210382	937253	659480	0	0	0	231709	850520
1	323314	555979	1507776	1802483	452567	131388	85535	381058	268125	0	0	81866	330393
2	41955	131447	226023	613015	732834	184000	53418	34776	154927	109011	0	24727	121856
3	11042	16962	53422	91886	249189	297898	74802	21533	14004	62478	44290	8298	49210
4	3402	9331	14521	45864	78824	214177	255870	64064	17325	11402	52500	5838	41024
5	29191	2904	8005	12192	38485	66824	181134	213617	52631	12670	9482	3884	32950
6	4444	25015	2486	6844	9685	29756	51751	141360	167237	41889	9658	2514	24055
7	102644	3724	21394	2129	5811	6813	19719	35848	103229	127651	32080	1614	17730
8	268	86250	3123	18303	1799	4857	3734	13218	23822	77157	95021	1036	13121
9	46	219	72208	2635	15479	1473	4037	2259	8362	16976	55642	631	10538
10	46	25	165	60059	2095	12977	1121	3422	1383	5995	11918	417	8938
11	478	21	18	119	47896	1474	10524	896	2760	798	4180	267	7382
12	8	389	17	9	103	35254	501	8446	473	2141	553	171	6779
13	6	1	329	13	8	62	21925	269	6432	375	1473	93	6209
14	289	3	0	271	11	3	16	11168	58	4495	256	53	4787
15	13	244	0	0	233	8	0	14	6198	0	3050	26	3968
+gp	24	5	0	0	0	0	0	0	0	3166	2134		
TOTAL	1884671	4541049	6342907	3769059	1958188	1197346	1701338	1591429	826965	476205	322236		

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Table 3.5.6.3

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 2/05/2000 18:23

Traditional vpa using screen input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
AGE										
0	74737	14391	9390	8358	3970	2375	2747	2365	2781	40534
1	20989	240568	46001	23894	24396	7836	5244	6356	5292	4511
2	66837	44389	552634	83883	42731	38396	10726	6910	6234	5047
3	108558	54134	35944	470458	68991	31748	30092	5554	4649	1618
4	81936	185391	94927	62369	812060	110983	54252	33756	9311	7832
5	114323	75574	171727	90828	59530	701456	106781	46624	43345	9482
6	219285	104712	68046	149653	84290	54480	658633	94478	47236	37412
7	219789	189613	93007	59690	129854	72230	46685	534524	87831	37980
8	56926	182615	158259	78927	51977	104703	60469	39420	460663	71477
9	85474	49285	148313	132523	68313	43434	87023	48982	33650	385239
10	100863	73395	41561	120818	108642	54899	36121	69653	39829	27850
11	83905	86272	62687	34524	95412	83235	42936	28146	57231	31669
12	185821	70672	72246	52166	28286	69326	63717	31472	22562	43124
13	208988	158658	59283	60675	43388	22302	55083	47924	24451	16315
14	32827	170756	130466	48363	49985	34680	17603	42893	37841	18574
15	92923	27421	142548	111573	40366	40685	28485	13788	34139	30517
+gp	207790	177966	172778	268794	217113	188878	153848	102182	92867	54738
0 TOTALBIO	1961972	1905812	2059817	1857495	1929304	1661649	1460445	1155027	1009911	823918

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
AGE										
0	19134	7328	1771	16464	9056	793	4535	358	464	961
1	123056	55928	20804	3988	51187	27680	1489	12833	958	678
2	5308	254985	88390	38094	3777	114396	55302	1732	5262	1087
3	2442	2291	202893	70081	20760	1959	81610	37672	1075	2275
4	2555	2283	3685	291492	103368	31261	1590	92389	22540	43
5	8252	2275	2247	3477	272374	83911	26492	1121	29718	256
6	8726	6922	2235	1869	2993	215104	68842	16450	477	300
7	32312	7112	6008	1793	1682	2208	144762	39622	3905	76
8	32772	26148	5986	4769	1675	1607	1685	69240	6428	1113
9	58128	26191	22275	4839	3807	1292	863	416	13116	2435
10	315187	44585	21854	17816	4145	2583	940	331	102	2614
11	23357	237588	36024	17486	12729	2706	1660	241	52	23
12	25257	17392	190266	28236	12704	8363	1061	460	59	13
13	34841	17957	13504	141538	19225	8908	3706	514	125	24
14	12553	24268	13851	10527	99253	12471	3576	926	151	15
15	14692	8492	18513	10732	7221	64121	5655	811	97	39
+gp	38387	15234	24467	22192	45879	16313	26900	5113	818	193
0 TOTALBIO	756960	756978	674773	685393	671834	595675	430668	280231	85347	12145

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Run title : Herring spring-spawn (run: SVPBJA12/V12)

At 2/05/2000 18:23

Traditional vpa using screen input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
AGE										
0	62	21	91	1270	850	294	1002	504	613	1243
1	2850	271	67	167	5146	3416	1178	4061	2022	2481
2	308	9023	334	40	558	17743	11785	4057	14002	6976
3	164	79	6098	130	16	440	15341	10189	3458	11908
4	532	157	76	8215	114	18	463	18337	13643	3772
5	68	112	87	41	8538	122	17	356	19153	13934
6	164	40	66	78	17	7381	85	16	320	18744
7	154	85	25	18	16	6	5606	78	15	278
8	49	43	44	10	6	7	5	4700	58	14
9	662	13	8	3	3	5	6	5	3863	26
10	1207	176	1	2	3	2	5	6	5	3390
11	1238	271	22	1	2	3	2	4	5	4
12	12	236	25	6	1	1	2	2	3	4
13	5	0	33	4	5	1	1	2	1	3
14	15	1	0	13	3	4	1	1	2	1
15	5	6	0	0	3	3	4	0	1	1
+gp	104	0	0	0	3	3	4	0	1	1
0 TOTALBIO	7599	10532	6977	10000	15283	29448	35506	42318	57164	62781

Table 3.5.6.3 (continued)

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
0,	154,	109,	233,	31842,	1140,	6008,	606,	1669,	2541,	7953,
1,	5036,	622,	439,	933,	129380,	4615,	24411,	2454,	10167,	15483,
2,	8555,	17398,	2142,	1511,	3201,	120982,	15881,	54581,	4969,	27540,
3,	5819,	6952,	14022,	1586,	997,	2243,	114794,	6819,	39324,	6135,
4,	16128,	6278,	7102,	17359,	1737,	1337,	2278,	254496,	8557,	59420,
5,	4795,	16301,	7180,	8886,	17122,	1810,	925,	1901,	292612,	10917,
6,	13174,	4416,	14541,	7352,	8206,	13809,	1258,	466,	1403,	309320,
7,	17204,	10623,	3773,	14008,	6250,	6647,	8848,	694,	350,	1064,
8,	251,	13752,	9167,	3519,	11539,	4861,	4082,	4045,	456,	227,
9,	12,	168,	11664,	8524,	2858,	9361,	2443,	924,	2892,	230,
10,	23,	11,	151,	10354,	6758,	2135,	5570,	529,	439,	2121,
11,	2871,	20,	4,	136,	8339,	5380,	1437,	1986,	167,	96,
12,	3,	2242,	11,	2,	98,	7023,	3143,	527,	1619,	54,
13,	3,	3,	1862,	8,	0,	82,	3757,	329,	183,	1344,
14,	2,	3,	2,	1562,	0,	0,	65,	359,	61,	69,
15,	1,	2,	2,	2,	1152,	0,	0,	54,	69,	0,
+gp,	1,	2,	2,	2,	1,	383,	137,	0,	0,	0,
0 TOTALBIO,	74033,	78902,	72299,	107586,	198778,	186677,	189636,	331833,	365811,	441975,

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,
AGE										
0,	13675,	37085,	44334,	11132,	3232,	2104,	9373,	6595,	0,	0,
1,	25865,	61158,	105544,	144199,	45257,	23650,	15396,	68591,	48262,	0,
2,	20138,	48635,	67807,	153254,	183209,	46000,	13355,	8694,	38732,	27253,
3,	24181,	24934,	68380,	74428,	186892,	196613,	56849,	20671,	10363,	63727,
4,	6737,	19595,	32527,	92187,	119024,	295565,	301926,	75596,	25468,	17104,
5,	75313,	7085,	23696,	32308,	97753,	153695,	340531,	371694,	91577,	28254,
6,	12797,	75044,	8130,	22107,	30799,	88078,	135070,	323714,	362904,	100534,
7,	317169,	12066,	75949,	7536,	21559,	23572,	62311,	102526,	249814,	336998,
8,	1147,	289799,	10775,	65525,	6241,	18846,	12919,	42694,	66225,	218355,
9,	170,	750,	265003,	10039,	63775,	5345,	15098,	8360,	25421,	53475,
10,	186,	97,	563,	221618,	8004,	53077,	4371,	12935,	4287,	20684,
11,	1850,	77,	64,	472,	194936,	6101,	41042,	3460,	9908,	3081,
12,	37,	1654,	74,	37,	421,	148771,	1924,	30405,	1608,	8264,
13,	24,	6,	1544,	47,	33,	255,	87263,	1059,	22125,	1447,
14,	1273,	13,	1,	1093,	44,	11,	65,	43667,	222,	17170,
15,	55,	1035,	2,	1,	957,	34,	0,	55,	22500,	0,
+gp,	105,	19,	2,	1,	0,	0,	0,	0,	0,	12885,
0 TOTALBIO,	500723,	579053,	704396,	835982,	962134,	1061717,	1097494,	1120714,	979418,	909231,

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Table 3.5.6.4

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 2/05/2000 18:23

Traditional vpa using screen input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	2494	2361	0	365	126
4	8031	18178	9338	6134	79681	23924	11632	0	2009	1684
5	33648	22205	50293	26768	17486	253913	38627	22772	15690	3429
6	128696	61620	39993	87861	49424	45343	545487	55460	39312	30965
7	193150	166707	81908	52702	113774	70581	45659	520777	85895	37046
8	55829	177955	154693	77404	50795	102268	58910	38606	450687	69608
9	83911	48296	144835	129497	66621	42503	84833	47824	32913	375776
10	98989	72021	40670	117631	105456	53399	35121	67982	38804	27125
11	82351	84626	61452	33791	92272	80917	41559	27406	55634	30741
12	182362	69234	70784	51061	27539	67548	61743	30551	21842	41734
13	204510	155357	58003	59424	42365	21749	53644	46643	23788	15722
14	32087	166896	127825	47269	48731	33841	17096	41747	37004	17993
15	91121	26825	139410	109056	39250	39664	27700	13447	33356	29726
+gp	203759	174098	168975	262730	211109	184134	149608	99659	90738	53319
0 TOTSPBIO	1398444	1244019	1148177	1061326	944504	1022278	1173981	1012876	928037	734992

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	178	89	0	2727	407	0	779	0	0	1133
4	544	780	397	8564	6059	10285	226	814	0	37
5	2977	1516	1476	1091	73726	28480	24745	233	183	222
6	7240	6364	2178	1652	931	156291	61324	14215	298	278
7	31519	6942	5847	1754	1652	2114	132254	32985	3408	72
8	32026	25553	5854	4630	1638	1514	1457	58810	5766	1051
9	56536	25627	21730	4734	3645	1243	771	358	11041	2258
10	306308	43433	21334	17127	3959	2458	810	282	88	2418
11	22678	231448	35044	16859	12126	2452	1470	213	45	22
12	24355	16943	184337	27095	12162	7710	990	400	54	12
13	33668	17512	13130	135677	18259	8188	3183	453	101	23
14	12118	23653	13425	10021	94286	11543	3041	749	131	13
15	14274	8278	17972	10304	6890	59367	4947	690	83	36
+gp	37294	14849	23752	21307	43775	15103	23531	4345	703	180
0 TOTSPBIO	581715	422987	346478	263541	279513	306746	259527	114547	21901	7754

1

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 2/05/2000 18:23

Traditional vpa using screen input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	3	51	1621	1077	0	0	0
3	9	8	0	62	8	213	7534	7296	442	1172
4	59	38	7	7218	100	18	395	16018	12061	2301
5	20	64	19	37	8318	116	16	350	18796	13015
6	26	34	32	66	15	7135	84	16	312	18418
7	136	80	19	16	14	6	5463	75	14	273
8	43	36	32	9	5	7	5	4577	53	13
9	580	10	6	3	3	5	6	5	3779	25
10	1036	143	1	2	3	2	5	6	4	3326
11	1044	212	19	1	2	3	2	4	5	4
12	8	193	20	6	1	1	2	2	3	4
13	4	0	29	4	5	1	1	2	1	3
14	13	1	0	12	3	4	1	1	2	1
15	5	5	0	0	3	3	4	0	1	1
+gp	89	0	0	0	3	3	4	0	1	1
0 TOTSPBIO	3072	823	185	7440	8534	9138	14598	28351	35475	38558

Table 3.5.6.4 (continued)

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
3,	1430,	2052,	1379,	156,	98,	217,	11277,	670,	3867,	604,
4,	7935,	3087,	3350,	8522,	850,	637,	440,	74981,	2518,	17558,
5,	4574,	14424,	4941,	6019,	14997,	1557,	773,	1637,	258377,	9668,
6,	12943,	4342,	14300,	5125,	7615,	13099,	1182,	447,	1352,	303837,
7,	16876,	10446,	3709,	13770,	6105,	6292,	8240,	657,	331,	1036,
8,	245,	13511,	9009,	3460,	11300,	4513,	3545,	3880,	422,	220,
9,	12,	164,	11464,	8375,	2783,	8917,	2124,	854,	2791,	224,
10,	22,	10,	148,	10166,	6582,	2056,	5051,	469,	373,	2077,
11,	2813,	19,	4,	133,	8186,	5140,	1304,	1938,	148,	87,
12,	3,	2203,	11,	2,	96,	6650,	2521,	474,	1581,	50,
13,	3,	3,	1834,	5,	0,	81,	2985,	278,	166,	1323,
14,	2,	3,	2,	1534,	0,	0,	64,	304,	38,	67,
15,	1,	2,	2,	2,	1127,	0,	0,	51,	65,	0,
+gp,	1,	2,	2,	2,	1,	364,	118,	0,	0,	0,
0 TOTSPBIO,	46861,	50269,	50156,	57271,	59740,	49523,	39624,	86640,	272028,	336750,

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
3,	9511,	2455,	6734,	733,	1841,	0,	0,	0,	0,	0,
4,	5305,	13508,	6393,	27175,	35122,	2907,	2965,	22237,	7405,	5037,
5,	66743,	6976,	18662,	25258,	76216,	119853,	149487,	326436,	80559,	24748,
6,	11316,	73880,	8005,	21748,	29734,	84527,	130201,	313696,	353233,	97887,
7,	280528,	11855,	74773,	7410,	21176,	22196,	59867,	98420,	242647,	327195,
8,	1124,	284694,	10593,	64436,	6117,	18500,	12286,	40783,	64019,	211332,
9,	160,	729,	260166,	9811,	62660,	5201,	14851,	7959,	24589,	51616,
10,	172,	94,	545,	216659,	7727,	51976,	4274,	12660,	4058,	19952,
11,	1812,	76,	60,	465,	189053,	5478,	40149,	3246,	9660,	2970,
12,	31,	1626,	72,	36,	400,	141871,	1809,	29587,	1571,	7960,
13,	23,	5,	1515,	46,	29,	223,	81571,	907,	21346,	1393,
14,	1251,	11,	1,	1077,	43,	7,	64,	41170,	109,	16517,
15,	54,	1017,	2,	1,	934,	34,	0,	53,	21708,	0,
+gp,	102,	19,	2,	1,	0,	0,	0,	0,	0,	12386,
0 TOTSPBIO,	378131,	396946,	387523,	374857,	431054,	452773,	497524,	897155,	830905,	778995,

1

Table 3.5.6.5

Run title : Herring spring-spawn (run: SVPBJA12/V12) ,

At 2/05/2000 18:23

Table 16 Summary (without SOP correction)

Traditional vpa using screen input for terminal F

,	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-14,
1950,	747374656,	19619720,	13984440,	933000,	.0667,	.0536,
1951,	143907888,	19058122,	12440190,	1278400,	.1028,	.0623,
1952,	93898752,	20598168,	11481773,	1254800,	.1093,	.0673,
1953,	83577056,	18574948,	10613262,	1090600,	.1028,	.0646,
1954,	39702936,	19293042,	9445040,	1644500,	.1741,	.1083,
1955,	23753764,	16616486,	10222784,	1359800,	.1330,	.0928,
1956,	27474770,	14604452,	11739808,	1659400,	.1413,	.1202,
1957,	23650588,	11550268,	10128764,	1319500,	.1303,	.1009,
1958,	27810502,	10099109,	9280374,	986600,	.1063,	.0960,
1959,	405342656,	8239182,	7349922,	1111100,	.1512,	.1333,
1960,	191338608,	7569599,	5817149,	1101800,	.1894,	.1393,
1961,	73282680,	7569780,	4229869,	830100,	.1962,	.0904,
1962,	17712448,	6747726,	3464778,	848600,	.2449,	.1121,
1963,	164640160,	6853931,	2635414,	984500,	.3736,	.1697,
1964,	90556040,	6718337,	2795131,	1281800,	.4586,	.2374,
1965,	7932618,	5956750,	3067464,	1547700,	.5046,	.4594,
1966,	45349292,	4306677,	2595274,	1955000,	.7533,	.9968,
1967,	3582245,	2802309,	1145466,	1677200,	1.4642,	1.3567,
1968,	4638550,	853466,	219013,	712200,	3.2519,	1.6790,
1969,	9607348,	121451,	77541,	67800,	.8744,	.6100,
1970,	620670,	75989,	30718,	62300,	2.0281,	1.3720,
1971,	209800,	105320,	8231,	21100,	2.5633,	1.4276,
1972,	907351,	69767,	1854,	13161,	7.0991,	1.3812,
1973,	12701698,	100002,	74400,	7017,	.0943,	.6185,
1974,	8500675,	152834,	85341,	7619,	.0893,	.2015,
1975,	2942588,	294481,	91377,	13713,	.1501,	.0741,
1976,	10018746,	355060,	145980,	10436,	.0715,	.0333,
1977,	5039343,	423184,	283511,	22706,	.0801,	.0582,
1978,	6133163,	571644,	354752,	19824,	.0559,	.1088,
1979,	12434718,	627810,	385577,	12864,	.0334,	.0242,
1980,	1539331,	740332,	468611,	18577,	.0396,	.0327,
1981,	1091881,	789022,	502691,	13736,	.0273,	.1327,
1982,	2329740,	722993,	501560,	16655,	.0332,	.0920,
1983,	318415008,	1075859,	572712,	23054,	.0403,	.5791,
1984,	11403318,	1987779,	597396,	53532,	.0896,	.1151,
1985,	60083496,	1866773,	495227,	169872,	.3430,	.3436,
1986,	6056173,	1896358,	396241,	225256,	.5685,	.9997,
1987,	16692028,	3318327,	866396,	127306,	.1469,	.6946,
1988,	25411758,	3658107,	2720279,	135301,	.0497,	.9753,
1989,	79533192,	4419749,	3367504,	103830,	.0308,	.2346,
1990,	136750272,	5007226,	3781308,	86411,	.0229,	.3359,
1991,	370853120,	5790529,	3969456,	84683,	.0213,	.4060,
1992,	443341728,	7043957,	3875228,	104448,	.0270,	.0995,
1993,	111323584,	8359822,	3748570,	232457,	.0620,	.0288,
1994,	32316820,	9621340,	4310537,	479228,	.1112,	.2168,
1995,	21038196,	10617174,	4527734,	905501,	.2000,	.7503,
1996,	93725248,	10974940,	4975237,	1220283,	.2453,	.2072,
1997,	65948036,	11207135,	8971548,	1426507,	.1590,	.3675,
1998,	0,	9794176,	8309052,	1223131,	.1472,	.8415,
1999,	0,	9092314,	7789946,	1235433,	.1586,	.1885,
Arith. Mean ,	81649915,	6370271,	3978850,	634407,	.4863,	.3938,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 3.5.6.6 Summary

Traditional vpa using screen input for terminal F

	RECR Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-14	FWEI 5-14
1950	10855814	17994092	13984440	933000	0.0667	0.0536	0.0584
1951	5413445	16064644	12440190	1278400	0.1028	0.0623	0.0696
1952	3594390	14517919	11481773	1254800	0.1093	0.0673	0.0728
1953	47045816	17413606	10613262	1090600	0.1028	0.0646	0.0663
1954	6899106	18582072	9445040	1644500	0.1741	0.1083	0.1124
1955	3174835	16130418	10222784	1359800	0.133	0.0928	0.0783
1956	3009160	14417274	11739808	1659400	0.1413	0.1202	0.1099
1957	555352	11393960	10128764	1319500	0.1303	0.1009	0.1026
1958	464887	9956042	9280374	986600	0.1063	0.096	0.0787
1959	161775	7738261	7349922	1111100	0.1512	0.1333	0.1129
1960	244166	6094614	5817149	1101800	0.1894	0.1393	0.1359
1961	229051	4387368	4229869	830100	0.1962	0.0904	0.1046
1962	20289260	5638075	3464778	848600	0.2449	0.1121	0.1458
1963	7008123	6268470	2635414	984500	0.3736	0.1697	0.2525
1964	2076012	6078144	2795131	1281800	0.4586	0.2374	0.2271
1965	195852	4528063	3067464	1547700	0.5046	0.4594	0.2803
1966	8160987	3693424	2595274	1955000	0.7533	0.9968	0.7002
1967	3767195	2653075	1145466	1677200	1.4642	1.3567	1.5170
1968	107482	786631	219013	712200	3.2519	1.679	3.4499
1969	227478	94191	77541	67800	0.8744	0.61	0.5949
1970	16366	43788	30718	62300	2.0281	1.372	1.3236
1971	7864	12172	8231	21100	2.5633	1.4276	1.5203
1972	406549	64847	1854	13161	7.0991	1.3812	1.4875
1973	7657	85230	74366	7017	0.0944	0.6185	1.1639
1974	927	87292	84835	7619	0.0898	0.2015	0.1138
1975	24303	79951	75163	13713	0.1824	0.0741	0.1899
1976	847581	215420	135212	10436	0.0772	0.0333	0.1059
1977	562941	336967	283511	22706	0.0801	0.0582	0.1105
1978	192132	405272	354752	19824	0.0559	0.1088	0.0439
1979	668978	520800	385577	12864	0.0334	0.0242	0.0241
1980	332522	602892	468611	18577	0.0396	0.0327	0.0345
1981	408937	607737	502691	13736	0.0273	0.1327	0.0217
1982	824830	694852	501560	16655	0.0332	0.092	0.0202
1983	102350	733004	572712	23054	0.0403	0.5791	0.0294
1984	71228	650571	597396	53532	0.0896	0.1151	0.0910
1985	151564	550717	495227	169872	0.343	0.3436	0.3793
1986	21258166	1487385	396241	225256	0.5685	0.9997	1.0613
1987	757721	2731292	866396	127306	0.1469	0.6946	0.3986
1988	4012640	3481340	2720279	135301	0.0497	0.9753	0.0454
1989	398407	3909985	3367504	103830	0.0308	0.2346	0.0289
1990	1104164	4410442	3781308	86411	0.0229	0.3359	0.0205
1991	1696172	4321744	3969456	84683	0.0213	0.406	0.0229
1992	5342191	4867102	3875228	104448	0.027	0.0995	0.0258
1993	9188598	5273975	3748570	232457	0.062	0.0288	0.0607
1994	24918866	7304371	4310537	479228	0.1112	0.2168	0.1212
1995	29789822	9899636	4527734	905501	0.2	0.7503	0.2003
1996	7480189	10593705	4975237	1220283	0.2453	0.2072	0.1625
1997	2153250	10368342	8971548	1426507	0.159	0.3675	0.1500
1998	1400440	8924235	8309052	1223131	0.1472	0.8415	0.1294
1999	6247771	8819785	7789946	1235433	0.1586	0.1885	0.1556
Arith. Mean	4877106	5530305	3978299	634407	0.4871	0.3938	
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)			

Table 3.6.1.1.

The SAS System 14:20 Thursday, May 4, 2000
Norwegian spring-spawning herring

Prediction with management option table: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	4627400.0	0.1500	0.0000	0.1000	0.1000	0.119	0.0240	0.173
4	5250000.0	0.1500	0.3000	0.1000	0.1000	0.178	0.0344	0.228
5	948200.00	0.1500	0.9000	0.1000	0.1000	0.225	0.1215	0.262
6	965800.00	0.1500	1.0000	0.1000	0.1000	0.271	0.1168	0.274
7	3208000.0	0.1500	1.0000	0.1000	0.1000	0.285	0.1452	0.292
8	9502100.0	0.1500	1.0000	0.1000	0.1000	0.298	0.1769	0.307
9	5564200.0	0.1500	1.0000	0.1000	0.1000	0.311	0.2038	0.335
10	1191800.0	0.1500	1.0000	0.1000	0.1000	0.339	0.2106	0.362
11	418000.00	0.1500	1.0000	0.1000	0.1000	0.390	0.2174	0.371
12	55300.000	0.1500	1.0000	0.1000	0.1000	0.398	0.2242	0.399
13	147300.00	0.1500	1.0000	0.1000	0.1000	0.406	0.2310	0.396
14	25600.000	0.1500	1.0000	0.1000	0.1000	0.414	0.2378	0.400
15	305000.00	0.1500	1.0000	0.1000	0.1000	0.422	0.2446	0.400
16+	213400.00	0.1500	1.0000	0.1000	0.1000	0.431	0.2446	0.404
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	13171000	0.1500	0.0000	0.1000	0.1000	0.119	0.0240	0.173
4	.	0.1500	0.3000	0.1000	0.1000	0.178	0.0344	0.228
5	.	0.1500	0.9000	0.1000	0.1000	0.225	0.1215	0.262
6	.	0.1500	1.0000	0.1000	0.1000	0.271	0.1168	0.274
7	.	0.1500	1.0000	0.1000	0.1000	0.285	0.1452	0.292
8	.	0.1500	1.0000	0.1000	0.1000	0.298	0.1769	0.307
9	.	0.1500	1.0000	0.1000	0.1000	0.311	0.2038	0.335
10	.	0.1500	1.0000	0.1000	0.1000	0.339	0.2106	0.362
11	.	0.1500	1.0000	0.1000	0.1000	0.390	0.2174	0.371
12	.	0.1500	1.0000	0.1000	0.1000	0.398	0.2242	0.399
13	.	0.1500	1.0000	0.1000	0.1000	0.406	0.2310	0.396
14	.	0.1500	1.0000	0.1000	0.1000	0.414	0.2378	0.400
15	.	0.1500	1.0000	0.1000	0.1000	0.422	0.2446	0.400
16+	.	0.1500	1.0000	0.1000	0.1000	0.431	0.2446	0.404
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	3679000.0	0.1500	0.0000	0.1000	0.1000	0.119	0.0240	0.173
4	.	0.1500	0.3000	0.1000	0.1000	0.178	0.0344	0.228
5	.	0.1500	0.9000	0.1000	0.1000	0.225	0.1215	0.262
6	.	0.1500	1.0000	0.1000	0.1000	0.271	0.1168	0.274
7	.	0.1500	1.0000	0.1000	0.1000	0.285	0.1452	0.292
8	.	0.1500	1.0000	0.1000	0.1000	0.298	0.1769	0.307
9	.	0.1500	1.0000	0.1000	0.1000	0.311	0.2038	0.335
10	.	0.1500	1.0000	0.1000	0.1000	0.339	0.2106	0.362
11	.	0.1500	1.0000	0.1000	0.1000	0.390	0.2174	0.371
12	.	0.1500	1.0000	0.1000	0.1000	0.398	0.2242	0.399
13	.	0.1500	1.0000	0.1000	0.1000	0.406	0.2310	0.396
14	.	0.1500	1.0000	0.1000	0.1000	0.414	0.2378	0.400
15	.	0.1500	1.0000	0.1000	0.1000	0.422	0.2446	0.400
16+	.	0.1500	1.0000	0.1000	0.1000	0.431	0.2446	0.404
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANBJA03
Date and time: 04MAY00:14:23

Table 3.6.2.1

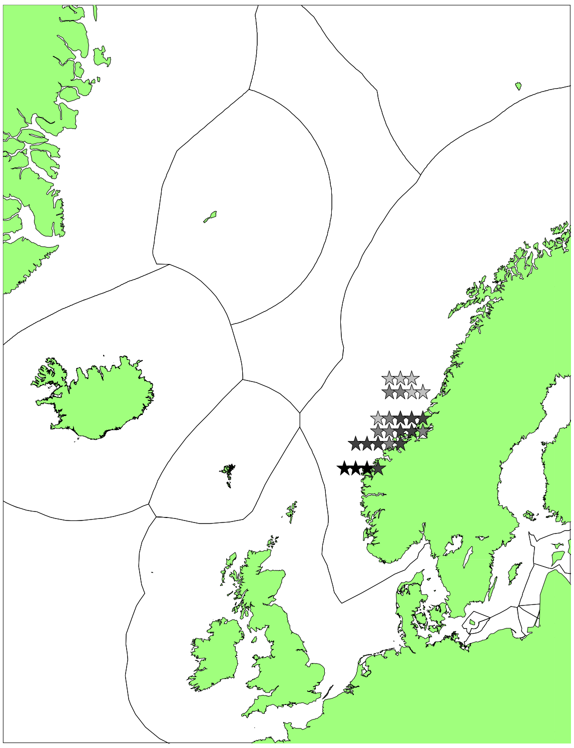
The SAS System 14:20 Thursday, May 4, 2000

Norwegian spring-spawning herring

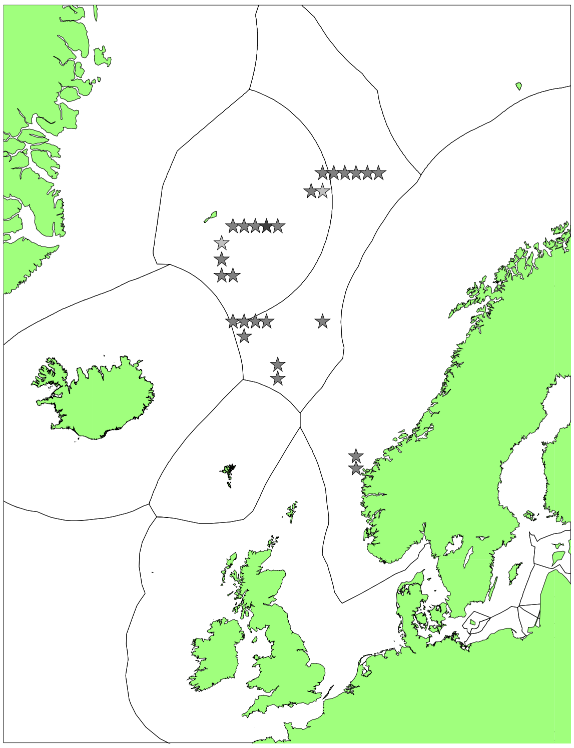
Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0950	0.2064	8316747	6852013	1249999	0.0000	0.0000	8376044	6134679	0	9027549	6996368
.	.	.	.	.	0.0500	0.0094	.	6129081	59944	8970045	6935504
.	.	.	.	.	0.1000	0.0189	.	6123488	119359	8913063	6875264
.	.	.	.	.	0.1500	0.0283	.	6117901	178251	8856597	6815643
.	.	.	.	.	0.2000	0.0377	.	6112319	236624	8800642	6756632
.	.	.	.	.	0.2500	0.0471	.	6106742	294483	8745194	6698226
.	.	.	.	.	0.3000	0.0566	.	6101171	351833	8690247	6640418
.	.	.	.	.	0.3500	0.0660	.	6095605	408680	8635796	6583201
.	.	.	.	.	0.4000	0.0754	.	6090044	465028	8581838	6526569
.	.	.	.	.	0.4500	0.0848	.	6084489	520881	8528366	6470516
.	.	.	.	.	0.5000	0.0943	.	6078939	576246	8475376	6415035
.	.	.	.	.	0.5500	0.1037	.	6073395	631125	8422863	6360121
.	.	.	.	.	0.6000	0.1131	.	6067856	685525	8370823	6305767
.	.	.	.	.	0.6500	0.1225	.	6062322	739449	8319252	6251967
.	.	.	.	.	0.7000	0.1320	.	6056794	792902	8268144	6198715
.	.	.	.	.	0.7500	0.1414	.	6051271	845889	8217494	6146006
.	.	.	.	.	0.8000	0.1508	.	6045753	898414	8167300	6093833
.	.	.	.	.	0.8500	0.1602	.	6040241	950482	8117555	6042190
.	.	.	.	.	0.9000	0.1697	.	6034734	1002097	8068257	5991073
.	.	.	.	.	0.9500	0.1791	.	6029232	1053263	8019399	5940474
.	.	.	.	.	1.0000	0.1885	.	6023735	1103985	7970979	5890389
.	.	.	.	.	1.0500	0.1979	.	6018244	1154266	7922991	5840813
.	.	.	.	.	1.1000	0.2074	.	6012759	1204112	7875432	5791739
.	.	.	.	.	1.1500	0.2168	.	6007278	1253526	7828298	5743162
.	.	.	.	.	1.2000	0.2262	.	6001803	1302513	7781584	5695077
.	.	.	.	.	1.2500	0.2357	.	5996333	1351076	7735286	5647479
.	.	.	.	.	1.3000	0.2451	.	5990868	1399220	7689400	5600362
.	.	.	.	.	1.3500	0.2545	.	5985409	1446948	7643923	5553722
.	.	.	.	.	1.4000	0.2639	.	5979955	1494265	7598849	5507552
.	.	.	.	.	1.4500	0.2734	.	5974506	1541175	7554176	5461848
.	.	.	.	.	1.5000	0.2828	.	5969063	1587680	7509900	5416606
.	.	.	.	.	1.5500	0.2922	.	5963624	1633787	7466015	5371819
.	.	.	.	.	1.6000	0.3016	.	5958191	1679497	7422520	5327484
.	.	.	.	.	1.6500	0.3111	.	5952763	1724815	7379410	5283595
.	.	.	.	.	1.7000	0.3205	.	5947341	1769745	7336680	5240147
.	.	.	.	.	1.7500	0.3299	.	5941924	1814290	7294329	5197137
.	.	.	.	.	1.8000	0.3393	.	5936512	1858454	7252351	5154558
.	.	.	.	.	1.8500	0.3488	.	5931105	1902241	7210743	5112407
.	.	.	.	.	1.9000	0.3582	.	5925703	1945654	7169502	5070679
.	.	.	.	.	1.9500	0.3676	.	5920307	1988697	7128625	5029369
.	.	.	.	.	2.0000	0.3770	.	5914915	2031373	7088106	4988473
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANBJA03
Date and time : 04MAY00:14:23
Computation of ref. F: Simple mean, age 5 - 14
Basis for 2000 : TAC constraints



Q1



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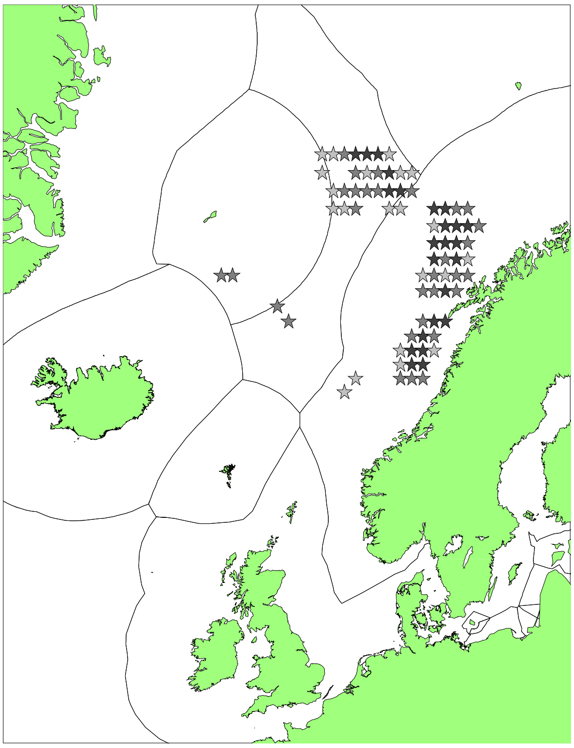

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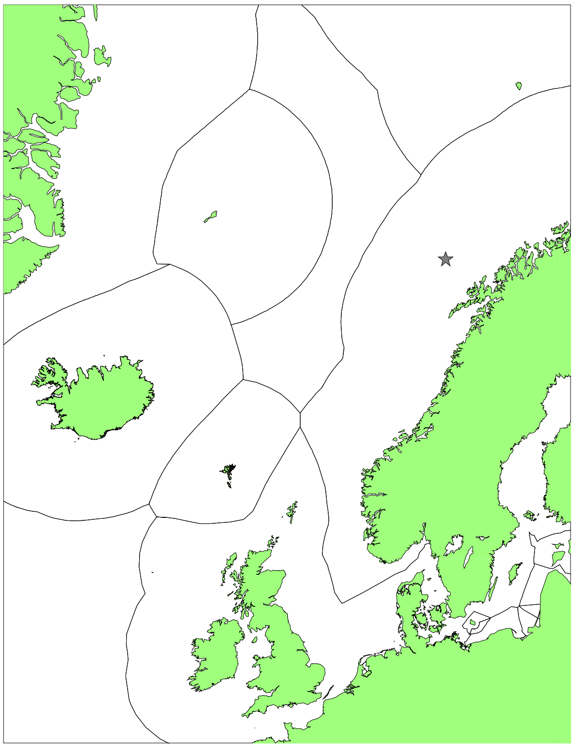
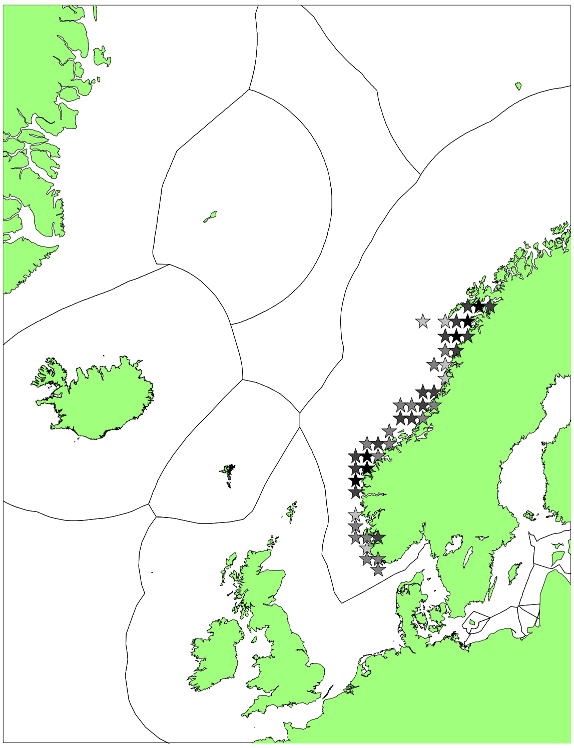


Q4

Figure 3.1.2.1.1. Russian catches of Norwegian spring spawning herring in 1999 by quarter and ICES rectangle. Grading of the symbols: white 0-100 t, gray 100-10 000 t, and black > 10 000 t.



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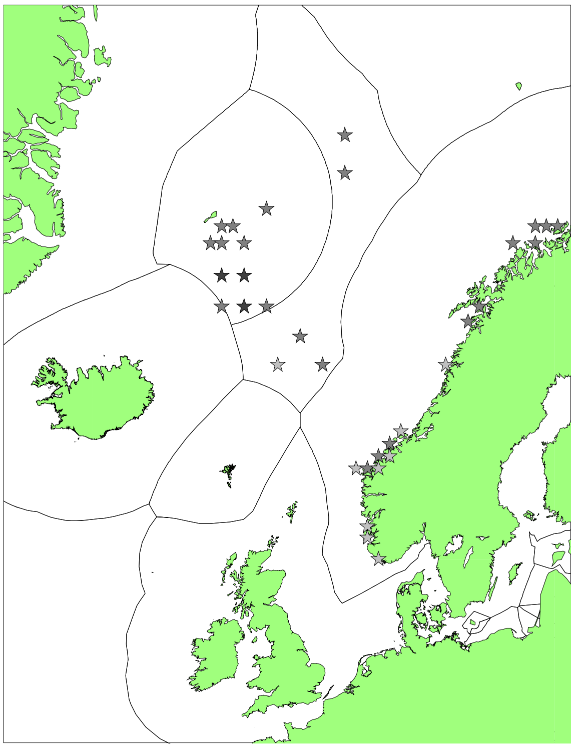

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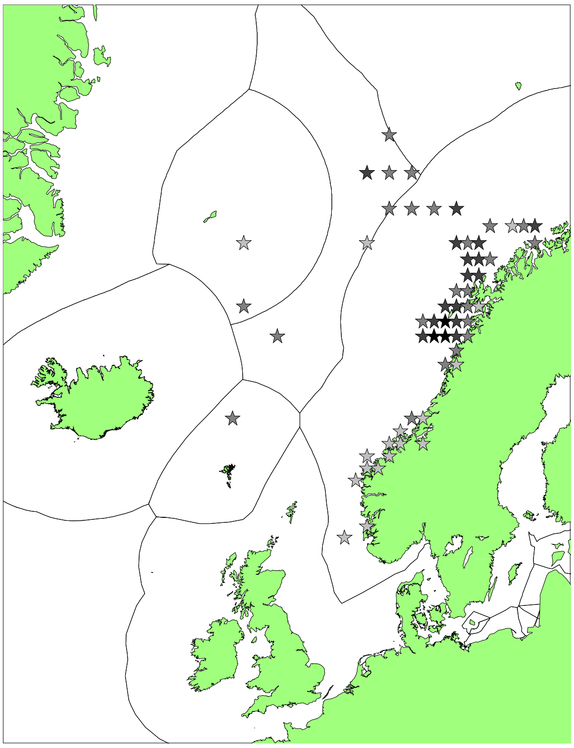

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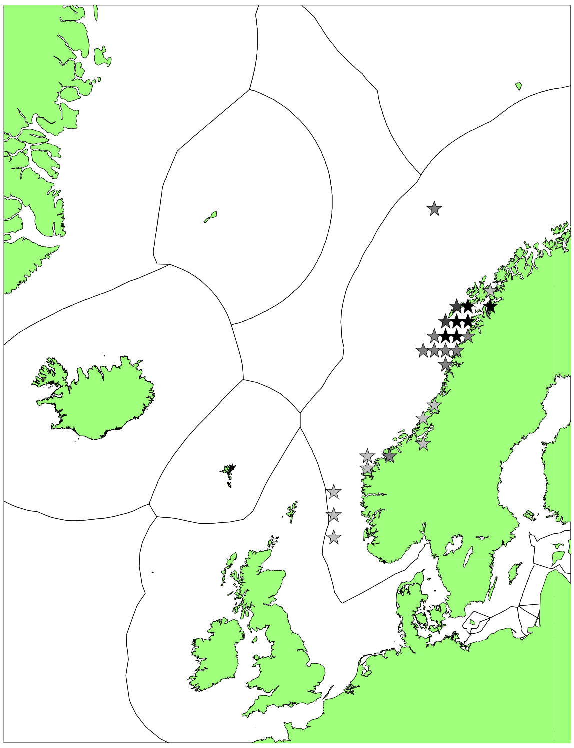


Q4

Figure 3.1.2.1.2. Norwegian catches of Norwegian spring spawning herring in 1999 by quarter and ICES rectangle. Grading of the symbols: white 0-100 t, gray 100-10 000 t, and black > 10 000 t.

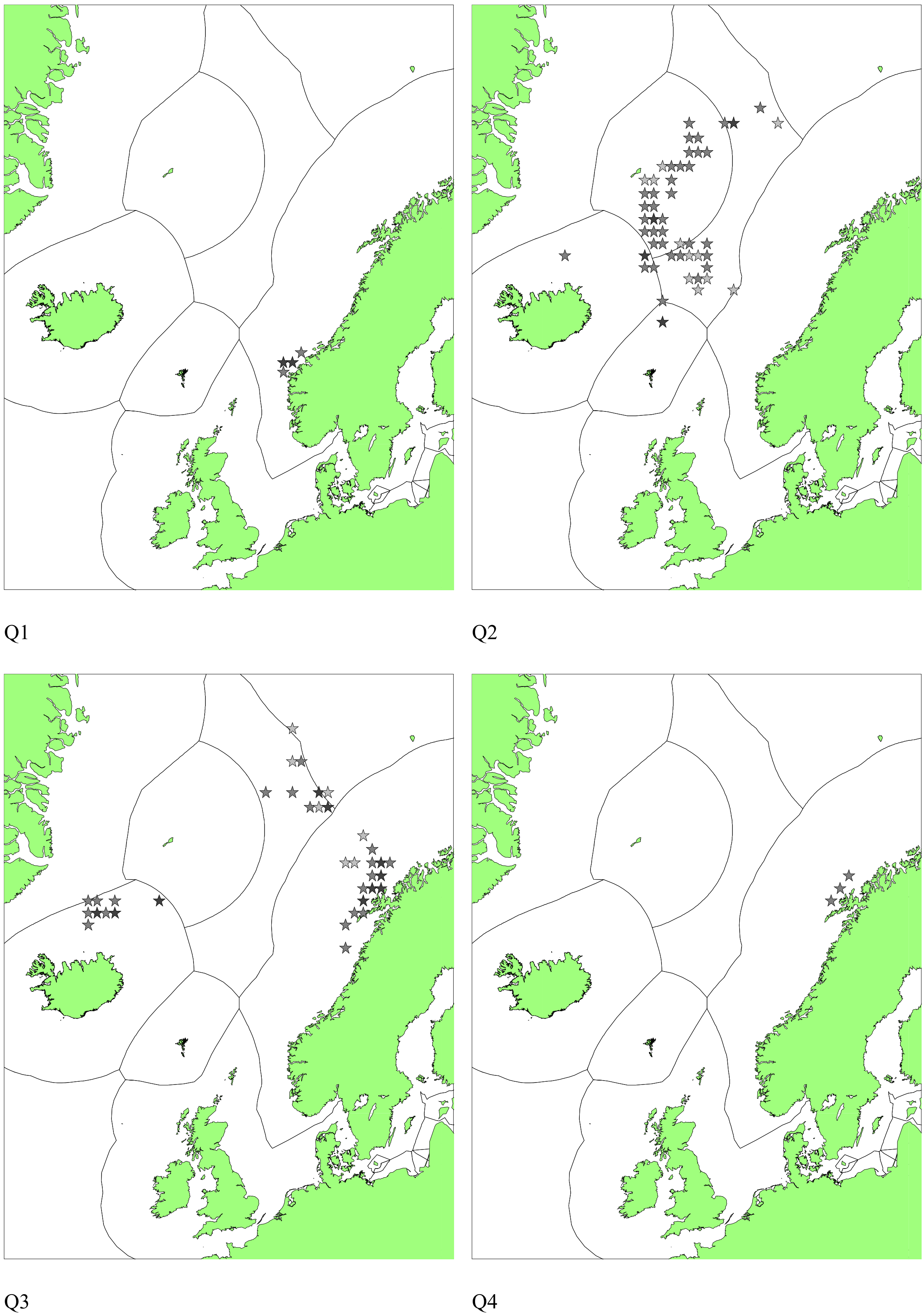
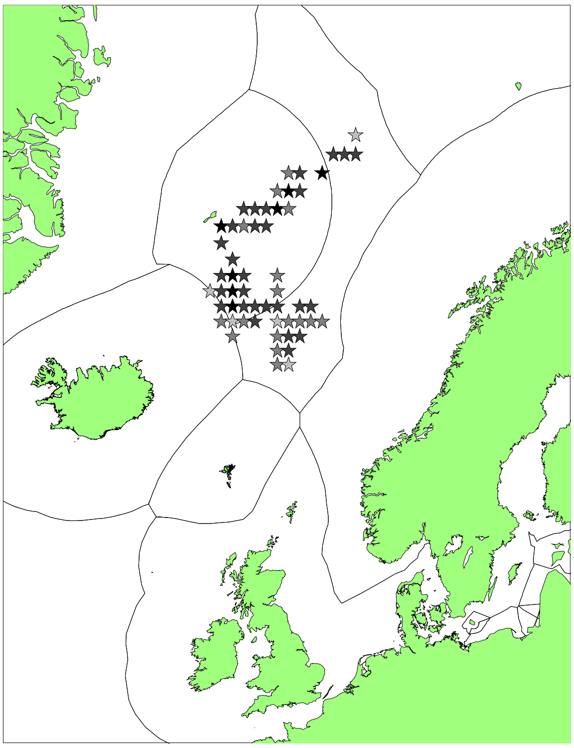


Figure 3.1.2.1.3. Faroese catches of Norwegian spring spawning herring in 1999 by quarter and ICES rectangle. Grading of the symbols: white 0-100 t, gray 100-10 000 t, and black > 10 000 t.



Q2

Figure 3.1.2.1.4. Icelandic catches of Norwegian spring spawning herring in 1999 by quarter and ICES rectangle. Grading of the symbols: white 0-100 t, gray 100-10 000 t, and black > 10 000 t.

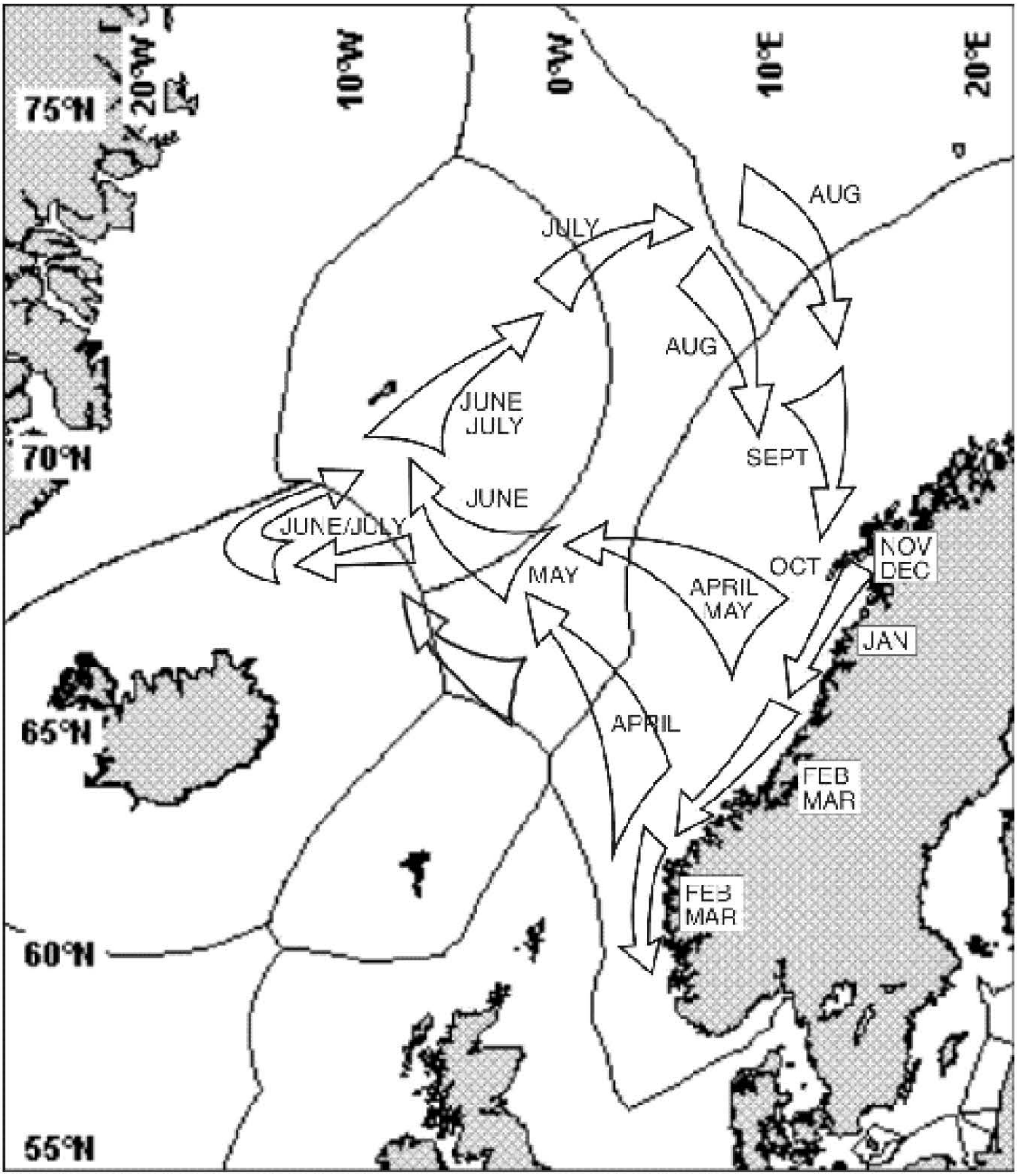


Figure 3.1.2.1.5. Approximate distribution of the fisheries and the migrations of the adult stock of Norwegian spring spawning herring in 1999.

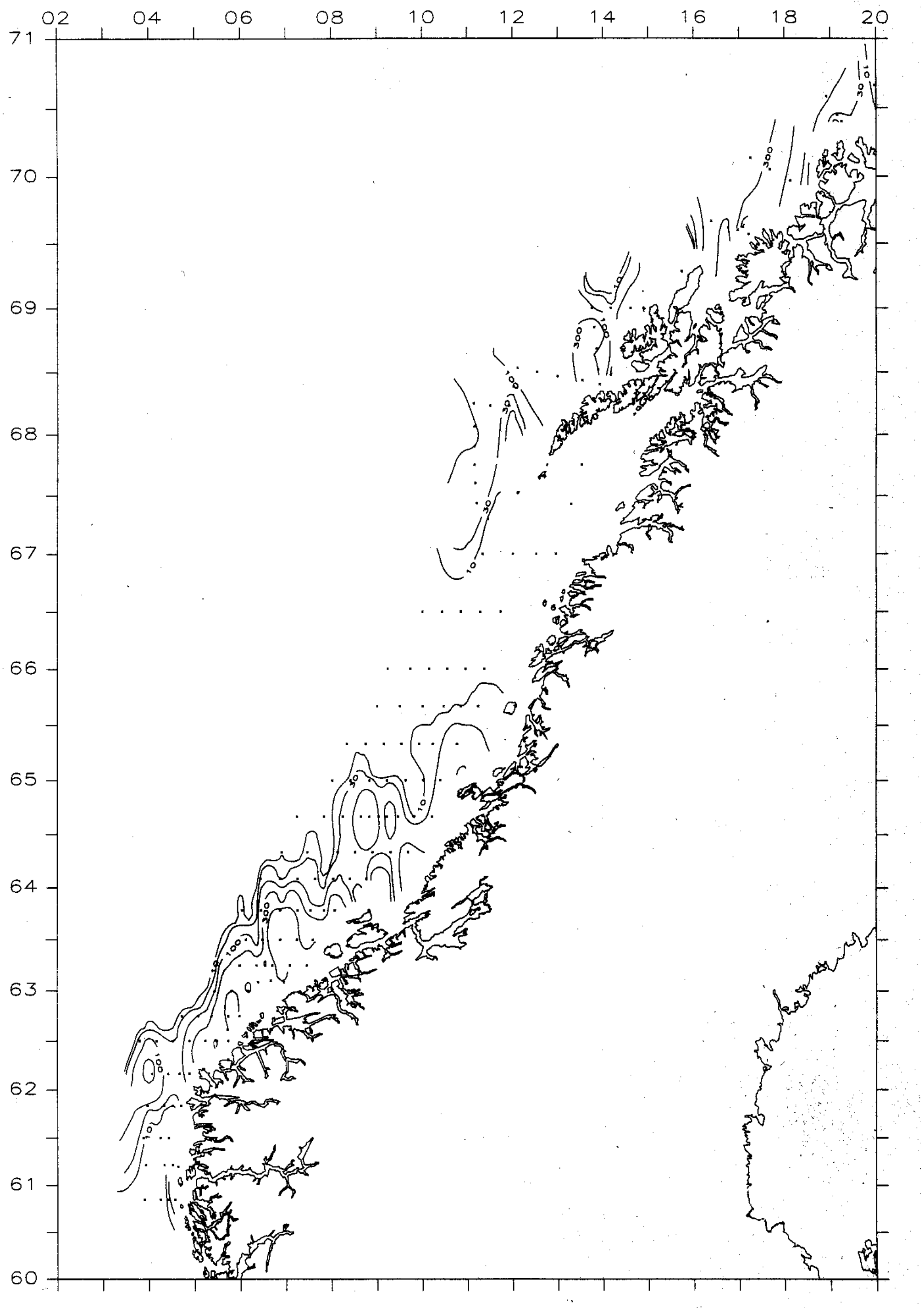
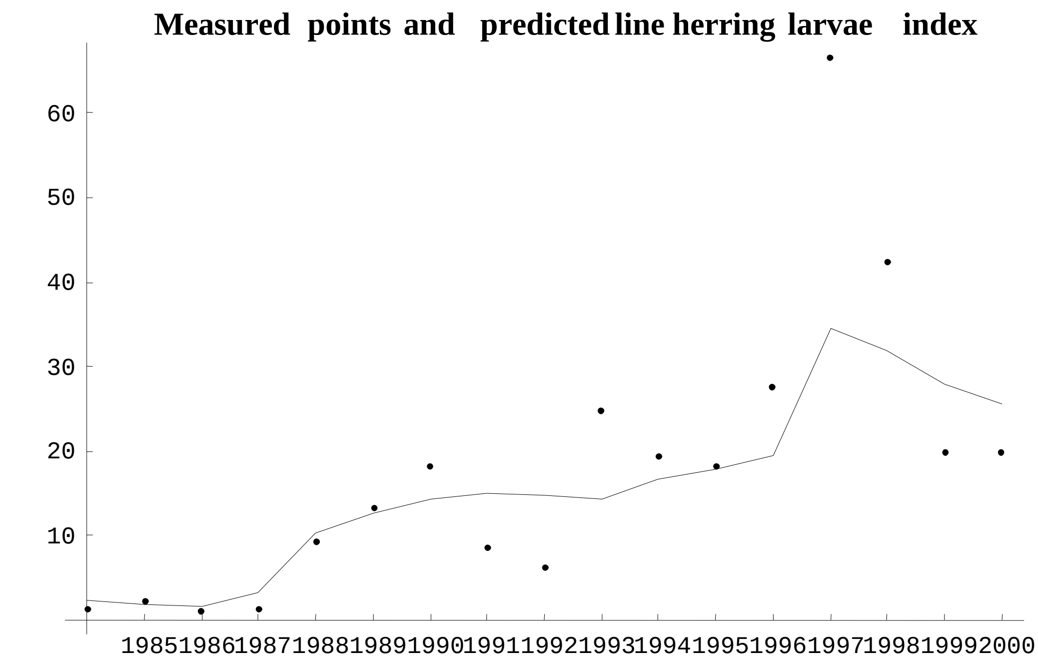


Figure 3.3.5.1 Herring larvae distribution in April 2000.

Figure 3.5.1. Measured points and fitted values for the larval production index (upper) and larval index (lower) for Norwegian spring spawning herring



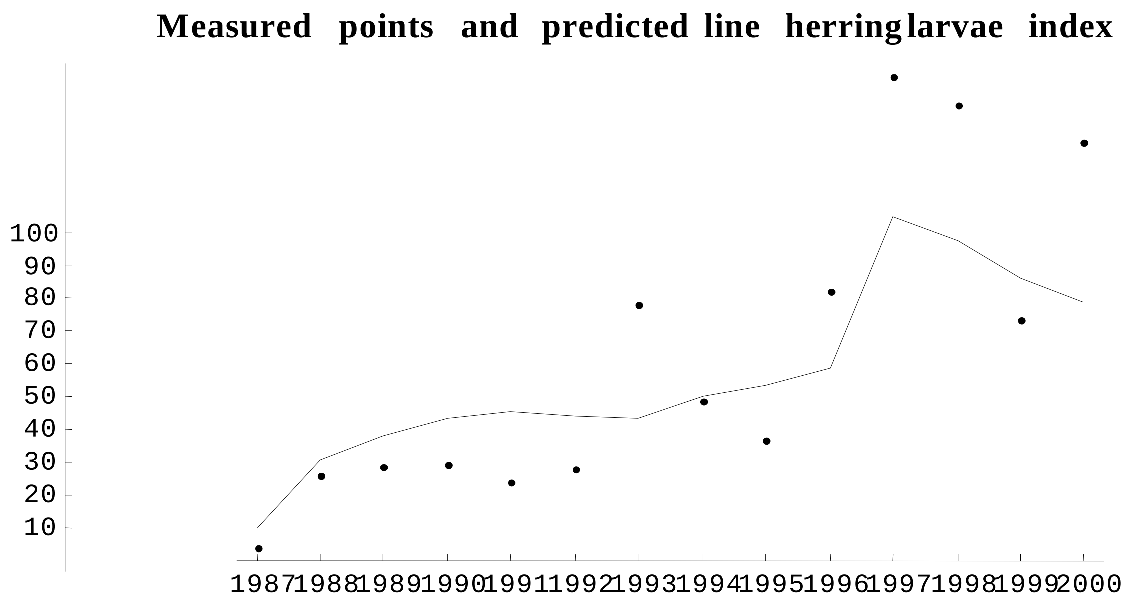
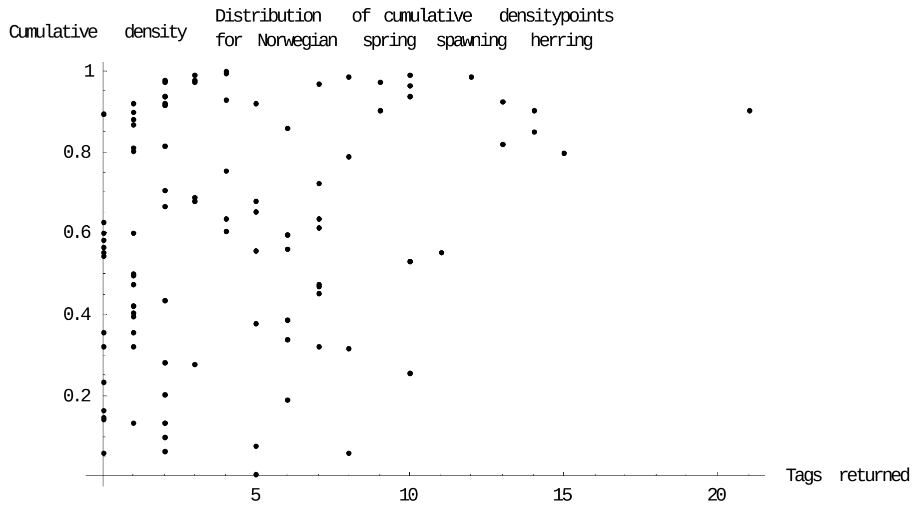


Figure 3.5.2. Scatterplot of cumulative density points for for Norwegian spring spawning herring for all tagging data (upper) and all survey data (lower).



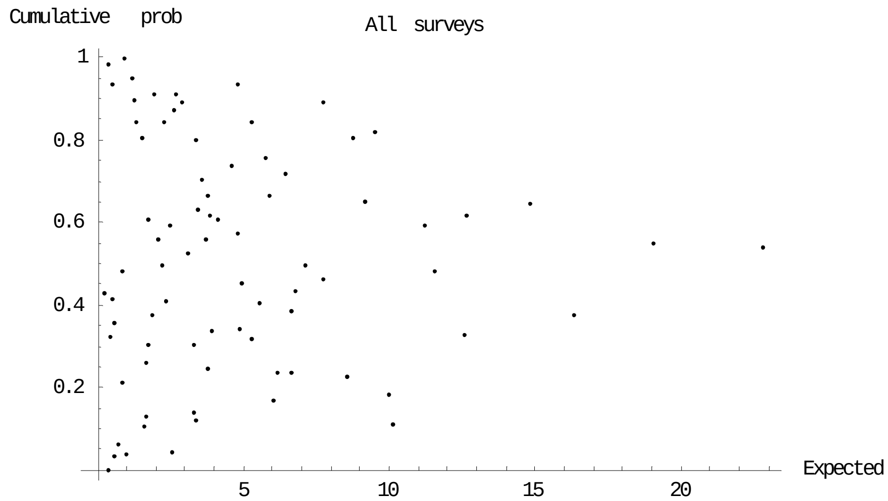
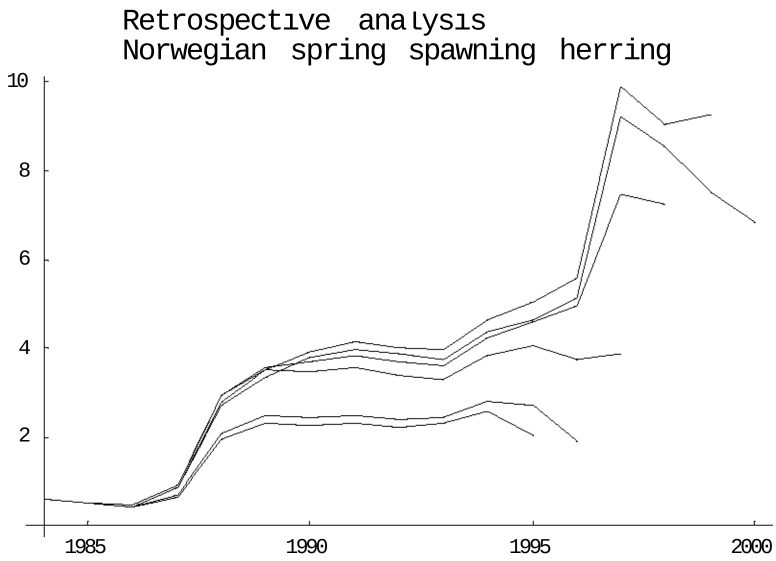
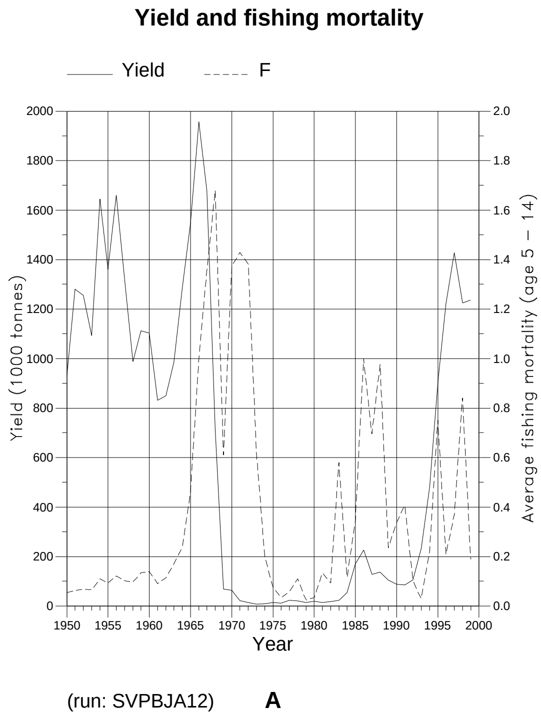


Figure 3.5.3. Retrospective analysis for Norwegian spring spawning herring





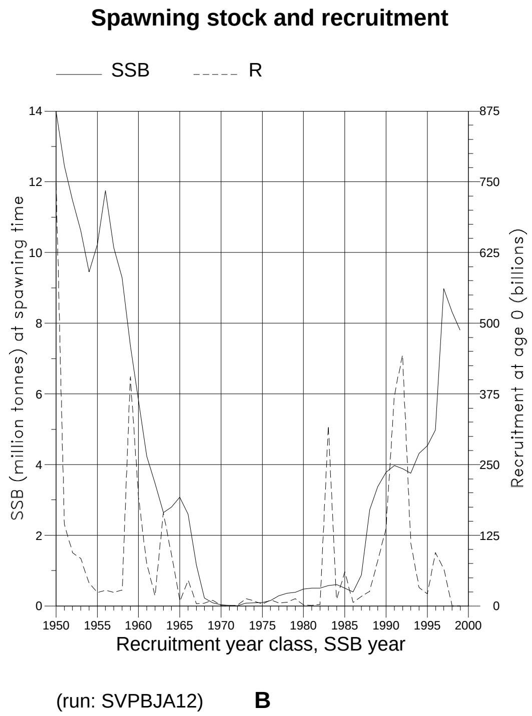


Figure 3.5.6.1

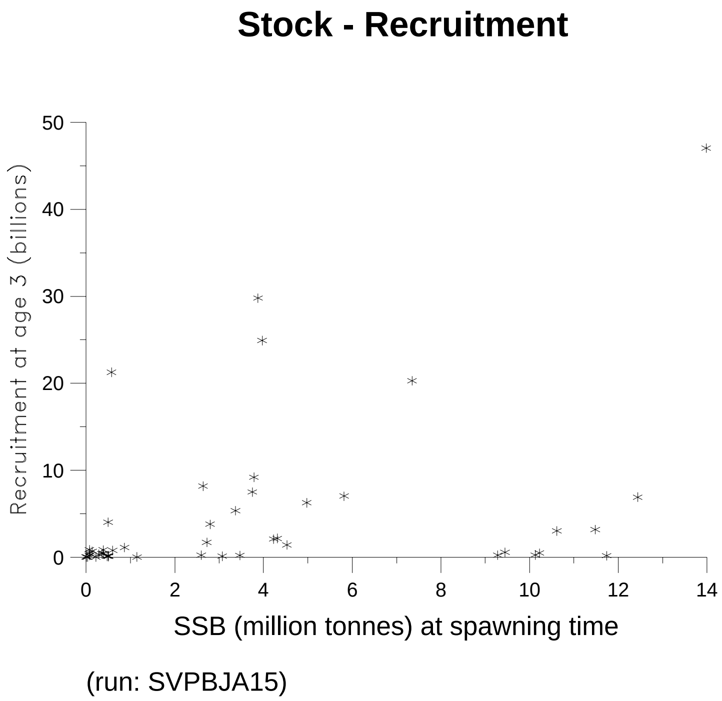


Figure 3.5.6.2

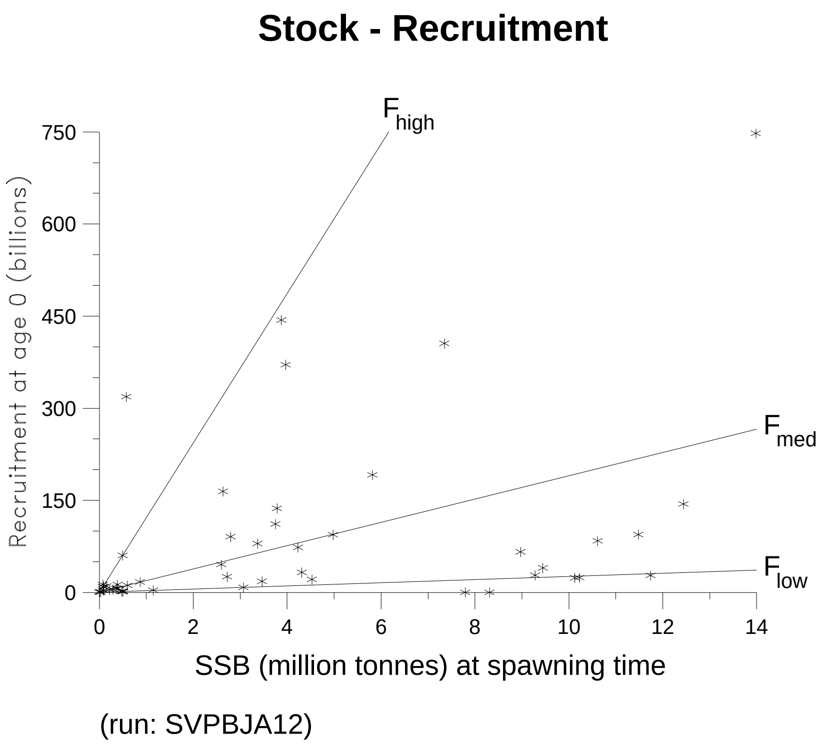


Figure 3.5.6.3

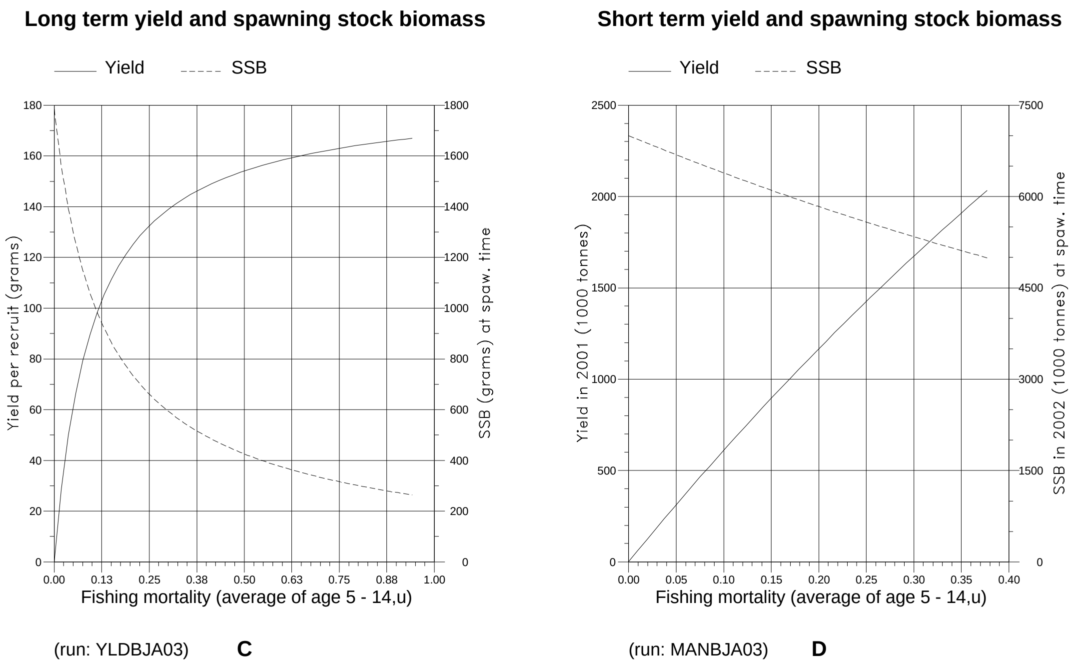
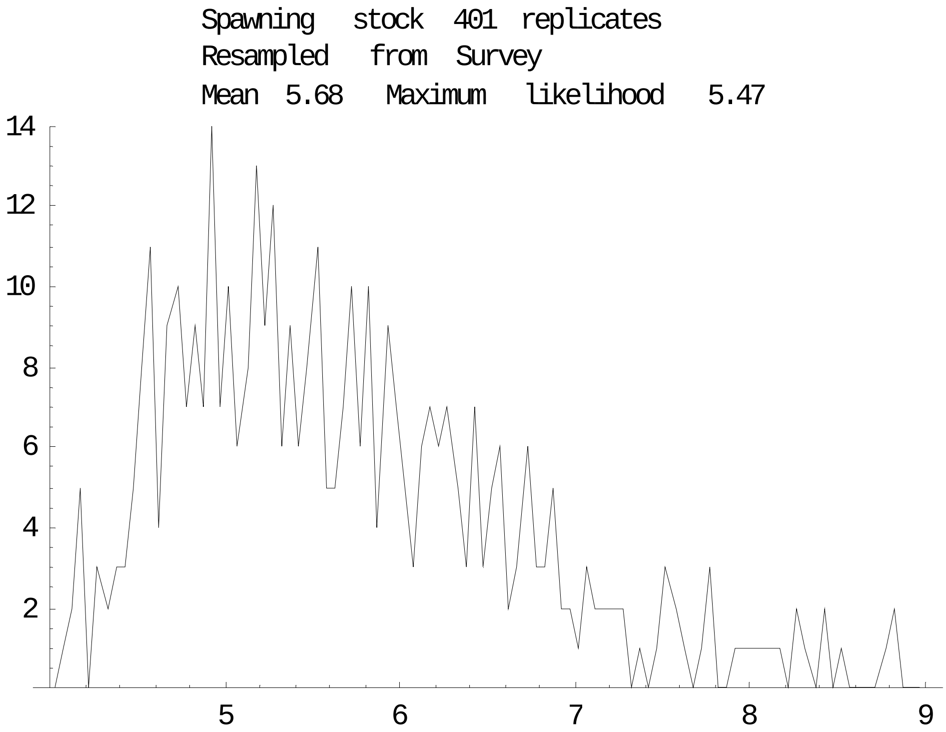


Figure 3.5.7.1

Figure 3.7.1. Distribution of bootstrap replicates of the spawning stock 2000 when only the surveys are resampled, from WD by Tjelmeland. The maximum likelihood value is 1.4 million tones lower than tah of Run 6.



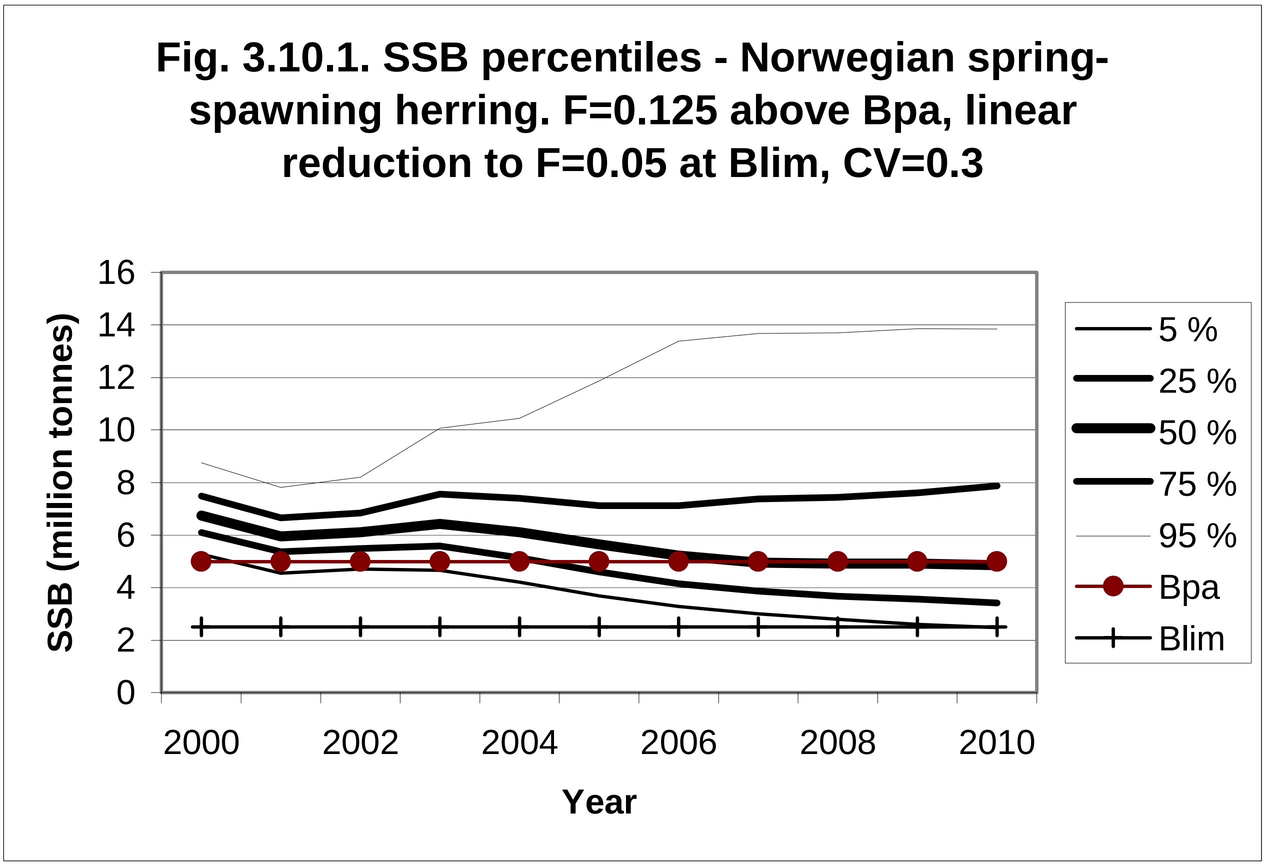
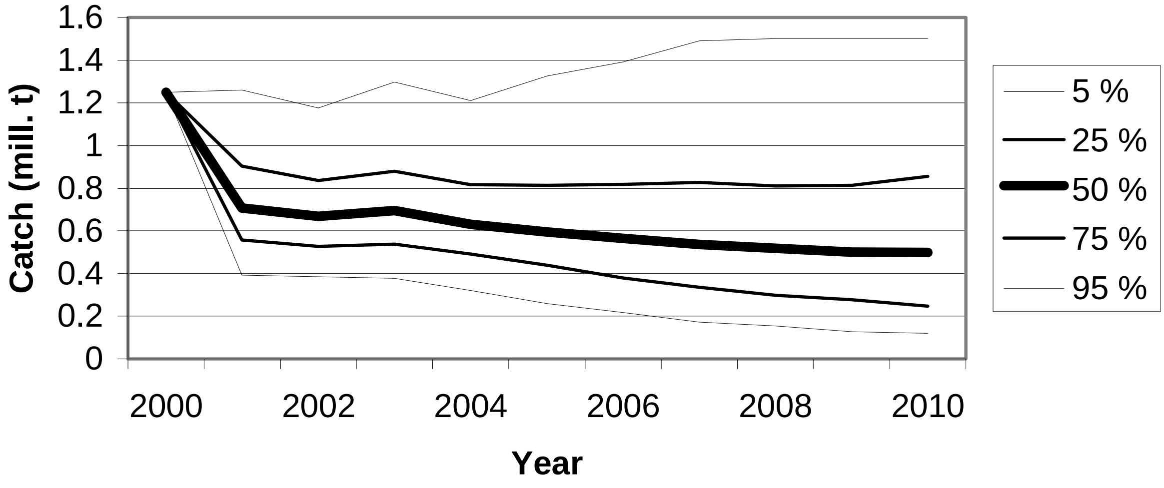


Fig. 3.10.1. SSB percentiles - Norwegian spring-spawning herring. F=0.125 above Bpa, linear reduction to F=0.05 at Blim, CV=0.3
SSB (million tonnes)
16
14
12
10
8
6
4
2
0
2000
2002
2004
2006
2008
2010
Year
5 %
25 %
50 %
75 %
95 %
Bpa
Blim

Fig. 3.10.2. Yield percentiles Norwegian Spring-spawning herring. F=0.125 above Bpa, linear reduction to F=0.05 at Blim, CV=0.3



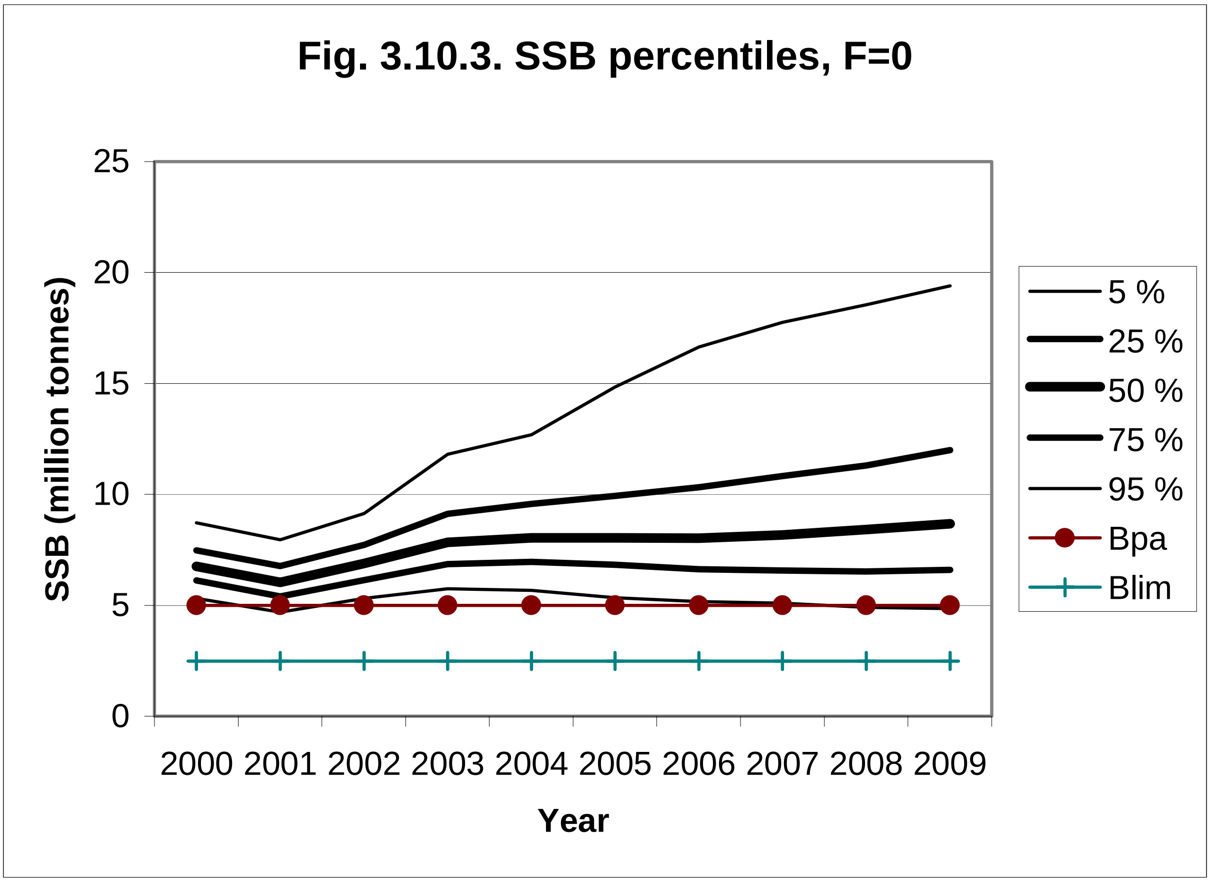


Fig. 3.10.3. SSB percentiles, F=0
SSB (million tonnes)
25
20
15
10
5
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Year
5 %
25 %
50 %
75 %
95 %
Bpa
Blim

4 BARENTS SEA CAPELIN

4.1 Regulation of the Barents Sea Capelin Fishery

Since 1979, the Barents Sea capelin fishery has been regulated by a bilateral fishery management agreement between USSR (now Russia) and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. The fishery was closed from 1 May to 15 August until 1984. During the period 1984 to 1986, the fishery was closed from 1 May to 1 September. A minimum landing size of 11 cm has been in force for several years. From the autumn of 1986 to the winter of 1991, no fishery took place. The fishery was re-opened in the winter season 1991, on a recovered stock. From the autumn 1993 to the winter 1999 the fishery was again closed.

In its autumn meeting in 1999 ACFM considered the harvest control rule that SSB should fall below B_{lim} with maximum 5% probability (corresponding to a catch of 435 000 t. of pre-spawning capelin in 2000) to be consistent with the precautionary approach and recommended that this harvest control rule be applied in 2000. (See also Section 4.5). During its autumn 1999 meeting the Mixed Russian Norwegian Fishery Commission decided to set a quota of 435 000 t on Barents Sea capelin for the winter season 2000, divided by 60% (261 000 t) to Norway and 40% (174 000 t) to Russia.

4.2 Catch Statistics

The international catch by country and season in the years 1965-1999 is given in Table 4.2.1, and by age- and length groups during the spring season 1999 in Table 4.2.2. The total catch in spring 1999 was 83 000 t. This is 3 000 t above the quota and 5 000 t above the maximum TAC recommended by ACFM.

The catch statistics for the winter-spring season 2000 is not available yet. By April 15 Norway had landed about 278 000 t (an additional quota of 29 000 t was transferred from Russia) and Russia 86 000 t.

4.3 Stock Size Estimates

4.3.1 Larval and 0-group estimates

Norwegian larval surveys based on Gulf III plankton samples have been carried out in June each year since 1981. The estimated total number of larvae is shown in Table 4.3.1.1. These larval abundance estimates do not show a high correlation with year class strength at age one, but are probably reflecting the amount of larvae produced in each year (Gundersen and Gjøsæter 1998). An exception is the year 1986, when no larvae were found, probably because the spawning took place so late that the eggs hatched after the survey was carried out. Also in other years some spawning is known to have taken place during the summer, and offspring from such late spawning is not reflected in the larval abundance estimates in Table 4.3.1.1. In 1997 and in 1998, permission was not granted to enter the Russian EEZ during the larval survey, and consequently the total larval distribution area was not covered. The estimate of $36.5 \cdot 10^{12}$ larvae in 1999 is the highest estimate obtained during the period 1981-1999. During the international 0-group surveys in August an area-based index for the amount of 0-group capelin is calculated (Table 4.3.1.1). Gundersen and Gjøsæter (1998) found these indices to be well correlated ($r^2 = 0.75$) with the 1-group acoustic estimates obtained at the annual acoustic capelin surveys in autumn. They included data points up to 1994. When this regression was updated with the survey results from 1995-1998 the parameters in the regression were slightly changed and the r^2 was reduced to 0.66. Based on this regression, (ln 1group estimate = -2.27 + 1.26 · ln 0-group index), the 0-group index obtained in 1999 of 722 would correspond to a year class strength of 413 billion one-year-olds in autumn 2000.

4.3.2 Acoustic stock size estimates in 1999

Two Russian and two Norwegian vessels carried out the 1999 acoustic survey jointly in the period 10 September to 6 October (WD by Bogstad *et al.*). The Norwegian vessels had restricted access to the Russian EEZ but because four vessels were available to the survey of which two (restricted access by a third vessel) could work in the Russian EEZ, the total coverage of the stock was incomplete but the impact to the assessment is considered minimal. The results from the survey are given in Table 4.3.2.1, and are compared to previous years' results in Table 4.3.2.2. The stock size was estimated at 2.8 mill. tonnes. The 1998 year class (one-year-olds) constituted about 55% by numbers and 23% by weight and was somewhat less abundant than the 1997 year class at the same age. About 62% (1.7 mill t) of the stock biomass consisted of maturing fish (> 14 cm).

4.3.3 Other surveys

During the Norwegian demersal fish survey in February 2000 observations of capelin by acoustics and by pelagic and demersal trawls were made (WD by Gjøsæter). No stock size estimate was attempted but the observations confirmed the age composition of the stock as observed during the autumn 1999 capelin survey. Samples of cod stomachs during this period give valuable information for the modelling of maturing capelin as prey item for cod (Bogstad and Gjøsæter, 2000). Russian observations of the capelin were made during a survey from 2 February to 20 March and during the fishery for capelin in 2000 (WD by Ushakov and Prozorkevich). The spawning stock of capelin was estimated at 694 thousand tonnes during those investigations.

4.4 Historical stock development

An overview of the development of the Barents Sea capelin stock in the period 1990-1999 is given in Tables 4.4.1-4.4.7. The methods and assumptions used for constructing the tables were explained in Appendix A to ICES C.M. 1995/Assess: 9. In that report, the complete time series back to 1973 also can be found. It should be noted that several of the assumptions and parameter values used in constructing these tables are provisional and future research may alter some of the tables considerably. For instance, M-values for immature capelin will be calculated using new estimates of the length at maturity and M-values for mature capelin will be calculated taking the predation by cod into account. This will also affect the spawning stock biomass estimates given in the stock summary table (Table 4.4.7). However, the WG considers the tables give an adequate overview of the development of the Barents Sea capelin.

Estimates of stock in number by age group and total biomass for the period are shown in Table 4.4.1. Catch in number by age group and total landings are shown for the spring and autumn seasons in Tables 4.4.2 and 4.4.3. Natural mortality coefficients by age group for immature and mature capelin are shown in Table 4.4.4. Stock size at 1 January in numbers by age group and total biomass is shown in Table 4.4.5. Spawning stock biomass per age group is shown in Table 4.4.6. Table 4.4.7 gives an aggregated summary for the entire period 1973-1999.

4.5 Stock assessment autumn 1999

As decided by the Northern Pelagic and Blue Whiting Fisheries Working Group at its 1999 meeting (ICES C.M. 1999/ACFM:18), the assessment of Barents Sea capelin was left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who reported directly to ACFM before its autumn 1999 meeting (WD by Bogstad *et al.*).

A probabilistic forecast of the spawning stock to the time of spawning at 1 April 2000 was presented, using the spreadsheet model CapTool, implemented in the @RISK add-on to EXCEL. The forecast was based on a probabilistic maturation model with parameters estimated by the model Capsex (mean value of cut-off maturation at 14.23 cm, with uncertainty taken into account) (Tjelmeland 1997), data on size and composition of the cod stock (from the Arctic Fisheries Working Group, ICES 2000/ACFM:3) but made probabilistic in CapTool in accordance with the risk analysis made by the Arctic Fisheries Working Group), and an estimate of the ambient temperature for the cod (with the long-term mean of the Kola section as the mean value and a standard deviation of 1°C).

Some exploratory work was undertaken to calculate a target reference point for capelin. Because of inconsistencies in the data or in the model assumptions, in some years (1974 and 1975, that are before quantitative stomach content data are available) the Capsex model produced positive recruitment at vanishing spawning stocks when the natural mortality of capelin was modelled based on the output from the model Multspec (Tjelmeland and Bogstad, 1998) and the predation from the cod stock. These problems were partly overcome by introducing a scaling factor for the acoustic estimates before 1989 (when the EK500 echo sounders were introduced in these investigations). Still, the results of the simulations are probably very uncertain. Therefore, a B_{lim} (SSB_{lim}) management approach was suggested for this stock. However, the choice of a B_{lim} should also be based on the above-mentioned SSB/R relationship. To overcome this problem, the meeting decided to choose the spawning stock size in 1989 as a $B_{lim.}$ The rationale behind this was that this year, one of the strongest year classes observed during the period 1972-1998 was produced. It should also be noted that this year is within the time range for which quantitative stomach content data are available. It can be argued that the SSB in 1989 was sufficiently large to produce a good year class in a “non-herring situation” (Gjøsæter and Bogstad, 1998). The (stochastic) size of the SSB in 1989 was estimated with an expected value of about 120 000 t.

Probabilistic prognoses for the maturing stock from October 1, 1999 until April 1, 2000 were made, with a CV on the abundance estimate of 0.30. The meeting also concluded that capelin recruitment in 2000 could, to some extent, be influenced by the growing stock of young herring now found in the Barents Sea.

ACFM at its autumn 1999 meeting (ICES 2000/CRR:236) took most of the points in the report into account but took a slightly divergent view on some of the topics. ACFM agreed to the view that fishing mortality reference points and a B_{pa} are not relevant for this stock, and that a target escapement management strategy is the most useful way of ensuring a minimum amount of spawners. Further they agreed to the strategy adopted of directing the fishery at the spawning stock just prior to spawning, to allow the capelin to be available to predators as long as possible. However, the idea of a stochastic B_{lim} set equal to the modelled density distribution of the spawning stock in 1989 was not adopted. Rather, ACFM set a B_{lim} of 200 000 t. (somewhat above the expected value of the modelled SSB in 1989) to be valid in years with low abundance of herring in the Barents Sea. Adopting the forecast of the SSB, using the limit reference points referred above, and following the harvest control rule that the SSB should fall below B_{lim} with maximum 5% probability, ACFM advised that a TAC should not exceed 435 000 t. ACFM further considered that adjustments of the harvest control rule should be further investigated for the purpose to better take account of the uncertainty in the predicted amount of spawners, likely interactions with herring, and the role of capelin as prey item.

4.6 Future reference points and principles of stock assessment

There clearly is a need for a target-based harvesting control rule in addition to the B_{lim}-based rule. The B_{lim} rule is intended to be a safeguard against recruitment failure. However, it is possible that even at higher values of the spawning stock recruitment would increase with an increasing spawning stock, especially for moderately good recruitment conditions. Therefore the value of SSB_{target} that in the long run gives the highest mean yield might be well above B_{lim}. The present inconsistencies in the data and assumptions have precluded a simulation analysis to find SSB_{target}. New information now available (e.g. Bogstad and Gjøsæter (2000) indicating that a significant proportion of the capelin consumed by cod in winter is immature capelin) may lead to more realistic consumption estimates of maturing capelin, and may partly aid to overcome the problems mentioned above. Also, the consumption model used is parameterised on stomach content data from the joint IMR-PINRO stomach content data base where there is very little data before 1984. Thus, assumptions about the amount of other food in relation to capelin inferred from this model may fail in the 1970s. Data exist in Russia, which may be used to adjust the model for the period before 1984. However, most of these data have not been computerised. A co-operation between Russia and Norway has made it possible to computerize data from 100 cruises with 12000 trawl stations in the period 1971-1974. The stomach content information from these data is in the form of frequency of occurrence, but still the data give useful insight into changes in the feeding of cod. A preliminary analysis (WD by Shleinik *et. al*) shows systematic changes in the amount of other food from the 1970s to the 1980s. However, the database and the information extraction programs need to be further scrutinized for errors before the data are used in management. The WG will emphasise the importance of continuing the establishing of historic data that can shed light on changes in feeding regime of the cod.

Important sources of uncertainty have not yet been quantified. Work has been undertaken to base the uncertainty of the capelin survey on survey data using parametric bootstrap (WD by Tjelmeland), but as yet important sources of uncertainty (migration during the cruise, day-night effects, weather effects) have not been considered. Also, work has been undertaken to base the uncertainty in the calculation of consumption on the uncertainty in the evacuation rate model and number of stomachs sampled (WD by Tjelmeland). One of the most important sources of uncertainty in the capelin assessment is the inherent uncertainty in the assessment of cod. The historic abundance of cod is independent of other parameters and variables in the capelin assessment and bootstrap replicates could be made and included into a bootstrap analysis of the historic capelin stock.

Assuming that a modification of the model for predation on capelin by cod by allowing predation on immature capelin in January-March and using stomach content information from before 1984 will resolve the present inconsistencies, a SSB_{target} for capelin could be based on bootstrapping the historic spawning stock biomass and recruits. For each bootstrap replicate a SSB_{target} can be found. During management-related probabilistic forecasts each trajectory can be based on one historic replicate giving one value of SSB_{target} and one value of B_{lim} together with a recording of whether the spawning stock exceeds either of these reference points. The full information in the assessment can then be summarised by two curves: the probability of exceeding SSB_{target} and the probability of exceeding B_{lim} as function of catch.

4.7 Management considerations

Since the assessment of the stock is directly based on the acoustic survey conducted annually in September-October, and the main fishing season does not begin until January, advice for this stock must be given during the autumn ACFM meeting and the TAC must be set by the Mixed Norwegian-Russian Fishery Commission during its meeting in November-December. As previously decided by the Northern Pelagic and Blue Whiting Fisheries Working Group, the assessment of Barents Sea capelin is left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who will report directly to the 2000 ACFM autumn meeting.

4.8 Age reading

The assessment surveys on the Barents Sea capelin are joint surveys where Russian and Norwegian vessels participate. The age-length keys applied to divide the estimated total number of fish on age groups are, therefore, based on age readings from both countries. In most years, the majority of the age readings are done on the Norwegian vessels. Recently, some discrepancies have been detected between age reported by Russian and Norwegian scientists (ICES CM 1999/ACFM:18).To investigate this further, and to try to reconcile the differences between Norwegian and Russian age readings, work is now being done to set up a reference material of capelin otoliths, and an age reading workshop was arranged in Murmansk in November 1999 (WD by Gjøsæter and Ushakov). It was concluded that bias existed among the participating age readers, although the reason for this could not be fully investigated within the short time available. The results showed that the agreement between Russian and Norwegian age readings was better for otoliths sampled during autumn than for those sampled in spring. To follow up this workshop, it was decided to exchange otolith material once or twice each year, and if need be, to arrange further workshops.

4.9 Sampling

The sampling from scientific surveys and from commercial fishing on capelin is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Acoustic survey 1999 (Norway)	178	11667	6407
Acoustic survey 1999 (Russia)	72	9743	3632
Norwegian bottom trawl survey winter 2000	248	9172	1910
Russian investigations winter 2000	24	1471	640
Norwegian fishery winter 2000[1]	109	12336	700
Russian fishery winter 2000	28	11240	1087

[1] Preliminary, samples in course of preparation

Table 4.2.1 Barents Sea CAPELIN. International catch ('000 t) as used by the Working Group.

Year	Winter				Summer-Autumn			Total
	Norway	Russia	Others	Total	Norway	Russia	Total	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	11	358	1591
1973	1078	35	0	1112	213	10	223	1336
1974	749	80	0	829	237	82	319	1149
1975	559	301	43	903	407	129	536	1439
1976	1252	231	0	1482	739	366	1105	2587
1977	1441	345	2	1788	722	477	1199	2987
1978	784	436	25	1245	360	311	671	1916
1979	539	343	5	887	570	326	896	1783
1980	539	253	9	801	459	388	847	1648
1981	784	428	28	1240	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	374	36	1161	758	439	1197	2358
1984	330	257	42	628	481	367	849	1477
1985	340	234	17	590	113	164	278	868
1986	72	51	0	123	0	0	0	123
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	528	156	20	704	31	195	226	929
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0
1999	50	33	0	83	0	0	0	83

Table 4.2.2 Barents Sea CAPELIN. International catch ('000 t) during the spring season 1999, as used by the Working Group

Length	Age 1		Age 2		Age 3		Age 4		Age 5+		Sum			
cm	N	B	N	B	N	B	N	B	N	B	N	%	B	%
5 - 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 - 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 - 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 - 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 - 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 - 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 - 12	0	0	2	14	0	0	0	0	0	0	2	0	14	0
12 - 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13 - 14	0	0	0	0	4	57	0	0	0	0	4	0	57	0
14 - 15	0	0	0	0	103	1800	52	795	0	0	155	5	2595	3
15 - 16	0	0	0	0	293	5853	360	6555	67	1228	721	23	13635	17
16 - 17	0	0	0	0	247	6267	492	11864	174	3978	913	29	22110	27
17 - 18	0	0	0	0	140	4318	337	10280	267	7469	744	24	22067	27
18 - 19	0	0	0	0	52	1942	215	8261	190	6552	456	15	16756	20
19 - 20	0	0	0	0	0	0	68	2970	24	1040	93	3	4010	5
20 - 21	0	0	0	0	0	0	0	0	17	860	17	1	860	1
21 - 22	0	0	0	0	0	0	0	0	11	448	11	0	448	1
Sum	0	0	2	14	838	20238	1524	40724	751	21575	3115	100	82551	100

Table 4.3.1.1 Barents Sea CAPELIN. Larval abundance estimate (10^{12}) in June, and 0-group index in August.

Year	Larval abundance	0-group index
1981	9.7	570
1982	9.9	393
1983	9.9	589
1984	8.2	320
1985	8.6	110
1986	-	125
1987	0.3	55
1988	0.3	187
1989	7.3	1300
1990	13.0	324
1991	3.0	241
1992	7.3	26
1993	3.3	43
1994	0.1	58
1995	0.0	43
1996	2.4	291
1997	6.9[1]	522
1998	14.1[1]	428
1999	36.5	722

[1] Is an underestimate, since the vessel was not allowed to work in Russian EEZ

Table 4.3.2.1 Barents Sea CAPELIN. Estimated stock size from the acoustic survey in September-October 1999. Based on TS value 19.1 log L –74.0 dB, corresponding to $\sigma = 5.0 \cdot 10^{7} \cdot L^{1.91}$.

Length (cm)	Age/Year class 1 1998	2 1997	3 1996	4 1995	5+ 1994	Sum (10^6)	Biomass (10^3 t)	Mean weight (g)
6.5 - 7.0	4314					4314	4.3	1.0
7.0 - 7.5	4858					4858	7.2	1.5
7.5 - 8.0	6501					6501	11.5	1.8
8.0 - 8.5	7951					7951	14.7	1.9
8.5 - 9.0	11077					11077	23.7	2.1
9.0 - 9.5	13118					13118	34.6	2.6
9.5 - 10.0	16033					16033	50.0	3.1
10.0 - 10.5	21022	197				21219	79.8	3.8
10.5 - 11.0	24778	93				24871	110.1	4.4
11.0 - 11.5	16489	1864				18353	97.2	5.3
11.5 - 12.0	13911	4687				18598	114.3	6.1
12.0 - 12.5	8732	6934	49			15715	114.4	7.3
12.5 - 13.0	3215	10071	28			13314	112.5	8.5
13.0 - 13.5	1269	10713	97			12079	122.5	10.1
13.5 - 14.0	933	12527	232			13692	160.3	11.7
14.0 - 14.5	763	12455	332			13550	178.9	13.2
14.5 - 15.0	462	12580	576			13618	204.7	15.0
15.0 - 15.5	388	11835	1767			13990	241.7	17.3
15.5 - 16.0	107	7717	2211	31		10066	195.5	19.4
16.0 - 16.5		4528	3379	58		7965	174.8	22.0
16.5 - 17.0		2805	3931	141		6877	169.9	24.7
17.0 - 17.5		1301	4580	132		6013	164.3	27.3
17.5 - 18.0		466	3527	227		4220	131.8	31.2
18.0 - 18.5		426	2923	202		3551	123.5	34.8
18.5 - 19.0		200	1900	32		2132	81.6	38.3
19.0 - 19.5		81	652	41		774	33.9	43.8
19.5 - 20.0			315			315	14.8	46.9
20.0 - 20.5			45			45	2.4	52.3
20.5 - 21.0				3		3	0.2	55.0
TSN (10^6)	155921	101480	26544	867		284812		
TSB (10^3 t)	652	1384	714	25			2775	
Mean length (cm)	10.19	14.15	17.01	17.57		12.26		
Mean weight (g)	4.2	13.6	26.9	29.3				9.7
SSN (10^6)	1720	54394	26138	867		83119		
SSB (10^3 t)	26	953	713	26			1718	

Based on TS value: 19.1 log L - 74.0, corresponding to $\sigma = 5.0 \cdot 10^{-7} \cdot L^{1.91}$

Table 4.3.2.2 Barents Sea CAPELIN. Stock size in numbers by age, total stock biomass and biomass of the maturing component. Stock in numbers (unit:10^9) and stock and maturing stock biomass (unit:10^3 tonnes) are given at 1. October.

Year	Stock in numbers (10^9)						Stock in weight ('000 t)	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	Maturing
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330
1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	932
1999	156	101	27	1	0	285	2776	1718

Table 4.4.1 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. August, back-calculated from the survey in September-October.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	707.7	415.0	396.2	3.1	29.5	8.3	88.9	111.8	188.4	171.4
2	179.4	600.9	223.9	73.0	5.1	9.4	12.5	44.2	76.5	111.5
3	16.4	36.7	162.8	25.3	6.4	1.6	2.2	2.2	12.1	27.9
4	0.1	1.4	1.6	3.7	0.3	0.4	0.1	0.1	0.7	0.9
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Sum	903.7	1054.0	784.4	105.0	41.4	19.7	103.7	158.3	277.8	311.7
Biomass	4901	6647	5371	991	259	189	467	866	1860	2580

Table 4.4.2 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the spring season.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.4	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	24.0	23.8	4.8	0.0	0.0	0.0	0.0	0.0	0.8
4	0.0	8.2	17.3	26.8	0.0	0.0	0.0	0.0	0.0	1.5
5	0.0	2.7	2.1	1.4	0.0	0.0	0.0	0.0	0.0	0.8
Sum	0.0	35.3	43.4	33.5	0.0	0.0	0.0	0.0	0.0	3.1
Landings	0	704	891	586	0	0	0	0	0	83

Table 4.4.3 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the autumn season.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.0	2.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	9.3	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	3.1	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	0.0	15.5	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Landings	0	226	232	0	0	0	0	0	0	0

Table 4.4.4 Barents Sea CAPELIN. Natural mortality coefficients (per month) for immature fish (M_{imm}), used for the whole year, and for mature fish (per season) (M_{mat}) used January to March, by age group and average for age groups 1-5.

	1990		1991		1992		1993		1994	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.005	0.016	0.015	0.046	0.059	0.178	0.157	0.471	0.201	0.602
2	0.005	0.016	0.015	0.045	0.058	0.174	0.157	0.470	0.201	0.602
3	0.005	0.016	0.051	0.153	0.107	0.322	0.190	0.571	0.201	0.602
4	0.005	0.016	0.051	0.154	0.074	0.221	0.214	0.642	0.282	0.847
5	0.005	0.016	0.051	0.154	0.071	0.212	0.214	0.642	0.282	0.847
Avr	0.005	0.016	0.037	0.111	0.074	0.222	0.186	0.559	0.221	0.700

Table 4.4.4 (Continued)

	1995		1996		1997		1998		1999	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.073	0.219	0.041	0.122	0.062	0.185	0.026	0.077	0.047	0.142
2	0.073	0.219	0.041	0.122	0.062	0.185	0.026	0.077	0.047	0.142
3	0.019	0.058	0.041	0.122	0.062	0.185	0.071	0.212	0.025	0.074
4	0.044	0.133	0.050	0.149	0.014	0.041	0.071	0.212	0.025	0.074
5	0.044	0.133	0.050	0.149	0.014	0.041	0.071	0.212	0.025	0.074
Avr	0.052	0.152	0.043	0.133	0.042	0.127	0.053	0.158	0.034	0.101

Table 4.4.5 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. January.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	734.0	462.4	600.1	9.2	120.3	13.8	118.2	172.0	225.5	238.5
2	181.4	689.5	382.0	293.7	1.4	10.8	5.7	72.5	82.2	165.8
3	17.0	174.8	548.6	162.6	33.3	1.9	6.5	10.2	32.5	67.3
4	1.6	16.0	25.7	89.2	9.8	2.4	1.4	1.8	1.6	8.5
5	0.0	0.1	0.3	0.5	1.3	0.1	0.3	0.1	0.1	0.5
Sum	934.0	1342.8	1556.8	555.2	166.1	28.9	132.2	256.6	341.9	480.6
Biomass	2011	7011	8299	4372	737	156	313	779	1240	2456

Table 4.4.6 Barents Sea CAPELIN. Estimated spawning stock biomass ('000 t) by 1. April.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0	0	0	0	0	0	0	0	0	0
2	2	19	0	0	0	1	3	1	1	2
3	140	1424	919	129	34	15	71	175	217	666
4	37	142	79	331	60	38	24	49	34	185
5	0	0	0	0	11	1	7	2	2	0
Sum	179	1584	998	460	105	55	105	228	254	853

Table 4.4.7 Barents Sea CAPELIN. Stock summary table. Recruitment (number of 1 year old fish (unit:10^9) and stock biomass ('000 t) given at 1. August, spawning stock ('000 t) at time of spawning (1. April). Landings ('000 t) are the sum of the total landings in the two fishing seasons within the year indicated.

Year	Stock biomass	Recruit-ment Age 1	Spawning stock biomass	Landings
1965				224
1966				389
1967				409
1968				537
1969				680
1970				1314
1971				1392
1972	5831			1592
1973	6630	1140	1242	1336
1974	7121	737	343	1149
1975	8841	494	90	1439
1976	7584	433	1147	2587
1977	6254	830	890	2987
1978	6119	855	460	1916
1979	6576	551	193	1783
1980	8219	592	87	1648
1981	4489	466	1731	1986
1982	4205	611	546	1760
1983	4772	612	47	2358
1984	3303	183	171	1477
1985	1087	47	106	868
1986	157	9	13	123
1987	107	46	16	0
1988	361	22	11	0
1989	771	195	141	0
1990	4901	708	179	0
1991	6647	415	1584	929
1992	5371	396	998	1123
1993	991	3	460	586
1994	259	30	105	0
1995	189	8	55	0
1996	467	89	105	0
1997	866	112	228	0
1998	1860	188	254	0
1999	2580	171	853	83

5 CAPELIN IN THE ICELAND-EAST GREENLAND-JAN MAYEN AREA

5.1 The Fishery

5.1.1 Regulation of the fishery

The fishery depends upon maturing capelin, i.e. that part of each year class which spawns at age 3 as well as those fish at age 4, which did not reach maturity to spawn at age 3. The abundance of the immature components is difficult to assess before their recruitment to the adult stock at ages 2 and 3. This is especially true of the age 3 immatures.

The fishery of the Iceland-East Greenland-Jan Mayen capelin has, therefore, been regulated by preliminary catch quotas set prior to each fishing season (July–March). Predictions of TACs have been computed based on data from surveys of the abundance of 1 and 2 year old capelin, carried out in the autumn of the year before. The process includes historical relationships between such data and the backcalculated abundance of the same year classes, an average growth rate and natural mortality and the provision of a remaining spawning stock of 400 000 t. Final catch quotas for each season have then been set in accordance with the results of acoustic surveys of the maturing, fishable stock abundance, carried out in autumn (October–November) and/or winter (January/February) in that fishing season. A more detailed description of the method is given in Section 5.5.1. A summary of the results of this catch regulation procedure is given in Table 5.1.1.

Over the years, fishing has not been permitted during April-June and the season opened in late July/August or later, depending on the state of the stock. Due to very low stock abundance there was a fishing ban lasting from December 1981 to November 1983. In addition, areas with high abundance of juvenile 1- and 2-group capelin (in the shelf region off NW-, N- and NE-Iceland) have usually been closed to the summer and autumn fishery.

This capelin stock occurs in the EEZs of Greenland, Iceland and Norway (Jan Mayen) and the fishery is managed through a tripartite agreement between these nations.

5.1.2 The fishery in the 1999/2000 season

In accordance with a previously determined procedure, ACFM recommended that the preliminary TAC should not exceed 856 667 t. This is 2/3 of the total TAC predicted for the season, i.e. 1 285 000 t. This advice was accepted by all parties concerned.

The season opened on 20 June and the fishery began in deep waters north of the shelf edge off the eastern north coast of Iceland. As usual the fishing grounds gradually shifted to the northwest. Catch rates were very low and by the end of August the total catch amounted to only 100 000 t. After that the capelin had become so scattered that the fishery was abandoned.

In spite of several attempts, the fishing fleet failed to locate fishable concentrations all through October-December. The autumn fishery was therefore a complete failure, the total catch amounting only to some 3 000 t.

The total catch in the 1999 summer and autumn season thus amounted to about 103 000 t.

In January 2000 large, fishable concentrations of adult capelin were located in deep waters off the shelf east of Iceland. In spite of interruptions due to stormy weather a total catch of about 235 000 t of capelin was taken off the southern east coast during January and early February just prior to the first spawning migration in shallow waters at the southeast coast.

Catch rates were extremely high off the south coast of Iceland during 11-29 February and the first 10 days of March. By mid-March, the fishing fleet had begun operating on large concentrations of ripe spawners off the central west coast. This coincided with the beginning of a series of storms. After that the capelin were only sporadically available to purse-seining and catch rates became extremely variable until the end of the winter fishery in late March.

The total catch during the 2000 winter season amounted to 830 000 t, which is the highest on record.

5.2 Catch Statistics

The total annual catch of capelin in the Iceland-East Greenland-Jan Mayen area since 1964 is given by weight, season and fleet in Table 5.2.1.

The total catch in numbers during the summer/autumn 1979–1999 and winter 1980–2000 seasons is given by age and years in Tables 5.2.2 and 5.2.3.

The distribution of the catch during the summer-autumn 1999 and winter 2000 seasons is given by size groups at age in Tables 5.2.4 and 5.2.5.

5.3 Surveys of Stock Abundance

5.3.1 0-group surveys

The distribution and abundance of 0-group capelin in the Iceland-East Greenland-Jan Mayen area has been recorded during surveys carried out in August since 1970. The survey methods and computations of abundance indices were described by Vilhjálmsson and Fridgeirsson (1976). The abundance indices of 0-group capelin, divided according to areas, are given in Table 5.3.1.1.

An acoustic estimate of the abundance of 1-group capelin has also been obtained during the August 0-group surveys (e.g. Vilhjálmsson 1994). Their abundance by number, mean length and weight for the period 1983–1999 is given in Table 5.3.1.2.

5.3.2 Stock abundance in autumn 1999 and winter 2000

An acoustic survey was carried out by two research vessels in the period 15 November-7 December 1999 (WD by Vilhjálmsson). The distribution of the stock was fairly wide and more or less continuous, reaching from 26°W, northwest of the NW-peninsula of Iceland, across the outer part of the northern shelf to 10°30'W off the northern and central east coast. The largest and most dense capelin concentrations were recorded near the shelf edge off the western north coast as well as north and northwest of the NW-peninsula of Iceland.

Conditions during the autumn 1999 survey were inadequate for acoustic assessment of capelin abundance. There was much drift ice in the Denmark Strait and frequent storms prevented observations in the deep water area northeast of Iceland. The capelin were almost exclusively recorded as scattering layers of varying densities at depths of 50-150 m in darkness but somewhat deeper in the daytime. Most of the densest concentrations, recorded north of the Vestfirdir peninsula and the western north coast of Iceland, consisted of a mixture of adults and 1-group juveniles. Small adult concentrations were recorded in a small area off the eastern north coast, while east of Iceland there were almost exclusively juveniles.

According to the autumn 1999 survey, the immature stock component amounted to 89.8 and 4.4 * 10^9 fish, belonging to age groups 1 and 2 respectively. The estimated total fishable/spawning stock abundance was 19.7 * 10^9 fish in early December 1999. The observed mean weight in the fishable stock was 15.1 g and the fishable/spawning stock biomass, therefore, just under 300 000 t. Details of the autumn 1999 stock abundance estimate in numbers and weights at age are given in Table 5.3.2.1.

Because both total adult stock biomass and the contribution of the older age group were much below expectations and the average weight far below the average in the catch taken in June/July, it was concluded that the autumn 1999 survey must have failed to locate and assess part of the adult fishable stock.

During 18 January-10 February 2000, the abundance of mature capelin was assessed in deep waters off the east and southeast coast of Iceland (WD by Vilhjálmsson). The survey was carried out under difficult weather conditions in the sense that it had to be broken off on three occasions due to storms. The total fishable/spawning stock, estimated by this survey, was 47 * 10^9 fish with an average weight of 18.8 g and a total biomass of 885 000 t. At this time, the capelin were migrating southwards against the direction of the survey. Therefore it was assumed that the survey had underestimated the adult stock abundance by about 20%. Details of the uncorrected January/February 2000 estimate and the applied correction of 20% are given in Table 5.3.2.2.

However, a weighted average of the age structure in samples from the catch taken after the survey (about 615 000 t) showed that the contribution by the older age group (age 4) was approximately two times that found during the January/February survey (about 13% as compared to 6%). The highest contribution in single samples, taken in either the survey or the catch, was about 20%. To reconcile the difference in weighted age distribution between the survey and catch data, an assumption must be made of the age distribution in that part of the stock which the survey missed. Single year classes have never been observed in pure concentrations in this capelin stock. In view of the highest observed ratio of 4:1 of 3 and 4 year olds respectively, among the capelin sampled during the winter season, an assumption of a 2:1

ratio of 3 and 4 years olds in the missing stock component should be on the conservative side. Based on these assumptions it was found that an addition of 9.6 and 4.8 * 10^9 fish, of age groups 3 and 4 respectively, must be added to the initial January/February estimate in order to obtain the same age distribution as recorded in the catch that was subsequently taken. This raises the January/February 2000 assessment of total stock abundance by numbers and biomass to 61.4 * 10^9 and 1 178 000 t respectively. Details of the initial January/February acoustic estimate and the correction just described are given in Table 5.3.2.3.

During 24 February-2 March 2000 a survey was made of mature capelin west of the NW-peninsula of Iceland (WD by Vilhjálmsson). This group of spawners consisted of smaller capelin than those east of Iceland and their abundance was estimated at about 76 000 t. Details of the February/March estimate are given in Table 5.3.2.4.

5.4 Historical Stock Abundance

The historical estimates of stock abundance are based on the "best" acoustic estimates of the abundance of maturing capelin in autumn and/or winter surveys, the "best" in each case being defined as that estimate on which the final decision on TAC was based. Taking account of the catch in number and a monthly natural mortality rate of M = 0.035 (ICES C.M. 1991/Assess:17) the abundance estimates of each age group are then projected to the appropriate point in time. Since natural mortality rates of juvenile capelin are not known, their abundance by number has been projected using the same natural mortality rate.

The annual abundance by number and weight at age for mature and immature capelin in the Iceland-East Greenland-Jan Mayen area has been calculated with reference to 1 August (before the fishing season) and 1 January of the following year for the 1978/79–1999/00 seasons. The results are given in Tables 5.4.1 and 5.4.2 (1 August and 1 January, respectively). Table 5.4.2 also gives the remaining spawning stock by number and biomass in March/April 1979–2000.

The observed annual mean weight at age was used to calculate the stock biomass on 1 January. With the exception of juvenile capelin, which are surveyed in summer, the average weight at age of adult capelin in autumn is used to calculate stock biomass of the maturing components in summer. Because there is a small weight increase among mature capelin in February and March, the remaining spawning stock biomass is slightly underestimated.

5.5 Stock Prognoses

5.5.1 Methods

The preliminary TAC should be set at a level to open the fishery before the October/November survey, and to keep the residual spawning stock at or above 400 000 tonnes. Thus the prognosis procedure needs to predict the fishable stock in the beginning of the season in order to predict the effects of fishing. To account for the highly variable year class strength and maturing ratio, the procedure needs to predict separately the two major components of the mature stock (age groups 2 and 3). These predictions need to be done in spring.

Available data include acoustic survey estimates of the different age groups in August, October and January. It has been found that, when available, autumn (October/November) acoustic estimates of the abundance of age groups 1 and 2 are good predictors of fishable stock abundance about 8 months prior to the fishery.

The maturing part of age group 2 in summer (N_{2mat}) is a part of the survivors of the 1-group of the previous autumn (N_1), which is measured in October. A prediction model was developed (ICES C.M.1993/Assess:6), based on a linear relationship between the historic back-calculated abundance of maturing capelin at age group 2 (N_{2mat}) and the autumn acoustic estimates of the same year classes at age 1 (N_1). This relationship was then used to predict the adult 2-group abundance at the beginning of the fishing season some 8 months later.

The maturing part of the 3-group in summer corresponds to that part of the year class which did not mature and spawn in the year before. Unfortunately, the surveys of the immature capelin of age 2 (N_{2imm}) in the year before have usually been gross underestimates and, therefore, have generally not been used. Similarly, the January survey of this year class only estimates the part which will spawn and thus is no indication of what will appear in summer of next year.

In general terms, however, maturity at age 2 is inversely related to year class size (N_{2tot}) i.e. the maturing ratio is a function of year class abundance. Therefore, the total abundance of age group 2 in autumn should be an indication of what will appear as 3-group in the following season. Since 1993, a regression relating the back-calculated total abundance of year classes at age 2 to their abundance at age 3 (N_{2tot} and N_{3mat}, respectively) has been used to predict the abundance of age 3 capelin.

The data sets comprising all comparisons of numbers by age and maturity, relevant to this prediction model, are given in Table 5.5.1.1. The mean weight of maturing 2- and 3-group capelin in autumn 1981–1999 (year classes 1978–1997) is given in Table 5.5.1.2. The above regressions have been updated as new data became available. A comparison of the predicted TAC updated with data from the autumn surveys is given in Table 5.5.1.3.

5.5.2 Stock prognosis and TAC in the 1999/2000 season

The 1993 models (ICES 1993/Assess:6) for predicting the numbers of maturing capelin of ages 2 and 3 from the November 1997 acoustic assessment of the 1995 and 1996 year classes gave estimates of 89.2 and 23.3 billion maturing 2- and 3-group capelin on 1 August 1999.

Since 1989 there has been a general downward trend in weight at age of adult capelin, apparently inversely related to adult stock abundance in number. Plotting these pairs of data as simple linear regressions results in $R^2 = 0.76$ and 0.86 for age groups 2 and 3 respectively. Applying the appropriate regression equations, $y = -0.032x + 19.1$ for the younger component and $y = -0.061x + 28.5$ for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 1999 combined, *i.e.* $112.5 * 10^9$ fish, resulted in estimated mean weights of 15.5 and 21.6 g for age groups 2 and 3 respectively.

The fishable stock biomass, obtained by multiplying the stock in numbers by the predicted mean weight of maturing capelin in autumn, was projected forward to spawning time in March 2000 assuming a monthly M = 0.035 and a remaining spawning stock of 400 000 tonnes. This gave a predicted TAC of 1 285 000 tonnes spread evenly over August 1999–March 2000 (Table 5.5.1.3). Using the same approach as in previous years, *i.e.* that the preliminary TAC be set at 2/3 of the predicted total for the season, the Working Group recommended that a preliminary TAC for the 1999/2000 capelin fishery be set at 856,667 t.

According to the January/February 2000 survey results and applying the first correction described in section 5.3.2 the estimated fishable/spawning stock was $56.4 * 10^9$ fish on 10 February 2000 (cf. Table 5.3.2.2). At that time the observed mean weight in the fishable stock was 18.8 g and the stock biomass therefore 1 062 000 t. With the usual prerequisite of a monthly natural mortality rate of 0.035, a remaining spawning stock of 400 000 t the above abundance estimate indicated a TAC of 662 000 t in the time remaining of the 2000 winter fishery. Counting the catch taken from late June 1999 to 10 February 2000, this corresponded to a total TAC of 1 000 000 t for all of the 1999/2000 season, which was subsequently set at that level.

As described in section 5.3.2 there is a large difference between the contribution of 4 year olds in the January/February acoustic estimate on one hand and of that in the catch taken during the remainder of the season. It therefore seems that an adjustment of the January/February acoustic estimate, based on the observed age distribution in the catch, better represents the actual fishable/spawning stock abundance east of Iceland in early February 2000. Applying this correction and adding the estimate from off NW-Iceland in February/March 2000 indicates a fishable/spawning stock abundance of about 1 262 000 t on 10 February 2000 (cf. Tables 5.3.2.3 and 5.3.2.4). Had these data been available and this correction made on February 10 2000 the TAC would have been set at 1 185 000 t for all of the 1999/2000 season, rather than the 1 000 000 t TAC that was actually set.

The difference between the predicted TAC and the hypothetical TAC calculated in the above manner, is mainly due to a smaller contribution by 1996 year class than that originally predicted by the Working Group in May 1999. Since about 250 000 t of the hypothetical TAC as calculated above remained at the end of the winter fishery, it follows that some 645 000 t of capelin remained to spawn in 2000.

5.5.3 Stock prognosis and assessment for the 2000/2001 season

Calculations of expected TAC for the 2000/2001 season, based on the method described in section 5.5.1 and data from Table 5.5.1.1, were used for predicting the abundance by number of maturing capelin of ages 2 and 3 on 1 August 1999.

An updated linear regression of the measured abundance of 1-group capelin (N_1) on the backcalculated abundance of mature 2-group fish (N_{2mat}) gives $y = 0.572x + 19.6$; $R^2 = 0.84$, $p < 0.05$. Similarly for the older stock component, where N_{2tot} is regressed on N_{3mat}, gives $y = 0.286x - 6.9$; $R^2 = 0.52$, $p < 0.05$. The two regression plots are shown in Figure 5.5.3.1.

The Working Group decided that the November 1999 estimate of the abundance of 1-group capelin (year class 1998) was realistic and could be used for predicting the abundance of maturing capelin of the 1998 year class on 1 August 2000.

The predictive figures for the 1998 and 1997 year classes are given in Table 5.5.1.1 These gave an estimate of 70.9 and 19.2 billion mature fish, belonging to the 1998 and 1997 year classes respectively.

During the last ten years there has been a general downward trend in weight at age of adult capelin, apparently inversely related to adult stock abundance in number. Plotting these pairs of data as simple linear regressions results in $R^2 = 0.66$ and 0.76 for age groups 2 and 3 respectively. These two regression plots are shown in Figure 5.5.3.2. Applying the appropriate regression equations, $y = -0.034x + 19.3$ for the younger component and $y = -0.069x + 28.8$ for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 1999 combined, *i.e.* $90.1 * 10^9$ fish, results in estimated mean weights of 16.2 and 22.7 g for age groups 2 and 3 respectively.

Using the predicted mean weight of maturing capelin in autumn instead of the "long-term" average mean weight, results in a predicted TAC of 975 000 t if spread evenly over the period August 2000–March 2001. This corresponds to a preliminary TAC of 650 000 t. As in previous years, decisions on the final TAC for the 2000/2001 season should be based on surveys carried out in October/November 2000 and/or January/February 2001.

5.5.4 Management of capelin in the Iceland-East Greenland-Jan Mayen area

The fishable stock consists of only 2 age groups (2 and 3 year olds, spawning at ages 3 and 4). The fishing season has usually begun in July and ends in March of the following year when the remainder of the fishable stock spawns and dies. The fishable stock, which is also the maturing stock, is thus renewed annually and its exploitation must of necessity be cautious. Due to the short life span and high spawning mortality, stock abundance can only be assessed by acoustics.

Since 1992, the key elements in the management of capelin in the Iceland-East Greenland-Jan Mayen area are as follows:

Acoustic survey estimates of juvenile capelin abundance have been used to predict fishable stock abundance by number in the following year (fishing season). Historical average mean weight at age (in later years a relationship between stock abundance and growth), growth rates and natural mortality have been used for calculations and projections of maturing and fishable stock biomass.

Based on the data described above, a prediction of TAC is made in spring of the year in which the season begins, allowing for 400 000 t remaining to spawn at the end of the season. For precautionary purposes, a preliminary TAC, corresponding to 2/3 of the predicted total TAC for the season, has then been allocated to the period July–December. With regard to a precautionary approach, the Working Group stresses the importance of the continued setting of a preliminary TAC for the first half of the season.

The final decisions on TACs for each fishing season have been based on the results of acoustic stock abundance surveys in late autumn or in January/February of the following year during that season.

The procedure just described has worked well in the past for 'normal' ranges of stock abundance. However, it is clear that extra care should be taken when dealing with stock abundance below or above the norm, corresponding to TACs <500 000 or >1,600 000 tonnes.

5.6 Precautionary Approach to Fisheries Management

Due to the short life span of capelin and their high spawning mortality, the main management objective is to maintain enough spawners for the propagation of the stock. Since 1979 the targeted remaining spawning stock for capelin in the Iceland-East Greenland Jan-Mayen area has been 400 000 tonnes. Although there have been large fluctuations in stock abundance during this period, these appear to be environmentally induced and not due to excessive fishing. Therefore, the criterion of maintaining a remaining spawning stock may be defined as B_{lim}, i.e. stock abundance below which no fishery should be permitted.

The definition of other precautionary reference points is more problematic. However, due to uncertainties inherent in predicting the abundance of short-lived species and the importance of capelin as forage fish for predators such as cod, saithe, Greenland halibut, baleen whales and sea birds, extra caution should be taken when stock predictions indicate TACs <500 000 tonnes and >1 600 000 tonnes. In the former case, the fishery should not be opened until after the completion of a stock assessment survey in autumn/winter in that season. The latter simply represents a scenario where predicted stock abundance is beyond the highest historic abundance on record. In such cases the preliminary TAC should not exceed 1 200 000 t.

5.7 Special Comments

In most years, by far the largest capelin can be caught in late June, July and the first half of August. After that, the average size in the catches has usually declined drastically and not increased again until late autumn. There are two main reasons for this. First, the oldest and largest fish migrate ahead of other stock components to feed in the plankton rich oceanic area between Iceland, Greenland and Jan Mayen. Later on, these larger capelin are joined by younger, slower growing adults and even juveniles in parts of the fishing area, the location of which is variable from year to year. Second, as the food supply diminishes in the southern part of the feeding area in August, the fishable stock becomes more scattered and sometimes mixed with juveniles.

The Working Group recommends that the 2000 summer/autumn season be opened around 20 June. In order to prevent catches of juvenile 1- and 2-group capelin it is recommended that the authorities responsible for the management of this stock (Greenland, Iceland and Norway) should monitor the fishery and be prepared for quick intervention on short notice, through area closures, to prevent eventual fishing on concentrations of capelin consisting of a mixture of juveniles and adults.

An overview of stock development during 1978–1999 is given in Table 5.7.1.

5.8 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Autumn fishery 1999	15	1500	1470
	53	5125	5100
Autumn survey 1999			
Winter fishery 2000	67	6700	6525
Winter survey 2000	62	6200	6135

Table 5.1.1 Preliminary TACs for the summer/autumn fishery, recommended TACs for the whole season, landings and remaining spawning stock (000 tonnes) in the 1987/88–1999/00 seasons.

Season	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00
Prelim. TAC	500	900	900	600	0	500	900	950	800	1100	850	950	857
Rec. TAC	1115	1065	-	250	740	900	1250	850	1390	1600	1265	1200	1000
Landings	1116	1036	808	314	677	788	1179	842	930	1571	1245	1100	933
Spawn. stock	400	445	115	330	475	460	460	420	830	550	500	500	650

Table 5.2.1 The international capelin catch 1964–2000 (thousand tonnes).

Year	Winter season					Summer and autumn season						Total
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	
1964	8.6	-	-		8.6	-	-	-		-	-	8.6
1965	49.7	-	-		49.7	-	-	-		-	-	49.7
1966	124.5	-	-		124.5	-	-	-		-	-	124.5
1967	97.2	-	-		97.2	-	-	-		-	-	97.2
1968	78.1	-	-		78.1	-	-	-		-	-	78.1
1969	170.6	-	-		170.6	-	-	-		-	-	170.6
1970	190.8	-	-		190.8	-	-	-		-	-	190.8
1971	182.9	-	-		182.9	-	-	-		-	-	182.9
1972	276.5	-	-		276.5		-	-		-	-	276.5
1973	440.9	-	-		440.9	-	-	-		-	-	440.9
1974	461.9	-	-		461.9	-	-	-		-	-	461.9
1975	457.1	-	-		457.1	3.1	-	-		-	3.1	460.2
1976	338.7	-	-		338.7	114.4	-	-		-	114.4	453.1
1977	549.2	-	24.3		573.5	259.7	-	-		-	259.7	833.2
1978	468.4	-	36.2		504.6	497.5	154.1	3.4		-	655.0	1,159.6
1979	521.7	-	18.2		539.9	442.0	124.0	22.0		-	588.0	1,127.9
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156.0	-	-		156.0	484.6	91.4	16.2		20.8	613.0	769.0
1982	13.2	-	-		13.2	-	-	-		-	-	13.2
1983	-	-	-		-	133.4	-	-		-	133.4	133.4
1984	439.6	-	-		439.6	425.2	104.6	10.2		8.5	548.5	988.1
1985	348.5	-	-		348.5	644.8	193.0	65.9		16.0	919.7	1,268.2
1986	341.8	50.0	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.7
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.1
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.6
1989	609.1	56.0	-		665.1	53.9	52.7	14.4		-	121.0	786,1
1990	612.0	62.5	12.3		686,8	83.7	21.9	5.6		-	111.2	798.0
1991	202.4	-	-		202.4	56.0	-	-		-	56.0	258.4
1992	573.5	47.6	-		621.1	213.4	65.3	18.9	0.5		298.1	919.2
1993	489.1	-	-	0.5	489.6	450.0	127.5	23.9	10.2		611.6	1,101.2
1994	550.3	15.0	-	1.8	567.1	210.7	99.0	12.3	2.1		324.1	891.2
1995	539.4	-	-	0.4	539.8	175.5	28.0	-	2.2		205.7	745.5
1996	707.9	-	10.0	5.7	723.6	474.3	206.0	17.6	15.0	60.9	773.8	1,497.4
1997	774.9	-	16.1	6.1	797.1	536.0	153.6	20.5	6.5	47.1	763.6	1561.5
1998	457.0	-	14.7	9.6	481.3	290.8	72.9	26.9	8.0	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83.0	11.4	6.0	2.0		102.4	761.3
2000	761.4	14.9	32.0	22.0	830.3							

Table 5.2.2 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age groups in numbers (billions) and the total catch by numbers and weight (thousand tonnes) the autumn season (August-December) 1979–1999.

					Year						
Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.6	4.9	0.6	-	0.6	0.5	0.8	+	+	0.3	1.7
2	29.4	17.2	27.9	-	7.2	9.8	25.6	10.0	27.7	13.6	6.0
3	6.1	5.4	2.0	-	0.8	7.8	15.4	23.3	6.7	5.4	1.5
4	-	-	+	-	-	0.1	0.2	0.5	+	+	+
Total number	36.1	27.5	30.5	-	8.6	18.2	42.0	33.8	34.4	19.3	9.2
Total weight	588.0	527.6	613.0	-	133.4	548.5	919.7	772.9	458.6	371.4	121.0

				Year						
Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.8	0.3	1.7	0.2	0.6	1.5	0.2	1.8	0.9	0.3
2	5.9	2.7	14.0	24.9	15.0	9.7	25.2	33.4	25.1	4.7
3	1.0	0.4	2.1	5.4	2.8	1.1	12.7	10.2	2.9	0.7
4	+	+	+	0.2	+	+	0.2	0.4	+	+
Total number	7.7	3.4	17.8	30.7	18.4	12.3	38.4	45.8	28.9	5.7
Total weight	111.2	56.0	298.1	611.6	324.1	205.7	773.7	763.6	440.5	102.4

Table 5.2.3 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age groups in numbers (billions) and the total catch by numbers and weight (thousand tonnes) the winter season (January-March) 1980–2000.

						Year					
Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	1.3	1.7	-	-	2.1	0.4	0.1	+	+	0.1	1.4
3	17.6	7.1	0.8	-	18.1	9.1	9.8	6.9	23.4	22.9	24.8
4	3.5	1.9	0.1	-	3.4	5.4	6.9	15.5	7.2	7.8	9.6
5	-	-	-	-	-	-	0.2	-	0.3	+	0.1
Total number	22.4	10.7	0.9	-	23.6	14.5	17.0	22.4	30.9	30.8	35.9
Total weight	392.1	156.0	13.2	-	439.6	348.5	391.8	560.5	657.2	665.1	686.8

					Year					
Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	0.5	2.7	0.2	0.6	1.3	0.6	0.9	0.3	0.5	0.3
3	7.4	29.4	20.1	22.7	17.6	27.4	29.1	20.4	31.2	36.3
4	1.5	2.8	2.5	3.9	5.9	7.7	11.0	5.4	7.5	5.4
5	+	+	+	+	+	+	+	+	+	+
Total number	9.4	34.9	22.8	27.2	24.8	35.7	41.0	26.1	39.2	42.0
Total weight	202.4	621.1	489.6	567.1	539.8	723.6	797.6	481.3	658.9	830.3

Table 5.2.4 The total international catch in numbers (millions) of capelin in the Iceland-East Greenland-Jan Mayen area in the summer/autumn season of 1999 by age and length, and the catch in weight (thousand tonnes) by age groups.

Total length (cm)	Age 1	Age 2	Age 3	Age 4	Total	Percentage
9.5	5	-	-	-	5	0.1
10	-	-	-	-		0.0
10.5	5	-	-	-	5	0.1
11	19	12	-	-	31	0.6
11.5	48	86	-	-	134	2.3
12	44	171	-	-	215	3.7
12.5	19	275	5	-	299	5.2
13	15	373	10	-	398	6.9
13.5	58	501	20	-	579	10.1
14	39	642	124	-	805	14.0
14.5	19	623	109	2	753	13.1
15	15	813	158	4	990	17.2
15.5	-	745	94	-	839	14.6
16	-	354	133	2	489	8.5
16.5	-	141	40	-	181	3.1
17	-	24	5	-	29	0.5
17.5	-	-	-	-	-	-
Total number	286	4760	698	8	5752	
Percentage	5.0	83.0	12.0	+	100.0	100.0
Total weight	3.3	83.4	15.4	0.2	102.4	

Table 5.2.5 The total international catch in numbers (millions) of capelin in the Iceland-East Greenland-Jan Mayen area in the winter season of 2000 by age and length, and the catch in weight (thousand tonnes) by age groups.

Total length (cm)	Age 2	Age 3	Age 4	Age 5	Total	Percentage
12	-	8	-	-	8	0.0
12.5	-	76	-	-	76	0.2
13	57	677	-	-	734	1.8
13.5	126	2269	35	-	2430	5.8
14	66	4028	158	-	4252	10.1
14.5	29	4768	298	-	5095	12.1
15	7	6232	703	-	6942	16.5
15.5	31	6114	921	6	7072	16.9
16	-	5311	917	-	6228	14.8
16.5	5	3441	1081	-	4527	10.8
17	-	1986	768	13	2767	6.6
17.5	-	880	302	-	1182	2.8
18	-	350	157	-	507	1.2
18.5	-	92	5	-	97	0.2
19	-	18	5	-	23	0.1
Total number	321	36250	5350	19	41940	
Percentage	0.8	86.4	12.7	+	100.0	100.0
Total weight	4.0	703.4	124.7	0.5	830.3	

Table 5.3.1.1 Abundance indices of 0-group capelin 1970–1999 and their division by areas.

	Year												
Area	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
NW-Irminger Sea	1	+	+	14	26	3	2	2	+	4	3	10	+
W-Iceland	8	7	30	39	44	37	5	19	2	19	18	13	8
N-Iceland	2	12	52	46	57	46	10	19	29	25	19	6	5
East Iceland	-	+	7	17	7	3	15	3	+	1	+	-	+
Total	11	19	89	116	134	89	32	43	31	49	40	29	13

	Year												
Area	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NW-Irminger Sea	+	+	1	+	1	3	1	+	8	3	2	3	+
W-Iceland	3	2	8	16	6	22	13	7	2	11	21	12	6
N-Iceland	18	17	19	17	6	26	24	12	43	20	13	69	10
East Iceland	1	9	3	4	1	1	2	2	1	+	15	10	8
Total	22	28	31	37	14	52	40	21	54	34	51	94	24

	Year			
	1996	1997	1998	1999
NW-Irminger Sea	2	5	+	+
W-Iceland	17	14	7	25
N-Iceland	57	30	34	51
East Iceland	6	12	5	7
Total	82	61	46	83

Table 5.3.1.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys of 1983–1999.

	Year													
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Number (10^9)	155	286	31	71	101	147	111	36	50	87	33	85	189	138
Mean length (cm)	10.4	9.7	10.2	9.5	9.1	8.8	10.1	10.4	10.7	9.7	9.4	9.0	9.8	9.3
Mean weight (g)	4.2	3.6	3.8	3.3	3.0	2.6	3.4	4.0	5.1	3.4	3.0	2.8	3.4	2.9

	1997	1998	1999
Number (10^9)	143	87	55
Mean length (cm)	9.3	9.0	9.5
Mean weight (g)	2.8	2.9	3.2

Table 5.3.2.1 Acoustic abundance estimate of capelin age groups 1-3, 15/11-07/12 1999.

Length (cm)	NUMBERS (10^{-9}) (Age) Year class (1) 1998	(2) 1997	(3) 1996	Total	Avgwt (g)	BIOMASS (10^{-3}t) (Age) Year class (1) 1998	(2) 1997	(3) 1996	Total
7.5	0.345	0.000	0.000	0.345	1.4	0.5	0.0	0.0	0.5
8	1.947	0.000	0.000	1.947	1.6	3.1	0.0	0.0	3.1
8.5	7.247	0.000	0.000	7.247	1.9	13.6	0.0	0.0	13.6
9	11.833	0.000	0.000	11.833	2.3	27.6	0.0	0.0	27.6
9.5	14.082	0.000	0.000	14.082	2.9	41.1	0.0	0.0	41.1
10	16.028	0.000	0.000	16.028	3.4	53.7	0.0	0.0	53.7
10.5	16.003	0.000	0.000	16.003	3.9	63.1	0.0	0.0	63.1
11	11.310	0.000	0.000	11.310	4.6	52.3	0.0	0.0	52.3
11.5	5.663	0.000	0.000	5.663	5.2	29.7	0.0	0.0	29.7
12	3.331	0.544	0.000	3.875	6.2	20.6	3.4	0.0	24.0
12.5	1.013	1.596	0.000	2.609	7.4	7.5	11.8	0.0	19.3
13	0.430	2.293	0.000	2.723	8.9	3.8	20.3	0.0	24.1
13.5	0.283	3.638	0.000	3.921	10.5	3.0	38.0	0.0	41.0
14	0.239	3.630	0.080	3.949	12.0	2.9	43.5	1.0	47.4
14.5	0.048	2.674	0.048	2.770	14.0	0.7	37.3	0.7	38.6
15	0.015	2.830	0.119	2.964	16.2	0.2	45.9	1.9	48.1
15.5	0.000	1.931	0.265	2.196	18.4	0.0	35.6	4.9	40.4
16	0.000	1.632	0.204	1.836	20.9	0.0	34.2	4.3	38.4
16.5	0.000	1.213	0.141	1.354	23.6	0.0	28.6	3.3	31.9
17	0.000	0.315	0.045	0.360	26.3	0.0	8.3	1.2	9.5
17.5	0.000	0.185	0.027	0.212	29.5	0.0	5.4	0.8	6.2
18	0.000	0.017	0.008	0.025	37.0	0.0	0.6	0.3	0.9
Total	89.817	22.496	0.938	113.251	5.8	323.3	312.9	18.3	654.6
Average length (cm)						10.1	14.3	15.7	11.0
Average weight (g)						3.6	13.9	19.5	5.8

Table 5.3.2.2 Acoustic estimate of adult capelin, 18/01-10/02 2000. A corrected estimate of stock abundance by assuming a factor of 1.2 to account for reduction of echo abundance due to the opposite movements of fish and survey, is given at the bottom of the table.

	NUMBERS (10^{-9})					BIOMASS (10^{-3}t)			
	(Age) Year class				Avgwt	(Age) Year class			
Length (cm)	(2) 1998	(3) 1997	(4) 1996	Total	(g)	(2) 1998	(3) 1997	(4) 1996	Total
11.5	0.034	0.000	0.000	0.034	5.0	0.1	0.0	0.0	0.1
12	0.069	0.000	0.000	0.069	5.7	0.4	0.0	0.0	0.4
12.5	0.118	0.123	0.000	0.241	7.3	0.9	0.9	0.0	1.8
13	0.147	0.653	0.000	0.799	8.9	1.3	5.8	0.0	7.1
13.5	0.129	2.647	0.033	2.810	10.5	1.4	27.9	0.3	29.6
14	0.148	4.637	0.036	4.821	12.0	1.8	55.7	0.4	57.9
14.5	0.155	4.288	0.090	4.532	14.0	2.2	60.0	1.3	63.4
15	0.159	5.406	0.134	5.699	15.7	2.5	85.0	2.1	89.6
15.5	0.085	5.878	0.401	6.365	18.0	1.5	105.9	7.2	114.6
16	0.109	6.606	0.323	7.037	20.3	2.2	134.4	6.6	143.2
16.5	0.063	5.980	0.568	6.611	23.1	1.5	138.4	13.2	153.1
17	0.000	3.851	0.550	4.401	25.7	0.0	99.1	14.2	113.2
17.5	0.000	1.657	0.578	2.235	28.7	0.0	47.6	16.6	64.2
18	0.000	0.829	0.142	0.972	32.5	0.0	26.9	4.6	31.5
18.5	0.000	0.327	0.036	0.364	36.4	0.0	11.9	1.3	13.2
19	0.000	0.028	0.009	0.037	38.6	0.0	1.1	0.4	1.4
19.5	0.000	0.015	0.000	0.015	51.1	0.0	0.8	0.0	0.8
Total	1.217	42.926	2.901	47.044	18.8	15.7	801.3	68.1	885.1
Average length (cm)						14.1	15.5	16.5	15.5
Average weight (g)						13.0	18.8	23.5	18.8
Corrected total	1.460	51.511	3.481	56.453	18.8	18.8	961.6	81.7	1062.2

Table 5.3.2.3 Acoustic estimate of adult capelin, 18/01-10/02 2000. Corrective figures to reconcile the assessed age structure of the stock to that of the catch taken after the survey was concluded and until the end of the winter season, as well as the total stock after correction, are given at the bottom of the table.

	NUMBERS (10^{-9})					BIOMASS (10^{-3}t)			
	(Age) Year class				Avgwt	(Age) Year class			
Length (cm)	(2) 1998	(3) 1997	(4) 1996	Total	(g)	(2) 1998	(3) 1997	(4) 1996	Total
11.5	0.034	0.000	0.000	0.034	5.0	0.1	0.0	0.0	0.1
12	0.069	0.000	0.000	0.069	5.7	0.4	0.0	0.0	0.4
12.5	0.118	0.123	0.000	0.241	7.3	0.9	0.9	0.0	1.8
13	0.147	0.653	0.000	0.799	8.9	1.3	5.8	0.0	7.1
13.5	0.129	2.647	0.033	2.810	10.5	1.4	27.9	0.3	29.6
14	0.148	4.637	0.036	4.821	12.0	1.8	55.7	0.4	57.9
14.5	0.155	4.288	0.090	4.532	14.0	2.2	60.0	1.3	63.4
15	0.159	5.406	0.134	5.699	15.7	2.5	85.0	2.1	89.6
15.5	0.085	5.878	0.401	6.365	18.0	1.5	105.9	7.2	114.6
16	0.109	6.606	0.323	7.037	20.3	2.2	134.4	6.6	143.2
16.5	0.063	5.980	0.568	6.611	23.1	1.5	138.4	13.2	153.1
17	0.000	3.851	0.550	4.401	25.7	0.0	99.1	14.2	113.2
17.5	0.000	1.657	0.578	2.235	28.7	0.0	47.6	16.6	64.2
18	0.000	0.829	0.142	0.972	32.5	0.0	26.9	4.6	31.5
18.5	0.000	0.327	0.036	0.364	36.4	0.0	11.9	1.3	13.2
19	0.000	0.028	0.009	0.037	38.6	0.0	1.1	0.4	1.4
19.5	0.000	0.015	0.000	0.015	51.1	0.0	0.8	0.0	0.8
Total	1.217	42.926	2.901	47.044	18.8	15.7	801.3	68.1	885.1
Average length (cm)						14.1	15.5	16.5	15.5
Average weight (g)						13.0	18.8	23.5	18.8
Correction *	0.000	9.600	4.800	14.400	20.3	0.000	180.5	112.8	293.3
Corrected total	1.217	52.526	7.701	61.444	19.1	15.7	981.8	180.9	1178.4

* The logistics underlying this correction of stock in numbers of 3 and 4 year old capelin are given in section 5.3.2. To correct for biomass at age for these age groups, the numbers to be added were multiplied by the corresponding mean weights given in the uncorrected estimate above.

Table 5.3.2.4 Acoustic estimate of mature capelin off Látrabjarg, NW-Iceland, 24/02-02/03 2000.

	NUMBERS (10^{-9})					BIOMASS (10^{-3}t)			
	(Age) Year class				Avg	(Age) Year class			
Length (cm)	(2) 1998	(3) 1997	(4) 1996	Total	wt (g)	(2) 1998	(3) 1997	(4) 1996	Total
12	0.032	0.000	0.000	0.032	7.5	0.1	0.0	0.0	0.2
12.5	0.063	0.070	0.000	0.133	8.5	0.5	0.6	0.0	1.1
13	0.032	0.209	0.000	0.241	9.1	0.3	1.9	0.0	2.2
13.5	0.063	0.209	0.000	0.273	11.0	0.7	2.3	0.0	3.0
14	0.063	0.605	0.000	0.668	13.3	0.8	8.0	0.0	8.9
14.5	0.095	0.488	0.000	0.583	14.8	1.4	7.2	0.0	8.6
15	0.063	0.651	0.256	0.971	16.7	1.1	10.9	4.3	16.2
15.5	0.000	0.628	0.064	0.692	18.9	0.0	11.9	1.2	13.1
16	0.032	0.326	0.096	0.453	21.2	0.7	6.9	2.0	9.6
16.5	0.000	0.070	0.064	0.134	23.6	0.0	1.6	1.5	3.2
17	0.000	0.140	0.032	0.172	25.7	0.0	3.6	0.8	4.4
17.5	0.000	0.023	0.032	0.055	28.0	0.0	0.7	0.9	1.5
18	0.000	0.000	0.096	0.096	32.0	0.0	0.0	3.1	3.1
18.5	0.000	0.000	0.000	0.000		0.0	0.0	0.0	0.0
19	0.000	0.000	0.032	0.032	38.0	0.0	0.0	1.2	1.2
Total	0.474	3.419	0.673	4.534	16.9	5.7	55.6	15.1	76.4
Average length (cm)						13.0	14.8	16.2	14.9
Average weight (g)						12.1	16.3	22.4	17.1

Table 5.4.1 The calculated number (billions) of capelin on 1 August 1978–1999 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components are also given.

	Year									
Age/maturity	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1 juvenile	163.8	60.3	66.1	48.9	146.4	124.2	250.5	98.9	156.2	144.0
2 immature	15.3	16.4	4.2	3.7	15.0	42.5	40.9	100.0	29.4	37.2
2 mature	81.9	91.3	35.4	39.7	17.1	53.7	40.7	64.6	35.6	65.4
3 mature	29.1	10.1	10.8	2.8	2.3	9.8	27.9	27.0	65.8	20.1
4 mature	0.4	0.3	+	+	+	0.1	0.4	0.4	0.7	0.1
Number immat.	179.2	76.7	70.3	52.6	161.4	166.7	291.4	198.9	185.6	181.2
Number mature	111.4	101.7	46.2	42.5	19.4	63.6	69.0	92.0	102.1	85.6
Weight immat	750.8	366	283	209	683	985	1067	1168	876	950
Weight mature	2081	1769	847	829	355	1085	1340	1643	2260	1689

	Year									
Age/maturity	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1 juvenile	80.8	63.9	117.5	132.9	162.9	144.3	224.1	197.3	191.2	165.4
2 immature	24.0	10.3	10.1	9.7	16.6	20.1	35.2	45.1	28.7	35.2
2 mature	70.3	42.8	31.9	67.7	70.7	86.9	59.8	102.2	100.7	90.3
3 mature	24.5	15.8	6.8	6.7	6.4	10.9	13.2	23.0	29.6	19.0
4 mature	0.4	+	+	+	+	0.2	-	+	+	+
Number immat.	104.8	74.2	127.6	142.6	179.5	164.7	259.2	242.4	219.9	200.6
Number mature	95.2	58.6	38.7	74.4	77.1	98.0	73.0	125.1	130.3	109.3
Weight immat	438	309	542	702	747	702	1019	1188	985	758
Weight mature	1663	1173	751	1273	1311	1585	1268	1819	1900	1590

	Year		
Age/maturity	1998	1999	2000
1 juvenile	*175.2	*158.2	
2 immature	19.2	*29.2	
2 mature	89.5	85.9	**70.9
3 mature	23.2	12.6	**19.2
4 mature	+	+	
Number immat.	*194.4	*187.4	
Number mature	112.7	98.5	**90.1
Weight immat	*662	*692	
Weight mature	1576	1702	**1583

* Preliminary
** Predicted

Table 5.4.2 The calculated number (billions) of capelin on 1 January 1979–2000 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components and the remaining spawning stock by number and weight are also given.

	Year									
Age/maturity	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2 juvenile	137.6	50.6	55.3	41.2	123.7	105.0	211.6	83.2	131.9	120.5
3 immature	12.8	13.8	3.5	3.0	12.6	35.7	34.3	83.9	25.6	31.2
3 mature	51.8	53.4	16.3	8.0	14.3	39.8	25.2	34.5	22.1	34.1
4 mature	14.8	3.6	4.9	0.5	2.0	7.6	15.6	10.5	37.0	11.7
5 mature	0.3	0.2	+	+	+	0.1	0.3	0.2	0.2	+
Number immat.	150.4	64.4	58.8	44.2	136.3	140.7	245.9	167.1	157.5	151.3
Number mature	66.9	57.2	21.2	8.5	16.3	47.5	41.1	45.2	59.1	45.8
Weight immat.	1028	502	527	292	685	984	1467	1414	1003	1083
Weight mature	1358	980	471	171	315	966	913	1059	1355	993
Number sp.st.	29.0	17.5	7.7	6.8	13.5	21.6	20.7	19.6	18.3	18.5
Weight sp. st	600	300	170	140	260	440	460	460	420	400

	Year									
Age/maturity	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2 juvenile	67.8	53.9	98.9	111.6	124.6	121.3	188.1	165.2	160.0	*138.0
3 immature	20.1	8.6	8.6	8.1	13.9	16.9	29.5	37.9	24.1	25.9
3 mature	48.8	31.2	22.3	54.8	46.5	50.5	35.1	75.5	72.4	50.1
4 mature	16.0	12.1	4.5	5.3	3.5	4.6	8.7	20.1	24.8	7.9
5 mature	0.3	+	+	+	+	+	+	+	+	+
Number immat.	87.9	62.5	107.5	119.7	138.5	138.2	217.6	203.1	184.1	*163.9
Number mature	64.8	43.3	26.8	60.1	50.0	55.1	43.8	95.6	97.2	58.0
Weight immat.	434	291	501	487	622	573	696	800	672	*621
Weight mature	1298	904	544	1106	1017	1063	914	1820	1881	1106
Number sp.st.	22.0	5.5	16.3	25.8	23.6	24.8	19.2	42.8	21.8	27.6
Weight sp. st.	440	115	330	475	499	460	420	830	422	492

	Year	
Age/maturity	1999	2000
2 juvenile	*147.1	*132.8
3 immature	*16.1	*24.5
3 mature	53.2	68.2
4 mature	16.0	10.0
5 mature	+	+
Number immat.	*163.2	*157.3
Number mature	69.2	78.2
Weight immat.	*570	*674.1
Weight mature	1171.3	1485.0
Number sp.st.	29.5	34.2
Weight sp. st.	490	650

*Preliminary/Predicted

Table 5.5.1.1 The data used in the comparisons between abundance of age groups (numbers) when predicting fishable stock abundance for calculations of preliminary TACs.

Year class	Age 1 Acoustics N_1	Age 2 Back-calc. Mature N_{2mat}	Age 2 Acoustics Immature N_{2imm}	Age 2 Back-calc. Total N_{2tot}	Age 3 Back-calc. Mature N_{3tot}
1980	23.7	17.1	1.7	32.1	9.8
1981	68.0	53.7	8.2	96.2	27.9
1982	44.1	40.7	4.6	81.6	27.0
1983	73.8	64.6	12.6	164.6	65.8
1984	33.8	35.6	1.4	65.0	20.1
1985	58.0	65.4	5.4	102.6	24.5
1986	70.2	70.3	6.7	94.6	15.8
1987	43.9	42.8	1.8	53.1	6.8
1988	29.2	31.9	1.3	42.0	6.7
1989	*39.2	67.7	5.2	77.2	6.4
1990	60.0	70.7	2.3	87.3	10.9
1991	104.6	86.9	10.8	107.0	13.2
1992	100.4	59.8	6.9	95.0	24.0
1992	100.4	59.8	6.9	95.0	24.0
1993	119.0	102.2	46.3	147.2	29.6
1994	165.0	100.7	16.4	129.4	19.0
1995	111.9	90.3	30.8	125.5	23.2
1996	128.5	89.5	6.3	108.0	12.6
1997	121.0	85.9	5.0	**91.3	
1998	89.8				

* Invalid due to ice conditions.
** Preliminary

Table 5.5.1.2 Mean weight (g) in autumn of mature capelin.

	Years							
	1981	1982	1983	1984	1985	1986	1987	1988
Age 2	19.2	16.5	16.1	15.8	15.5	18.1	17.9	15.5
Age 3	24.0	24.1	22.5	25.7	23.8	24.1	25.8	23.4

	Years							
	1989	1990	1991	1992	1993	1994	1995	1996
Age 2	18.0	18.1	16.3	16.5	16.2	16.0	15.3	15.8
Age 3	25.5	25.5	25.4	22.6	23.3	23.6	20.5	20.6

	Years		
	1997	1998	1999
Age 2	14.3	14.1	16.8
Age 3	20.3	18.1	20.6

Table 5.5.1.3 Predictions of fishable stock abundance and TACs for the 1983/84–1999/00 seasons. The last rowgives contemporary advice on TACs for comparison. Age 2 and age 3 = Numbers in billions in age groups at the beginning of season. Fish.st. = calculated weight of maturing capelin in thousand tonnes (ref. 1 August). TAC calc = predicted in thousand tonnes.

Season	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92
Year classes	81-80	82-81	83-82	84-83	85-84	86-85	87-86	88-87	89-88
Age 2	63.0	43.4	67.8	34.9	55.5	64.8	43.2	31.1	39.4
Age 3	0.0	26.3	20.2	55.0	13.7	29.0	25.5	8.2	3.7
Fishable stock	1065	1373	1637	1926	1268	1800	1350	724	755
Calculated TAC	465	733	963	1215	642	1105	713	170	197
Advised TAC	573	897	1311	1333	1115	1036	550	265	740

Season	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00
Year classes	90-89	91-90	92-91	93-92	94-93	95-94	96-95	97/96
Age 2	56.4	93.1	89.6	92.5	90.0	83.8	94.4	89.2
Age 3	18.3	22.6	27.0	14.9	35.0	30.9	30.8	23.3
Fishable stock	1398	2123	2170	1916	2352	2019	2088	1885
Calculated TAC	755	1385	1427	1200	1635	1265	1420	1285
Advised TAC	*900	1250	850	1390	1600	1265	1200	1000

In January 1993, 80 000 t were added to the 820 000 t recommended after the October 1992 survey due to an unexpectedly large increase in mean weights.

Table 5.7.1 Capelin in the Iceland-East Greenland-Jan Mayen area. Recruitment of 1 year old fish (unit 10^9) and stock biomass (‘000 t) given at 1 August, spawning stock (‘000 t) at the time of spawning (March next year). Landings (‘000 t) are the sum of the total landings in the season starting in the summer/autumn of the year indicated ending in March of the following year.

Year	Recruit-ment	Total stock biomass	Landings	Spawning stock biomass
1978	164	2832	1195	600
1979	60	2135	980	300
1980	66	1130	684	170
1981	49	1038	626	140
1982	146	1020	0	260
1983	124	2070	573	440
1984	251	2427	897	460
1985	99	2811	1312	460
1986	156	3106	1333	420
1987	144	2639	1116	400
1988	81	2101	1037	440
1989	64	1482	808	115
1990	118	1293	314	330
1991	133	1975	677	475
1992	163	2058	788	499
1993	144	2363	1179	460
1994	224	2287	864	420
1995	197	3174	929	830
1996	191	3310	1571	423
1997	165	3014	1245	423
1998	*175	2418	1100	490
1999	*158	2394	933	650

* Preliminary

Figure 5.5.3.1. The relationship between the neasured numbers of immature 1-group capelin in autumn acoustic surveys and the numbers of maturing capelin on 1 August of the following year (left figure) and between the measured total numbers of 2-group capelin and the numbers of maturing 3-group capelin in the following year (right figure)

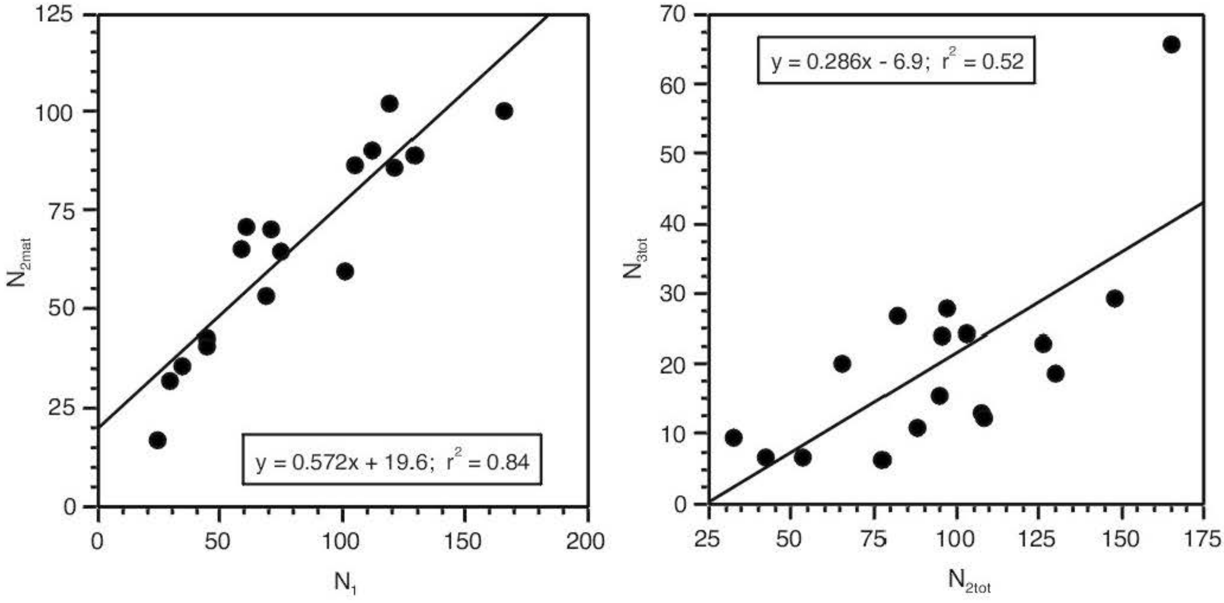
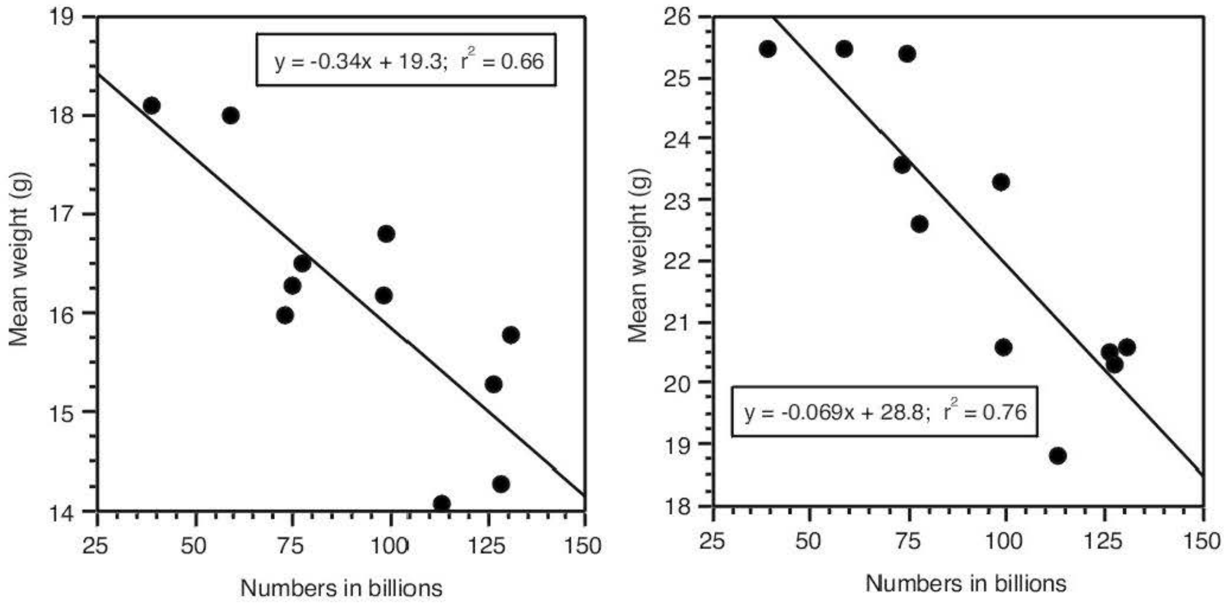


Figure 5.5.3.2. The relationship between the mean weight of maturing 2-group capelin in autumn and the total numbers in the maturing stock (left hand figure) and the total numbers in the maturing stock and the mean weight of maturing 3-group capelin (right hand figure).



6 BLUE WHITING

6.1 Stock Identity and Stock Separation

Prior to 1994 the northern and southern blue whiting stocks were treated as one for assessment purposes (ICES C.M.1996/Assess:14). In 1995 it was stated that several populations could appear in the spawning area, however no separation line was defined between the stocks west of the British Isles and those off Gibraltar (ICES C.M.1998/ACFM:18). Ongoing genetic, morphological and physiological research by Norway and Russia indicated that the two components of the stock may appear in the spawning area west of the British Isles (ICES C.M.1999/ACFM:18).

6.2 Fisheries in 1999

Estimates of the total landings of blue whiting in 1999 from the fisheries are given by country in Tables 6.2.1 - 6.2.4 and summarised in Table 6.2.5. The total landings from all blue whiting fisheries in 1999 were 1 256 328 tonnes, which is the highest catch on record, and 131 thousand tonnes greater than in 1998. This exceeded the recommended TAC of 800 000 tonnes by 57%.

The majority of blue whiting catches were taken, as usual, in the spawning area. The catch there was 941 000 tonnes in 1999, representing an increase of 14% from 1998 when the catch was 827 000 tonnes. The spawning concentrations of blue whiting during winter and spring 1999 were distributed over a larger area, and more to the west than usual, i.e. from the Irish shelf northwards to the Rockall Bank. This distribution of the spawning stock is similar to the distribution observed in 1999. About 25% were thus landed from international water (Table 6.8.1).

The landings in 1999 from the Norwegian Sea increased by 4% from 1998 and constituted 182 000 tonnes.

Denmark and Norway took the bulk of the catch in the mixed industrial fisheries, or 93 000 tonnes of a total catch of 107 000 tonnes. The total catch in this fishery increased from 95 000 tonnes in 1998 to 107 000 tonnes in 1999. The fishery in the southern area, mainly conducted by Spain and Portugal, was at an average level in 1999, with a total of 26 000 tonnes. Data on discards from the Spanish fleets are available for 1994, 1997 and 1999, and will also be estimated in 2000 (WD by Perez and Meixide). Discards were not included in the assessment because the time series is too short.

6.3 Biological Characteristics

6.3.1 Length composition of catches

Data on length composition of the 1999 commercial catches from the directed fishery of the blue whiting stock by quarter of the year were presented by Norway, Russia, Ireland, The Netherlands and Iceland (Table 6.3.1.1). Length composition of blue whiting varied from 11 to 42 cm, with an average length of 24 - 26 cm.

The majority of the Norwegian and Russian catches from the directed fisheries in the Norwegian Sea consisted of fish with lengths of 21 - 26 cm. The length compositions from the spawning area in first and second quarters were from 22 - 27 cm. The catches of blue whiting from the mixed industrial fisheries consisted of fishes with lengths of 15 - 22 cm. Length compositions from the mixed industrial fisheries were presented by Norway and Denmark. Fish ranged from 10 to 40 cm, with an average length of 22 - 24 cm (Table 6.3.1.2). Spain and Portugal caught blue whiting in the Southern area with length range 11 - 40 cm and modal length of 21 - 22 cm (Table 6.3.1.3).

6.3.2 Age composition of catches

For the directed fisheries in the northern area in 1999, age compositions were provided by the Faroe Islands, Iceland, Ireland, Norway and Russia, which together accounted for 72% of the catches.

The age compositions in the directed fisheries are given in Table 6.3.2.1.

Age compositions for the mixed industrial fisheries in 1999 were provided by Norway, which accounted for 45% of catches. For all other nations Norwegian data were used for allocation. The age compositions are given in Table 6.3.2.2.

For the fisheries in the Southern area, Spain and Portugal presented age compositions, and accounted for all catches. Age compositions are given in Table 6.3.2.3.

The combined age composition for the directed fisheries in the Northern area, i.e. the spawning area and the Norwegian Sea, as well as for the landings of blue whiting in the mixed industrial fisheries and for landings in the Southern area, were assumed to give the overall age composition of total landings for the blue whiting stock. The catch numbers at age used in the stock assessment are given in Table 6.3.2.4.

To calculate the total international catch at age, and to document how it was done, the program SALLOC (WD by Patterson) was used (ICES C.M.1998/ACFM:18). The allocation process is illustrated in Tables 6.3.2.5 - 6.3.2.7, which show the disaggregated fisheries assessment data (DISFAD files) presented for directed fisheries, mixed industrial fisheries and southern fisheries. The allocations are shown in Table 6.3.2.8 (ALLOC files).

6.3.3 Weight at age

Mean weight at age data were available from Norway, Russia, the Faroes, Iceland, Ireland, Spain and Portugal. Mean weight at age for other countries were based on the allocations shown in Table 6.3.2.8 (ALLOC files) and for the total international catch were estimated by the SALLOC program. Table 6.3.3.1 shows the mean weight-at-age for the total catch during 1982 - 1999 as used in the stock assessment. The weight in the stock was assumed to be the same as the weight in the catch.

6.3.4 Maturity at age

Maturity at age was obtained by combining maturity ogives from the southern and northern areas, weighted by catch in numbers at age (ICES C.M.1995/Assess:7). These are the same as those used since 1994.

6.4 Stock Estimates

6.4.1 Acoustic surveys

6.4.1.1 Surveys in the spawning season

In March - April, 2000, the Norwegian R.V. "Johan Hjort" carried out an acoustic survey on blue whiting in the spawning area to the west and north of the British Isles. The pre-spawning stock was estimated at 0.5 million tonnes (12.7 x 10^9 individuals). The spawning stock, estimated at 7.8 million tonnes (89.8 x 10^9 individuals), was 0.6 million tonnes lower than the estimate for 1999. In 2000 the largest concentrations were observed to the north and west of St. Kilda, and in both 1999 and 2000 the distribution of blue whiting was notably larger than in previous surveys (WD by Monstad *et al.*,). Estimates of total, and spawning biomass of blue whiting in the spawning area made by Russian, Norwegian and Faroese surveys since 1983 are given in Table 6.4.1.1.1.

6.4.1.2 Surveys in the feeding season

Since 1995, Norway, Russia, Iceland and Faroes, and since 1997 also the EU, have co-ordinated their survey effort on pelagic fish stocks in the Norwegian Sea. Holst *et al.* (1999) reported on distributions and migrations of blue whiting in 1999.

In 1999 blue whiting were recorded in the following surveys in the feeding area:

Period	Vessel	Country
23 April - 21 May	R.V. "Walther Herwig III"	Germany
28 April - 30 May	R.V. "G.O.Sars"	Norway
30 April - 25 May	R.V. "Magnus Heinason"	Faroes
20 May - 5 July	R.V. "F. Nansen"	Russia
6 - 22 May	R.V. "Árni Fridriksson"	Iceland
14 - 28 July	R.V. "Árni Fridriksson"	Iceland
21 July - 22 August	R.V. "G.O.Sars"	Norway

For both the Icelandic EEZ and Norwegian Sea age stratified estimates of blue whiting were reported, these are given in Tables 6.4.1.2.1 and 6.4.1.2.2 respectively.

6.4.2 Bottom trawl surveys in the southern area

Bottom trawl surveys have been conducted off the Galician (NW Spain) and Portuguese coasts since 1980 and 1979 respectively, following a stratified random sampling design and covering depths down to 500 m. Since 1983, the area covered in the Spanish survey was extended to completely cover Spanish waters in Division VIIIc. The area covered in the Portuguese survey was also extended in 1989 to the 750 m contour. Stratified mean catches and standard errors from the Spanish and Portuguese surveys are shown in Tables 6.4.2.1. and 6.4.2.2. In both areas the larger mean catch rates are observed in the 100 - 500 m depth range. Since 1988 the highest catch rates in the Spanish survey were observed in 1999 (108 kg/haul). The Portuguese summer surveys generally give higher values than in the autumn surveys, and a better correlation with the Spanish surveys (Figure 6.4.2.1).

6.4.3 Catch per unit effort

CPUE data for Spanish Pair Trawlers were presented to the Working Group in 2000. This data was added to the time series of overall aggregated CPUE values from Norway and Russia as used in the 1998 assessment (ICES C.M.1998/ACFM:18).

6.4.4 Stock assessment

There are six tuning fleets for blue whiting; The Norwegian Sea acoustic survey which covers the feeding area of the northern stock component, the Norwegian and the Russian acoustic surveys on the spawning grounds, the Spanish bottom trawl survey, the Portuguese bottom trawl survey and the CPUE from Spanish pair trawlers, where the last three fleets cover the southern component of the stock. The indices are shown in Table 6.4.4.1.

In 1998 it was decided to leave out the Spanish bottom trawl survey indices and the Portuguese bottom trawl indices, due to large contributions from these fleets in the variance. Last year, it was decided to split three of the tuning series, the Norwegian Sea acoustic survey, the Norwegian survey and the Russian survey on the spawning grounds. The reason for splitting these index series was the change to a Simrad EK-500 echo sounder in 1991 in the first two series and in the 1992 in the Russian tuning series.

ICA-runs

The data used in the ICA runs are shown within the rectangles in Table 6.4.4.1.

Because the separability model last year did not show a convincing fit, it was decided to study this more thoroughly. A separable VPA without tuning was used for this purpose. The study suggested that the high catches reported on the 1995 year class, especially on 0-group, did not fit well in a separability model. It was thus decided to run ICA with 4 years of separability, to avoid this year class in the separability model. It is generally preferable to choose a longer time period, and runs with 5 and 6 years of separability were made for comparison.

Table 6.4.4.2 shows the results of several runs. Run 1 is equivalent to the final run of the 1999 assessment. Runs 2 and 3 are similar except that the separability model is set at 6 and 4 years respectively. As the table suggests, the selection pattern in runs 1 and 2 provided smoother results than those from run 3, however the variance in run 3 was smaller. Another 3 runs, comparable to the previous runs, were made but with equal weights on all the age groups in the catches (Table 6.4.4.2). The variance increased and gave no reason to choose the option of equal weights in this years assessment. The next run (run 7) is similar to run 3 (4 years of separability) except that the catch of the 0-group in 1995 was considerably downweighted. No improvement was achieved.

An additional run (results not shown) was made with the early part of the split tuning series left out. Apart from this, the options were the same as for run 3. This option was explored as Norwegian spring spawning herring are assessed in this way. The difference between the two runs was negligible. Thus, it was decided to keep these data in the tuning.

Based on the reasoning above, run number 3 was chosen as the final run. The 1999 spawning stock was estimated to be 3.0 million tonnes, total stock 5.4 million tonnes and the reference fishing mortality rate, F_{3-7}, 0.48. A stock summary is shown in Table 6.4.4.3 and the ICA output in Table 6.4.4.4, Figures 6.4.4.1 and 6.4.4.2. The log-file is shown in Table 6.4.4.5.

Differences between the runs were small (Table 6.4.4.2), with the estimate of the 1999 F_{3-7} varying from 0.43 - 0.52 and the spawning stock biomass varying from 2.9 to 3.1 million tonnes. The estimates of the younger age groups varied somewhat and so the total stock estimates varied from 4.7 to 5.4 million tonnes.

A separable VPA on filtered catch-at-age data (WD by Belikov *et al.*) was run to compare the results (see the section 6.4.5). This run resulted in more optimistic estimates. The spawning stock biomass was estimated to be 4.8 million tonnes, the total biomass 6.9 million tonnes, while the F_{3-7} was estimated to be 0.37. The stock estimates of 1998 and 1999 were higher than the ICA estimates, but for earlier years the trends were comparable.

Compared to last year's assessment, the final run in 2000 indicates a somewhat more optimistic state of the stock than last year. All year classes are suggested to be slightly stronger in this year's assessment. The 1995, 1996 and 1997 year classes are also estimated to be quite strong.

6.4.5 Stock assessment by ISVPA

In order to clarify the origin of the discrepancy between the results of blue whiting stock assessment obtained by the Working Group and the results of surveys for recent years an attempt was made to carry out a special catch-at-age data analysis and to diminish the influence of possible errors in the catch-at-age data on the results of stock assessment. To make the results more transparent it was decided not to include available auxiliary information into the analysis and to outline tendencies in stock dynamics from catch-at-age data only. For this purpose a cohort separable model named ISVPA (WD by Belikov *et al.*) was used.

6.4.5.1 Method

ISVPA

The model ISVPA (Kizner and Vasilyev, 1997, Vasilyev and Kizner 1998; Vasilyev 1998a, 1998b, 2000), used in the assessment, is a separable cohort model and is similar in many aspects to other models of this kind, but its parameter estimating procedure is based on principles of robust statistics which helps to diminish the influence of error (noise) in catch-at-age data on the results if the assessment. Besides, special parameterization of the model makes it unnecessary to use any preliminary assumptions about the age of unit selectivity and about the shape of selectivity pattern.

Basic equations of the model and description of its parameter estimation procedure are described in the WD by Belikovet *et al.*) and were presented earlier in frames of ICES meetings and in several publications (Kizner & Vasilyev 1997, Vasilyev & Kizner 1998; Vasilyev, 1998; 1998a; 2000).

The procedure of the model parameter estimation "automatically" ensures an unbiased solution:

$$\Sigma\ [LnC(a,y)-LnC_{est}(a,y)] = 0 \qquad \text{for every year } y\text{, and}$$

$$\Sigma\ [LnC(a,y)-LnC_{est}(a,y)] = 0 \qquad \text{for every age } a,$$

and produces the estimates of all parameters of the model, except *f(n)* (that is *f(y)* for terminal year) and *M*, which are given on this stage as input. The best estimate of terminal effort factor *f(n)* is looked for in special procedure, constructed as an outer cycle with respect to the above mentioned. It is found by minimization of the median of the distribution of the squared logarithmic error (*SE*)

$$\text{MDN of } \{\ [LnC(a,y)-LnC_{est}\ (a,y)]^2\ \}, \quad a=1,...,m-1,\ y=1,...,n-1,$$

since median is known as resistant statistics with respect to outliers in the data (Huber 1981; Hampel *et al.* 1986)

Preliminary filtering of catch-at-age matrix (suppression of outliers).

Kriging is generally used for objective analysis and optimal interpolation of spatially distributed data (Journel and Huijbregts 1993; Isaaks and Srivastanva 1988). However, because it precludes over-smoothing, kriging also offers an effective means of "safe" smoothing of fields. This is for two reasons. First, in kriging the radius of correlation between points of the 'kriged' field, as well as the weights of these points in the interpolation formula are estimated objectively. Second, provided that the initial data grid remains unchanged within the kriging procedure, repeated application of the latter will not alter a previously 'kriged' field. Since catch-at-age matrices can be regarded as a two-dimensional field, kriging may be applied to such data to suppress outliers. The kriging parameters are estimated from variograms constructed separately in the age- and year-directions, or, alternatively, in the cohort direction and in that orthogonal to it. Testing of this approach (Vasilyev and Kizner 1998, Vasilyev 2000) showed that kriging does not change so called "clean" catch-at-age data (which were simulated by means of a special deterministic age-structured separable operating model without added noise), as the corresponding variograms have zero nuggets and smoothing by kriging does not alter the data. In contrast, the presence of considerable noise gives rise to non-zero nuggets in the variograms, and in such cases kriging does result in smoothing of the data. Variograms constructed for the previously smoothed catch-at-age matrices also have zero nuggets, so that produces no further undesired smoothing.

6.4.5.2 Results

Results of the assessment based on the 1999 WG (ICES C.M.1999/ACFM:18) input data (catch at age, weight in the stock, natural mortality and maturity), presented in the WD, showed the following. Analysis of the ISVPA model fitting error profile (the median of the distribution of the squared logarithmic error MDN(SE) in catch-at-age matrix) as a function of terminal value of effort factor f(n) reveals 2 local minima, the second one (corresponding to higher fishing mortality) being much more profound. The solution, corresponding to this minimum, is rather similar (even somewhat more pessimistic for terminal years) to the results, obtained by the Working Group (ICES 1999/ACFM:18). To the contrary, the left minimum of ISVPA loss function for catch-at-age data, preliminary filtered by kriging, becomes the prevailing one. The estimates of total and spawning biomass for terminal years became significantly higher. The estimate of total stock biomass in 1998 (7.96 million t.) is very close to combined estimate of stock biomass from surveys (8.1 mln.t.) (Anon., 1999, page 124). Calculated value of spawning biomass for 1998 (4.6 mln.t.) is also very close to the estimate from Norway surveys (4.7 million t.) (Table 6.4.1.3.1. in ICES 1999/ACFM:18). Estimates of average fishing mortalities for age groups (3-7), as a result of implementation ICA and ISVPA, are very similar for 1986-1994. The estimates of selection pattern, obtained by means of ISVPA, are very similar to those produced by ICA (ICES 1999/ACFM:18), despite in ISVPA the whole period of years was considered as separable and no user's input for age of unit selection was used. Residuals in log-transformed catches as a result of ISVPA fit have zero sums by years and ages, that is one of commonly used criteria of quality of the solution is fulfilled.

In the WG meeting the calculations were repeated with updated input data. The results obtained are given in tables 6.4.5.1. – 6.4.5.3 and on Figures 6.4.5.1 – 6.4.5.4. Results support good stock condition in 1999 (TSB = 6.8 million t.; SSB = 4.8 million t.). The WG express interest in trying different methods and encourages the inclusion of auxiliary information into ISVPA, as well as, possibly, separabilization of the model presently used for Norwegian spring spawning herring stock assessment.

6.5 Short-Term Projection

Based on the final ICA run, a deterministic short-term projection was made using the IFAP prediction program, with the input stated in Table 6.5.1. The weight in the stock and catch were taken from the average of the last three years values. The selection pattern and the reference F in 1999 from the final ICA run were used as input values in 2000. The recruitment in 2000-2002 was set as the geometric mean of the recruitment values in the period 1981-1999 in the ICA run. For all ages the output values in 2000 from the ICA run were used as the initial stock size. The proportion of F and M before spawning was set to 0.25, taking into account the proportion of the catches that take place before the spawning period.

The results are given in Table 6.5.2 and the standard plots are given in Figure 6.5.1. Continuing fishing at the 1999 level predicts a catch of 1.1 million t in 2000 and 0.9 million tonnes in 2001. This exploitation rate implies a decreasing trend of SSB with 2.8 million t in 2000 and 2.3 and 1.9 million t in 2001 and 2002 respectively. The predicted total stock biomass will also decrease from 4.8 million t in 2000 to 4.2 and 3.8 million t in the following years.

6.6 Medium-Term Projection

6.6.1 ICP Runs

Using the output data generated by the final ICA run, a series of medium-term projections were run using the ICP program (WD by Patterson). Projections were run over a 10-year period starting in 2000 with the same input data used for the short-term predictions. The maturity ogive, natural mortality and the weight-at-age were taken as the average of the period 1996-1999. The stock-recruitment relationship was modelled using an "Ockham" relationship *i.e.* the geometric mean recruitment over the observed SSB range and a linear decrease to the origin for lower SSBs. Autocorrelated errors of the stock-recruitment relationship were applied.

Several runs were made by the Working Group, each with 500 simulations.

1) With F_{mult} = 1 the model gives a high (greater than 10% in every year) probability that the SSB will fall below B_{lim} (1.5 million tonnes). This probability increases throughout the period modelled (2000-2009), rising to 38% by 2009. SSB is also predicted to decline throughout (Figure 6.6.1.1 and Table 6.6.1.1)
2) With F_{mult} = 0.8 the model again gives a high (10 – 14% throughout) probability that the SSB will fall below B_{lim} (1.5 million tonnes). SSB, however, after an initial decline remains relatively stable throughout at approximately 2.5 million tonnes (Figure 6.6.1.2 and Table 6.6.1.2).
3) With F_{mult} = 0.5 the model again gives a low (5% or less in 6 of the 10 years) probability that the SSB will fall below B_{lim} (1.5 million tonnes). SSB, after an initial decline during the period 2000-2001, rises steadily through the remaining years and remains above 3 million tonnes annually from 2006 (Figure 6.6.1.3 and Table 6.6.1.3).

6.6.2 STPR runs

When the blue whiting stock was considered by ACFM last year (ICES 1999/CRR No 236), it was stated that:

'ICES advises that F should not exceed the proposed F_{pa} = 0.32. In 2000 this would correspond to a catch of not more than 800 000 t, but in the long run catches exceeding 650 000 t are not likely to be sustainable.'

The last statement reflects a previous advise to NEAFC by ACFM, which was based on medium-term simulations done by the 1998 Working Group (ICES C.M.1998/ACFM:18). These simulations were done with the ICP program (Patterson and Melvin 1996), which cannot simulate harvest control rules where catch ceilings are combined with F-constraints.

To elucidate the risks and gains associated with various Harvest Control Rules (HCR), as well as the question about the relation between B_{pa} and F_{pa}, a series of medium-term predictions have been made (WD by Skagen), using the STPR program based on the assessment made by the WGNPBW in 1999 (ICES C.M.1999/ACFM:18).

The STPR is a medium-term (10 years) Monte Carlo prediction program. It follows largely the same principles as the standard ICES software ICP, but allows for simulating a wider range of HCRs. It it is a slight modification and extension (Skagen 1999) of a program that was first developed for evaluating HCR's for North Sea herring (ICES C.M.1997/Assess:8, Skagen 1997).

Some of the runs made by Skagen were rerun during the WGNPBW meeting in 2000. In general, the results obtained during the meeting (with input data from the 2000 assessment) did not differ much from those obtained based on input data from the 1999 assessment (WD by Skagen). This was to be expected since the 2000 assessment is only slightly more optimistic than that made in 1999.

Input data

The initial values (stock numbers at age and their variances and covariances on the log scale), as well as the selection pattern, were taken from the 2000 assessment (the ICA output files). Recruitment was assumed to be lognormally distributed with a fixed expectation value at the geometric mean of historical recruitments ($14119*10^6$) for SSB above B_{lim}, and with a linear decline towards 0 below B_{lim} ('Ockhams razor'). The recruitment was drawn according to $R = R_{expect}*\exp(\varepsilon)$, where ε has a normal distribution with a standard deviation (σ = 0.61) derived from the stock-recruit residuals for the period 1981 - 1997 in the 1999 assessment. The initial number for age 0 (by January 1 1999) was substituted by the geometric mean of previous recruitments with variance as the variance of the ε above, and it was assumed to be uncorrelated to other stock numbers.

Weights at age and maturity at age were drawn randomly from values in previous years, by drawing a year and using the values from that year. Future assessments, as used as basis for management decisions, were assumed to have a normally distributed error multiplier with a CV of 0.2 (truncated if necessary), while it was assumed that the catches were equal to the quotas derived from the HCR. The assumed CV of the future assessments is approximately equal to that estimated for the last year by the ICA assessment method.

Simulation assumptions

The harvest control rules to be evaluated were in effect from 2001 onwards. All HCR's had a B_{lim} = 1500 thousand tonnes. The HCR's consider 3 levels of the current SSB, below B_{lim}, between B_{lim} and B_{pa} and above B_{pa}, with an F-value and a maximum catch prescribed for each level. The biomasses are stochastic variables. F at and below (Blim) was set at 0.05.

Simulations with pure F-constraints

Simulations were made with pure F-constraints (WD by Skagen) for combinations of $F(B_{pa})$ and B_{pa}-levels. These simulations were based on the 1999 assessment. Since an error in future stock estimates as basis for management decisions was included in the simulations, the risks of passing reference points are expressed in two ways: The risk for the true modelled population (the deterministic population), and the risk for the assumed population (the population with errors applied to it). These risks are the risks that the biomass will drop below the reference sooner or later during the simulation period. This is conceptually different from the probability of being below the reference in a certain year, which *inter alia* depends on how the stock responds if its biomass is that low. The probability that the stock is below the reference already at the start of the simulation is not taken into account here. Table 6.6.2.1 shows the results for all combinations of $F(B_{pa})$ ranging from 0.15 to 0.40 and B_{pa} ranging from 2.0 million tonnes to 2.5 million tonnes.

Simulations with fixed catch

Another series of runs were made with a fixed catch at a range of levels (300 thousand tonnes - 1 million tonnes), irrespective of biomass level (WD by Skagen). These simulations were based on the 1999 assessment. Figure 6.6.2.1 shows the risk that the true SSB falls below B_{lim} at least once in the 10 years period.

Simulations with catch ceilings

Such simulations were done for combinations of $F(B_{pa})$ in the range 0.2 - 0.4, B_{pa} in the range 2.0 million tonnes to 2.5 million tonnes, and catch ceilings at 500, 650 and 800 thousand tonnes (WD by Skagen). The results presented (The risk of SSB to fall below B_{lim} and B_{pa} relate to the true model values only) in Table 6.6.2.2 are:

- Percent probability of reaching B_{lim} from above at least once in the 10 years period.
- Percent probability of reaching B_{pa} from above at least once in the 10 years period.
- Median of the mean catches over 10 years.
- Median SSB in year 10.

Due to limited time during the 2000 WGNPBW meeting only some few of these runs (with catch ceilings of 650 and 800 thousand tonnes) were rerun with the 2000 assessment as input. These runs gave comparable results to those made on the basis of the 1999 assessment but were somewhat more optimistic. The risk of SSB to fall below B_{lim} and B_{pa} was about 1% lower and the median SSB in the last year of simulation was 3-4% higher when the simulations were based on the 2000 assessment. This was expected since the 2000 assessment is higher than the 1999 assessment.

6.7 Precautionary Reference Points

Precautionary reference points were estimated during the 1999 Working Group (ICES 1999/ACFM:18) using the "PA Software" (MRAG 1997). The terminal population was that estimated by ICA for the beginning of 1999, however due to uncertainties in the population numbers at age 0 and age 1 derived from the ICA analysis the following values were assumed:

Age 0 - a geometric mean of the recruitment from 1988-1997 (assumed also as the 1998 recruitment).

Age 1 - the latter value projected one year ahead.

The corresponding coefficients of variation were computed from the whole historical data series.

B_{loss} = 1.5 million tonnes was chosen as B_{lim}, and B_{pa} was calculated to be 2.25 million tonnes by the formula $B_{pa} = B_{lim} e^{1.645\sigma}$, where σ was set to 0.25. This B_{pa} was used in the PA software.

Historic SSB against F_{bar} with stock recruitment, historic recruitment and historic yield against F_{bar} are shown in Figure 6.7.1

The 2000 Working Group recommends that no change be introduced to the existing reference points.

6.8 Spatial, temporal and Zonal distribution

The available international catch of blue whiting in 1978-1999, divided by areas within and beyond national fisheries jurisdiction as defined by NEAFC, are given in Table 6.8.1.

6.9 Management consideration

At present, no agreement on a TAC has been reached for this stock. The catches in 1998 and 1999 were the highest since 1980 reaching 1.1 million t. and 1.3 million t. respectively. In spite of this, the assessment shows an increase in the SSB in 1999. By use of ICA the spawning stock biomass in 1999 was estimated at 3.0 million t., which is the highest estimate since 1981. The reference fishing mortality rate, $F_{(3\text{-}7)}$ was estimated at 0.43. This is considerably higher than Fpa= 0.32. Assuming the same F in 2000 (F-factor = 1), the short-term projections show a decrease of the spawning stock size to 2.8 million tonnes in 2000. The fishing intensity of the stock seems quite high so far in 2000 (May), and the same F is chosen for the projections in 2000. However, keeping the same F it is predicted that SSB will decrease to 2.3 and further to 1.9 million t. in 2001 and 2002 respectively. Fishing at F_{pa} (0.32) in year 2001 the predicted SSB in 2002 will be 2.2 million t., which is at the B_{pa} level. The medium-term projections show that fishing at the same F level as in 1999 will cause the stock to decrease over the entire 10 years period. The risk that SSB will fall below B_{lim} increases and reaches about 40 % by the end of the period. To obtain a risk of about 5 % that the SSB will fall below B_{lim} during the period, one would have to decrease the F-level by about 50 % of the 1999 level.

6.10 Sampling

Eight countries reported length samples of blue whiting in 1999, and seven of these also had age readings (Table 6.10.1).

Table 6.2.1 Landings (tonnes) of BLUE WHITING from the directed fisheries in the Norwegian Sea (Sub-areas I and II, Division Va, XIVa and XIVb) 1986–1999, as estimated by the Working Group.

Country	1986	1987	1988	1989 [3])	1990	1991	1992	1993	1994 [2])	1995 [3])	1996	1997	1998	1999
Faroes	-	9,290	-	1,047	-	-	-	-	-	-	345	-	44,594	11,507
Germany	3,647	1,010	3	1,341	-	-	-	-	2	3	32	-	78	
Greenland	10	-	-	-	-	-	-	-	-	-	-	-		
Iceland	-	-	-	4,977	-	-	-	-	-	369	302	10,464	64,863[4]	99,092
Netherlands	-	-	-	-	-	-	-	-	-	72	25	-	63	435
Norway	-	-	-	-	566	100	912	240	-	-	58	1,386	12,132	5,455
Poland	-	56	10	-	-	-	-	-	-	-	-	-		
UK (Eng.&Wales)	-	-	-	-	-	-	-	-	-	-	-	-		
USSR/Russia [1])	156,404	112,686	55,816	35,250	1,540	78,603	61,400	43,000	22,250	23,289	22,308	50,559	51,042	65,932
Estonia	-	-	-	-	-	-	-	-	-	-	377	161	904	
Latvia	-	-	-	-	-	-	-	-	422	-	-	-		
Denmark														15
Total	160,061	123,042	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,447	62,570	173,676	182,436

[1]) From 1992 only Russia

[2]) Includes Vb for Russia.

[3]) Icelandic mixed fishery in Va.

[4]) include mixed in Va and directed in Vb.

Table 6.2.2 Landings (tonnes) of BLUE WHITING from directed fisheries in the spawning area (Division Vb,VIa,b, VIIb,c. VIIg-k and Sub-area XII) 1986–1999, as estimated by the Working Group.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998[1]	1999
Denmark	11,364	2,655	797	25	-	-	3,167	-	770	-	269		5051	19,625
Faroes	80,564	70,625	79,339	70,711	43,405	10,208	12,731	14,984	22,548	26,009	18,258	22,480	26,328	93,234
France	-	-	-	2,190	-	-	-	1,195	-	720	6,442	12,446	7,984	6,662
Germany	2,750	3,850	5,263	4,073	1,699	349	1,307	91	-	6,310	6,844	4,724	17,891	3,170
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	-	61,438
Ireland	16,440	3,300	245	-	-	-	-	-	3	-	-		45635	35,240
Netherlands	8,888	5,627	800	2,078	7,280	17,359	11,034	18,436	21,076	26,703	17,644	23,676	27,884	35,408
Norway	283,162	191,012	208,416	258,386	281,036	114,866	148,733	198,916	226,235	261,272	337,434	318,531	519,622	475,004
UK (Scotland)	3,482	3,315	5,071	8,020	6,006	3,541	6,849	2,032	4,465	10,583	14,325	33,398	92,383	98,853
USSR/Russia [2])	127,613	165,497	121,705	127,682	124,069	72,623	115,600	96,000	94,531	83,931	64,547	68,097	79,000	112,247
Japan	-	-	-	-	-	-	918	1,742	2,574	-	-			
Estonia	-	-	-	-	-	-	6,156	1,033	4,342	7754	10,605	5,517	5,416	
Latvia	-	-	-	-	-	-	10,742	10,626	2,160	-	-			
Lithauen	-	-	-	-	-	-	-	2,046	-	-	-			
Total	534,263	445,881	421,636	473,165	463,495	218,946	317,237	347,101	378,704	423,282	476,368	488,869	827,194	940,881

[1]) Including some directed fishery also in Division IVa.

[2]) From 1992 only Russia

Table 6.2.3 Landings (tonnes) of BLUE WHITING from the mixed industrial fisheries and caught as by-catch in ordinary fisheries in Divisions IIIa, IVa 1986–1999, as estimated by the WG.

Country	1986	1987	1988	1989	1990	1991	1992	1993 [3])	1994	1995	1996	1997	1998[2]	1999
Denmark	57,315	28,541	18,144	26,605	27,052	15,538	31,189	41,053	19,686	12,439	51,832	26,270	56,472	45,013
Faroes	5,678	7,051	492	3,325	5,281	355	705	1,522	1,794	-	6,068	6,066	296	265
Germany [1])	-	115	280	3	-	-	25	9	-	-	-	-		
Netherlands	1,114	-	-	-	20	-	2	46	-	-	-	793		
Norway	26,941	24,969	24,898	42,956	29,336	22,644	31,977	12,333	3,408	78,565	57,458	27,394	28,814	48,338
Sweden	8,532	2,013	1,229	3,062	1,503	1,000	2,058	2,867	3,675	13,000	4,000	4,568	9,299	12,993
UK	-	-	100	7	-	335	18	252	-	-	1	-		
Total	99,580	62,689	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359	65,091	94,881	106,609

[1]) Including directed fishery also in Division IVa.

[2]) Including mixed industrial fishery in the Norwegian Sea

[3]) Imprecise estimates for Sweden: reported catch of 34265 t in 1993 is replaced by the mean of 1992 and 1994, i.e. 2,867 t, and used in the assessment.

Table 6.2.4 Landings (tonnes) of BLUE WHITING from the Southern areas (Sub-areas VIII and IX and Divisions VIIg-k and VIId,e) 1986–1999, as estimated by the Working Group.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Netherlands	-	-	-	-	450	10	-	-	-	-	-	-	10[1]	
Norway	-	4	-	-	-	-	-	-	-	-	-	-		
Portugal	8,116	9,148	5,979	3,557	2,864	2,813	4,928	1,236	1,350	2,285	3,561	2,439	1,900	2,625
Spain	24,965	23,644	24,847	30,108	29,490	29,180	23,794	31,020	28,118	25,379	21,538	27,683	27,490	23,777
UK	1	23	12	29	13	-	-	-	5	-	-	-		
France	-	-	-	1	-	-	-	-	-	-	-	-		
Total	33,082	32,819	30,838	33,695	32,817	32,003	28,722	32,256	29,473	27,664	25,099	30,122	29,400	26,402

[1]) Directed fisheries in VIIIa

Table 6.2.5 Landings (tonnes) of BLUE WHITING from the main fisheries, 1986–1999, as estimated by the Working Group.

Area	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Norwegian Sea Fishery (Subareas I+II and Divisions Va,XIVa-b)	160,061	123,042	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,447	62,570	173,676	182,436
Fishery in the spawning area (Divisions Vb, VIa, VIb and VIIb-c)	534,263	445,881	421,636	473,165	463,495	218,946	317,237	347,101	378,704	423,282	476,368	488,869	827,194	940,881
Industrial mixed Fishery (Divisions Iva-c, Vb and IIIa)	99,580	62,689	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359	65,091	94,881	106,609
Subtotal northern Fishery	793,904	631,612	522,608	591,738	528,793	337,521	445,523	448,423	429,941	551,019	619,174	616,530	1,095,751	1,229,926
Southern fishery (Subareas VIII+IX, Divisions VIId,e,g-k)	33,082	32,819	30,838	33,695	32,817	32,003	28,722	32,256	29,473	27,664	25,099	30,122	29,400	26,402
Grand total	826,986	664,431	553,446	625,433	561,610	369,524	474,245	480,679	459,414	578,683	644,273	646,652	1,125,151	1,256,328

Table 6.3.1.1.
LENGTH DISTRIBUTIONS BY QUARTER

ALL COUNTRIES
DIRECTED Fishery

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	41	41
12	0	0	0	0	0
13	0	0	0	65	65
14	0	17	0	41	58
15	0	34	0	229	263
16	386	254	6	621	1268
17	2026	2102	7	2507	6642
18	4915	2540	3	2848	10306
19	6697	19694	11	6664	33066
20	15184	63577	256	18516	97532
21	48207	96876	2289	40914	188286
22	139281	146387	9546	49690	344904
23	418803	267862	22193	58774	767632
24	666054	525432	51328	60401	1303215
25	694165	494277	117511	50823	1356776
26	522326	482405	105419	39247	1149398
27	306056	303022	42952	25699	677729
28	196671	210907	9779	13681	431038
29	107396	101862	1414	7014	217685
30	71027	74754	618	3723	150122
31	37488	67721	39	2081	107329
32	38638	43338	28	1404	83408
33	20628	54872	0	1195	76696
34	26358	34614	16	1093	62081
35	11275	18629	0	1413	31317
36	7304	20998	0	845	29147
37	5247	8541	5	572	14366
38	314	4748	5	536	5604
39	39	2067	0	114	2221
40	79	2000	0	120	2199
41	0	17	0	0	17
42	0	84	0	0	84
43	0	0	0	0	0
44	0	0	0	0	0
45	0	17	0	0	17
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	0	0
TOTAL numbers	3346566	3049646	363426	390872	7150510
Official Catch (t)	341609	309664	119687	81338	852298

Table 6.3.1.2.
LENGTH DISTRIBUTIONS BY QUARTER

ALL COUNTRIES
MIXED Fishery

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	511	0	0	0	511
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	2555	0	0	2532	5088
16	13288	0	0	3482	16770
17	33162	653	0	7280	41095
18	45802	2937	0	8230	56969
19	43985	7832	2599	2216	56631
20	21282	14684	9276	3437	48678
21	41383	18437	22545	3120	85484
22	66774	26330	22034	11487	126625
23	60663	29907	31774	16913	139257
24	42930	33733	61575	24375	162612
25	33993	27916	39981	35048	136938
26	14212	27916	28514	32289	102931
27	8389	22487	20800	16913	68590
28	6550	11021	15273	14697	47542
29	6539	4613	7141	6557	24851
30	2861	2611	2514	3437	11423
31	1328	2447	0	2487	6263
32	1033	1142	0	317	2492
33	738	1632	295	0	2664
34	295	979	0	0	1274
35	738	489	0	0	1227
36	295	1513	0	0	1808
37	295	489	0	0	785
38	295	0	0	0	295
39	0	0	0	0	0
40	511	0	0	0	511
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	0	0
TOTAL numbers	450409	239768	264320	194819	1149315
Official Catch (t)	27970	21333	24525	19523	93351

Table 6.3.1.3.
LENGTH DISTRIBUTIONS BY QUARTER

ALL COUNTRIES
SOUTHERN FISHERY

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	61	46	0	107
12	0	154	282	0	436
13	0	158	199	0	357
14	1	53	68	0	121
15	101	14	20	18	153
16	245	31	74	1272	1622
17	1787	142	538	5356	7823
18	10702	990	1240	11493	24425
19	31724	7887	2026	8998	50635
20	28710	19912	4452	4924	57998
21	18070	29597	11090	6327	65084
22	10202	24644	21146	9558	65550
23	6944	15789	18329	10525	51586
24	5366	7211	10801	7544	30922
25	4676	4335	6143	5024	20178
26	2904	2231	2181	2435	9751
27	2455	718	1064	967	5204
28	2390	521	521	358	3789
29	1457	355	289	194	2294
30	877	141	69	103	1191
31	324	149	83	41	597
32	224	29	18	38	309
33	36	25	5	4	71
34	45	17	5	2	70
35	27	15	3	2	47
36	30	7	2	1	40
37	2	4	1	1	8
38	0	3	2	1	6
39	0	3	1	0	4
40	0	1	0	0	1
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	0	0
TOTAL numbers	32595	11491	18976	15887	78949
Official Catch (t)	7803	7416	6192	4989	26400

Table 6.3.2.1 BLUE WHITING. Catch in number (millions) by age group in the directed fisheries (Sub-areas I and II, Divisions Va, and XIVa+b, Vb, Via+b, VIIbc and VIIg-k) in 1989-1999.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	36.5	8.4	63.6	-	-	-	0.7	3.8	167.0	15	61
1	86.4	537.8	33.4	82.4	36.8	43.6	99.4	497.1	1,351.9	984	544
2	359.4	353.1	533.2	52.2	130.1	31.2	142.7	327.1	1,078.6	3535	1180
3	1,176.7	565.7	384.4	1,508.5	334.5	190.0	337.7	450.5	750.6	3211	5257
4	696.2	709.1	243.9	510.4	1,348.2	361.9	416.2	424.7	526.5	929	3235
5	785.7	489.2	329.9	200.1	375.7	1,242.4	565.9	248.4	268.2	346	362
6	680.7	562.1	235.3	138.8	196.1	294.2	769.0	429.9	238.0	311	186
7	127.2	291.7	149.9	92.0	107.9	201.3	245.5	619.4	269.9	298	143
8	44.8	75.5	39.9	86.7	59.8	102.5	154.1	213.9	391.2	257	146
9	23.8	26.6	4.3	84.6	37.9	88.3	57.7	87.8	101.2	209	66
10+	37.0	91.8	14.0	14.5	13.6	32.1	40.0	70.2	163.9	85.0	138
Total	4,054.4	3,711.0	2,031.8	2,770.2	2,640.6	2,587.5	2,828.9	3,372.8	5,306.8	10,180.0	11,318.0
Tonnes	521,415	465,601	297,649	379,549	389,010	401,378	447,015	493,373	545,058	994,709	941,499

Table 6.3.2.2 BLUE WHITING. Catch in number (million) by age group in the mixed industrial fisheries (Sub-area IV, Divisions IIIa, IVb and Va, 1989-1999.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	1871.6	0.5	24.9	-	132.2	94.8	3,303.0	811.8	29.4	11.0	60
1	578.9	874.8	8.4	159.8	166.9	33.1	100.7	1,334.4	621.0	576	188
2	183.7	167.6	397.9	63.9	38.8	20.7	88.3	71.2	268.7	524	286
3	70.0	49.5	42.3	167.1	90.8	17.5	28.7	58.4	50.3	259	434
4	33.5	11.8	11.4	75.1	97.3	36.7	11.0	71.3	14.0	47	168
5	24.1	7.0	11.3	25.2	15.0	6.1	6.0	38.8	14.3	6	16
6	12.2	3.8	11.2	16.7	6.7	3.0	11.4	45.4	5.1	4	5
7	5.9	4.9	6.2	6.7	8.3	1.2	1.8	32.6	3.7	3	5
8	2.1	0.6	3.4	2.7	-	0.6	2.0	14.3	6.0	4	6
9	0.8	0.4	0.7	0.9	-	0.1	1.2	9.0	0.7	4	1
10+	1.0	-	0.2	0.6	-	-	0.8	11.4	1.6		3
Total	2,783.8	1,120.9	517.9	518.7	556.0	213.8	3,554.9	2,498.6	1,014.7	1,438.0	1,172.0
Tonnes	75,978	63,195	39,872	66,174	55,215	28,563	104,004	119,359	65,091	101,040	182,436

Table 6.3.2.3 BLUE WHITING. Catch in number (millions) by age group in the Southern area, 1989-1999.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	41	74	70	19	25	13	3	9	11	18	18
1	200	198	181	139	41	12	96	43	118	97	57
2	175	182	182	205	146	56	123	131	143	122	82
3	93	57	70	95	181	149	55	117	86	71	130
4	61	25	39	43	62	72	38	36	26	69	57
5	27	24	17	12	12	27	44	33	8	32	35
6	15	11	8	6	7	9	20	17	4	7	15
7	6	2	3	2	2	5	6	5	3	2	3
8+	3	2	3	1	1	4	5	3	3	4	2
Total	621	575	573	522	477	347	390	394	402	422	399
Tonnes	33,695	32,817	32,003	28,722	32,256	29,468	27,664	25,099	30,122	29,400	26,402

Table 6.3.2.4. Blue Whiting. Total catch in numbers at age (millions) 1982-1999.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	3512	437	584	1174	84	341	46	1949	83	161	19	198	42	3307	824	208	43	139
1	148	2283	2291	1305	650	838	425	865	1611	267	408	263	307	296	1875	2091	1657	788
2	274	567	2331	2044	816	578	721	718	703	1024	654	305	108	354	529	1490	4181	1549
3	326	270	455	1933	1862	728	614	1340	672	514	1642	621	368	422	626	887	3541	5821
4	548	286	260	303	1717	1897	683	791	753	302	569	1571	389	465	532	567	1045	3461
5	264	299	285	188	393	726	1303	837	520	363	217	411	1222	616	320	290	384	413
6	276	304	445	321	187	137	618	708	577	258	154	191	281	800	492	247	323	207
7	266	287	262	257	201	105	84	139	299	159	110	107	174	254	657	277	303	151
8	272	286	193	174	198	123	53	50	78	49	80	65	90	160	230	399	264	153
9	284	225	154	93	174	103	33	25	27	5	32	38	79	60	97	102	212	69
10+	673	334	255	259	398	195	50	38	95	10	12	17	31	42	82	166	86	141
Total	6843	5578	7515	8051	6680	5771	4630	7460	5418	3112	3896	3788	3091	6775	6264	6722	12039	12892
Tonnes	576419	570072	641776	695596	826986	664434	553413	625433	561610	369525	474245	480672	459414	578693	637825	634206	1,125,149	1,256,328

Table 6.3.2.5 BLUE WHITING Disaggregated Fisheries Assessment Data from Directed fisheries. (DISFAD file)

Record No	Country	Quarter	Area	Sampled Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12
Blue whiting		0	15	1999																	
1	Denmark	1	IIa	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Denmark	2	Vb	0	3085	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Denmark	2	VIa	0	9560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Denmark	3	VIa	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Denmark	4	VIa	0	1240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Denmark	1	VIb	0	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Denmark	1	VIIb,c	0	3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Denmark	2	VIIb,c	0	1820	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Denmark	1	VIIh	0	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Faroe Islands	3	Va	0	7797	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Faroe Islands	4	Va	0	3710	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Faroe Islands	2	Vb	19410	19410	2	200	552	0	4783	108856	124248	28867	5031	735	0	0	1157	0	308	0
13	Faroe Islands	4	Vb	21851	21851	5	500	1101	3240	34681	43476	87793	16708	2045	766	0	0	0	0	0	0
14	Faroe Islands	2	VIa + VIb	19370	19370	1	100	234	0	0	2253	109067	64613	12439	5707	923	8052	8865	1293	1727	0
15	Faroe Islands	4	VIa + VIb	793	793	1	100	234	119	1276	1600	3230	615	75	28	0	0	0	0	0	0
16	Faroe Islands	1	VIIb,c	31810	31810	5	500	1149	0	0	54995	210985	42311	6771	2568	1167	995	820	0	0	0
17	France	1	VII,Vb,VI	0	6519	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	France	1	VIIIabd	0	122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	France	1	VIIIc	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	GERMANY	1	VIa	0	174	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	GERMANY	2	VIa	0	2996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Iceland	2	IIa	690	690	2	50	150	0	0	131	3286	3023	131	0	0	0	0	0	0	0
23	Iceland	3	IIa	16590	16590	5	250	250	0	1154	10387	59435	62898	9233	577	577	0	0	0	0	0
24	Iceland	4	IIa	6550	6550	4	100	278	0	3417	8543	23352	18226	1709	1139	579	0	0	0	0	0
25	Iceland	2	Va	0	3510	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Iceland	3	Va	63665	63665	17	598	969	0	16104	59047	167299	245134	38470	6263	895	895	895	0	0	0
27	Iceland	4	Va	8087	8087	9	250	597	17213	4748	5045	16025	21961	4748	2671	1187	297	297	0	0	0
28	Iceland	2	Vb	0	17117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Iceland	3	Vb	4489	4489	5	150	326	593	2963	7704	24001	8889	296	0	0	0	0	0	0	0
30	Iceland	4	Vb	30979	30979	12	250	780	14162	20063	38945	139258	70809	7081	3540	1180	0	0	0	0	0
31	Iceland	2	VIa	0	239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	Iceland	1	VIb	0	6750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Iceland	2	VIb	0	1864	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Ireland	1	VIa+VIIb,c	18830	18830	5	298	743	0	0	8494	108585	67496	20186	7751	1690	525	1763	0	0	0
35	Ireland	2	VIa+VIIb,c	16410	16410	2	137	137	0	0	7377	92955	76725	17706	2951	2951	0	1476	0	0	0
36	Netherlands	2	IIa	0	435	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Netherlands	2	IVa	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	Netherlands	2	VIa	0	26470	16	0	2121	0	0	0	0	0	0	0	0	0	0	0	0	0
39	Netherlands	2	VIb	0	401	1	0	309	0	0	0	0	0	0	0	0	0	0	0	0	0
40	Netherlands	1	VIIb	0	573	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	Netherlands	1	VIIc	0	2044	2	0	494	0	0	0	0	0	0	0	0	0	0	0	0	0
42	Netherlands	2	VIIc	0	5622	2	0	602	0	0	0	0	0	0	0	0	0	0	0	0	0
43	Netherlands	1	VIIh	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	Netherlands	4	VIIIb	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	Netherlands	1	VIIj	0	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46	Netherlands	2	VIIj	0	212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	NORWAY	1	IIa	772	772	0	110	0	0	2069	5094	1858	870	393	138	47	0	47	0	0	19
48	NORWAY	2	IIa	2313	2313	0	240	0	172	3216	5786	10332	3714	1129	189	34	69	34	0	0	34
49	NORWAY	3	IIa	260	260	0	250	0	22	832	642	1324	133	6	0	0	0	0	0	0	0
50	NORWAY	2	IVa	25761	25761	0	100	0	0	43454	37152	119633	72223	5248	4797	2822	7562	3950	2257	0	0
51	NORWAY	1	Vb	3487	3487	5	260	560	0	835	10429	16291	7685	1731	399	151	164	114	310	0	205
52	NORWAY	2	Vb	34731	34731	5	250	750	0	0	19928	112727	111264	21613	13867	13299	19396	6015	5588	2196	3514
53	NORWAY	4	Vb	2627	2627	3	200	200	1130	3729	6442	7911	1921	565	226	226	226	0	113	113	0
54	NORWAY	1	VIa	4374	4374	4	200	400	0	0	5593	26119	15405	1250	775	254	508	0	444	0	444
55	NORWAY	2	VIa	116363	116363	6	300	1000	0	4419	82584	448062	344880	26601	43919	37590	52340	26351	37013	0	1105
56	NORWAY	1	VIb	129335	129335	7	360	1910	0	0	41683	665992	432385	45069	23631	12139	3399	0	5018	0	7284
57	NORWAY	2	VIb	15921	15921	2	100	350	0	0	4403	96523	69585	5415	2642	3698	0	0	1585	0	1057
58	NORWAY	1	VIIb,c	137748	137748	11	555	2310	0	1183	68142	756415	434046	50550	10260	16776	8904	0	12567	3154	3928
59	NORWAY	2	VIIb,c	651	651	2	100	350	0	0	167	4121	2691	163	195	109	0	65	65	0	22
60	NORWAY	1	VIIg,k+XII	4006	4006	6	300	850	0	0	1787	20437	13180	1903	256	587	370	0	455	92	211
61	Russia	1	IIa	0	5986	1	0	310	0	1836	18197	38623	10632	1275	574	0	0	0	0	0	0
62	Russia	2	IIa	6815	6815	49	231	4451	0	10250	6549	30796	20708	4745	558	0	0	0	547	0	723
63	Russia	3	IIa	0	34527	6	0	1869	0	29494	71447	233292	23874	0	0	0	0	0	0	0	0
64	Russia	4	IIa	0	18604	58	0	5656	10258	117495	63285	33009	3358	1394	511	1001	368	0	388	0	0
65	Russia	1	IVa	0	3311	0	0	0	0	1169	5249	17076	9393	1553	288	179	42	44	108	0	219
66	Russia	2	IVa	0	1968	0	0	0	0	3320	2838	9139	5517	401	366	216	578	302	172	0	0
67	Russia	1	Vb	0	20480	21	0	6457	0	7230	32467	105619	58101	9604	1778	1110	257	271	670	0	1353
68	Russia	2	Vb	61746	61746	1	50	50	0	121231	75769	333385	227308	0	0	0	0	0	0	0	0
69	Russia	4	Vb	0	14471	0	0	0	2957	30895	44972	45569	8157	1166	493	565	361	0	204	577	0
70	Russia	1	VIb	0	2806	0	0	0	0	0	904	14449	9381	978	513	263	74	0	109	0	158
71	Russia	2	VIb	0	3565	0	0	0	0	0	986	21613	15581	1213	591	828	0	0	355	0	237
72	Russia	3	VIb	0	156	0	0	0	0	0	43	946	682	53	26	36	0	0	16	0	10
73	Russia	4	VIb	0	20	0	0	0	0	0	6	121	87	7	3	5	0	0	2	0	1
74	Russia	1	VIIb,c	0	3424	0	0	0	0	29	1694	18802	10789	1257	255	417	221	0	312	78	98
75	Russia	1	VIIk	0	300	0	0	0	0	0	134	1530	987	142	19	44	28	0	34	7	16
76	Scotland	4	IVa	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	Scotland	1	Vb	0	678	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	Scotland	2	Vb	0	4862	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	Scotland	4	Vb	0	1483	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	Scotland	1	VIa	0	11661	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81	Scotland	2	VIa	0	49461	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	Scotland	1	VIb	0	8364	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	Scotland	2	VIb	0	198	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	Scotland	1	VIIb,c	0	11679	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	Scotland	1	VIIg,k+XII	0	10461	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6.3.2.5 (cont.)

Record No	Country	Quarter	Area	Sampled Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7	CW 8	CW 9	CW 10	CW 11	CW 12
Blue whiting		0	15	1999																	
1	Denmark	1	IIa	0	15	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Denmark	2	Vb	0	3085	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	Denmark	2	VIa	0	9560	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	Denmark	3	VIa	0	10	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	Denmark	4	VIa	0	1240	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	Denmark	1	VIb	0	350	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Denmark	1	VIIb,c	0	3400	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Denmark	2	VIIb,c	0	1820	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	Denmark	1	VIIh	0	160	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	Faroe Islands	3	Va	0	7797	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	Faroe Islands	4	Va	0	3710	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	Faroe Islands	2	Vb	19410	19410	2	200	552	0.000	0.034	0.069	0.075	0.100	0.141	0.219	0.000	0.000	0.180	0.000	0.202	0.000
13	Faroe Islands	4	Vb	21851	21851	5	500	1101	0.051	0.095	0.114	0.130	0.177	0.248	0.259	0.000	0.000	0.000	0.000	0.000	0.000
14	Faroe Islands	2	VIa + VIb	19370	19370	1	100	234	0.000	0.000	0.058	0.071	0.094	0.136	0.167	0.245	0.175	0.196	0.161	0.180	0.000
15	Faroe Islands	4	VIa + VIb	793	793	1	100	234	0.051	0.095	0.114	0.130	0.177	0.248	0.259	0.000	0.000	0.000	0.000	0.000	0.000
16	Faroe Islands	1	VIIb,c	31810	31810	5	500	1149	0.000	0.000	0.078	0.099	0.140	0.176	0.200	0.192	0.300	0.267	0.000	0.000	0.000
17	France	1	VII,Vb,VI	0	6519	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	France	1	VIIIabd	0	122	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	France	1	VIIIc	0	21	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	GERMANY	1	VIa	0	174	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	GERMANY	2	VIa	0	2996	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	Iceland	2	IIa	690	690	2	50	150	0.000	0.000	0.071	0.106	0.107	0.106	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	Iceland	3	IIa	16590	16590	5	250	250	0.000	0.077	0.089	0.108	0.119	0.138	0.208	0.299	0.000	0.000	0.000	0.000	0.000
24	Iceland	4	IIa	6550	6550	4	100	278	0.000	0.083	0.095	0.107	0.120	0.170	0.232	0.330	0.000	0.000	0.000	0.000	0.000
25	Iceland	2	Va	0	3510	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	Iceland	3	Va	63665	63665	17	598	969	0.000	0.079	0.085	0.107	0.129	0.161	0.195	0.199	0.240	0.261	0.000	0.000	0.000
27	Iceland	4	Va	8087	8087	9	250	597	0.033	0.080	0.091	0.110	0.133	0.173	0.217	0.337	0.302	0.315	0.000	0.000	0.000
28	Iceland	2	Vb	0	17117	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	Iceland	3	Vb	4489	4489	5	150	326	0.039	0.081	0.090	0.102	0.116	0.131	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	Iceland	4	Vb	30979	30979	12	250	780	0.037	0.076	0.091	0.104	0.127	0.156	0.154	0.281	0.000	0.000	0.000	0.000	0.000
31	Iceland	2	VIa	0	239	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	Iceland	1	VIb	0	6750	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	Iceland	2	VIb	0	1864	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	Ireland	1	VIa+VIIb,c	18830	18830	5	298	743	0.000	0.000	0.058	0.073	0.089	0.115	0.163	0.220	0.236	0.183	0.000	0.000	0.000
35	Ireland	2	VIa+VIIb,c	16410	16410	2	137	137	0.000	0.000	0.047	0.069	0.087	0.095	0.165	0.117	0.000	0.271	0.000	0.000	0.000
36	Netherlands	2	IIa	0	435	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	Netherlands	2	IVa	0	16	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	Netherlands	2	VIa	0	26470	16	0	2121	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	Netherlands	2	VIb	0	401	1	0	309	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40	Netherlands	1	VIIb	0	573	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	Netherlands	1	VIIc	0	2044	2	0	494	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
42	Netherlands	2	VIIc	0	5622	2	0	602	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
43	Netherlands	1	VIIh	0	6	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
44	Netherlands	4	VIIIh	0	3	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	Netherlands	1	VIIj	0	67	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
46	Netherlands	2	VIIj	0	212	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
47	NORWAY	1	IIa	772	772	0	110	0	0.000	0.038	0.061	0.083	0.117	0.172	0.192	0.272	0.000	0.272	0.000	0.000	0.351
48	NORWAY	2	IIa	2313	2313	0	240	0	0.030	0.065	0.073	0.096	0.118	0.156	0.136	0.272	0.260	0.272	0.000	0.000	0.351
49	NORWAY	3	IIa	260	260	0	250	0	0.036	0.070	0.087	0.097	0.117	0.175	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	NORWAY	2	IVa	25761	25761	0	100	0	0.000	0.051	0.057	0.080	0.101	0.132	0.153	0.190	0.173	0.175	0.255	0.000	0.000
51	NORWAY	1	Vb	3487	3487	5	260	560	0.000	0.040	0.067	0.082	0.107	0.166	0.154	0.222	0.223	0.239	0.235	0.000	0.316
52	NORWAY	2	Vb	34731	34731	5	250	750	0.000	0.000	0.064	0.073	0.096	0.128	0.157	0.176	0.185	0.167	0.216	0.233	0.272
53	NORWAY	4	Vb	2627	2627	3	200	200	0.034	0.080	0.097	0.120	0.163	0.202	0.287	0.249	0.404	0.000	0.267	0.403	0.000
54	NORWAY	1	VIa	4374	4374	4	200	400	0.000	0.000	0.064	0.074	0.095	0.135	0.148	0.189	0.212	0.000	0.211	0.000	0.234
55	NORWAY	2	VIa	116363	116363	6	300	1000	0.000	0.050	0.068	0.077	0.100	0.135	0.160	0.190	0.184	0.191	0.236	0.000	0.280
56	NORWAY	1	VIb	129335	129335	7	360	1910	0.000	0.000	0.076	0.089	0.113	0.155	0.200	0.221	0.214	0.000	0.235	0.000	0.257
57	NORWAY	2	VIb	15921	15921	2	100	350	0.000	0.000	0.060	0.072	0.092	0.131	0.131	0.177	0.000	0.000	0.198	0.000	0.273
58	NORWAY	1	VIIb,c	137748	137748	11	555	2310	0.000	0.047	0.073	0.084	0.111	0.154	0.200	0.233	0.232	0.000	0.255	0.238	0.276
59	NORWAY	2	VIIb,c	651	651	2	100	350	0.000	0.000	0.060	0.072	0.091	0.126	0.144	0.188	0.000	0.193	0.198	0.000	0.267
60	NORWAY	1	VIIg,k+XII	4006	4006	6	300	850	0.000	0.000	0.070	0.083	0.109	0.153	0.207	0.233	0.235	0.000	0.252	0.235	0.267
61	Russia	1	IIa	0	5986	1	0	310	0.000	0.038	0.071	0.085	0.105	0.131	0.113	0.000	0.000	0.000	0.000	0.000	0.000
62	Russia	2	IIa	6815	6815	49	231	4451	0.000	0.047	0.076	0.090	0.098	0.132	0.155	0.000	0.000	0.000	0.159	0.000	0.315
63	Russia	3	IIa	0	34527	6	0	1869	0.000	0.075	0.092	0.099	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
64	Russia	4	IIa	0	18604	58	0	5656	0.037	0.062	0.092	0.113	0.157	0.205	0.277	0.246	0.298	0.000	0.267	0.000	0.000
65	Russia	1	IVa	0	3311	0	0	0	0.000	0.038	0.071	0.084	0.108	0.156	0.131	0.220	0.223	0.239	0.236	0.000	0.315
66	Russia	2	IVa	0	1968	0	0	0	0.000	0.051	0.057	0.080	0.101	0.132	0.153	0.190	0.173	0.175	0.255	0.000	0.000
67	Russia	1	Vb	0	20480	21	0	6457	0.000	0.038	0.071	0.084	0.108	0.156	0.131	0.220	0.223	0.239	0.236	0.000	0.315
68	Russia	2	Vb	61746	61746	1	50	50	0.000	0.054	0.076	0.082	0.097	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
69	Russia	4	Vb	0	14471	0	0	0	0.039	0.080	0.095	0.119	0.156	0.204	0.281	0.245	0.298	0.000	0.267	0.403	0.000
70	Russia	1	VIb	0	2806	0	0	0	0.000	0.000	0.076	0.089	0.113	0.155	0.200	0.221	0.215	0.000	0.235	0.000	0.257
71	Russia	2	VIb	0	3565	0	0	0	0.000	0.000	0.060	0.072	0.092	0.131	0.131	0.177	0.000	0.000	0.198	0.000	0.274
72	Russia	3	VIb	0	156	0	0	0	0.000	0.000	0.060	0.072	0.092	0.131	0.131	0.177	0.000	0.000	0.198	0.000	0.274
73	Russia	4	VIb	0	20	0	0	0	0.000	0.000	0.060	0.072	0.092	0.131	0.131	0.177	0.000	0.000	0.198	0.000	0.274
74	Russia	1	VIIb,c	0	3424	0	0	0	0.000	0.047	0.073	0.084	0.111	0.154	0.200	0.233	0.232	0.000	0.255	0.238	0.276
75	Russia	1	VIIk	0	300	0	0	0	0.000	0.000	0.070	0.083	0.109	0.153	0.207	0.233	0.235	0.000	0.252	0.235	0.267
76	Scotland	4	IVa	0	6	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
77	Scotland	1	Vb	0	678	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
78	Scotland	2	Vb	0	4862	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
79	Scotland	4	Vb	0	1483	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80	Scotland	1	VIa	0	11661	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
81	Scotland	2	VIa	0	49461	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
82	Scotland	1	VIb	0	8364	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83	Scotland	2	VIb	0	198	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84	Scotland	1	VIIb,c	0	11679	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
85	Scotland	1	VIIg,k+XII	0	10461	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 6.3.2.6 BLUE WHITING Disaggregated Fisheries Assessment Data from Mixed Industrial fisheries. (DISFAD file)

Record No	Country	Quarter	Area	Sampled Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12
Blue whiting	0	15	1999																		
1	NORWAY	1	IIa	171	171	6	200	1323	0	152	544	740	255	43	12	21	22	4	4	0	9
2	NORWAY	2	IIa	777	777	12	350	2010	0	1245	1872	2973	1900	261	104	44	84	20	26	0	0
3	NORWAY	3	IIa	124	124	14	350	1055	0	373	292	531	207	0	0	0	0	0	0	0	0
4	NORWAY	4	IIa	1038	1038	3	200	300	3036	1103	2979	3768	582	42	19	0	0	0	0	0	0
8	SWEDEN	1	IIIa	0	277	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Denmark	2	IIIa	0	173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	SWEDEN	2	IIIa	0	1118	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Denmark	3	IIIa	0	2519	2	0	73	0	0	0	0	0	0	0	0	0	0	0	0	0
10	SWEDEN	3	IIIa	0	9159	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Denmark	4	IIIa	0	1204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	SWEDEN	4	IIIa	0	958	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Denmark	1	IVa	0	17310	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Faroe Islar	1	IVa	0	265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	NORWAY	1	IVa	10489	10489	4	200	763	0	9302	33397	45419	15635	2647	726	1270	1319	242	242	0	581
13	Denmark	2	IVa	0	1986	1	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0
18	NORWAY	2	IVa	18397	18397	9	350	1820	0	29479	44333	70384	44982	6190	2453	1044	1983	470	626	0	0
21	SWEDEN	2	IVa	0	769	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Denmark	3	IVa	0	12052	1	0	79	0	0	0	0	0	0	0	0	0	0	0	0	0
19	NORWAY	3	IVa	9830	9830	8	350	130	0	29587	23141	42060	16435	0	0	0	0	0	0	0	0
22	SWEDEN	3	IVa	0	712	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Denmark	4	IVa	0	9769	1	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0
20	NORWAY	4	IVa	7512	7512	3	200	300	21971	7979	21558	27270	4210	306	139	0	0	0	0	0	0

Record No	Country	Quarter	Area	Sampled Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7	CW 8	CW 9	CW 10	CW 11	CW 12
Blue whiting	0	15	1999																		
1	NORWAY	1	IIa	171	171	6	200	1323	0.000	0.043	0.072	0.092	0.129	0.184	0.215	0.211	0.217	0.270	0.270	0.000	0.327
2	NORWAY	2	IIa	777	777	12	350	2010	0.000	0.047	0.066	0.090	0.114	0.170	0.201	0.218	0.248	0.243	0.331	0.000	0.000
3	NORWAY	3	IIa	124	124	14	350	1055	0.000	0.064	0.082	0.097	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	NORWAY	4	IIa	1038	1038	3	200	300	0.034	0.083	0.099	0.118	0.155	0.212	0.236	0.000	0.000	0.000	0.000	0.000	0.000
8	SWEDEN	1	IIIa	0	277	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	Denmark	2	IIIa	0	173	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	SWEDEN	2	IIIa	0	1118	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	Denmark	3	IIIa	0	2519	2	0	73	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	SWEDEN	3	IIIa	0	9159	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Denmark	4	IIIa	0	1204	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	SWEDEN	4	IIIa	0	958	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	Denmark	1	IVa	0	17310	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	Faroe Islar	1	IVa	0	265	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	NORWAY	1	IVa	10489	10489	4	200	763	0.000	0.043	0.072	0.092	0.129	0.184	0.215	0.211	0.217	0.270	0.270	0.000	0.327
13	Denmark	2	IVa	0	1986	1	0	42	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	NORWAY	2	IVa	18397	18397	9	350	1820	0.000	0.047	0.066	0.090	0.114	0.170	0.201	0.218	0.248	0.243	0.331	0.000	0.000
21	SWEDEN	2	IVa	0	769	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	Denmark	3	IVa	0	12052	1	0	79	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	NORWAY	3	IVa	9830	9830	8	350	130	0.000	0.064	0.082	0.097	0.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	SWEDEN	3	IVa	0	712	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	Denmark	4	IVa	0	9769	1	0	46	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	NORWAY	4	IVa	7512	7512	3	200	300	0.034	0.083	0.099	0.118	0.155	0.212	0.236	0.000	0.000	0.000	0.000	0.000	0.000

Table 6.3.2.7 BLUE WHITING Disaggregated Fisheries Assessment Data from Southern Fisheries

Record No	Country	Quarter	Area	Sampled Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12
Blue whitir	0	15	1999																		
1	Portugal	1	IXa	1075	1075	69	739	7337	0	16821	4951	2941	410	77	0	0	0	0	0	0	0
2	Portugal	2	IXa	242	242	21	340	1817	0	1798	1108	371	33	8	0	0	0	0	0	0	0
3	Portugal	3	IXa	949	949	66	528	6500	1436	8446	1815	131	56	3	1	0	0	0	0	0	0
4	Portugal	4	IXa	359	359	53	615	5415	5209	3086	241	36	53	0	0	0	0	0	0	0	0
5	Spain	1	VIIIc+IXa	6729	6729	86	273	7395	0	11751	27510	30506	14877	10841	6299	1222	478	584	32	0	0
6	Spain	2	VIIIc+IXa	7175	7175	88	89	8172	0	3564	26255	39386	22435	14949	4310	589	104	573	13	0	0
7	Spain	3	VIIIc+IXa	5243	5243	86	109	7089	940	3316	10813	32844	11267	6913	1292	1179	229	20	0	0	0
8	Spain	4	VIIIc+IXa	4630	4630	90	341	7263	10167	7996	9564	24190	8263	2472	3524	373	2	8	1	0	0

Record No	Country	Quarter	Area	Sampled Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7	CW 8	CW 9	CW 10	CW 11	CW 12
Blue whitir	0	15	1999																		
1	Portugal	1	IXa	1075	1075	69	739	7337	0.000	0.043	0.047	0.044	0.047	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Portugal	2	IXa	242	242	21	340	1817	0.000	0.053	0.078	0.081	0.086	0.098	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	Portugal	3	IXa	949	949	66	528	6500	0.036	0.078	0.081	0.096	0.089	0.119	0.133	0.387	0.000	0.285	0.000	0.000	0.000
4	Portugal	4	IXa	359	359	53	615	5415	0.037	0.045	0.072	0.090	0.104	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	Spain	1	VIIIc+IXa	6729	6729	86	273	7395	0.000	0.038	0.048	0.056	0.069	0.085	0.124	0.123	0.144	0.108	0.328	0.000	0.000
6	Spain	2	VIIIc+IXa	7175	7175	88	89	8172	0.000	0.042	0.057	0.059	0.066	0.072	0.100	0.108	0.134	0.099	0.309	0.000	0.000
7	Spain	3	VIIIc+IXa	5243	5243	86	109	7089	0.038	0.042	0.065	0.072	0.087	0.096	0.114	0.111	0.132	0.267	0.000	0.000	0.000
8	Spain	4	VIIIc+IXa	4630	4630	90	341	7263	0.034	0.039	0.062	0.075	0.093	0.106	0.123	0.100	0.310	0.257	0.322	0.000	0.000

Table 6.3.2.8 BLUE WHITING. Allocations files in the directed fisheries and in the mixed industrial fisheries

DIRECTED FISHERIES

Record	no. samples	type	alloc
1	2	C	47,61
2	3	C	12,52,68
3	1	C	55
4	1	C	15
5	1	C	15
6	2	C	56,70
7	3	C	16,58,74
8	1	C	59
9	1	C	60
10	1	C	26
11	1	C	27
17	3	C	16,58,74
18	1	C	60
19	1	C	60
20	1	C	54
21	1	C	55
25	1	C	26
31	1	C	55
32	2	C	56,70
33	2	C	57,71
36	3	C	22,48,62
37	2	C	50,66
38	1	C	55
39	2	C	57,71
40	3	C	16,58,74
41	3	C	16,58,74
42	1	C	59
43	1	C	60
44	1	C	60
45	1	C	60
46	1	C	60
75	1	C	60
76	1	C	50
77	2	C	51,67
78	3	C	12,52,68
79	4	C	13,30,53,69
80	1	C	54
81	1	C	55
82	2	C	56,70
83	2	C	57,71
84	3	C	16,58,74
85	1	C	60

MIXED INDUSTRIAL FISHERIES

Record	no. samples	type	alloc
8	1	C	17
5	1	C	18
9	1	C	18
6	1	C	19
10	1	C	19
7	1	C	20
11	1	C	20
12	1	C	17
16	1	C	17
13	1	C	18
21	1	C	18
14	1	C	19
22	1	C	19
15	1	C	20

Table 6.3.3.1 Blue Whiting. Mean weights at age for the total catch 1982-1999.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.018	0.020	0.026	0.016	0.030	0.023	0.031	0.014	0.034	0.036	0.024	0.028	0.033	0.022	0.018	0.031	0.033	0.035
1	0.045	0.046	0.035	0.038	0.040	0.048	0.053	0.059	0.045	0.055	0.057	0.066	0.061	0.064	0.041	0.047	0.048	0.063
2	0.072	0.074	0.078	0.074	0.073	0.086	0.076	0.079	0.070	0.091	0.083	0.082	0.087	0.091	0.080	0.072	0.071	0.078
3	0.111	0.118	0.089	0.097	0.108	0.106	0.097	0.103	0.136	0.107	0.119	0.109	0.108	0.118	0.102	0.102	0.094	0.088
4	0.143	0.140	0.132	0.114	0.130	0.124	0.128	0.126	0.123	0.136	0.140	0.137	0.137	0.143	0.116	0.121	0.125	0.109
5	0.156	0.153	0.153	0.157	0.165	0.147	0.142	0.148	0.147	0.174	0.167	0.163	0.164	0.154	0.147	0.140	0.148	0.142
6	0.177	0.176	0.161	0.177	0.199	0.177	0.157	0.158	0.138	0.190	0.193	0.177	0.189	0.167	0.170	0.166	0.178	0.17
7	0.195	0.195	0.175	0.199	0.209	0.208	0.179	0.171	0.175	0.206	0.226	0.200	0.207	0.203	0.214	0.177	0.183	0.199
8	0.200	0.200	0.189	0.208	0.243	0.221	0.199	0.203	0.214	0.230	0.235	0.217	0.217	0.206	0.230	0.183	0.188	0.193
9	0.204	0.204	0.186	0.218	0.246	0.222	0.222	0.224	0.217	0.232	0.284	0.225	0.247	0.236	0.238	0.203	0.221	0.192
10+	0.231	0.228	0.206	0.237	0.257	0.254	0.260	0.253	0.256	0.266	0.294	0.281	0.254	0.256	0.279	0.232	0.248	0.253

Table 6.4.1.1.1. BLUE WHITING Biomass estimate (million tonnes) in the spawning area.

Year	Russia total	Russia spawning	Norway total	Norway spawning	Faroes total	Faroes spawnng	Combined total	Combined spawning
1983	3.6	3.6	4.7	4.4				
1984	3.4	2.7	2.8	2.1	2.4	2.2		
1985	2.8	2.7			6.4	1.7		
1986	6.4	5.6	2.6	2.0				
1987	5.4	5.1	4.3	4.1				
1988	3.7	3.1	7.1	6.8				
1989	6.3	5.7	7.0	6.1				
1990	5.4	5.1	6.3	5.7				
1991	4.6	4.2	5.1	4.8			4.7	4.4
1992	3.6	3.3	4.3	4.2			4.6	4.3
1993	3.8	3.7	5.2	5.0			5.1	4.9
1994			4.1	4.1				
1995	6.8	6.0	6.7	6.1			6.9	6.1
1996	7.1	5.8	5.1	4.5				
1997								
1998			5.5	4.7				
1999			8.9	8.5				
2000			8.3	7.8				
Mean	4.8	4.4	5.5	5.0	4.4	2.0	5.3	4.9

* with calibration factor 1.38

Table 6.4.1.2.1. Age stratified estimates of blue whiting in the Icelandic EEZ, R.V. Árni Fridriksson, July 1999. Numbers in millions, weight in thousand tonnes, length in cm, mean weight in grams

Age	0	1	2	3	4	5	6	7	8	9	10	Total
Numbers	14869	2100	1357	1772	5790	1344	316	50	15	33	9	2765
Percentage	53.8	7.6	4.9	6.4	20.9	4.9	1.1	0.2	0.1	0.1	0.0	100
Mean length	14	24	26	26	28	29	30	34	36	37	38	20
Weight	265	163	127	201	764	212	55	13	4	10	3	1817
Mean weight	18	77	94	113	132	158	174	254	248	307	380	66

Table 6.4.1.2.2. Age stratified estimates of blue whiting in the Norwegian Sea, R.V. G.O.Sars, July 1999. Numbers in millions, weight in thousand tonnes, length in cm, mean weight in grams

Age	0	1	2	3	4	5	6	7	8	9	10	Total
Numbers	185	12267	8393	21929	3964	389	150	29	33	58	25	47422
Percentage	0.4	25.9	17.7	46.1	8.4	0.8	0.3	0.1	0.1	0.1	0.1	100
Mean length	17	22.1	25	26	28	31	32	33	36	35	37	25
Weight	6	723.4	723	2185	473	58	26	5	8	14	7	4228
Mean weight	32	59.0	86	100	119	150	174	187	245	235	259	89

Table 6.4.2.1 Stratified mean catch (Kg/haul and Number/haul) and standard error of BLUE WHITING in bottom trawl surveys in Spanish waters (Divisions VIIIc and IXa north). All surveys in September-October.

Kg/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	9.50	5.87	119.75	45.99	68.18	13.79	92.83	28.24
1986	9.74	7.13	45.41	12.37	29.54	8.70	36.93	7.95
1987	-	-	-	-	-	-	-	-
1988	2.90	2.59	154.12	38.69	183.07	141.94	143.30	45.84
1989	14.17	12.03	76.92	17.08	18.79	6.23	59.00	11.68
1990	6.25	3.29	52.54	9.00	18.80	4.99	43.60	6.60
1991	64.59	34.65	126.41	26.06	46.07	18.99	97.10	17.16
1992	6.37	2.59	44.12	6.64	29.50	6.16	34.60	4.23
1993	1.06	0.63	14.07	3.73	51.08	22.02	22.59	6.44
1994	8.04	5.28	37.18	8.45	25.42	5.27	29.70	5.19
1995	19.97	13.87	36.43	4.82	15.97	4.10	28.52	3.66
1996	7.27	3.95	49.23	7.19	92.54	17.76	54.52	6.36
1997	7.60	4.44	44.21	10.61	60.18	17.54	44.01	8.00
1998	5.29	1.92	41.09	7.64	73.80	24.06	44.48	7.82
1999	31.41	7.28	108.46	17.24	150.24	39.53	108.12	14.62

Number/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	267	181.71	3669	1578.86	1377	262.98	2644	963.20
1986	368	237.56	2486	1006.67	752	238.87	1763	616.40
1987	-	-	-	-	-	-	-	-
1988	83	71.74	6112	1847.36	7276	6339.88	5694	2086.00
1989	629	537.29	3197	876.75	566	213.11	2412	599.00
1990	220	115.48	2219	426.46	578	185.43	1722	276.00
1991	2922	1645.73	5563	1184.69	1789	847.33	4214	780.88
1992	124	50.81	1412	233.99	845	199.12	1069	146.87
1993	14	8.61	257	69.61	894	427.77	401	124.53
1994	346	234.12	2002	456.50	997	245.91	1487	689.00
1995	1291	864.97	2004	341.48	485	137.81	1493	240.37
1996	147	82.71	1167	167.20	2097	385.23	1263	142.30
1997	224	121.69	1425	359.12	1254	330.37	1228	234.50
1998	123	44.12	1442	334.24	1823	592.92	1347	251.37
1999	795	218.58	3996	697.66	5279	1521.62	3861	576.10

Table 6.4.2.2 BLUE WHITING. Stratified mean catch (Kg/haul) and standard error of in bottom trawl surveys in Portuguese waters (Division IXa).

		20-100 m		100-200 m		200-500 m		500-750 m		TOTAL: 20-500 m		TOTAL: 20-750 m	
Year	Month	y	sy	y	sy	y	sy	y	sy	y	sy	y	sy
1979	June	0	0	33	23	86	35	-	-	31	12	-	-
	Oct./Nov.	5	5	17	8	103	48	-	-	28	9	-	-
1980	March	0	0	178	173	5	1	-	-	72	69	-	-
	May/June	1	3	4	2	45	18	-	-	11	4	-	-
	October	4	3	10	4	587	306	-	-	117	58	-	-
1981	March	0	0	24	17	186	113	-	-	42	22	-	-
	June	0	0	4	2	178	25	-	-	34	4	-	-
1982	April/May	0	0	3	3	136	39	-	-	26	7	-	-
	September	1	1	85	42	271	123	-	-	86	29	-	-
1983	March	1	1	14	10	259	96	-	-	54	18	-	-
	June	0	0	23	8	177	47	-	-	42	9	-	-
1985	June	0	0	194	146	405	162	-	-	159	68	-	-
	October	4	3	133	84	341	39	-	-	120	35	-	-
1986	June	4	1	59	19	196	31	-	-	65	10	-	-
	October	2	1	357	144	650	111	-	-	276	63	-	-
1987	October	3	0	297	64	747	229	-	-	263	50	-	-
1988	October	4	2	165	47	457	106	-	-	155	28	-	-
1989	July	0	0	42	21	323	143	79	36	-	-	78	24
	October	7	4	70	26	306	84	24	2	-	-	79	16
1990	July	2	2	153	103	242	42	50	5	-	-	96	35
	October	11	5	90	28	762	234	42	10	-	-	153	35
1991	July	1	1	140	40	268	38	64	18	-	-	98	15
	October	8	5	83	18	259	53	121	27	-	-	91	11
1992	February	7	7	43	35	249	21	73	3			68	12
	July	1	1	29	18	216	43	27	5	-	-	47	9
	October	1	1	22	7	208	44	80	3	-	-	54	7
1993	February	0	0	19	14	105	31	36	0	-	-	42	10
	July	0	0	3	3	151	28	55	5	-	-	34	4
	November	0	0	90	0	189	43	6	1	-	-	86	9
1994	October	0	0	374	30	283	32	49	7	-	-	174	11
1995	July	0	0	18	14	130	20	52	3	-	-	35	5
	October	18	15	103	21	328	91	31	12	-	-	94	16
1996	October	25	24	12	2	36	6	25	7			22	8
1997	June	0	0	3	3	116	42	45	12	-	-	27	7
	October	2	1	54	20	77	13	7	2	-	-	32	8
1998	July	0	0	8	5	105	17	38	3	-	-	25	3
	October	1	1	384	87	427	101	20	2	-	-	212	36
	July	1		60		66		25		-	-	37	n/a
	October	0		70		78		18		-	-	41	n/a

Table 6.4.4.1 Tuning data for the blue whiting assessment with input values framed.

Table 6.4.4.1. Tuning data for the blue whiting assessment

BLUE WHITING-COMBINED

107

Norway Spawning Acoustic 1981-90

1981	1990								
1	1	0.17	0.25						
2	10								
1	2372	7583	3253	3647	4611	4638	3654	2591	1785
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	297	2108	2723	6511	3735	3650	3153	2279	1182
1	15767	1721	1616	1719	1858	1128	567	440	348
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	1003	5829	4122	624	228	203	250	137	170
1	4960	8417	22589	4735	282	417	385	159	27
1	9712	9090	12367	20392	7355	723	599	326	398
1	6787	22270	9973	10504	7803	933	293	177	46
1	14169	12670	11228	5587	6556	3273	516	183	108

Norway Spawning Acoustic 1991-2000

1991	2000								
1	1	0.17	0.25						
2	10								
1	11147	6340	8497	7407	4558	2019	545	96	16
1	1232	26123	4719	1574	1386	810	616	257	19
1	4489	3321	26771	2643	1270	557	426	108	22
1	1603	2950	4476	11354	1742	1687	908	770	207
1	8538	9874	7906	6861	9467	1795	1083	482	149
1	8781	7433	8371	2399	4455	4111	1202	459	162
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	18218	34991	4697	1674	279	407	381	351	86
1	19034	60309	26103	1481	316	72	153	141	0
1	8613	31011	41382	6843	898	427	228	139	115

Russian spawning acoustic 1982-91

1982	1991							
1	1	0.17	0.25					
3	10							
1	540	2750	1340	1380	1570	2350	1730	1290
1	2330	2930	9390	3880	1970	1370	780	660
1	2900	800	1100	4200	2200	1200	1700	1200
1	13220	930	580	1780	860	610	580	540
1	18750	23180	2540	610	620	750	640	710
1	4480	19170	5660	1070	500	810	860	670
1	3710	4550	8610	4130	1270	480	250	260
1	11910	7120	6670	6970	4580	2750	1880	810
1	9740	12140	5740	2580	1470	220	80	10
1	10300	5350	5130	2630	1770	870	300	220

Russian spawning acoustic 1992-96

1992	1996							
1	1	0.17	0.25					
3	10							
1	20010	6700	1350	440	390	170	0	0
1	4728	12337	5304	2249	1316	621	386	150
1	-1	-1	-1	-1	-1	-1	-1	-1
1	12657	10028	8942	2651	1093	408	131	14
1	15285	10629	4697	6940	1482	653	85	0

CPUE Spanish Pair Trawlers

1983	1999					
1	1	0	1			
1	6					
1	7196	16392	9311	7476	6326	1718
1	13710	27286	14645	4836	1755	1750
1	14573	23823	14126	6256	1232	217
1	3721	14131	14745	7113	1278	505
1	25328	13153	6664	2938	1029	166
1	7778	21473	18436	6391	1300	781
1	15272	18486	17160	8374	3760	1003
1	21444	19407	5194	1803	1357	451
1	15924	15370	4989	2329	1045	440
1	10007	24235	9671	4316	1194	462
1	4036	13991	22493	7979	1354	658
1	543	6066	15917	7474	2990	1055
1	9090	14409	6633	4551	1990	623
1	3905	14557	14449	3931	3639	1834
1	8742	15875	11134	3698	1046	450
1	5884	13236	9603	10844	5229	1153
1	2048	10268	20242	9833	6287	3047

Norwegian Sea acoustic 1981-90

1981	1990											
1	1	0.6	0.75									
0	11											
1	0	182	728	4542	3874	2678	2834	2964	2756	2054	1300	1092
1	3680	184	460	1242	4715	3611	3128	2323	1679	874	414	253
1	8280	22356	396	468	756	1404	576	468	432	324	216	108
1	1862	30380	13916	833	392	539	539	343	49	49	49	49
1	2256	5969	23876	12502	658	423	188	235	141	376	141	47
1	5040	2324	2380	7224	6944	1876	952	336	308	140	196	56
1	3192	8204	4032	5180	5572	1204	224	168	56	84	28	28
1	8760	4992	2880	2640	3480	912	120	96	24	48	-1	0
1	20430	1172	1125	812	379	410	212	22	32	-1	8	1
1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

Norwegian Sea acoustic 1991-99

1991	1999											
1	1	0.6	0.75									
0	11											
1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0
1	0	792	1134	6939	766	247	172	90	11	18	1	3
1	0	830	125	1070	6392	1222	489	248	58	88	71	0
1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0
1	0	6974	2811	1999	1209	1622	775	173	61	1	15	0
1	0	23464	1057	899	649	436	505	755	69	41	50	0
1	0	30227	25638	1524	779	300	407	260	137	123	105	0
1	0	24244	47815	16282	556	212	100	64	10	255	27	0
1	0	14367	9750	23701	9754	1733	466	79	48	91	34	0

Spanish Survey (Bottom trawl)

1985	1998							
1	1	0.67	0.75					
0	7							
1	1748.4	508.3	266.4	104	11.4	3.5	1	0.5
1	1572.8	26.7	67.5	63.2	28.7	2	2.6	0.2
1	-1	-1	-1	-1	-1	-1	-1	-1
1	4979.6	368.7	344.9	37.3	7.2	3	5	0.3
1	1923.3	163	51.2	28.6	3.8	2.8	0.7	0.2
1	1525	74.9	46.1	10.7	10.4	2.4	0.1	0.5
1	4003.2	95.2	49.6	24.5	17.9	5.1	1.5	0.8
1	299.8	428.2	233.3	77	20.4	6.9	2.3	0.9
1	115.7	107.5	150.8	19.4	5.5	1.6	0.2	0.2
1	1415.4	30.9	4.8	16	13.5	5.1	0.9	0.3
1	1309	58.5	93.1	17.3	10.2	4.4	0.6	0.2
1	271	257.9	599.1	116.1	12	4.4	2.3	0.3
1	508.8	564.5	106.3	10.2	3.6	0.4	0.1	0.1
1	568.1	351.6	352.0	86.9	22.8	5.4	0.1	0.0

Portuguese Survey (Bottom trawl)

1985	1997					
1	1	0.75	0.83			
0	5					
1	719	1467	306	129	18	6
1	-1	-1	-1	-1	-1	-1
1	4757	1190	366	110	26	19
1	4018	158	218	27	3	4
1	835	690	318	143	45	41
1	1935	519	270	262	271	87
1	1445	144	154	169	124	55
1	109	164	120	200	147	59
1	43	134	431	127	59	23
1	2677	1595	12	34	59	31
1	2405	200	342	79	57	42
1	251	72	96	15	3	6
1	2428	3235	770	27	9	1
1	4143	1201	14	11	2	2

Table 6.4.4.2 Blue Whiting

Comparison of ICA Runs	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**
No of years for separable constraint	5	6	4	5	6	4	4
Reference age for separable constraint	5	5	5	5	5	5	5
Constant selection pattern model (y/n)	Y	Y	Y	Y	Y	Y	Y
S to be fixed on last age	1.5	1.5	1.5	1.5	1.5	1.5	1.5
First and Last ages for calculation of reference F	3-7	3-7	3-7	3-7	3-7	3-7	3-7
Use default weighting (Y/N)	N	N	N	N	N	N	N
Weight on catches of age 0	0.1	0.1	0.1	1	1	1	1
Weight on catches of age 1	0.5	0.5	0.5	1	1	1	1
Weight on catches of age 2+	1	1	1	1	1	1	1
Model for" " Survey data at ages XX and XX+ is to be A/L/P	L	L	L	L	L	L	L
Fit a stock recruit relationship (Y/N)	N	N	N	N	N	N	N
Enter lowest feasible F	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Enter highest feasible F	1	1	1	1	1	1	1
Survey weighting to be Manual or Interative (M/I)	M	M	M	M	M	M	M
Do you want to shrink the final fishing mortality (Y/N)	N	N	N	N	N	N	N
Estimate historical assessment uncertain	N	N	N	N	N	N	N
Comment: In run 7 the 0-group in the catches in 1995 is downweighted by 0.01							
Diagnostics							
Range of year residuals	-1.5 to 1.5	-1.2 to 1.6	-0.90 to 0.8	-0.35 to 0.1	-0.34 to 0.22	-0.30 to 0.04	-0.3 to 2.1
Range of age residuals	-0.56 to 0.04	-0.18 to 0.08	-0.18 to 0.1	-0.57 to 0.05	-0.22 to 0.05	-0.21 to 0.08	-0.7 to 2.3
Selection pattern	smooth	smooth	satisfactory	smooth	very smooth	satisfactory	smooth
Variance							
Total for model	0.014	0.015	0.013	0.023	0.025	0.014	0.014
Catch at age	0.063	0.069	0.04	0.236	0.211	0.091	0.091
Results							
spawning stock biomass (in mill. t)	2.9	3.0	3.0	2.9	3.1	3.1	3.1
total biomass (in mill t)	5.0	5.1	5.4	4.7	5.1	5.3	5.3
F (3-7)	0.47	0.48	0.43	0.52	0.52	0.45	0.45

Table 6.4.4.3. Blue Whiting. Stock summary table

Year	Recruits Age 0 thousands	Total Biomass 000 t.	Spawning Biomass 000 t.	Landings 000 t.	Yield /SSB ratio	Mean F Ages 3-7
1981	5.57	4854	3661	910	0.25	0.23
1982	24.37	3961	2750	576	0.21	0.18
1983	24.26	3535	1846	570	0.31	0.21
1984	13.86	3417	1593	642	0.40	0.26
1985	12.32	3453	1847	696	0.38	0.32
1986	11.16	3772	2154	827	0.38	0.48
1987	9.15	3282	1827	664	0.36	0.39
1988	11.97	3006	1553	553	0.36	0.48
1989	28.80	3101	1488	625	0.42	0.50
1990	11.39	3386	1446	562	0.39	0.44
1991	7.85	3922	1921	370	0.19	0.23
1992	6.19	3971	2519	474	0.19	0.16
1993	8.03	3736	2412	481	0.20	0.18
1994	10.63	3717	2327	459	0.20	0.19
1995	35.21	4037	2068	579	0.28	0.24
1996	48.82	4487	1936	638	0.33	0.30
1997	21.89	5763	2167	634	0.29	0.29
1998	8.55	5889	2818	1125	0.40	0.44
1999	11.59	5354	3007	1256	0.42	0.43

Table 6.4.4.4 Output file from final ICA run on standalone PC (#8)

Output Generated by ICA Version 1.4

BLUE WHITING,2000 WG,ANON,COMBSEX,PLUSGR

Catch in Number

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	48.0	3512.0	437.0	584.0	1174.0	84.0	341.0	46.0	1949.0	83.0
1	258.0	148.0	2283.0	2291.0	1305.0	650.0	838.0	425.0	865.0	1611.0
2	348.0	274.0	567.0	2331.0	2044.0	816.0	578.0	721.0	718.0	703.0
3	681.0	326.0	270.0	455.0	1933.0	1862.0	728.0	614.0	1340.0	672.0
4	334.0	548.0	286.0	260.0	303.0	1717.0	1897.0	683.0	791.0	753.0
5	548.0	264.0	299.0	285.0	188.0	393.0	726.0	1303.0	837.0	520.0
6	559.0	276.0	304.0	445.0	321.0	187.0	137.0	618.0	708.0	577.0
7	466.0	266.0	287.0	262.0	257.0	201.0	105.0	84.0	139.0	299.0
8	634.0	272.0	286.0	193.0	174.0	198.0	123.0	53.0	50.0	78.0
9	578.0	284.0	225.0	154.0	93.0	174.0	103.0	33.0	25.0	27.0
10	1460.0	673.0	334.0	255.0	259.0	398.0	195.0	50.0	38.0	95.0

x 10 ^ 6

Catch in Number

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	161.1	19.0	197.7	42.0	3306.6	832.6	211.7	43.0	139.0
1	266.7	407.7	263.2	307.0	296.1	1893.5	2131.5	1656.9	788.2
2	1024.5	653.8	305.2	107.9	353.9	534.2	1519.3	4181.2	1549.1
3	514.0	1641.7	621.1	368.0	421.6	632.4	904.1	3541.2	5820.8
4	301.6	569.1	1571.2	389.3	465.4	537.3	577.7	1044.9	3460.6
5	363.2	217.4	411.4	1221.9	616.0	323.3	295.7	383.7	412.8
6	258.0	154.0	191.2	281.1	800.2	497.5	251.6	322.8	207.2
7	159.2	109.6	107.0	174.3	253.8	663.1	282.1	303.1	151.2
8	49.4	79.7	64.8	90.4	159.8	232.4	406.9	264.1	153.1
9	5.1	32.0	38.1	79.0	59.7	98.4	104.3	212.5	68.8
10	9.6	11.7	17.5	30.6	41.8	82.5	169.2	85.5	140.5

x 10 ^ 6

Predicted Catch in Number

AGE	1996	1997	1998	1999
0	407.3	177.3	104.7	139.0
1	1733.8	2581.1	1722.3	656.6
2	569.8	1590.0	3616.1	1530.0
3	658.5	870.3	3612.4	5190.7
4	532.5	594.6	1146.2	2913.4
5	342.6	245.5	406.9	466.2
6	443.4	276.3	288.4	290.4
7	686.7	310.3	277.2	171.9
8	272.5	424.5	270.8	140.4
9	89.2	103.9	234.8	84.6

x 10 ^ 6

Table 6.4.4.4 (Continued)

Weights at age in the catches (Kg)

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.03800	0.01800	0.02000	0.02600	0.01600	0.03000	0.02300	0.03100	0.01400	0.03400
1	0.05200	0.04500	0.04600	0.03500	0.03800	0.04000	0.04800	0.05300	0.05900	0.04500
2	0.06500	0.07200	0.07400	0.07800	0.07400	0.07300	0.08600	0.07600	0.07900	0.07000
3	0.10300	0.11100	0.11800	0.08900	0.09700	0.10800	0.10600	0.09700	0.10300	0.10600
4	0.12500	0.14300	0.14000	0.13200	0.11400	0.13000	0.12400	0.12800	0.12600	0.12300
5	0.14100	0.15600	0.15300	0.15300	0.15700	0.16500	0.14700	0.14200	0.14800	0.14700
6	0.15500	0.17700	0.17600	0.16100	0.17700	0.19900	0.17700	0.15700	0.15800	0.16800
7	0.17000	0.19500	0.19500	0.17500	0.19900	0.20900	0.20800	0.17900	0.17100	0.17500
8	0.17800	0.20000	0.20000	0.18900	0.20800	0.24300	0.22100	0.19900	0.20300	0.21400
9	0.18700	0.20400	0.20400	0.18600	0.21800	0.24600	0.22200	0.22200	0.22400	0.21700
10	0.21300	0.23100	0.22800	0.20600	0.23700	0.25700	0.25400	0.26000	0.25300	0.25600

Weights at age in the catches (Kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.03600	0.02400	0.02800	0.03300	0.02200	0.01800	0.03100	0.03300	0.03500
1	0.05500	0.05700	0.06600	0.06100	0.06400	0.04100	0.04700	0.04800	0.06300
2	0.09100	0.08300	0.08200	0.08700	0.09100	0.08000	0.07200	0.07200	0.07800
3	0.10700	0.11900	0.10900	0.10800	0.11800	0.10200	0.10200	0.09400	0.08800
4	0.13600	0.14000	0.13700	0.13700	0.14300	0.11600	0.12100	0.12500	0.10900
5	0.17400	0.16700	0.16300	0.16400	0.15400	0.14700	0.14000	0.14900	0.14200
6	0.19000	0.19300	0.17700	0.18900	0.16700	0.17000	0.16600	0.17800	0.17000
7	0.20600	0.22600	0.20000	0.20700	0.20300	0.21400	0.17700	0.18300	0.19900
8	0.23000	0.23500	0.21700	0.21700	0.20600	0.23000	0.18300	0.18800	0.19300
9	0.23200	0.28400	0.22500	0.24700	0.23600	0.23800	0.20300	0.22100	0.19200
10	0.26600	0.29400	0.28100	0.25400	0.25600	0.27900	0.23200	0.24800	0.24500

Weights at age in the stock (Kg)

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.03800	0.01800	0.02000	0.02600	0.01600	0.03000	0.02300	0.03100	0.01400	0.03400
1	0.05200	0.04500	0.04600	0.03500	0.03800	0.04000	0.04800	0.05300	0.05900	0.04500
2	0.06500	0.07200	0.07400	0.07800	0.07400	0.07300	0.08600	0.07600	0.07900	0.07000
3	0.10300	0.11100	0.11800	0.08900	0.09700	0.10800	0.10600	0.09700	0.10300	0.10600
4	0.12500	0.14300	0.14000	0.13200	0.11400	0.13000	0.12400	0.12800	0.12600	0.12300
5	0.14100	0.15600	0.15300	0.15300	0.15700	0.16500	0.14700	0.14200	0.14800	0.14700
6	0.15500	0.17700	0.17600	0.16100	0.17700	0.19900	0.17700	0.15700	0.15800	0.16800
7	0.17000	0.19500	0.19500	0.17500	0.19900	0.20900	0.20800	0.17900	0.17100	0.17500
8	0.17800	0.20000	0.20000	0.18900	0.20800	0.24300	0.22100	0.19900	0.20300	0.21400
9	0.18700	0.20400	0.20400	0.18600	0.21800	0.24600	0.22200	0.22200	0.22400	0.21700
10	0.21300	0.23100	0.22800	0.20600	0.23700	0.25700	0.25400	0.26000	0.25300	0.25600

Table 6.4.4.4 (Continued)

Weights at age in the stock (Kg)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.03600	0.02400	0.02800	0.03300	0.02200	0.01800	0.03100	0.03300	0.03500
1	0.05500	0.05700	0.06600	0.06100	0.06400	0.04100	0.04700	0.04800	0.06300
2	0.09100	0.08300	0.08200	0.08700	0.09100	0.08000	0.07200	0.07200	0.07800
3	0.10700	0.11900	0.10900	0.10800	0.11800	0.10200	0.10200	0.09400	0.08800
4	0.13600	0.14000	0.13700	0.13700	0.14300	0.11600	0.12100	0.12500	0.10900
5	0.17400	0.16700	0.16300	0.16400	0.15400	0.14700	0.14000	0.14900	0.14200
6	0.19000	0.19300	0.17700	0.18900	0.16700	0.17000	0.16600	0.17800	0.17000
7	0.20600	0.22600	0.20000	0.20700	0.20300	0.21400	0.17700	0.18300	0.19900
8	0.23000	0.23500	0.21700	0.21700	0.20600	0.23000	0.18300	0.18800	0.19300
9	0.23200	0.28400	0.22500	0.24700	0.23600	0.23800	0.20300	0.22100	0.19200
10	0.26600	0.29400	0.28100	0.25400	0.25600	0.27900	0.23200	0.24800	0.24500

Natural Mortality (per year)

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
1	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
2	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
3	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
4	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
5	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
6	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
7	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
8	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
9	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
10	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000

Natural Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
1	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
2	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
3	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
4	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
5	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
6	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
7	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
8	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
9	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
10	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000

Table 6.4.4.4 (Continued)

Proportion of fish spawning

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100
2	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
3	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200
4	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600
5	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100
6	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100
2	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
3	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200
4	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600
5	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100
6	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

AGE-STRUCTURED INDICES

Norway Spawning Area/Acoustic 1981-90

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	2372.	999990.	297.	15767.	999990.	1003.	4960.	9712.	6787.	14169.
3	7583.	999990.	2108.	1721.	999990.	5829.	8417.	9090.	22270.	12670.
4	3253.	999990.	2723.	1616.	999990.	4122.	22589.	12367.	9973.	11228.
5	3647.	999990.	6511.	1719.	999990.	624.	4735.	20392.	10504.	5587.
6	4611.	999990.	3735.	1858.	999990.	228.	282.	7355.	7803.	6556.
7	4638.	999990.	3650.	1128.	999990.	203.	417.	723.	933.	3273.
8	3654.	999990.	3153.	567.	999990.	250.	385.	599.	293.	516.
9	2591.	999990.	2279.	440.	999990.	137.	159.	326.	177.	183.
10	1785.	999990.	1182.	348.	999990.	170.	27.	398.	46.	108.

Table 6.4.4.4 (Continued)

Norway Spawning Area/Acoustic 1991-1999

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	11147.	1232.	4489.	1603.	8538.	8781.	999990.	18218.	19034.
3	6340.	26123.	3321.	2950.	9874.	7433.	999990.	34991.	60309.
4	8497.	4719.	26771.	4476.	7906.	8371.	999990.	4697.	26103.
5	7407.	1574.	2643.	11354.	6861.	2399.	999990.	1674.	1481.
6	4558.	1386.	1270.	1742.	9467.	4455.	999990.	279.	316.
7	2019.	810.	557.	1687.	1795.	4111.	999990.	407.	72.
8	545.	616.	426.	908.	1083.	1202.	999990.	381.	153.
9	96.	257.	108.	770.	482.	459.	999990.	351.	141.
10	16.	19.	22.	207.	149.	162.	999990.	86.	1.

Russian Spawning Area/Acoustic 1982-91

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	540.	2330.	2900.	13220.	18750.	4480.	3710.	11910.	9740.	10300.
4	2750.	2930.	800.	930.	23180.	19170.	4550.	7120.	12140.	5350.
5	1340.	9390.	1100.	580.	2540.	5860.	8610.	6670.	5740.	5130.
6	1380.	3880.	4200.	1780.	610.	1070.	4130.	6970.	2580.	2630.
7	1570.	1970.	2200.	860.	620.	500.	1270.	4580.	1470.	1770.
8	2350.	1370.	1200.	610.	750.	810.	480.	2750.	220.	870.
9	1730.	780.	1700.	580.	640.	860.	250.	1880.	80.	300.
10	1290.	660.	1200.	540.	710.	670.	260.	810.	10.	220.

Russian Spawning Area/Acoustic 1992-99

AGE	1992	1993	1994	1995	1996	1997	1998	1999
3	20010.	4728.	999990.	12657.	15285.	999990.	999990.	999990.
4	6700.	12337.	999990.	10028.	10629.	999990.	999990.	999990.
5	1350.	5304.	999990.	8942.	4897.	999990.	999990.	999990.
6	440.	2249.	999990.	2651.	6940.	999990.	999990.	999990.
7	390.	1316.	999990.	1093.	1482.	999990.	999990.	999990.
8	170.	621.	999990.	408.	653.	999990.	999990.	999990.
9	999990.	386.	999990.	131.	85.	999990.	999990.	999990.
10	999990.	150.	999990.	14.	999990.	999990.	999990.	999990.

CPUE Spanish Pair Trawlers

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	7196.	13710.	14573.	3721.	25328.	7778.	15272.	21444.	15924.	10007.
2	16392.	27286.	23823.	14131.	13153.	21473.	18486.	19407.	15370.	24235.
3	9311.	14845.	14126.	14745.	6664.	18436.	17160.	5194.	4989.	9671.
4	7476.	4836.	6256.	7113.	2938.	6391.	8374.	1803.	2329.	4316.
5	6326.	1755.	1232.	1278.	1029.	1300.	3760.	1357.	1045.	1194.
6	1718.	1750.	217.	505.	166.	781.	1003.	451.	440.	462.

Table 6.4.4.4 (Continued)

CPUE Spanish Pair Trawlers

AGE	1993	1994	1995	1996	1997	1998	1999
1	4036.	543.	9090.	3905.	8742.	5884.	2048.
2	13991.	6066.	14409.	14557.	15875.	13236.	10268.
3	22493.	15917.	6833.	14449.	11134.	9803.	20242.
4	7979.	7474.	4551.	3931.	3698.	10844.	9833.
5	1354.	2990.	1990.	3639.	1046.	5229.	6287.
6	658.	1055.	623.	1834.	450.	1153.	3047.

Table 6.4.4.4 (Continued)

Norwegian Sea acoustic - 1981-90

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	182.	184.	22356.	30380.	5969.	2324.	8204.	4992.	1172.	999990.
2	728.	460.	396.	13916.	23876.	2380.	4032.	2880.	1125.	999990.
3	4542.	1242.	468.	833.	12502.	7224.	5180.	2640.	812.	999990.
4	3874.	4715.	756.	392.	658.	6944.	5572.	3480.	379.	999990.
5	2678.	3611.	1404.	539.	423.	1876.	1204.	912.	410.	999990.
6	2834.	3128.	576.	539.	188.	952.	224.	120.	212.	999990.
7	2964.	2323.	468.	343.	235.	336.	168.	96.	22.	999990.
8	2756.	1679.	432.	49.	141.	308.	56.	24.	32.	999990.
9	2054.	874.	324.	49.	376.	140.	84.	48.	999990.	999990.
10	1300.	414.	216.	49.	141.	196.	28.	999990.	8.	999990.

Norwegian Sea acoustic - 1991-99

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	999990.	792.	830.	999990.	6974.	23464.	30227.	24244.	14367.
2	999990.	1134.	125.	999990.	2811.	1057.	25638.	47815.	9750.
3	999990.	6939.	1070.	999990.	1999.	899.	1524.	16282.	23701.
4	999990.	766.	6392.	999990.	1209.	649.	779.	556.	9754.
5	999990.	247.	1222.	999990.	1622.	436.	300.	212.	1733.
6	999990.	172.	489.	999990.	775.	505.	407.	100.	466.
7	999990.	90.	248.	999990.	173.	755.	260.	64.	79.
8	999990.	11.	58.	999990.	61.	69.	137.	10.	48.
9	999990.	18.	88.	999990.	1.	41.	123.	255.	91.
10	999990.	1.	71.	999990.	15.	50.	105.	27.	34.

Fishing Mortality (per year)

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.0096	0.1727	0.0201	0.0476	0.1109	0.0083	0.0420	0.0042	0.0775	0.0081
1	0.0831	0.0368	0.1621	0.1387	0.1424	0.0827	0.1075	0.0675	0.1027	0.0848
2	0.0994	0.1191	0.1923	0.2474	0.1768	0.1244	0.0983	0.1269	0.1552	0.1136
3	0.1601	0.1273	0.1651	0.2328	0.3339	0.2420	0.1558	0.1437	0.3651	0.2129
4	0.1125	0.1871	0.1571	0.2368	0.2398	0.5595	0.4151	0.2144	0.2779	0.3603
5	0.2815	0.1220	0.1476	0.2317	0.2690	0.5569	0.4905	0.5632	0.4409	0.2973
6	0.3119	0.2233	0.2013	0.3399	0.4424	0.4679	0.3830	1.0567	0.6948	0.6258
7	0.2899	0.2395	0.3813	0.2672	0.3362	0.5529	0.5257	0.4296	0.7304	0.7283
8	0.3268	0.2742	0.4372	0.4790	0.2855	0.4704	0.7978	0.5554	0.4939	1.3121
9	0.3051	0.2380	0.3830	0.4473	0.4492	0.5143	0.4805	0.5139	0.5583	0.5464
10	0.3051	0.2380	0.3830	0.4473	0.4492	0.5143	0.4805	0.5139	0.5583	0.5464

Table 6.4.4.4 (Continued)

Fishing Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0229	0.0034	0.0275	0.0044	0.1092	0.0092	0.0090	0.0136	0.0133
1	0.0323	0.0742	0.0591	0.0544	0.0384	0.0768	0.0745	0.1129	0.1106
2	0.0713	0.1033	0.0730	0.0310	0.0820	0.0964	0.0936	0.1419	0.1389
3	0.1136	0.1559	0.1350	0.1181	0.1623	0.2152	0.2089	0.3165	0.3099
4	0.1396	0.1774	0.2194	0.1173	0.2149	0.3164	0.3071	0.4654	0.4557
5	0.2954	0.1414	0.1879	0.2651	0.2742	0.2427	0.2356	0.3570	0.3495
6	0.2358	0.1964	0.1780	0.1894	0.2781	0.3246	0.3150	0.4774	0.4674
7	0.3486	0.1487	0.2035	0.2441	0.2609	0.4085	0.3965	0.6009	0.5883
8	0.2460	0.2947	0.1230	0.2649	0.3697	0.4933	0.4789	0.7257	0.7105
9	0.2468	0.2490	0.2238	0.2166	0.2802	0.3641	0.3534	0.5355	0.5243
10	0.2468	0.2490	0.2238	0.2166	0.2802	0.3641	0.3534	0.5355	0.5243

Population Abundance (1 January)

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	5570.	24366.	24263.	13859.	12316.	11157.	9146.	11974.	28802.	11393.
1	3565.	4517.	16786.	19470.	10820.	9025.	9059.	7180.	9762.	21823.
2	4051.	2686.	3564.	11686.	13876.	7682.	6803.	6661.	5495.	7212.
3	5064.	3003.	1952.	2408.	7471.	9520.	5554.	5048.	4804.	3852.
4	3458.	3532.	2165.	1355.	1562.	4380.	6119.	3891.	3580.	2730.
5	2453.	2530.	2399.	1514.	876.	1006.	2049.	3308.	2571.	2220.
6	2290.	1516.	1833.	1694.	984.	548.	472.	1027.	1542.	1355.
7	2033.	1373.	993.	1227.	988.	517.	281.	263.	292.	630.
8	2495.	1246.	884.	555.	769.	578.	244.	136.	140.	115.
9	2413.	1473.	775.	468.	281.	473.	295.	90.	64.	70.
10	6095.	3492.	1151.	774.	784.	1083.	559.	136.	97.	247.

x 10 ^ 6

Population Abundance (1 January)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	7854.	6194.	8026.	10630.	35213.	48819.	21887.	8552.	11590.	15975.
1	9253.	6285.	5054.	6392.	8665.	25848.	39601.	17759.	6907.	9364.
2	16414.	7335.	4778.	3900.	4957.	6827.	19599.	30094.	12987.	5063.
3	5271.	12514.	5416.	3636.	3096.	3739.	5076.	14612.	21380.	9254.
4	2549.	3852.	8767.	3874.	2645.	2155.	2468.	3372.	8717.	12840.
5	1559.	1815.	2641.	5763.	2821.	1747.	1286.	1486.	1734.	4525.
6	1350.	950.	1290.	1792.	3620.	1756.	1122.	832.	852.	1001.
7	593.	873.	639.	884.	1214.	2244.	1039.	670.	422.	437.
8	249.	343.	616.	427.	567.	766.	1221.	572.	301.	192.
9	25.	159.	209.	446.	268.	321.	383.	619.	227.	121.
10	48.	58.	96.	173.	188.	297.	624.	226.	377.	292.

x 10 ^ 6

Table 6.4.4.4 (Continued)

Weighting factors for the catches in number

AGE	1996	1997	1998	1999
0	0.1000	0.1000	0.1000	0.1000
1	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Predicted Age-Structured Index Values

Norway Spawning Area/Acoustic 1981-90 Predicted

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	2543.	999990.	2194.	7111.	999990.	4797.	4271.	4157.	3409.	4513.
3	7816.	999990.	3010.	3660.	999990.	14443.	8581.	7819.	7103.	5880.
4	6870.	999990.	4260.	2623.	999990.	7922.	11408.	7568.	6870.	5149.
5	5323.	999990.	5353.	3321.	999990.	2060.	4255.	6764.	5395.	4800.
6	4623.	999990.	3788.	3401.	999990.	1070.	939.	1774.	2872.	2560.
7	4127.	999990.	1977.	2503.	999990.	994.	543.	519.	541.	1167.
8	4964.	999990.	1719.	1069.	999990.	1115.	439.	258.	270.	187.
9	3423.	999990.	1082.	644.	999990.	643.	404.	122.	86.	95.
10	2515.	999990.	467.	310.	999990.	428.	222.	54.	38.	97.

Norway Spawning Area/Acoustic 1991-1999 Predicted

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	12157.	5396.	3537.	2913.	3663.	5030.	999990.	21961.	9483.
3	8821.	20757.	9022.	6079.	5128.	6125.	999990.	23432.	34334.
4	5939.	8904.	20086.	9069.	6067.	4837.	999990.	7337.	19006.
5	2332.	2804.	4041.	8676.	4239.	2642.	999990.	2195.	2564.
6	1623.	1151.	1570.	2175.	4312.	2071.	999990.	950.	975.
7	624.	958.	693.	951.	1301.	2332.	999990.	669.	423.
8	322.	439.	818.	550.	714.	940.	999990.	669.	353.
9	32.	199.	262.	559.	332.	390.	999990.	726.	267.
10	12.	15.	24.	44.	47.	72.	999990.	53.	89.

Table 6.4.4.4 (Continued)

Russian Spawning Area/Acoustic 1982-91 Predicted

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	3689.	2380.	2894.	8789.	11418.	6783.	6181.	5615.	4648.	6495.
4	5879.	3625.	2232.	2571.	6741.	9707.	6440.	5846.	4381.	4285.
5	4844.	4568.	2834.	1626.	1758.	3632.	5773.	4604.	4097.	2878.
6	3312.	4025.	3613.	2053.	1137.	997.	1885.	3052.	2720.	2942.
7	3294.	2312.	2928.	2322.	1162.	635.	608.	633.	1365.	1391.
8	3312.	2272.	1414.	2040.	1474.	580.	341.	356.	247.	666.
9	4432.	2262.	1346.	810.	1343.	845.	255.	180.	198.	76.
10	3427.	1095.	727.	736.	1003.	522.	126.	89.	227.	47.

Russian Spawning Area/Acoustic 1992-99 Predicted

AGE	1992	1993	1994	1995	1996	1997	1998	1999
3	27606.	12000.	999990.	6820.	8146.	999990.	999990.	999990.
4	10152.	22900.	999990.	6917.	5515.	999990.	999990.	999990.
5	3523.	5077.	999990.	5325.	3319.	999990.	999990.	999990.
6	1189.	1621.	999990.	4454.	2140.	999990.	999990.	999990.
7	770.	557.	999990.	1046.	1874.	999990.	999990.	999990.
8	257.	480.	999990.	419.	551.	999990.	999990.	999990.
9	999990.	132.	999990.	167.	197.	999990.	999990.	999990.
10	999990.	33.	999990.	64.	999990.	999990.	999990.	999990.

CPUE Spanish Pair Trawlers Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	10361.	12159.	6744.	5796.	5746.	4646.	6207.	14000.	6094.	4053.
2	6485.	20684.	25442.	14460.	12973.	12523.	10185.	13649.	31727.	13952.
3	4188.	4993.	14729.	19651.	11971.	10946.	9324.	8068.	11602.	26969.
4	3702.	2227.	2563.	6126.	9199.	6468.	5764.	4218.	4398.	6522.
5	2696.	1632.	926.	921.	1940.	3020.	2495.	2315.	1627.	2046.
6	1229.	1060.	585.	321.	289.	449.	808.	735.	890.	638.

CPUE Spanish Pair Trawlers Predicted

AGE	1993	1994	1995	1996	1997	1998	1999
1	3284.	4164.	5690.	16650.	25537.	11234.	4375.
2	9227.	7692.	9530.	13031.	37462.	56152.	24269.
3	11794.	7986.	6650.	7822.	10653.	29060.	42661.
4	14534.	6760.	4395.	3403.	3917.	4944.	12842.
5	2909.	6107.	2976.	1872.	1383.	1504.	1761.
6	875.	1209.	2335.	1107.	711.	486.	500.

Table 6.4.4.4 (Continued)

Norwegian Sea acoustic - 1981-90 Predicted

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	1193.1	1559.5	5325.2	6275.1	3478.4	3021.0	2982.0	2428.1	3223.7	*******
2	1528.1	1000.1	1262.9	3989.3	4968.1	2849.6	2568.3	2466.7	1996.2	*******
3	2777.5	1683.8	1067.3	1257.4	3644.0	4940.7	3055.4	2799.9	2294.4	*******
4	2266.8	2201.8	1376.7	816.9	939.5	2123.2	3269.8	2381.3	2098.7	*******
5	1488.9	1710.0	1593.5	950.6	536.0	507.1	1080.1	1659.9	1401.3	*******
6	1118.8	786.1	965.1	812.3	440.0	240.9	219.8	303.6	581.7	*******
7	1007.9	704.1	462.7	617.9	474.5	214.8	118.8	118.9	107.7	*******
8	924.8	478.3	304.2	185.6	293.1	194.3	65.7	43.2	46.5	*******
9	1141.0	729.1	347.8	200.9	120.8	194.4	124.1	36.9	*******	*******
10	788.4	472.6	141.2	91.0	92.0	121.6	64.3	*******	10.6	*******

Norwegian Sea acoustic - 1991-99 Predicted

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	999990.	3870.	3144.	999990.	5467.	15891.	24384.	10655.	4151.
2	999990.	2517.	1673.	999990.	1725.	2353.	6769.	10060.	4350.
3	999990.	6320.	2774.	999990.	1557.	1814.	2473.	6622.	9732.
4	999990.	1604.	3548.	999990.	1074.	817.	942.	1156.	3008.
5	999990.	616.	869.	999990.	876.	554.	410.	436.	511.
6	999990.	278.	382.	999990.	1001.	471.	303.	201.	207.
7	999990.	192.	135.	999990.	248.	414.	193.	109.	69.
8	999990.	27.	55.	999990.	43.	53.	86.	34.	18.
9	999990.	25.	33.	999990.	41.	46.	55.	79.	29.
10	999990.	7.	12.	999990.	23.	35.	74.	24.	40.

Fitted Selection Pattern

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.0339	1.4147	0.1360	0.2053	0.4123	0.0150	0.0856	0.0075	0.1758	0.0271
1	0.2952	0.3015	1.0986	0.5987	0.5296	0.1485	0.2190	0.1198	0.2329	0.2853
2	0.3532	0.9761	1.3032	1.0677	0.6573	0.2233	0.2003	0.2253	0.3521	0.3819
3	0.5690	1.0431	1.1186	1.0047	1.2416	0.4346	0.3175	0.2552	0.8282	0.7162
4	0.3996	1.5329	1.0648	1.0219	0.8914	1.0048	0.8462	0.3807	0.6304	1.2118
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.1080	1.8299	1.3641	1.4667	1.6447	0.8403	0.7808	1.8763	1.5759	2.1048
7	1.0301	1.9622	2.5837	1.1531	1.2500	0.9929	1.0716	0.7629	1.6566	2.4495
8	1.1612	2.2468	2.9631	2.0673	1.0616	0.8447	1.6264	0.9862	1.1203	4.4133
9	1.0841	1.9502	2.5956	1.9303	1.6700	0.9236	0.9796	0.9125	1.2663	1.8376
10	1.0841	1.9502	2.5956	1.9303	1.6700	0.9236	0.9796	0.9125	1.2663	1.8376

Table 6.4.4.4 (Continued)

Fitted Selection Pattern

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	0.0774	0.0240	0.1466	0.0165	0.3981	0.0381	0.0381	0.0381	0.0381
1	0.1093	0.5247	0.3146	0.2051	0.1401	0.3164	0.3164	0.3164	0.3164
2	0.2412	0.7310	0.3885	0.1169	0.2989	0.3974	0.3974	0.3974	0.3974
3	0.3845	1.1028	0.7183	0.4456	0.5920	0.8867	0.8867	0.8867	0.8867
4	0.4724	1.2545	1.1678	0.4423	0.7838	1.3037	1.3037	1.3037	1.3037
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.7981	1.3895	0.9474	0.7143	1.0142	1.3372	1.3372	1.3372	1.3372
7	1.1800	1.0515	1.0831	0.9208	0.9516	1.6832	1.6832	1.6832	1.6832
8	0.8326	2.0843	0.6547	0.9992	1.3483	2.0327	2.0327	2.0327	2.0327
9	0.8355	1.7612	1.1910	0.8170	1.0220	1.5000	1.5000	1.5000	1.5000
10	0.8355	1.7612	1.1910	0.8170	1.0220	1.5000	1.5000	1.5000	1.5000

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 7	SoP (%)
1981	5569840	4854205	3661020	909556	0.2484	0.2312	98
1982	24365720	3960656	2750374	576419	0.2096	0.1799	93
1983	24262540	3535229	1846270	570072	0.3088	0.2105	101
1984	13858930	3417205	1593195	641776	0.4028	0.2617	101
1985	12316360	3452963	1846795	695596	0.3767	0.3242	99
1986	11157460	3772340	2153930	826986	0.3839	0.4759	97
1987	9145630	3282468	1827131	664434	0.3636	0.3940	100
1988	11973760	3006328	1553366	553413	0.3563	0.4815	99
1989	28802190	3100704	1488014	625433	0.4203	0.5018	95
1990	11393140	3385577	1445960	561610	0.3884	0.4449	100
1991	7853630	3921868	1921361	369525	0.1923	0.2266	99
1992	6193610	3970879	2518900	474245	0.1883	0.1639	99
1993	8025530	3735655	2412205	480672	0.1993	0.1848	99
1994	10630140	3717057	2326988	459414	0.1974	0.1868	100
1995	35212960	4037414	2067503	578693	0.2799	0.2381	100
1996	48818510	4486675	1936417	637825	0.3294	0.3015	100
1997	21886860	5763250	2166679	634206	0.2927	0.2926	98
1998	8551880	5889092	2818263	1125149	0.3992	0.4435	99
1999	11590350	5354342	3007355	1256328	0.4178	0.4342	99

No of years for separable analysis : 4
Age range in the analysis : 0 . . . 10
Year range in the analysis : 1981 . . . 1999
Number of indices of SSB : 0
Number of age-structured indices : 7

Parameters to estimate : 85
Number of observations : 553

Conventional single selection vector model to be fitted.

Table 6.4.4.4 (Continued)

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1996	0.2427	18	0.1699	0.3468	0.2023	0.2912	0.2468
2	1997	0.2356	18	0.1651	0.3361	0.1965	0.2824	0.2395
3	1998	0.3570	18	0.2481	0.5138	0.2965	0.4299	0.3632
4	1999	0.3495	22	0.2266	0.5391	0.2802	0.4360	0.3582
Separable Model: Selection (S) by age								
5	0	0.0381	60	0.0115	0.1258	0.0207	0.0701	0.0459
6	1	0.3164	30	0.1750	0.5718	0.2339	0.4279	0.3311
7	2	0.3974	23	0.2492	0.6336	0.3132	0.5042	0.4088
8	3	0.8867	22	0.5736	1.3705	0.7100	1.1073	0.9088
9	4	1.3037	20	0.8664	1.9615	1.0584	1.6058	1.3323
	5	1.0000	Fixed : Reference Age					
10	6	1.3372	20	0.8956	1.9966	1.0899	1.6407	1.3655
11	7	1.6832	19	1.1421	2.4806	1.3810	2.0515	1.7165
12	8	2.0327	18	1.4106	2.9291	1.6870	2.4492	2.0683
	9	1.5000	Fixed : Last true age					
Separable model: Populations in year 1999								
13	0	11590358	115	1209404	111076517	3658630	36717669	22532879
14	1	6907114	39	3168082	15059026	4640796	10280183	7475426
15	2	12987222	26	7689026	21936191	9939645	16969211	13460058
16	3	21380188	21	14055048	32523007	17260881	26482566	21875502
17	4	8717195	19	5937058	12799182	7165920	10604290	8886186
18	5	1733553	19	1179316	2548262	1424218	2110074	1767364
19	6	851649	18	593180	1222742	708143	1024237	866273
20	7	422440	19	286091	623771	346264	515373	430874
21	8	300952	21	195657	462912	241595	374892	308302
22	9	226753	24	139063	369738	176691	290998	233919
Separable model: Populations at age								
23	1996	320730	29	179065	574472	238227	431804	335229
24	1997	382778	25	232954	628962	297104	493159	395265
25	1998	619321	22	395056	970897	492373	778999	635831

Age-structured index catchabilities

Norway Spawning Area/Acoustic 1981-90

Linear model fitted. Slopes at age :

26	2 Q	.6684E-03	32	.4899E-03	.1742E-02	.6684E-03	.1277E-02	.9735E-03
27	3 Q	.1665E-02	32	.1220E-02	.4339E-02	.1665E-02	.3180E-02	.2425E-02
28	4 Q	.2122E-02	32	.1555E-02	.5529E-02	.2122E-02	.4053E-02	.3090E-02
29	5 Q	.2401E-02	32	.1759E-02	.6257E-02	.2401E-02	.4586E-02	.3496E-02
30	6 Q	.2248E-02	32	.1648E-02	.5859E-02	.2248E-02	.4294E-02	.3274E-02
31	7 Q	.2250E-02	32	.1649E-02	.5864E-02	.2250E-02	.4298E-02	.3277E-02
32	8 Q	.2222E-02	32	.1629E-02	.5791E-02	.2222E-02	.4245E-02	.3236E-02
33	9 Q	.1578E-02	32	.1156E-02	.4112E-02	.1578E-02	.3014E-02	.2298E-02
34	10 Q	.4588E-03	32	.3363E-03	.1196E-02	.4588E-03	.8765E-03	.6682E-03

Table 6.4.4.4 (Continued)

Norway Spawning Area/Acoustic 1991-1999

Linear model fitted. Slopes at age :

35	2	Q	.7840E-03	32	.5720E-03	.2073E-02	.7840E-03	.1512E-02	.1149E-02
36	3	Q	.1787E-02	32	.1306E-02	.4706E-02	.1787E-02	.3438E-02	.2615E-02
37	4	Q	.2502E-02	32	.1829E-02	.6581E-02	.2502E-02	.4809E-02	.3659E-02
38	5	Q	.1660E-02	32	.1213E-02	.4366E-02	.1660E-02	.3190E-02	.2427E-02
39	6	Q	.1317E-02	32	.9627E-03	.3463E-02	.1317E-02	.2531E-02	.1926E-02
40	7	Q	.1181E-02	32	.8624E-03	.3112E-02	.1181E-02	.2273E-02	.1729E-02
41	8	Q	.1420E-02	32	.1036E-02	.3759E-02	.1420E-02	.2741E-02	.2083E-02
42	9	Q	.1369E-02	33	.9951E-03	.3657E-02	.1369E-02	.2659E-02	.2016E-02
43	10	Q	.2750E-03	32	.2006E-03	.7272E-03	.2750E-03	.5305E-03	.4031E-03

Russian Spawning Area/Acoustic 1982-91

Linear model fitted. Slopes at age :

44	3	Q	.1316E-02	27	.1013E-02	.2952E-02	.1316E-02	.2272E-02	.1795E-02
45	4	Q	.1805E-02	27	.1389E-02	.4049E-02	.1805E-02	.3116E-02	.2462E-02
46	5	Q	.2049E-02	27	.1577E-02	.4595E-02	.2049E-02	.3536E-02	.2794E-02
47	6	Q	.2388E-02	27	.1838E-02	.5357E-02	.2388E-02	.4123E-02	.3257E-02
48	7	Q	.2632E-02	27	.2025E-02	.5903E-02	.2632E-02	.4542E-02	.3589E-02
49	8	Q	.2937E-02	27	.2260E-02	.6588E-02	.2937E-02	.5069E-02	.4005E-02
50	9	Q	.3297E-02	27	.2537E-02	.7396E-02	.3297E-02	.5691E-02	.4496E-02
51	10	Q	.1076E-02	27	.8279E-03	.2413E-02	.1076E-02	.1857E-02	.1467E-02

Russian Spawning Area/Acoustic 1992-99

Linear model fitted. Slopes at age :

52	3	Q	.2377E-02	43	.1569E-02	.8562E-02	.2377E-02	.5650E-02	.4025E-02
53	4	Q	.2853E-02	43	.1883E-02	.1028E-01	.2853E-02	.6781E-02	.4830E-02
54	5	Q	.2085E-02	43	.1376E-02	.7511E-02	.2085E-02	.4957E-02	.3531E-02
55	6	Q	.1361E-02	43	.8979E-03	.4901E-02	.1361E-02	.3234E-02	.2304E-02
56	7	Q	.9490E-03	43	.6259E-03	.3425E-02	.9490E-03	.2259E-02	.1608E-02
57	8	Q	.8331E-03	43	.5488E-03	.3019E-02	.8331E-03	.1988E-02	.1415E-02
58	9	Q	.6904E-03	50	.4238E-03	.3109E-02	.6904E-03	.1909E-02	.1306E-02
59	10	Q	.3776E-03	61	.2102E-03	.2299E-02	.3776E-03	.1280E-02	.8374E-03

CPUE Spanish Pair Trawlers

Linear model fitted. Slopes at age :

60	1	Q	.7397E-03	18	.6188E-03	.1283E-02	.7397E-03	.1073E-02	.9065E-03
61	2	Q	.2214E-02	18	.1855E-02	.3818E-02	.2214E-02	.3199E-02	.2707E-02
62	3	Q	.2575E-02	18	.2159E-02	.4432E-02	.2575E-02	.3716E-02	.3146E-02
63	4	Q	.2045E-02	18	.1715E-02	.3518E-02	.2045E-02	.2950E-02	.2498E-02
64	5	Q	.1337E-02	18	.1121E-02	.2300E-02	.1337E-02	.1929E-02	.1633E-02
65	6	Q	.8195E-03	18	.6872E-03	.1410E-02	.8195E-03	.1182E-02	.1001E-02

Norwegian Sea acoustic - 1981-90

Linear model fitted. Slopes at age :

66	1	Q	.4051E-03	32	.2975E-03	.1050E-02	.4051E-03	.7707E-03	.5884E-03
67	2	Q	.4617E-03	32	.3391E-03	.1196E-02	.4617E-03	.8785E-03	.6707E-03
68	3	Q	.6994E-03	32	.5136E-03	.1812E-02	.6994E-03	.1331E-02	.1016E-02
69	4	Q	.8094E-03	32	.5944E-03	.2097E-02	.8094E-03	.1540E-02	.1176E-02
70	5	Q	.8400E-03	32	.6169E-03	.2176E-02	.8400E-03	.1598E-02	.1220E-02
71	6	Q	.6902E-03	32	.5068E-03	.1788E-02	.6902E-03	.1313E-02	.1003E-02
72	7	Q	.6901E-03	32	.5068E-03	.1788E-02	.6901E-03	.1313E-02	.1002E-02
73	8	Q	.5288E-03	32	.3884E-03	.1370E-02	.5288E-03	.1006E-02	.7682E-03
74	9	Q	.6651E-03	34	.4793E-03	.1826E-02	.6651E-03	.1316E-02	.9915E-03
75	10	Q	.1819E-03	34	.1311E-03	.4994E-03	.1819E-03	.3599E-03	.2712E-03

Table 6.4.4.4 (Continued)

Norwegian Sea acoustic - 1991-99

Linear model fitted. Slopes at age :

76	1	Q	.7411E-03	37	.5151E-03	.2275E-02	.7411E-03	.1581E-02	.1163E-02
77	2	Q	.4211E-03	37	.2942E-03	.1272E-02	.4211E-03	.8885E-03	.6558E-03
78	3	Q	.6422E-03	37	.4495E-03	.1929E-02	.6422E-03	.1350E-02	.9978E-03
79	4	Q	.5372E-03	37	.3760E-03	.1614E-02	.5372E-03	.1129E-02	.8346E-03
80	5	Q	.4275E-03	37	.2994E-03	.1282E-02	.4275E-03	.8979E-03	.6637E-03
81	6	Q	.3820E-03	37	.2674E-03	.1147E-02	.3820E-03	.8031E-03	.5934E-03
82	7	Q	.2784E-03	37	.1945E-03	.8415E-03	.2784E-03	.5879E-03	.4338E-03
83	8	Q	.1110E-03	37	.7711E-04	.3408E-03	.1110E-03	.2368E-03	.1742E-03
84	9	Q	.2090E-03	38	.1445E-03	.6519E-03	.2090E-03	.4507E-03	.3304E-03
85	10	Q	.1722E-03	37	.1197E-03	.5289E-03	.1722E-03	.3676E-03	.2704E-03

Table 6.4.4.4 (Continued)

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1996	1997	1998	1999
0	0.7151	0.1774	-0.8904	0.0000
1	0.0881	-0.1914	-0.0387	0.1827
2	-0.0645	-0.0454	0.1452	0.0124
3	-0.0405	0.0381	-0.0199	0.1146
4	0.0089	-0.0289	-0.0925	0.1721
5	-0.0578	0.1858	-0.0588	-0.1217
6	0.1150	-0.0933	0.1126	-0.3380
7	-0.0350	-0.0955	0.0893	-0.1284
8	-0.1590	-0.0423	-0.0251	0.0871
9	0.0978	0.0042	-0.1000	-0.2058

AGE-STRUCTURED INDEX RESIDUALS

Norway Spawning Area/Acoustic 1981-90

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	-0.069	*******	-2.000	0.796	*******	-1.565	0.150	0.849	0.689	1.144
3	-0.030	*******	-0.356	-0.755	*******	-0.907	-0.019	0.151	1.143	0.768
4	-0.748	*******	-0.448	-0.484	*******	-0.653	0.683	0.491	0.373	0.780
5	-0.378	*******	0.196	-0.658	*******	-1.194	0.107	1.103	0.666	0.152
6	-0.003	*******	-0.014	-0.604	*******	-1.546	-1.203	1.422	0.999	0.940
7	0.117	*******	0.613	-0.797	*******	-1.588	-0.263	0.331	0.545	1.031
8	-0.306	*******	0.606	-0.635	*******	-1.495	-0.131	0.843	0.083	1.018
9	-0.279	*******	0.745	-0.381	*******	-1.546	-0.933	0.983	0.722	0.660
10	-0.343	*******	0.928	0.115	*******	-0.922	-2.109	2.002	0.191	0.110

Norway Spawning Area/Acoustic 1991-1999

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	-0.087	-1.477	0.238	-0.597	0.846	0.557	*******	-0.187	0.697
3	-0.330	0.230	-0.999	-0.723	0.655	0.194	*******	0.401	0.563
4	0.358	-0.635	0.287	-0.706	0.265	0.548	*******	-0.446	0.317
5	1.156	-0.578	-0.425	0.269	0.482	-0.097	*******	-0.271	-0.549
6	1.033	0.186	-0.212	-0.222	0.786	0.766	*******	-1.226	-1.127
7	1.174	-0.168	-0.219	0.573	0.322	0.567	*******	-0.497	-1.770
8	0.526	0.339	-0.652	0.502	0.416	0.246	*******	-0.563	-0.836
9	1.109	0.258	-0.885	0.320	0.374	0.163	*******	-0.727	-0.637
10	0.285	0.263	-0.091	1.559	1.160	0.805	*******	0.481	-4.488

Table 6.4.4.4 (Continued)

Russian Spawning Area/Acoustic 1982-91

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	-1.922	-0.021	0.002	0.408	0.496	-0.415	-0.511	0.752	0.740	0.461
4	-0.760	-0.213	-1.026	-1.017	1.235	0.680	-0.347	0.197	1.019	0.222
5	-1.285	0.721	-0.946	-1.031	0.368	0.478	0.400	0.371	0.337	0.578
6	-0.876	-0.037	0.150	-0.143	-0.623	0.070	0.785	0.826	-0.053	-0.112
7	-0.741	-0.160	-0.286	-0.993	-0.629	-0.239	0.737	1.979	0.074	0.241
8	-0.343	-0.506	-0.164	-1.207	-0.676	0.333	0.343	2.043	-0.114	0.267
9	-0.941	-1.065	0.233	-0.334	-0.742	0.018	-0.020	2.348	-0.905	1.369
10	-0.977	-0.507	0.501	-0.309	-0.345	0.250	0.724	2.207	-3.122	1.542

Russian Spawning Area/Acoustic 1992-99

Age	1992	1993	1994	1995	1996	1997	1998	1999
3	-0.322	-0.931	*******	0.618	0.629	*******	*******	*******
4	-0.416	-0.619	*******	0.371	0.656	*******	*******	*******
5	-0.959	0.044	*******	0.518	0.389	*******	*******	*******
6	-0.994	0.327	*******	-0.519	1.177	*******	*******	*******
7	-0.680	0.860	*******	0.044	-0.235	*******	*******	*******
8	-0.415	0.258	*******	-0.027	0.169	*******	*******	*******
9	*******	1.073	*******	-0.245	-0.839	*******	*******	*******
10	*******	1.511	*******	-1.522	*******	*******	*******	*******

CPUE Spanish Pair Trawlers

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	-0.364	0.120	0.770	-0.443	1.483	0.515	0.900	0.426	0.960	0.904
2	0.927	0.277	-0.066	-0.023	0.014	0.539	0.596	0.352	-0.725	0.552
3	0.799	1.090	-0.042	-0.287	-0.586	0.521	0.610	-0.440	-0.844	-1.026
4	0.703	0.775	0.892	0.149	-1.141	-0.012	0.373	-0.850	-0.636	-0.413
5	0.853	0.073	0.285	0.327	-0.634	-0.843	0.410	-0.534	-0.443	-0.539
6	0.335	0.501	-0.991	0.452	-0.554	0.553	0.216	-0.488	-0.704	-0.323

CPUE Spanish Pair Trawlers

Age	1993	1994	1995	1996	1997	1998	1999
1	0.206	-2.037	0.469	-1.450	-1.072	-0.647	-0.759
2	0.416	-0.237	0.413	0.111	-0.859	-1.445	-0.860
3	0.646	0.690	0.027	0.614	0.044	-1.087	-0.746
4	-0.600	0.100	0.035	0.144	-0.057	0.785	-0.267
5	-0.765	-0.714	-0.402	0.665	-0.279	1.246	1.273
6	-0.285	-0.136	-1.321	0.505	-0.457	0.864	1.808

Table 6.4.4.4 (Continued)

Norwegian Sea acoustic - 1981-90

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-1.880	-2.137	1.435	1.577	0.540	-0.262	1.012	0.721	-1.012	*******
2	-0.741	-0.777	-1.160	1.249	1.570	-0.180	0.451	0.155	-0.573	*******
3	0.492	-0.304	-0.824	-0.412	1.233	0.380	0.528	-0.059	-1.039	*******
4	0.536	0.761	-0.599	-0.734	-0.356	1.185	0.533	0.379	-1.712	*******
5	0.587	0.747	-0.127	-0.567	-0.237	1.308	0.109	-0.599	-1.229	*******
6	0.929	1.381	-0.516	-0.410	-0.850	1.374	0.019	-0.928	-1.009	*******
7	1.079	1.194	0.011	-0.589	-0.703	0.448	0.347	-0.214	-1.588	*******
8	1.092	1.256	0.351	-1.332	-0.732	0.461	-0.160	-0.587	-0.373	*******
9	0.588	0.181	-0.071	-1.411	1.136	-0.328	-0.391	0.263	*******	*******
10	0.500	-0.132	0.425	-0.619	0.427	0.477	-0.831	*******	-0.280	*******

Norwegian Sea acoustic - 1991-99

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	*******	-1.587	-1.332	*******	0.243	0.390	0.215	0.822	1.242
2	*******	-0.797	-2.594	*******	0.488	-0.800	1.332	1.559	0.807
3	*******	0.093	-0.953	*******	0.250	-0.702	-0.484	0.900	0.890
4	*******	-0.739	0.589	*******	0.118	-0.230	-0.190	-0.732	1.176
5	*******	-0.914	0.341	*******	0.617	-0.239	-0.311	-0.722	1.220
6	*******	-0.479	0.247	*******	-0.256	0.070	0.296	-0.699	0.810
7	*******	-0.758	0.604	*******	-0.359	0.600	0.296	-0.530	0.134
8	*******	-0.906	0.054	*******	0.354	0.260	0.469	-1.224	0.977
9	*******	-0.313	0.987	*******	-3.702	-0.111	0.804	1.175	1.141
10	*******	-2.005	1.745	*******	-0.445	0.359	0.351	0.133	-0.157

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1996 to 1999	
Variance	0.0396
Skewness test stat.	-1.7515
Kurtosis test statistic	0.3998
Partial chi-square	0.0468
Significance in fit	0.0000
Degrees of freedom	15

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Norway Spawning Area/Acoustic 1981-90

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8	9	10
Variance	0.1526	0.0546	0.0456	0.0593	0.1287	0.0808	0.0773	0.0946	0.1643
Skewness test stat.	-0.9739	0.3719	0.0421	-0.1773	-0.1346	-0.8550	-0.5325	-0.5734	-0.1347
Kurtosis test statisti	-0.4899	-0.5325	-1.0312	-0.4340	-0.7617	-0.2784	-0.3920	-0.6664	-0.1218
Partial chi-square	0.1315	0.0432	0.0365	0.0506	0.1231	0.0805	0.0852	0.1156	0.2377
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	8	8	8	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7	7	7	7
Weight in the analysis	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

Table 6.4.4.4 (Continued)

DISTRIBUTION STATISTICS FOR Norway Spawning Area/Acoustic 1991-1999

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8	9	10
Variance	0.0659	0.0417	0.0283	0.0403	0.0821	0.0887	0.0368	0.0521	0.3961
Skewness test stat.	-0.8931	-0.6655	-0.5647	0.9851	-0.3467	-0.9057	-0.5946	0.0736	-2.2103
Kurtosis test statisti	-0.1935	-0.6638	-0.8902	-0.2382	-0.7412	0.0434	-0.9098	-0.6152	1.3374
Partial chi-square	0.0541	0.0320	0.0220	0.0356	0.0795	0.0984	0.0415	0.0785	0.6392
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
Number of observations	8	8	8	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7	7	7	7
Weight in the analysis	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111	0.1111

DISTRIBUTION STATISTICS FOR Russian Spawning Area/Acoustic 1982-91

Linear catchability relationship assumed

Age	3	4	5	6	7	8	9	10
Variance	0.0814	0.0826	0.0727	0.0350	0.0919	0.0945	0.1520	0.2675
Skewness test stat.	-1.7774	0.1842	-1.0848	0.1353	1.5561	1.4686	1.3876	-0.8031
Kurtosis test statisti	0.7829	-0.8132	-0.7206	-0.3229	0.5803	0.8360	0.0570	0.2517
Partial chi-square	0.0873	0.0890	0.0811	0.0406	0.1218	0.1333	0.2503	0.4802
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	10	10	10	10	10	10	10	10
Degrees of freedom	9	9	9	9	9	9	9	9
Weight in the analysis	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250

DISTRIBUTION STATISTICS FOR Russian Spawning Area/Acoustic 1992-99

Linear catchability relationship assumed

Age	3	4	5	6	7	8	9	10
Variance	0.0729	0.0468	0.0559	0.1146	0.0524	0.0112	0.1197	0.5750
Skewness test stat.	-0.2509	0.0346	-0.7187	0.1941	0.3553	-0.5797	0.2913	-0.0062
Kurtosis test statisti	-0.6558	-0.7326	-0.3710	-0.5814	-0.4382	-0.4326	-0.5330	-0.5773
Partial chi-square	0.0237	0.0153	0.0204	0.0458	0.0243	0.0058	0.0476	0.1512
Significance in fit	0.0010	0.0005	0.0008	0.0026	0.0010	0.0001	0.0235	0.3026
Number of observations	4	4	4	4	4	4	3	2
Degrees of freedom	3	3	3	3	3	3	2	1
Weight in the analysis	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250	0.1250

DISTRIBUTION STATISTICS FOR CPUE Spanish Pair Trawlers

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.1541	0.0679	0.0819	0.0597	0.0825	0.0976
Skewness test stat.	-0.8752	-1.3083	-0.2163	-0.3008	0.8997	0.7364
Kurtosis test statisti	-0.4948	-0.2178	-1.1248	-0.7046	-0.8585	0.0785
Partial chi-square	0.2799	0.1084	0.1397	0.1128	0.1726	0.2387
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	17	17	17	17	17	17
Degrees of freedom	16	16	16	16	16	16
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR Norwegian Sea acoustic - 1981-90

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9	10
Variance	0.1947	0.0889	0.0526	0.0832	0.0611	0.0962	0.0790	0.0740	0.0571	0.0287
Skewness test stat.	-0.5390	0.6362	0.1767	-0.6861	0.2009	0.5821	-0.3421	0.1046	-0.4965	-0.5131
Kurtosis test statisti	-0.7867	-0.6237	-0.5522	-0.4045	-0.4823	-0.8742	-0.4332	-0.6527	-0.0559	-0.8057
Partial chi-square	0.2010	0.0905	0.0541	0.0881	0.0714	0.1247	0.1131	0.1060	0.0771	0.0449
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9	9	8	8
Degrees of freedom	8	8	8	8	8	8	8	8	7	7
Weight in the analysis	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

DISTRIBUTION STATISTICS FOR Norwegian Sea acoustic - 1991-99

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9	10
Variance	0.1128	0.2183	0.0551	0.0486	0.0583	0.0265	0.0303	0.0615	0.3019	0.1259
Skewness test stat.	-0.6175	-0.7044	0.0596	0.5847	0.3968	0.1491	-0.1939	-0.5957	-1.7110	-0.3768
Kurtosis test statisti	-0.6007	-0.3944	-0.7881	-0.4526	-0.5816	-0.5222	-0.8204	-0.5379	0.6001	0.0678
Partial chi-square	0.0810	0.1645	0.0398	0.0380	0.0553	0.0292	0.0348	0.1104	0.4878	0.3355
Significance in fit	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0007
Number of observations	7	7	7	7	7	7	7	7	7	7
Degrees of freedom	6	6	6	6	6	6	6	6	6	6
Weight in the analysis	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Table 6.4.4.4 (Continued)

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	365.4308	553	85	468	0.7808
Catches at age	1.8351	40	25	15	0.1223
Aged Indices					
Norway Spawning Area/Acoustic 1981-90	54.0410	72	9	63	0.8578
Norway Spawning Area/Acoustic 1991-199	52.4154	72	9	63	0.8320
Russian Spawning Area/Acoustic 1982-91	63.1883	80	8	72	0.8776
Russian Spawning Area/Acoustic 1992-99	15.0068	29	8	21	0.7146
CPUE Spanish Pair Trawlers	52.2053	102	6	96	0.5438
Norwegian Sea acoustic - 1981-90	64.3842	88	10	78	0.8254
Norwegian Sea acoustic - 1991-99	62.3546	70	10	60	1.0392

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	5.8470	553	85	468	0.0125
Catches at age	0.5934	40	25	15	0.0396
Aged Indices					
Norway Spawning Area/Acoustic 1981-90	0.6672	72	9	63	0.0106
Norway Spawning Area/Acoustic 1991-199	0.6471	72	9	63	0.0103
Russian Spawning Area/Acoustic 1982-91	0.9873	80	8	72	0.0137
Russian Spawning Area/Acoustic 1992-99	0.2345	29	8	21	0.0112
CPUE Spanish Pair Trawlers	1.4501	102	6	96	0.0151
Norwegian Sea acoustic - 1981-90	0.6438	88	10	78	0.0083
Norwegian Sea acoustic - 1991-99	0.6235	70	10	60	0.0104

Table 6.4.4.5. Blue Whiting. Log-file from final ICA run (#8)

```
                         Integrated Catch at Age Analysis
                         --------------------------------

                                 Version 1.4 w

                                 K.R.Patterson
                          Fisheries Research Services
                               Marine Laboratory
                                   Aberdeen

                                 15 April 1998

 Enter the name of the index file -->combbw.ndx
CombbwCN.DAT
CombbwCW.DAT
 Stock weights in 2000  used for the year 1999
CombbwSW.DAT
 Natural mortality in 2000  used for the year 1999
CombbwNM.DAT
 Maturity ogive in 2000  used for the year 1999
CombbwMO.DAT
 Name of age-structured index file (Enter if none) : -->combbw.tun
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 4
 Reference age for separable constraint ?--> 5
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.500000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 7
 Use default weighting (Y/N) ?-->n
Enter relative weights at age
 Weight for age 0-->    0.100000000000000
 Weight for age 1-->    0.500000000000000
 Weight for age 2-->    1.000000000000000
 Weight for age 3-->    1.000000000000000
 Weight for age 4-->    1.000000000000000
 Weight for age 5-->    1.000000000000000
 Weight for age 6-->    1.000000000000000
 Weight for age 7-->    1.000000000000000
 Weight for age 8-->    1.000000000000000
 Weight for age 9-->    1.000000000000000
 Weight for age 10-->    1.000000000000000
Enter relative weights by year
 Weight for year 1996-->    1.000000000000000
 Weight for year 1997-->    1.000000000000000
 Weight for year 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
Enter new weights for specified years and ages if needed
 Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000000000000000
 Is the last age of Norway Spawning Area/Acoustic 1981-90 a plus-group (Y/N)-->n
 Is the last age of Norway Spawning Area/Acoustic 1991-1999 a plus-group (Y/-->n
 Is the last age of Russian Spawning Area/Acoustic 1982-91 a plus-group (Y/N-->n
 Is the last age of Russian Spawning Area/Acoustic 1992-99 a plus-group (Y/N-->n
 Is the last age of CPUE Spanish Pair Trawlers a plus-group (Y/N) ?-->n
 Is the last age of Norwegian Sea acoustic - 1981-90 a plus-group (Y/N) ?-->n
 Is the last age of Norwegian Sea acoustic - 1991-99 a plus-group (Y/N) ?-->n
You must choose a catchability model for each index.
```

Table 6.4.4.5 (Continued)

```
Models:   A  Absolute:  Index = Abundance . e
          L  Linear:    Index = Q. Abundance . e
          P  Power:     Index = Q. Abundance^ K .e

   where Q and K are parameters to be estimated, and
   e is a lognormally-distributed error.

 Model for Norway Spawning Area/Acoustic 1981-90  is to be A/L/P ?-->L
 Model for Norway Spawning Area/Acoustic 1991-1999  is to be A/L/P ?-->L
 Model for Russian Spawning Area/Acoustic 1982-91  is to be A/L/P ?-->L
 Model for Russian Spawning Area/Acoustic 1992-99  is to be A/L/P ?-->L
 Model for CPUE Spanish Pair Trawlers  is to be A/L/P ?-->L
 Model for Norwegian Sea acoustic - 1981-90  is to be A/L/P ?-->L
 Model for Norwegian Sea acoustic - 1991-99  is to be A/L/P ?-->L
 Fit a stock-recruit relationship (Y/N) ?-->n
 Enter lowest feasible F-->   5.0000000000000003E-02
 Enter highest feasible F-->    1.000000000000000
Mapping the F-dimension of the SSQ surface

    F                  SSQ
+--------+------------------
    0.05        60.0189793869
    0.10        52.9551113798
    0.15        49.2286388691
    0.20        46.9989798238
    0.25        45.6288052620
    0.30        44.7879282953
    0.35        44.2859702313
    0.40        44.0080099349
    0.45        43.8824229217
    0.50        43.8633644324
    0.55        43.9207731710
    0.60        44.0344851957
    0.65        44.1907612848
    0.70        44.3800993100
    0.75        44.5959730041
    0.80        44.8338859378
    0.85        45.0910286651
    0.90        45.3659172744
    0.95        45.6583949583
    1.00        45.9698152040
Lowest SSQ is for F =     0.486
-----------------------------------------------------------------
No of years for separable analysis : 4
Age range in the analysis : 0  . . . 10
Year range in the analysis : 1981  . . . 1999
Number of indices of SSB : 0
Number of age-structured indices : 7

Parameters to estimate : 85
Number of observations : 553

Conventional single selection vector model to be fitted.



----------------------------------------------------
```

Table 6.4.4.5 (Continued)

```
Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 2-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 3-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 4-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 5-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 6-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 7-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 8-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 9-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1981-90  at age 10-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 2-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 3-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 4-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 5-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 6-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 7-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 8-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 9-->    1.000000000000000
 Enter weight for Norway Spawning Area/Acoustic 1991-1999  at age 10-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1982-91  at age 3-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1982-91  at age 4-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1982-91  at age 5-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1982-91  at age 6-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1982-91  at age 7-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1982-91  at age 8-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1982-91  at age 9-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1982-91  at age 10-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1992-99  at age 3-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1992-99  at age 4-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1992-99  at age 5-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1992-99  at age 6-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1992-99  at age 7-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1992-99  at age 8-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1992-99  at age 9-->    1.000000000000000
 Enter weight for Russian Spawning Area/Acoustic 1992-99  at age 10-->    1.000000000000000
 Enter weight for CPUE Spanish Pair Trawlers  at age 1-->    1.000000000000000
 Enter weight for CPUE Spanish Pair Trawlers  at age 2-->    1.000000000000000
 Enter weight for CPUE Spanish Pair Trawlers  at age 3-->    1.000000000000000
 Enter weight for CPUE Spanish Pair Trawlers  at age 4-->    1.000000000000000
 Enter weight for CPUE Spanish Pair Trawlers  at age 5-->    1.000000000000000
 Enter weight for CPUE Spanish Pair Trawlers  at age 6-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 1-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 2-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 3-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 4-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 5-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 6-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 7-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 8-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 9-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1981-90  at age 10-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 1-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 2-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 3-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 4-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 5-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 6-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 7-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 8-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 9-->    1.000000000000000
 Enter weight for Norwegian Sea acoustic - 1991-99  at age 10-->    1.000000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
  Enter value for Norway Spawning Area/Acoustic 1981-90-->    1.000000000000000
  Enter value for Norway Spawning Area/Acoustic 1991-1999-->    1.000000000000000
  Enter value for Russian Spawning Area/Acoustic 1982-91-->    1.000000000000000
  Enter value for Russian Spawning Area/Acoustic 1992-99-->    1.000000000000000
  Enter value for CPUE Spanish Pair Trawlers-->    1.000000000000000
  Enter value for Norwegian Sea acoustic - 1981-90-->    1.000000000000000
  Enter value for Norwegian Sea acoustic - 1991-99-->    1.000000000000000
 Do you want to shrink the final fishing mortality (Y/N) ?-->N
Seeking solution. Please wait.
```

Table 6.4.4.4 (Continued)

```
Aged index weights
Norway Spawning Area/Acoustic 1981-90
 Age   :        2     3     4     5     6     7     8     9    10
 Wts :     0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111
Norway Spawning Area/Acoustic 1991-1999
 Age   :        2     3     4     5     6     7     8     9    10
 Wts :     0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111 0.111
Russian Spawning Area/Acoustic 1982-91
 Age   :        3     4     5     6     7     8     9    10
 Wts :     0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
Russian Spawning Area/Acoustic 1992-99
 Age   :        3     4     5     6     7     8     9    10
 Wts :     0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
CPUE Spanish Pair Trawlers
 Age   :        1     2     3     4     5     6
 Wts :     0.167 0.167 0.167 0.167 0.167 0.167
Norwegian Sea acoustic - 1981-90
 Age   :        1     2     3     4     5     6     7     8     9    10
 Wts :     0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100
Norwegian Sea acoustic - 1991-99
 Age   :        1     2     3     4     5     6     7     8     9    10
 Wts :     0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100
F in 1999  at age 5  is 0.349527  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 90
 Estimate historical assessment uncertainty ?-->n
Succesful exit from ICA
```

Year	Recruits Age 0 (mln.)	Total Biomass (th.t.)	Spawning Biomass (th.t.)	Mean F Ages (3-7)
1981	12391.87	5691.73	4333.50	0.211
1982	3310.48	4418.49	3431.11	0.278
1983	15329.41	3686.85	2711.51	0.315
1984	12596.14	3000.26	2026.14	0.381
1985	17041.44	2868.19	1763.18	0.417
1986	11097.33	3173.96	1888.86	0.482
1987	16682.68	3108.75	1700.62	0.508
1988	14679.45	3088.11	1566.84	0.510
1989	23571.74	3125.63	1604.77	0.504
1990	12541.98	3373.34	1698.52	0.449
1991	11050.02	3855.58	2062.69	0.281
1992	7076.02	3788.95	2493.14	0.244
1993	6323.36	3552.61	2434.89	0.245
1994	8759.65	3424.61	2390.90	0.288
1995	55710.57	4077.19	2062.55	0.292
1996	82670.48	5372.85	1927.98	0.286
1997	23011.92	7594.79	2641.18	0.321
1998	12503.26	7976.89	4242.92	0.449
1999	2458.84	6860.35	4844.61	0.372

Table 6.4.5.1. Blue Whiting. Results of stock assessment (ISVPA on filtered catch-at-age data)

Year\age	0	1	2	3	4	5	6	7	8	9	10+
1981	12391.87	7009.62	5469.79	9016.90	7653.83	2323.88	2042.87	1851.94	1367.80	1948.50	4921.83
1982	3310.48	9754.94	5414.43	4115.33	6510.04	5289.45	1542.49	1301.63	1123.75	752.73	1783.75
1983	15329.41	2577.65	7412.19	3975.99	2862.94	4273.05	3288.03	906.66	714.82	536.41	796.27
1984	12596.14	11867.30	1941.64	5373.11	2711.33	1827.23	2562.10	1847.81	470.60	313.94	519.84
1985	17041.44	9656.18	8807.49	1376.62	3539.50	1647.55	1027.75	1328.38	865.28	176.42	491.32
1986	11097.33	12997.61	7111.28	6172.37	890.40	2095.01	895.16	509.82	587.29	295.70	676.37
1987	16682.68	8391.73	9447.75	4886.17	3868.93	503.54	1071.21	410.47	203.08	168.14	318.32
1988	14679.45	12572.50	6068.16	6440.50	3024.21	2147.75	251.11	475.36	156.42	53.70	81.36
1989	23571.74	11059.79	9087.53	4134.02	3982.17	1676.30	1068.89	111.14	180.48	41.09	62.45
1990	12541.98	17774.63	8004.62	6203.35	2564.26	2217.71	839.59	477.04	42.68	48.40	170.30
1991	11050.02	9524.95	13004.99	5554.78	3950.25	1483.92	1169.40	400.72	200.45	13.40	25.22
1992	7076.02	8600.04	7232.54	9540.40	3858.36	2587.27	919.88	685.00	219.12	95.08	34.77
1993	6323.36	5540.27	6589.36	5377.01	6763.82	2600.20	1663.38	563.64	396.13	112.67	51.75
1994	8759.65	4949.88	4243.57	4896.48	3809.32	4553.58	1669.52	1017.57	325.30	203.12	78.68
1995	55710.57	6809.72	3752.13	3105.14	3387.78	2481.28	2802.91	969.43	550.36	151.85	106.32
1996	82670.48	43284.25	5157.45	2742.00	2144.12	2200.56	1521.87	1620.32	521.41	254.82	213.64
1997	23011.92	64292.08	32829.21	3777.06	1899.62	1399.18	1357.73	886.28	879.58	244.71	396.98
1998	12503.26	17798.17	48360.67	23748.22	2567.33	1206.88	833.99	757.39	455.74	380.92	153.26
1999	2458.84	9495.51	13022.12	33559.38	15122.47	1485.66	636.37	398.03	318.23	143.08	291.94

Table 6.4.5.2. Blue Whiting stock abundance estimates (ISVPA)

Year\Age	0	1	2	3	4	5	6	7	8	9	10+	AgeSUM
1981	6.02E-01	5.31E-01	2.04E-01	-7.36E-01	-9.71E-01	1.17E-01	1.05E-01	1.80E-02	1.28E-01	-1.39E-17	-1.08E-17	1.09E-05
1982	2.22E+00	3.03E-01	1.99E-01	-1.41E-01	-1.04E+00	-1.15E+00	-1.03E-01	-9.98E-02	-2.00E-01	-6.11E-17	-6.51E-18	9.39E-06
1983	4.17E-01	1.94E+00	2.12E-01	2.48E-02	-3.12E-01	-1.13E+00	-1.08E+00	-6.01E-03	-7.35E-02	9.84E-17	1.95E-17	9.19E-06
1984	4.14E-01	3.68E-01	1.77E+00	-5.02E-02	-1.48E-01	-3.40E-01	-9.86E-01	-9.94E-01	-3.12E-02	-7.33E-17	3.04E-18	9.63E-06
1985	-5.24E-02	3.37E-01	1.98E-01	1.56E+00	-1.39E-01	-7.60E-02	-1.35E-01	-8.29E-01	-8.67E-01	6.94E-17	5.38E-17	9.66E-06
1986	-1.44E-01	-3.92E-01	5.24E-02	-4.68E-02	1.46E+00	-1.14E-01	-1.19E-02	-7.88E-02	-7.24E-01	4.21E-17	-4.60E-17	9.30E-06
1987	-7.38E-01	-1.99E-01	-5.25E-01	-6.95E-02	-2.17E-02	1.45E+00	-5.27E-02	7.94E-02	7.35E-02	-7.07E-17	-5.38E-17	9.37E-06
1988	-6.00E-01	-6.91E-01	-1.69E-01	-4.98E-01	2.18E-02	8.91E-02	1.61E+00	6.13E-02	1.71E-01	8.67E-18	4.03E-17	1.00E-05
1989	-7.25E-01	-3.69E-01	-5.28E-01	-3.56E-02	-3.60E-01	2.07E-01	1.73E-01	1.61E+00	2.72E-02	-1.34E-17	-3.62E-17	1.15E-05
1990	-3.50E-01	-7.21E-01	-3.27E-01	-4.90E-01	1.43E-02	-2.26E-01	3.30E-01	2.12E-01	1.56E+00	-4.25E-17	4.73E-17	1.22E-05
1991	-2.14E-01	-9.96E-02	-4.96E-01	-4.95E-02	-1.86E-01	3.22E-01	3.60E-02	4.66E-01	2.21E-01	-3.09E-17	6.22E-17	1.66E-05
1992	3.09E-01	-1.81E-01	4.28E-02	-3.55E-01	5.93E-02	-1.31E-01	2.45E-01	-1.60E-01	1.71E-01	-2.15E-17	-7.81E-18	1.64E-05
1993	5.04E-01	2.46E-01	-1.26E-01	-3.60E-03	-3.56E-01	5.77E-02	-1.62E-01	1.58E-01	-3.19E-01	-3.45E-17	-5.07E-17	1.53E-05
1994	4.73E-01	4.77E-01	9.33E-02	-2.74E-01	-1.54E-01	-4.68E-01	-4.26E-02	-2.19E-01	1.15E-01	-3.56E-17	3.69E-17	1.37E-05
1995	-7.47E-01	5.61E-01	5.09E-01	1.98E-01	-1.46E-01	4.55E-03	-4.05E-01	9.83E-02	-7.39E-02	9.24E-17	6.51E-17	1.25E-05
1996	-1.25E+00	-8.55E-01	7.04E-01	7.61E-01	4.77E-01	2.38E-02	1.32E-01	-2.30E-01	2.37E-01	-1.47E-17	-1.99E-17	1.06E-05
1997	-2.15E-01	-1.17E+00	-7.66E-01	9.01E-01	9.43E-01	5.42E-01	-5.44E-04	8.64E-02	-3.19E-01	7.37E-18	-1.34E-17	8.26E-06
1998	9.11E-02	-8.82E-02	-1.05E+00	-7.00E-01	8.54E-01	8.16E-01	3.41E-01	-1.74E-01	-9.32E-02	-7.11E-17	4.77E-18	5.80E-06
1999	-5.20E-18	-1.43E-17	4.55E-17	8.67E-17	5.46E-17	5.64E-18	-7.37E-17	5.42E-17	5.77E-17	-7.81E-18	-3.99E-17	1.63E-16
YearSUM:	9.86E-06	9.68E-06	8.82E-06	9.12E-06	9.30E-06	9.18E-06	9.27E-06	9.02E-06	1.27E-04	-1.73E-16	4.77E-17	

Table 6.4.5.3. Residual in lnC. (ISVPA on filterd catch-at-age data)

Table 6.5.1 Input data for the deterministic short-term prediction

09:21 Thursday, May 4, 2000
Blue whiting combined stock (Sub-areas I-IX, XII & XIV)

Prediction with management option table: Input data

Year: 2000								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	14119.000	0.2000	0.0000	0.2500	0.2500	0.033	0.0133	0.033
1	9362.000	0.2000	0.1100	0.2500	0.2500	0.053	0.1106	0.053
2	5062.000	0.2000	0.4000	0.2500	0.2500	0.074	0.1389	0.074
3	9253.000	0.2000	0.8200	0.2500	0.2500	0.095	0.3100	0.095
4	12838.000	0.2000	0.8600	0.2500	0.2500	0.118	0.4557	0.118
5	4524.000	0.2000	0.9100	0.2500	0.2500	0.144	0.3496	0.144
6	1000.000	0.2000	0.9400	0.2500	0.2500	0.171	0.4675	0.171
7	437.000	0.2000	1.0000	0.2500	0.2500	0.186	0.5884	0.186
8	192.000	0.2000	1.0000	0.2500	0.2500	0.188	0.7106	0.188
9	121.000	0.2000	1.0000	0.2500	0.2500	0.205	0.5244	0.205
10+	292.000	0.2000	1.0000	0.2500	0.2500	0.242	0.5244	0.242
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2001								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	14119.000	0.2000	0.0000	0.2500	0.2500	0.033	0.0133	0.033
1	.	0.2000	0.1100	0.2500	0.2500	0.053	0.1106	0.053
2	.	0.2000	0.4000	0.2500	0.2500	0.074	0.1389	0.074
3	.	0.2000	0.8200	0.2500	0.2500	0.095	0.3100	0.095
4	.	0.2000	0.8600	0.2500	0.2500	0.118	0.4557	0.118
5	.	0.2000	0.9100	0.2500	0.2500	0.144	0.3496	0.144
6	.	0.2000	0.9400	0.2500	0.2500	0.171	0.4675	0.171
7	.	0.2000	1.0000	0.2500	0.2500	0.186	0.5884	0.186
8	.	0.2000	1.0000	0.2500	0.2500	0.188	0.7106	0.188
9	.	0.2000	1.0000	0.2500	0.2500	0.205	0.5244	0.205
10+	.	0.2000	1.0000	0.2500	0.2500	0.242	0.5244	0.242
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2002								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
0	14119.000	0.2000	0.0000	0.2500	0.2500	0.033	0.0133	0.033
1	.	0.2000	0.1100	0.2500	0.2500	0.053	0.1106	0.053
2	.	0.2000	0.4000	0.2500	0.2500	0.074	0.1389	0.074
3	.	0.2000	0.8200	0.2500	0.2500	0.095	0.3100	0.095
4	.	0.2000	0.8600	0.2500	0.2500	0.118	0.4557	0.118
5	.	0.2000	0.9100	0.2500	0.2500	0.144	0.3496	0.144
6	.	0.2000	0.9400	0.2500	0.2500	0.171	0.4675	0.171
7	.	0.2000	1.0000	0.2500	0.2500	0.186	0.5884	0.186
8	.	0.2000	1.0000	0.2500	0.2500	0.188	0.7106	0.188
9	.	0.2000	1.0000	0.2500	0.2500	0.205	0.5244	0.205
10+	.	0.2000	1.0000	0.2500	0.2500	0.242	0.5244	0.242
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANMM05
Date and time: 04MAY00:19:49

Table 6.5.2 Prediction with management option table

09:21 Thursday, May 4, 2000
Blue whiting combined stock (Sub-areas I-IX, XII & XIV)

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.0000	0.4342	4762068	2755821	1135781	0.0000	0.0000	4174256	2476166	0	4799559	2966404
.	.	.	.	.	0.1000	0.0434	.	2452567	107526	4684131	2839608
.	.	.	.	.	0.2000	0.0868	.	2429212	211096	4573003	2719039
.	.	.	.	.	0.3000	0.1303	.	2406100	310873	4465998	2604370
.	.	.	.	.	0.4000	0.1737	.	2383228	407016	4362944	2495289
.	.	.	.	.	0.5000	0.2171	.	2360594	499672	4263678	2391503
.	.	.	.	.	0.6000	0.2605	.	2338193	588984	4168044	2292737
.	.	.	.	.	0.7000	0.3040	.	2316025	675091	4075893	2198727
.	.	.	.	.	0.8000	0.3474	.	2294087	758121	3987081	2109227
.	.	.	.	.	0.9000	0.3908	.	2272375	838201	3901473	2024002
.	.	.	.	.	1.0000	0.4342	.	2250888	915449	3818938	1942831
.	.	.	.	.	1.1000	0.4777	.	2229622	989980	3739351	1865506
.	.	.	.	.	1.2000	0.5211	.	2208577	1061904	3662593	1791828
.	.	.	.	.	1.3000	0.5645	.	2187748	1131325	3588548	1721611
.	.	.	.	.	1.4000	0.6079	.	2167134	1198344	3517109	1654677
.	.	.	.	.	1.5000	0.6514	.	2146733	1263055	3448170	1590859
.	.	.	.	.	1.6000	0.6948	.	2126542	1325551	3381632	1529999
.	.	.	.	.	1.7000	0.7382	.	2106559	1385920	3317397	1471947
.	.	.	.	.	1.8000	0.7816	.	2086781	1444246	3255376	1416560
.	.	.	.	.	1.9000	0.8251	.	2067207	1500609	3195479	1363705
.	.	.	.	.	2.0000	0.8685	.	2047834	1555086	3137623	1313255
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANMM05
Date and time : 04MAY00:19:49
Computation of ref. F: Simple mean, age 3 - 7
Basis for 2000 : F factors

Table 6.6.1.1. Run 1 Total Landings

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	7.45E+05	6.85E+05	6.09E+05	5.85E+05	4.91E+05	4.23E+05	3.89E+05	3.33E+05	3.29E+05	2.81E+05
25th %ile	1.01E+06	8.66E+05	7.79E+05	7.51E+05	6.61E+05	6.10E+05	6.00E+05	5.81E+05	5.68E+05	5.59E+05
50th %ile	1.20E+06	1.01E+06	9.28E+05	8.82E+05	8.01E+05	7.50E+05	7.53E+05	7.43E+05	7.33E+05	7.30E+05
75th %ile	1.44E+06	1.17E+06	1.10E+06	1.07E+06	9.80E+05	9.70E+05	9.60E+05	9.61E+05	9.51E+05	9.25E+05
95th %ile	1.95E+06	1.57E+06	1.42E+06	1.42E+06	1.42E+06	1.37E+06	1.47E+06	1.56E+06	1.44E+06	1.42E+06

Run 1 Fishing Mortality

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
25th %ile	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
50th %ile	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
75th %ile	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
95th %ile	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86

Run 1 Recruitment

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	5.48E+06	5.50E+06	5.18E+06	4.76E+06	4.81E+06	4.15E+06	3.47E+06	3.30E+06	2.59E+06	2.09E+06
25th %ile	1.03E+07	1.02E+07	9.84E+06	9.31E+06	8.95E+06	8.24E+06	7.92E+06	8.34E+06	7.62E+06	8.39E+06
50th %ile	1.37E+07	1.37E+07	1.35E+07	1.37E+07	1.32E+07	1.28E+07	1.29E+07	1.27E+07	1.23E+07	1.29E+07
75th %ile	2.43E+07	2.43E+07	2.43E+07	2.43E+07	2.40E+07	2.42E+07	2.42E+07	2.13E+07	2.02E+07	2.39E+07
95th %ile	4.96E+07	5.03E+07	5.72E+07	4.86E+07	4.87E+07	4.71E+07	5.20E+07	4.32E+07	4.75E+07	4.82E+07

Run 1 Stock Size

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	1.70E+06	1.21E+06	9.88E+05	9.08E+05	7.27E+05	6.27E+05	5.65E+05	4.59E+05	4.11E+05	3.92E+05
25th %ile	2.37E+06	1.86E+06	1.62E+06	1.45E+06	1.35E+06	1.28E+06	1.26E+06	1.21E+06	1.20E+06	1.17E+06
50th %ile	2.87E+06	2.37E+06	2.16E+06	1.99E+06	1.88E+06	1.89E+06	1.89E+06	1.90E+06	1.85E+06	1.82E+06
75th %ile	3.60E+06	3.17E+06	2.91E+06	2.71E+06	2.66E+06	2.58E+06	2.65E+06	2.64E+06	2.59E+06	2.63E+06
95th %ile	4.71E+06	4.25E+06	4.27E+06	4.06E+06	3.92E+06	4.02E+06	4.08E+06	4.09E+06	3.98E+06	3.99E+06

Run 1 Risk to SSB

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Risk	3.20E-02	1.08E-01	1.94E-01	2.80E-01	3.14E-01	3.40E-01	3.50E-01	3.72E-01	3.66E-01	3.78E-01

Table 6.6.1.2. Run 2 Total Landings

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	7.09E+05	4.74E+05	4.81E+05	4.77E+05	4.51E+05	4.31E+05	4.22E+05	4.21E+05	4.30E+05	4.09E+05
25th %ile	9.55E+05	6.17E+05	6.18E+05	6.44E+05	6.15E+05	5.84E+05	5.98E+05	6.08E+05	5.89E+05	5.85E+05
50th %ile	1.19E+06	7.24E+05	7.38E+05	7.76E+05	7.22E+05	7.04E+05	7.18E+05	7.26E+05	7.21E+05	7.15E+05
75th %ile	1.45E+06	8.62E+05	8.87E+05	9.29E+05	8.85E+05	8.78E+05	8.77E+05	9.02E+05	8.80E+05	8.73E+05
95th %ile	1.94E+06	1.13E+06	1.21E+06	1.36E+06	1.28E+06	1.34E+06	1.28E+06	1.41E+06	1.28E+06	1.40E+06

Run 2 Fishing Mortality

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	0.22	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
25th %ile	0.34	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
50th %ile	0.45	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
75th %ile	0.60	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
95th %ile	0.99	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69

Run 2 Recruitment

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	5.49E+06	5.51E+06	5.14E+06	5.37E+06	5.38E+06	5.30E+06	4.55E+06	5.24E+06	5.20E+06	4.52E+06
25th %ile	1.01E+07	1.01E+07	9.45E+06	1.02E+07	9.54E+06	9.18E+06	8.98E+06	9.33E+06	9.41E+06	9.17E+06
50th %ile	1.40E+07	1.35E+07	1.36E+07	1.34E+07	1.38E+07	1.31E+07	1.35E+07	1.30E+07	1.36E+07	1.35E+07
75th %ile	2.43E+07	2.42E+07	2.41E+07	2.42E+07	2.43E+07	2.43E+07	2.43E+07	2.31E+07	2.43E+07	2.41E+07
95th %ile	4.99E+07	4.37E+07	4.40E+07	4.60E+07	5.88E+07	5.57E+07	5.52E+07	4.49E+07	5.27E+07	4.41E+07

Run 2 Stock Size

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	1.54E+06	1.15E+06	1.11E+06	1.03E+06	9.60E+05	9.07E+05	9.25E+05	9.64E+05	9.54E+05	9.05E+05
25th %ile	2.35E+06	1.93E+06	1.94E+06	1.88E+06	1.81E+06	1.80E+06	1.87E+06	1.88E+06	1.85E+06	1.84E+06
50th %ile	2.98E+06	2.56E+06	2.53E+06	2.48E+06	2.42E+06	2.42E+06	2.39E+06	2.50E+06	2.43E+06	2.39E+06
75th %ile	3.46E+06	3.16E+06	3.28E+06	3.29E+06	3.16E+06	3.21E+06	3.27E+06	3.26E+06	3.33E+06	3.31E+06
95th %ile	4.82E+06	4.65E+06	4.67E+06	5.08E+06	4.91E+06	4.92E+06	5.18E+06	5.37E+06	5.32E+06	5.43E+06

Run 2 Risk to SSB

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Risk	4.40E-02	1.28E-01	1.26E-01	1.36E-01	1.54E-01	1.48E-01	1.38E-01	1.48E-01	1.44E-01	1.42E-01

Table 6.6.1.3. Run 3 Total Landings

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	7.41E+05	3.51E+05	3.78E+05	4.14E+05	4.21E+05	4.13E+05	4.22E+05	4.27E+05	4.12E+05	4.20E+05
25th %ile	9.59E+05	4.57E+05	4.93E+05	5.30E+05	5.38E+05	5.31E+05	5.37E+05	5.42E+05	5.46E+05	5.54E+05
50th %ile	1.18E+06	5.47E+05	5.94E+05	6.45E+05	6.31E+05	6.36E+05	6.55E+05	6.58E+05	6.70E+05	6.56E+05
75th %ile	1.43E+06	6.59E+05	7.07E+05	7.77E+05	7.69E+05	7.81E+05	8.17E+05	8.29E+05	8.50E+05	8.33E+05
95th %ile	1.85E+06	8.21E+05	9.39E+05	1.07E+06	1.10E+06	1.05E+06	1.13E+06	1.15E+06	1.16E+06	1.13E+06

Run 3 Fishing Mortality

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	0.22	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
25th %ile	0.33	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
50th %ile	0.44	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
75th %ile	0.61	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
95th %ile	0.85	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42

Run 3 Recruitment

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	5.58E+06	5.52E+06	5.47E+06	5.44E+06	5.51E+06	5.52E+06	5.47E+06	5.54E+06	5.50E+06	5.50E+06
25th %ile	1.07E+07	9.76E+06	9.90E+06	9.83E+06	9.86E+06	9.74E+06	9.60E+06	1.03E+07	1.03E+07	9.44E+06
50th %ile	1.38E+07	1.34E+07	1.38E+07	1.28E+07	1.39E+07	1.33E+07	1.35E+07	1.41E+07	1.36E+07	1.36E+07
75th %ile	2.43E+07	2.41E+07	2.43E+07	2.40E+07	2.43E+07	2.42E+07	2.40E+07	2.39E+07	2.44E+07	2.43E+07
95th %ile	5.46E+07	4.90E+07	4.99E+07	4.26E+07	5.48E+07	5.04E+07	4.28E+07	4.36E+07	5.02E+07	5.17E+07

Run 3 Stock Size

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
5th %ile	1.71E+06	1.32E+06	1.37E+06	1.33E+06	1.46E+06	1.55E+06	1.52E+06	1.49E+06	1.54E+06	1.59E+06
25th %ile	2.36E+06	1.99E+06	2.11E+06	2.13E+06	2.21E+06	2.23E+06	2.32E+06	2.34E+06	2.29E+06	2.35E+06
50th %ile	2.91E+06	2.54E+06	2.74E+06	2.86E+06	2.91E+06	2.97E+06	3.02E+06	3.10E+06	3.12E+06	3.12E+06
75th %ile	3.59E+06	3.32E+06	3.55E+06	3.70E+06	3.81E+06	3.93E+06	3.95E+06	3.99E+06	4.02E+06	4.04E+06
95th %ile	4.88E+06	4.65E+06	4.77E+06	5.13E+06	5.31E+06	5.34E+06	5.53E+06	5.64E+06	5.96E+06	5.80E+06

Run 3 Risk to SSB

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Risk	2.60E-02	9.20E-02	8.00E-02	6.80E-02	6.00E-02	4.60E-02	5.20E-02	5.40E-02	5.00E-02	4.80E-02

Table 6.6.2.1. Blue whiting. Simulations with F-constraints only. Based on the 1999 assessment (WD by Skagen). For details, see text.

Blue whiting
Medium term predictions with STPR, using input data from WGNPBW 1999 assessment

Fixed F above Bpa, sliding F between Bpa and Blim (Fatbpa=>0.05)

Risk of **true B<Blim**
at least once in 10 years

F	Bpa 2000	2250	2500
0.15	0.7	0.7	0.7
0.175	1	0.9	0.8
0.2	1.3	1.2	1.1
0.25	3.1	2.8	2.4
0.32	10.8	10.5	9.2
0.4	26	26.3	24.1

Risk of **true B<Bpa**
at least once in 10 years

F	Bpa 2000	2250	2500
0.15	3.2	7.5	15
0.175	6.4	13	24.1
0.2	10	21.8	35.2
0.25	25.7	42.8	58.1
0.32	51.5	69.4	78.8
0.4	74.2	84.2	85.8

Risk of **assumed B<Blim**
at least once in 10 years

F	Bpa 2000	2250	2500
0.15	12.6	12.2	11.8
0.175	15.3	15.1	14.4
0.2	19.5	18.5	17.4
0.25	30.4	28.4	26.5
0.32	49	46.8	43.2
0.4	68	64.4	60.7

Risk of **assumed B<Bpa**
at least once in 10 years

F	Bpa 2000	2250	2500
0.15	37.9	55.9	71.9
0.175	45.9	64.7	78
0.2	54.2	71.1	83.4
0.25	69.1	84.5	91.5
0.32	79.9	89.5	92.8
0.4	84.8	90	92.3

Median of **average catch** years 2-10

F	Bpa 2000	2250	2500
0.15	552	550	547
0.175	599	596	593
0.2	639	636	632
0.25	701	696	689
0.32	759	748	740
0.4	796	787	778

Median of **catch variation** years 5-10

F	Bpa 2000	2250	2500
0.15	104	108	114
0.175	109	117	124
0.2	116	127	135
0.25	140	149	156
0.32	172	179	186
0.4	200	208	216

Table 6.6.2.2. Blue whiting. Results of simulations with F-constraints and catch ceiling

Blue whiting
Medium term predictions with STPR, using input data from WGNPBW 1999 assessment
Regimes with catch ceiling and sliding F between Bpa and Blim (Fatpa=>0.05)
Risk of true B<Blim at least once in 10 years

Catch ceiling 500

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	1	1	1
0.25	1	1	1
0.32	1	1	1
0.4	1	1	1

Catch ceiling 650

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	1	1	1
0.25	2	2	1
0.32	3	2	2
0.4	3	3	2

Risk of true B<Bpa at least once in 10 years

Catch ceiling 500

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	4	8	12
0.25	5	9	13
0.32	6	10	14
0.4	6	10	14

Catch ceiling 650

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	6	13	19
0.25	11	18	24
0.32	14	20	26
0.4	16	22	29

Median average catch years 2-10

Catch ceiling 500

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	488	483	474
0.25	500	493	483
0.32	500	500	492
0.4	500	500	500

Catch ceiling 650

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	573	568	561
0.25	602	594	586
0.32	620	609	597
0.4	629	617	608

Median SSB in year 10

Catch ceiling 500

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	4081	4102	4138
0.25	4041	4080	4106
0.32	4016	4051	4082
0.4	4015	4036	4054

Catch ceiling 650

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	3521	3549	3589
0.25	3371	3405	3466
0.32	3292	3347	3388
0.4	3257	3308	3353

Table 6.6.2.2 cont.

Risk of true B<Blim at least once in 10 years

Catch ceiling 800

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	1	1	1
0.25	2	2	1
0.32	5	4	3
0.4	7	6	5

No catch ceiling

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	1	1	1
0.25	3	3	2
0.32	11	11	9
0.4	26	26	24

Risk of true B<Blim at least once in 10 years

Catch ceiling 800

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	8	17	26
0.25	16	27	36
0.32	25	36	45
0.4	30	40	48

No catch ceiling

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	10	22	35
0.25	26	43	58
0.32	52	69	79
0.4	74	84	86

Median average catch years 2-10

Catch ceiling 800

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	614	608	603
0.25	660	651	643
0.32	697	685	672
0.4	716	702	688

No catch ceiling

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	639	636	632
0.25	701	696	689
0.32	759	748	740
0.4	796	788	778

Median SSB in year 10

Catch ceiling 800

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	3263	3285	3331
0.25	3015	3050	3108
0.32	2795	2859	2938
0.4	2706	2775	2848

No catch ceiling

	Bpa=>		
F at B>Bpa	2000	2250	2500
0.2	3051	3081	3112
0.25	2691	2739	2777
0.32	2348	2411	2468
0.4	2114	2177	2245

Table 6.8.1 Total catches of BLUE WHITING in 1978–1999 divided into areas within and beyond areas of national fisheries jurisdiction of NEAFC contracting parties, as estimated by the Working Group members.

Note that the total column does not quite coincide with the total catch in the assessment. The reason is that not all countries are listed in this table.

Year	International	Jan Mayen	Norway	Iceland	Greenland	Faroes	EU	Total (t)
1978	136,504	-	67,391	26,444	6.580	195,361	136,421	568,701
	(24 %)		(12 %)	(5 %)	(1 %)	(34 %)	(24 %)	
1979	614,734	-	75,545	15,117	204	224,202	191,564	1,121,365
	(55 %)		(7 %)	(1 %)	(0 %)	(20 %)	(17 %)	
1980	567,693	-	152,095	4,562	8,757	164,342	160,361	1,057,810
	(54 %)		(14 %)	(0 %)	(1 %)	(16 %)	(15 %)	
1981	168,681	123,000	215,004	7,751	-	174,801	203,223	892,460
	(19 %)	(14 %)	(24 %)	(1 %)		(20 %)	(23 %)	
1982	22,993	-	130,435	5,797	-	125,072	279,474	563,771
	(4 %)		(23 %)	(1 %)		(22 %)	(50 %)	
1983	15,203	-	109,675	7,000	-	91,804	325,816	549,498
	(3 %)		(20 %)	(1 %)		(17 %)	(59 %)	
1984	18,407	-	150,603	105	-	124,905	313,591	607,611
	(3 %)		(25 %)	(0 %)		(21 %)	(52 %)	
1985	38,978	-	114,785	-	-	196,003	335,162	684,928
	(6 %)		(17 %)			(29 %)	(49 %)	
1986	20,665	-	187,768	-	116	171,074	408,338	787,961
	(3 %)		(24 %)		(0 %)	(22 %)	(52 %)	
1987	103,535	-	109,201	-	-	135,980	267,045	615,761
	(17 %)		(18 %)			(22 %)	(43 %)	
1988	65,172	-	38,449	-	-	157,368	265,182	526,171
	(12 %)		(7 %)			(30 %)	(50 %)	
1989	137,093	-	68,817	4,977	-	101,177	318,033	630,097
	(22 %)		(11 %)	(1 %)		(16 %)	(50 %)	
1990	88, 509	-	39,160	-	-	115,308	318,710	561,687
	(16 %)		(7 %)			(21 %)	(57 %)	
1991	51,950	-	72,309	-	-	99,268	197,522	421,049
	(12 %)		(17 %)			(24 %)	(47 %)	
1992	47,786	-	66,333	-	-	135,294	253,754	503,167
	(9 %)		(13 %)			(27 %)	(50 %)	
1993	69,213	-	47,917	-	-	112,773	249,094	478,997
	(14 %)		(10 %)			(24 %)	(52 %)	
1994	68,926	-	36,933	-	-	133,678	218,303	457,840
	(15 %)		(8 %)			(29 %)	(48 %)	
1995	82,784	-	98,034	369	-	107,483	290,010	578,680
	(14,0 %)	-	(17,0 %)	(0 %)	-	(19,0 %)	(50,0 %)	
1996	34,788	-	67,977	302	-	111,627	387,209	601,903
	(5,7 %)		(11,3 %)	(0 %)	-	(18,6 %)	(64,4 %)	
1997	46,961	-	53,592	10,464	-	151,791	368,398	634,206
	(7.9%)		(8.5%)	(1.6%)		(23.9%)	(58.1%)	
1998[2]	271,873	4,770	105,674	90,649	-	129,799	498,399	1,101,670
	(24.7 %)	(0.4 %)	(9.6 %)	(8.2 %)	-	(11.8 %)	(45.2 %)	
1999	276,256	+	73,623	111,504	-	224,588	426,557	1,112,624
	(24,8%)		(6,6%)	(10,0%)	-	(20,3%)	(38,3%)	

[2] The catch by zones in 1998 was estimated according to the procedure developed in the NEAFC Workshop meetings on mackerel and blue whiting in Aberdeen 1998 and in Torshavn in1999, where a database on zonal attachment was developed.

Table 6.10.1 BLUE WHITING. Sampling in fishery during 1999.

Country	No. of samples	No. fish aged	No. fish measured
DIRECTED FISHERIES			
Faroe Islands	14	1400	3270
Ireland	61	2083	4230
Netherlands	21		3526
Norway	51	2625	8680
Russia	136	281	18793
MIXED INDUSTRIAL FISHERIES			
Denmark	5		240
Norway	59	2200	7701
SOUTHERN FISHERIES			
Portugal	209	2222	21069
Spain	350	812	29919

Country	No. of samples	No. fish aged	No. fish measured
TOTAL	906	11623	97428

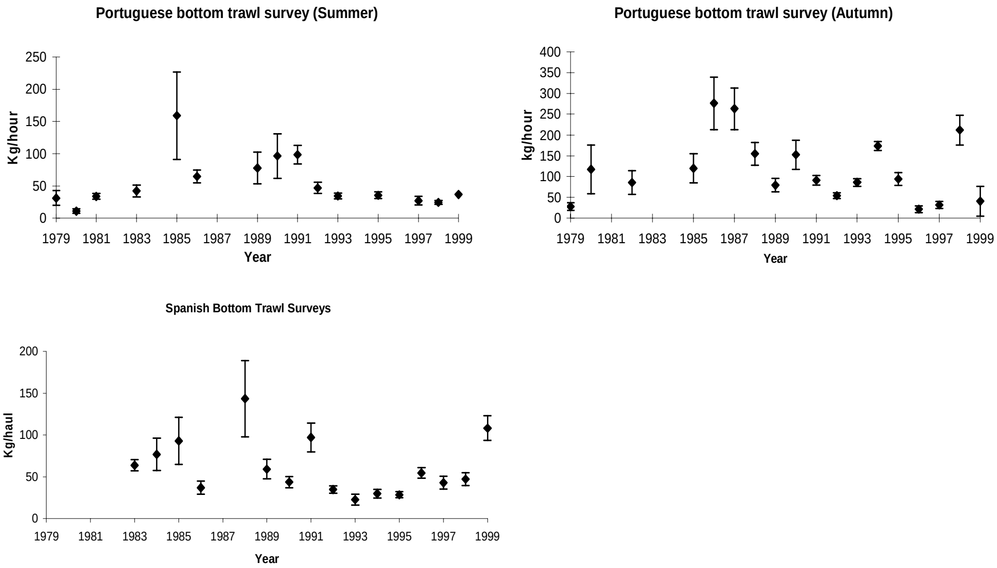


Figure 6.4.2.1 - Mean catch rates in the bottom trawl surveys from the southern area.

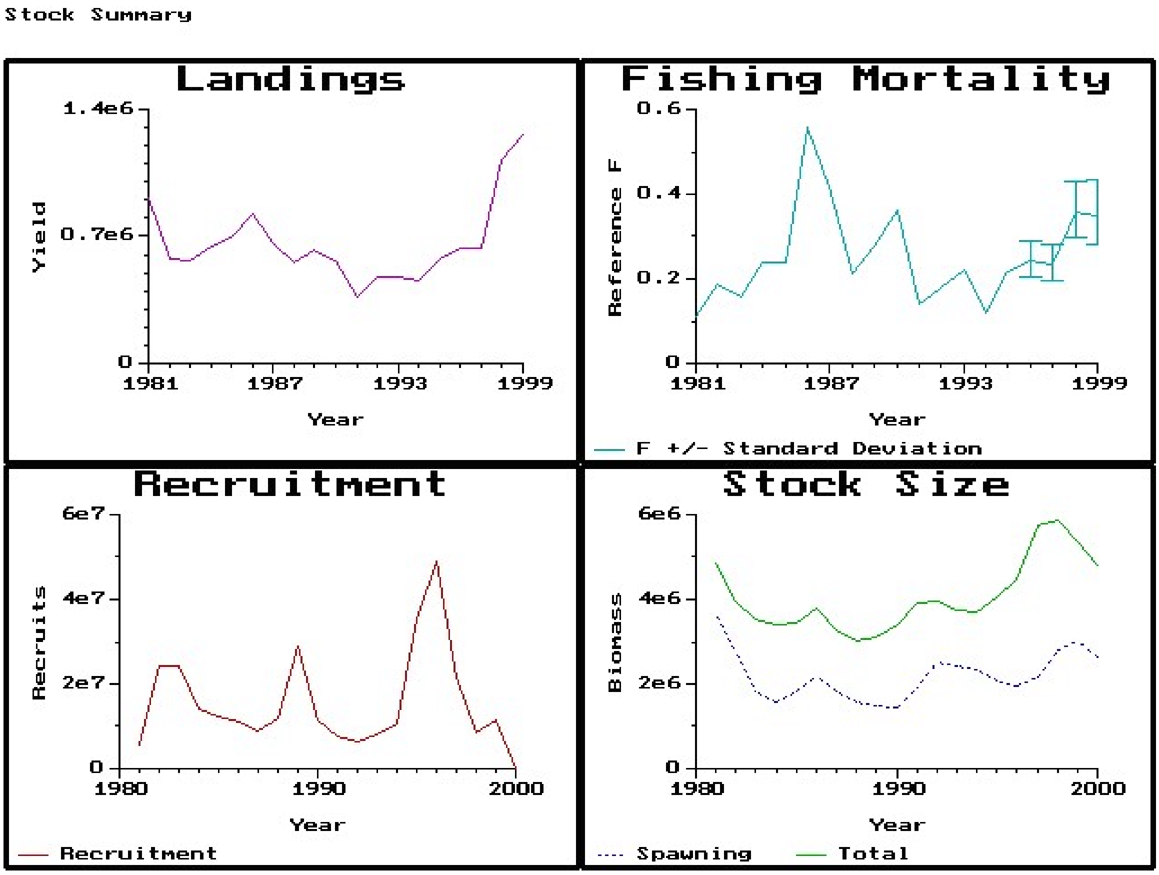


Figure 6.4.4.1. Diagnostic plots from ICA run 3 (I).

Separable Model Diagnostics

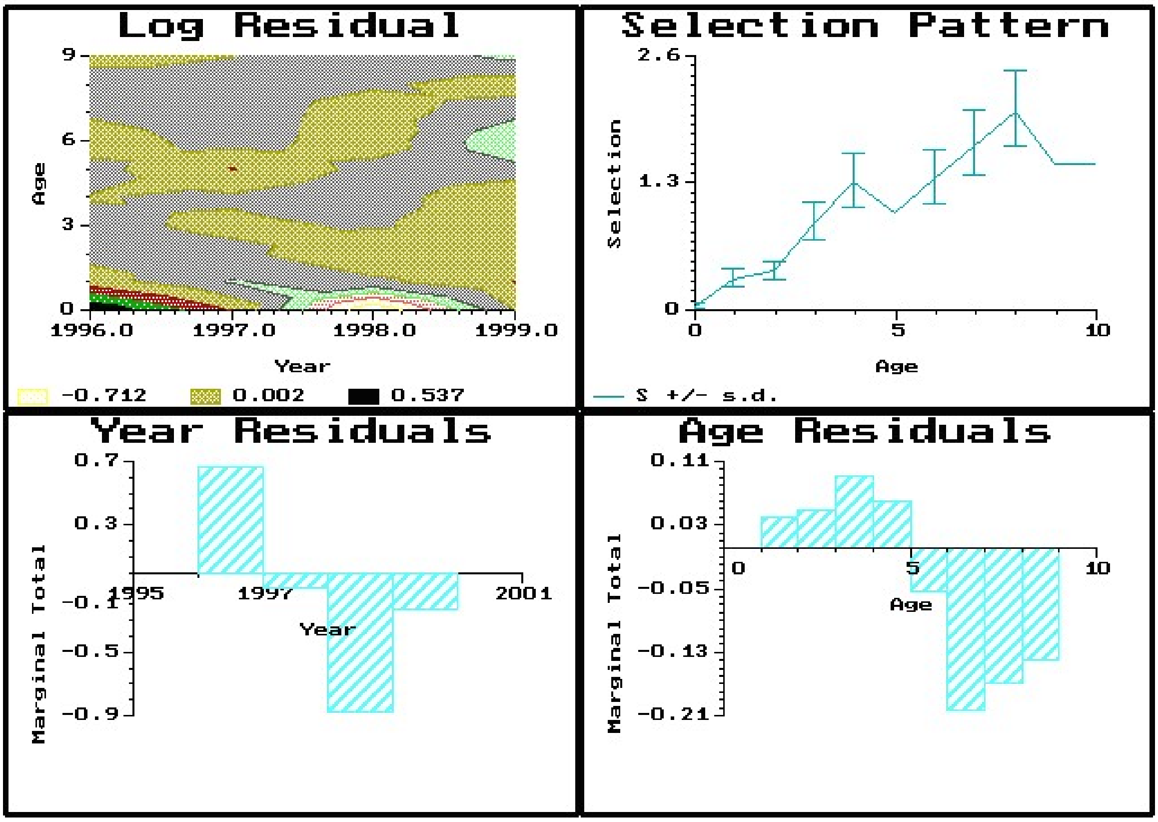


Figure 6.4.4.2. Diagnostic plots from ICA run 3 (ii).

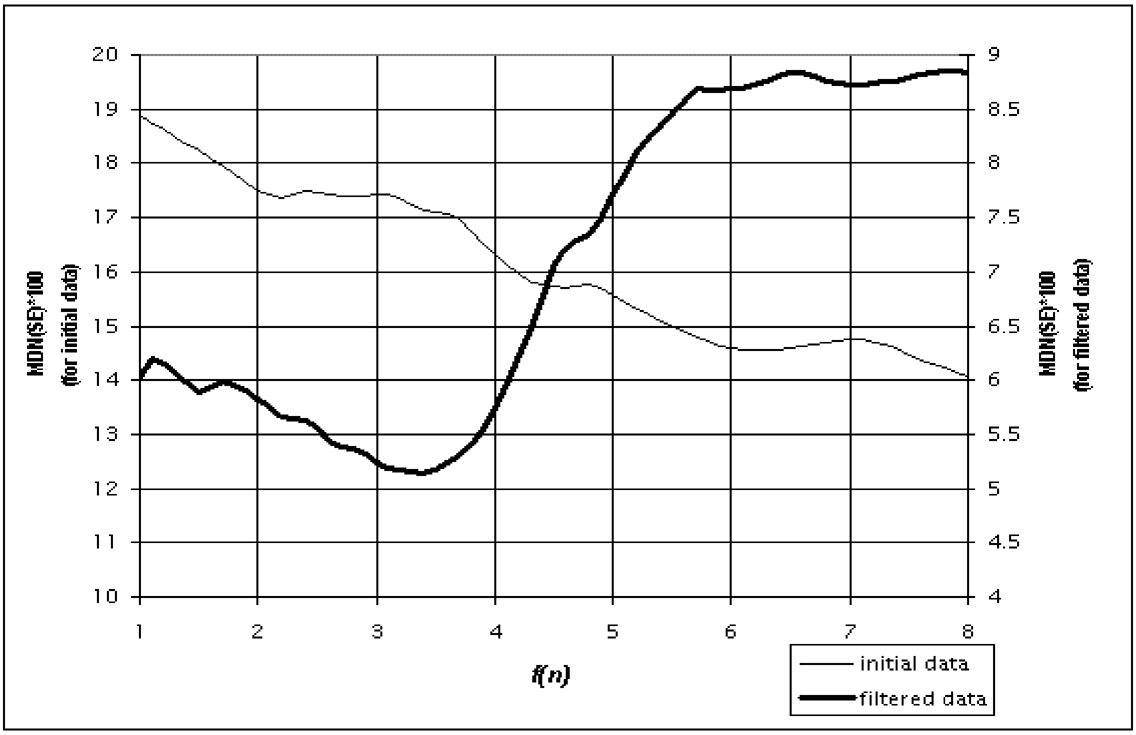
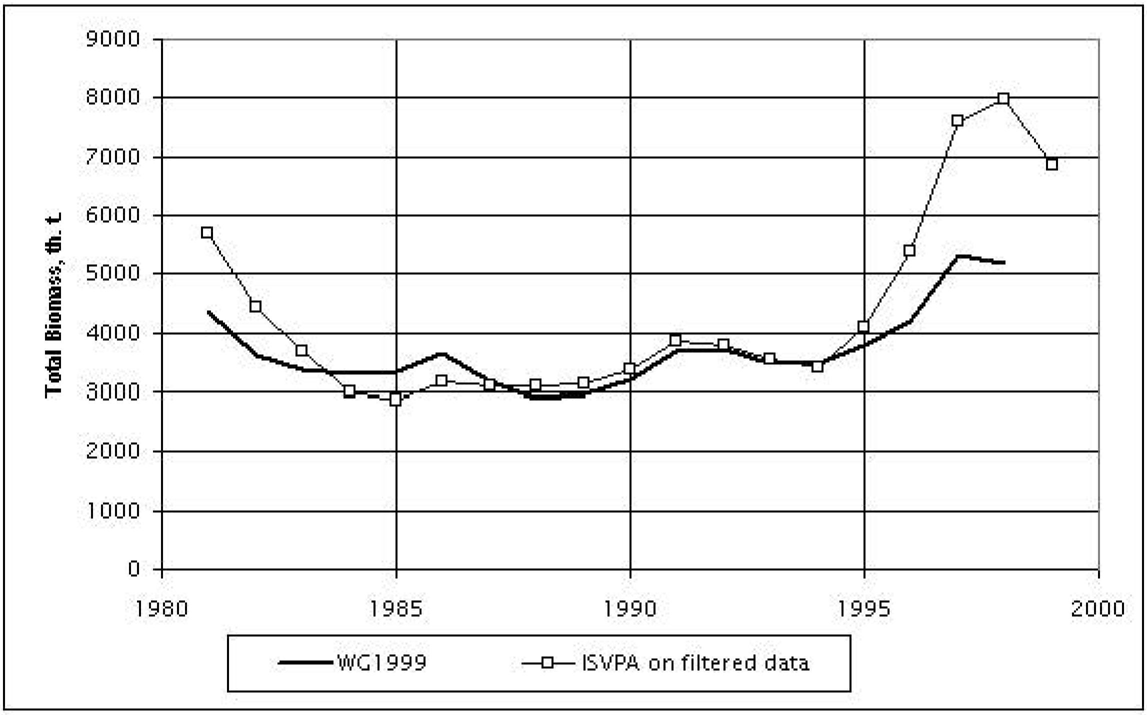
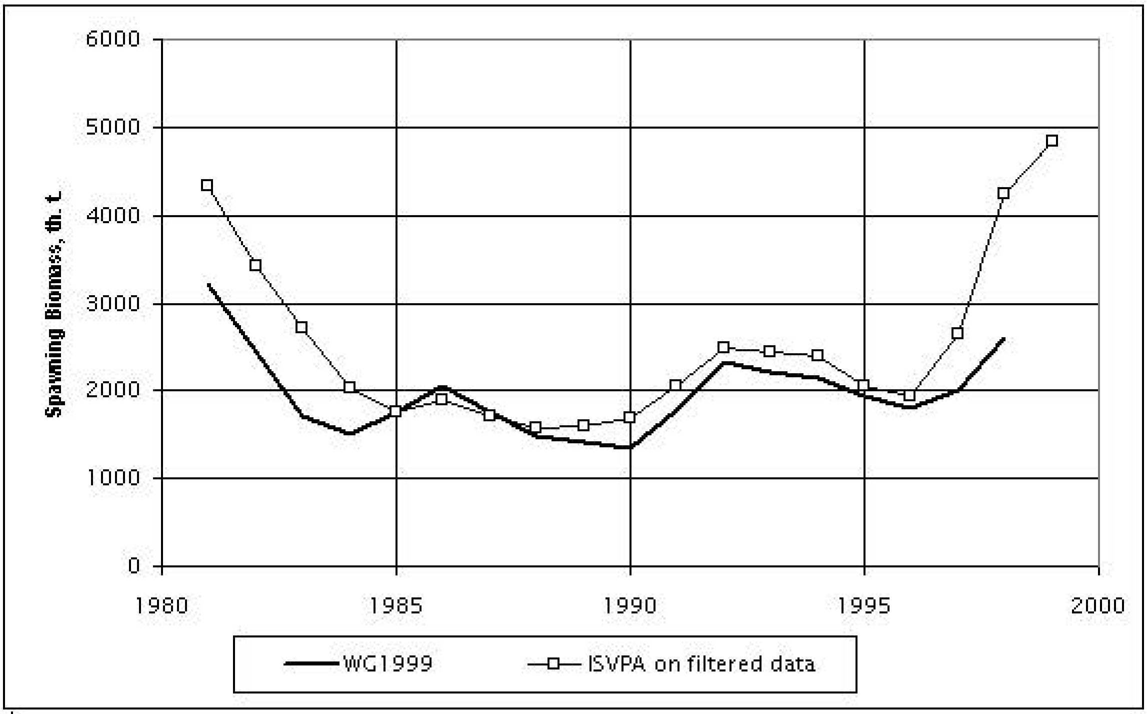


Fig. 6.4.5.1. Profiles of ISVPA loss function MDN(SE) as function of terminal *f(y)* calculated for initial and "filtered" catch-at-age data



a



b

Fig.6.4.5.2 a,b Estimates of total (a) and spawning (b) stock biomass

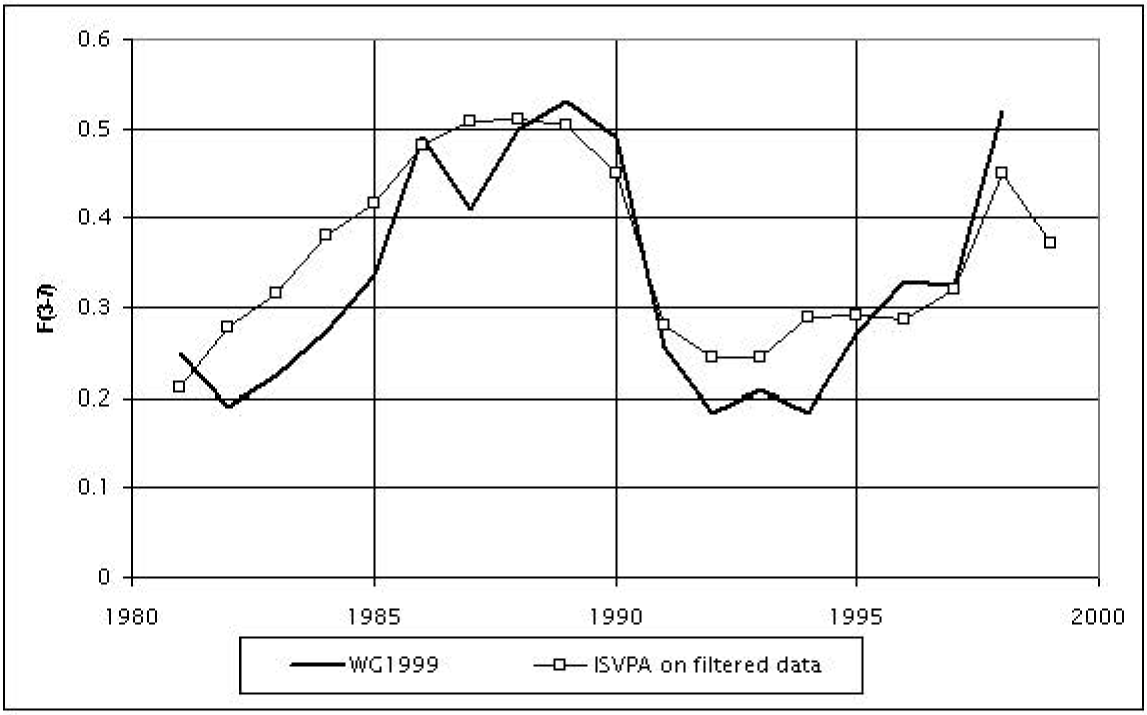


Fig. 6.4.5.3 Estimates of average fishing mortality for ages 3–7

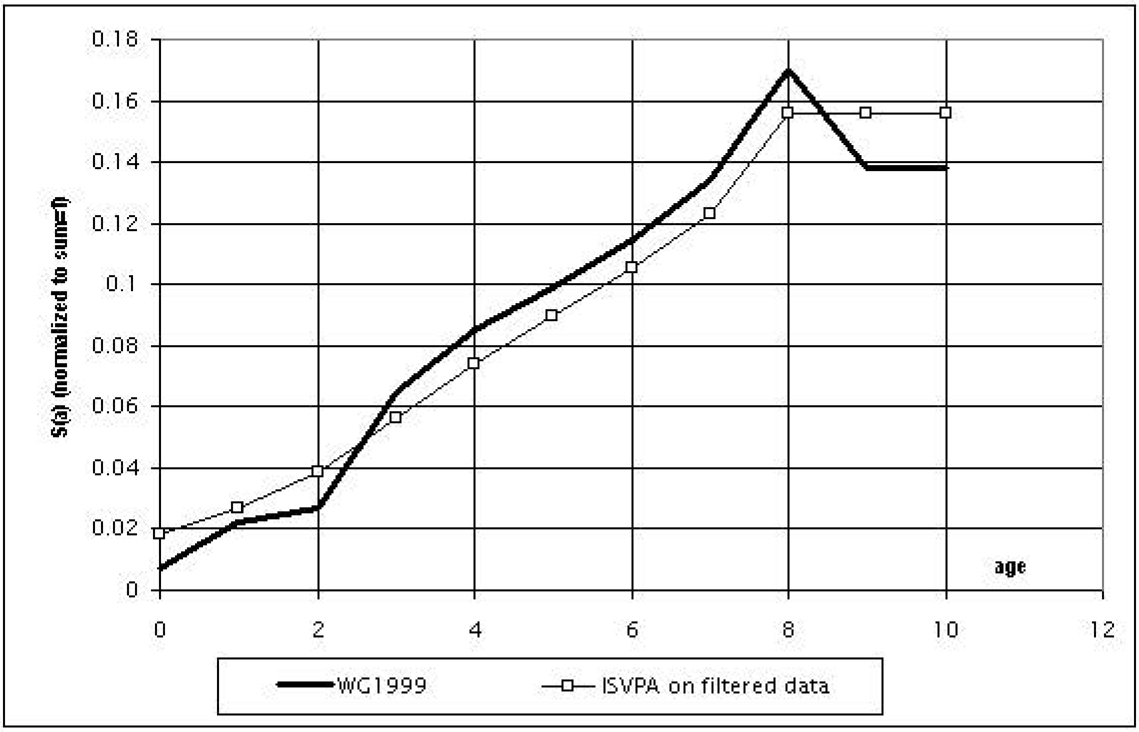


Fig. 6.4.5.4. Estimates of selectivity pattern (normalized to sum = 1)

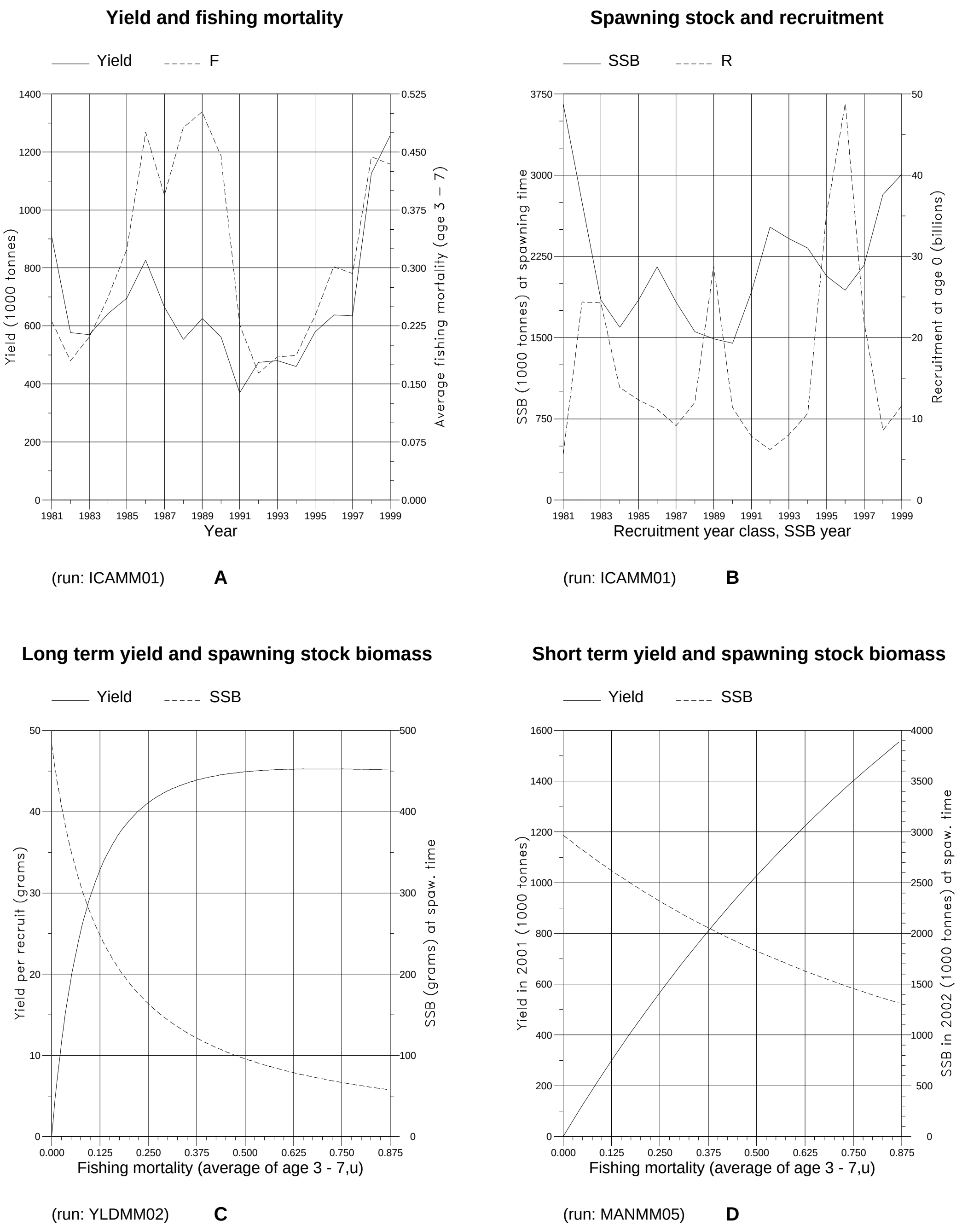


Figure 6.5.1. Blue Whiting. Standard plots from the short-term projection

Figure 6.6.1.1. Run 1

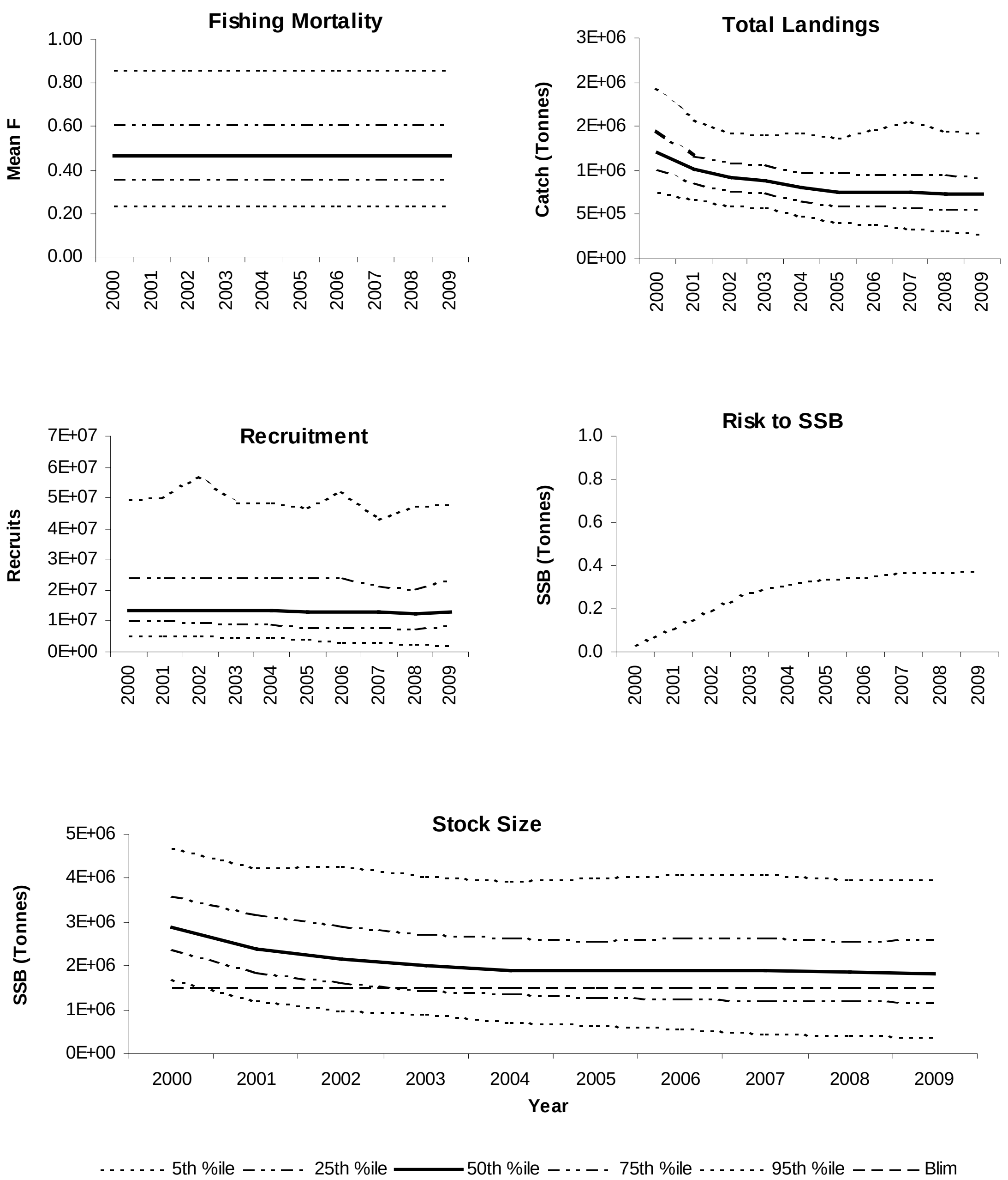


Figure 6.6.1.2. Run 2

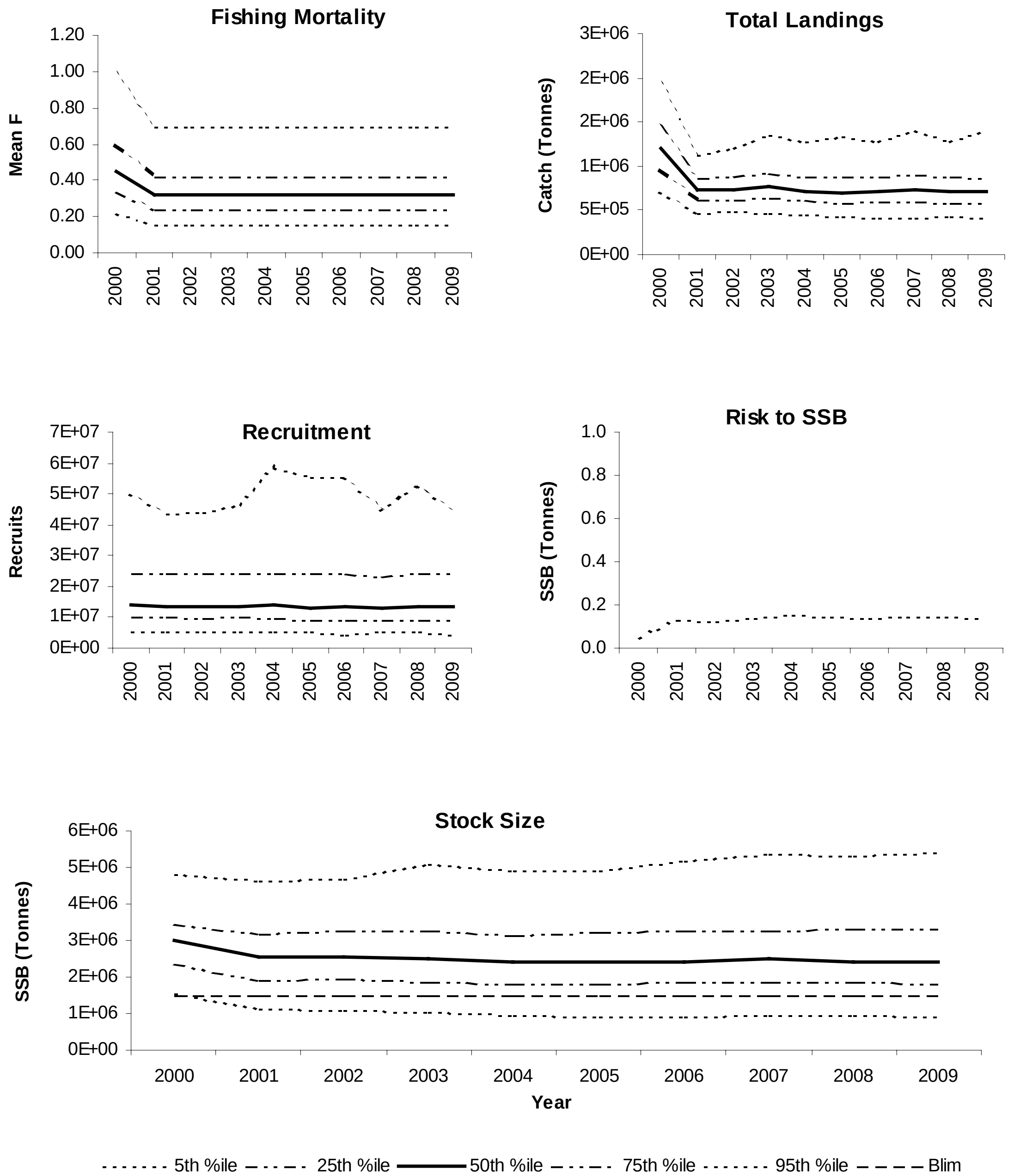


Figure 6.6.1.3. Run 3

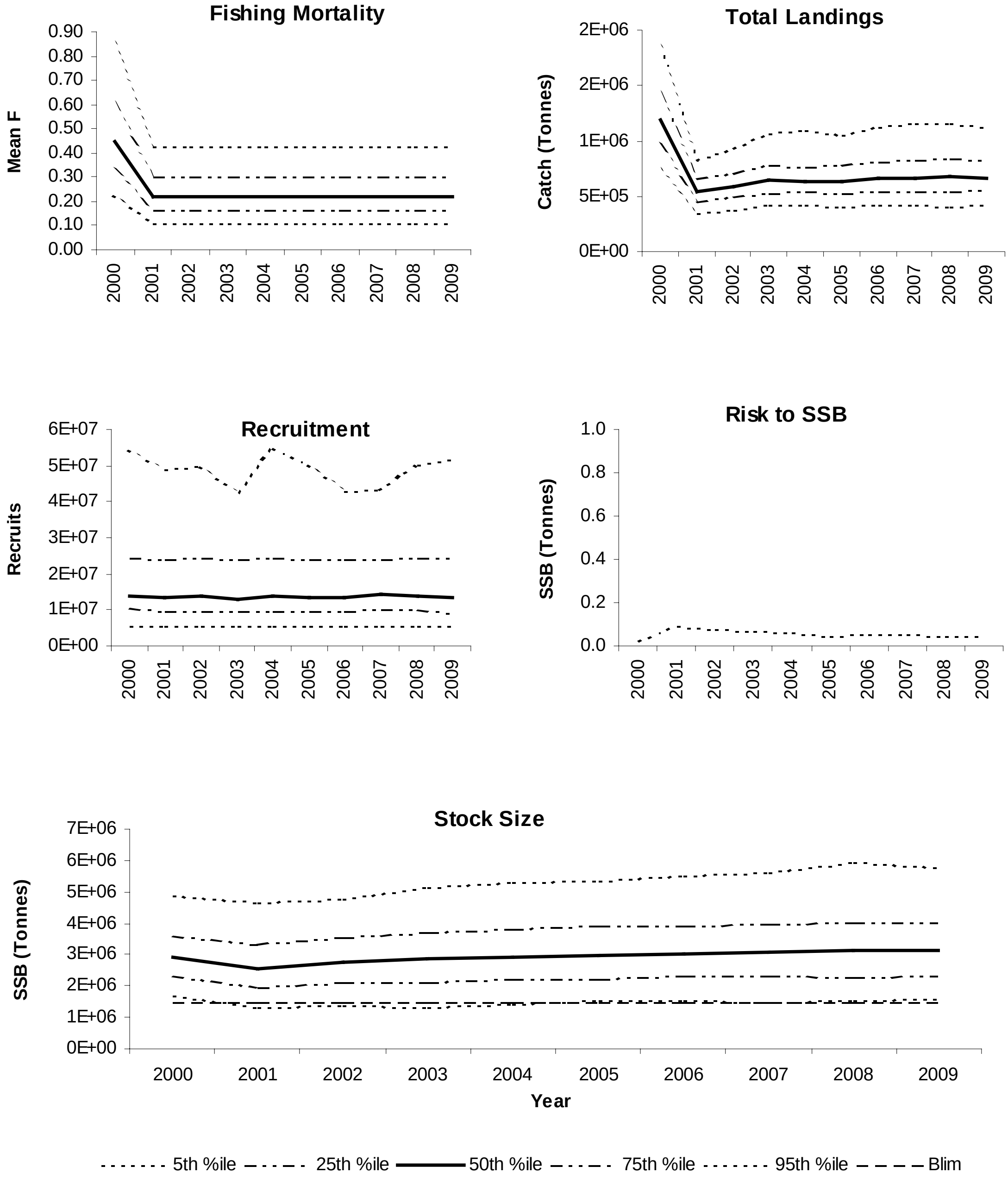
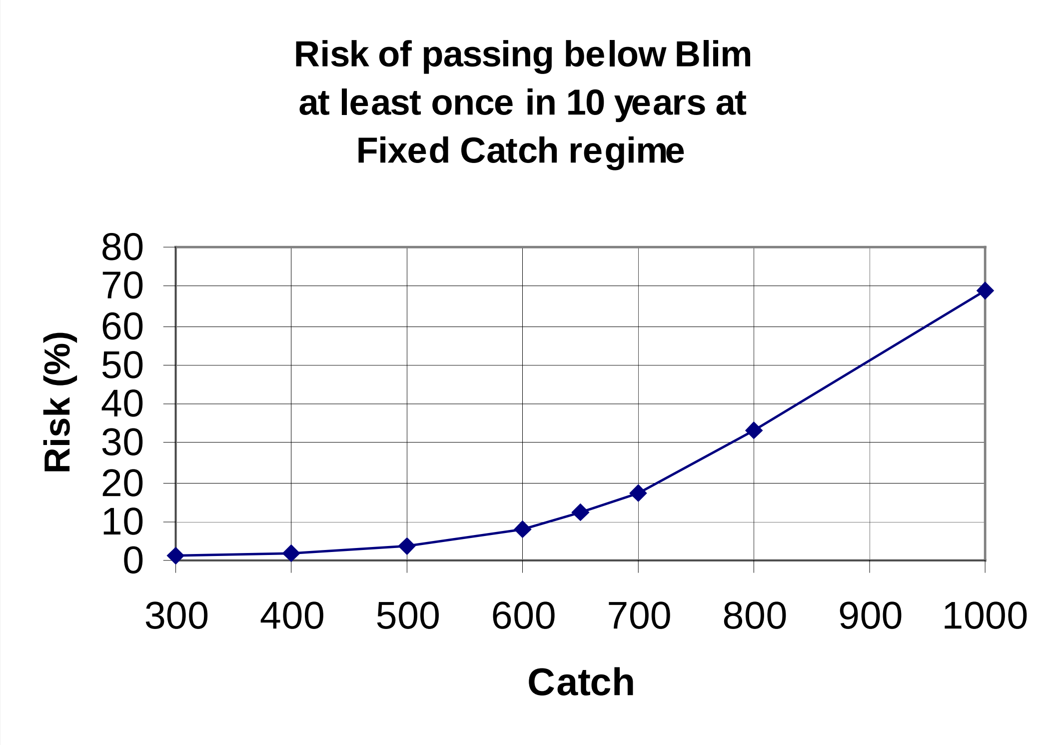


Figure 6.6.2.1. Blue Whiting. Risk of passing below Blim at least once in 10 years at fixed catch regime. Simulations based on the 1999 assessment (WD by Skagen).



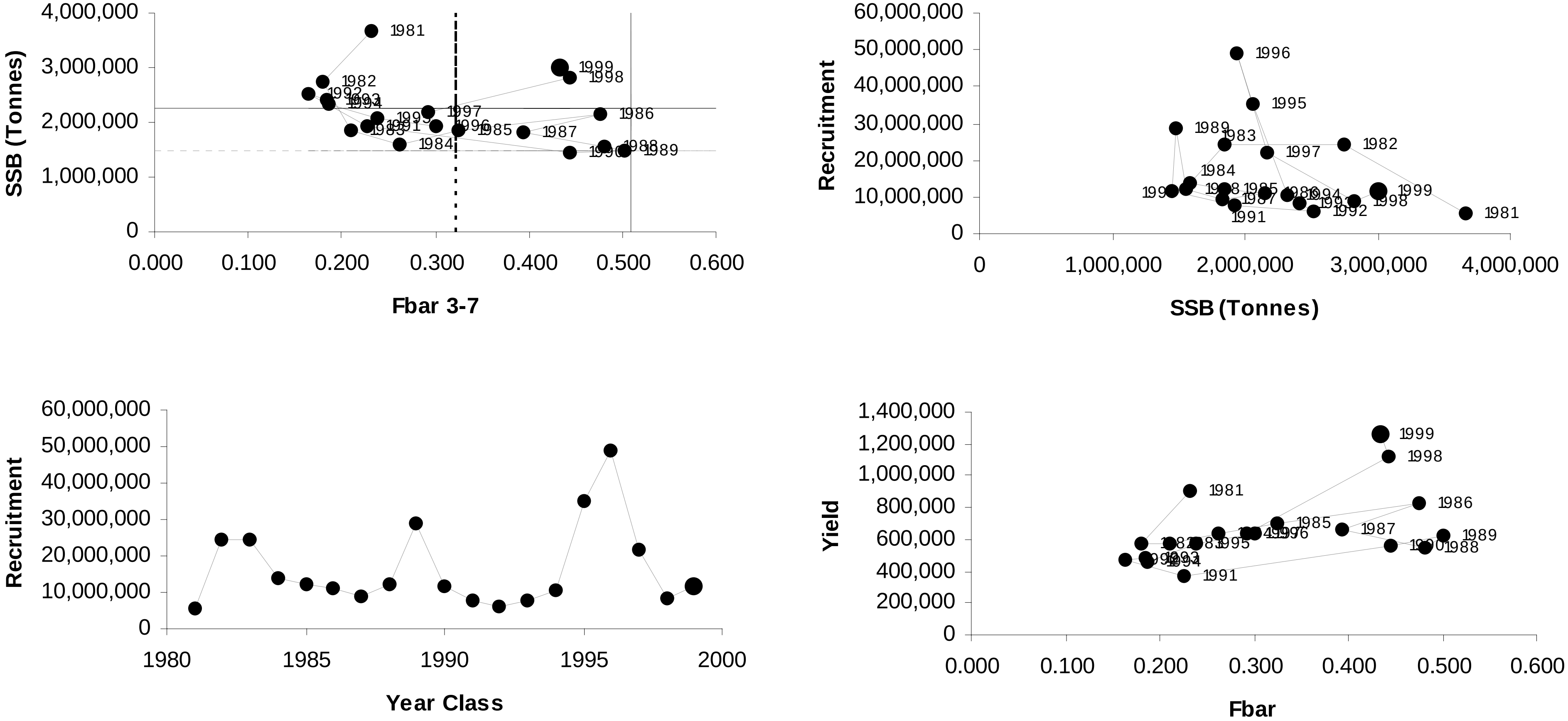


Figure 6.7.1

a) Historic SSB against Fbar with precautionary and limit reference points indicated. B)Stock recruitment plot. C) Historic Recruitment. D) Historic yield against Fbar.

7 ICELANDIC SUMMER-SPAWNING HERRING

7.1 The fishery

The catches of summer-spawning herring from 1979-1999 are given in Tables 7.1.1, 7.1.2 and 7.1.3. No estimate of discards was made for the 1999/2000 season. The fishery started in September and terminated in January. The catch in September-January was 92 896 t, see Table 7.1.2. The purse-seine fishery took place off the east coast of Iceland in September through November, but west of Iceland in November -January. The pelagic trawl fishery took place both east and west of Iceland in October-December, but only east of Iceland in January. In the 1997/98 season 59% of the catch was taken by purse seiners, 78% in 1998/99 and 61% in 1999/2000. The remaining 41%, 22% and 39% were taken by pelagic trawl.

The proportion used for reduction to meal and oil decreased from 74% in 1992/93 to 23% in 1996/97, it increased to 29% in 1997/98, then to 72% in 1998/99 and was 69% in the 1999/2000 season. The remainder of the catch was either salted or frozen for human consumption.

Until 1990, the herring fishery took place during the last three months of the calendar year, but since 1990 the autumn fishery has continued in January and early February of the following year. In 1994 the fishery started in September. Therefore, all references to the years 1990-1993 imply seasons starting in October of that year, but after that in September. Landings, catches and recommended TACs since 1984 are given in thousand tonnes in Table 7.1.1.

7.2 Catch in numbers, weight at age and maturity

The catches in numbers at age for the Icelandic summer-spawners for the period 1979–1999 are given in Table 7.1.3. As usual, age is given in rings where age in years equals the number of rings+1.

During the 1995/96 - 1997/98 seasons, the catches were mainly distributed on the 4 year classes from 1988–1991. The catch in numbers of 2-ringers, i.e. the 1994 year class, was 11% of the total number caught in the 1997/98 season. This 1994 year class dominated in the catch of 1998/99 and in 1999/2000.

The weight at age for each year is given in Table 7.2.1 and the proportion mature at age is given in Table 7.2.2. The most striking feature of these parameters in this stock is that, despite inter-annual variations, the weights at age as well as other biological variables have remained relatively stable over a wide range of stock sizes and fluctuations of environmental conditions of Icelandic waters.

7.3 Acoustic surveys

The Icelandic summer-spawning herring stock has been monitored by annual acoustic surveys since 1973. These surveys have been carried out in October-December or January. During a survey carried out during 25 November – 9 December 1999, an estimate was obtained of the adult stock in open waters east of Iceland, and estimates of 1 year old herring in Icelandic coastal waters were made. The estimated size of the adult stock was 80 000 t. West of Iceland an acoustic survey was carried out 11.-14. January 2000 and an estimate was obtained of the adult stock there. The total abundance of herring in this area was estimated to be 385 000 t.

Since mid-1996 there have been large changes in the marine environment of Icelandic waters (cf. Section 2.3). The main feature is an increased flow of warm and saline Atlantic water to the south and west of Iceland and, to some degree also eastwards off the north coast especially in 1999. There is little doubt that the changed environment has resulted in a wider distribution of the Icelandic summer-spawning herring in autumn and winter. This is supported by the observation that summer spawning herring were caught at almost all trawl stations off the west, northwest and western north coast of Iceland during groundfish surveys in October 1997, 1998 and 1999.

According to the 1999/2000 acoustic assessment surveys, the abundance of the 1992, 1993 and 1995 year classes is low. On the other hand, the abundance of the 1994 and 1996 year classes is above average. The 1997 year class is greater than the average of the same age group over the last ten years. This is the first estimate available for this year class. The results from the acoustic survey indicate that the 1998 year class is above average.

The sum of results obtained in the autumn 1999 and the winter 2000 acoustic surveys have been used as the basis for the present assessment of 4-ringed (5-ringed on 1 January) and older herring (Table 7.3.1).

Jakobsson *et al.* (1993) formally tested whether it was feasible to maintain a one-to-one relationship between acoustic and VPA estimates of stock size. It was found that a modification of the target strength, from TS=21.7 log(L) - 75.5 dB to TS=20 log(L)-72 dB, gave a much better fit between the two data sets. The resulting target strength TS = 20 log(L) - 72 dB was used to recalculate historic acoustic stock assessments. This TS = 20 log(L) - 72 dB has been the basis of calculations of stock abundance from acoustic survey data since 1993.

7.4 Stock assessment

Using the results from the acoustic survey and the catch in numbers a first estimate of F was made. The results are given in Table 7.4.1 as F_{ac}. In this analysis, 5-ringers and older have been grouped for estimating the fishing mortality for the oldest herring, whereas the fishing mortality on the younger age groups is calculated for each year class. For F on the oldest age group an average of F for 6–13 ringers was used. When the abundance of juvenile 2–4 ringed herring has been assessed by acoustic surveys, the resulting abundance estimates have been used in the tuning process. In cases where no such information is available for the youngest age group (2 ringers) the size of this age group is set at 400 millions, which is close to the lower quartile of the recruitment observed since 1980.

A series of VPAs were run using varying terminal F's on 5+ ringers. For each terminal F, a sum of squares (SSE(F)) of differences between the 5+ group from the VPA and from the acoustic estimates, was computed. A plot of these values is shown in Figure 7.4.1. From this series of VPAs it is clear that the best (giving the minimum value of SSE) one-to-one relation between the acoustic estimates and virtual population analysis is obtained with an input F of 0.164. The confidence intervals (0.13, 0.21) for the fitted terminal F values are obtained as described by Halldórsson *et al.* (1986) and Stefánsson (1987) by using the tabled F-distribution to set limits on the SSE and finding the terminal F values corresponding to these limits (Figure 7.4.1). The resulting stock trend from VPA is plotted together with the acoustic estimates in Figure 7.4.2 and the relationship between the two estimates is shown in Figure 7.4.3.

Like last year an XSA was run with a result similar to last year, i.e. about 20% lower stock. Retrospective plots (Figure 7.4.4) showed more consistency using the ADAPT-type of assessment than obtained by the XSA. Therefore it was decided to retain the ADAPT-type. However, the retroplot showed that the terminal F values were underestimated in the last 4 years. Therefore the terminal F this year was increased by 12.5%, which is the mean underestimate of the last 4 years, resulting in a F of 0.185.

Using the catch data given in Table 7.1.3 and the fitted values of fishing mortalities given in Table 7.4.1, a final VPA was run, using a natural mortality rate of 0.1 for all age groups and the proportion of M before spawning as 0.5. Fishing mortality at age for 1980–1999 and stock in numbers at age and spawning stock biomass on 1 July 1980–1999 are given in Tables 7.4.2 and 7.4.3 respectively. The standard stock summary is given in Table 7.4.4 and the standard plots of the time series of spawning stock biomass and recruitment and trends in yield and fishing mortality are shown in Figure 7.4.5. In the absence of reliable abundance estimates for the 1996, 1997 and 1998 year classes, the RCT3 programme was used. It estimated the sizes of these year classes as 1075, 768 and 912 million respectively (see Tables 7.4.5 and 7.4.6).

According to the present assessment, the spawning stock biomass was about 507 000 t on 1 July 1999 which is about the same as last year.

7.5 Catch and stock projections

The input data for the projections are given in Table 7.5.1. Although the variations of mean weight at age are relatively small with regard to the extreme variations of environmental conditions and changes in stock size, observed during the past decades, an earlier Working Group found that a simple model of the interannual variation explains a statistically significant portion of the variance in weight at age (ICES 1993/Assess:6).

Like in previous years, a regression of increase in weight on mean weight in the previous year has been used to predict the weight at age for 2–8 ringers, using as input the weight at age for 1–7 ringers in the year before. Data for the regression included the period 1989–1999 as starting years. For 1 ringers and 9+ ringers, a simple average of mean weights at age for the period 1995–1999 was used for the prediction. Weights at age for 2–8 ringers in the catch were obtained using the relationship:

$$W_{y+1} - W_y = -0.1976 * W_y + 81.9884 \text{ (g)}$$

where W_y and W_{y+1} are the mean weight of the same year class in year y and y+1 respectively.

As a selection pattern, the mean selection pattern of 1995–1998 is used, assuming 1 on 4 ringers and older.

Outputs of the prediction, assuming catches corresponding to a fishing mortality rate of $F_{0.1}$=0.22, are given in Table 7.5.2, and projections of spawning stock biomass and catches (tonnes) for a range of values of Fs are given in Table 7.5.3.

In 2000, it is expected that the largest contribution in numbers at age will be herring of the 1994 and 1996 year classes, i.e 6 and 4-ringed herring. In 2001, the 1994 and the 1996 year classes will have the largest contribution to the total catch in numbers.

Yield per recruit, spawning stock per recruit and short-term yield and spawning stock biomass are shown in Figure 7.5.1, using the long-term average (1980-1999) values given in Table 7.5.4.

7.6 Management consideration

During the last 20 years the Icelandic summer-spawning herring stock has been managed at levels corresponding fairly closely to fishing at $F_{0.1}$. Exploiting the stock at a fishing mortality rate of $F_{0.1}$=0.22 during the 2000/2001 season would result in a catch of about 110 000 t (Table 7.5.2 and 7.5.3). The spawning stock biomass in 2000 is expected to be about 580 000 t and about 600 000 t in the year 2001. This is due to the very large contribution of the 1994 and 1996 year classes. Harvesting at higher fishing mortality rates than $F_{0.1}$ would give a correspondingly higher short-term yield, but would reduce the stock sharply when the effect of the strong year classes presently in the stock has been further reduced.

The Working Group points out that managing this stock at an exploitation rate at or near $F_{0.1}$ has been successful in the past. Thus the Working Group agreed in 1998 with the SGPAFM on using $F_{pa}=F_{0.1}=0.22$, $B_{pa}=B_{lim}e^{1.645\sigma}=300\ 000$ t where $B_{lim}=200\ 000$ t.

Jakobsson and Stefansson (1999) made a risk analysis and stated that the probability of stock collapse needs no further consideration as long as the target fishing mortality is kept below 0.25. The present F for this stock is estimated to be 0.185 which is well below F_{pa}=0.22. Furthermore, the spawning stock is 507 000 t compared to B_{pa}=300 000 t. Therefore, the stock is in a healthy state and well above any “alarm level”.

7.7 Stock and recruitment

Part of the analysis by Jakobsson *et al.* (1993) was repeated for the time series of spawning stock biomass and recruitment in the period 1947–1996. A stock recruitment relationship is shown in Figure 7.7.1 along with the lines used to identify the parameters F_{high}, F_{med} and F_{low}.

7.8 Sampling

Investigation	No. of samples	Length measured individuals	Aged individuals
Fishery	78	4183	3723
Acoustic, wintering area	8	2934	703

Table 7.1.1 Icelandic summer spawners. Landings, catches and recommended TACs in thousand tonnes.

Year	Landings	Catches	Recommended TACs
1984	50.3	50.3	50.0
1985	49.1	49.1	50.0
1986	65.5	65.5	65.0
1987	73.0	73.0	70.0
1988	92.8	92.8	100.0
1989	97.3	101.0	90.0
1990/1991	101.6	105.1	90.0
1991/1992	98.5	109.5	79.0
1992/1993	106.7	108.5	86.0
1993/1994	101.5	102.7	90.0
1994/1995	132.0	134.0	120.0
1995/1996	125.0	125.9	110.0
1996/1997	95.9	95.9	100.0
1997/1998	64.7	64.7	100.0
1998/1999	87.0	87.0	90.0
1999/2000*	92.9	92.9	100.0

*Preliminary

Table 7.1.2 Icelandic summer spawners. Catch in tonnes by Icelandic squares, ICES rectangles and months.

Icelandic squares	ICES rectangels	September 1999	October 1999	November 1999	December 1999	January 2000
363			30	40		
365		10				
366			1230	620		
367	55 D2			830		
373	56 C6			110		
412	57 D7	625	870	350	241	2326
413	57 D6	2332	5318	70		
414	57 D5		200			
424	57 C5			3620		843
425	57 C4			4025	89	
426	57 C3			710		
461					304	
462	58 D7	226	2200		228	628
463			1535			
473	58 C6			200	380	
474	58 C5			310		246
475	58 C4			8426	3496	1292
476	58 C3		400	7848	2394	1539
511	59 D8				823	
512	59 D7		230	10	1989	
525					1716	739
526					4465	9146
561	60 D8			470	773	
562	60 D7		805	2145	1944	
563	60 D6		5717	5021	25	
612	59 D7		375			
613			280			
614			60			
Total		3194	19250	34800	18893	16759

Table 7.1.3 Icelandic summer spawners. Catch in numbers (millions) and total catch in weight (thous. tonnes). Age in years is number of rings+1.

Rings/Year	1979	1980	1981	1982	1983	1984	1985
1	0.929	3.147	2.283	0.454	1.475	0.421	0.112
2	15.098	14.347	4.629	19.187	22.499	18.015	12.872
3	47.561	20.761	16.771	28.109	151.718	32.244	24.659
4	69.735	60.727	12.126	38.280	30.285	141.354	21.656
5	16.451	65.328	36.871	16.623	21.599	17.043	85.210
6	8.003	11.541	41.917	38.308	8.667	7.113	11.903
7	26.040	9.285	7.299	43.770	14.065	3.916	5.740
8	3.050	19.442	4.863	6.813	13.713	4.113	2.336
9	1.869	1.796	13.416	6.633	3.728	4.517	4.363
10	0.494	1.464	1.032	10.457	2.381	1.828	4.053
11	0.439	0.698	0.884	2.354	3.436	0.202	2.773
12	0.032	0.001	0.760	0.594	0.554	0.255	0.975
13	0.054	0.110	0.101	0.075	0.100	0.260	0.480
14	0.006	0.079	0.062	0.211	0.003	0.003	0.581
Catch	45.072	53.268	39.544	56.528	58.867	50.304	49.368

Rings/year	1986	1987	1988	1989	1990	1991	1992
1	0.100	0.029	0.879	3.974	11.009	35.869	12.006
2	8.172	3.144	4.757	22.628	14.345	92.758	79.782
3	33.938	44.590	41.331	26.649	57.024	51.047	131.543
4	23.452	60.285	99.366	77.824	34.347	87.606	43.787
5	20.681	20.622	69.331	188.654	77.819	33.436	56.083
6	77.629	19.751	22.955	43.114	152.236	54.840	41.932
7	18.252	46.240	20.131	8.116	32.265	109.418	36.224
8	10.986	15.232	32.201	5.897	8.713	9.251	44.765
9	8.594	13.963	12.349	7.292	4.432	3.796	9.244
10	9.675	10.179	10.250	4.780	4.287	2.634	2.259
11	7.183	13.216	7.378	3.449	2.517	1.826	0.582
12	3.682	6.224	7.284	1.410	1.226	0.516	0.305
13	2.918	4.723	4.807	0.844	1.019	0.262	0.203
14	1.788	2.280	1.957	0.348	0.610	0.298	0.102
Catch	65.500	75.439	92.828	101.000	105.097	109.489	108.504

Rings/Year	1993	1994	1995	1996	1997	1998	1999
1	0.869	6.225	7.411	1.100	9.323	16.161	0.629
2	35.560	110.079	26.221	18.723	27.072	37.787	43.537
3	170.106	99.377	159.170	45.304	28.397	151.853	65.871
4	87.363	150.310	86.940	92.948	29.451	42.833	145.127
5	25.146	90.824	105.542	69.878	42.267	19.872	24.653
6	28.802	23.926	74.326	86.261	35.285	30.280	20.614
7	18.306	20.809	20.076	37.447	28.506	22.572	25.853
8	24.268	19.164	13.797	13.207	21.828	32.779	21.163
9	14.318	17.973	8.873	6.854	8.160	14.366	14.436
10	3.639	16.222	9.140	4.012	3.815	4.802	6.973
11	0.878	2.955	7.079	1.672	1.696	2.199	2.164
12	0.300	1.433	2.376	4.179	6.570	1.084	2.426
13	0.200	0.345	0.927	1.672	1.378	5.081	0.473
14	0.100	0.345	0.124	0.100	1.802	3.036	0.961
Catch	102.741	134.003	125.851	95.882	64.682	86.998	92.896

Table 7.2.1 Icelandic summer spawners. Weight at age (g). Age in years is number of rings+1.

Rings/Year	1979	1980	1981	1982	1983	1984	1985
1	75	69	61	65	59	49	53
2	145	115	141	141	132	131	146
3	182	202	190	186	180	189	219
4	231	232	246	217	218	217	266
5	285	269	269	274	260	245	285
6	316	317	298	293	309	277	315
7	334	352	330	323	329	315	335
8	350	360	356	354	356	322	365
9	367	380	368	385	370	351	388
10	368	383	405	389	407	334	400
11	371	393	382	400	437	362	453
12	350	390	400	394	459	446	469
13	350	390	400	390	430	417	433
14	450	390	400	420	472	392	447

Rings/Year	1986	1987	1988	1989	1990	1991	1992
1	60	60	75	63	75	74	63
2	140	168	157	130	119	139	144
3	200	200	221	206	198	188	190
4	252	240	239	246	244	228	232
5	282	278	271	261	273	267	276
6	298	304	298	290	286	292	317
7	320	325	319	331	309	303	334
8	334	339	334	338	329	325	346
9	373	356	354	352	351	343	364
10	380	378	352	369	369	348	392
11	394	400	371	389	387	369	444
12	408	404	390	380	422	388	399
13	405	424	408	434	408	404	419
14	439	430	437	409	436	396	428

Rings/Year	1993	1994	1995	1996	1997	1998	1999	2000*
1	74	67	69	78	62	78	64	70
2	150	135	129	140	137	147	143	134
3	212	204	178	166	197	184	211	197
4	245	249	236	208	234	213	236	251
5	288	269	276	258	270	246	268	272
6	330	302	292	294	299	286	300	297
7	358	336	314	312	323	314	318	323
8	373	368	349	324	342	341	349	337
9	387	379	374	360	358	351	347	360
10	401	398	381	349	363	354	377	373
11	425	387	400	388	373	350	359	388
12	387	421	409	403	412	372	403	400
13	414	402	438	385	394	400	408	410
14	420	390	469	420	429	437	445	425

* Predicted

Table 7.2.2 Icelandic summer spawners. Proportion mature at age.
Age in years is number of rings+1.

Rings/Year	1979	1980	1981	1982	1983	1984	1985
1	0.000	0.000	0.000	0.020	0.000	0.000	0.000
2	0.070	0.050	0.030	0.050	0.000	0.010	0.000
3	0.650	0.920	0.650	0.850	0.640	0.820	0.900
4	0.980	1.000	0.990	1.000	1.000	1.000	1.000
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Rings/Year	1986	1987	1988	1989	1990	1991	1992
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.030	0.010	0.045	0.060	0.000	0.013	0.020
3	0.890	0.870	0.900	0.930	0.780	0.720	0.930
4	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Rings/Year	1993	1994	1995	1996	1997	1998	1999	2000*
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.049	0.054	0.157	0.049	0.160	0.265	0.074	0.166
3	0.999	1.000	0.982	0.990	0.925	0.935	0.879	0.913
4	1.000	0.992	0.998	1.000	0.989	0.995	0.977	0.987
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

* Predicted (mean of 97-99)

Table 7.3.1 Acoustic estimates (in millions) of the Icelandic summer spawning herring, 1974-2000. The surveys are conducted in October-December or January. The year given is the following year, i.e. if the survey is conducted in the season 1973/1974, then 1974 is given.

Rings/Year	74	75	76	77	78	79	80	81	82	83	84	85	86	87
1	-	-	-	-	-	-	-	625	-	-	-	-	201	-
2	154	5	136	-	212	158	19	361	17	-	171	28	652	-
3	-	137	20	-	424	334	177	462	75	-	310	67	208	-
4	-	19	133	-	46	215	360	85	159	-	724	56	110	-
5	-	21	17	-	19	49	253	170	42	-	80	360	86	-
6	-	2	10	-	139	20	51	182	123	-	39	65	425	-
7	-	2	3	-	18	111	41	33	162	-	15	32	67	-
8	-	-	3	-	18	30	93	29	24	-	27	16	41	-
9	-	-	-	-	10	30	10	58	8	-	26	17	17	-
10	-	-	-	-	-	20	-	10	46	-	10	18	27	-
11	-	-	-	-	-	-	-	-	10	-	5	9	26	-
12	-	-	-	-	-	-	-	-	-	-	12	7	16	-
13	-	-	-	-	-	-	-	-	-	-	-	4	6	-
14	-	-	-	-	-	-	-	-	-	-	-	5	6	-
15	-	-	-	-	-	-	-	-	-	-	-	5	1	-
5+	-	25	33	-	204	260	448	482	415	-	214	538	718	-

Rings/Year	88	89	90	91	92	93	94	95	96	97	98	99	2000
1	406	370	-	710	465	1418	183	-	845	266	1629	-	1069
2	126	725	178	805	745	254	234	-	98	792	237	-	527
3	352	181	593	227	850	858	533	-	165	65	716	188	740
4	836	249	177	304	353	687	860	-	515	139	100	790	296
5	287	381	302	137	273	160	443	-	316	459	116	240	606
6	53	171	538	176	94	99	55	-	361	280	240	101	99
7	37	42	185	387	81	87	69	-	166	410	161	73	71
8	76	23	-	40	210	44	43	-	110	150	130	47	164
9	25	30	-	10	32	92	86	-	52	101	97	77	108
10	21	16	-	2	11	39	55	-	29	50	35	47	98
11	14	10	18	-	-	-	2	-	16	35	15	10	15
12	17	9	-	-	17	-	-	-	27	15	11	10	44
13	8	5	-	-	-	-	-	-	19	65	43	-	5
14	6	3	-	-	-	-	-	-	8	32	8	22	13
15	3	2	-	-	-	-	-	-	2	-	15	-	7
5+	547	692	1043	752	718	521	753	-	1105	1597	870	627	1230

Table 7.4.1 Icelandic summer spawners. Stock abundance and catches by age group (millions) and fishing mortality rate. F_{ac} is the F calculated from the acoustic survey estimates for 1-4 ringers in 1999. F_{99} is the F in 1999 and F_{p99} is the exploitation pattern in 1999 (used in prognosis).

Rings in 1999	Year class	Acoustic estimate Dec. 99	Catch 1999/2000	F_{ac}	F_{99}	F_{p99}
1	1997	527	0.629	0.001	0.001	0.048
2	1996	740	43.537	0.054	0.049	0.219
3	1995	296	65.871	0.191	0.185	0.661
4+	1994	1230	264.843	0.186	0.185	1.000

Table 7.4.2 Icelandic summer spawners. Fishing mortality at age. Age in years is number of rings+1.

```
Run title : Herring summer-spawn (run: SVPAGB08/V08)

   At 28/04/2000  17:35

                Traditional vpa  using file input  for terminal F
```

Table 8 Fishing mortality (F) at age

AGE	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	.0131	.0027	.0020	.0071	.0009	.0001	.0002	.0001	.0018	.0116
2	.0697	.0217	.0257	.1164	.1008	.0308	.0077	.0058	.0165	.0532
3	.1648	.0979	.1589	.2576	.2174	.1749	.0957	.0480	.0878	.1087
4	.2833	.1229	.2999	.2293	.3599	.1988	.2241	.2193	.1290	.2117
5	.3255	.2483	.2206	.2461	.1748	.3406	.2640	.2797	.3728	.3403
6	.2019	.3186	.3904	.1535	.1072	.1595	.5242	.3835	.5046	.3718
7	.2431	.1701	.5658	.2157	.0865	.1064	.3463	.6040	.7445	.2970
8	.3663	.1736	.2123	.3066	.0811	.0615	.2707	.4800	1.0113	.4443
9	.1233	.4114	.3361	.1544	.1402	.1043	.2974	.5720	.7997	.5786
10	.5732	.0870	.5759	.1728	.0949	.1616	.3132	.6018	.9785	.7428
11	.5576	.7254	.2599	.3332	.0179	.1825	.4197	.8052	1.0751	.9613
12	.0017	2.1832	1.5429	.0805	.0331	.1012	.3472	.6895	1.3869	.5267
13	.5094	.2034	1.9670	1.1594	.0445	.0725	.4320	.8815	1.8326	.4898
14	.3220	.5340	.7310	.3220	.0760	.1190	.3690	.6270	1.0420	.5520
+gp	.3220	.5340	.7310	.3220	.0760	.1190	.3690	.6270	1.0420	.5520
FBAR 4-14	.3189	.4707	.6456	.3067	.1106	.1462	.3461	.5585	.8979	.5015
W.Ave 4-14	.297	.246	.366	.224	.255	.228	.360	.379	.294	.313

Table 8 Fishing mortality (F) at age

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	FBAR 97-99
1	.0124	.0320	.0163	.0010	.0174	.0222	.0008	.0179	.0159	.0010	.0116
2	.0475	.1233	.0831	.0551	.1579	.0852	.0646	.0220	.0841	.0490	.0517
3	.1649	.2121	.2300	.2282	.1921	.3188	.1860	.1186	.1484	.1850	.1507
4	.1785	.3624	.2534	.2105	.2880	.2290	.2776	.1589	.2354	.1850	.1931
5	.3017	.2359	.3696	.2023	.3133	.2997	.2595	.1754	.1375	.1850	.1660
6	.4481	.3205	.4589	.2929	.2687	.4042	.3790	.1809	.1647	.1850	.1768
7	.4655	.5952	.3227	.3302	.3171	.3365	.3251	.1846	.1510	.1850	.1736
8	.5267	.2086	.4592	.3312	.6009	.3194	.3437	.2844	.2976	.1850	.2557
9	.6235	.4067	.2956	.2312	.3874	.5476	.2316	.3286	.2735	.1850	.2624
10	.7104	.8380	.4006	.1623	.3933	.3094	.4535	.1748	.2918	.1850	.2172
11	1.0211	.6680	.3878	.2385	.1721	.2648	.0763	.3126	.1298	.1850	.2091
12	1.0059	.5176	.1937	.3148	.6608	.1826	.2205	.4204	.3000	.1850	.3018
13	.8042	.5297	.3498	.1684	.6330	1.0997	.1693	.0943	.5907	.1850	.2900
14	.7010	.5110	.3580	.2590	.4290	.4330	.2750	.2480	.2750	.1850	.2360
FBAR 4-14	.6170	.4721	.3499	.2492	.4058	.4023	.2737	.2330	.2588	.1850	
W.Av.4-14	.364	.388	.356	.238	.313	.300	.298	.193	.206	.185	

Table 7.4.3 Icelandic summer spawners. VPA stock size (thousands) and SSB (tonnes).
Age in years is number of rings+1.

Run title : Herring summer-spawn (run: SVPAGB08/V08)

At 28/04/2000 17:35

Traditional vpa using file input for terminal F

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,
AGE										
1,	253928,	880322,	237989,	219458,	492441,	1230086,	634245,	337358,	507855,	363082,
2,	223687,	226772,	794378,	214910,	197171,	445178,	1112921,	573793,	305226,	458690,
3,	143422,	188766,	200791,	700543,	173086,	161293,	390578,	999243,	516201,	271658,
4,	258031,	110060,	154869,	154992,	489928,	126012,	122531,	321166,	861772,	427807,
5,	246414,	175870,	88069,	103824,	111501,	309302,	93463,	88614,	233387,	685384,
6,	66211,	161016,	124148,	63911,	73449,	84709,	199077,	64948,	60618,	145458,
7,	45117,	48955,	105943,	76027,	49599,	59702,	65345,	106639,	40047,	33115,
8,	66405,	32013,	37366,	54437,	55443,	41158,	48568,	41822,	52744,	17212,
9,	16254,	41656,	24349,	27344,	36251,	46259,	35021,	33524,	23416,	17359,
10,	3509,	13001,	24979,	15743,	21202,	28512,	37712,	23537,	17120,	9523,
11,	1708,	1790,	10783,	12706,	11984,	17447,	21950,	24948,	11667,	5822,
12,	637,	885,	784,	7524,	8239,	10651,	13153,	13054,	10090,	3603,
13,	288,	576,	90,	152,	6281,	7213,	8710,	8411,	5927,	2281,
14,	301,	157,	425,	11,	43,	5436,	6070,	5117,	3152,	858,
TOTAL,	1325916,	1881842,	1804966,	1651586,	1726633,	2572968,	2789349,	2642176,	2649224,	2441855,
TOTSPBIO,	212878,	186411,	192941,	220003,	233045,	250175,	262054,	368104,	427213,	393316,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE								
1,	939405,	1198188,	782587,	875073,	378998,	355041,	1444230,	553452,
2,	324752,	839542,	1050069,	696700,	790971,	337014,	314209,	1305748,
3,	393534,	280213,	671542,	874335,	596604,	611171,	280028,	266515,
4,	220490,	301938,	205096,	482800,	629695,	445490,	402067,	210370,
5,	313229,	166898,	190157,	144032,	353933,	427194,	320588,	275631,
6,	441289,	209614,	119286,	118899,	106456,	234118,	286438,	223781,
7,	90748,	255081,	137661,	68215,	80265,	73627,	141404,	177418,
8,	22264,	51552,	127279,	90210,	44366,	52893,	47584,	92438,
9,	9988,	11897,	37865,	72765,	58614,	22012,	34776,	30534,
10,	8807,	4845,	7168,	25494,	52252,	36002,	11519,	24962,
11,	4100,	3916,	1896,	4345,	19613,	31905,	23908,	6622,
12,	2014,	1336,	1817,	1164,	3097,	14941,	22153,	20044,
13,	1925,	667,	721,	1354,	769,	1447,	11263,	16078,
14,	1265,	779,	355,	460,	1036,	369,	436,	8604,
TOTAL,	2773812,	3326468,	3333503,	3455850,	3116672,	2643227,	3340607,	3212202,
TOTSPBIO,	354334,	300645,	350420,	465239,	480888,	464402,	378565,	377899,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1998,	1999,	2000,	GMST 47-97	AMST 47-97
AGE					
1,	1073908,	661299,	0,	299287,	420713,
2,	491921,	956347,	597770,	255681,	364662,
3,	1155753,	409205,	823959,	190034,	279775,
4,	214179,	901560,	307728,	129705,	200830,
5,	162385,	153150,	677986,	81355,	138785,
6,	209271,	128059,	115171,	48131,	90142,
7,	168985,	160604,	96302,	28089,	55203,
8,	133471,	131469,	120777,	15060,	31799,
9,	62936,	89680,	98867,	8362,	19665,
10,	19891,	43318,	67440,	4707,	12895,
11,	18964,	13443,	32576,	2459,	8152,
12,	4384,	15071,	10110,	1365,	5399,
13,	11911,	2938,	11333,	713,	3507,
14,	13239,	5970,	2210,	305,	2152,
TOTAL,	3741202,	3672119,	2966722,		
TOTSPBIO,	486172,	506709,			

Table 7.4.4 Icelandic summer spawners.

Run title : Herring summer-spawn (run: SVPAGB08/V08) ,

At 28/04/2000 17:35

Table 17 Summary (with SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 4-14,
1947,	179506,	172244,	126736,	47800,	.3772,	.9923,	.3916,
1948,	68007,	134015,	101459,	56800,	.5598,	.9343,	2.1742,
1949,	77472,	93518,	76142,	5400,	.0709,	.9479,	.0882,
1950,	197367,	162383,	119850,	13600,	.1135,	1.3783,	.1742,
1951,	116475,	129882,	88394,	15800,	.1787,	1.0075,	.2071,
1952,	323928,	117213,	79459,	10500,	.1321,	.7904,	.3858,
1953,	197295,	215685,	134014,	17600,	.1313,	1.2380,	.3833,
1954,	167414,	165084,	124396,	11000,	.0884,	.8459,	.1406,
1955,	191196,	162663,	127308,	20500,	.1610,	.7515,	.1194,
1956,	469184,	236683,	165691,	20400,	.1231,	.9754,	.2495,
1957,	791378,	247235,	139749,	22800,	.1631,	.7770,	.2522,
1958,	369217,	328224,	197382,	33500,	.1697,	.9887,	.2422,
1959,	555110,	374149,	272138,	35000,	.1286,	.9781,	.2493,
1960,	712881,	231612,	161362,	28500,	.1766,	.6234,	.0406,
1961,	531006,	349041,	254629,	74000,	.2906,	.8878,	.3056,
1962,	525297,	295216,	222430,	92900,	.4177,	.7173,	.4133,
1963,	467070,	307439,	222164,	130300,	.5865,	.8319,	.7999,
1964,	585838,	229302,	167159,	86500,	.5175,	.8833,	.8644,
1965,	507385,	217451,	128389,	122900,	.9572,	.8198,	1.2481,
1966,	99675,	147522,	80319,	58400,	.7271,	.9593,	.8179,
1967,	39216,	94098,	79386,	67700,	.8528,	.8889,	1.3970,
1968,	178055,	41548,	24212,	16800,	.6939,	.8833,	.8007,
1969,	46316,	42715,	16436,	20913,	1.2724,	.9925,	.9695,
1970,	33782,	31099,	20521,	16445,	.8014,	1.0422,	1.4174,
1971,	70414,	24573,	14014,	11831,	.8442,	1.0780,	1.6255,
1972,	89707,	31556,	12350,	370,	.0300,	1.1927,	.1959,
1973,	417963,	73483,	28577,	254,	.0089,	.9975,	.0541,
1974,	131875,	121521,	45931,	1275,	.0278,	1.0009,	.0379,
1975,	198506,	162809,	116938,	13280,	.1136,	1.0000,	.1176,
1976,	554241,	224953,	129361,	17168,	.1327,	1.0000,	.1808,
1977,	436184,	257809,	132997,	28925,	.2175,	1.0000,	.2940,
1978,	195464,	266135,	175673,	37333,	.2125,	1.0000,	.4073,
1979,	248188,	273647,	198404,	45072,	.2272,	1.0001,	.2502,
1980,	253928,	267903,	212746,	53268,	.2504,	.9994,	.3189,
1981,	880322,	293234,	186196,	39544,	.2124,	.9988,	.4707,
1982,	237989,	330396,	192990,	56528,	.2929,	1.0003,	.6456,
1983,	219458,	317633,	219753,	58867,	.2679,	.9989,	.3067,
1984,	492441,	300338,	232855,	50304,	.2160,	.9992,	.1106,
1985,	1230086,	396822,	250236,	49368,	.1973,	1.0002,	.1462,
1986,	634245,	473238,	262035,	65500,	.2500,	.9999,	.3461,
1987,	337358,	528572,	368062,	75439,	.2050,	.9999,	.5585,
1988,	507855,	543828,	426969,	92828,	.2174,	.9994,	.8979,
1989,	363082,	496606,	393197,	101000,	.2569,	.9997,	.5015,
1990,	939405,	498375,	354010,	105097,	.2969,	.9991,	.6170,
1991,	1198188,	534775,	300516,	109489,	.3643,	.9996,	.4721,
1992,	782587,	574452,	350204,	108504,	.3098,	.9994,	.3499,
1993,	875073,	652547,	464826,	102741,	.2210,	.9991,	.2492,
1994,	378998,	634114,	481015,	134003,	.2786,	1.0003,	.4058,
1995,	355041,	551754,	464696,	125851,	.2708,	1.0006,	.4023,
1996,	1444230,	552822,	378526,	95882,	.2533,	.9999,	.2737,
1997,	553452,	586057,	377922,	64395,	.1704,	1.0001,	.2330,
1998,	1073908,	660915,	486207,	86999,	.1789,	1.0001,	.2588,
1999,	661299,	718006,	507085,	92896,	.1832,	1.0007,	.1850,
Arith. Mean ,	437577,	299526,	205548,	53775,	.3094		.4725,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 7.4.5 Icelandic summer spawners. Input data for the RCT3 program.

```
Iceland Herring: VPA and acoustic survey data
3 21 2
'Yearcl'   'VPAage2'  'Surv4''Surv3''Surv2'
1978       254        75       361     -11
1979       880        -11      17      625
1980       238        310      -11     -11
1981       219        67       171     -11
1982       492        208      28      -11
1983       1230       -11      652     -11
1984       634        352      -11     201
1985       337        181      126     -11
1986       508        593      725     406
1987       363        227      178     370
1988       939        850      805     -11
1989       1198       858      745     710
1990       783        533      254     465
1991       875        -11      234     1418
1992       378        165      -11     183
1993       355        65       98      -11
1994       1444       716      792     845
1995       553        188      237     266
1996       -11        740      -11     1629
1997       -11        -11      527     -11
1998       -11        -11      -11     1069
```

Table 7.4.6 Icelandic summer spawners. Input data for the RCT3 program.

```
Analysis by RCT3 ver3.1 of data from file :

 adhighf.dat

 Iceland Herring: VPA and acoustic survey data

 Data for    3 surveys over   21 years :  1978 - 1998

 Regression type = C
 Tapered time weighting applied
 power =    3 over  20 years
 Survey weighting not applied

 Final estimates shrunk towards mean
 Minimum S.E. for any survey taken as    .20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Year class =   1996

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4      .75   2.05    .38   .699     15   6.61    7.03     .467     .458
 Surv3
 Surv2      .96    .65    .48   .553     10   7.40    7.76     .695     .207

                                        VPA Mean =    6.43     .546     .336

Year class =   1997

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4
 Surv3      .84   1.71    .59   .491     15   6.27    6.99     .715     .363
 Surv2

                                        VPA Mean =    6.45     .540     .637

 Year class =   1998

          I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4
 Surv3
 Surv2      .94    .76    .47   .576     10   6.98    7.34     .649     .405

                                        VPA Mean =    6.46     .536     .595
```

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1996	1075	6.98	.32	.34	1.14		
1997	768	6.64	.43	.26	.37		
1998	912	6.82	.41	.43	1.08		

Table 7.5.1

The SAS System 14:51 Saturday, April 29, 2000

Icelandic summer-spawning herring (Division Va)

Single option prediction: Input data

Year: 2000

Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	912.000	0.1000	0.0000	0.0000	0.5000	0.070	0.0089	0.070
2	694.929	0.1000	0.1660	0.0000	0.5000	0.134	0.0405	0.134
3	825.125	0.1000	0.9130	0.0000	0.5000	0.197	0.1223	0.197
4	307.728	0.1000	0.9870	0.0000	0.5000	0.251	0.1850	0.251
5	677.986	0.1000	1.0000	0.0000	0.5000	0.272	0.1850	0.272
6	115.171	0.1000	1.0000	0.0000	0.5000	0.297	0.1850	0.297
7	96.302	0.1000	1.0000	0.0000	0.5000	0.323	0.1850	0.323
8	120.777	0.1000	1.0000	0.0000	0.5000	0.337	0.1850	0.337
9	98.867	0.1000	1.0000	0.0000	0.5000	0.360	0.1850	0.360
10	67.440	0.1000	1.0000	0.0000	0.5000	0.373	0.1850	0.373
11	32.576	0.1000	1.0000	0.0000	0.5000	0.388	0.1850	0.388
12	10.110	0.1000	1.0000	0.0000	0.5000	0.400	0.1850	0.400
13	11.333	0.1000	1.0000	0.0000	0.5000	0.410	0.1850	0.410
14	2.210	0.1000	1.0000	0.0000	0.5000	0.425	0.1850	0.425
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2001

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	650.000	0.1000	0.0000	0.0000	0.5000	0.070	0.0089	0.070
2	.	0.1000	0.1660	0.0000	0.5000	0.134	0.0405	0.134
3	.	0.1000	0.9130	0.0000	0.5000	0.197	0.1223	0.197
4	.	0.1000	0.9870	0.0000	0.5000	0.251	0.1850	0.251
5	.	0.1000	1.0000	0.0000	0.5000	0.272	0.1850	0.272
6	.	0.1000	1.0000	0.0000	0.5000	0.297	0.1850	0.297
7	.	0.1000	1.0000	0.0000	0.5000	0.323	0.1850	0.323
8	.	0.1000	1.0000	0.0000	0.5000	0.337	0.1850	0.337
9	.	0.1000	1.0000	0.0000	0.5000	0.360	0.1850	0.360
10	.	0.1000	1.0000	0.0000	0.5000	0.373	0.1850	0.373
11	.	0.1000	1.0000	0.0000	0.5000	0.388	0.1850	0.388
12	.	0.1000	1.0000	0.0000	0.5000	0.400	0.1850	0.400
13	.	0.1000	1.0000	0.0000	0.5000	0.410	0.1850	0.410
14	.	0.1000	1.0000	0.0000	0.5000	0.425	0.1850	0.425
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2002

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	650.000	0.1000	0.0000	0.0000	0.5000	0.070	0.0089	0.070
2	.	0.1000	0.1660	0.0000	0.5000	0.134	0.0405	0.134
3	.	0.1000	0.9130	0.0000	0.5000	0.197	0.1223	0.197
4	.	0.1000	0.9870	0.0000	0.5000	0.251	0.1850	0.251
5	.	0.1000	1.0000	0.0000	0.5000	0.272	0.1850	0.272
6	.	0.1000	1.0000	0.0000	0.5000	0.297	0.1850	0.297
7	.	0.1000	1.0000	0.0000	0.5000	0.323	0.1850	0.323
8	.	0.1000	1.0000	0.0000	0.5000	0.337	0.1850	0.337
9	.	0.1000	1.0000	0.0000	0.5000	0.360	0.1850	0.360
10	.	0.1000	1.0000	0.0000	0.5000	0.373	0.1850	0.373
11	.	0.1000	1.0000	0.0000	0.5000	0.388	0.1850	0.388
12	.	0.1000	1.0000	0.0000	0.5000	0.400	0.1850	0.400
13	.	0.1000	1.0000	0.0000	0.5000	0.410	0.1850	0.410
14	.	0.1000	1.0000	0.0000	0.5000	0.425	0.1850	0.425
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRAGB02
Date and time: 29APR00:14:53

Table 7.5.2

The SAS System 14:51 Saturday, April 29, 2000
Icelandic summer-spawning herring (Division Va)

Single option prediction: Detailed tables

Year: 2000 F-factor: 1.1890 Reference F: 0.2200

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1	0.0106	9116	636	912000	63658	0	0	0	0
2	0.0482	31118	4170	694929	93120	115358	15458	109732	14704
3	0.1454	106388	20937	825125	162385	753339	148257	716598	141027
4	0.2200	57928	14546	307728	77271	303728	76266	288915	72546
5	0.2200	127628	34677	677986	184209	677986	184209	644920	175225
6	0.2200	21680	6448	115171	34252	115171	34252	109554	32581
7	0.2200	18128	5855	96302	31106	96302	31106	91605	29589
8	0.2200	22736	7669	120777	40738	120777	40738	114887	38751
9	0.2200	18611	6708	98867	35632	98867	35632	94045	33894
10	0.2200	12695	4732	67440	25135	67440	25135	64151	23909
11	0.2200	6132	2382	32576	12653	32576	12653	30987	12035
12	0.2200	1903	760	10110	4039	10110	4039	9617	3842
13	0.2200	2133	874	11333	4643	11333	4643	10780	4417
14	0.2200	416	177	2210	940	2210	940	2102	894
Total		436615	110570	3972554	769779	2405197	613326	2287894	583414
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2001 F-factor: 1.1890 Reference F: 0.2200

Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1	0.0106	6497	454	650000	45370	0	0	0	0
2	0.0482	36564	4900	816545	109417	135546	18163	128936	17277
3	0.1454	77261	15205	599222	117927	547089	107667	520407	102416
4	0.2200	121526	30515	645569	162102	637177	159995	606101	152192
5	0.2200	42066	11429	223464	60715	223464	60715	212566	57754
6	0.2200	92680	27563	492336	146421	492336	146421	468325	139280
7	0.2200	15744	5085	83634	27014	83634	27014	79555	25696
8	0.2200	13164	4440	69932	23588	69932	23588	66521	22438
9	0.2200	16510	5950	87705	31609	87705	31609	83428	30067
10	0.2200	13515	5037	71795	26758	71795	26758	68293	25453
11	0.2200	9219	3581	48973	19021	48973	19021	46585	18094
12	0.2200	4453	1779	23656	9451	23656	9451	22502	8990
13	0.2200	1382	566	7342	3008	7342	3008	6984	2861
14	0.2200	1549	659	8230	3500	8230	3500	7828	3329
Total		452131	117163	3828402	785901	2436879	636910	2318031	605847
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 7.5.2 (Continued)

The SAS System 14:51 Saturday, April 29, 2000
Icelandic summer-spawning herring (Division Va)

Single option prediction: Detailed tables
(cont.)

Year: 2002	F-factor: 1.1890	Reference F: 0.2200			1 January			Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0106	6497	454	650000	45370	0	0	0	0
2	0.0482	26060	3492	581967	77984	96607	12945	91895	12314
3	0.1454	90782	17866	704088	138565	642832	126509	611481	120339
4	0.2200	88254	22161	468825	117722	462730	116191	440162	110525
5	0.2200	88249	23977	468796	127372	468796	127372	445932	121160
6	0.2200	30547	9085	162274	48260	162274	48260	154360	45907
7	0.2200	67302	21739	357522	115480	357522	115480	340085	109848
8	0.2200	11433	3856	60733	20485	60733	20485	57771	19486
9	0.2200	9560	3445	50783	18302	50783	18302	48306	17410
10	0.2200	11989	4468	63689	23737	63689	23737	60583	22579
11	0.2200	9814	3812	52135	20249	52135	20249	49593	19262
12	0.2200	6695	2674	35563	14207	35563	14207	33829	13515
13	0.2200	3234	1325	17178	7038	17178	7038	16340	6695
14	0.2200	1004	427	5331	2267	5331	2267	5071	2157
Total		451419	118781	3678885	777038	2476174	653044	2355409	621195
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRAGB03
Date and time : 29APR00:15:29
Computation of ref. F: Weighted mean, age 4 - 14
Prediction basis : F factors

The SAS System 14:51 Saturday, April 29, 2000
Icelandic summer-spawning herring (Division Va)

Single option prediction: Summary table

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size (1 January)	Sp.stock biomass (1 January)	Sp.stock size (Spawning time)	Sp.stock biomass (Spawning time)
2000	1.1890	0.2200	436615	110570	3972554	769779	2405197	613326	2287894	583414
2001	1.1890	0.2200	452131	117163	3828402	785901	2436879	636910	2318031	605847
2002	1.1890	0.2200	451419	118781	3678885	777038	2476174	653044	2355409	621195
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRAGB03
Date and time : 29APR00:15:29
Computation of ref. F: Weighted mean, age 4 - 14
Prediction basis : F factors

Table 7.5.3 The SAS System 14:51 Saturday, April 29, 2000

Icelandic summer-spawning herring (Division Va)

Prediction with management option table

Year: 2000					Year: 2001					Year: 2002	
F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp.stock biomass	Catch in weight	Stock biomass	Sp.stock biomass
1.1890	0.2200	769779	583414	110570	0.5000	0.0925	785901	605847	52120	845813	685783
.	.	.	.	.	0.5500	0.1018	.	605847	57096	840553	680841
.	.	.	.	.	0.6000	0.1110	.	605847	62030	835336	675939
.	.	.	.	.	0.6500	0.1203	.	605847	66924	830163	671079
.	.	.	.	.	0.7000	0.1295	.	605847	71777	825032	666260
.	.	.	.	.	0.7500	0.1388	.	605847	76589	819944	661480
.	.	.	.	.	0.8000	0.1480	.	605847	81361	814898	656741
.	.	.	.	.	0.8500	0.1573	.	605847	86094	809894	652041
.	.	.	.	.	0.9000	0.1665	.	605847	90788	804931	647381
.	.	.	.	.	0.9500	0.1758	.	605847	95442	800009	642759
.	.	.	.	.	1.0000	0.1850	.	605847	100058	795128	638176
.	.	.	.	.	1.0500	0.1943	.	605847	104636	790287	633632
.	.	.	.	.	1.1000	0.2035	.	605847	109175	785486	629125
.	.	.	.	.	1.1500	0.2128	.	605847	113678	780725	624655
.	.	.	.	.	1.2000	0.2220	.	605847	118142	776003	620223
.	.	.	.	.	1.2500	0.2313	.	605847	122570	771320	615828
.	.	.	.	.	1.3000	0.2405	.	605847	126961	766675	611469
.	.	.	.	.	1.3500	0.2498	.	605847	131316	762069	607147
.	.	.	.	.	1.4000	0.2590	.	605847	135635	757500	602861
.	.	.	.	.	1.4500	0.2683	.	605847	139919	752969	598610
.	.	.	.	.	1.5000	0.2775	.	605847	144167	748476	594394
.	.	.	.	.	1.5500	0.2868	.	605847	148379	744019	590214
.	.	.	.	.	1.6000	0.2960	.	605847	152558	739599	586068
.	.	.	.	.	1.6500	0.3053	.	605847	156701	735215	581957
.	.	.	.	.	1.7000	0.3145	.	605847	160811	730867	577879
.	.	.	.	.	1.7500	0.3238	.	605847	164886	726555	573836
.	.	.	.	.	1.8000	0.3330	.	605847	168929	722278	569826
.	.	.	.	.	1.8500	0.3423	.	605847	172937	718036	565849
.	.	.	.	.	1.9000	0.3515	.	605847	176913	713829	561905
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAGB04
Date and time : 29APR00:15:37
Computation of ref. F: Weighted mean, age 4 - 14
Basis for 2000 : F factors

Table 7.5.4

The SAS System 14:51 Saturday, April 29, 2000

Icelandic summer-spawning herring (Division Va)

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	650.000	0.1000	0.0000	0.0000	0.5000	0.066	0.0310	0.066
2	.	0.1000	0.0560	0.0000	0.5000	0.139	0.2210	0.139
3	.	0.1000	0.8760	0.0000	0.5000	0.196	0.6220	0.196
4	.	0.1000	0.9970	0.0000	0.5000	0.235	0.8250	0.235
5	.	0.1000	1.0000	0.0000	0.5000	0.269	1.0000	0.269
6	.	0.1000	1.0000	0.0000	0.5000	0.300	1.0000	0.300
7	.	0.1000	1.0000	0.0000	0.5000	0.325	1.0000	0.325
8	.	0.1000	1.0000	0.0000	0.5000	0.345	1.0000	0.345
9	.	0.1000	1.0000	0.0000	0.5000	0.365	1.0000	0.365
10	.	0.1000	1.0000	0.0000	0.5000	0.376	1.0000	0.376
11	.	0.1000	1.0000	0.0000	0.5000	0.393	1.0000	0.393
12	.	0.1000	1.0000	0.0000	0.5000	0.408	1.0000	0.408
13	.	0.1000	1.0000	0.0000	0.5000	0.410	1.0000	0.410
14	.	0.1000	1.0000	0.0000	0.5000	0.425	1.0000	0.425
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDAGB02
Date and time: 29APR00:16:27

Figure 7.4.1 Icelandic summer spawners. Sum of squares used for fitting VPA to acoustic data, as a function of terminal fishing mortality.

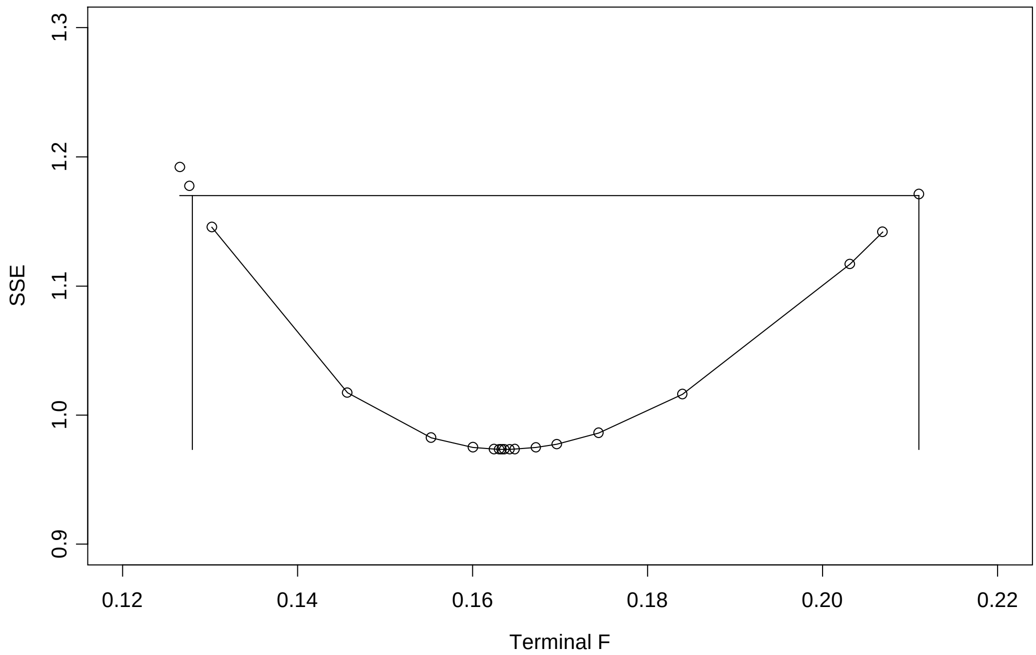


Figure 7.4.2 Icelandic summer spawners. Trend in acoustics and VPA stock numbers.

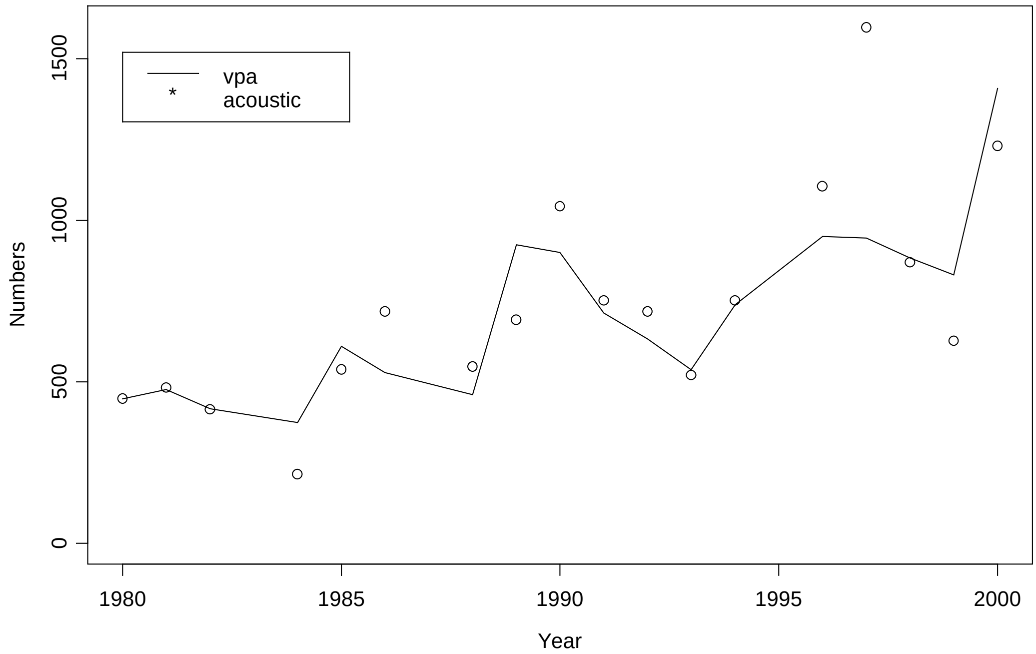


Figure 7.4.3 Icelandic summer spawners. Acoustic estimates vs VPA stock numbers (at the 1st of January).

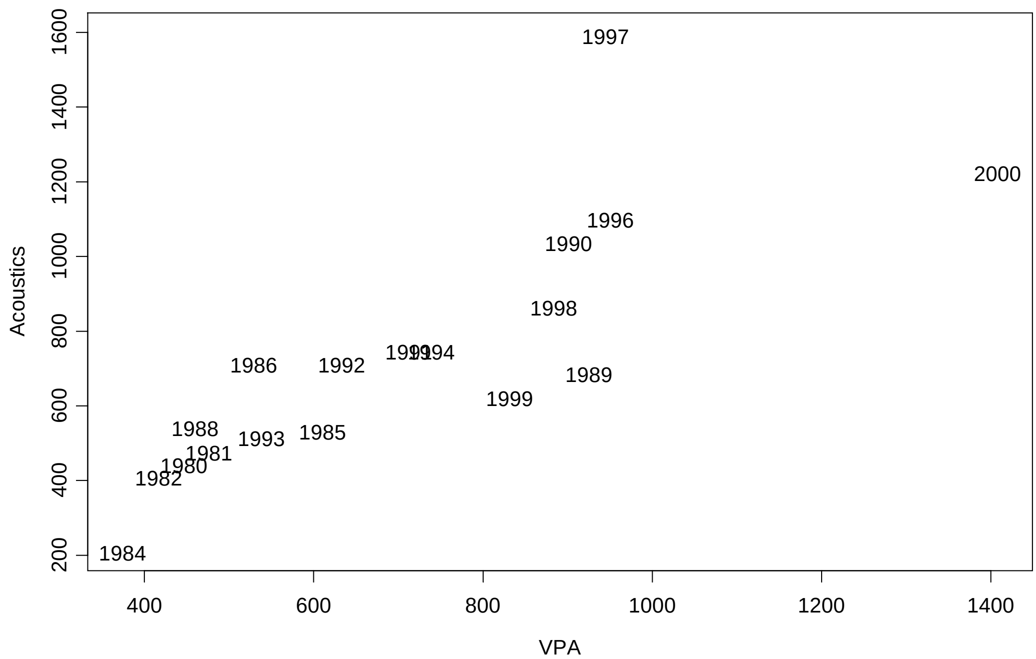


Figure 7.4.4 Retrospective plots

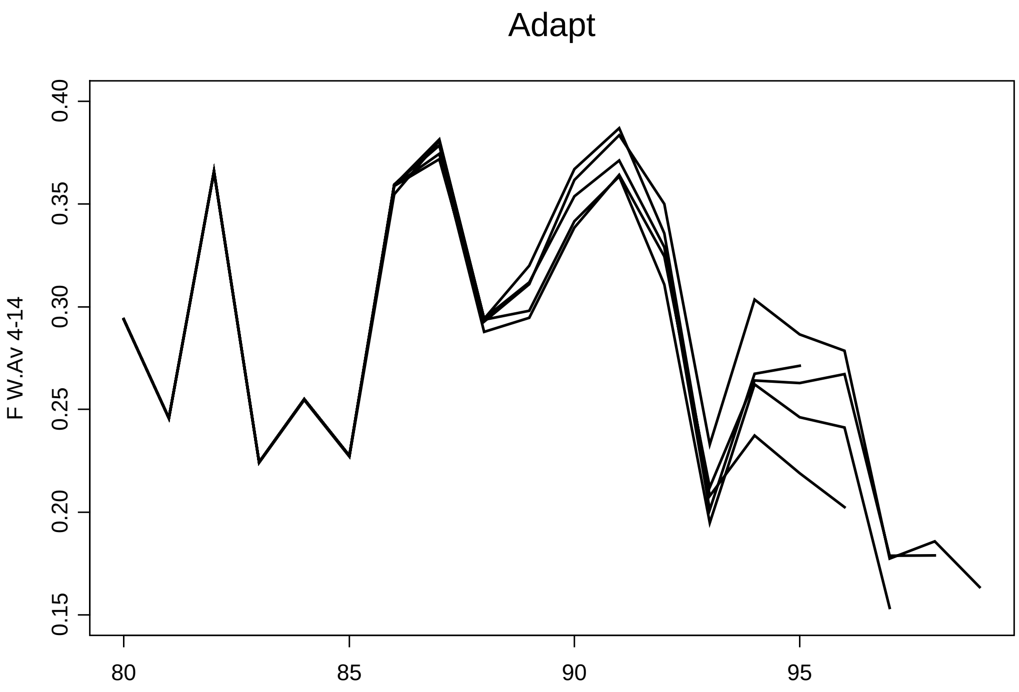
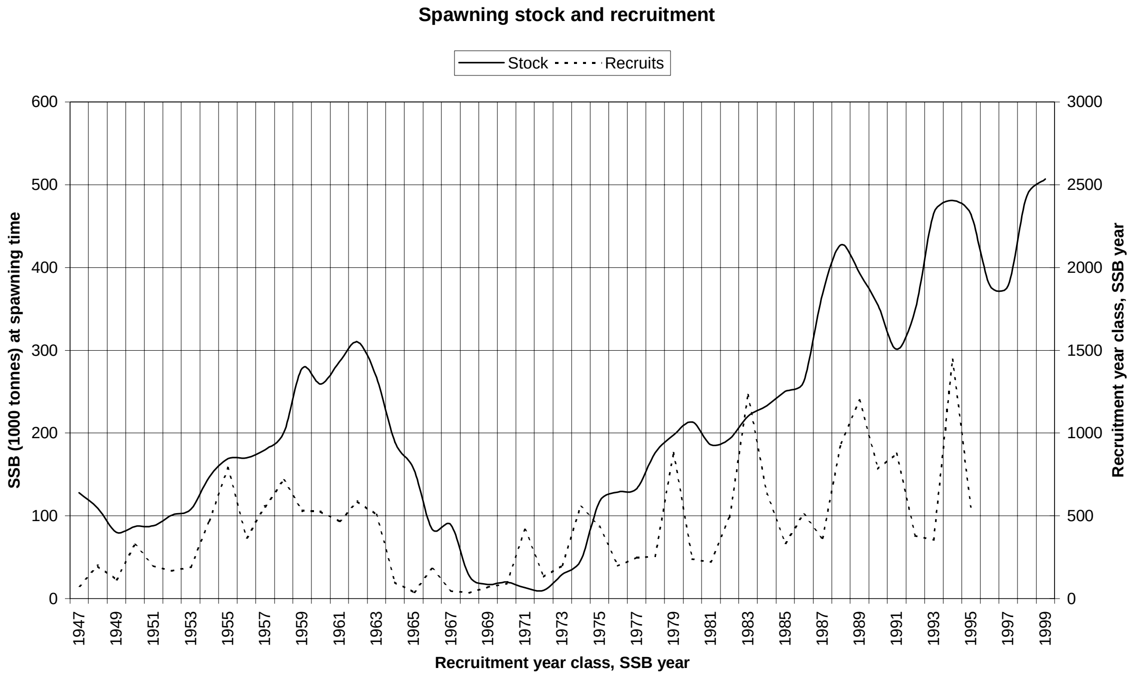


Figure 7.4.5 Fish stock summary. Herring Icelandic Summer-spawning (Fishing Area Va)



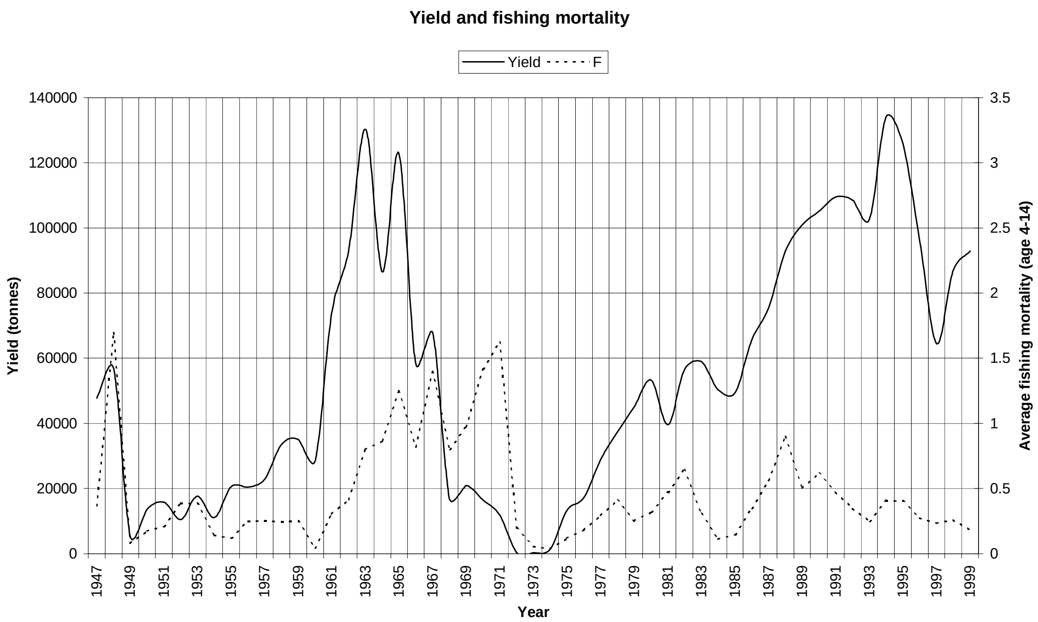


Figure 7.5.1 Fish stock summary. Herring Icelandic summer spawners (Fishing area Va). 2-5-1999

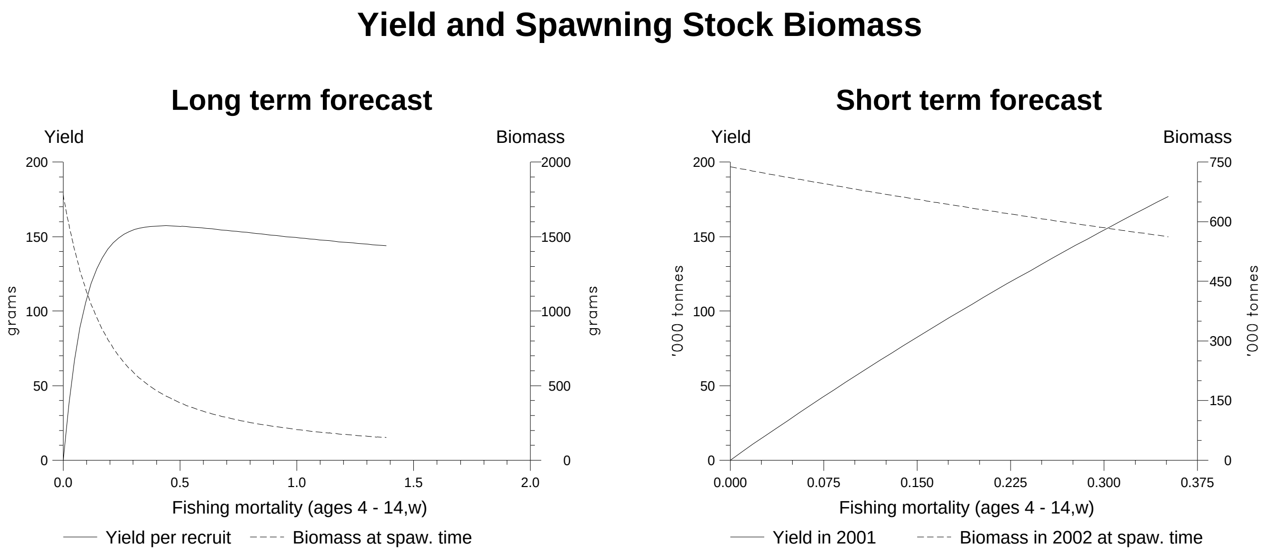
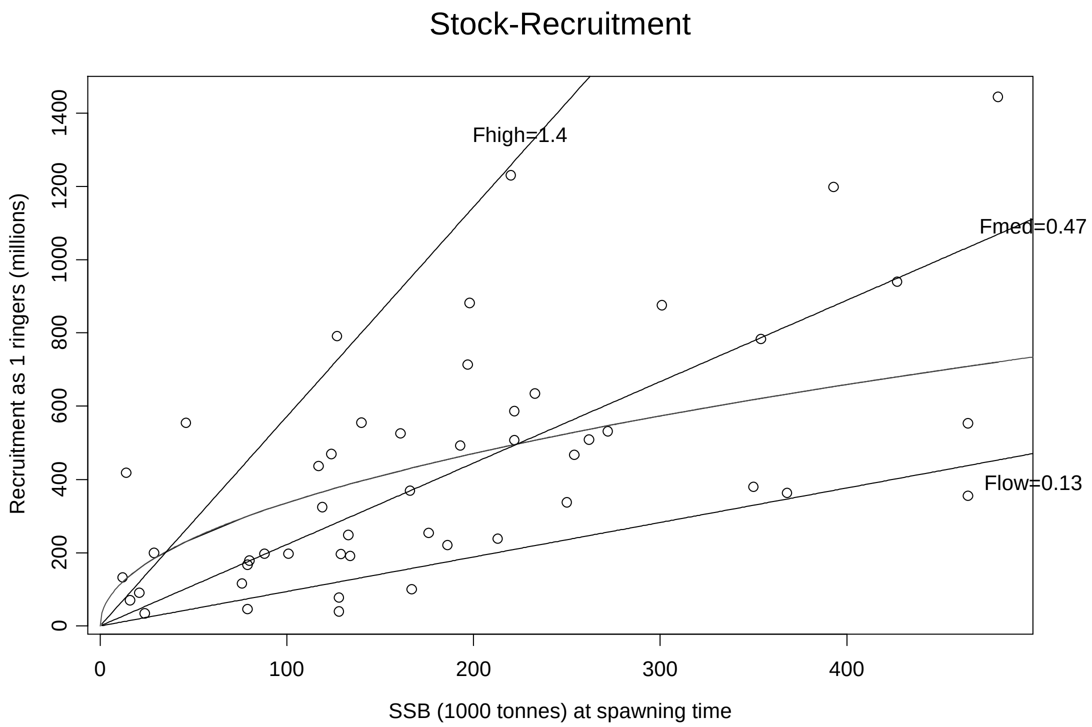


Figure 7.7.1



8 OTHER

8.1 Distribution of Blue Whiting in the Barents Sea

NEAFC has requested that ICES validate information concerning the distribution of blue whiting in the Barents Sea. In the letter from NEAFC it was stated that "During the meeting of the Blue Whiting Working Group of NEAFC on 5 and 6 April 2000, Russia presented a scientific paper dealing with the distribution of blue whiting in the Barents Sea. In order to further discuss the management of the Blue Whiting stock within NEAFC, ICES is requested to validate this information at its forthcoming ACFM meeting, …"

The Northern Pelagic and Blue Whiting Fisheries Working Group at its meeting in April-May 2000 considered the request. The basic information given in the Russian paper (WD by Anon-2) was:

1) It is claimed that when massive spawning occurs on northern spawning grounds (the Hebrides) and the North Atlantic current is strong the likelihood of influx of larvae into the Barents Sea is greater than when spawning occurs on southern spawning grounds (the Porcupine Bank) and the North Atlantic current is weak. According to the paper 1983, 1990 and 1991 were the years when the highest number of 0-group blue whiting were caught in Russian waters.

2) Figure 2 in the WD by Anon-2 shows a map of the distribution of 0-group blue whiting in the Barents Sea, aggregated for the years 1976-1998. The map is based on the ICES-reports of the international 0-group surveys in the Barents Sea and adjacent waters in August-September 1976-1996 and the joint Norwegian-Russian 0-group surveys in the Barents Sea in August-September 1997 and 1998.

   The map shows occurrence of 0-group blue whiting in the south-eastern Barents Sea, and one occurrence at 71°N 41°E.

3) The WD by Anon-2 claims that juvenile blue whiting of ages 1-3+ occur regularly in bottom trawl catches with sizes ranging from 15 to 25 cm, and refers to four series of Russian cruises in the Barents Sea and adjacent waters. Material from those cruises has been used to draw maps of the distribution of juvenile blue whiting by quarter of the year, and the result is given in Figure 3 in the WD by Anon-2, aggregated for the years 1977-1998.

   The aggregated maps show occurrence of juvenile blue whiting in the south-eastern part of the Barents Sea in all quarters of the year. The paper claims that the catch of blue whiting varied from a few tens of fish to hundreds of kilogrammes. The maps for the four quarters of the year are aggregated into one map in Figure 4 in the WD by Anon-2.

4) According to the WD by Anon-2 Russia conducted a blue whiting fishery in the "grey zone"[3] in the late 70's and although only 539 t were fished the question of how far east fishable aggregations of blue whiting move still remains open. A report of this fishery was submitted to the NEAFC Workshop on Mackerel and Blue Whiting in Torshavn in February 1999.

In order to validate the claims in the Russian paper (WD by Anon-2), the Working Group considered other available information (WD by Gjøsæter; WD by Fossum; WD by Monstad; WD by Anon-1; Bjørke 1983; Giæver and Stien, 1998; Whitehead *et al.* 1986), which are attached as Appendixes I - VII. In addition the Working Group considered Russian trawl sampling data on electronic media supplied by S. Belikov. The claims are addressed in the order listed above.

1) According to Bjørke (1983), WD by Fossum, and Giæver and Stien (1998) there is some spawning by blue whiting along the continental slope northern Norway. This could be the origin of blue whiting larvae in the Barents Sea. Blue whiting larvae drifting into the Barents Sea from spawning areas west of the Hebrides or on the Porcupine Bank will have passed from the larval stage to 0-group by the time they reach the Barents Sea. There may be uncertainty to which extent the 0-group blue whiting found in the Barents Sea originate from the spawning areas west of the British Isles. However, the Working Group agrees that the presence of blue whiting 0-group in the Barents Sea may be related to the amount of Atlantic water entering the Barents Sea that year.

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[3] Area related to "Agreement dated 11 January, 1978, between Norway and the Soviet Union on provisional practical arrangements for fishing in an adjacent area of the Barents Sea."

2) In the WD by Monstad the spatial distribution of blue whiting during the international and Norwegian-Russian 0-group surveys in the Barents Sea is shown by year, and the paper also gives information of the numbers of blue whiting recorded in the trawl hauls. It is shown that during the observation period 1965-1999, 0-group blue whiting were observed in 1977, 1983-1986, and in 1988-1993. In most of these years, only a few specimens of blue whiting were recorded, and only in the south-western part of the area. Only in three years observations exist from areas east of 30°E.

3) The WD by Monstad also gives data from Norwegian bottom trawl surveys during the period 1980 to 1999 by year and quarter. The data confirm findings of juvenile blue whiting in the Barents Sea but again, the presence and probably the abundance of this species in the area varies much from year to year. In most years in the period, scattered observations exist for the areas east of 30°E. Only in seven years were dense concentrations (> 100 specimens caught per trawl haul) observed east of 30°E. The most eastern blue whiting observation is, according to these data, approximately 45°E.

   A third data source explored was the joint Russian-Norwegian cod stomach content database, consisting of about 125 000 cod stomachs sampled during the period 1984-1999 (WD by Gjøsæter). All instances of blue whiting as prey for cod recorded in this database were plotted at the position of the trawl haul where the sample was taken. The results show that blue whiting is very rare as prey for cod, and only about 80 occurrences of blue whiting were found. About 90% of these were found in the area west of 30°E.

4) The Working Group reviewed maps from Anon-1 showing the Russian fishery for blue whiting in the Northeast Atlantic during 1977-1997. The report shows Russian catches of blue whiting in the south-western part of the "grey zone" in the years 1977-1980.

General

According to Whitehead *et al.* (1986) blue whiting is distributed from the western Mediterranean, across to the western North Atlantic, up to Iceland, Greenland, the North Sea, Eastern Norwegian Sea toward Spitsbergen and the western Barents Sea. On the map accompanying the article the distribution area in the Barents Sea extends to the Cap Kanin area (about 45°E.).

Conclusion

It may be concluded that larval and juvenile blue whiting is found in the Barents Sea. Its distribution mainly covers the area to the west of 30°E, but occasionally this species is recorded in the southeastern Barents Sea, east to about 45°E. The presence and probably the abundance varies from year to year, and is probably related to the amount of Atlantic water entering the Barents Sea.

The data available were not quantitative, and therefore the relative importance of the Barents Sea as a nursery area for blue whiting could not be determined.

8.2 Salmon post-smolts by-catch in pelagic fisheries

NASCO requested the Working Group to update what is known on salmon by-catch in the fisheries dealt with.

8.2.1 Post-smolt surveys

Post-smolt sampling cruises have been undertaken by the Institute of Marine Research (IMR), Norway since 1990 with the primary aim of describing the post-smolt distribution in the Northeast Atlantic. Similar cruises were undertaken by Fisheries Research Services Scotland in 1996 and 1997. The results of these surveys were reported to the Working Group in 1998 (ICES C.M.1998/ACFM:18) and 1999 (ICES C.M.1999/ACFM:18). In summary, a surface trawl technique was developed and proved successful in capturing post-smolts. Over 1,000 hauls were undertaken covering an area from the south west of Ireland (50°N) to the east of Bear Island (75°N), and in the order of 1,000 post smolts and 25 1SW salmon were caught. The highest concentrations of post-smolts catches were found within the strong north-east running slope current along the north-west European continental shelf edge. In the central and northern Norwegian Sea post-smolts have been fond in varying concentrations. In 1999 for the first time some post-smolts were caught in the Barents Sea (ICES C.M.2000/ACFM:13).

Analyses of the hydrographical regimes at the capture sites show a strong concentration of the captures to the 9.0-10.9°C temperature interval and in salinities of ≥35 000 ppm, indicating a preference for the warm, saline, productive Atlantic water masses over the colder and less saline Arctic water in the north west and the warmer but less saline waters of the Norwegian coastal current in the east.

8.2.2 Estimates of post-smolt by-catch in pelagic fisheries

Only one country (Faroe Islands) implemented dedicated sampling of post-smolts in its pelagic fisheries and reported that no by-catch of salmon was found (ICES C.M.2000/ACFM:13).

The Fishery Laboratory of the Faroes and the Russian Polar Institute (PINRO) have initiated a bilateral collaboration on the by-catch of salmon post-smolts north of the Faroes, but to date no joint report is available.

Observing post-smolts in large herring and/or mackerel catches is extremely difficult due to their resemblance both in size and coloration with the target species. To be certain of the absence of post-smolts in such catches and due to their seemingly low occurrences the whole catch must be screened. Assessment of by-catches on board commercial fishing vessels may prove too time consuming to be carried out in practice, however, efforts should be made to arrange screening of whole catches at landing sites.

Although some preliminary investigations have been carried out, the Working Group was unable to provide estimates of the by-catch of post-smolts in pelagic fisheries. While observations on catch on pelagic fishing vessels is a possibility, in reality this is likely to provide only a qualitative assessment of post-smolt by-catch. An alternative approach would be to carry out directed research fisheries with similar gear, locations and time as commercial fishing boats or carry out co-operative fishing with a commercial fishing vessel.

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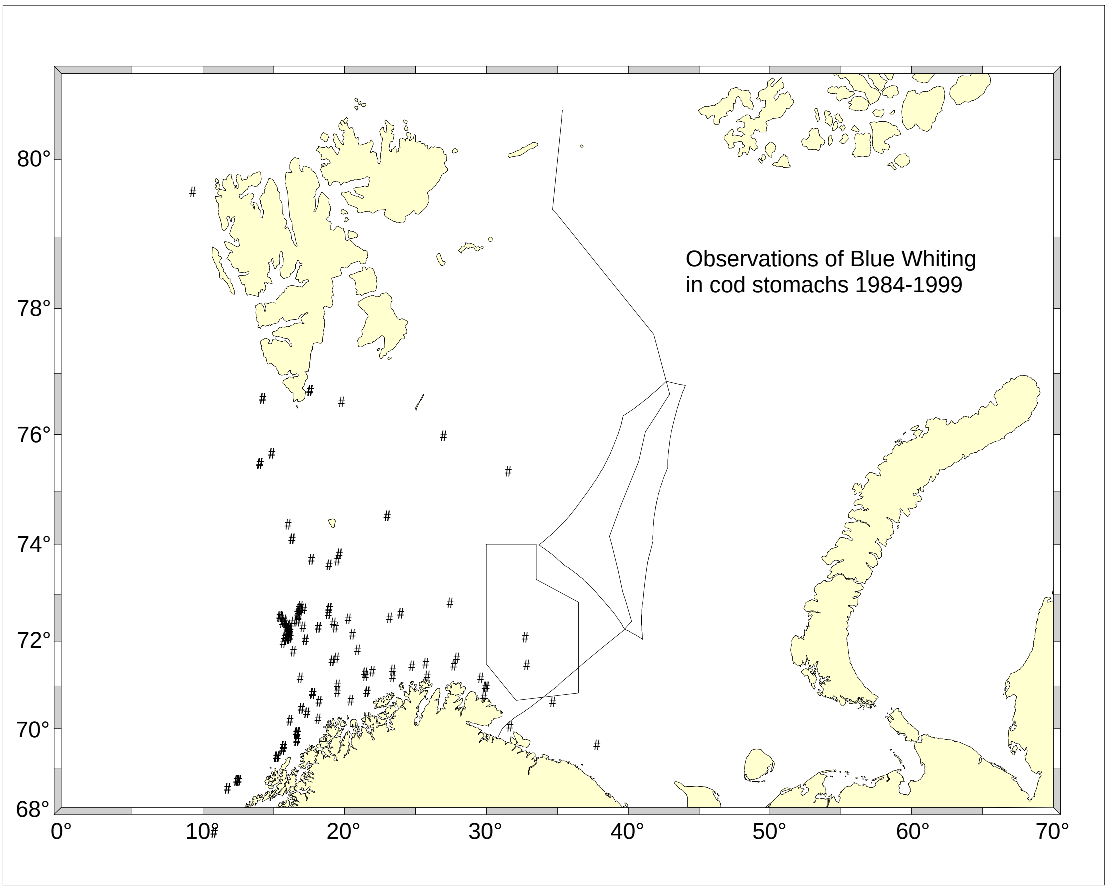
APPENDIX I

Observations of Blue Whiting in The Russian-Norwegian Stomach database

WD to the WGNPBW 2000 meeting Copenhagen 26 April to 4 May 2000

By Harald Gjøsæter, Institute of Marine Research, Bergen Norway

The map below shows all occurrences of blue whiting in the stomachs of cod (approximately 125 000 stomachs) during the period 1984-1999. Relatively few occurrences of blue whiting was found in the undisputed Russian EEZ and in the Grey zone.



APPENDIX II

Working document to the ICES-WG, Northern Pelagic and Blue Whiting, Copenhagen 26 April-4 May 2000

Observations of egg, larvae and juvenile blue whiting in Norwegian Waters

by

Petter Fossum

Institute of Marine Research, Bergen, Norway

Blue whiting spawning products have been reported from Norwegian waters on several occations. Bjørke (1983) report that blue whiting eggs and newly hatched larvae (2-6mm) were found south of 66^0N on the Norwegian shelf sampled with Juday nets on a survey for postlarvae in June/July in 1982. Eggs and larvae were also recorded on herring larvae cruises in the same area in April during the period 1976-1982. In addition to this Bjørke(1983) report that eggs and larvae of blue whiting were registered on fixed oceanographic stations at Bud and Sognesjøen in the period 1976-1981. Bjørke (1983) concludes that spawning seems to take place in fjords and over deeper parts of the continental shelf from April to June with a peak in May. Coombs and Pipe (1980) report findings of eggs and larvae in Norwegian fjords, young blue whiting north of Norway and in the Barents Sea, and spawning adults in the Norwegian Sea. I addition to this Zilanov (1968) report that 5-33 mm long larvae and juvenils were found outside Røst. Blue whiting eggs were also found off Møre on a cruise in 1985 Bjørke (pers. comm.) and Nedreaas (pers. comm.) report that he identified some blue whiting eggs on the Norwegian shelf between Stad and Lofoten in May 1988.

Institute of Marine Research in Bergen carried out surveys for larvae and juvenils in June/July during the period 1976-1991. This survey was primarely aimed against estimating the abundance and distribution of juvenile cod outside northern Norway, however, some years the sampling were carried out as far south as Stad (62^0N). The sampling was carried out by pelagic trawl (Harstad trawl) stepvise from the surface to 60 m depth with 30 minutes hawls. A summing up figure from these investigations with the trawl stations where blue whiting larvae and juveniles (below 40mm) were found during the period 1976-1991 is shown in Figure 1.

There is evident from all these observations that all or a significant part of the 0-group entering the Barents Sea comes from blue whiting spawning along the Norwegian shelf.

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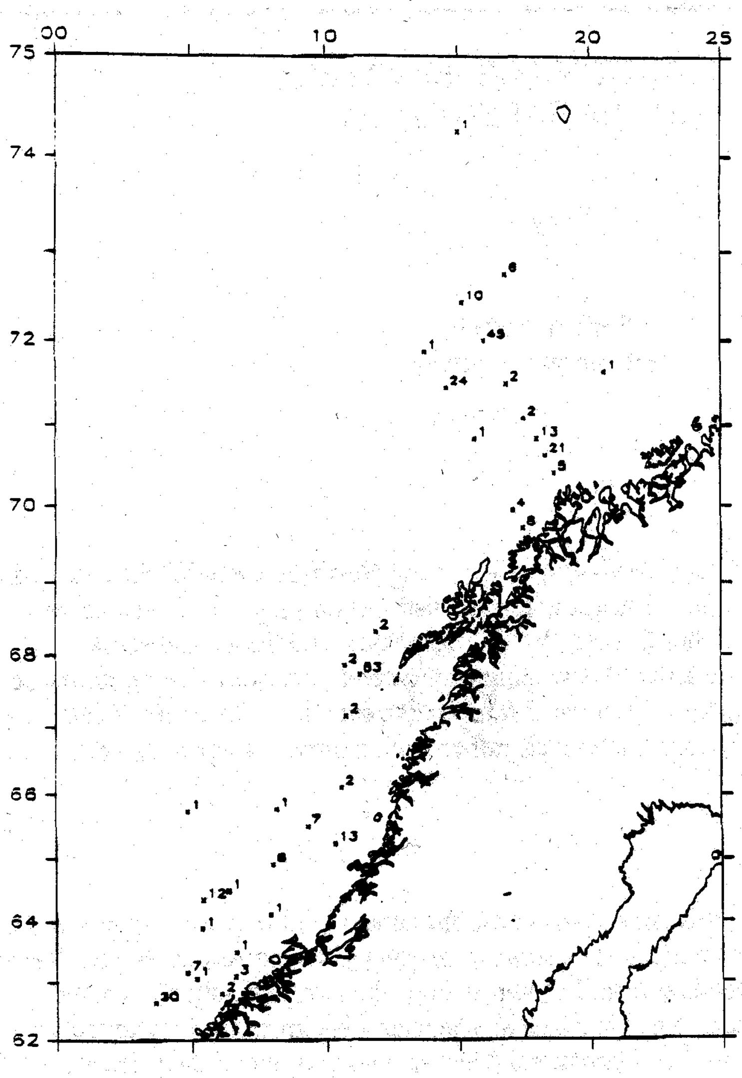

Figure 1. Observations of blue whiting juveniles (15-30 mm) in Norwegian waters in June/July during the period 1986-1991.

APPENDIX III

Working Document

for

The Northern Pelagic and Blue Whiting Fisheries Working Group, Copenhagen, 26 April - 4 May 2000

BLUE WHITING OBSERVATIONS IN THE BARENTS SEA

by

Terje Monstad
IMR, Bergen, Norway

INTRODUCTION

The "oceanic" part of the blue whiting stock in the North-east Atlantic has its feeding area in the Norwegian Sea. The geographical distribution varies from year to year depending on, among other factors, the hydrographical conditions and stock abundance. Concentrations of blue whiting may extend northwards along the slope west of Spitzbergen and also eastwards into the Barents Sea. The limits of the distribution in these areas are, however, rather unclear towards north as well as towards east.

O-group

Since 1965 Norway and Russia have conducted annual joint 0-group surveys in the Barents Sea and adjacent areas. The surveys take place during August/September and cover a large area extending from Lofoten Isles to the north of Spitzbergen and eastwards to the coast of Novaya Zemlya. The main objectives are to map the area distribution of the 0-groups of commercial fish species and obtain their density indices.

The common cruise reports from these surveys have been presented at the annual scientific meetings of ICES up to 1996. The text about blue whiting observations in these reports is given in Appendix I, and the maps of the blue whiting distributions presented, i.e. for the years 1983, 1984, 1986, 1988, 1989 and 1990, given in Figure 1.

During these investigations 0-group blue whiting was for the first time observed in 1977, when a few specimens were caught on some of the trawl stations (ICES 1977/H: 45). Thereafter no new observations were made until 1983 when 0-group

blue whiting was recorded in an area limited to south of 75° N between 20° and 35° E. A total number of 761 specimens were caught that year, with lengths from 25 to 100 mm and a mean length of 65.6 mm (ICES 1983/G: 35).

The following years, minor numbers of 0-group blue whiting were observed every year up to 1993, except for 1987. Thereafter no observations have been made up to 1999 (Appendix I). In 1984 a number of 95 specimens of blue whiting were caught, also in an area south of N 75° as in 1983, but somewhat more to the west. The lengths were from 30 to 105 mm with a mean of 58.4 mm (ICES 1984/H: 36).

The recordings of 0-group blue whiting are rather modest in the Barents Sea. The observations are made mostly off the Finnmark Coast between E 15° and E 30° (Figure 1).

By-catches

Only few and modest acoustic observations have been made of blue whiting in the Barents Sea. During pelagic fish surveys in the Norwegian Sea in summer and autumn, blue whiting have for a number of years been acoustically recorded eastwards to the western slope of the Barents Sea, and no limit of distribution observed in the area. That clearly indicates further extension of blue whiting concentrations eastwards into the Barents Sea, as described for example in Monstad and Holst (1999). Examples of acoustic recordings of blue whiting in the Barents Sea can be shown, however, as in Figure 2 when observations were made during a bottom trawl survey in October 1981 (Randa and Smedstad, 1982).

The main observations of blue whiting in the Barents Sea have been obtained when the species appears in the catches during trawl surveys on other target species. That is as by-catches especially in bottom trawl surveys for cod, which Norway has conducted for many years. From the database of IMR, Bergen, these by-catches of blue whiting have been collected for the years 1980 – 1999 and used as basis for the maps shown in Appendix II. The geographical distributions presented for 1st and 3rd quarter of the year, are based on numbers of blue whiting caught per trawl station of all the surveys conducted in the respective quarter of the year.

The catches have consisted of individuals older than 0-group, notable parts being juveniles. The older blue whiting represented has usually been caught in the more western and northern part of the sea.

The results for 1991 and 1995 are shown in Figure 3 and 4 as examples of the number of trawl stations conducted and the numbers of blue whiting caught.

The distribution of blue whiting in the Barents Sea is mostly confined to the western part. The eastward extension, however, might vary in accordance with the hydrological conditions and stock abundance, and hence in some years stretches more eastwards than usual. This is especially the case for 1984 and 1985 when parts of abundant year-classes entered the Barents Sea (Appendix II).

The observations of blue whiting east of latitude 30° E are shown in greater detail in Appendix III, where the stations holding catches of blue whiting are presented with numbers caught and symbols indicating the amount.

Based on genetic analysis it has been demonstrated that a self-recruiting population of the blue whiting stock exists in the Barents Sea and Spitzbergen area (Jarle Mork, pers. com). During the feeding period in summer and autumn it mingles with blue whiting of other populations, i.e. blue whiting which in winter and early spring migrates southwards to spawn west of The British Isles. The main spawning location of the blue whiting population in the Barents Sea has, however, not yet been clearly defined.

Acknowledgements

Attention is shown with thanks to Knut Korsbrekke, IMR, Bergen, for helping with extraction of the data from the database, and to Ole Gullaksen and Jaime Alvarez, also from IMR, Bergen, for technical assistance in preparation of the maps.

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1978 : ICES CM 1978/H: 33.
1979 : ICES CM 1979/H: 65.
1980 : ICES CM 1980/H: 53.
1981 : ICES CM 1981/G: 78.
1982 : ICES CM 1982/G: 44.
1983 : ICES CM 1983/G: 35.
1984 : ICES CM 1984/G: 36.
1985 : ICES CM 1985/G: 75.
1986 : ICES CM 1986/G: 78.
1987 : ICES CM 1987/G: 38.
1988 : ICES CM 1988/G: 45.
!989 : ICES CM 1989/G: 40.
1990 : ICES CM 1990/G: 46.
1991 : ICES CM 1991/G: 50.
1992 : ICES CM 1992/G: 82.
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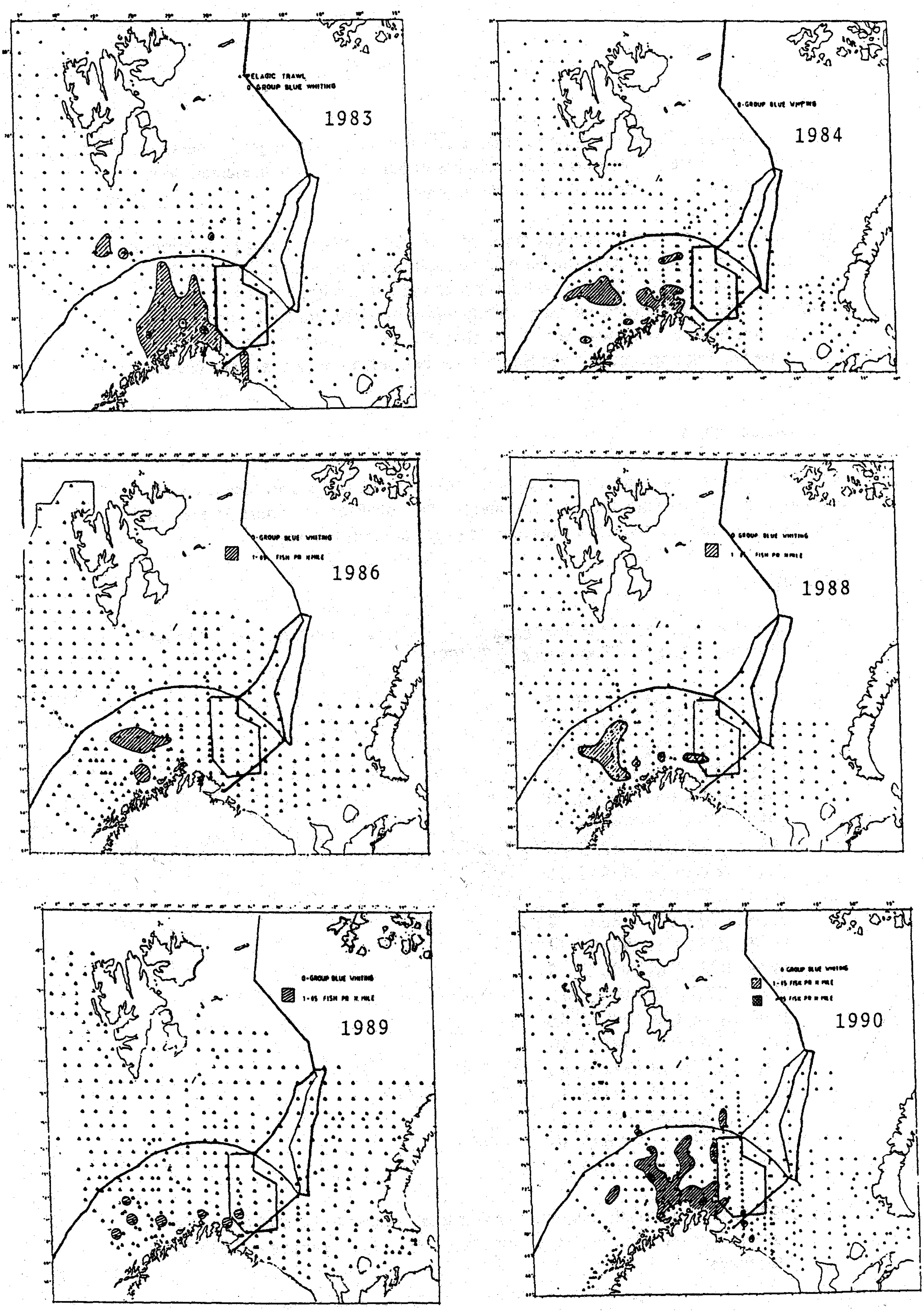


Figure 1. Observations of 0-group blue whiting based on trawl catches.
From the ICES-reports on The joint Norwegian-Russian 0-group surveys in the Barents Sea and adjacent areas. (See Appendix I).

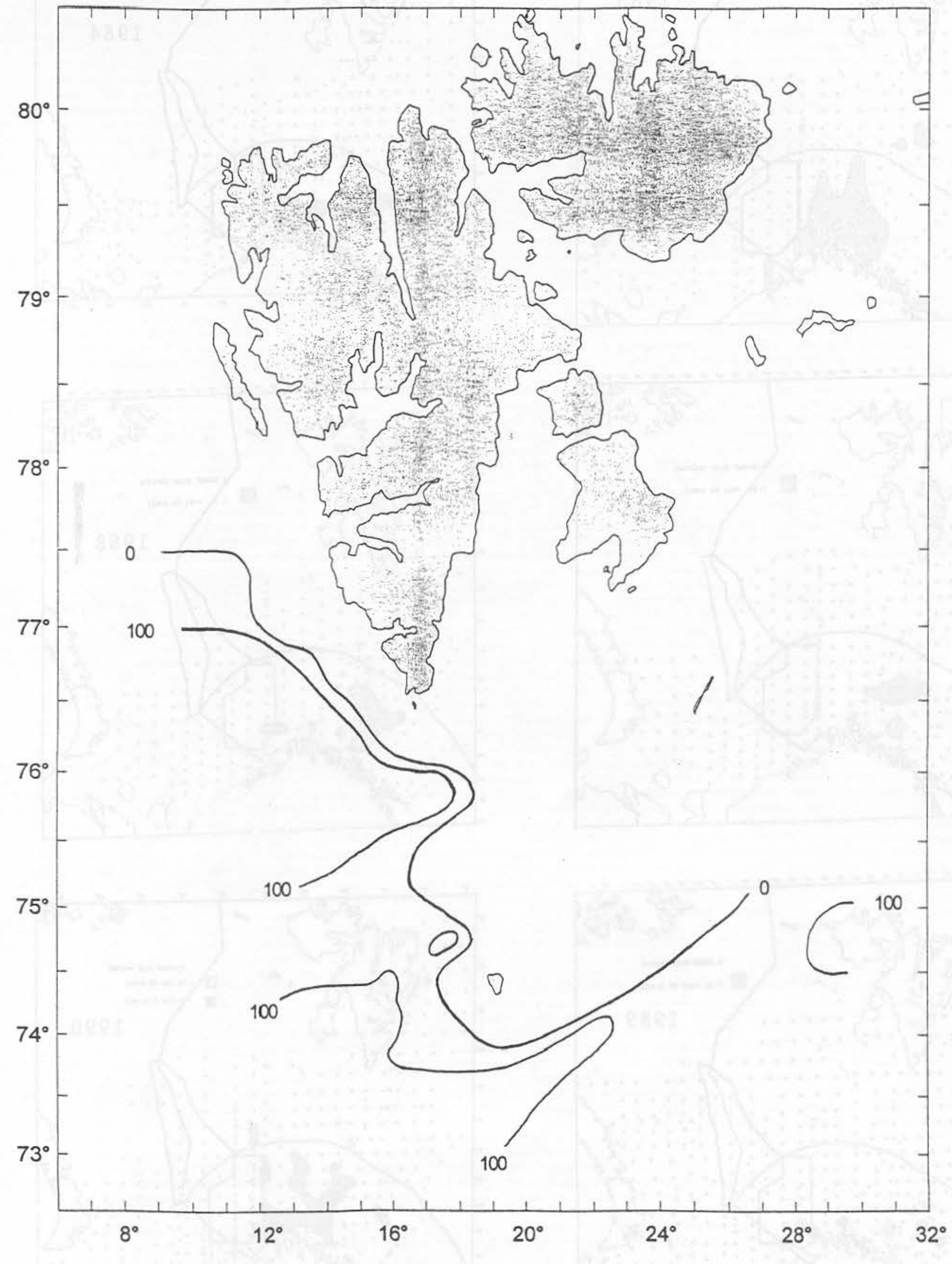
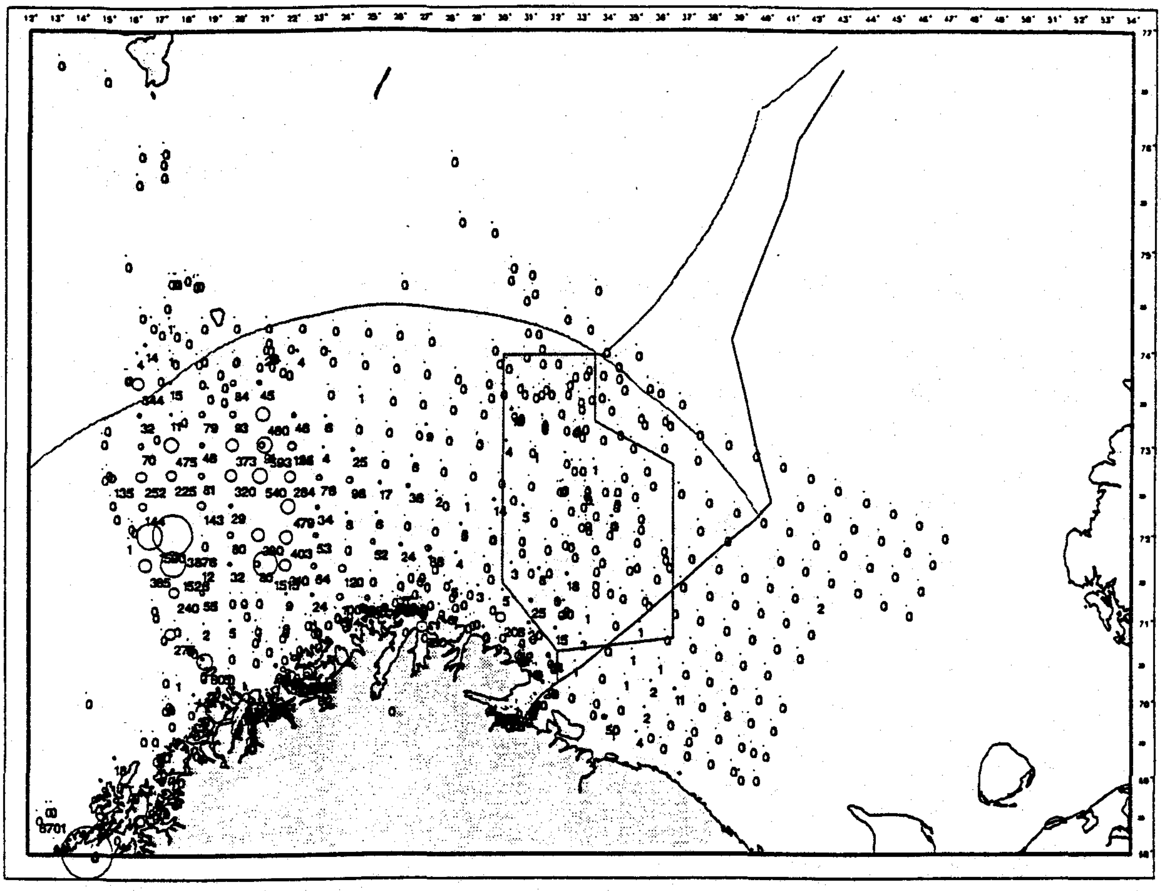


Figure 2. Recordings of blue whiting Sept./Oct. 1981. Integrated echo intensity in deflection of mm/nautical mile. From Randa and Smedstad (1981).



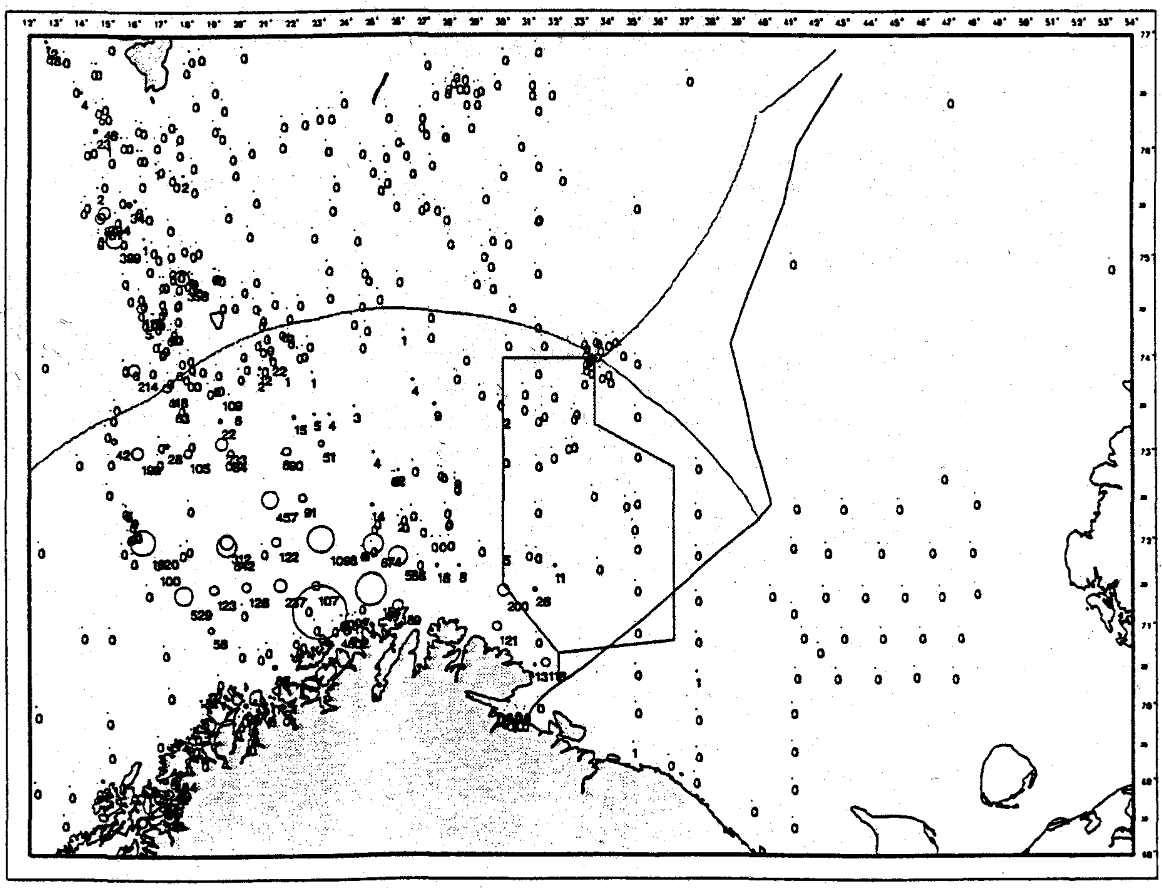


Figure 3. Blue whiting 1991. Trawl stations worked and numbers of specimens caught on surveys during 1st quarter (upper) and 3rd quarter (lower) of the year.

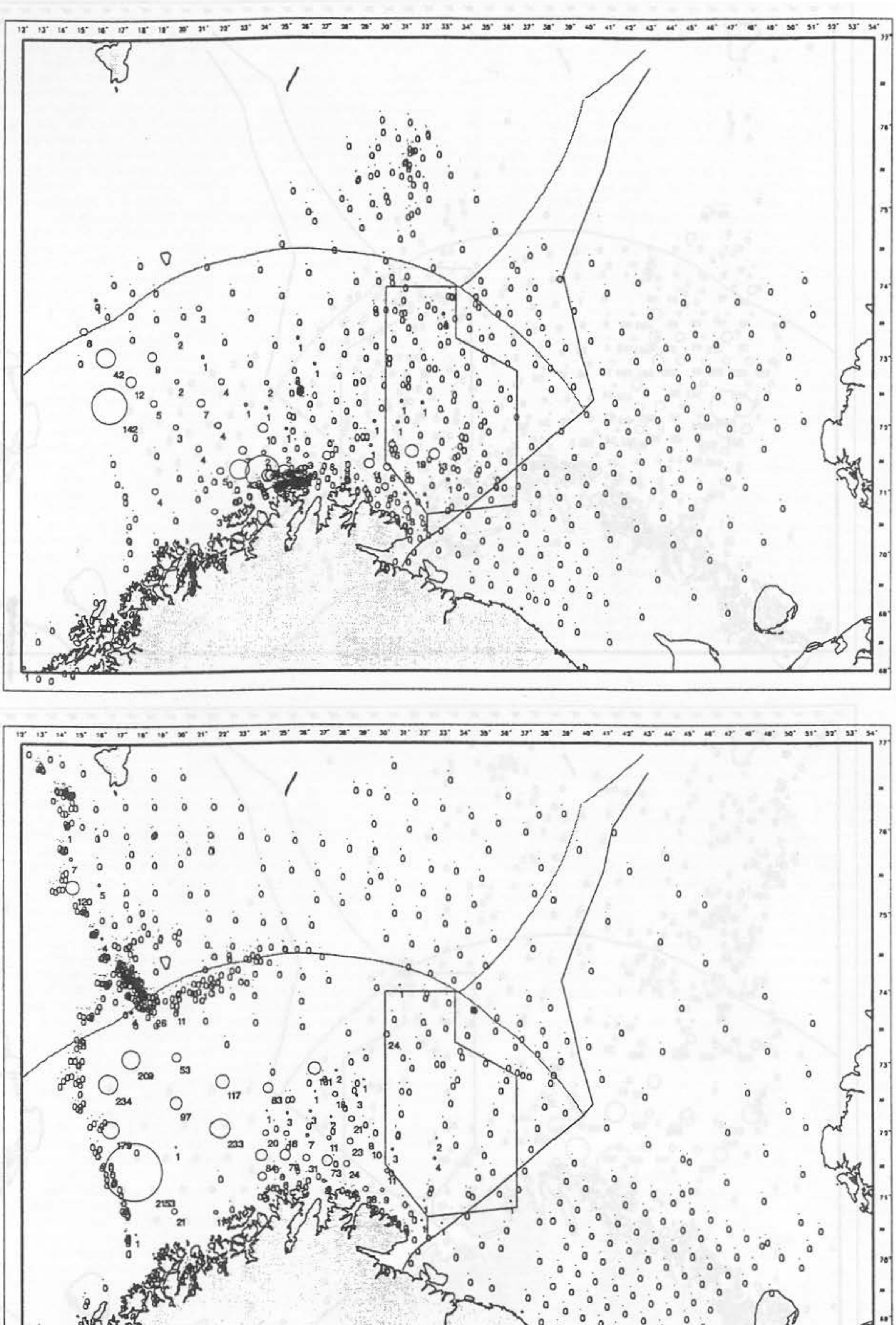


Figure 4. Blue whiting 1995. Trawl stations worked and numbers of specimens caught on surveys during 1st quarter (upper) and 3rd quarter (lower) of the year.

Appendix I

O-GROUP BLUE WHITING IN THE BARENTS SEA

From the ICES-reports of the International 0-group surveys in the Barents Sea and adjacent waters in August – September, the following is reported about blue whiting observations since 1977:

1977: Other species
Small numbers of 0-group mackerel, saithe catfish and blue whiting were caught on a few trawl stations during the survey.
(CM 1977/H: 45). (No Figure presented).

1978: (CM 1978/H: 33). (No observations of blue whiting)
1979: (CM 1979/H: 65). (No observations of blue whiting)
1980: (CM 1980/H: 53). (No observations of blue whiting)
1981: (CM 1981/G: 78). (No observations of blue whiting)
1982: (CM 1982/G: 44). (No observations of blue whiting)

1983: Blue whiting (Fig. 19)
0-group blue whiting was recorded south of N 75° and between E 20° and E 35°. This is the first year 0-group blue whiting has been recorded during the 0-group survey in the Barents Sea.[1)] As for saithe no index of abundance has been calculated. (CM 1983/G: 35).

1984: Blue whiting (Fig. 19)
0-group blue whiting was recorded in the same area as in 1983, -south of N 75 and between E 20 and E 35. No index of abundance has been calculated.
(CM 1984/H: 36).

1985: Blue whiting
0-group blue whiting was only recorded on four stations within a small area south of N 70° 50' and between E 15° and E 19°. The catches and the area of distribution were smaller than in 1983 and 1984. No abundance index has been calculated. (CM 1985/G: 75) (No Figure presented).

1986: Blue whiting (Fig. 18)
This map is included only to show the distribution and no indices are given.
(CM 1986/G: 78).

1987: Blue whiting
No blue whiting is found this year. (CM 1987/G: 38).

1988: Blue whiting (Fig. 21)
Only some scattered catches of blue whiting were taken. No abundance index has been calculated. (CM 1988/G: 45).

Appendix I

1989: <u>Blue whiting</u> (Fig. 23)
Only a few catches of blue whiting were obtained and these are shown in tha map. No index has been calculated. (CM 1989/G: 40).

1990: <u>Blue whiting</u> (Fig. 20)
The blue whiting was located in a limited area from the coast of Finnmark to the central part of the Barents Sea. Only low numbers were caught per haul, but more frequently than in previous year. (CM 1990/G: 46).

1991: <u>Blue whiting</u>
Only a few specimens of blue whiting were caught this year. (CM 1991/G: 50) (No Figure presented).

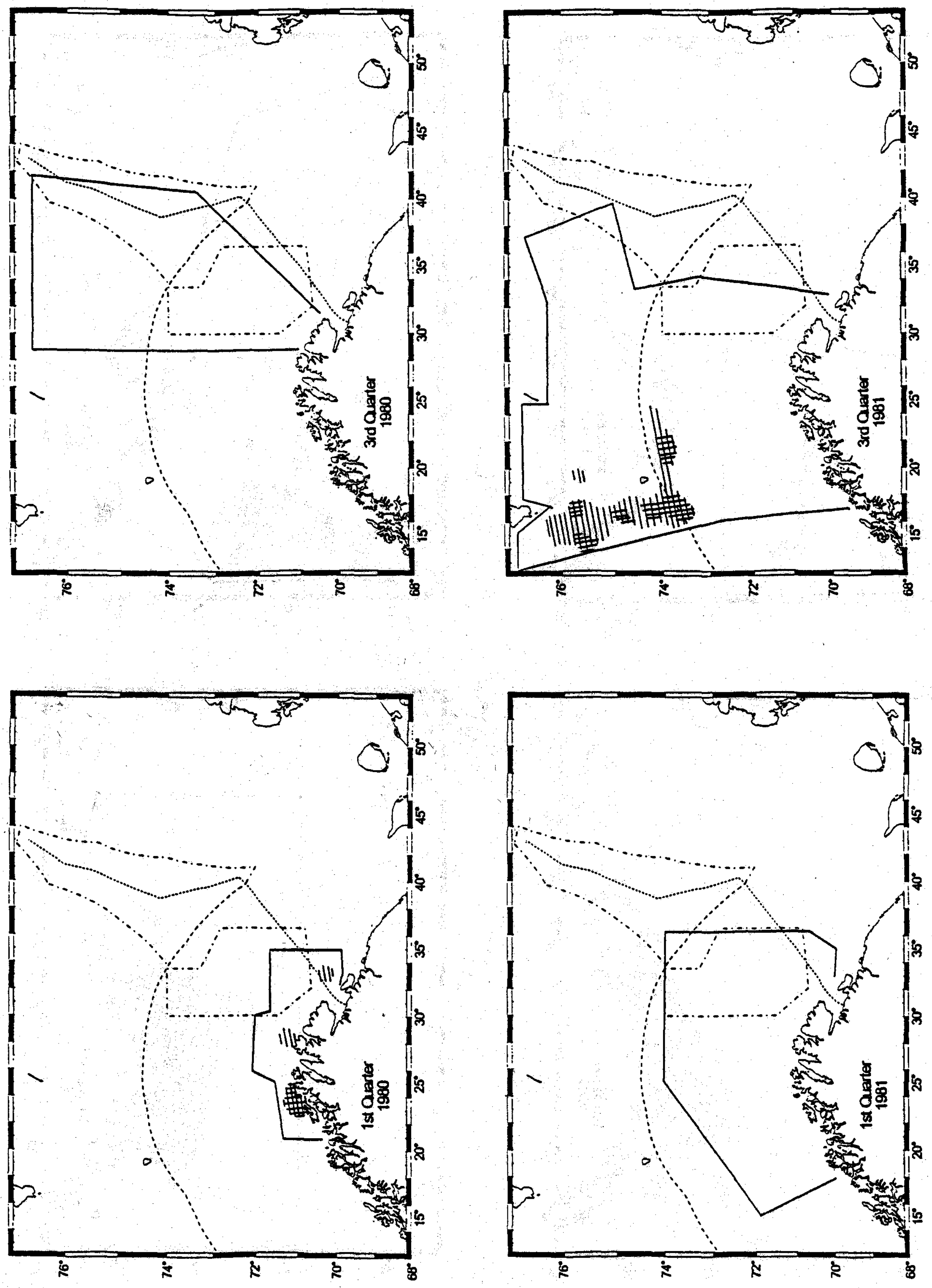
1992: <u>Blue whiting, sandeel and catfish.</u>
Only a few specimens of these species were caught this year.
(CM 1992/G: 82). (No Figure presented)
(Positions of blue whiting catches: N 77° 50' E 08° 04': 1 no. 50 mm
N 76° 50' E 11° 12': 1 no. 60 mm
N 76° 00' E 14° 11': 1 no. 55 mm)

1993: <u>Catfish (Fig. 26) and blue whiting</u>
Only a few specimens of catfish and blue whiting were caught.
(CM 1994/G:3) (No Figure presented).

1994: (CM 1995/G: 3) (No observations of blue whiting).
1995: (CM 1996/G: 30) (No observations of blue whiting).
1996: (CM 1996/G: 31) (No observations of blue whiting).
1997: (Cruise report, IMR, Bergen + PINRO, Murmansk) (No observations of blue whiting).
1998: (Cruise report, IMR, Bergen + PINRO, Murmansk) (No observations of blue whiting).
1999: (Cruise report, IMR, Bergen + PINRO, Murmansk) (No observations of blue whiting).

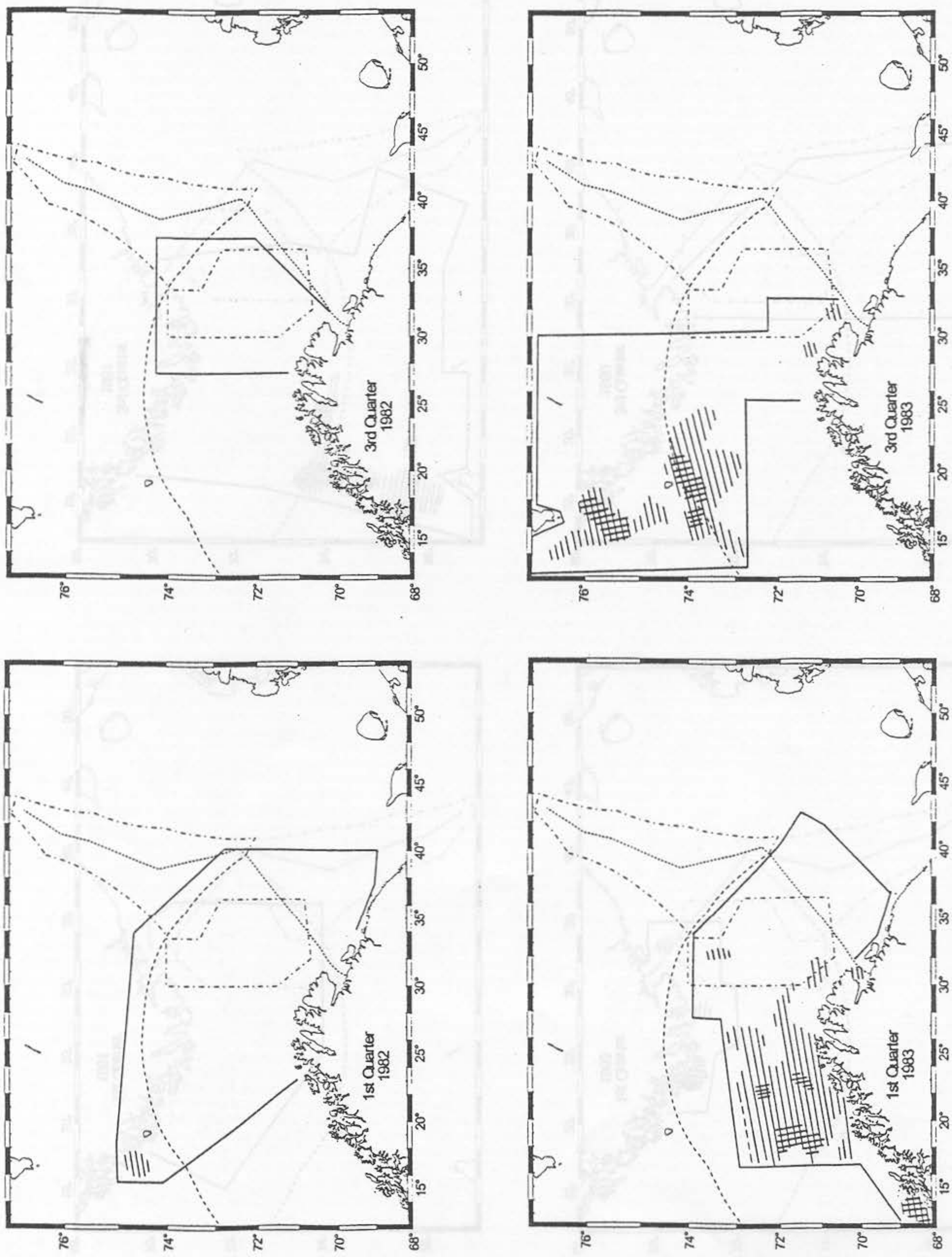
1) Not correct. 0-group blue whiting was recorded for the first time in 1977 (remarks by T. Monstad)

Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.

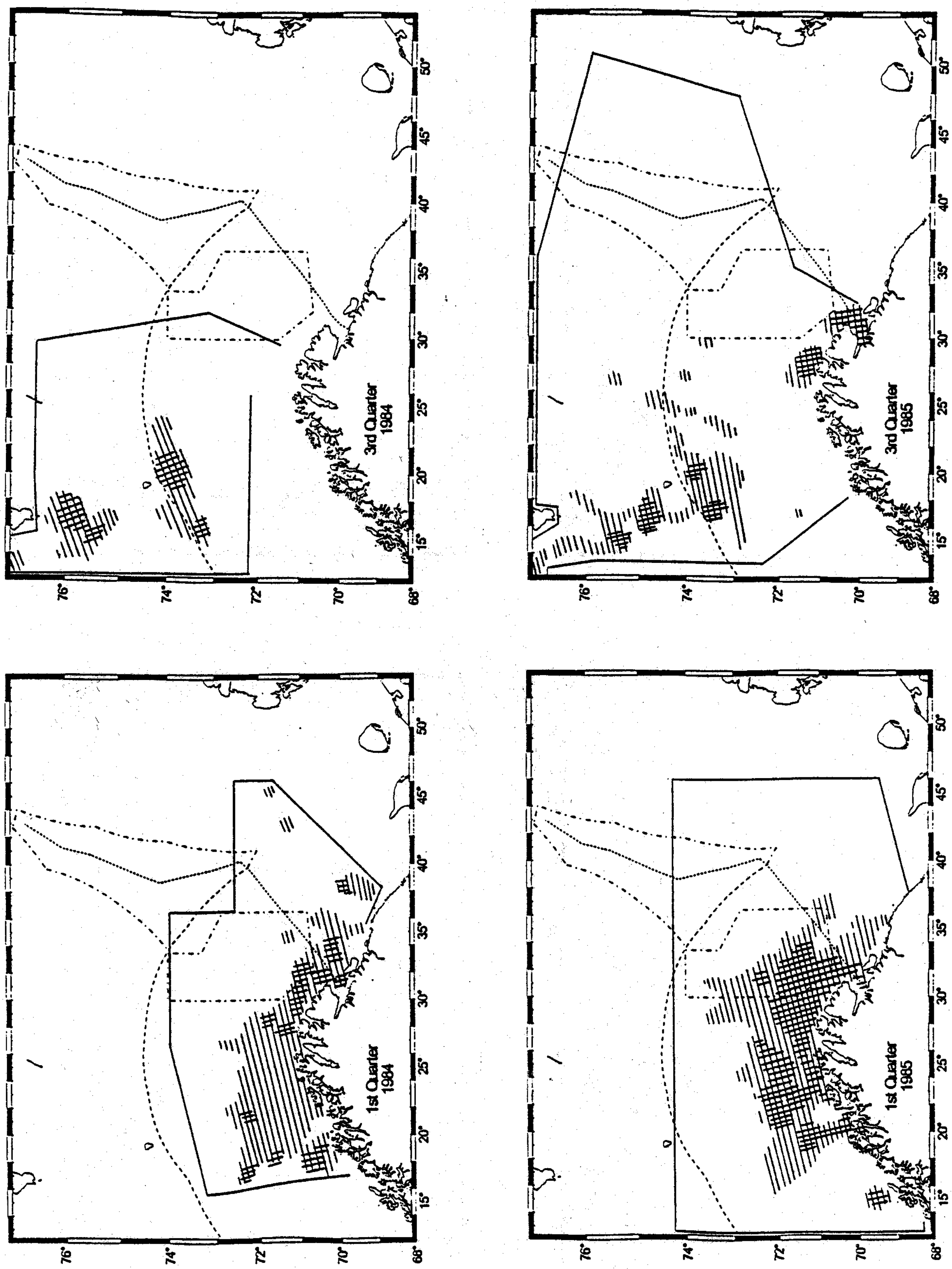


Appendix II (1982-83)

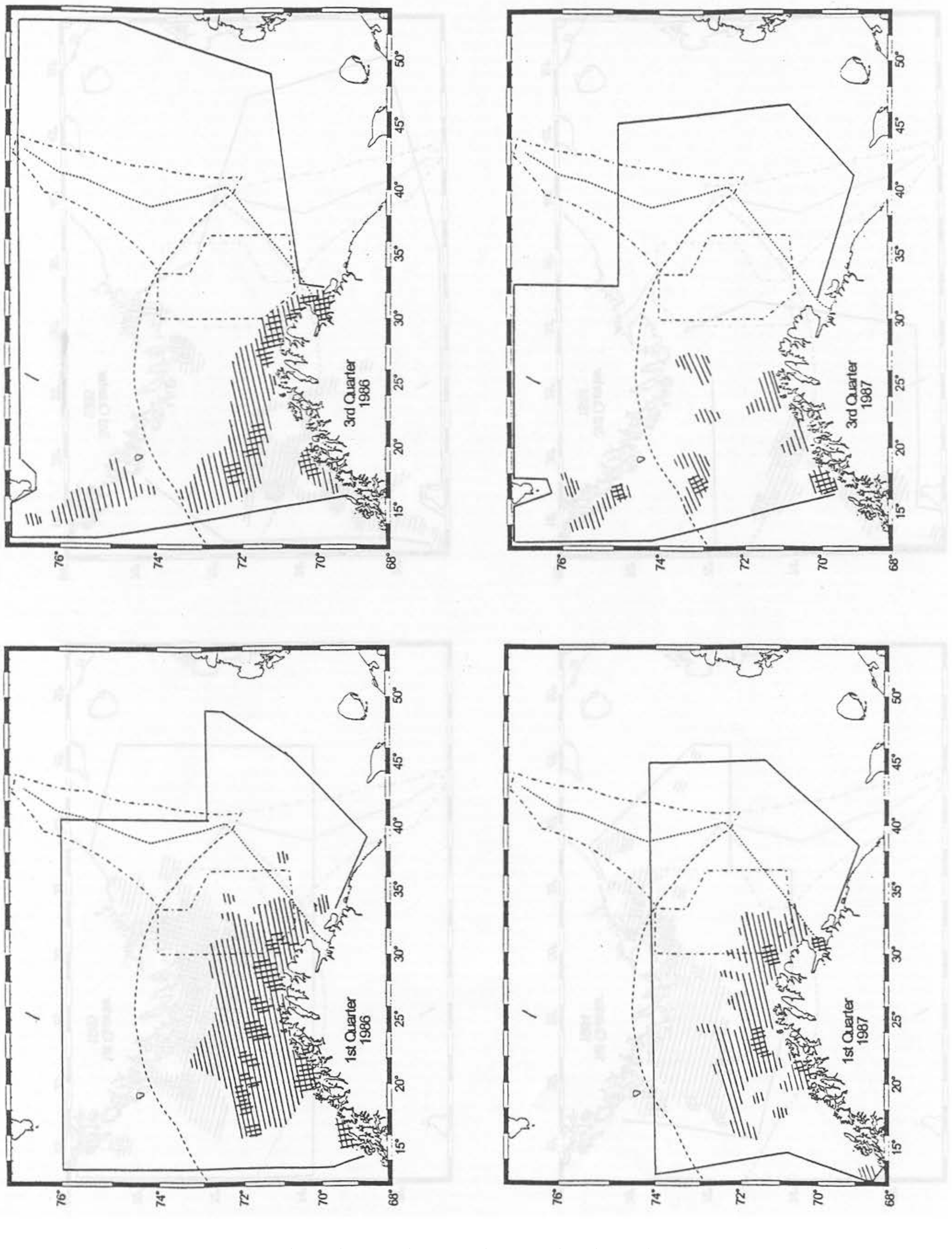
Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.



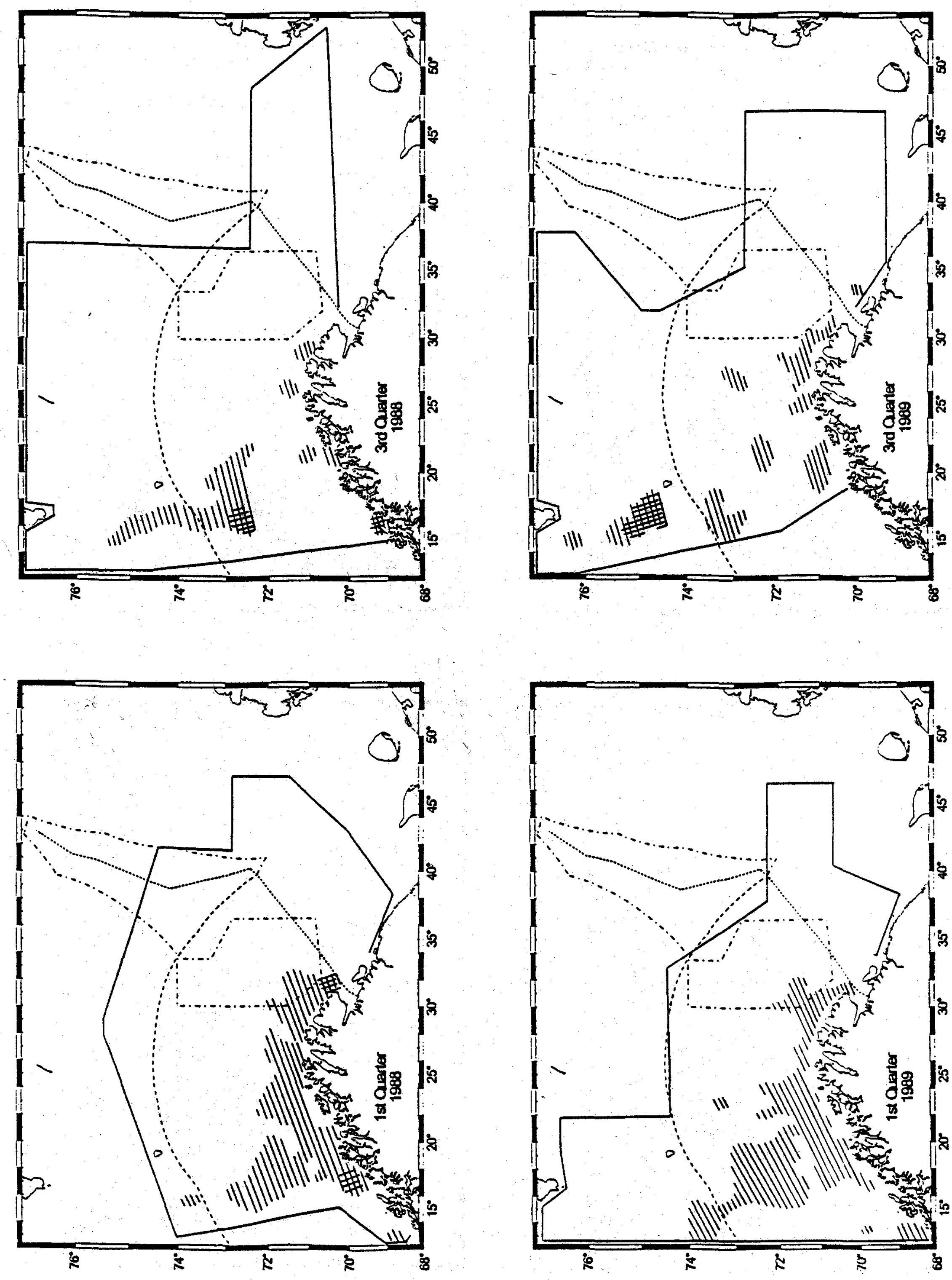
Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.



Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.

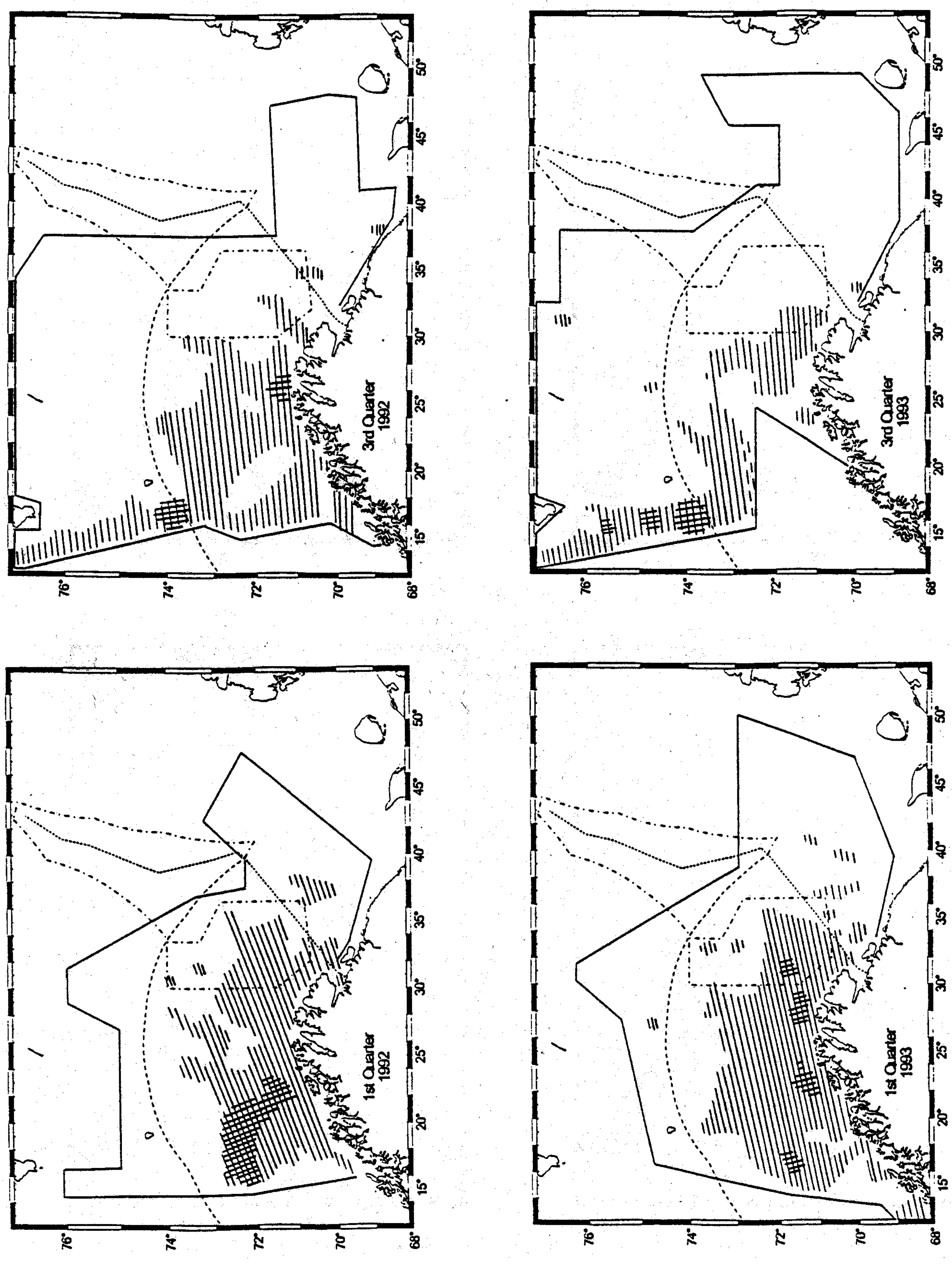


Distribution of BLUE WHITING. Hatched area based on nos./trawl station. Double hatched: > 100. Full line: surveyed area.

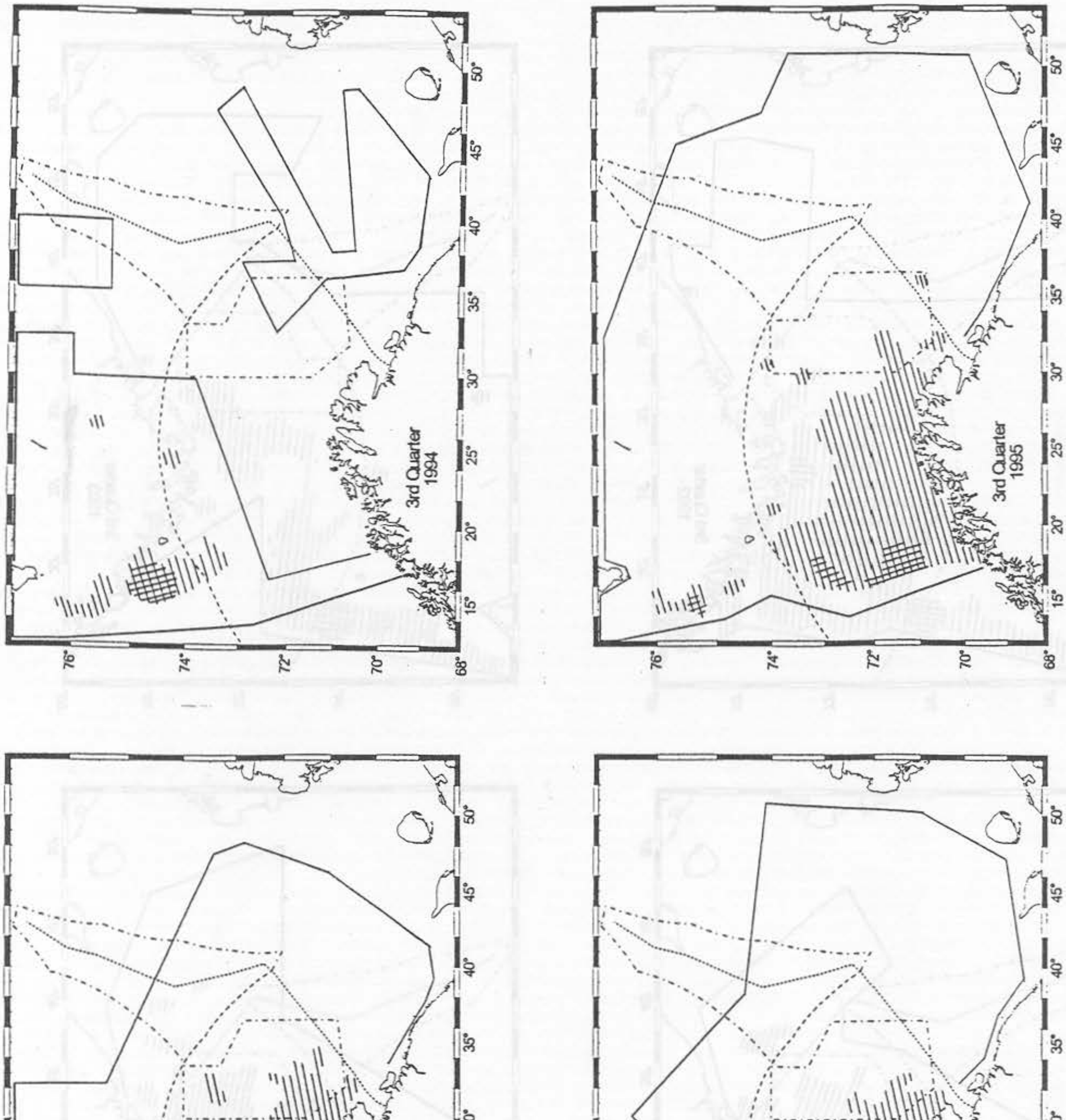


Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.

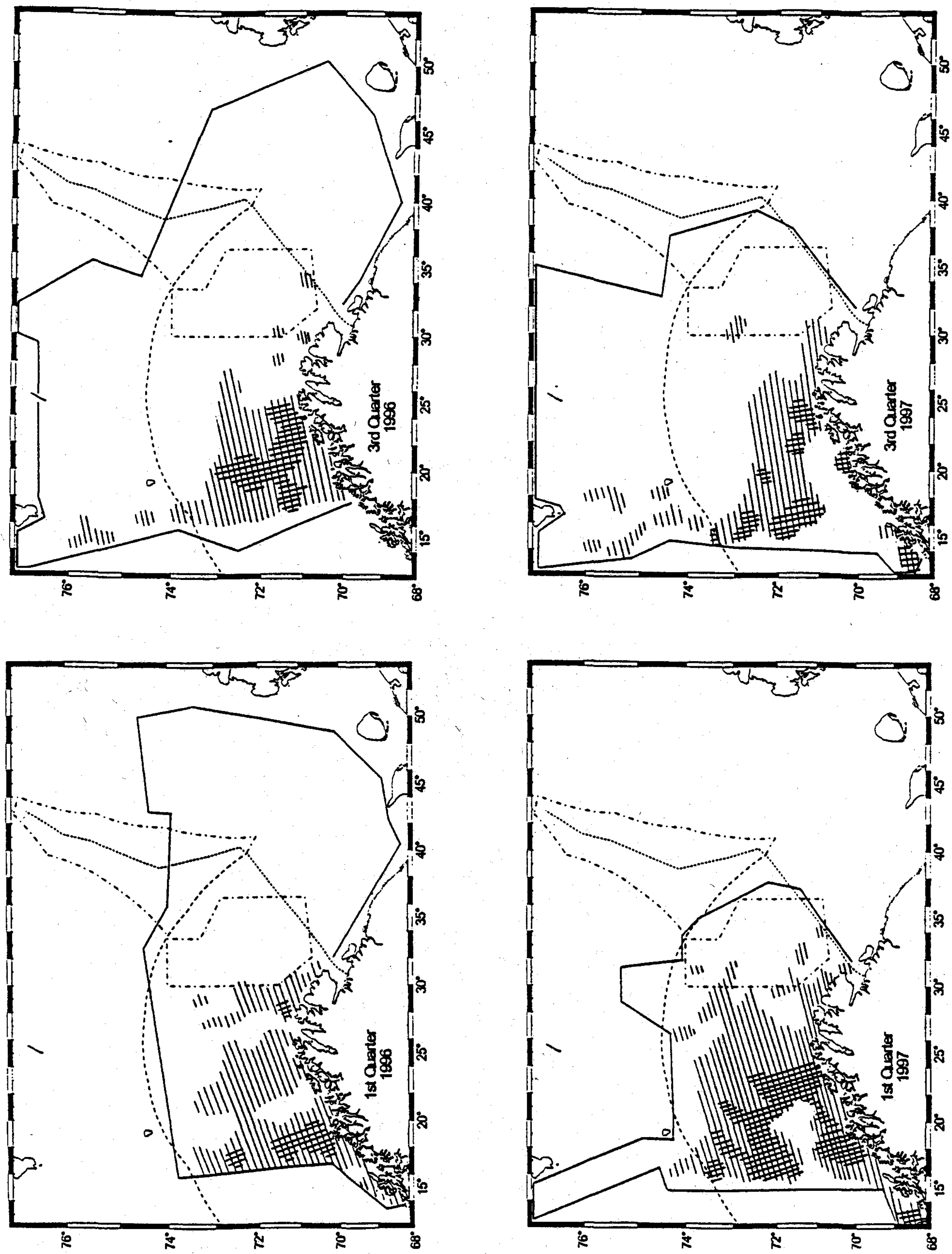
Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.



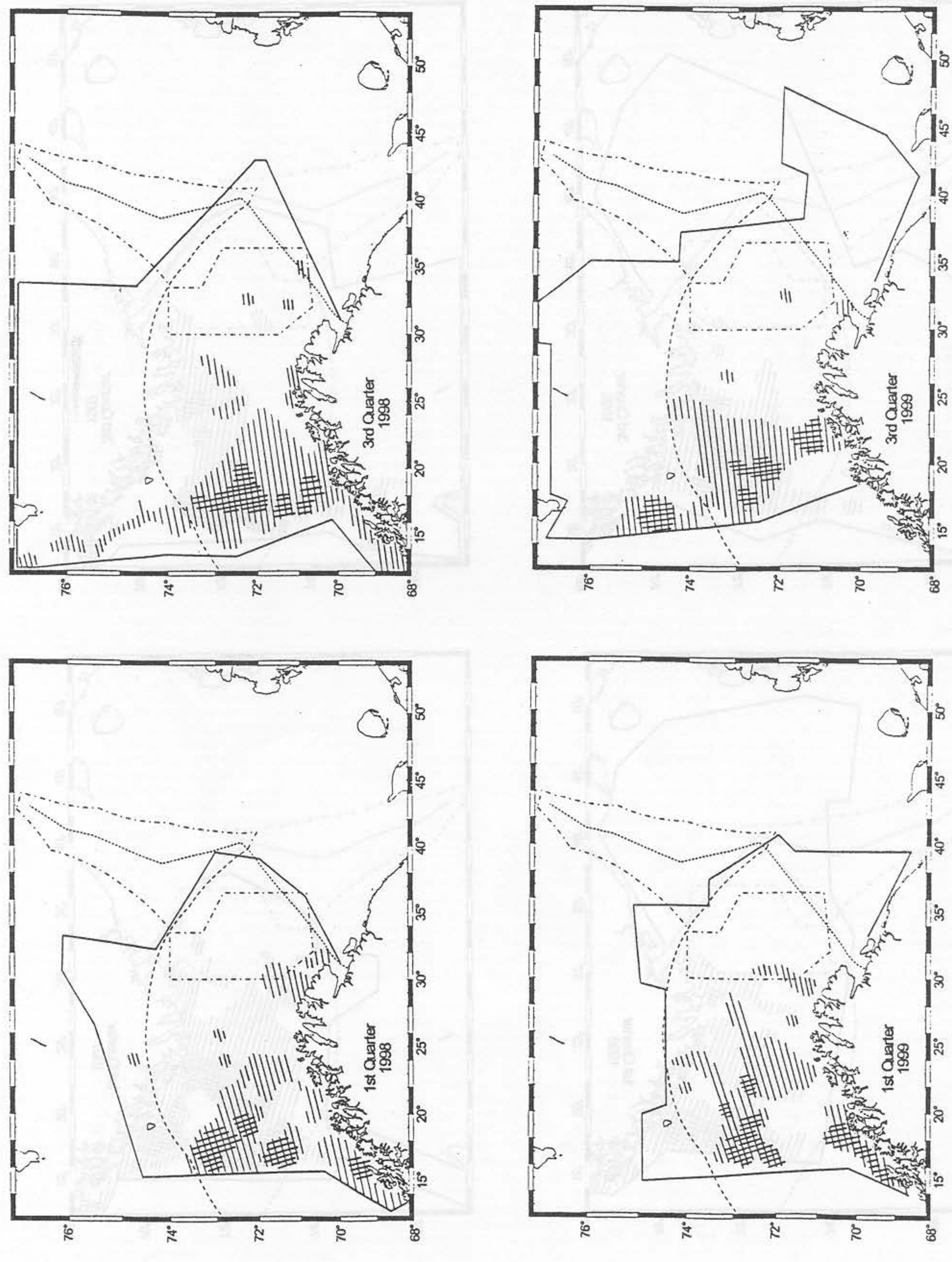
Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.



Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.



Distribution of BLUE WHITING. Hatched area based on nos./trawl station.
Double hatched: > 100. Full line: surveyed area.



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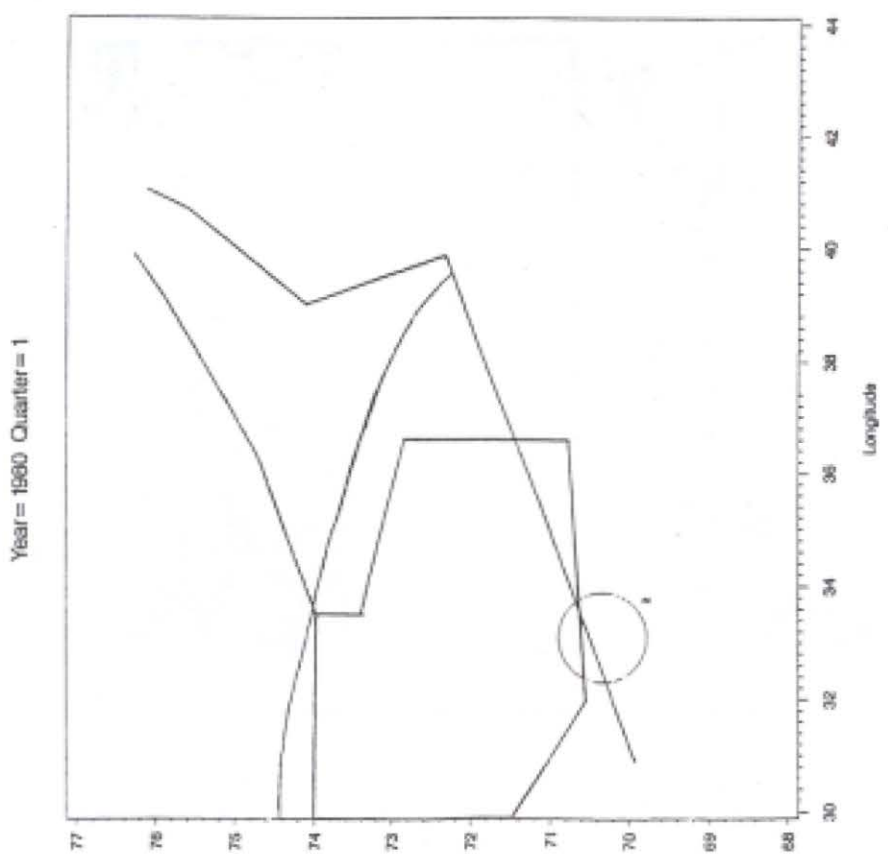
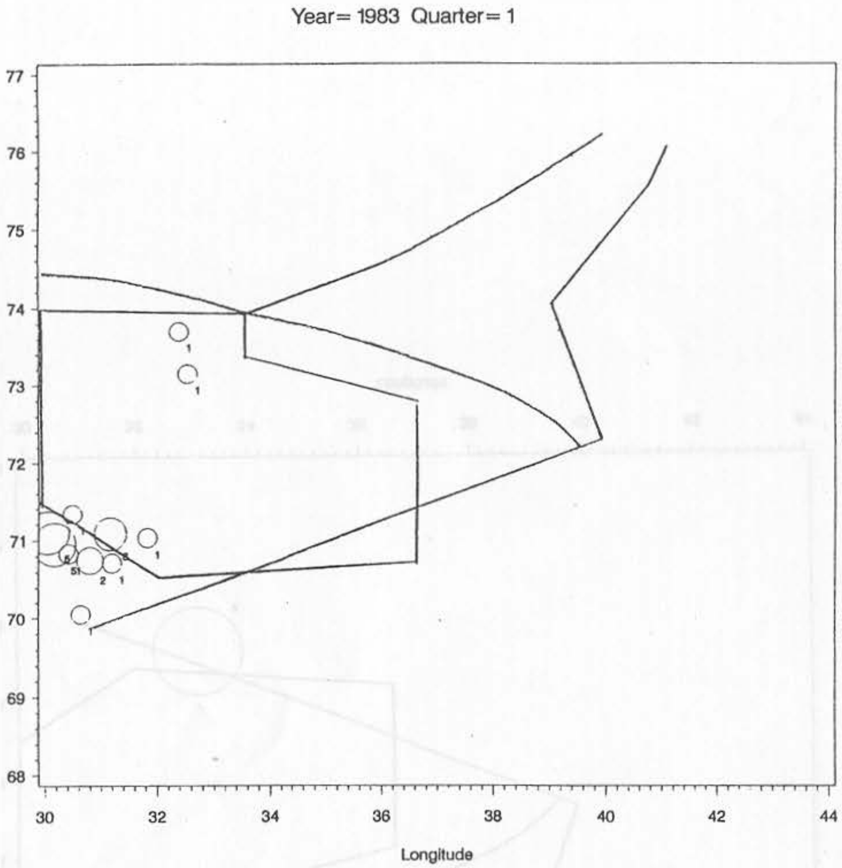
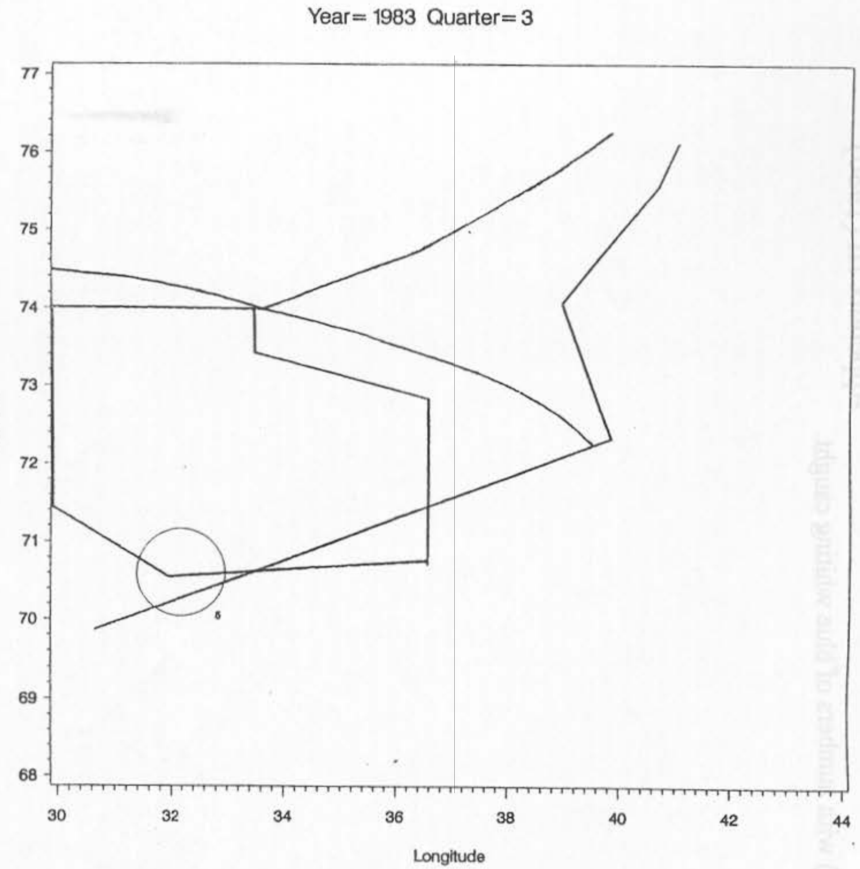
Trawl stations (circles) with numbers of blue whiting caught.



Appendix III (1983)

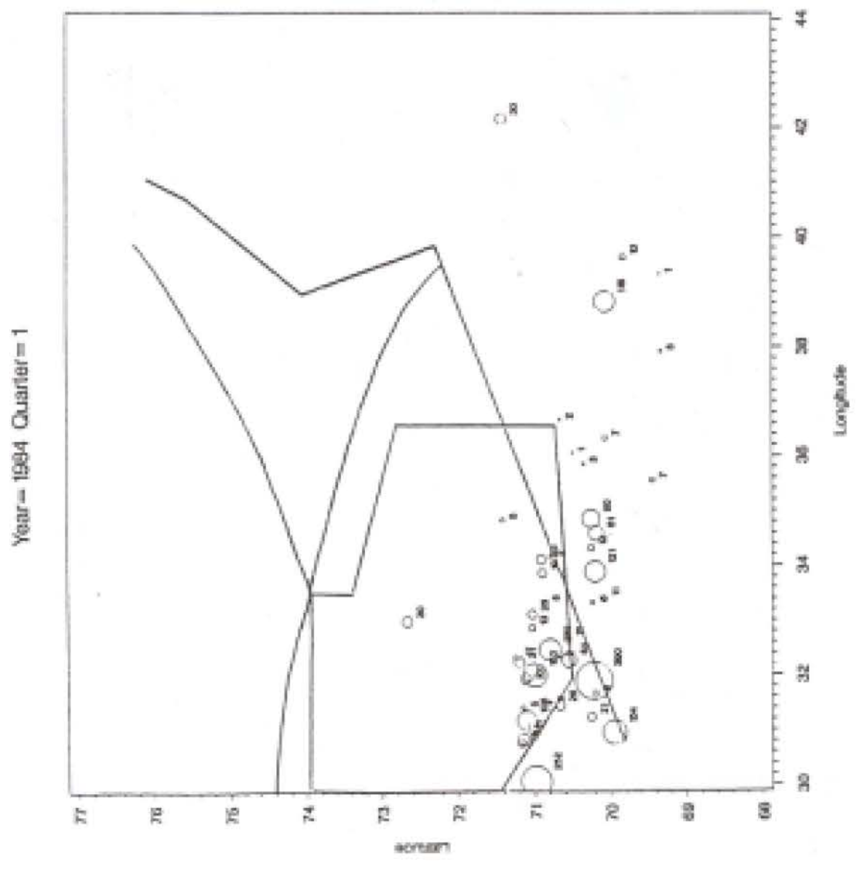
Trawl stations (circles) with numbers of blue whiting caught.





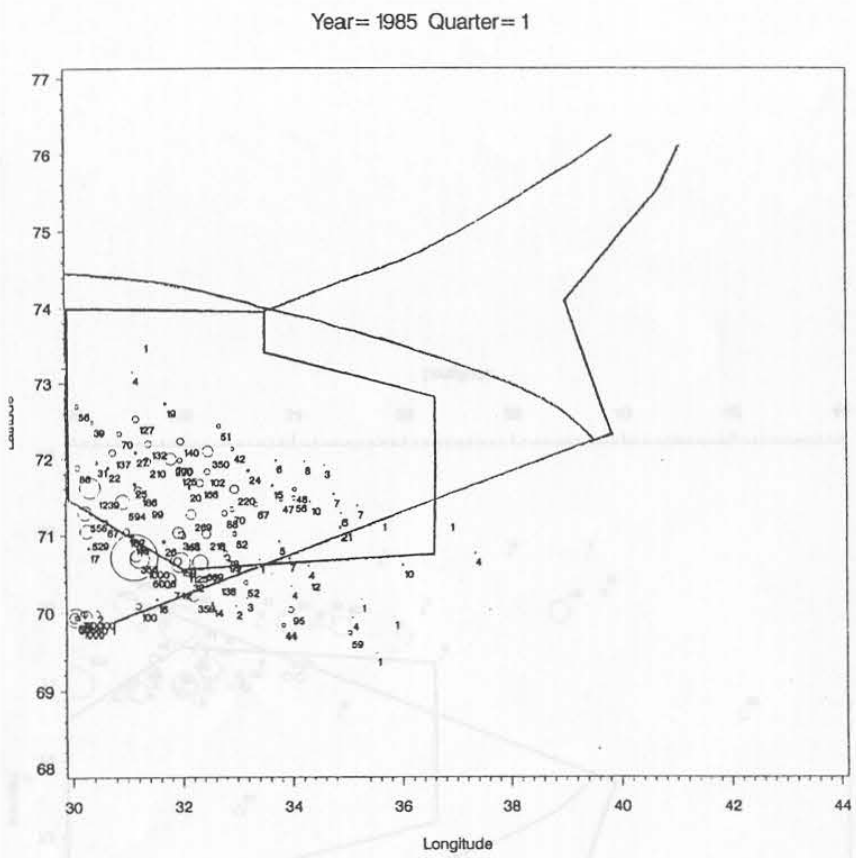
Appendix III (1984)

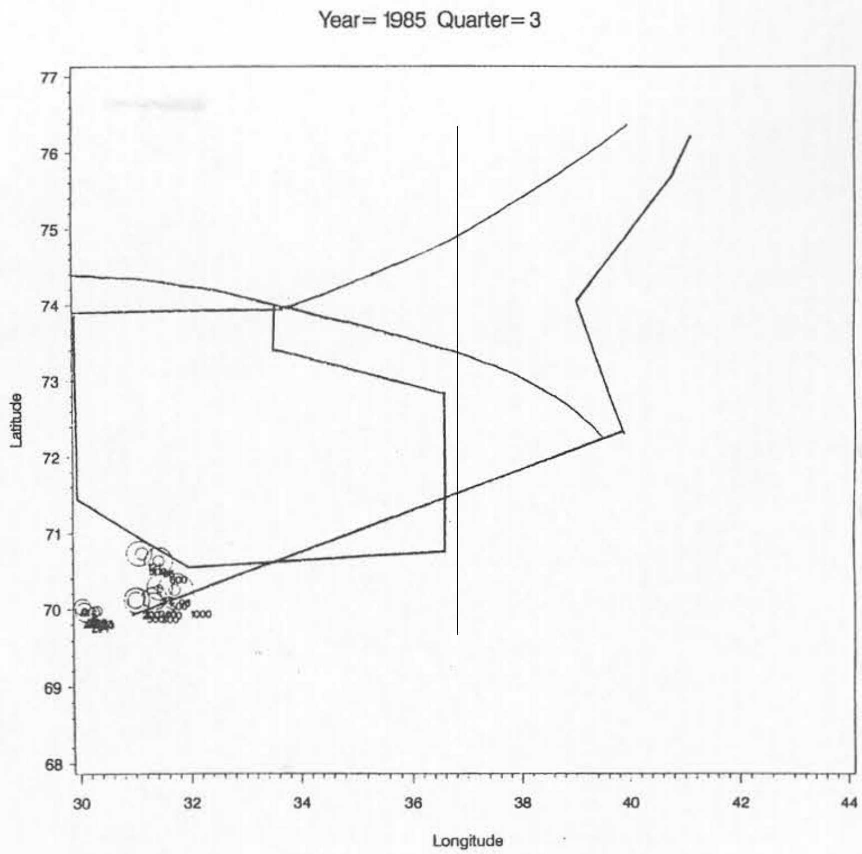
Trawl stations (circles) with numbers of blue whiting caught.



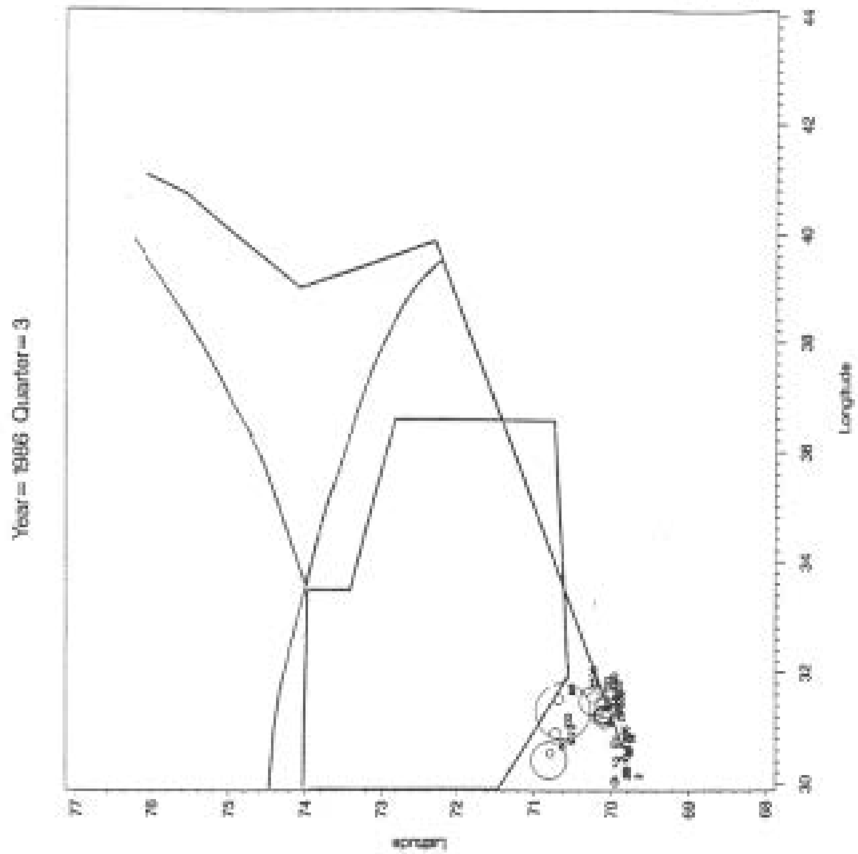
Appendix III (1985)

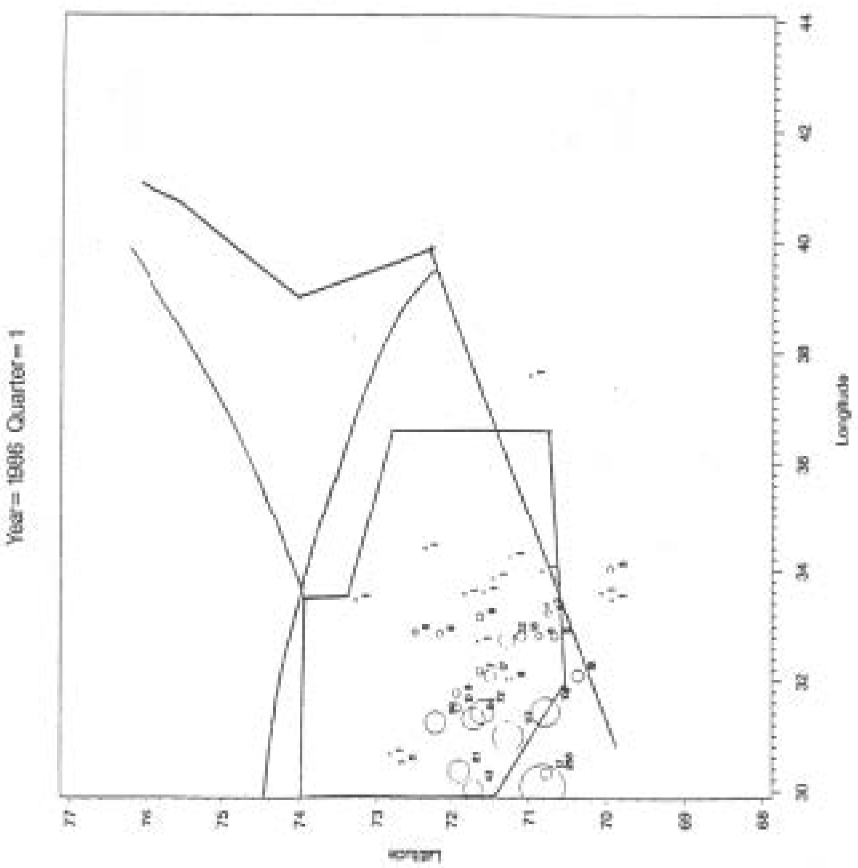
Trawl stations (circles) with numbers of blue whiting caught.



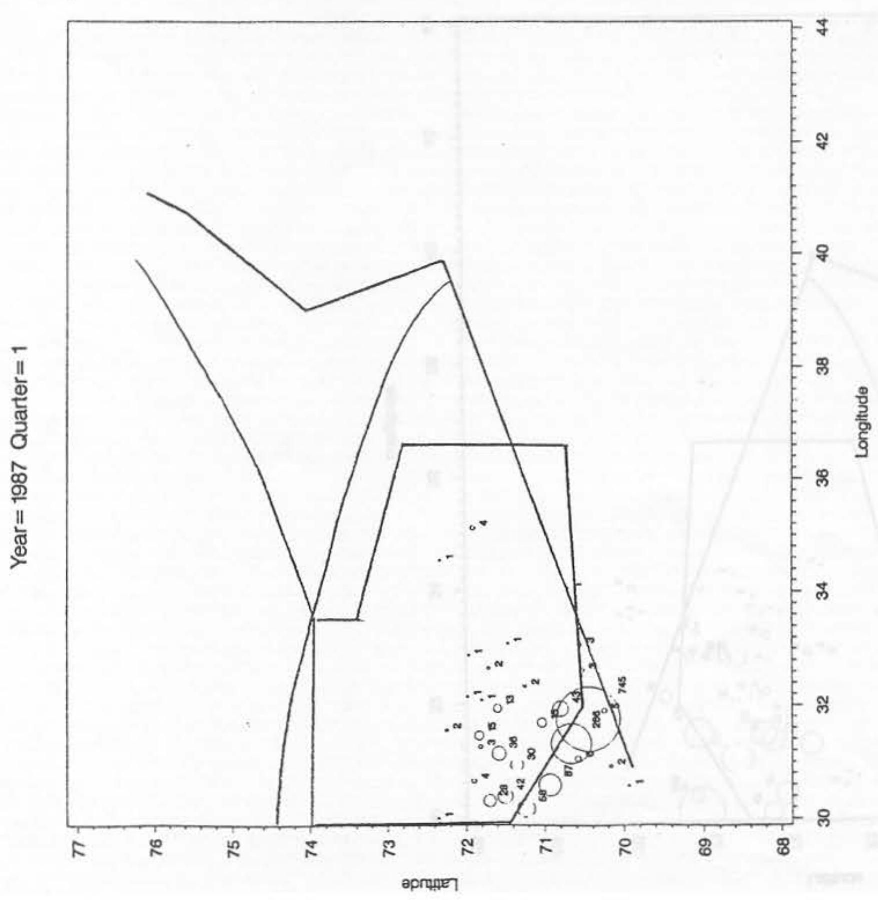


Trawl stations (circles) with numbers of blue whiting caught.





Trawl stations (circles) with numbers of blue whiting caught.



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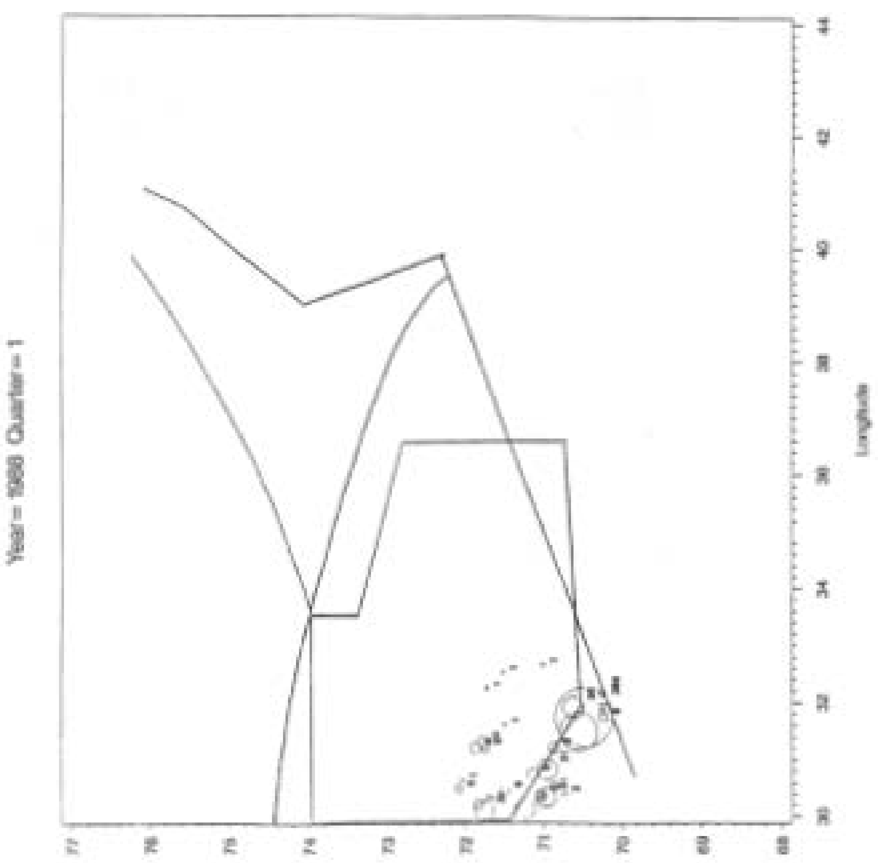
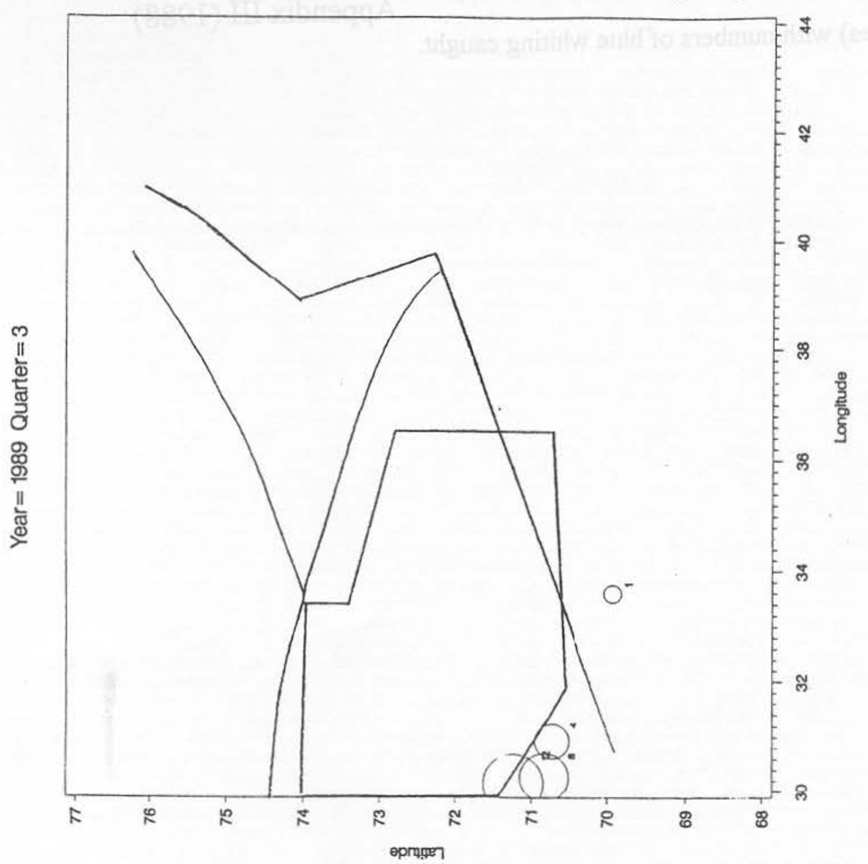
Appendix III (1988)

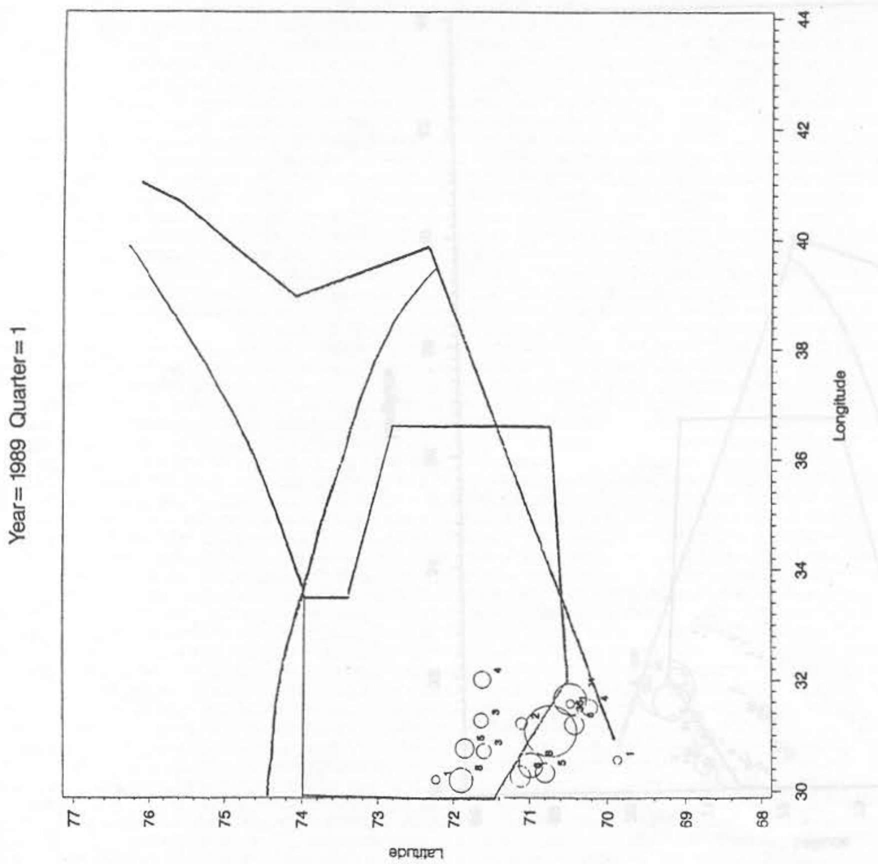
Trawl stations (circles) with numbers of blue whiting caught.



Appendix III (1989)

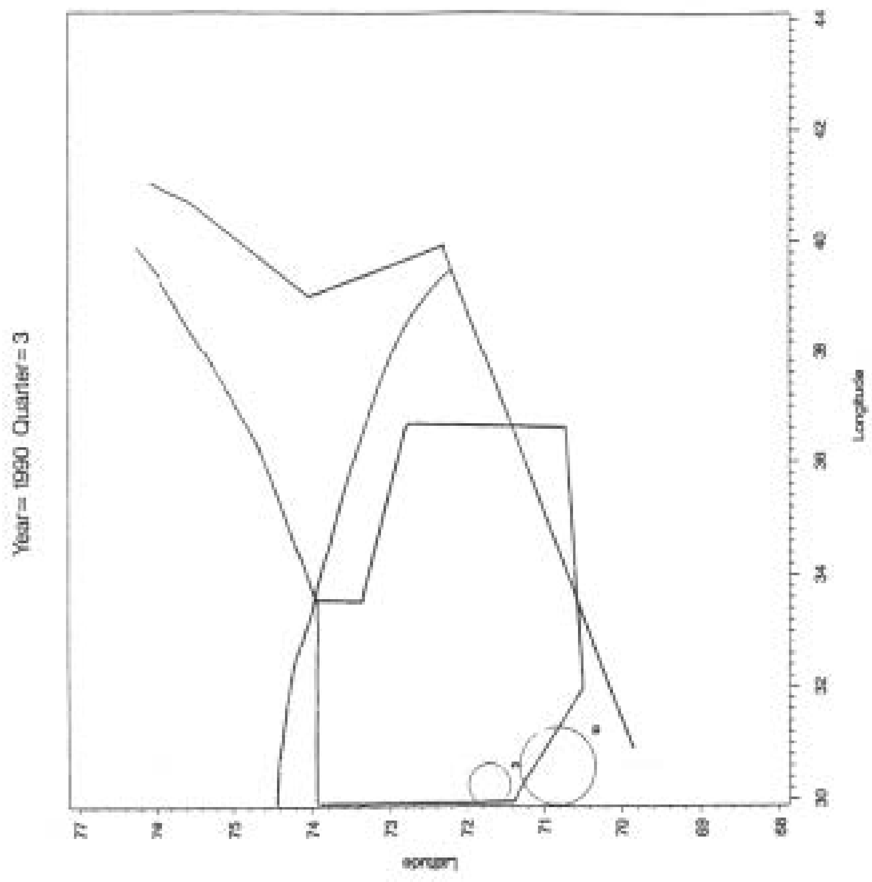
Trawl stations (circles) with numbers of blue whiting caught.

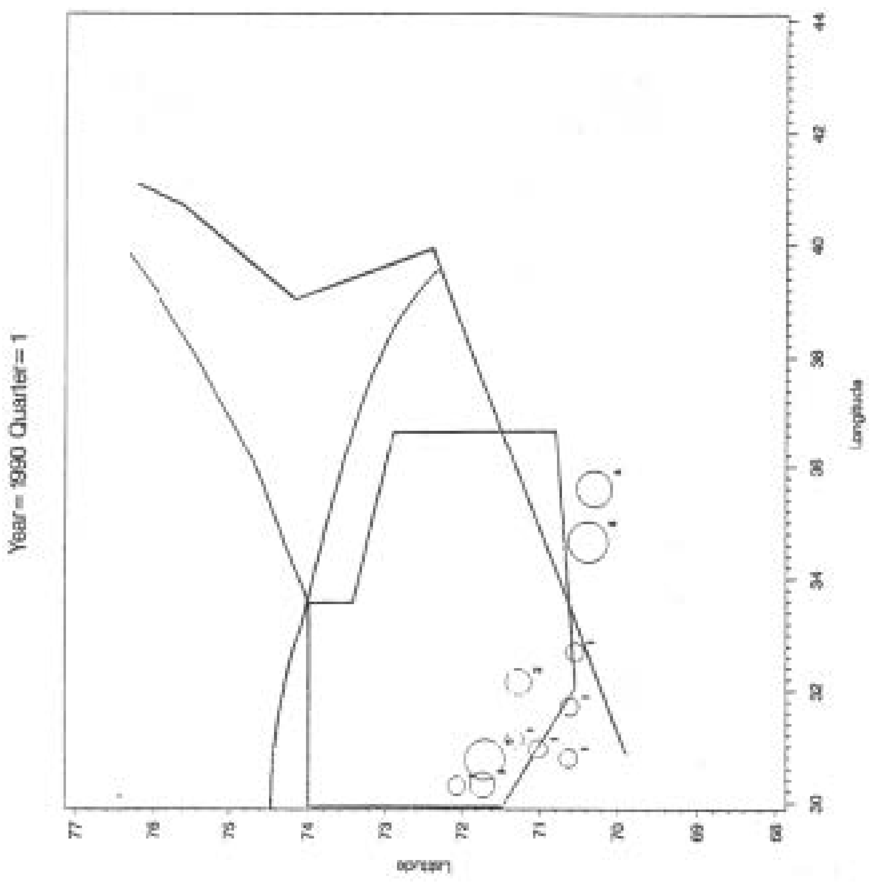




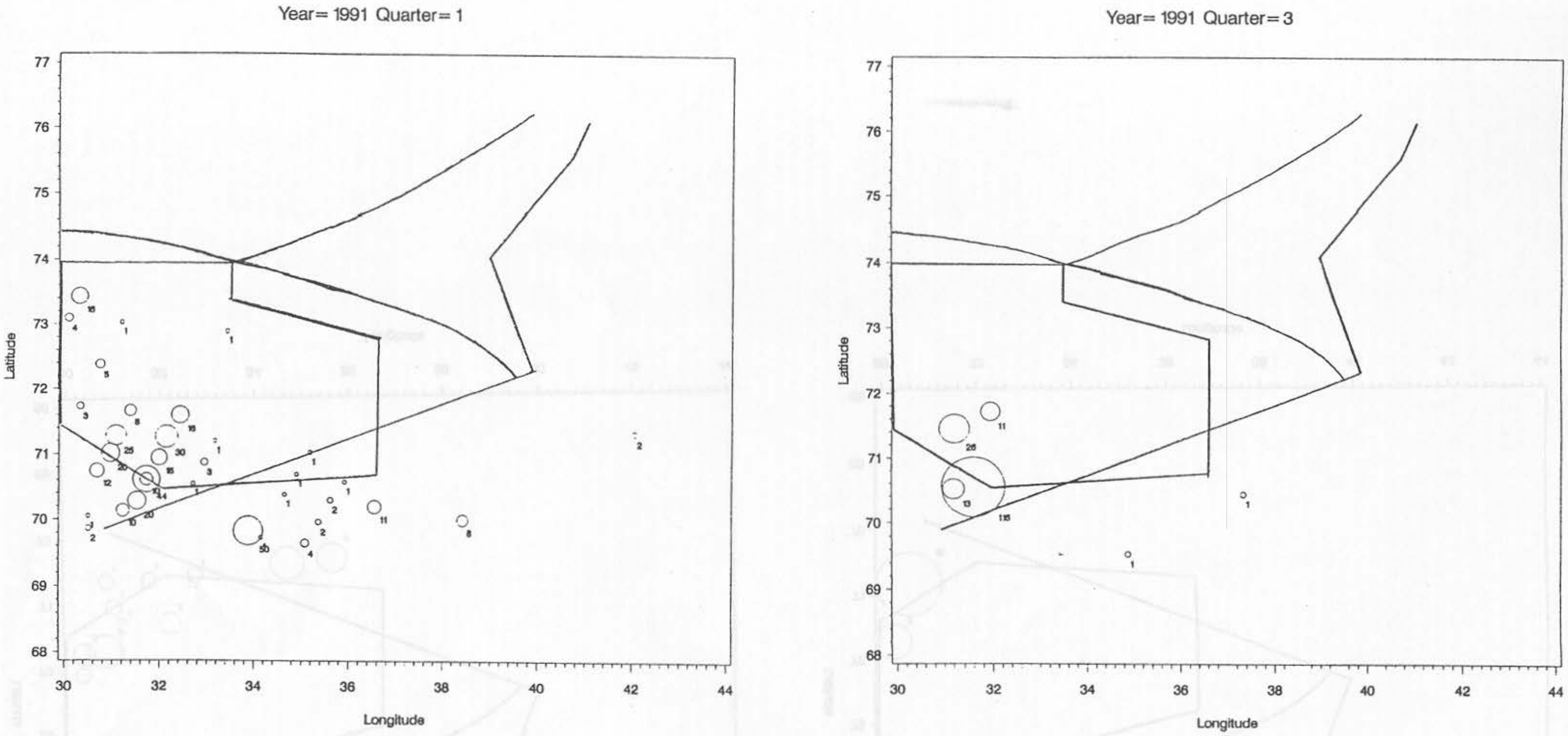
Appendix III (1990)

Trawl stations (circles) with numbers of blue whiting caught.



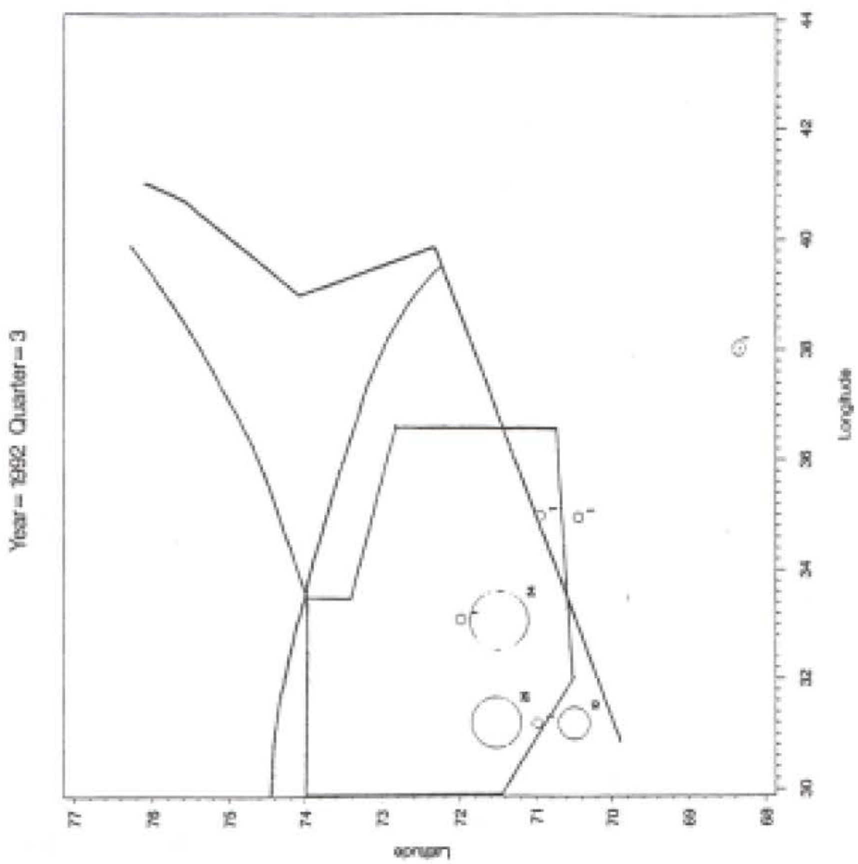


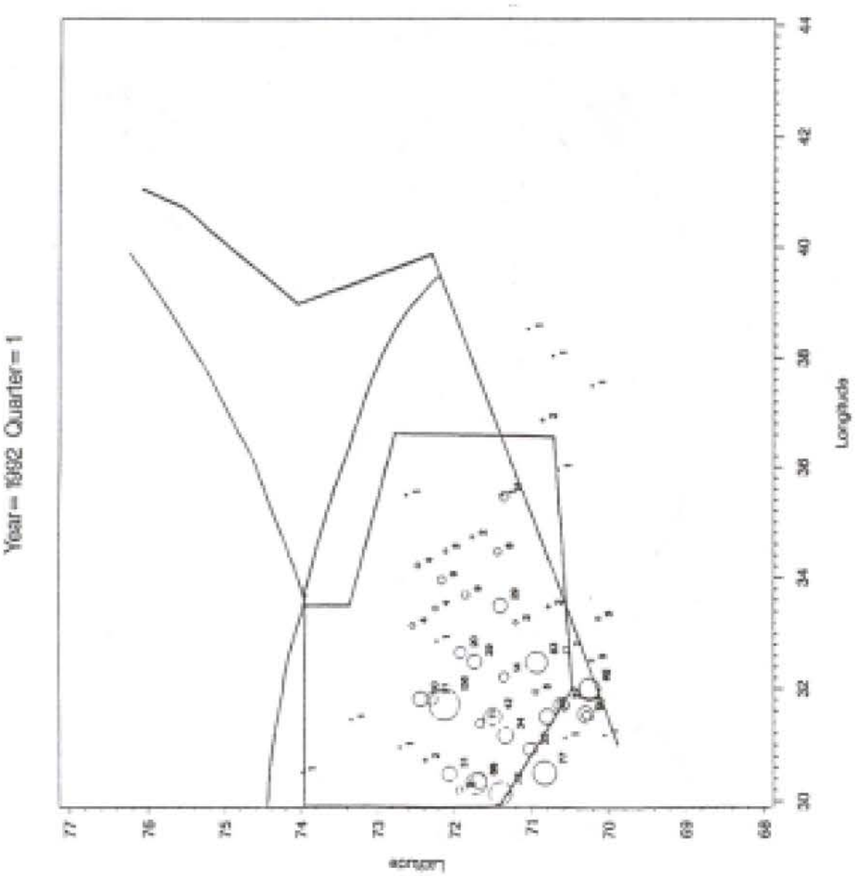
Appendix III (1991)



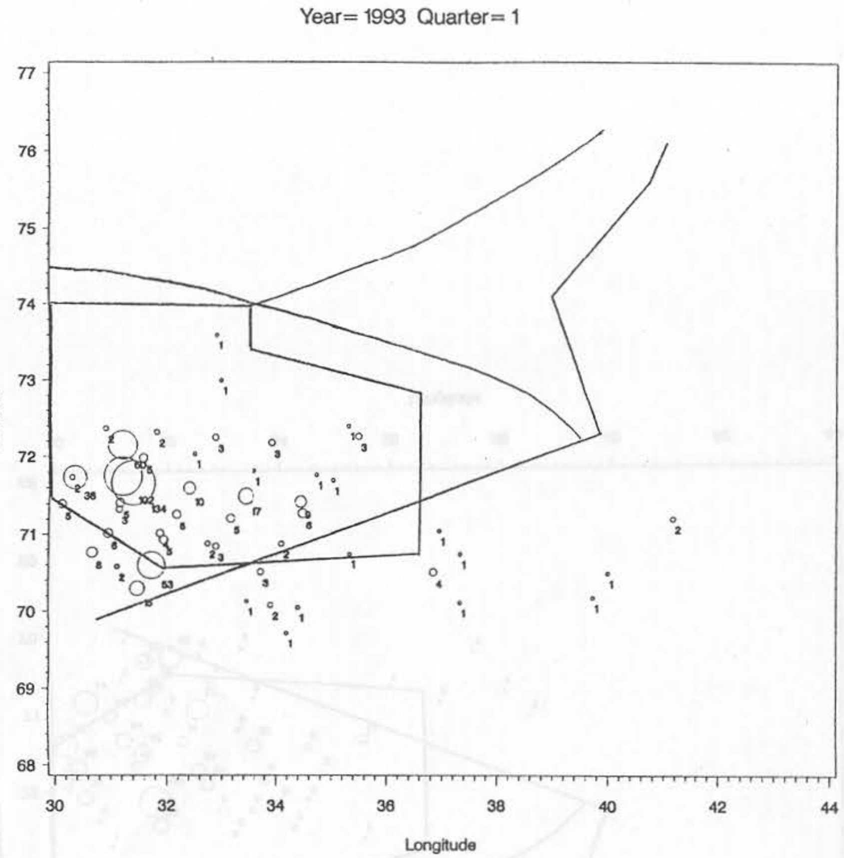
Trawl stations (circles) with numbers of blue whiting caught.

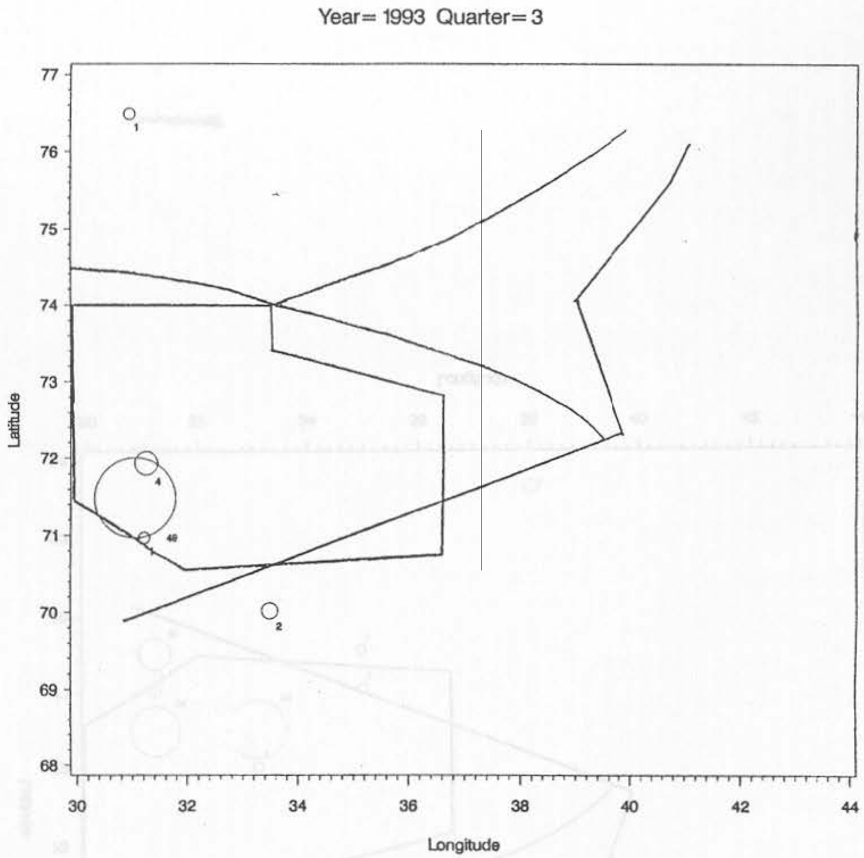
Trawl stations (circles) with numbers of blue whiting caught.





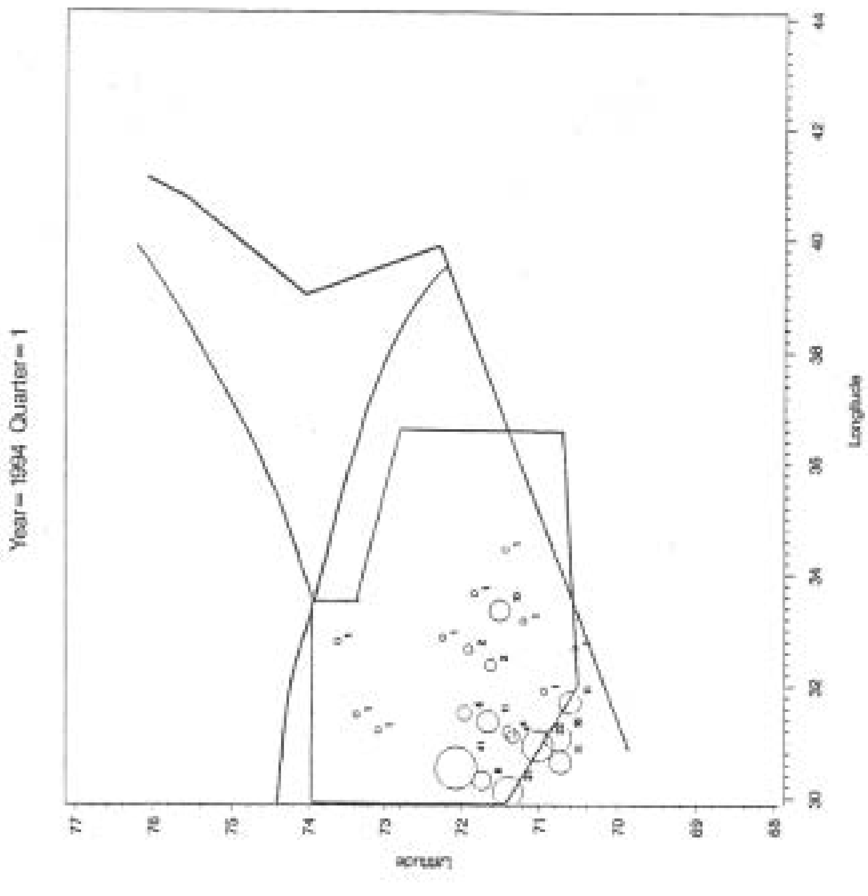
Trawl stations (circles) with numbers of blue whiting caught.



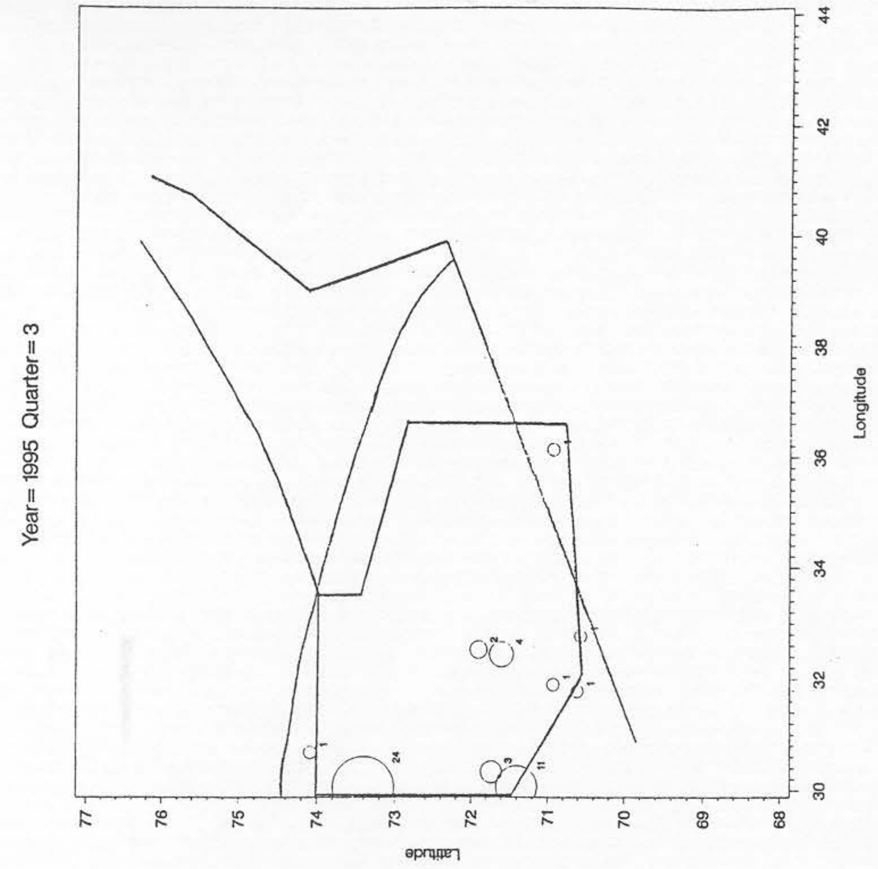


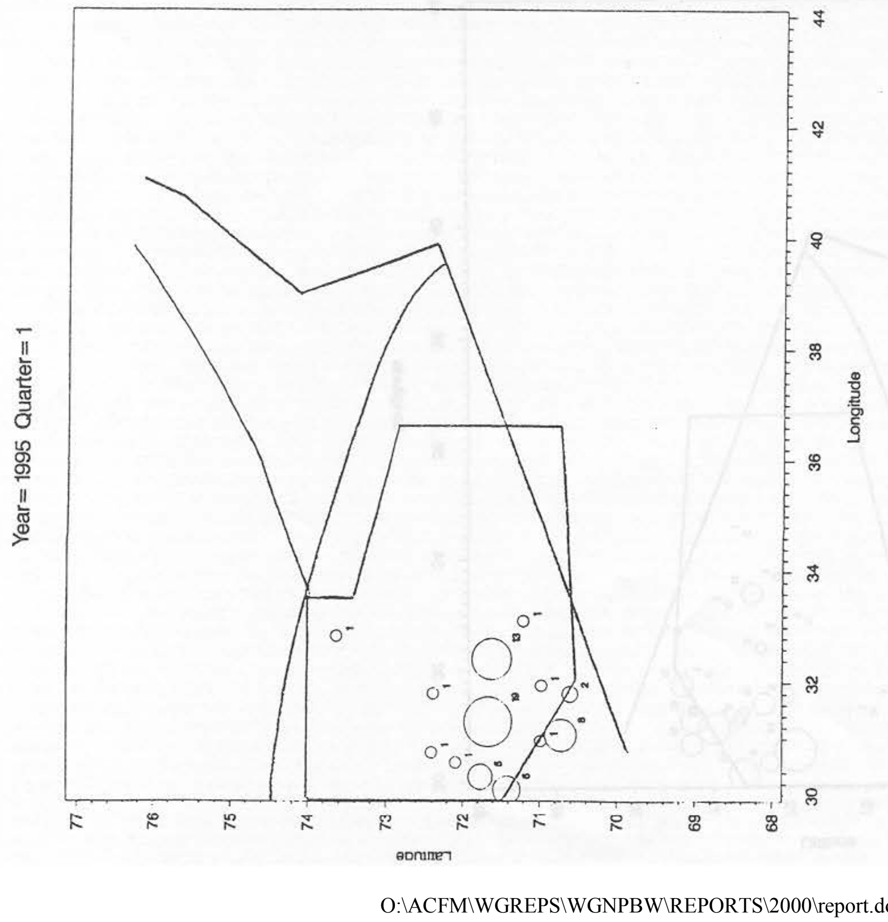
Appendix III (1994)

Trawl stations (circles) with numbers of blue whiting caught.

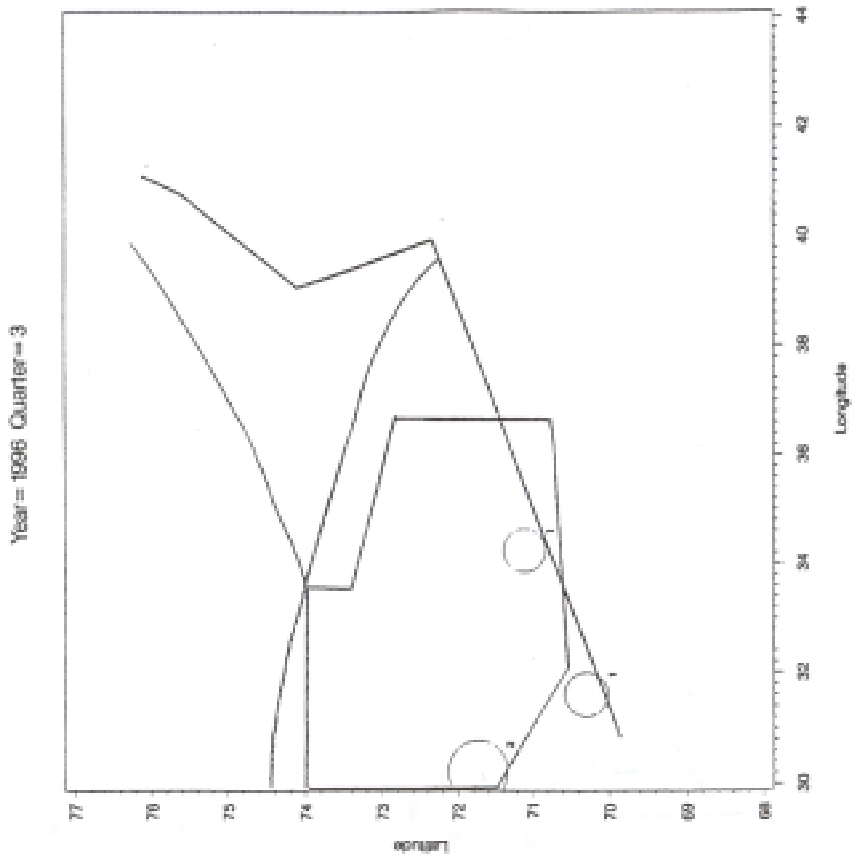


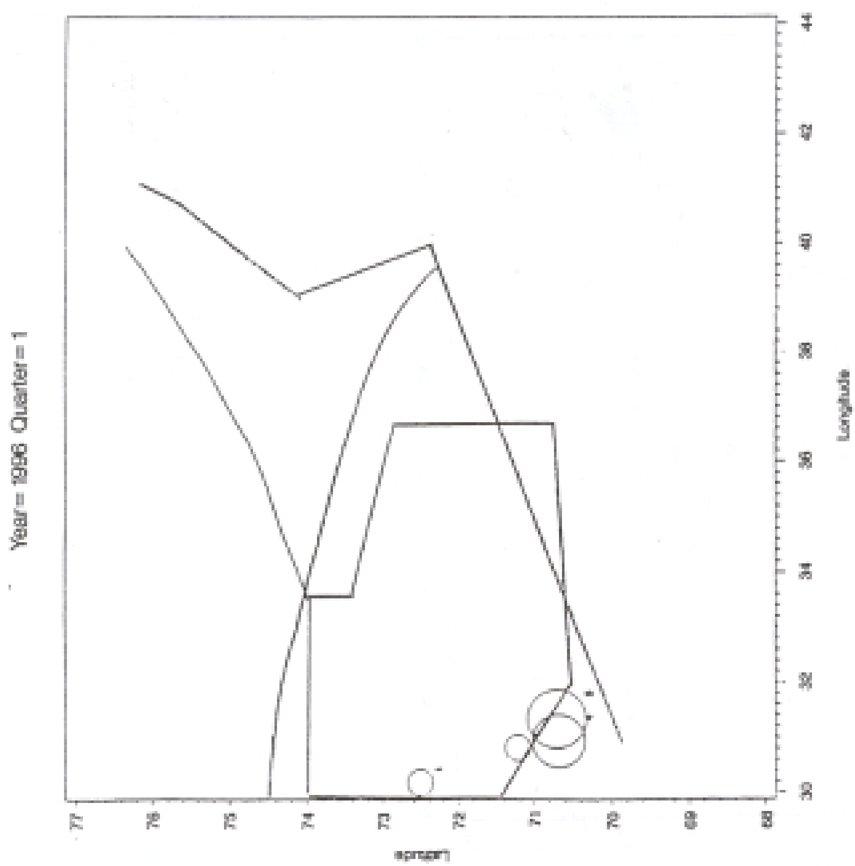
Trawl stations (circles) with numbers of blue whiting caught.



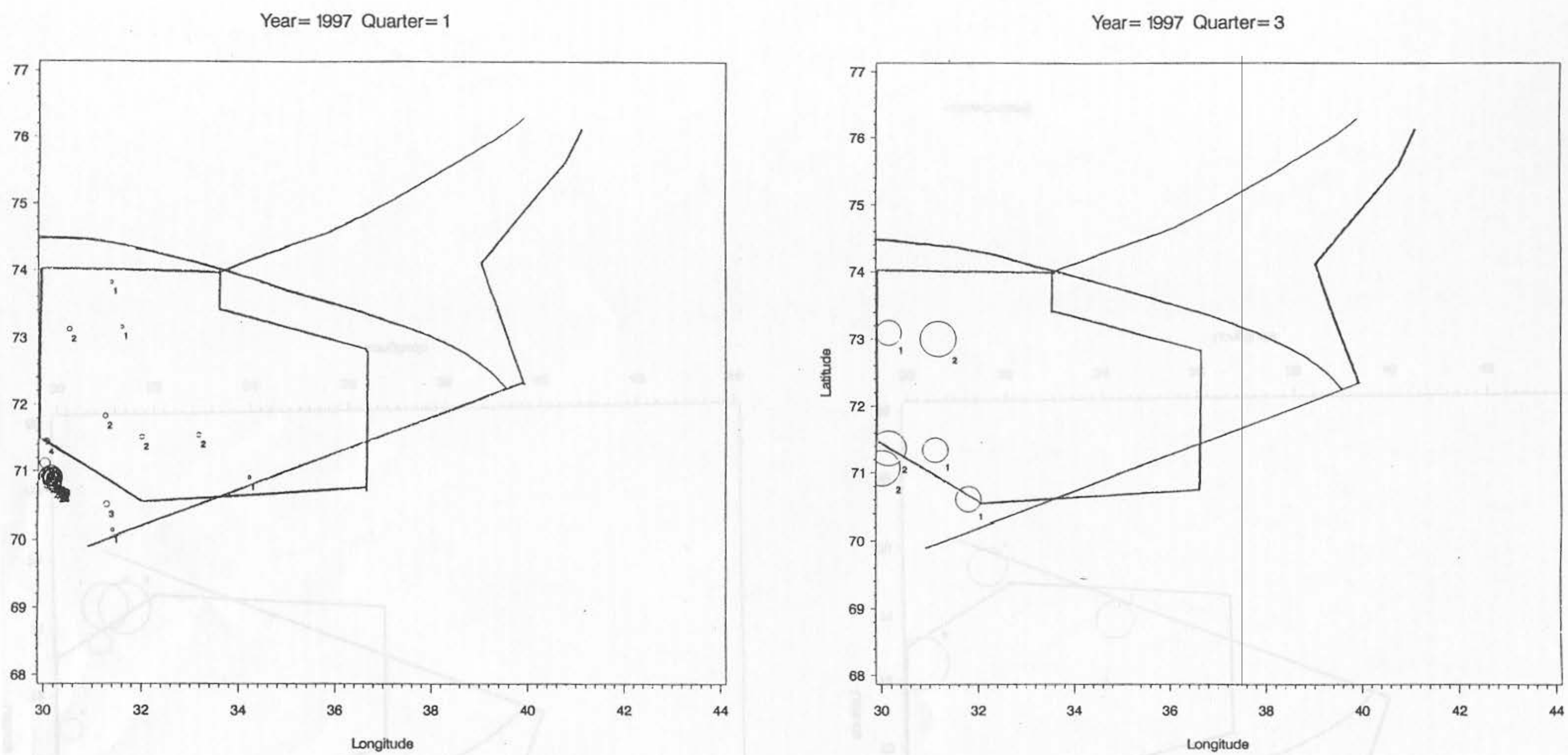


Trawl stations (circles) with numbers of blue whiting caught.



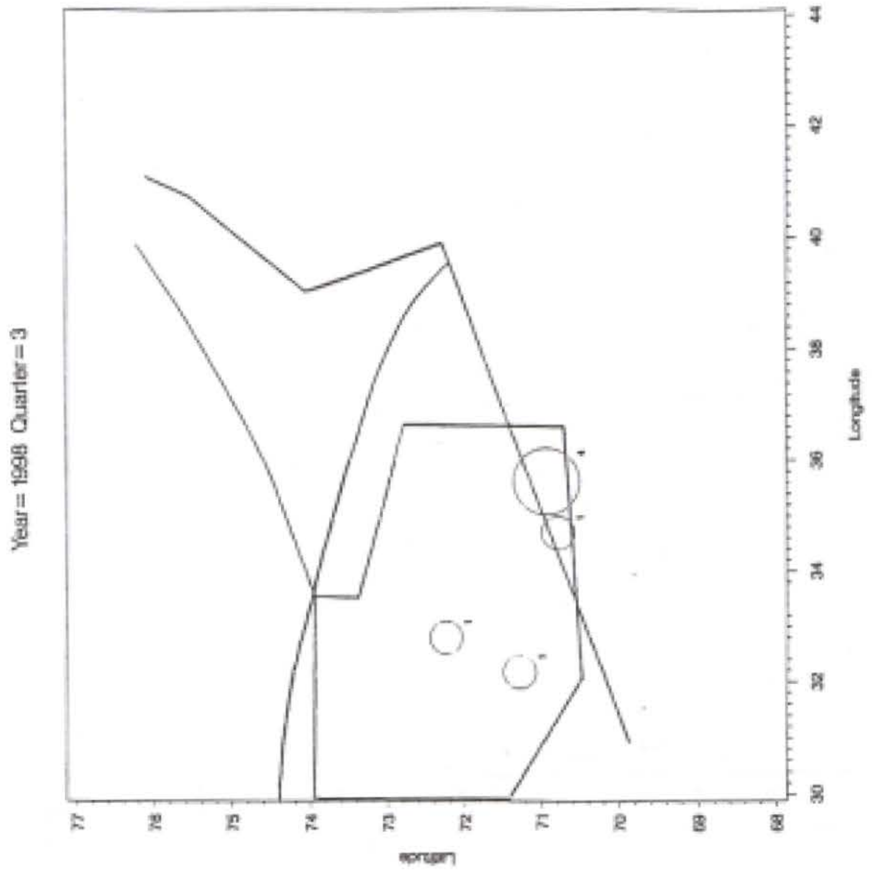


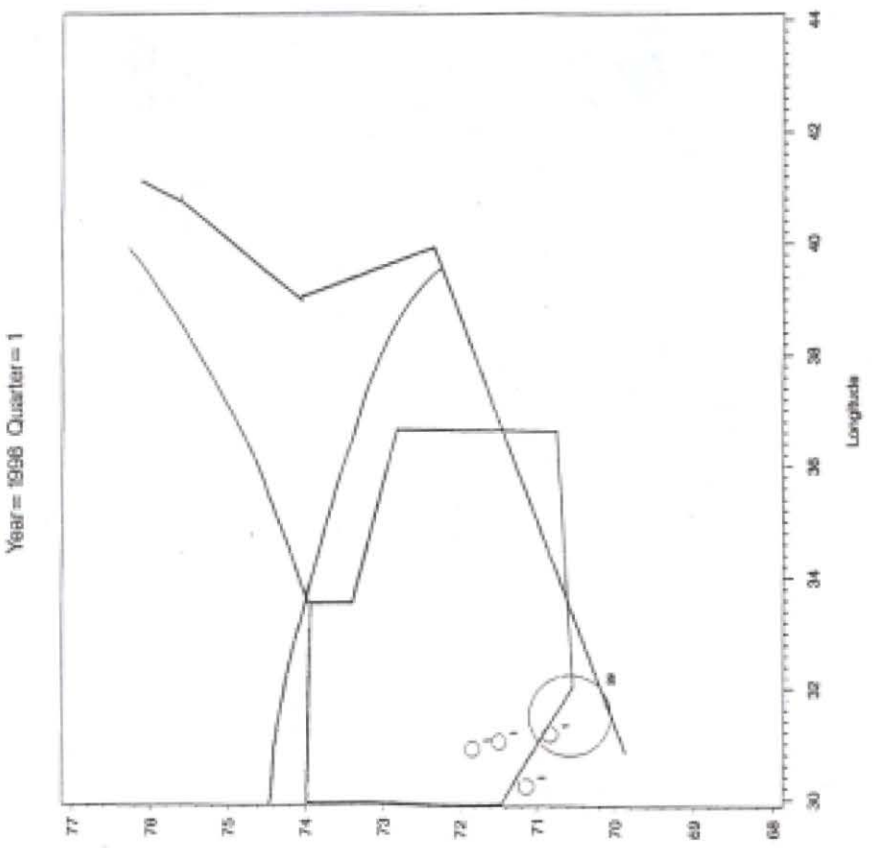
Appendix III (1997)



Trawl stations (circles) with numbers of blue whiting caught.

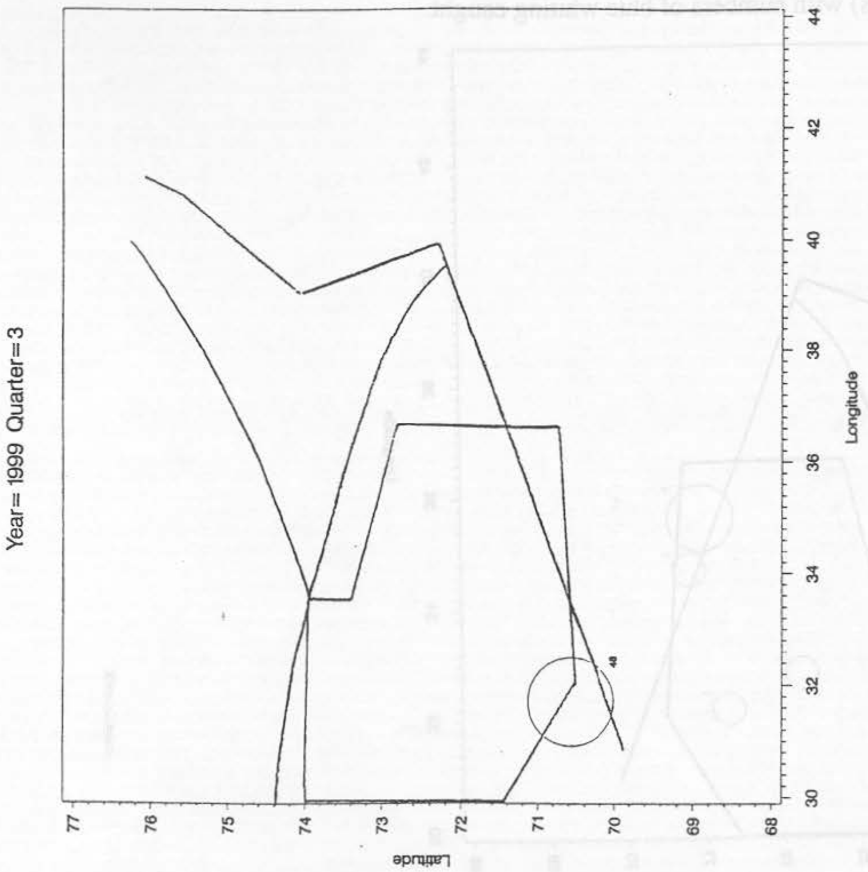
Trawl stations (circles) with numbers of blue whiting caught.

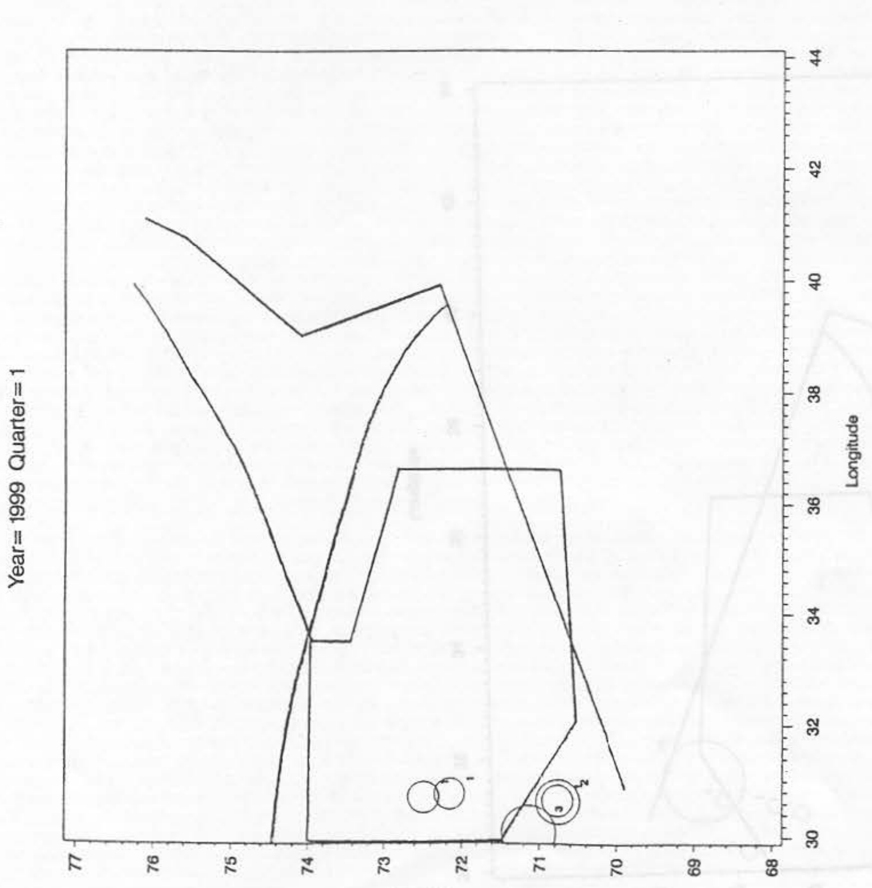




Appendix III (1999)

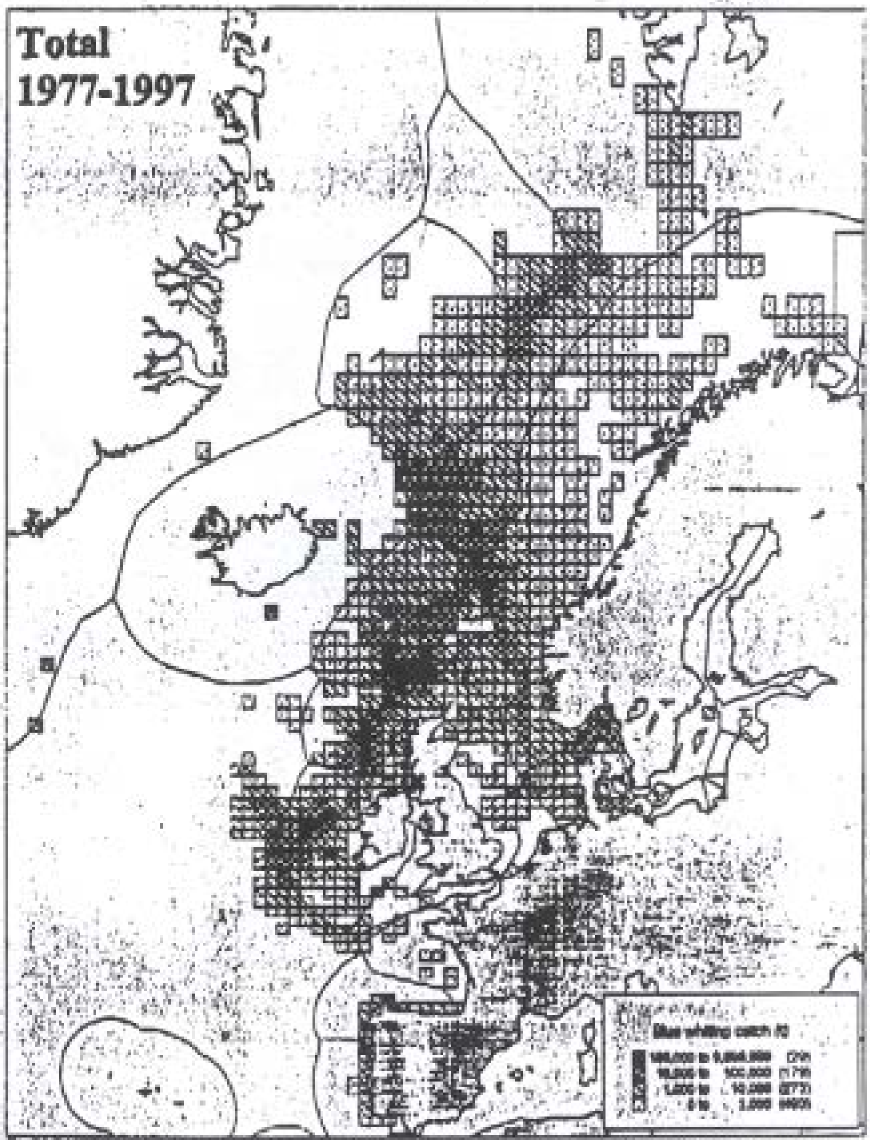
Trawl stations (circles) with numbers of blue whiting caught.





APPENDIX IV

REPORT OF THE NEAFC WORKSHOP ON MACKEREL AND BLUE WHITING – TÓRSHAVN, FEBRUARY 1999



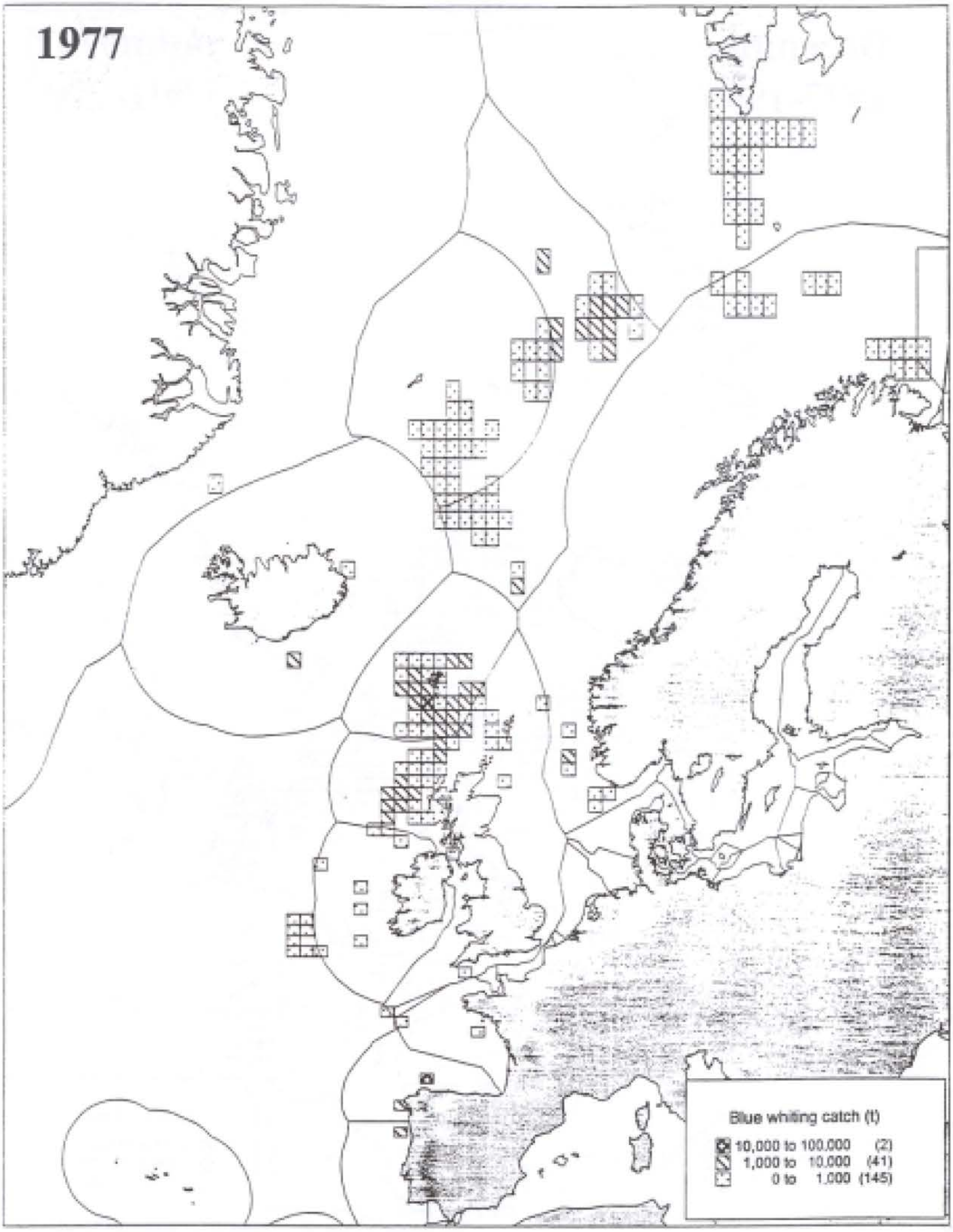


Figure 3.7.14 Blue whiting catch 1977.

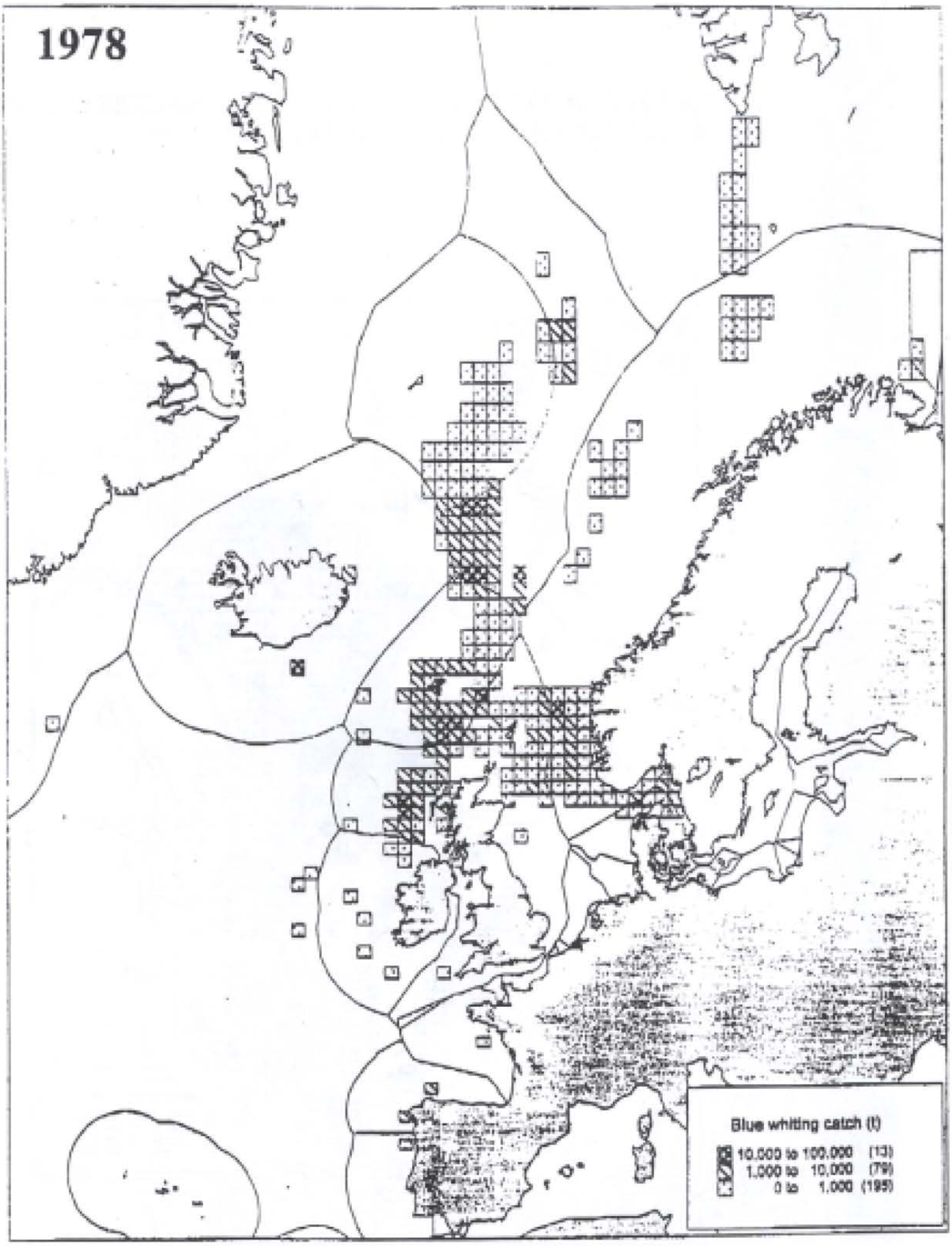


Figure 3.7.15 Blue whiting catch 1978.

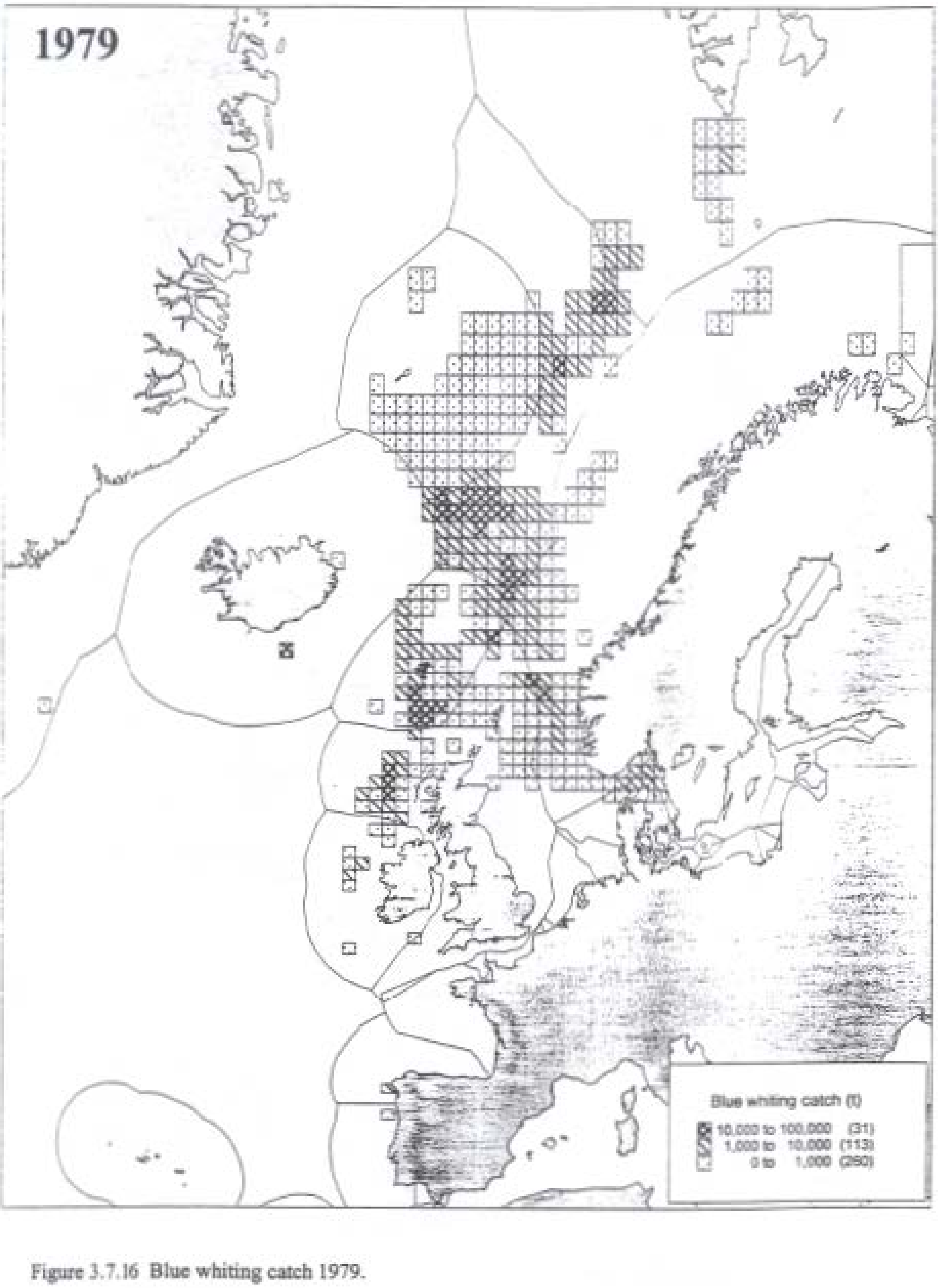


Figure 3.7.16 Blue whiting catch 1979.

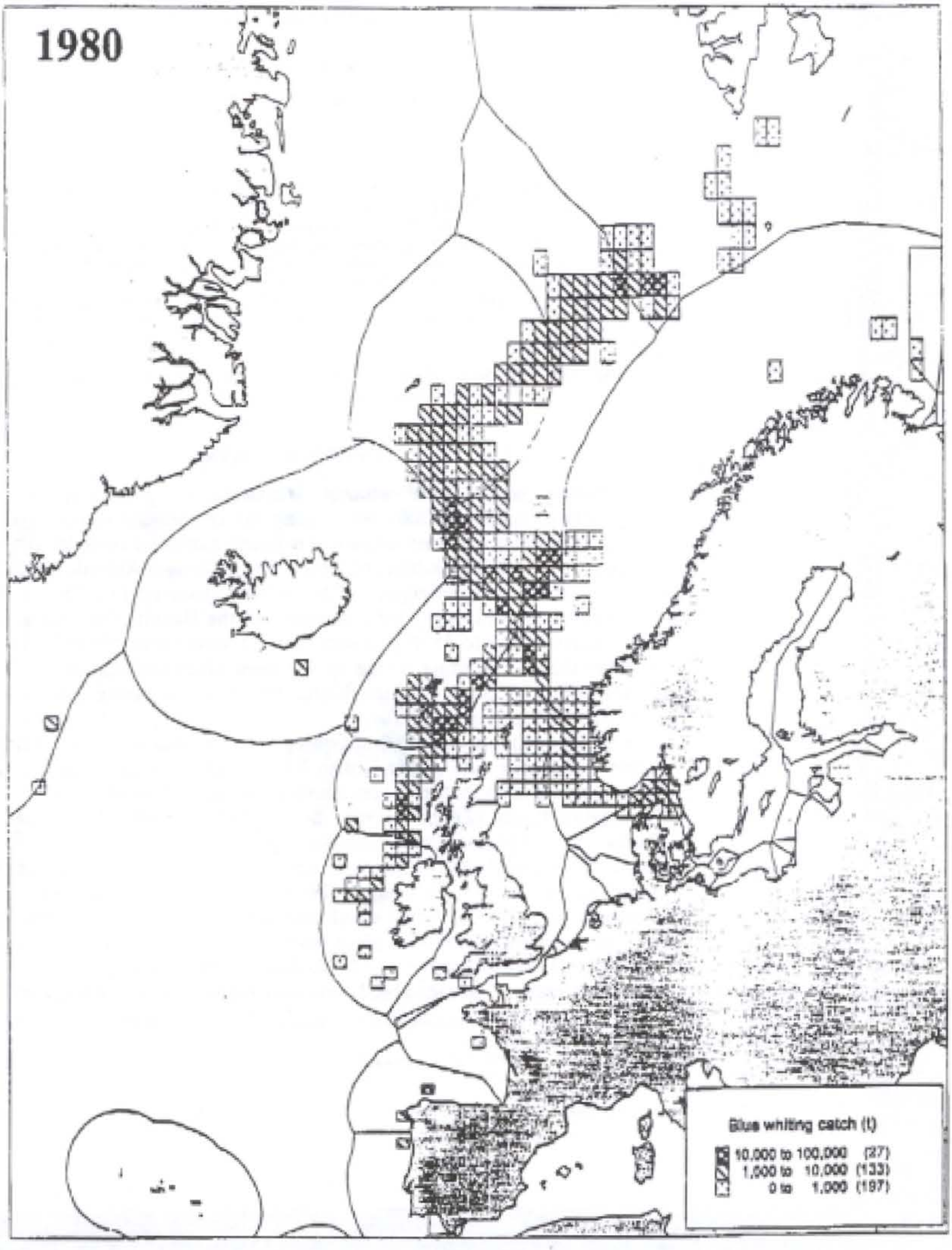


Figure 3.7.17 Blue whiting catch 1980.

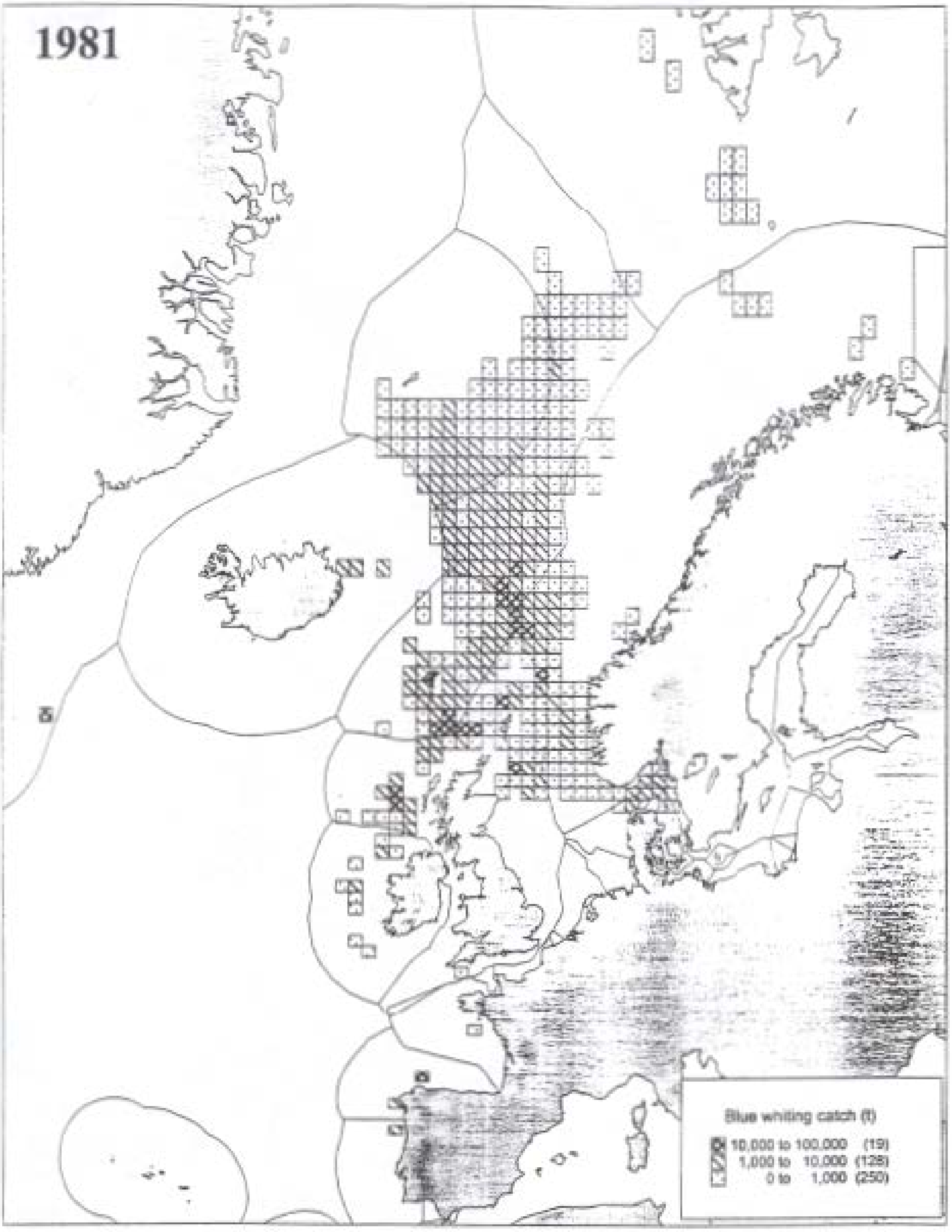


Figure 3.7.18 Blue whiting catch 1981.

APPENDIX V

International Council for
the Exploration of the Sea

C.M. 1983/H:35
Pelagic Fish Committee

SPAWNING OF BLUE WHITING (*MICROMESISTIUS POUTASSOU*) IN NORWEGIAN WATERS

by

Herman Bjørke
Institute of Marine Research
Box 1870, N-5011 Bergen, Norway

ABSTRACT

From two permanent oceanographic stations 56 eggs of blue whiting were recorded in the period March-July. Half of these were recorded in May indicating a peak in spawning this month. During a survey covering the area Stad-Bear Island (62-74°N) in June/July eggs and newly hatched larvae were found as far north as to Træna (66°N), indicating spawning south of this area. Surveys in April from Stad to Lofoten (68°N) in the period 1976-1982 and in June/July from Træna to Bear Island in the period 1977-1982 confirm this. Spawning seems to take place in the fjords and over the deeper parts of the continental shelf. A maximum of 30 eggs and 50 larvae per m^2 surface was recorded. Most of the recordings were from the Møre area.

INTRODUCTION

The main spawning area of blue whiting is west of the British Isles, and the spawning lasts from March to late April with a peak in April (Anon. 1979). The existance of subsidiary spawning areas outside this area is suggested by Coombs and Pipe (1980) referring to findings of eggs and larvae in the fjords on the west coast of Norway, of young blue whiting found to the north of Norway and in the Barents Sea, and of spawning adults taken in the Norwegian Sea. The evidence indicates that spawning in the Norwegian Sea is from late May through June, and the location of the spawning grounds in the Norwegian Sea appears to be mostly adjacent to the edge of the continental shelf as they do to the west of the British Isles (Coombs and Pike 1980).

In Norwegian waters larvae of blue whiting are recorded in Nordfjord and off Svinø, 8-13 mm long, (Anon. 1976) and off Røst, 5-33 mm long (Zilanov 1968). Monstad and Tangen (pers. comm.) found 64 larvae in some fjords in the area from 59°N to 62°N. The length of the larvae varied from 11 to 31 mm and they were sampled with a pelagic trawl in June. Eggs and/or larvae are recorded in Masfjorden and Fensfjorden (Lopes 1979) and from Stad to Træna (Bjørke 1983).

MATERIALS AND METHODS

Parts of this material were derived from herring larvae surveys made in April from Stad to Lofoten in the period 1976-1982. The area was covered twice and samples taken with a Gulf III-samples. (Zijlstra 1970). The samples are taken as double oblique hauls from 60 m to the surface and the station grid is nearly the same each year. The station grid for 1980 is indicated in Fig. 1.

Another part of the material was derived from a postlarvae survey in June/July 1982 (Fig. 2). Vertical hauls were taken with a 0.1m^2 Juday net from 20-0 m and from 200 m, or bottom if shallower, to surface. Mesh size was 180 micron.

The rest of this material was derived from permanent oceanographic stations at the entrance of Sognefjorden (Sognesjøen) and off Bud (Fig. 2). Vertical hauls from 300 to 0 m and from 250 to 0 m, from Sognesjøen and Bud respectively, were taken with a 0.1m^2 Juday net at intervals from one week to one month (Wiborg 1978). The samples included are from the period 1976-1979 and from 1976-1981 from Sognesjøen and Bud respectively. Seaton and

Bailey (1971) and Russel (1976) were used for identification purposes.

RESULTS AND DISCUSSION

Seasonal distribution

Table 1 shows the recordings of eggs and larvae of blue whiting at Sognesjøen. Eggs and/or larvae are recorded from March to July with a small maximum in May. The length of the larvae varied from 2.0 to 5.3 mm. Off Bud five eggs were recorded from April to July in the period 1976-1981; three of these in May in different years. (Bjørke 1983). Spawning of blue whiting in Norwegian waters have thus been recorded from March to July with an indication of a peak in May.

Vertical distribution

During the postlarvae survey most of the eggs were found in the deepest hauls, while the larvae were more evenly distributed (Table 2). The length of the larvae varied from 2.0 to 6.4 mm.

Highest recordings of eggs in deeper hauls is in correspondence with findings by Coombs, Pipe and Mitchell (1981) West of the British Isles they found the highest number of eggs between 250 and 450 m. They also found larvae most frequently in the upper 100 and 40 m, depending on length. This might explain the relatively high number of larvae (40) compared to eggs (14) recorded during the postlarvae survey.

Horizontal distribution

In the present material, eggs of blue whiting were found from Sognefjorden (61°10'N) to Træna (66°20'N) (Fig. 1). Findings of egg and larvae are also reported from Fensfjorden and Masfjorden (60°50'N) (Lopes 1979). Monstad and Tangen (pers. comm.) found larvae from 11 to 31 mm in length in Botnafjord, Osterfjord, Sognefjord, Sunnfjord and Nordfjord.

Although vertical zooplanktonhauls were taken off the coast in the fjords from 67°N and 5°E north to 74°N and during postlarvae surveys in the period 1977-1982, no find of eggs or newly hatched larvae were recorded north of Træ The northern limits of spawning seems thus to be found in area (66°N). The distribution of eggs and small larvae see to indicate spawning in Norwegian fjords and over the deep parts of the continental shelf. It should be noted that edge of the continental shelf suggested as spawning grounds Coombs and Pipe (1980), was not investigated in the area sou of Træna during the surveys in April and June. Most of recordings were from the Møre area.

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Table 1. Numbers of eggs and larvae in vertical hauls with 0.1 m^2 Juday net from Sognesjøen.

	Eggs					Larvae				
Year	March	April	May	June	July	March	April	May	June	July
1976		1	8		2		3	9		
1977		6	5	2			4		7	
1978		1	9	1				2	1	
1979		3	5	8		1	2	11	4	
1976-1979		11	27	11	2	1	9	22	12	

Table 2. Numbers of eggs and larvae in different hauls with 0.1 m^2 Juday net sampled during the postlarvae survey in June/July 1982. Depths are rounded off to the nearest hundred meter when the depths were less than 200 m.

Depth in m	Eggs	Larvae
20-0	3	12
100-0	1	11
200-0	10	17

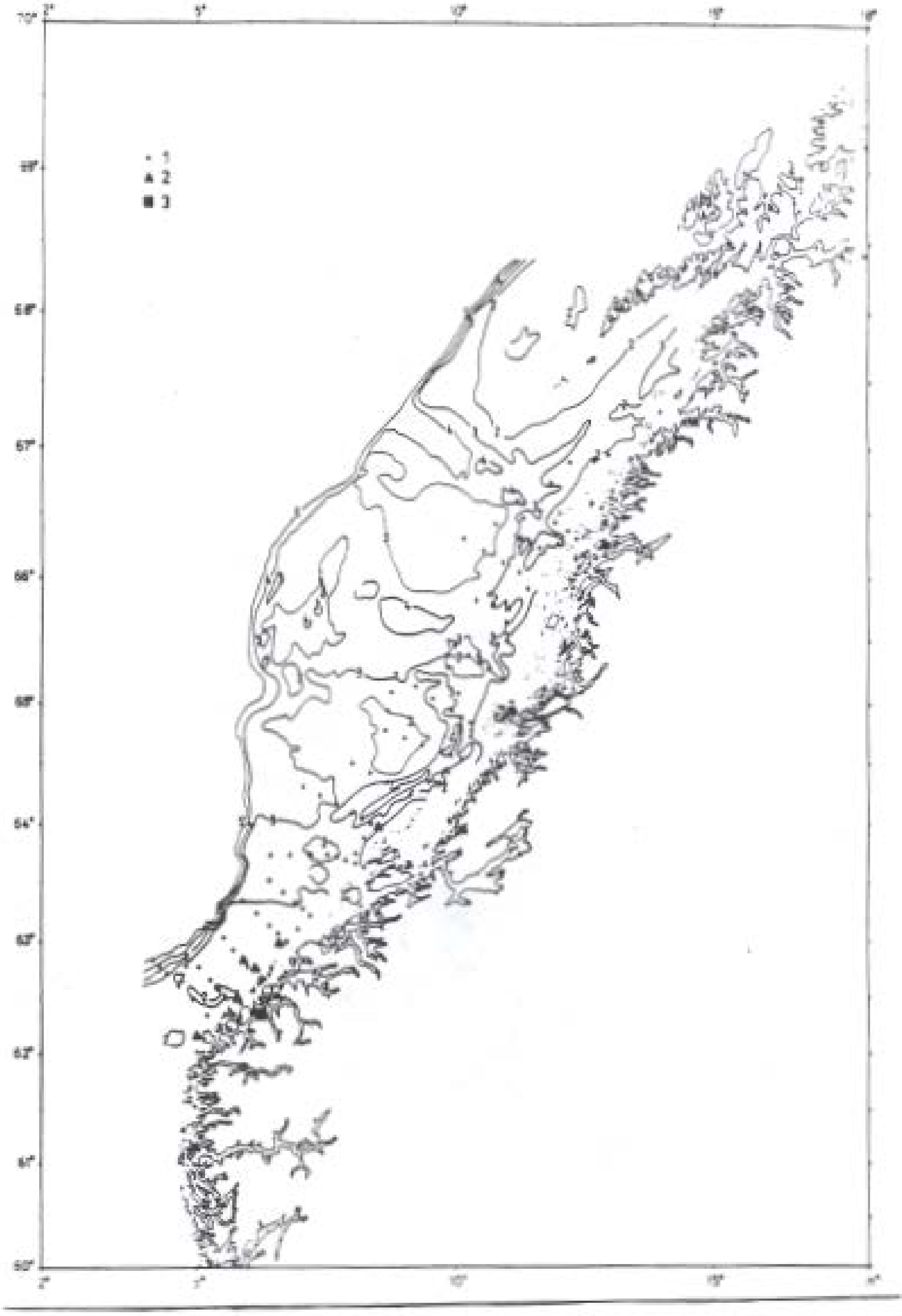

Fig. 1. Station grid for 1980 and recordings of eggs and larvae of blue whiting in April 1976-1982. 1. Stations without recordings. 2. Eggs. 3. Larvae. Depth contours in hundred meters.

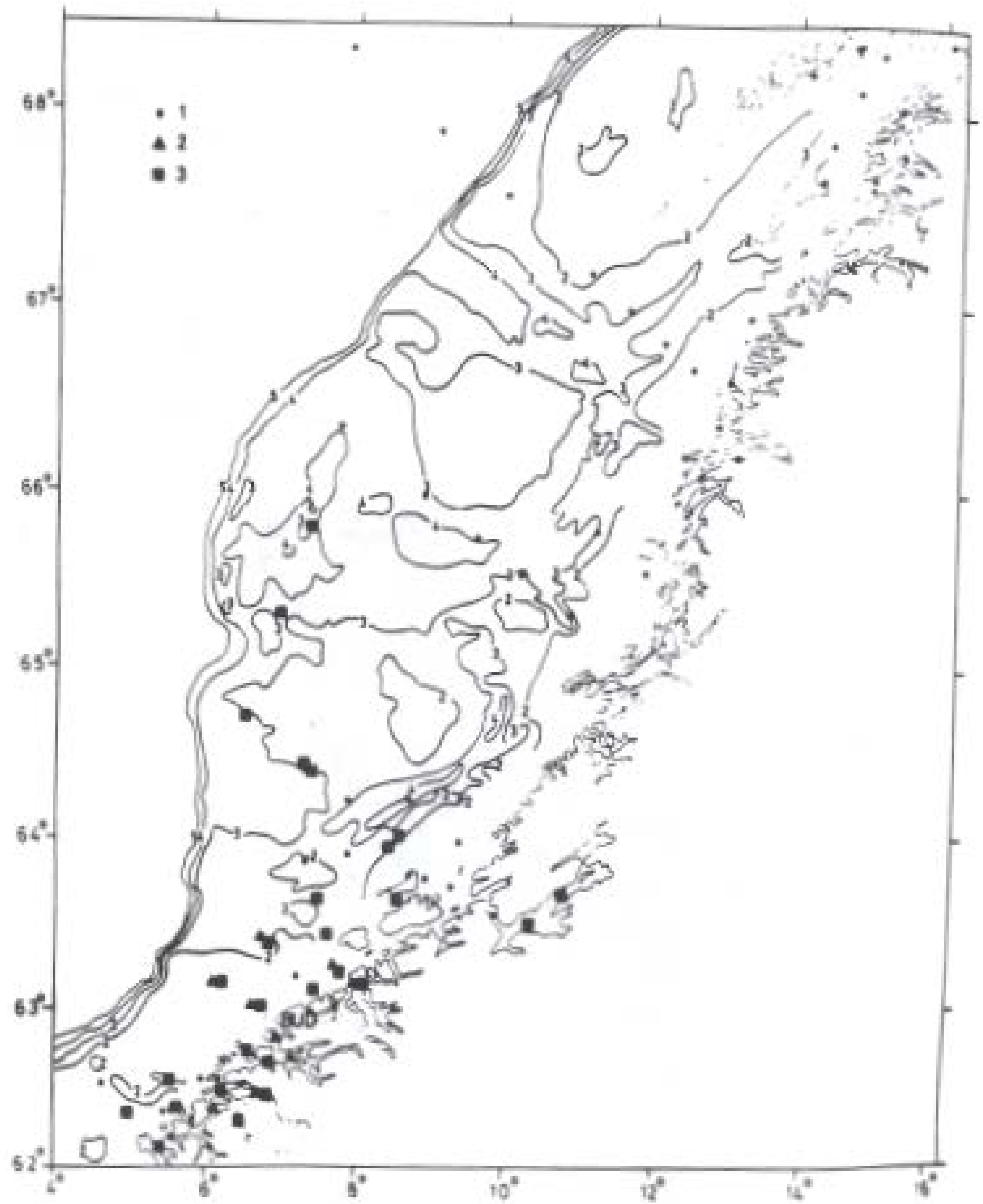

Fig. 2. Station grid from the postlarvae survey in June/July 1982 and recordings of eggs and larvae of blue whiting. 1. Stations without recordings. 2. Eggs 3. Larvae. Depth contours in hundred meters.

APPENDIX VI

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Population genetic substructure in blue whiting based on allozyme data

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The genetic population structure of the pelagic gadoid blue whiting *Micromesistius poutassou* throughout its east Atlantic distribution range was explored using polymorphisms at the tissue enzyme loci *IDHP-2** and *PGM-1**. The study included 5025 individuals from 65 locations in the east Atlantic and the Mediterranean. Significant geographic heterogeneity in allele frequencies was demonstrated at both loci (*IDHP-2**: $P=0.030$, *PGM-1**: $P=0.005$). The degree of genetic differentiation ($F_{ST}=1.1\%$) in blue whiting appears to be at the same level as for the demersal gadoids cod and haddock. Several separate reproductive units were indicated at the fringes of the distribution range, i.e. in the Barents Sea, and in one Norwegian fjord (Romsdalsfjord).

Key words: blue whiting; *Micromesistius poutassou*; population genetics; population structure; isozymes; allele frequencies.

INTRODUCTION

The marine teleost blue whiting *Micromesistius poutassou* (Risso) lives pelagically at depths of 200–700 m along the continental slopes of the North Atlantic. In the north-west Atlantic it is found patchwise from West Greenland to south-east of Newfoundland (40° N), while in the east Atlantic it is distributed continuously from Spitsbergen (82° N) to the Canary Islands (26° N). It is also relatively common in the Mediterranean. In the Barents Sea blue whiting has been observed east to 45° E in warm years (Zilanov, unpublished). In terms of biomass the blue whiting is one of the most abundant teleosts in the North Atlantic, and its economic significance has been increasing since commercial exploitation began in the 1970s.

In the east Atlantic, the main spawning areas are located along the continental slopes and banks west of the British Isles. Local spawning aggregations have been reported also in the Mediterranean, in the Norwegian Sea and in some Norwegian fjords (Zilanov, 1966; Lopes, 1979; Froglia & Gramitto, 1981; Bailey, 1982; Bjørke, 1984). Spawning time depends on latitude, starting in January in the south but as late as in June in the Norwegian Sea (Zilanov, 1966). The eggs and larvae are pelagic. Based on considerations of ocean current transport and egg and larval development stage, local blue whiting spawning has been suggested to take place also in Icelandic waters (Sveinbjørnsson, unpublished; Magnusson *et al.*, 1965; Bailey, 1982). There are also reports of the occurrence of larvae, post-larvae and 0-group blue whiting off northern

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Norway (Zilanov, 1968), and in the Barents Sea (Boldovski, 1939). The nursery areas appear to be intermediate water layers at the shallower fringes of the adult population's distribution range (Bailey, 1982).

Several approaches to blue whiting stock structure have been adopted. Andersen & Jákupsstova (unpublished) reported morphological differences in blue whiting from north of 72° N and south of 63° N. In accordance, Schultz *et al.* (unpublished), considered it probable that blue whiting from the Spitsbergen area rarely or never participate in spawning migrations to the British Isles. Bussmann (1984) compared blue whiting caught at Spitsbergen, Iceland, the Faroes, and west of Ireland by means of morphometrics and electrophoretic patterns of eye lens proteins. She concluded that blue whiting form separate populations in these four areas. Zilanov (1984) suggested four separate stocks of blue whiting: (1) the Mediterranean, (2) the west Atlantic, (3) the Bay of Biscay, and (4) the Hebrido-Norwegian stock. The latter stock is the largest. It spawns west of the British Isles and conducts feeding migrations northwards into the Norwegian Sea. Zilanov's model was modified later by Isaev & Seliverstov (1991). Based on morphometric and meristic studies, they suggested that the Hebrido-Norwegian stock component consisted of two separate stocks which th named after their respective spawning areas: the Hebridean stock and the Porcupine stock. They suggested that the Porcupine stock migrates to the west ε north-west to feed, while the Hebridean stock conducts feeding migrations into the Norwegian Sea. Karasev (1990) compared parasite types and infestation rates in blue whiting from different parts of the North Atlantic. He concluded that there were separate stocks in three areas: (1) the Barents Sea, Spitsbergen and Iceland, (2) the Norwegian Sea, Faroes and Hebrides, and (3) the Porcupine Bank, Celtic Sea, Bay of Biscay and areas near Shetland.

Previous population genetic studies of blue whiting are few. Møller & Nævdal (1969) described a haemoglobin polymorphism and its allele frequencies at one location in the North Sea. In Bussmann's (1984) study a genetic basis for the electrophoretic variation was not established.

The object of the present study was to explore the genetic population structure of the blue whiting. As a first approach to this species' genetic population structure on a large geographical scale, allozymes were used as genetic markers. Preliminary results have been reported previously (Mork & Giæver, 1995; Giæver & Mork, unpublished).

MATERIALS AND METHODS

Blue whiting were collected by trawl gear (except for the Trondheimsfjord sample which was taken by rod and lure) at 65 locations throughout the species range in the north-east Atlantic and the Mediterranean (Fig. 1). Samples representing the large spawning aggregations west of the British Isles were obtained during the spawning season, in the spring of 1992. Extensive sampling was performed in the Norwegian Sea in late summer 1995, during a cruise where post-spawning blue whiting were followed on their feeding migration from the British Isles into the Norwegian Sea. The northward extension of these feeding migrations shows annual variations (from *c.* 65° N to 72° N; Isaev *et al.*, unpublished). Therefore, in order to obtain samples of possible local populations in north-eastern areas, samples were collected in the Barents Sea region and off the coast of northern Norway both in the winter and summer of 1992, and again in

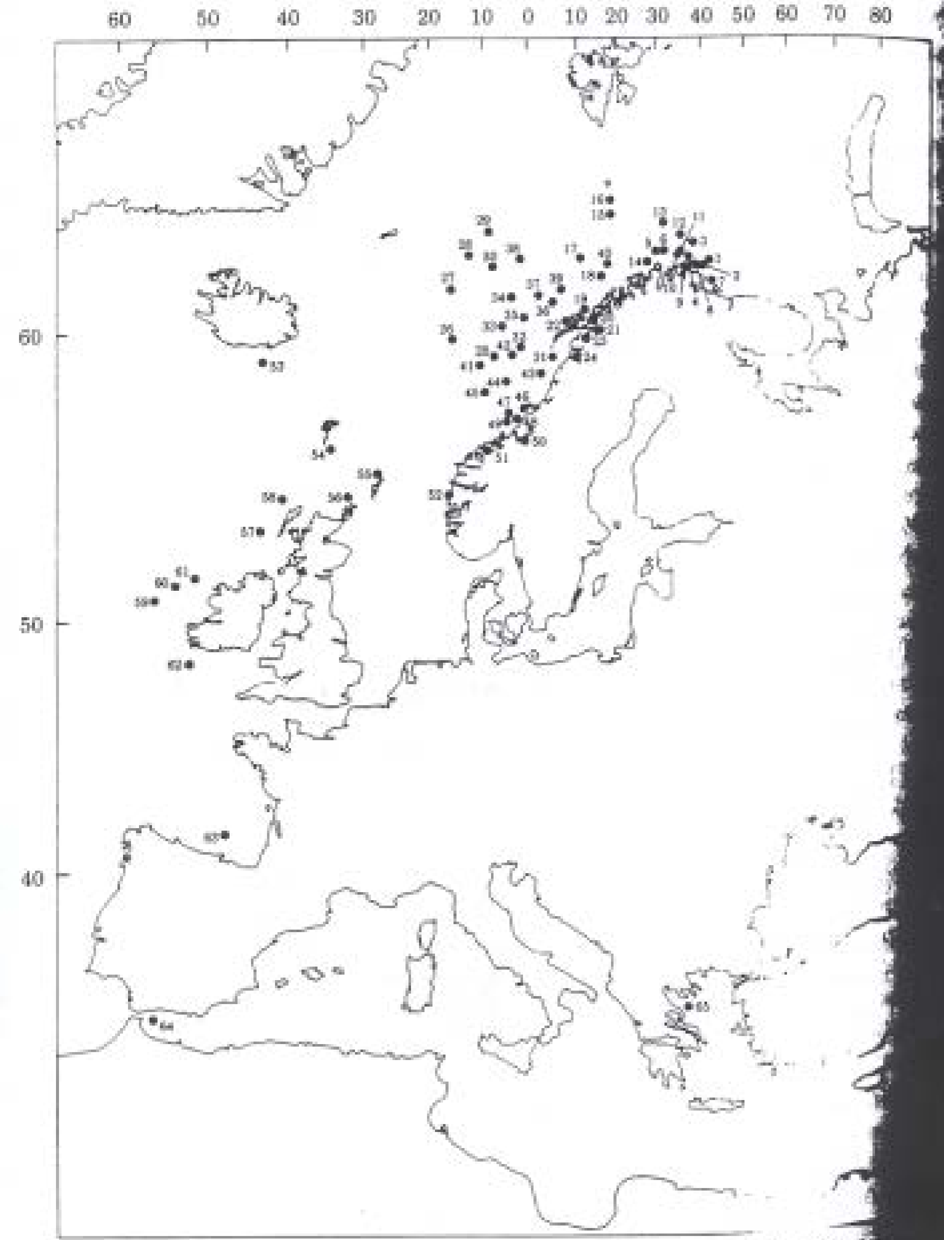

FIG. 1. Blue whiting sampling sites in the east Atlantic and the Mediterranean. The 65
collected in the period 1990–1995.

late summer 1995. Also samples were collected in several Norwegian fjords,
was obtained near Iceland, and two in the Mediterranean (Table I).

Body length, weight and sex were recorded for each specimen, and oto
collected for age determination. Gonad maturity stage was recorded in all
the spawning areas west of the British Isles and in select samples in the
material. Tissue samples (muscle and liver) for electrophoresis were cut immedi
catch and frozen in individually numbered plastic bags. The tissues were

− 82° C until analysis. Personnel at the Institute of Marine Research in Bergen, Norway performed the otolith readings.

Tissue extracts were prepared by mincing equal amounts of muscle and liver tissue in an equal amount of distilled water. The homogenate was centrifuged at 10 000 *g* for 10 min and the supernatant used for electrophoresis. Care was taken to keep sample temperature below 4° C at all stages of preparation. Starch gel electrophoresis was performed according to Allendorf *et al.* (1977), using the buffer system described by Ridgway *et al.* (1970). The pH of the staining buffer was 9·0 (Mork, 1990).

The selection of genetic markers for the present study was based on an introductory study of genetic variation in blue whiting (Mork & Giæver, 1995), showing low polymorphism (P=0·12; three out of 25: *IDDH-2**, *IDHP-2**, and *PGM-1**). *IDDH-2** could not be genotyped reliably in routine analysis, and was omitted from this study.

Each of the 65 samples described in Table I consist of blue whiting caught in one single trawl haul. In several cases the samples were small (<50 specimens). Therefore, in order to increase the power of statistical tests and the accuracy of allele frequency estimates, some samples were pooled into larger entities (called areas). When pooling samples several precautions were taken. The blue whiting has a large migratory potential, which makes it possible that shoals from different populations might overlap in distribution. Hence a specific area may host different populations at different times. As a consequence, only samples caught at nearby locations within a restricted time period were considered [illegible] pooling. Samples with different age or sex distributions were not pooled. Also it was [illegible]cked that genetically heterogeneous samples were not pooled, and that the pooling did not increase any imbalance relative to Hardy–Weinberg proportions.

Statgraphics Plus (STSC Inc.), Biosys 1.7 (Swofford & Selander, 1981), the Monte [illegible]arlo type exact tests Chihw and Chirxc (Zaykin & Pudovkin, 1993), and various in-house software for genetic analysis (Mork, unpublished) were used in the analysis of the biological and genetic data. The exact tests were employed for Hardy–Weinberg goodness-of-fit and χ^2 $R \times C$ tests in cases where the data did not meet the cell size assumptions for ordinary χ^2 tests. In cases where no χ^2 values are listed, P values refer to output from the exact tests by Zaykin & Pudovkin (1993).

RESULTS

The sex ratios in the samples varied significantly. Extremes were sample 46 (males only) and sample 52 (96·0% females). There was, however, no obvious geographic pattern in sex ratios. In the total material, all year classes from 1976 to 1995 except 1978 and 1979, and all age groups from 0 to 18 except 17 were represented. Females dominated in fish older than 6 years. Among 68 individuals older than 11 years, only one male was present. Year class 1989 was by far the most abundant (35·9% of total), but also 1988 (8·2%), 1990 (14·8%), 1991 (11·6%) and 1995 (9·3%) were well represented. The age composition in [illegible]ividual samples varied substantially. Young fish (one- and two-year-olds) [illegible]ominated the 1992 Barents Sea samples (1–11) and samples from the [illegible]thernmost areas (62–65), while the age composition of the other samples was [illegible]oader. Mature blue whiting caught during spawning west of the British Isles were mostly 3 years or older, although in the Celtic Sea a few maturing 1- and 2-year-old specimens were observed.

Of the 5025 blue whiting tissue samples which were analysed by electrophoresis, 99% showed sufficient enzyme activity to allow genotyping for *PGM-1** and 97% for *IDHP-2**. Three alleles (**100*, **78* and **139*) were recorded at *IDHP-2** and five (**100*, **78*, **88*, **110* and **116*) at *PGM-1**. Calculated sample allele frequencies, and observed and expected heterozygosities at both loci are given in Table I.

Table I. Blue whiting sample locations and dates, number of specimens in each sample (*n*), and allele frequencies and heterozygosities at two loci (*IDHP-2** and *PGM-1**)

	Date	Location name	Location		*n*	*IDHP-2**						*PGM-1**							
			N/S	E/W		**100*	**78*	**139*	Nidhp	Hdc	Hexp	**100*	**110*	**88*	**78*	**116*	Npgm	Hdc	Hexp
1	23/2/92	Barents Sea 1	N 70°56'	E 32°29'	61	0·730	0·270	0·000	61	0·443	0·395	0·828	0·156	0·008	0·008	0·000	61	0·279	0·290
2	24/2/92		N 70°48'	E 31°30'	13	0·545	0·455	0·000	11	0·364	0·496	0·923	0·038	0·038	0·000	0·000	13	0·154	0·145
3	25/2/92		N 71°56'	E 30°12'	8	0·643	0·357	0·000	7	0·429	0·459	0·813	0·188	0·000	0·000	0·000	8	0·125	0·305
4	25/2/92		N 71°17'	E 29°27'	14	0·692	0·308	0·000	13	0·462	0·426	0·846	0·154	0·000	0·000	0·000	13	0·308	0·260
5	27/2/92		N 71°35'	E 26°30'	15	0·542	0·458	0·000	12	0·250	0·497	0·900	0·100	0·000	0·000	0·000	15	0·200	0·180
6	1/3/92		N 71°35'	E 25°35'	12	0·667	0·333	0·000	12	0·500	0·444	0·909	0·091	0·000	0·000	0·000	11	0·182	0·165
		(1–6 pooled)			123	0·677	0·323	0·000	116	0·422	0·438	0·855	0·132	0·008	0·004	0·000	121	0·240	0·251
7	28/8/92	Barents Sea 2	N 70°17'	E 31°29'	18	0·571	0·429	0·000	14	0·429	0·490	0·853	0·088	0·059	0·000	0·000	17	0·235	0·261
8	29/8/92		N 70°47'	E 30°33'	20	0·618	0·382	0·000	17	0·294	0·472	0·868	0·105	0·026	0·000	0·000	19	0·158	0·234
9	30/8/92		N 70°58'	E 29°42'	30	0·672	0·328	0·000	29	0·517	0·441	0·850	0·117	0·033	0·000	0·000	30	0·233	0·263
		(7–9 pooled)			68	0·633	0·367	0·000	60	0·433	0·464	0·856	0·106	0·038	0·000	0·000	66	0·212	0·254
10	1/9/92	Barents Sea 3	N 71°13'	E 28°30'	110	0·720	0·280	0·000	107	0·449	0·404	0·930	0·061	0·009	0·000	0·000	107	0·121	0·131
11	10/9/92	Barents Sea 4	N 71°14'	E 24°12'	100	0·716	0·284	0·000	95	0·505	0·407	0·855	0·135	0·005	0·005	0·000	100	0·230	0·251
12	21/8/95	Barents Sea 5	N 71°33'	E 28°06'	24	0·771	0·229	0·000	24	0·375	0·353	0·750	0·188	0·021	0·042	0·000	24	0·333	0·400
13	21/8/95		N 72°11'	E 28°21'	21	0·786	0·214	0·000	21	0·238	0·337	0·786	0·190	0·024	0·000	0·000	21	0·333	0·346
14	22/8/95		N 72°55'	E 26°29'	100	0·765	0·235	0·000	100	0·390	0·360	0·815	0·180	0·000	0·005	0·000	100	0·350	0·303
		(12–14 pooled)			145	0·769	0·231	0·000	145	0·366	0·355	0·800	0·183	0·007	0·010	0·000	145	0·345	0·326
15	5/8/95	Bear Island	N 73°06'	E 19°40'	53	0·783	0·217	0·000	53	0·321	0·340	0·840	0·151	0·000	0·009	0·000	53	0·189	0·272
16	5/8/95		N 73°45'	E 19°40'	11	0·818	0·182	0·000	11	0·364	0·298	0·818	0·182	0·000	0·000	0·000	11	0·364	0·298
		(15–16 pooled)			64	0·789	0·211	0·000	64	0·328	0·333	0·836	0·156	0·000	0·008	0·000	64	0·219	0·277
17	18/4/92	Norwegian Sea 1	N 71°52'	E 15°53'	96	0·843	0·157	0·000	89	0·247	0·265	0·813	0·182	0·005	0·000	0·000	96	0·250	0·307
18	23/9/92	Norwegian Sea 2	N 70°35'	E 19°33'	105	0·803	0·197	0·000	104	0·317	0·317	0·876	0·105	0·019	0·000	0·000	105	0·210	0·221
19	5/8/93	Andfjord	N 69°13'	E 16°09'	100	0·821	0·179	0·000	98	0·276	0·293	0·855	0·140	0·005	0·000	0·000	100	0·250	0·249
20	3/8/93	Vågsfjord	N 68°43'	E 16°44'	96	0·728	0·272	0·000	81	0·370	0·396	0·875	0·120	0·005	0·000	0·000	96	0·229	0·220
21	17/8/93	Herjangsfjord	N 68°31'	E 17°28'	96	0·833	0·167	0·000	96	0·333	0·278	0·844	0·151	0·005	0·000	0·000	96	0·260	0·265
22	11/8/93	Vesterålsfjord	N 68°36'	E 14°09'	96	0·771	0·229	0·000	94	0·330	0·353	0·821	0·174	0·005	0·000	0·000	95	0·316	0·296
23	15/8/93	Tysfjord	N 68°11'	E 16°10'	100	0·828	0·172	0·000	99	0·263	0·284	0·860	0·135	0·005	0·000	0·000	100	0·240	0·242
24	5/8/93	Saltfjord	N 67°12'	E 14°04'	96	0·797	0·203	0·000	96	0·365	0·324	0·823	0·156	0·021	0·000	0·000	96	0·333	0·298
25	21/7/95	Norwegian Sea 3	N 67°02'	E 06°09'	63	0·778	0·222	0·000	63	0·349	0·346	0·817	0·159	0·024	0·000	0·000	63	0·317	0·306
26	22/7/95	Norwegian Sea 4	N 67°56'	E 03°48'	100	0·820	0·180	0·000	100	0·300	0·295	0·815	0·170	0·010	0·000	0·005	100	0·230	0·307
27	22/7/95	Norwegian Sea 5	N 69°23'	E 00°03'	100	0·790	0·210	0·000	100	0·380	0·332	0·835	0·140	0·025	0·000	0·000	100	0·310	0·283
28	23/7/95	Norwegian Sea 6	N 70°25'	E 01°44'	72	0·806	0·194	0·000	72	0·361	0·313	0·819	0·160	0·021	0·000	0·000	72	0·333	0·303
29	23/7/95	Norwegian Sea 7	N 71°23'	E 03°19'	100	0·790	0·210	0·000	100	0·360	0·332	0·860	0·140	0·000	0·000	0·000	100	0·220	0·241
30	24/7/95	Norwegian Sea 8	N 70°15'	E 04°41'	100	0·820	0·175	0·005	100	0·330	0·297	0·855	0·135	0·000	0·010	0·000	100	0·210	0·251

Table I. *Continued*

Location	*IDHP-2**	*PGM-1**

TABLE 1. *Continued*

	Date	Location name	Location N/S	Location E/W	n	IDHP-2* *100	IDHP-2* *78	IDHP-2* *139	IDHP-2* Nidhp	IDHP-2* Hdc	IDHP-2* Hexp	PGM-1* *100	PGM-1* *110	PGM-1* *88	PGM-1* *78	PGM-1* *116	PGM-1* Npgm	PGM-1* Hdc	PGM-1* Hexp
31	26/7/95	Norwegian Sea 9	N 67°06'	E 12°17'	60	0·783	0·217	0·000	60	0·333	0·339	0·808	0·167	0·025	0·000	0·000	60	0·367	0·318
32	26/7/95	Norwegian Sea 10	N 67°25'	E 09°10'	100	0·795	0·205	0·000	100	0·370	0·326	0·830	0·145	0·020	0·005	0·000	100	0·320	0·290
33	27/7/95	Norwegian Sea 11	N 68°32'	E 06°20'	100	0·765	0·230	0·005	100	0·400	0·362	0·790	0·205	0·005	0·000	0·000	100	0·360	0·334
34	27/7/95	Norwegian Sea 12	N 69°34'	E 07°04'	100	0·800	0·200	0·000	100	0·320	0·320	0·825	0·175	0·000	0·000	0·000	100	0·310	0·289
35	28/7/95	Norwegian Sea 13	N 68°39'	E 09°37'	100	0·855	0·145	0·000	100	0·230	0·248	0·795	0·200	0·005	0·000	0·000	100	0·390	0·328
36	29/7/95	Norwegian Sea 14	N 69°10'	E 11°51'	86	0·826	0·174	0·000	86	0·233	0·288	0·849	0·140	0·012	0·000	0·000	86	0·279	0·260
37	30/7/95	Norwegian Sea 15	N 69°43'	E 10°10'	24	0·833	0·167	0·000	24	0·250	0·278	0·854	0·146	0·000	0·000	0·000	24	0·292	0·249
38	30/7/95	Norwegian Sea 16	N 70°32'	E 08°18'	100	0·780	0·215	0·005	100	0·340	0·345	0·830	0·160	0·005	0·005	0·000	100	0·300	0·285
39	31/7/95	Norwegian Sea 17	N 70°03'	E 12°58'	20	0·725	0·275	0·000	20	0·350	0·399	0·775	0·225	0·000	0·000	0·000	20	0·450	0·349
40	5/8/95	Norwegian Sea 18	N 70°47'	E 19°33'	21	0·762	0·238	0·000	21	0·381	0·363	0·857	0·095	0·000	0·048	0·000	21	0·286	0·254
41	26/8/93	Norwegian Sea 19	N 66°20'	E 06°55'	96	0·776	0·224	0·000	96	0·385	0·348	0·854	0·135	0·010	0·000	0·000	96	0·292	0·252
42	25/4/92	Norwegian Sea 20	N 67°10'	E 08°33'	23	0·870	0·130	0·000	23	0·174	0·227	0·826	0·152	0·022	0·000	0·000	23	0·348	0·294
43	27/4/92	Norwegian Sea 21	N 66°11'	E 10°50'	100	0·805	0·195	0·000	100	0·290	0·314	0·775	0·210	0·015	0·000	0·000	100	0·370	0·355
44	28/4/92	Norwegian Sea 22	N 65°58'	E 08°11'	57	0·825	0·175	0·000	57	0·281	0·289	0·904	0·096	0·000	0·000	0·000	57	0·158	0·174
45	29/4/92	Norwegian Sea 23	N 65°27'	E 05°55'	100	0·820	0·180	0·000	89	0·315	0·295	0·840	0·145	0·015	0·000	0·000	100	0·280	0·273
46	22/9/94	Sklinna	N 65°17'	E 11°12'	100	0·784	0·216	0·000	97	0·330	0·339	0·833	0·157	0·010	0·000	0·000	99	0·293	0·281
47	1/3/92	Frohavet	N 64°06'	E 09°36'	100	0·823	0·177	0·000	99	0·293	0·291	0·792	0·202	0·006	0·000	0·000	89	0·281	0·332
48	11/10/94	Linesøya	N 64°00'	E 09°46'	96	0·807	0·193	0·000	96	0·344	0·311	0·854	0·141	0·005	0·000	0·000	96	0·250	0·251
49	6/10/94	Tarvafjord	N 63°48'	E 09°35'	96	0·785	0·215	0·000	93	0·344	0·338	0·837	0·147	0·016	0·000	0·000	95	0·263	0·278
50	1/9/92	Trondheimsfjord	N 63°76'	E 10°23'	92	0·803	0·197	0·000	71	0·338	0·317	0·773	0·210	0·017	0·000	0·000	88	0·341	0·358
51	12/10/94	Romsdalsfjord	N 62°36'	E 07°23'	93	0·696	0·304	0·000	92	0·391	0·423	0·861	0·120	0·018	0·000	0·000	83	0·253	0·243
52	4/4/95	Herdlefjord	N 60°30'	E 05°11'	126	0·821	0·179	0·000	126	0·294	0·293	0·873	0·127	0·000	0·000	0·000	126	0·222	0·222
53	11/3/92	Iceland	N 64°11'	W 11°45'	135	0·794	0·202	0·004	126	0·365	0·329	0·826	0·152	0·022	0·000	0·000	135	0·304	0·294
54	3/4/92	Faroes	N 61°13'	W 05°14'	100	0·783	0·217	0·000	99	0·333	0·340	0·775	0·215	0·000	0·000	0·000	100	0·310	0·353
55	3/4/92	Shetland	N 61°07'	W 02°21'	100	0·853	0·147	0·000	95	0·253	0·251	0·835	0·160	0·005	0·000	0·000	100	0·310	0·277
56	1/4/92	Orkneys	N 59°57'	W 05°02'	100	0·828	0·172	0·000	96	0·260	0·285	0·837	0·158	0·005	0·000	0·000	98	0·255	0·275
57	29/3/92	Hebrides 1	N 56°39'	W 09°16'	100	0·813	0·187	0·000	99	0·313	0·304	0·790	0·200	0·010	0·000	0·000	100	0·310	0·336
58	31/3/92	Hebrides 2	N 58°30'	W 09°17'	100	0·790	0·210	0·000	100	0·400	0·332	0·845	0·140	0·015	0·000	0·000	100	0·230	0·266
59	25/3/92	Porcupine Bank 1	N 52°29'	W 14°42'	100	0·825	0·175	0·000	100	0·350	0·289	0·830	0·150	0·020	0·000	0·000	100	0·280	0·288
60	26/3/92	Porcupine Bank 2	N 53°39'	W 13°59'	100	0·859	0·141	0·000	99	0·202	0·243	0·805	0·180	0·010	0·000	0·005	100	0·300	0·319
61	27/3/92	Porcupine Bank 3	N 54°11'	W 11°43'	100	0·816	0·184	0·000	79	0·316	0·300	0·805	0·190	0·005	0·000	0·000	100	0·330	0·316
62	18/3/92	Celtic Sea	N 50°00'	W 11°04'	100	0·808	0·192	0·000	91	0·319	0·311	0·816	0·168	0·015	0·000	0·000	98	0·347	0·305
63	18/11/90	Biscaya	N 44°00'	W 02°30'	102	0·784	0·216	0·000	102	0·314	0·338	0·843	0·142	0·015	0·000	0·000	102	0·304	0·269
64	10/11/90	Gibraltar	N 35°19'	W 15°03'	100	0·825	0·175	0·000	100	0·310	0·289	0·820	0·160	0·015	0·000	0·005	100	0·310	0·302
65	23/8/92	Greece	N 39°50'	E 23°14'	68	0·889	0·111	0·000	54	0·148	0·198	0·879	0·121	0·000	0·000	0·000	66	0·242	0·213

Nidhp/Npgm, Number of specimens successfully genotyped; Hdc, direct count heterozygosity; Hexp, Hardy-Weinberg expected heterozygosity.

TABLE II. Results of χ^2 tests performed to verify genetic homogeneity between blue whiting samples subject to pooling

Samples	Designation (catch time)	*IDHP-1** Allele distribution	*IDHP-1** Genotype distribution	*PGM-1** Allele distribution	*PGM-1** Genotype distribution
1–6	Barents Sea 1 (winter 1992)	$\chi^2=5{\cdot}401$ d.f.=5 $P=0{\cdot}369$	$P=0{\cdot}847$	$P=0{\cdot}797$	$P=0{\cdot}281$
7–9	Barents Sea 2 (summer 1992)	$\chi^2=0{\cdot}880$ d.f.=2 $P=0{\cdot}644$	$P=0{\cdot}435$	$P=0{\cdot}958$	$P=0{\cdot}740$
12–14	Barents Sea 5 (summer 1995)	$\chi^2=0{\cdot}085$ d.f.=2 $P=0{\cdot}958$	$P=0{\cdot}649$	$P=0{\cdot}111$	$P=0{\cdot}076$
15–16	Bear Island (summer 1995)	$P=0{\cdot}784$	$P>0{\cdot}999$	$P=0{\cdot}806$	$P=0{\cdot}400$

Where no χ^2 values are listed, the P values refer to output from the exact tests by Zaykin & Pudovkin (1993).

Genotypic distributions conformed with Hardy–Weinberg equilibrium values. No significant correlation was observed between genotype and sex, age or gonad maturity stage in any sample. Also, sample allele distribution appeared independent of these factors. Length at age appeared to vary independently of genotype, and no significant linkage disequilibrium was observed in any sample.

In the Barents Sea region the calculated allele frequencies were affected by small sample size (<50). To reduce the allele frequency variance, and hence increase the power of statistical tests, samples were pooled according to the criteria described above (Table I). The tests of genetic heterogeneity performed prior to pooling are summarized in Table II. The pooling of samples resulted in areas Barents Sea 1 (samples 1–6, winter 1992), Barents Sea 2 (samples 7–9, summer 1992), Barents Sea 5 (samples 12–14, summer 1995), and Bear Island (samples 15–16, summer 1995). Some Norwegian Sea samples were also small (37, 39, 40, and 42). Nevertheless these were not pooled because, due to sample location and/or time, it was not obvious with which samples to pool them. Also, the Norwegian Sea was well represented with samples large enough to provide sufficient accuracy in local allele frequency estimates. The results reported below are thus based on allele frequencies in 55 samples (four pooled areas and 51 single samples).

F_{ST} analysis indicated that 1·1% (average over two loci) of the total genetic variation was due to between-sample variation. Single locus results were 1·3% for *IDHP-2** and 0·8% for *PGM-1**. χ^2 tests of heterogeneity of allele frequencies revealed significant heterogeneity between the 55 samples at both *IDHP-2** ($P=0{\cdot}030$) and *PGM-1** ($P=0{\cdot}005$), suggesting that more than one breeding unit is represented in the material. In χ^2 tests in which rare alleles were pooled (two allele groups: **100* and *non*100*), significant heterogeneity among samples was observed at *IDHP-2** only (*IDHP-2**: $\chi^2=112{\cdot}687$, d.f.=54, $P \leqslant 0{\cdot}001$; *PGM-1**: $\chi^2=67{\cdot}863$, d.f.=54, $P=0{\cdot}097$).

THE CENTRAL PARTS OF THE DISTRIBUTION RANGE

In the areas near the British Isles, including the main spawning grounds, blue whiting from the different locations showed quite similar genetic characteristics at *IDHP-2** and *PGM-1**. The Porcupine Bank and areas near the Hebrides have been postulated to host separate spawning populations (Isaev & Seliverstov, 1991). Nevertheless, we were not able to distinguish blue whiting from those areas using *IDHP-2** and *PGM-1** as genetic markers. The *PGM-1** allele frequencies in the two areas were very similar (Table I). At *IDHP-2** the Porcupine area showed a somewhat higher frequency of the **100*-allele, but the difference from the Hebridean area was not statistically significant ($\chi^2=1{\cdot}720$, d.f.=1, $P=0{\cdot}190$).

The samples collected in the Norwegian Sea showed allele frequencies similar to those of the samples collected on the main spawning grounds by the British Isles (*IDHP-2**: $P=0{\cdot}181$, *PGM-1**: $P=0{\cdot}546$). Also, the allele frequencies of the Icelandic sample (53; Table I) resembled those of the main spawning areas (χ^2 tests: *IDHP-2**, $P=0{\cdot}067$; *PGM-1**, $P=0{\cdot}290$).

THE BARENTS SEA

In the Barents Sea, samples were collected in winter 1992 (Barents Sea 1), summer 1992 (Barents Sea 2-4), and in summer 1995 (Barents Sea 5 and Bear Island). Genetic heterogeneity within the north-eastern region was observed (Table III). Pair-wise χ^2 tests of heterogeneity in allele frequencies between these samples showed a change in allele frequencies from 1992 to 1995: Barents Sea 3 (1992) differed in *PGM-1** frequencies from Barents Sea 5 and Bear Island (both from 1995, $P=0{\cdot}001$ and $P=0{\cdot}002$, respectively). Thirty such pair-wise tests were performed, and as many as 10 resulted in P values less than 0·05. This happened not only in the between year tests, but also when samples collected within the same year and season were compared. However, only the between-year differences mentioned above were formally significant when the significance level was adjusted for the number of tests performed (0·05/30=0·002). Hierarchical F-statistics showed that 75% of the between sample component of the observed genetic variation within the Barents Sea region was due to between-year differences ($F_{\text{sample total}}=0{\cdot}008$, $F_{\text{year total}}=0{\cdot}006$, $F_{\text{sample year}}=0{\cdot}002$). As compared to the blue whiting of the central parts of the distribution area, it was the 1992 Barents Sea samples which contained the genetically most deviating blue whiting (Table IV).

NORWEGIAN FJORDS

Two Norwegian fjord samples, Vågsfjord (20) and Romsdalsfjord (51), stood out by having low *IDHP-2*100* frequencies. However, the Vågsfjord sample did not differ significantly from the Norwegian Sea samples at either *IDHP-2** ($P=0{\cdot}125$) or *PGM-1** ($P=0{\cdot}345$). The Romsdalsfjord sample from mid-Norway showed, as the only sample from this region, a low *IDHP-2*100* and a high *PGM-1*100* allele frequency. Comparisons with the allele frequencies of

Table III. Results from χ^2 tests of genetic heterogeneity between blue whiting samples collected in the Barents Sea region

	Barents Sea 1 (winter 1992)	Barents Sea 2 (summer 1992)	Barents Sea 3 (summer 1992)	Barents Sea 4 (summer 1992)	Barents Sea 5 (summer 1995)	Bear Island (summer 1995)
Barents Sea 1 (winter 1992)		$\chi^2=0{\cdot}665$ d.f.=1 $P=0{\cdot}415$	$\chi^2=0{\cdot}971$ d.f.=1 $P=0{\cdot}324$	$\chi^2=0{\cdot}751$ d.f.=1 $P=0{\cdot}386$	$\chi^2=5{\cdot}538$ d.f.=1 $P=0{\cdot}019$	$\chi^2=5{\cdot}127$ d.f.=1 $P=0{\cdot}024$
Barents Sea 2 (summer 1992)	$P=0{\cdot}142$		$\chi^2=2{\cdot}670$ d.f.=1 $P=0{\cdot}102$	$\chi^2=2{\cdot}313$ d.f.=1 $P=0{\cdot}128$	$\chi^2=7{\cdot}909$ d.f.=1 $P=0{\cdot}005$	$\chi^2=7{\cdot}351$ d.f.=1 $P=0{\cdot}007$
Barents Sea 3 (summer 1992)	$P=0{\cdot}025$	$P=0{\cdot}056$		$\chi^2=0{\cdot}007$ d.f.=1 $P=0{\cdot}933$	$\chi^2=1{\cdot}590$ d.f.=1 $P=0{\cdot}207$	$\chi^2=2{\cdot}036$ d.f.=1 $P=0{\cdot}154$
Barents Sea 4 (summer 1992)	$P=0>0{\cdot}999$	$P=0{\cdot}073$	$P=0{\cdot}032$		$\chi^2=1{\cdot}722$ d.f.=1 $P=0{\cdot}189$	$\chi^2=2{\cdot}163$ d.f.=1 $P=0{\cdot}142$
Barents Sea 5 (summer 1995)	$P=0{\cdot}375$	$P=0{\cdot}014$	$P=0{\cdot}001$	$P=0{\cdot}490$		$\chi^2=2{\cdot}163$ d.f.=1 $P=0{\cdot}141$
Bear Island (summer 1995)	$P=0{\cdot}714$	$P=0{\cdot}035$	$P=0{\cdot}002$	$P=0{\cdot}891$	$P=0{\cdot}713$	

Above diagonal: *IDHP-1** test results; below diagonal: *PGM-1** test results. Where no χ^2 values are listed, the P values refer to exact tests by Zaykin & Pudovkin (1993). Formal significance level: 0·002.

TABLE IV. Results from χ^2 contingency table tests of differences in allelic proportions between the Norwegian Sea and samples from the Barents Sea region

Samples tested v. the Norwegian Sea	*IDHP-2** tests results (*P*)	*PGM-1** test results (*P*)
Barents Sea 1 (winter 1992)	<0·001	0·546
Barents Sea 2 (summer 1992)	0·003	0·062
Barents Sea 3 (summer 1992)	0·015	0·069
Barents Sea 4 (summer 1992)	0·008	0·468
Barents Sea 5 (summer 1995)	0·316	0·090
Bear Island (summer 1995)	0·754	0·255

P values refer to exact tests by Zaykin & Pudovkin (1993). Formal significance level: 0·004.

the Norwegian Sea samples showed that the difference in *IDHP-2** frequencies as significant (P=0·003), while *PGM-1** frequency difference was not (P=0·434).

THE MEDITERRANEAN

The sample from Greece (65; Table I) showed the lowest heterozygosity of the 65 samples. It had higher frequencies of the most common allele than the Gibraltar sample (64; Table I) at both loci, but not significantly so (*IDHP-2**: χ^2=2·214, d.f.=1, P=0·137; *PGM-1**: P=0·255). The Gibraltar sample allele frequencies resembled those of the samples from west of the British Isles (*IDHP-2**: χ^2=0·039, d.f.=1, P=0·844, *PGM-1**: P=0·328). The Greek sample showed a higher *IDHP-2*100* frequency than the British Isles samples, but the difference was not formally significant (*IDHP-2**: χ^2=3·380, d.f.=1, P=0·066, *PGM-1**: P=0·290).

DISCUSSION

Marine species with a pelagic way of life, shoaling behaviour and extensive migrations can be difficult study subjects for population structure descriptions. In blue whiting, the problems in obtaining representative samples from populations were emphasised by Bailey (1982), who noted that the shoal affinity of blue whiting might depend on factors like age, size and sex. Although in this report most conclusions are based on observations in relatively large samples, the conclusions drawn still depend on whether the samples are representative of the populations involved.

The use of only two polymorphic loci puts restrictions on the level of detail in genetic differentiation that can be revealed by the present material. Nevertheless, the present analyses of *IDHP-2** and *PGM-1** revealed a clear genetic substructure within the species.

The level of genetic substructure indicated in blue whiting by the present material (F_{ST}=1·1%) is moderate but still, perhaps, higher than might be expected on the basis of certain traits in the biology of the species. Large population sizes (e.g. billions of individuals on the spawning grounds west of the British Isles), pelagic eggs and larvae, extensive feeding and spawning migrations, and a pelagic way of life are factors which would be expected to inhibit genetic differentiation due to isolation and genetic drift, unless severe population bottlenecks have been an important feature of the recent evolutionary history of the species. Nevertheless, the blue whiting shows levels of genetic differentiation which are of the same magnitude as those of non-shoaling, demersal gadoids on comparable geographic scales: cod *Gadus morhua* L., $F_{ST}=2{\cdot}1\%$ (Mork *et al.*, 1985), and haddock *Melanogrammus aeglefinus* (L.), $F_{ST}=0{\cdot}6\%$ (Giæver *et al.*, unpublished).

THE CENTRAL DISTRIBUTION AREA

The blue whiting in the central parts of the distribution range appeared genetically homogeneous at *IDHP-2** and *PGM-1** over large geographic areas. According to the hypothesis of Isaev & Seliverstov (1991) on blue whiting population structure, one would expect the blue whiting collected in the Norwegian Sea during summer to represent the Hebridean stock unit, rather than the Porcupine. Using *IDHP-2** and *PGM-1** as genetic markers, it was not possible to verify the conclusion of Isaev & Seliverstov (1991) of separate populations on the Porcupine Bank and in the Hebridean area. However, that does not exclude the possibility that those areas host separate populations with similar allele frequencies at *IDHP-2** and *PGM-1**.

Based on current knowledge of blue whiting migration routes, and on the observed genetic similarity between the samples from the British Isles and the Norwegian Sea, the blue whiting in the present Norwegian Sea samples might be regarded as representative of the blue whiting that spawn west of the British Isles. This justifies comparisons between Norwegian Sea allele frequencies and those of adjacent areas (i.e. Norwegian fjords or the Barents Sea region) to reveal possible genetically deviating local populations.

NORTH-EAST AREAS

The samples that showed the genetically most deviating blue whiting were collected off the coast of noth-east Norway in 1992 (Barents Sea 1–4; Table I). Both winter and autumn samples in these areas in 1992 were characterized by significantly lower *IDHP-2*100* frequencies than those in the central distribution area, and indicate the existence of one or more separate reproductive units in the north-east. The deviating genetic characteristics of the 1992 Barents Sea blue whiting became formally significant only once small Barents Sea samples were pooled. Based on the comparisons of sample catch time and location, age and sex composition, and noting intrinsic genetic homogeneity, it was considered likely that the various samples which were pooled, contained blue whiting from the same population. If this assumption is correct, conclusions based on allele frequency estimates in pooled samples will be more realistic than those based on small single samples. However, also when the north-eastern samples were not pooled, a drop in *IDHP-2*100* frequencies could be seen north of 70° N (Fig. 2).

There are several reports on the presence of adult blue whiting off the coast of northern Norway and in the Barents Sea during and shortly after the main spawning events west of the British Isles. Lahn-Johansen (1968) found adult

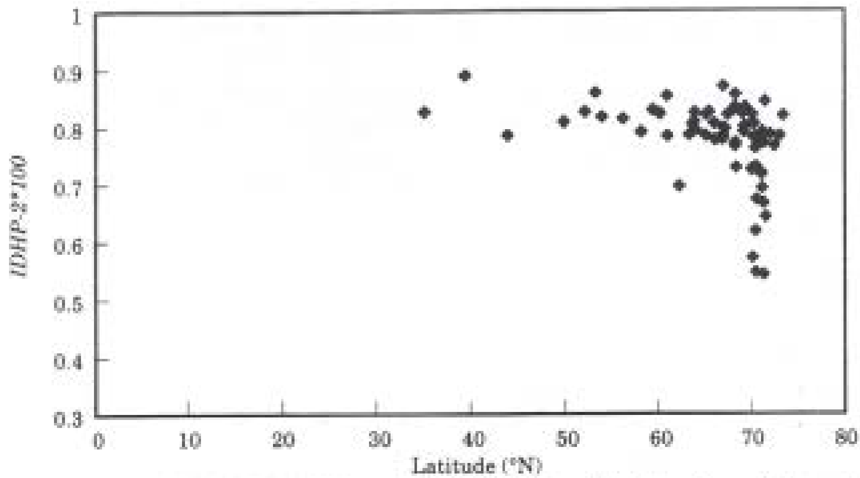

FIG. 2. Plot of blue whiting *IDHP-2*100* frequency v. sample location latitude in 65 samples from the east Atlantic and the Mediterranean.

b'ue whiting along the northern Norwegian coast from March to December, and .hrhage & Schöne (unpublished) and Schultz *et al.* (unpublished) observed adult blue whiting near Bear Island in early and late winter. From observations on blue whiting larvae in the Vesterålen area in June, Zilanov (1966, 1968) stated that it was likely that the blue whiting of the northern Norwegian Sea do not participate in spawning migrations to the west of the British Isles, but spawn locally along the continental slope of northern Norway. Early development stage larvae have been reported also in the Barents Sea proper (Boldovski, 1939). The present results indicate the existence of separate reproductive units of blue whiting in the north-eastern Atlantic, and offer genetic support to previous studies which have postulated such units based on biological observations.

After spawning west of the British Isles in March–April, large masses of blue whiting migrate into the Norwegian Sea to feed. In the course of the present study, preliminary results showed a genetically deviating stock component in the north-east. To investigate its southern and western extension, and in order to detect a possible transition area, the Norwegian Sea was sampled extensively in 1995, on a cruise where post-spawning blue whiting were followed on their f·ing migration from west of the British Isles into the Norwegian Sea. The n·rthward limit of this migration varies and may in some, but not all years, be far enough to the north and east to have influenced the present autumn samples the north-eastern areas.

Such annual variability could explain the observed heterogeneities within the north-eastern region, where in 1995 the autumn Barents Sea samples were similar to the Norwegian Sea samples while in 1992 they were not. Thus the present results indicate that the areas off the coast of northern Norway and in the Barents Sea host a local blue whiting population which seems to have its own genetic substructure, and in addition a variable annual visit by blue whiting on feeding migration from the south-west. Isaev & Seliverstov (unpublished) suggested that blue whiting in northern areas spawn in June along the continental slope west of Norway.

FJORD POPULATIONS

The results from the allele frequency analysis suggested the existence of a separate reproductive unit in the Romsdalsfjord (20; Table I). These observations lend genetic support to previous suggestions (Bailey, 1982; and references therein) that local populations of blue whiting exist and reproduce in some Norwegian fjords. The analysis did not reveal genetically differentiated (at *IDHP-2** and *PGM-1**) fjord populations in any of the other fjords represented in the present study.

THE MEDITERRANEAN

The Greek sample showed a low level of genetic variability in terms of heterozygosity, and had relatively high frequencies of the most common allele at both loci. However, the Mediterranean blue whiting has not been studied extensively and little is known currently about its stock structure, spawning areas and migration routes. The present data do not permit firm conclusions on blue whiting stock structure in the Mediterranean.

CONCLUSIONS

Genetically isolated blue whiting reproductive units appeared to exist in the north-east Atlantic and in the Romsdalsfjord, Norway. The allele frequencies of the 1992 Barents Sea samples of blue whiting were consistently and very significantly different from those taken at other locations, including post-spawning blue whiting in the Norwegian Sea. Furthermore, there were indications of a substructure within the Barents Sea area that would justify further study. The present material from Greek waters was too small as a basis for conclusions about the inner Mediterranean blue whiting.

Usable allozyme polymorphisms in blue whiting are scarce currently (Mork & Giæver, 1995), and limit the level of detail that can be achieved in analyses. More genetic markers might remedy this problem, and it appears worthwhile to explore the performance of various DNA markers (e.g. DNA micro- and minisatellites) in further studies of the genetic population structure of blue whiting.

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APPENDIX VII

Fishes of the North-eastern Atlantic and the Mediterranean

Poissons de l'Atlantique du Nord-Est et de la Méditerranée

Volume II

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Distribution: European coasts from Iceland and south-western Barents Sea to northern coasts of Portugal, western Baltic to Gotland Island, doubtful in western Mediterranean (*M. merlangus merlangus*), Black Sea, adjacent parts of Azov Sea, Sea of Marmora, Aegean Sea and Adriatic (*M. merlangus euxinus*).

Subspecies

Merlangius merlangus merlangus: no barbel on chin. Pectoral fin 13.8–15.6% of body length.
Merlangius merlangus euxinus (Nordmann): barbel on chin conspicuous. Pectoral fin 15.4–18.2% of body length.

MICROMESISTIUS Gill, 1864 — Clofnam 101.8

Lower jaw slightly projecting beyond upper one. No barbel on chin. Sensory canals with large pores on head. Coronal fossa on frontals closed in front of commissure between supra-orbital canals. First anal fin long, its base more than preanal distance and its origin in front of or just behind first dorsal fin origin. Dorsal fins widely spaced, interspace between second and third fins longer than base length of first dorsal fin. Lateral line continuous over whole body.

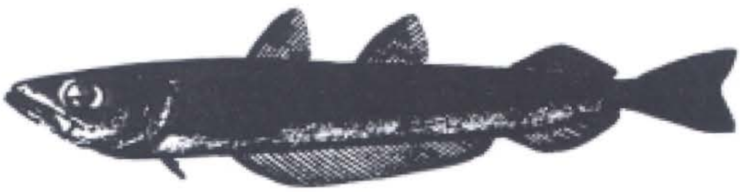
See species for biology, etc.

Species 2; in Clofnam area 1.

Micromesistius poutassou (Risso, 1826) — Clofnam 101.8.1

Common synonyms: none.

Common names: Blue whiting (En), Poutassou (Fr), Bacaladilla (Sp), Putassu (Ru).



Diagnosis: first dorsal finrays 12–14, second dorsal finrays 12–14, third dorsal finrays 23–28; first anal finrays 33–39, second anal finrays 24–27. Vertebrae 55–58. Gillrakers 27–33. *Colour:* bluish-grey on back, silvery on sides, belly milk white. *Size:* to 47 cm SL, usually 25–30 cm.

Habitat: mesopelagic, over depths of 160–3,000 m in midwater, 30–400 m from the surface, also near the bottom at 180–400 m; immature live in shallow waters, occasionally inshore. *Behaviour:* in shoals, less dense in winter, during daytime in deeper water, rising at night. Seasonal and spawning migrations not exactly known. *Food:* chiefly small crustaceans, euphausiids, amphipods, rarely fishes. *Reproduction:* from February in the south to May in the north, at 180–360 m, over edge of continental shelf, in water layers at 10–30 m from the bottom.

689

Distribution: North Atlantic from western Barents Sea, Spitzbergen, Iceland and Greenland, Skagerrak, Kattegat to Morocco, western Mediterranean, also western North Atlantic.

POLLACHIUS Nilsson, 1832 — Clofnam 101.9

Lower jaw projecting beyond upper one. A barbel on chin, minute or absent. Sensory canals with large pores on head. Coronal fossa on frontals closed in front of commissure between supra-orbital canals. First anal fin long, its base more than one-half of preanal distance and its origin below middle or end of first dorsal fin base. Dorsal and anal interspaces short. Lateral line continuous over whole body. No dark spot at pectoral fin base.

Inshore or offshore waters, from the surface to bottom in small shoals. Feed mainly on fish and crustaceans. Spawning from January to May.

Species 2, both in Clofnam area.

KEY TO SPECIES

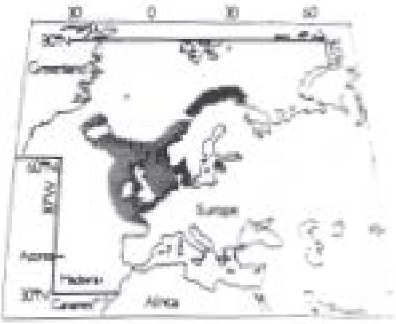
1a	Lateral line arched over pectoral fin. No barbel on chin. Less than 30 gillrakers on first gill arch	*P. pollachius* (p. 690)
1b	Lateral line straight. A barbel on chin, minute or obsolete. More than 30 gillrakers on first gill arch	*P. virens* (p. 691)

Pollachius pollachius (Linnaeus, 1758) — Clofnam 101.9.1

Common synonyms: none.

Common names: Pollack (En), Lieu jaune (Fr), Lyur (Ru), Abadejo (Sp).

Diagnosis: lower jaw distinctly projecting beyond upper one. Eye large, about one and half times in snout length. Pelvic fin length about equal to orbit diameter. Caudal fin lunate. First dorsal finrays 12–13, second dorsal finrays 17–20, third dorsal finrays 17–19; first anal finrays 27–30, second anal finrays 17–20. Vertebrae 52–55. Gillrakers 25–28. *Colour:* dark brown or olive on back, rather abruptly shading to pale on sides and lighter on belly. *Size:* to 60–80 cm SL, usually less; may reach 130 cm.



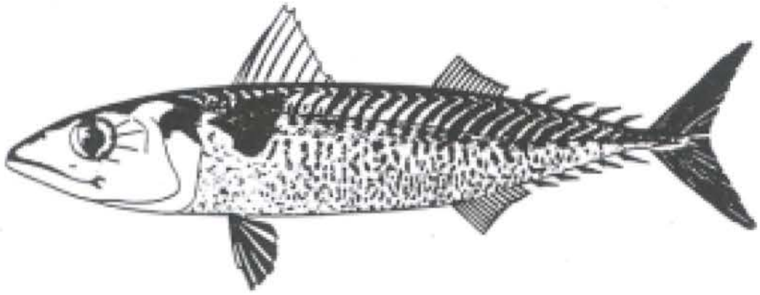
Habitat: mainly inshore, young closer to the shore than the adults, midwater and demersal fish, near rough ground and rocks. *Behaviour:* adults live in shoals only during spawning period. *Food:* mainly small fish

Scomber japonicus Houttuyn, 1782

Clofnam 156.1.2
Suppl.: 364

Common synonym: *Pneumatophorus colias* (Gmelin, 1788).

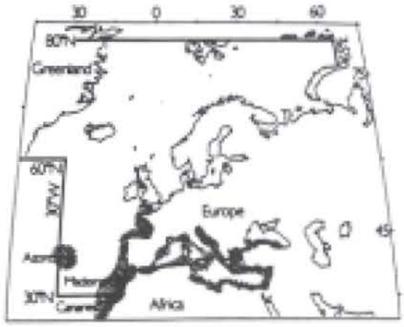
Common names: Chub mackerel (En), Maquereau espagnol (Fr), Estornino (Sp).



Diagnosis: first dorsal spines 8–10; space between posterior end of first dorsal fin groove and origin of second dorsal fin approximately equal in length to groove. Swimbladder present. Vertebrae 14 + 17, first haemal spine posterior to first inter-haemal process. *Colour:* belly usually clearly marked by broken, wavy lines or spotting in the eastern Atlantic. *Size:* to 50 cm fork length, common to 30 cm.

Habitat: epipelagic or mesodemersal in depths to 250–300 m. Schooling and strongly migratory. *Food:* small pelagic fishes such as anchovies, pilchards, sprats, and silversides; also pelagic invertebrates. *Reproduction:* eggs and larvae planktonic.

Distribution: eastern Atlantic from the Canaries and the Azores commonly north to the Bay of Biscay. Occasional individuals reach the southern parts of the British Isles, the Irish Sea, and the coast of Belgium. Frequent in the Mediterranean and the southern part of the Black Sea. Elsewhere, worldwide in warm and warm-temperate waters.

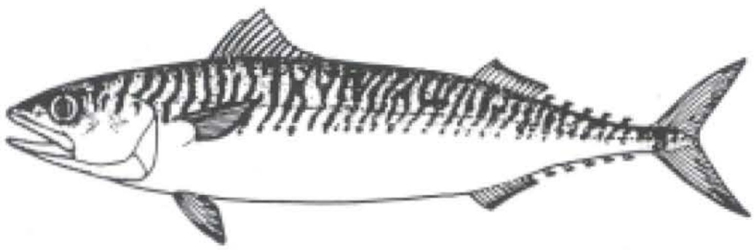


Scomber scombrus Linnaeus, 1758

Clofnam 156.1.1
Suppl.: 364

Common synonyms: none.

Common names: Atlantic mackerel (En), Maquereau commun (Fr), Makrele (G), Caballa (Sp).

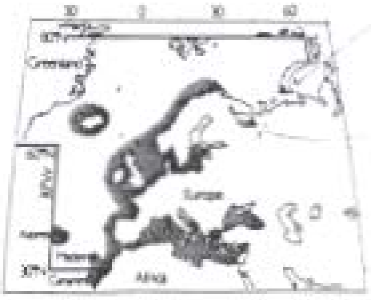


Diagnosis: first dorsal spines 11–13; space between posterior end of first dorsal fin groove and origin of second dorsal fin clearly greater than

991

groove, approximately 1.5 times as long. Swimbladder absent. Vertebrae 13 + 18, first haemal spine anterior to first inter-haemal process. *Colour:* belly unmarked. *Size:* commonly to 35–46 cm fork length; exceptional individuals may reach 1.8 kg in weight.

Habitat: epipelagic or mesodemersal in depths to 200–250 m. Schooling, sometimes in enormous schools. *Food:* adults eat vast quantities of pelagic crustaceans, chiefly copepods and euphausiids, but also crab larvae, amphipods, arrow worms, and young clupeoid fishes. *Reproduction:* spawn in shallow water over the continental shelf in spring and early summer. Eggs and larvae planktonic.



Distribution: a north Atlantic species found throughout the area from Norway to the Azores and Morocco, the Mediterranean and Black Seas. Present in the western Baltic Sea. Common in Murmansk in warmer years and occasionally reaches the White Sea and Novaya Zemlya. Elsewhere, extends south to the Cape Verde Is. and Cabo Bojador (26° N) on the north-west coast of Africa.

SCOMBEROMORUS Lacepède, 1801 — Clofnam 158.1

Body elongate and compressed. Snout much shorter than rest of head; posterior part of maxilla exposed, not quite reaching to a vertical from hind margin of eye. Jaw teeth large, triangular and compressed. Gill-rakers 1–27 on first arch. 2 dorsal fins, the first with 12–22 spines; 6–11 dorsal and 5–12 anal finlets; pectoral fin short, 20–26 rays. Inter-pelvic process small and bifid. Median keel present between the 2 small keels on each side of caudal peduncle. No bony keel on caudal peduncle vertebrae. Swimbladder usually present. Intestine folded or straight. Liver trilobed, left and right lobes longer than middle lobe. No cutaneous artery. Vertebrae 41–56.

Epipelagic, usually in coastal waters. Schooling, some species migratory. Feeding chiefly on small schooling fishes such as clupeoids. Pelagic eggs and larvae.

Species 18; in Clofnam area 2.

Recent revision: Collette & Russo (1978); see also Collette (1983).

KEY TO SPECIES

1a Lateral line gradually curving down toward caudal peduncle, without a sharp dip under second dorsal fin; total gillrakers on first arch 12–15 . . . . *S. tritor* (p. 993)

1b Prominent dip in lateral line under the second dorsal fin; total gillrakers on first arch 3–8 . . . . *S. commerson* (p. 992)

Scomberomorus commerson (Lacepède, 1802) — Clofnam 158.1.3

Common synonym: *Cybium commersoni* (Lacepède, 1802).

Common name: Narrow-barred Spanish mackerel (En).

APPENDIX VIII

Special opinion of Russian delegation

Norwegian Spring-Spawning herring

Russian delegation agrees with WG conclusion about decrease in Norwegian Spring-Spawning herring spawning stock in 1999 but considers that this process is not so abrupt as it can be seen from results of WG. The method used by the WG this year for stock assessment includes a number of innovations. For example, catches from 1985 year class after 13 years old were partially redistributed over 1983 and 1984 year classes, which participate in fishery in last years to less extent. This innovation may additionally decrease the estimate of SSB in 1999. Another problem is the role of larvae indices used for tuning: it is well known that larva is, perhaps, the least precise estimator for spawning stock. Besides that the model is not separable, that is for terminal years the solution is based mostly on auxiliary information, which is, at least for larvae and tagging, very imprecise and controversial. According to this the WG estimate of spawning stock of 7.5 million tonnes in 1999 seems not to be sufficiently proved. Results for previous years, obtained by the WG this year, are also in striking contrast to estimates obtained earlier. Results of stock assessment based on separable analysis of catch-at-age data (SSB in 1999 is equal to 8.7 million tonnes) supports the assumption that the value of SSB in 1999 obtained by the WG may be underestimated.

Blue Whiting

Russian delegation would like to draw attention to systematic discrepancy between the results of the Blue Whiting stock assessment and survey results, which is most dramatic in recent years. Results of the assessment, presented by Russian delegation to the WG and based on careful analysis of catch-at-age data, are in more agreement with survey estimates and seem to be more realistic. According to this assessment the Blue Whiting spawning stock in 1999 is estimated as 4.8 million tonnes and F(1999) = 0.37 witch is rather close to Fpa . Unfortunately these results were not taken into account by the WG to sufficient degree.